This is the final Interim Action Work Plan which was finalized on September 23, 2010 after minor changes were made on pages 30-33 at the end of the public comment period.

BROWN AND CALDWELL

Technical Memorandum

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Prepared for: The City of Olympia

The LOTT Alliance

Project Title: East Bay Redevelopment

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Technical Memorandum

Subject: Parcel 4/Parcel 5 Interim Action Work Plan – Public Comment Draft

Date: June 23, 2010

To: Jay Burney, Assistant City Manager, City of Olympia

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Limitations:

This is a draft memorandum and is not intended to be a final representation of the work done or recommendations made by Brown and Caldwell. It should not be relied upon; consult the final report.

This document was prepared solely for The City of Olympia and the LOTT Alliance in accordance with professional standards at the time the services were performed and in accordance with the contract between The City of Olympia and Brown and Caldwell dated September 4, 2009, and the contract between the LOTT Alliance and Brown and Caldwell dated June 18, 2008. This document is governed by the specific scope of work authorized by the City of Olympia and the LOTT Alliance; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the City of Olympia and the LOTT Alliance and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Acronyms and Abbreviations

AO – Agreed Order

CA – Cleanup Action

City – The City of Olympia

CL – Cleanup Level

COPC – Constituent of Potential Concern

cPAHs – Carcinogenic Polynuclear Aromatic Hydrocarbons

CY – Cubic Yard

Ecology – The Washington State Department of Ecology

g - Gram

HOCM – Hands-On Children's Museum

IA – Interim Action

IACL – Interim Action Cleanup Level

IARL – Interim Action Remediation Level

IAWP – Interim Action Work Plan

Kg - Kilogram

LOTT – The LOTT Alliance

L - Liter

LS – Lump Sum

mg - Milligram

MTCA – The Model Toxics Control Act

NPDES – National Pollutant Discharge Elimination System

PCBs – Polychlorinated Biphenyls

pg - Picogram

PLP – Potentially Liable Person

ppt – Parts Per Trillion

Port – The Port of Olympia

PQL – Practical Quantitation Limit

RI – Remedial Investigation

RIWP – Remedial Investigation Work Plan

RL – Remediation Level

SF – Square Foot

TPH-D – Diesel-range total petroleum hydrocarbons

TPH-G – Gasoline-range total petroleum hydrocarbons

TPH-HO – Heavy oil-range total petroleum hydrocarbons

ug - Microgram

VCP – Voluntary Cleanup Program

VOC – Volatile Organic Compounds

WAC – Washington Administrative Code

1. INTRODUCTION

1.1 General Introduction

This memorandum presents the proposed Interim Action Work Plan (IAWP) for Parcel 4 and Parcel 5 of the East Bay Redevelopment. The IAWP proposes a remedy for cleanup of a portion of the Site, specifically Parcels 4 and 5, and develops the alternative selected into a program of specific activities to implement the alternative. The Interim Action (IA) will facilitate construction of the Hands-On Children's Museum (HOCM) on Parcel 5 by the City of Olympia (the City) and the Plaza on Parcel 4 by the LOTT Clean Water Alliance (LOTT). It is the intent of the City and LOTT to implement the IAWP for Parcels 4 and 5 as a single joint project.

The East Bay Redevelopment (the Site) is a 13.3 acre property located on the Port of Olympia (Port) peninsula in Olympia, WA. Parcels 4 and 5 are part of the Site. A map of the Site and the surrounding area is shown on Figure 1-1. The Port has short platted the property into eight parcels for public and commercial mixed use development. Remedial activities at the Site will be carried out under Agreed Order (AO) No. DE7830 between the Port, the City, LOTT, and the Washington State Department of Ecology (Ecology). The AO provides for completion of a Remedial Investigation/Feasibility Study (RI/FS) of the Site and the Parcel 4 and 5 IA. An RI work plan and an IA for site infrastructure were completed under a previous AO between the Port and Ecology.

1.2 Regulatory Basis

1.2.1 Interim Action Purpose

According to WAC 173-340-430(1), an IA is distinguished from a cleanup action in that an IA only partially addresses the cleanup of a site. An IA is:

- A remedial action that is technically necessary to reduce a threat to human health or the environment by eliminating or substantially reducing one or more pathways for exposure to a hazardous substance at a facility;
- A remedial action that corrects a problem that may become substantially worse or cost substantially more to address if the remedial action is delayed; or
- A remedial action needed to provide for completion of a site hazard assessment, remedial investigation/feasibility study or design of a cleanup action.

The IA proposed herein provides for the cleanup of a portion of the Site and reduces a threat to human health and the environment by addressing impacts to Parcel 4 and Parcel 5.

1.2.2 Interim Action General Requirements

General requirements of IAs are described in WAC 173-340-430(2). The IA proposed in this technical memorandum will provide cleanup of a portion of the Site by eliminating or substantially reducing one or more pathways for exposure to a hazardous substance at or originating from Parcel 4 and Parcel 5.

1.2.3 Relationship to the Cleanup Action

The relationship of an IA to the final Cleanup Action is described in WAC 173-340-430(3). If the final Cleanup Action for a site is known, the IA must be consistent with the final Cleanup Action. If it is not known the IA must not foreclose any reasonable cleanup alternatives.

The final Cleanup Action for the East Bay Redevelopment is not known. The IA described in this technical memorandum will not foreclose any reasonable alternatives for the final Cleanup Action.

1.3 Studies and Plans to Date

A number of studies and planning documents have been completed for the Site. These include:

- *Phase I ESA, Port of Olympia East Bay Redevelopment.* Prepared by GeoEngineers, Inc. for the Port of Olympia. March 14, 2007
- *RI/FS and Conceptual CAP* [now known as the RI/FS IA]*, Port of Olympia East Bay Redevelopment, City Hall lot.* Prepared by GeoEngineers, Inc. for The Rants Group. April 24, 2007.
- *Supplemental Site Use History and Soil and Groundwater Sampling Clarifications, Port of Olympia East Bay Redevelopment.* Prepared by GeoEngineers, Inc. for the Port of Olympia. August 3, 2007.
- *Voluntary Cleanup Program (VCP) Draft Remedial Investigation and Feasibility Study and Conceptual Cleanup Action Plan, East Bay Redevelopment, Port of Olympia.* Prepared by GeoEngineers Inc. for the Port of Olympia. December 20, 2007.
- *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia.* Prepared by GeoEngineers, Inc, and Pioneer Technologies Corporation for the Port of Olympia. October 22, 2008, amended January 30, 2009.
- *East Bay Remedial Investigation Phase 1 Summary.* Prepared by Pioneer Technologies Corporation for the Port of Olympia. December 2008.
- *Final Interim Action Work Plan, East Bay Redevelopment, Port of Olympia.* Prepared by Pioneer Technologies Corporation for the Port of Olympia. May 2009.
- *Draft Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the Port of Olympia's East Bay Redevelopment Site.* Prepared by

Pioneer Technologies Corporation for the Port of Olympia. February 2010. Ecology Comments issued by letter on April 16, 2010.

- *Infrastructure Interim Action Report for East Bay Redevelopment Site*. Prepared by Pioneer Technologies Corporation for the Port of Olympia. June 2010.

1.4 East Bay Properties History

The areas within the Parcel 4 and 5 boundaries lie within the original tideflat of Budd Inlet, and are situated on fill material. Fill operations on the Site began as early as the late 1800s and continued until as late as the 1970s. Much of the fill on the site appears to be marine dredge spoils from dredging operations in the East and West Bays of Budd Inlet. In addition, fill has been found to contain wood debris, construction debris, and roadway fill.

Lumber milling operations were located on the Site as early as 1888 and operated until 1968. Various support facilities and services accompanied the lumber milling operations. Log booming operations also took place in the adjacent East Bay of Budd Inlet. Following cessation of lumber milling activities in 1968, the area was used for commercial and light industrial activities and warehousing. Warehousing and light industry ceased in 2008 as the Site was cleared of tenants and operators in preparation for redevelopment.

1.4.1 Historical Fill Boundaries and Shoreline Progression

Historical shorelines, interpreted from aerial photography, correlate to the approximate fill boundaries across the site and are shown on Figure 1-2. Fill lithologies were classified in the *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia* (GeoEngineers/PIONEER, 2008, 2009) as follows, from oldest to youngest:

- Pre-1891: Dark-colored sand with pockets of wood debris and pockets of silt.
- 1891 to 1908: Dark brown to black coarse to fine sand. Based on historical records, this fill may have been sourced from a dredging operation to widen the Budd Inlet shipping channel.
- 1908 to 1948: Light colored sand with pockets of wood debris and pockets of gravel.
- 1948 to 1975: Light colored sand with pockets of gravel.

Underlying the fill layers are native silt and clay sediments.

A detailed historical review of fill horizons and the associated fill operation dates, as well as fill cross sections developed based on boring and drilling observations, is presented in ‘Section 2.0 Site History’ of the *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia* (GeoEngineers/PIONEER, 2008, 2009).

1.4.2 Historical Areas of Concern

The St. Paul and Tacoma Lumber Mill, in operation between 1942 and 1968, was the primary industrial operator on Parcels 4 and 5. Historical areas of concern associated with this mill include an oil house and engine room, tar dipping tanks, a boiler house, transformers, and a spray painting shop. These areas of concern are identified on Figure 1-3. Chemicals typically associated with these types of operations include petroleum hydrocarbons for the oil house; petroleum hydrocarbons and carcinogenic polynuclear aromatic hydrocarbons (cPAHs) for the tar dipping tanks; petroleum hydrocarbons, PAHs, and dioxins/furans for the boiler house; petroleum hydrocarbons and polychlorinated biphenyls (PCBs) for the transformers; and metals and volatile organic compounds (VOCs) for the spray paint shop.

2. SITE CONDITIONS

2.1 Current and Proposed Land Use

Current land use plans for Parcel 4 call for a public-use plaza. It is anticipated that the plaza will include a water feature running approximately east-west through the middle of the parcel. The water feature and associated equipment will be fully contained on the parcel in a concrete basin, and will be hydraulically separate from any natural ground- or storm-water on the parcel.

Current land use plans for Parcel 5 call for construction of the HOCM. The HOCM building will be situated in the southern portion of the parcel. The northern portion of the parcel will consist of a parking lot.

The landscaping on both Parcel 4 and Parcel 5 will consist of a mix of hardscaped areas (areas surfaced with an impervious material such as concrete or brick paving) and planted areas. A conceptual land use plan for Parcel 4 and Parcel 5 is shown in Figure 2-1. Approximate hardscaped and planted areas for each parcel are shown in Table 2-1. Excavation volumes are discussed below in Section 3.

2.2 Constituents of Potential Concern

The following are Constituents of Potential Concern (COPCs) for the Parcel 4 and 5 IA:

- Arsenic
- Cadmium
- Lead
- Copper
- Nickel
- Total carcinogenic polynuclear aromatic hydrocarbons (cPAHs)
- Total dioxins/furans
- Total naphthalenes
- TPH-D
- TPH-HO
- TPH-G
- Benzene

- Toluene
- Ethylbenzene
- Total xylenes

2.3 Conceptual Site Contaminant Transport Model

The Conceptual Site Contaminant Transport Model for the Site was developed in the *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia* (GeoEngineers/PIONEER, 2008, 2009) and shows potential historical sources of releases of COPCs, as well as potential routes of migration. The Conceptual Site Contaminant Transport Model is shown on Figure 2-2. Potential sources and migration paths are discussed below.

1. **Direct discharge to ground surface –** Spills, leaks, or operational discharges from former industries on-site may have resulted in contaminants on the historical working surface. This contamination may have been covered by fill or seeped further into the ground. Potential sources include tanks, hog fuel or refuse piles, or transformers.
2. **Contaminated fill –** Dredge spoils or other material used as fill may be a source of contaminants.
3. **Buried debris –** Debris from former industrial operations at the site may be buried at the site.
4. **Leaching to groundwater –** Some contaminants may have leached to groundwater, and may be transported as dissolved chemicals in groundwater. The potential for leaching to groundwater is discussed in Section 2.5.4 below.
5. **Air deposition –** Contaminant containing airborne particulates from on-site or off-site smokestacks or burn piles may be deposited on the historical working surface. The contaminated surface would be buried under subsequent layers of fill.
6. **Groundwater flow –** Constituents may be transported through the movement of groundwater.
7. **Vertical groundwater gradients –** Artesian pressure in the area of the site may result in upward gradients in the shallow groundwater unit.
8. **Historical artesian flow/leakage –** Artesian wells may have been historically located on the site.

2.4 Conceptual Site Exposure Model

A conceptual site exposure model (CSEM) was developed in 'Section 6: Conceptual Site Exposure Model' in the *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia*

(GeoEngineers/PIONEER, 2008, 2009), and revised based on an Ecology comment in the *Final Interim Action Work Plan, East Bay Redevelopment, Port of Olympia* (PIONEER, 2009) prepared by Pioneer Technologies Corporation on behalf of the Port for the infrastructure IA. The CSEM is presented on Figure C-1 of the *Final Interim Action Work Plan, East Bay Redevelopment, Port of Olympia* (PIONEER, 2009) report, and is included as Appendix A to this work plan.

Complete or potentially complete exposure pathways addressed in the CSEM may be broadly divided into human exposure pathways and ecological exposure pathways. These are summarized below.

2.4.1 Human Health Pathways

Complete or potentially complete human exposure pathways identified in the *Final Interim Action Work Plan, East Bay Redevelopment, Port of Olympia* (PIONEER, 2009) include the following:

- Ingestion of soil. Groups subject to exposure include trespassers (current land use); utility installation workers, trespassers during utility installation, building construction workers, and trespassers during building construction (construction phase); and urban residents, commercial workers, utility workers, and recreators or subsistence fishers (future land use).

- Dermal contact with soil. Groups subject to exposure include trespassers (current land use); utility installation workers, trespassers during utility installation, building construction workers, and trespassers during building construction (construction phase); and urban residents, commercial workers, utility workers, and recreators or subsistence fishers (future land use).

- Inhalation of soil particulates. Groups subject to exposure include utility installation workers, trespassers during utility installation, building construction workers, and trespassers during building construction (construction phase); and urban residents, commercial workers, utility workers, and recreators or subsistence fishers (future land use).

- Inhalation of vapors from soil or groundwater. Groups subject to exposure include trespassers (current land use); utility installation workers, trespassers during utility installation, building construction workers, and trespassers during building construction (construction phase); and urban residents, commercial workers, utility workers, and recreators or subsistence fishers (future land use).

- Ingestion of groundwater. Groups subject to exposure include urban residents, commercial workers, utility workers, and recreators or subsistence fishers (future land use).

- Dermal contact with groundwater. Groups subject to exposure include trespassers (current land use); utility installation workers and trespassers during utility installation (construction phase); and urban residents, commercial workers, utility workers, and recreators or subsistence fishers (future land use).
- Ingestion of surface water impacted by groundwater from on site. Recreators and subsistence fishers are subject to exposure (current land use, construction phase, and future land use).
- Dermal contact with surface water impacted by groundwater from on site. Recreators and subsistence fishers are subject to exposure (current land use, construction phase, and future land use).
- Consumption of seafood from the East Bay of Budd Inlet, where surface water may be impacted by groundwater from on site. Recreators and subsistence fishers are subject to exposure (current land use, construction phase, and future land use).

2.4.2 Ecological Pathways

Complete or potentially complete ecological pathways identified in the *Final Interim Action Work Plan, East Bay Redevelopment, Port of Olympia* (PIONEER, 2009) include:

- Ingestion of soil by terrestrial organisms.
- Dermal contact with soil by terrestrial organisms.
- Inhalation of soil particulates by terrestrial organisms.
- Inhalation of vapors from soil or groundwater by terrestrial organisms.
- Ingestion of groundwater from wells by terrestrial organisms.
- Dermal contact with groundwater from wells by terrestrial organisms.
- Ingestion of surface water impacted by groundwater from on site. Aquatic organisms are subject to exposure.
- Dermal contact with surface water impacted by groundwater from on site. Aquatic organisms are subject to exposure.
- Consumption of seafood from the East Bay of Budd Inlet, where surface water may be impacted by groundwater from on site. Aquatic organisms are subject to exposure.

The terrestrial ecological evaluation for the IA is deferred; a site-wide terrestrial ecological evaluation that includes Parcel 4 and Parcel 5 may eventually be required. It is recognized that additional controls or activities may be required if final cleanup levels are based on terrestrial ecological pathways.

2.5 Site Subsurface Conditions

A series of studies have evaluated subsurface conditions at the Site, including conditions at Parcel 4 and Parcel 5. These include the *Voluntary Cleanup Program (VCP) Draft Remedial Investigation and Feasibility Study and Conceptual Cleanup Action Plan, East Bay Redevelopment, Port of Olympia* (GeoEngineers, 2007), the *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia* (GeoEngineers/PIONEER, 2008, 2009), the *East Bay Remedial Investigation Phase 1 Summary* (PIONEER, 2008), and the *Draft Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the Port of Olympia's East Bay Redevelopment Site* (PIONEER, 2010). This subsection summarizes results completed in these reports.

Additionally, the Port has completed the second phase of the RI. Soil sampling activities were completed by PIONEER Technologies (Bussey, 2009); data from the second phase of the RI is included as Appendix B. The City and LOTT have also collected and analyzed a series of supplemental soil samples from Parcels 4 and 5. Soil sample results from Parcels 4 and 5 are summarized in Tables 2-3 through 2-15.

Results of subsurface investigations are summarized in this section.

2.5.1 Hydrogeologic Conditions

Hydrogeology - Subsurface hydrogeologic conditions at the site are the result of decades of fill operations that elevated the ground surface and extended usable land seaward into Budd Inlet. The thick heterogeneous sequence of fill deposits beneath the Site extends from ground surface to elevations as deep as -10 feet. A detailed historical review of fill horizons and the associated fill operation dates, as well as fill cross sections developed based on boring and drilling observations, is presented in 'Section 2.0 Site History' of the *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia* (GeoEngineers/PIONEER, 2008, 2009). Fill cross sections from this report are included as Appendix C.

A network of groundwater monitoring wells was installed on the Site (including on Parcels 4 and 5) and on the adjacent Parcel 8 for the study of groundwater conditions. On Parcels 4 and 5 and the adjacent parcels, MW-01, MW-02, MW-03, MW-04, MW-16, MW-17 (Parcel 8), MW-18 (in the adjacent infrastructure corridor), and MW-19 (Parcel 7) were installed in 2007. MW-02R, MW-23S, and MW-21S (Parcel 7) were installed in 2009.

MW-02, situated in East Bay Redevelopment infrastructure corridor, was damaged during the infrastructure project and subsequently decommissioned. MW-02R was installed on Parcel 8, approximately 70 ft W-NW of the original MW-02 location, as a replacement for this well.

MW-17 was last sampled in 2007, and its status is currently unknown. A visual inspection of the area in 2009 showed a water-filled depression in the area of the well. A number of construction activities have occurred on Parcel 8 since 2007, including the deconstruction of the warehouse annex previously situated on the property and the use of the property as a staging are for the construction of the LOTT Administrative and Education Center on the adjacent Budd Inlet Treatment Plant property. MW-17 may have been damaged or buried during these activities. The vicinity of MW-17 was surveyed with a metal detector, but the well monument was not located. Interim Action work will include locating and decommissioning MW-17 as described in Section 4.2. Monitoring well locations are shown on Figure 2-3.

The occurrence and flow of groundwater beneath the site is predicated upon the various fill horizons and respective hydraulic properties. Localized groundwater gradients occur across the site where zones of more permeable fill are bounded by less permeable materials. Additionally, water levels fluctuate throughout the course of the year as a result of seasonal fluctuations in atmospheric conditions. Groundwater levels are shown in Table 2-2. Groundwater levels at the site were variable; the difference between the minimum and maximum elevations in a single well was as high as 5.9 feet. The average difference between the minimum and maximum elevations was 2.17 feet. While groundwater flow generally appears to be from the southwest to northeast across Parcels 4 and 5, there may be an artesian influence on the site with upward gradients from deeper confined groundwater units.

Tidal Influence - Tidal influence studies of the Site were performed by GeoEngineers in 2007 and by Greylock Consulting, LLC in 2008. The 2007 study used downhole pressure transducers to record static head in four monitoring wells (MW-05, MW-06, MW-07, and MW-09) located on Parcel 3. Static head was recorded at 5-minute intervals over a 72-hour period from 1/30/2007 to 2/2/2007. According to the NOAA Tides and Currents historical dataset, the highest tide over this period was +15.9’ at 11:59 AM on 2/1/2007, while the lowest tide was at -1.6’, at both 9:58 PM on 1/30/2207 and 10:43 PM on 1/31/2007. Barometric pressure varied by approximately 0.2 in Hg over the course of the 72-hour study. Groundwater levels in wells varied by 0.1 feet to 0.2 feet over the course of the study. In general, groundwater levels were correlated with the barometric pressure but were uncorrelated with the tidal elevation. The study concluded that groundwater monitoring well elevations in the Parcel 3 area was not strongly influenced by tidal fluctuations (GeoEngineers, 2007b).

The 2008 Greylock study measured water level at twenty wells throughout the site, with one measurement set taken near low tide and the second taken near high tide on 7/16/2008. The first set of measurements was recorded within 1 hour, 20 minutes of the 11:25 AM low tide of -1.4’. The second set of measurements was recorded within 1 hour of the 7:21 PM high tide of 14.4’. The study found fluctuations of greater than one foot in two wells, MW-12 and MW-18 (MW-03 fluctuated by 0.99 feet). Both of these wells are screened in coarse fill and are within 110 feet of the shoreline, and the Greylock study concluded that tidal influence was limited to areas near the shoreline (GeoEngineers/PIONEER, 2008, 2009).

Observations by Pioneer Technologies Corporation during groundwater monitoring events at the Site have indicated high salinity in MW-04, MW-12, MW-16, and MW-18, wells that are located near the Budd Inlet shoreline. Salinity measurements and anecdotal observations in construction trenches also suggest tidal influence in the area near the shoreline (PIONEER, 2010a).

2.5.2 Soil COPC Concentrations

Soil sampling locations and Historical AOCs are shown on Figures 2-4 through 2-16. Measured COPC concentrations in soil are summarized in Tables 2-3 through 2-15. Copper and nickel were added to the COPC list after the most recent groundwater sampling event.

The MTCA Method A cleanup levels for unrestricted land use were taken as soil screening levels. The Interim Action Cleanup Level for dioxins/furans developed for the Infrastructure IA (PIONEER, 2009) was taken as the dioxin/furan soil screening level. Soil concentrations for a number of COPCs were either below laboratory reporting limits or soil screening levels for all samples on Parcels 4 and 5. These COPCs include:

- Cadmium
- TPH-D
- TPH-G
- Benzene
- Toluene
- Ethylbenzene
- Total Xylenes
- Total Naphthalenes

Laboratory reporting limits exceeded the screening levels for the following samples and COPCs:

- Cadmium: DP-17, 4-6 ft (RL = 2.4 mg/Kg)
- Benzene: DP-11, 8-10 ft (RL = 67 ug/Kg); DP-17, 4-6 ft (RL = 140 ug/Kg); DP-17, 10-12’ (RL = 100 ug/Kg); DP-18, 10-12 ft (RL = 75 ug/Kg); DP-20, 10-12 ft (RL = 46 ug/Kg); DP-21, 10-12 ft (RL = 110 ug/Kg); MW-16, 14-16 ft (RL = 41 ug/Kg); MW-23s, 5-6 ft (RL = 50 ug/Kg); MW-23s, 9-11 ft (RL = 50 ug/Kg)

- Total xylenes: DP-17, 4-6 ft (RL = 1440 ug/Kg); DP-17, 10-12 ft (RL = 1020 ug/Kg); DP-21, 10-12 ft (RL = 1060 ug/Kg)

COPCs that exceeded laboratory reporting limits and screening levels included arsenic, lead, TPH-HO, cPAH toxicity equivalent (TEQ), and dioxin/furan TEQ. These results are discussed below. Samples with laboratory reporting limits exceeding screening levels are also noted.

Arsenic – Arsenic exceeded screening levels and reporting limits in the following samples: DP-17, 10-12 ft (84 mg/Kg); DP-21, 6-8 ft (72 mg/Kg).

Lead – Lead exceeded screening levels and reporting limits in the following sample: DP-11, 8-10 ft (2500 mg/Kg).

TPH-HO – TPH-HO exceeded screening levels and reporting limits in the following sample: DP-18, 10-12 feet (4,600 mg/Kg).

cPAH TEQ – cPAH equivalent concentration exceeded screening levels and reporting limits in the following samples: DP-11, 0-2 feet (1000 ug/Kg); DP-11, 8-10 ft (170 ug/Kg); DP-18, 10-12 ft (160 ug/Kg); DP-29, 1-2 ft (390 ug/Kg); DP-29, 7-8 ft (200 ug/Kg); DP-29, 13-14 ft (200 ug/Kg); DP-44, 9-10 ft (190 ug/Kg); MW-04, 2-4 ft (110 ug/Kg); MW-23s, 5-6 ft, (180 ug/Kg); MW-23s, 9-11 ft (620 ug/Kg). Additionally, the reporting limits for the following samples exceeded the screening level for cPAHs: DP-17, 4-6 ft (RL = 110 ug/Kg).

Dioxin/Furan TEQ – Dioxin/Furan equivalent concentration exceeded screening levels and reporting limits in the following samples: DP-26, 1-2 ft (45 ppt); DP-42, 1-2 ft (31 ppt); DP-42, 7-8 ft (160 ppt); TP-01, 2-3 ft (430 ppt); TP-02, 2-3 ft (650 ppt).

2.5.3 Groundwater COPC Concentrations

Groundwater monitoring locations are shown on Figure 2-3. COPC concentrations in groundwater are summarized in Tables 2-16 through 2-30.

The surface water ARARs established in the *Draft Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the Port of Olympia's East Bay Redevelopment Site* (PIONEER, 2010a) were applied for groundwater screening. Groundwater concentrations were below laboratory reporting limits or screening levels in all samples from MW-02, MW-02R, MW-03, MW-04, MW-16, MW-17, MW-18, MW-19, MW-21S, and MW-23S for the following COPCs:

- Nickel
- Cadmium
- TPH-G

- Benzene
- Toluene
- Ethylbenzene
- Total Xylenes
- Total Naphthalenes
- Dioxins/Furans

Groundwater concentrations exceeded laboratory reporting limits and screening levels for the following COPCs:

- Arsenic
- Lead
- Copper
- cPAHs
- TPH-D
- TPH-HO

These detections are discussed below. The laboratory reporting limits did not exceed screening levels for any of these COPCs.

Arsenic – Total arsenic concentrations exceeding the reporting limits and screening levels include the following:

- January 2007: MW-04 (16 ug/L)
- June – August 2007: MW-04 (13 ug/L), MW-17 (140 ug/L)
- June 2009: MW-03 (7.3 ug/L), MW04 (9.5 ug/L)
- September 2009: MW-02R (9.8 ug/L), MW-04 (8.0 ug/L)
- November 2009: MW-02R (8.0 ug/L), MW-04 (7.3 ug/L)
- December 2009: MW-02R (7.5 ug/L), MW-04 (5.3 ug/L)
- March 2010: MW-02R (10.3 ug/L), MW-04 (5.2 ug/L)

Dissolved arsenic concentrations exceeding the reporting limits and screening levels include the following:

- June 2009: MW-02 (5.4 ug/L), MW-03 (10 ug/L), MW-04 (8.7 ug/L), MW-18 (6.2 ug/L), MW-21S (5.1 ug/L)
- September 2009: MW-02R (13 ug/L), MW-03 (9.7 ug/L), MW-04 (9.9 ug/L), MW-21S (5.9 ug/L)

Arsenic was detected in the method blanks for the June 2009 analysis batch and the September 2009 analysis batch, and all dissolved arsenic concentrations reported by the laboratory for these events are estimated. Additionally, there may be data quality issues for these data points, since the reported dissolved arsenic concentrations actually exceed the reported total arsenic concentrations. The November and December 2009 and March 2010 analyses were conducted by a different laboratory than the June and September 2009 analyses, and the reported dissolved arsenic concentrations for MW-03 and MW-04 do not exceed the screening level for the November 2009 and December 2009 events.

Lead – Total arsenic concentrations exceeding the reporting limits and screening levels include the following:

- September 2009: MW-02R (45 ug/L)
- November 2009: MW-02R (9.3 ug/L)

The dissolved lead concentration did not exceed the reporting limit and screening levels in any sample.

Copper – Total copper concentrations exceeding the reporting limits and screening levels include the following:

- June 2009: MW-03 (4.6 ug/L), MW04 (8.4 ug/L), MW-16 (5.4 ug/L), MW-18 (3.6 ug/L), MW-23S (2.9 ug/L)
- September 2009: MW-01 (2.5 ug/L), MW-02R (3.4 ug/L), MW-16 (2.6 ug/L)
- December 2009: MW-18 (4.5 ug/L)
- March 2010: MW-04 (2.6 ug/L), MW-16 (4.7 ug/L), MW-18 (3.7 ug/L)

Copper was detected in the method blanks for the June 2009 analysis batch and the September 2009 analysis batch, and all total copper concentrations reported by the laboratory for these events are estimated.

Dissolved copper concentrations exceeding the reporting limits and screening levels include the following:

- June 2009: MW-02 (2.7 ug/L)

Copper was detected in the method blank for the June 2009 analysis batch, and all dissolved copper concentrations reported by the laboratory for this event are estimated. Additionally, the reported dissolved copper concentration for MW-02 in June 2009 exceeds the reported total copper concentration for the same sample.

cPAHs – cPAH TEQ concentrations exceeding the reporting limits and screening levels include the following:

- January 2007: MW-02 (0.033 ug/L)
- June 2009: MW-01 (0.38 ug/L), MW-03 (0.20 ug/L), MW-04 (0.20 ug/L), MW-16 (0.38 ug/L), MW-18 (0.19 ug/L), MW-21s (0.19 ug/L), MW-23S (0.027 ug/L)

As discussed in the *Draft Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the Port of Olympia's East Bay Redevelopment Site* (PIONEER, 2010a), the reported concentrations are suspect for a number of reasons:

- The physiochemical transport properties of cPAHs do not typically result in significant leaching from soil to groundwater. Specifically, cPAHs are hydrophobic, have a low solubility in water, and are readily adsorbed by organic carbon.
- The reported groundwater cPAH concentrations were similar Site-wide and did not correlate with areas of higher cPAH soil concentrations.
- Widespread cPAH groundwater detections were not reported in January 2007 and June-August 2007 sampling events, where sample analysis was performed by a different laboratory. In the September 2009, November 2009, and December 2009 sampling events, cPAH detections reported by the primary laboratory were not reported for split samples sent to a secondary laboratory.
- The only two cPAH groundwater constituents reported in the June 2009 event were benzo(a)anthracene and dibenzo(a,h)anthracene. Soil cPAH detections for the Site have typically included all seven cPAH constituents.
- The instrument response for cPAH detections was at or near the practical quantitation limit; the laboratory required a 100-times concentration factor to observe instrument response. The dilution protocol the laboratory used to achieve the 100-fold concentration factor is unknown.

TPH-D and TPH-HO – TPH-D concentrations exceeding the reporting limits and screening levels include the following:

- December 2009: MW-18 (1060 ug/L)

TPH-HO concentrations exceeding the reporting limits and screening levels include the following:

- December 2009: MW-02R (620 ug/L), MW-03 (960 ug/L), MW-18 (690 ug/L)

TPH-D and TPH-HO had not been detected on site at concentrations exceeding reporting and screening levels prior to or following the December 2009 groundwater monitoring event. The most plausible explanation for the detection of TPH-D and TPH-HO in the December 2009 groundwater monitoring is the direct discharge of TPH-D and TPH-HO as a result of construction activities at the site.

2.5.4 Potential Transport of COPCs from Soil to Surface Water

Empirical data and evidence presented in the *Draft Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the Port of Olympia's East Bay Redevelopment Site* (PIONEER, 2010a), suggests that an empirical demonstration in accordance with WAC 173-340-747(9) is complete for cadmium, cPAHs, dioxins/furans, and total naphthalenes.

2.6 Discussion

The arsenic, lead, and TPH-HO screening level exceedances are in the general vicinity of Historical AOCs. There are relatively few exceedances of the screening levels relative to the total number of samples for these COPCs, and the exceedances identified appear to be isolated occurrences. The sample depths for screening level exceedances for these COPCs range from 6 to 12 feet below ground surface. There is not a readily apparent source for these exceedances based on depth and location; potential sources include historical operations and fill sources from on- or off-site.

The dioxin/furan screening level exceedances may be associated with Historical AOCs. There is also a spatial correlation with the historical shorelines shown in Figure 1-2. Also, the sample depths with screening level exceedances are relatively shallow, with the exception of the 7-8 foot sample at DP-42. However, as described in PIONEER 2010b, three of nine stockpile samples from areas that included Parcels 4 and 5 also exceeded screening levels. These stockpiles were excavated from depths up to 9 feet below grade and had a maximum measured dioxin/furan concentration of 40 ppt. Potential sources include historical operations on Parcel 4 and 5, aerial deposition, and fill sources from on- or off-site.

Screening level exceedances for cPAHs are widespread and are not necessarily spatially associated with Historical AOCs. Samples exceeding screening levels have been taken from a depths ranging from the 0-2 foot interval to the 13-14 foot interval and are not associated with a particular fill unit. The concentrations are also wide ranging, from 110 ug/Kg (slightly in excess of the 100 ug/Kg screening level) to 1000 ug/Kg. There is not a readily apparent pattern in the distribution of sample concentrations. Potential sources of cPAHs, in addition to historical operations on Parcels 4 and 5, include aerial deposition from historical operations on- or off-Site and contaminated fill.

The maximum arsenic concentration was 140 ug/L, taken from MW-17 during the June 2007 – August 2007 event. This was the only arsenic sample from this well. With the exception of this sample, exceedances of the arsenic groundwater concentrations were within approximately 3 times the screening level. Exceedances were primarily in MW-02R and MW-04, with one exceedance in MW-03 and MW-17. As noted above, dissolved concentrations exceeded total concentrations in some samples, which may be indicative of a laboratory quality control issue.

Lead exceeded the groundwater screening level in the September 2009 and December 2009 samples from MW-02R. The maximum concentration in this well was 45 ug/L, in the September 2009 sample. This was the first sample taken after the well was installed. Concentrations have generally decreased since this sample was taken.

The maximum copper concentration was 8.4 ug/L, measured in the June 2009 sample from MW-04. Copper concentrations were within 4 times the screening level. As described above, there may be laboratory data quality issues with the June 2009 and September 2009 results.

Concentrations of cPAHs exceeded screening levels only in the June 2009 samples. As discussed above and in the *Draft Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the Port of Olympia's East Bay Redevelopment Site* (PIONEER, 2010a), these exceedances appear to be suspect for a number of reasons. .

TPH-D exceeded screening levels in MW-18 in the December 2009 event, and TPH-HO exceeded screening levels in MW-02R, MW-03, and MW-18. There were no screening level exceedances for these COPCs prior to December 2009, nor were the screening levels exceeded in the March 2010 event. The most plausible explanation for these exceedances is the direct discharge to groundwater from heavy equipment on site for the East Bay infrastructure project.

The LOTT Expansion Site is situated upgradient of Parcels 4 and 5. Monitoring wells MW-02R and MW-17 are located on Parcel 8. As described in the previous section, arsenic, lead, copper, and TPH-D have been detected in these wells. TPH-D/TPH-HO have also been detected in discrete groundwater grab samples (Brown and Caldwell, 2007) during a site investigation of Parcel 8. The same site investigation also identified TPH-HO, lead, and arsenic impacts to soil on Parcel 8. The LOTT Alliance is currently conducting an investigation of the LOTT Expansion Site. A work plan for the investigation (Brown and Caldwell, 2008) was submitted to Ecology; an opinion letter issued by Ecology on July 25, 2008 stated that the work plan met the substantive requirements of MTCA.

It is not currently believed that impacts at the LOTT Expansion Site and the East Bay Redevelopment are comingled. It is anticipated that following the site investigation environmental impacts at the LOTT Expansion Site will be addressed through Ecology's VCP.

3. INTERIM ACTION ALTERNATIVES AND ALTERNATIVES EVALUATION

IA alternatives were screened to identify potential means to control the complete or potentially complete exposure pathways identified in Section 2.4 above. These alternatives were screened using the procedure described for final Cleanup Actions in WAC 173-340-360. Threshold criteria for Cleanup Actions (WAC 173-340-360(2)(a)) are as follows: the selected action protect human health and the environment, must comply with cleanup standards, must comply with applicable state and federal laws, must provide for compliance monitoring.

Alternatives meeting these threshold criteria were further evaluated based on the additional minimum criteria for cleanup actions (WAC 173-340-360(2)(b)): the use of permanent solutions to the maximum extent practicable, provision of a reasonable restoration timeframe, and consideration of public concerns.

‘Permanent’ solutions are those that do not require future action to meet cleanup standards. By ‘maximum extent practicable’, it is meant that the incremental benefits of a particular alternative are not outweighed by the incremental costs. To determine this, a cost/benefit analysis or business case evaluation of each alternative is conducted; guidelines for conducting a disproportionate cost analysis of a given alternative are listed in WAC 173-340-360(3)(e). The guidelines for disproportionate cost analysis include several sub-criteria that should be considered. These include protectiveness, permanence, cost, effectiveness over the long term, management of short term risks, technical and administrative implementability, and consideration of public concerns. These criteria are discussed below in Section 3.5. Under MTCA 173-340-360(3)(e), the ‘most practicable permanent solution’ is the baseline against which other alternatives are compared. Other alternatives are evaluated based on incremental cost vs. benefit relative to this baseline.

In addition to these requirements, IAs must be consistent with the final Cleanup Action, if known. If the final Cleanup Action is not known, the IA must not foreclose reasonable alternatives for the final Cleanup Action (WAC 173-340-430(3)).

3.1 Basis for Alternatives

The following approach was taken to develop a basis for remediation alternatives:

- To identify alternatives protective of human health and the environment, complete and potentially complete exposure pathways were reviewed to determine those that would be applicable to the construction phase activities and future land uses specific to Parcels 4 and 5. For each complete or potentially complete pathway, practices and technologies for eliminating the pathway or controlling the source of contamination were identified (Section 3.1.1).

- Other design criteria for remedial alternatives in addition protectiveness of human health and the environment were reviewed (Section 3.1.2).
- Potential practices and technologies were screened based on implementability, effectiveness, timeframe, and cost (Section 3.1.3).

Exposure pathways under the current land use were not considered, since the land use will change once implementation of the IA and construction of the proposed development begins.

3.1.1 Exposure Pathways

The first design objective of the IA is to be protective of human health and the environment. Protectiveness is achieved by eliminating the complete or potentially complete exposure pathways described in Section 2.4. To develop IA alternatives, complete and potentially complete pathways were identified. Effectiveness of potential practices and technologies was evaluated based on the ability of the technology to eliminate complete or potentially complete pathways (as described in Section 3.1.3).

Ingestion or dermal contact (“direct contact”) with soil – The technologies and practices for controlling ingestion and dermal contact are largely the same, so these pathways are combined into a single “direct contact” pathway.

For construction receptors, the direct contact pathway will be controlled using engineering controls and appropriate site control measures. In addition, institutional controls shall be incorporated as a means of controlling direct contact for future land use receptors.

Inhalation of particulates – For construction phase receptors, inhalation will be controlled using the appropriate engineering controls and site control measures. For future land use receptors, the technologies and practices described above will be used to control direct contact.

In addition to capping and excavation and disposal, institutional controls shall be incorporated as a means of controlling direct contact for future land use receptors.

Inhalation of vapors – The CSEM shows inhalation of vapors as a potentially complete pathway. No volatile constituents (TPH-G, VOCs, or total naphthalenes) have been detected in soil or groundwater on Parcels 4 or 5 at concentrations exceeding screening levels.

Ecology’s *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology, 2009) recommends that the vapor intrusion pathway be considered if the lateral distance from the edge subsurface contamination is less than 100’ from a building. In addition to the 100’ radius recommendation, the guidance document requires the pathway assessment to consider developable areas on a property as well as buildings. The only additional developable land on Parcels 4 and 5 is the area immediately to the east of the planned HOCM building. Figure 3-1 shows a 100' buffer from the planned building and developable areas, and shows soil samples within these areas. Expansion of the building into this area does not bring the 100' buffer into contact with any known areas of volatile contamination. The vapor intrusion pathway is therefore considered incomplete.

The guidance document also cites special cases where the 100' radius may not be sufficiently protective:

1. When a continuous low permeability surface covers the ground between the contaminated area and the building;
2. When vadose zone geology has a very high gas permeability;
3. When utility lines may present a preferential pathway for soil gas transport; and
4. When soil gas is under pressure.

Of these, 1, 2, and 4 are not applicable based on development plans for the properties and the understanding of Site hydrogeology. Portions of Parcels 4 and 5 will be covered with low permeability surfaces, but these surfaces will not be continuous. Planned utilities for the HOCM and plaza will exit the 100' buffer either east to Marine View Drive or west to Jefferson Street. No volatile contamination has been identified in these utility corridors. Based on this assessment, the 100' radius guideline is sufficiently protective for the properties.

Ingestion of groundwater – The CSEM shows ingestion of groundwater from wells as a potentially complete pathway. However, given the shallow depth to groundwater and proximity to saltwater, a suitable drinking water well could not be installed on Parcel 4 or 5 or downgradient in shallow groundwater unit per WAC 173-340-720(2)(b)(i), WAC 173-160, and WAC 246-290. Further, all known artesian wells on the site have been decommissioned. Institutional controls barring the future construction of drinking water wells may be implemented. The ingestion of groundwater pathway is therefore considered incomplete for the IA for all future receptors.

Dermal contact with groundwater – The CSEM shows dermal contact with groundwater as a potentially complete pathway. As discussed for the ingestion of groundwater pathway analysis, there will be no onsite or downgradient wells for the future land use, all known artesian wells on the site have been decommissioned, and institutional controls barring the future construction of drinking water wells may be implemented. Dermal contact with groundwater from wells is therefore an incomplete pathway for all future receptors for the IA. For construction phase receptors, dermal contact with groundwater will be controlled with construction dewatering equipment (required because of the high groundwater table on the parcels) and through engineering controls and construction phase site control measures.

Soil to surface water via groundwater – human health – This pathway includes ingestion of surface water impacted by groundwater from on site, dermal contact with surface water impacted by groundwater from on site, and ingestion of seafood impacted by groundwater from on site. The technologies and practices for controlling the effect of groundwater from Parcels 4 and 5 on surface water are the same for all three of these pathways. Additionally, the consumption of seafood pathway can conservatively estimate the risk for all three pathways. Therefore, ingestion of surface water impacted by groundwater from on site, dermal contact with surface water from on site, and ingestion of seafood are grouped into a single pathway, termed the "surface water via groundwater" pathway. The surface water via groundwater pathway for human receptors will be assessed jointly with the pathway for aquatic organism receptors, described below.

For construction phase receptors, control of this exposure pathway will be implemented through construction dewatering and through appropriate Engineering Controls and site control measures. Dewatering and Engineering Controls for the selected IA alternative are discussed in Section 4.8.

The soil to surface water pathway is considered potentially complete for these COPCs:

- Arsenic
- Lead
- Copper
- Nickel
- TPH-D
- TPH-HO

In addition, institutional controls shall be incorporated as a means of controlling the surface water via groundwater for future land use receptors.

Terrestrial ecological pathways – The Terrestrial Ecological Evaluation (TEE) for Parcels 4 and 5 has been deferred; if a sitewide TEE is required, pathways with terrestrial organism receptors will be assessed at that time.

Although the exact nature of terrestrial ecological exposure pathways, if any, are not known at this time, the technologies and practices for addressing human receptor pathways will also completely or partially control exposure for terrestrial organisms. Cleanup levels or remediation level for ecological receptors may differ from those for human receptors, and cannot be developed without the TEE. However, remedial alternatives that address the human direct contact pathway or soil to surface water via pathway by reducing the volume, mobility, or toxicity of contamination will at least in part accomplish the same goal for ecological receptors.

Containment will also be partially effective as a remedial measure for ecological receptors. Containment will prevent direct contact for terrestrial organisms, although it may not address exposure for soil biota.

Soil to surface water via groundwater – aquatic organisms– This pathway includes ingestion of surface water impacted by groundwater from on site, dermal contact with surface water impacted by groundwater from on site, and ingestion of seafood impacted by groundwater from on site. As described above for human receptors, these pathways are grouped into a single pathway, termed surface water via groundwater. Technologies and practices for controlling this pathway are described above.

3.1.2 Technology Screening

Potential technologies identified in Section 3.1.1 were screened according to four criteria:

- Effectiveness of the technology against the specific COPCs known to be present on Parcels 4 and 5.
- Implementability – The practical feasibility of applying a particular technology to Parcels 4 and 5.
- Timeframe to implement and complete the interim action.
- Cost per cubic yard of contaminated material treated.

Remedial technologies included in-situ biological treatment, in-situ physical/chemical treatment, in-situ thermal treatment, ex-situ biological treatment, ex-situ physical/chemical treatment, ex-situ thermal treatment, containment, and excavation and disposal. The specific rationale for each technology is summarized in Table 3-1. Generalized comments for each group of technologies are as follows:

- In-situ biological treatment: No in-situ biological methods were considered for further evaluation. The development timeframe for Parcels 4 and 5 calls for development within the next 6 months to 1 year; in-situ biological methods may take 1-3 years or longer to implement. Additionally, in-situ biological methods are not typically effective for metal COPCs.
- In-situ physical/chemical treatment: One in-situ physical/chemical method, soil solidification/stabilization, was selected for further evaluation. This method can be implemented in less than one year, can be designed to be effective for both cPAHs and metals, and is cost competitive with other methods selected for further evaluation. Other in-situ physical/chemical methods were screened from further analysis for reasons that included restoration time frame, cost, or effectiveness against target COPCs.

- In-situ thermal treatment – In-situ thermal treatment was not selected for further evaluation. This technology is not effective for all COPCs. Also, it is primarily used to mobilize COPCs, so a separate capture and treatment system would likely be required.

- Ex-situ biological treatment – No ex-situ biological methods were selected for further evaluation. These methods are not typically effective for metal COPCs. Additionally, they are space intensive, and may take longer than 1-year to implement.

- Ex-situ physical/chemical treatment – No ex-situ chemical/physical methods were selected for further evaluation. These methods often result in a secondary waste stream that must be managed. These methods may also require mobilization of temporary equipment to the site that is not appropriate for use in a residential/commercial area.

- Ex-situ thermal treatment – No ex-situ thermal treatment methods were selected for further evaluation. These methods are more costly on a unit basis than most of the other methods considered, and are not effective for metal COPCs. Additionally, they result in secondary waste streams that must be managed, and require the mobilization of temporary equipment (incinerators, concrete batch plants, asphalt plants) that are not appropriate for use in a residential/commercial area.

- Containment – Containment was selected for further evaluation. Containment may be implemented quickly and cost effectively, and is suitable for all COPCs at the site. Because containment reduces only the mobility of COPCs and not the toxicity or volume of impacted material, institutional controls must be implemented along with containment.

- Excavation and disposal – Excavation and disposal was selected for further evaluation. Excavation and disposal may be implemented quickly and cost-effectively and addresses all COPCs on the site.

3.1.3 Basis for Alternatives Summary

In summary, IA alternatives will address the direct contact pathway through capping, excavation and disposal, and/or solidification/stabilization. The soil to surface water pathway for arsenic, lead, copper, nickel, TPH-D, and TPH-HO is considered potentially complete. Alternatives will consider reduction of the volume of the toxic material through excavation and disposal and the reduction of mobility through solidification/stabilization. In addition, control of exposure pathways for future land use receptors will incorporate engineering controls.

Construction phase pathways will be addressed through engineering controls.

Application of some of the identified remedial alternatives, specifically excavation and disposal and solidification/stabilization, requires sufficient characterization of the extent of the impacted area to be effective. Characterization of the extents of impacted areas varies on the properties; some areas are well characterized, while others are reliant on a single sample result to identify an impacted area. To define the extents of impacts, soil sampling and characterization will be incorporated into the IA. Characterization activities are described conceptually for each alternative in Sections 3.4.2, 3.4.3, 3.4.4, and 3.4.5 below.

3.2 Development of Interim Action Cleanup Levels and Remediation Levels

Interim Action Cleanup Levels (IACLs) and Interim Action Remediation Levels (IARLs) for Parcels 4 and 5 were developed based on the exposure pathways described in Section 3.1.1 above. IACL and IARL calculations are included in Appendix D. IACLs and IARLs are summarized in Table 3-2.

3.3 Point of Compliance

For soil cleanup levels based on human exposure via direct contact or other exposure pathways where contact with the soil is required to complete the pathway, the point of compliance (POC) is established in the soils throughout the Interim Action Area from the ground surface to 15 feet below grade (fbg). For soil cleanup levels based on the protection of ground water, the point of compliance shall be established in soils throughout the Interim Action Area.

3.4 Interim Action Alternatives

Alternatives were developed by identifying potential practical means of implementing the selected technologies and practices for mitigation of exposure pathways (capping, excavation and disposal, engineering controls, and institutional controls) discussed in Section 3.1. These methods were assembled into alternatives that address all exposure pathways/all receptors.

Four alternatives were developed: one with solidification/stabilization as a basis, one with only excavation and disposal as a basis, and two alternatives were developed using containment as a basis.

Solidification/stabilization -Solidification/stabilization includes two technologies that are applied in the same manner but control contamination using different principles. Solidification physically immobilizes COPCs by blending cement-like additives into the soil, resulting in a concrete-like mass. Solidification agents include Portland cement, lime, limestone, and other cement-like agents. Stabilization agents act chemically on COPCs to reduce mobility or toxicity. Treatability studies are required to determine the appropriate additives for soil conditions and COPCs. This alternative also incorporated excavation and disposal in limited areas of the properties.

Containment -Two alternatives were developed using containment as a basis. Containment caps may be broadly divided into two classes – impermeable caps and permeable caps. Both types effectively prevent direct contact with capped material. Impermeable caps are constructed of hard construction materials such as concrete or asphalt, or from impermeable geomembranes covered with layers of compacted soil. The primary advantage of impermeable caps is that they do not allow rainwater to infiltrate. This can reduce or eliminate leaching from soils in the vadose or unsaturated zones. Impermeable caps are typically more costly than permeable caps to design, and must be designed with a drainage system to avoid the collection of rainwater in the cap. This drainage must be routed to a collection system to realize any benefit in terms of leaching prevention. Finally, with multilayer geomembrane and soil caps, it is difficult to monitor the condition of the geomembrane after installation. Permeable caps are typically comprised of clean, compacted soil. Rainwater may infiltrate through the compacted soil. However, permeable caps are typically simpler to design, construct, and maintain than impermeable caps. Based of the differing design considerations and benefits of these two approaches, it was determined that the inclusion of two alternatives based on capping was justified.

All of the alternatives have taken sea level rise into consideration. Rising groundwater levels at the site as a result of sea level rise will not increase the risk to human health or the environment. In each alternative, COPCs present at concentrations that pose a risk of leaching to groundwater will be removed (either through targeted hot spot excavation or bulk excavation), or solidified/stabilized to reduce mobility or toxicity. Rising groundwater levels therefore do not add additional exposure pathways. The Multilayer Cap with Controls alternative (Section 3.4.3) relies on an impervious cap over the entire property; in some areas of the property the cap will be buried under 3 feet of compacted soil, with a drainage system to prevent the accumulation of water in the capped areas. If groundwater levels rise above the level of the buried portion of the cap, the cap may in effect act as a confining boundary, resulting in increased groundwater head. Sea level rise above the buried portion of the cap, while not adding new exposure pathways, could overwhelm the drainage system. The drainage system may need to be redesigned and replaced as a result. Sea level rise is a consideration in the long-term effectiveness of the Multilayer Cap with Controls alternative. Alternatives are discussed in detail below.

3.4.1 No Action

Under the No Action alternative, the City and LOTT would take no further action on Parcels 4 and 5. The No Action alternative does not meet the threshold criteria described above, and is included only to provide a baseline for comparison. The alternative evaluation criteria are discussed below:

Threshold Criteria – The No Action alternative does not meet the MTCA threshold criteria applied for IA selection. The No Action alternative does not address the potentially complete pathways under the current land use, nor does it adequately address construction phase or future land use pathways. As a result, it is not protective of human health or the environment.

Incremental Cost Evaluation – This criterion is not applicable because the alternative does not meet the threshold criteria.

Restoration Timeframe – This criterion is not applicable because the alternative does not meet the threshold criteria.

Consideration of Public Concerns – This criterion is not applicable because the alternative does not meet the threshold criteria.

3.4.2 Soil Solidification/Stabilization

Exposure Pathways – Solidification/stabilization will address both the direct contact and soil to surface water via groundwater pathways by reducing the mobility and/or toxicity of material on the site.

Interim Action Sampling – Prior to construction, direct push soil samples will be collected from the site to define areas requiring solidification/stabilization. The properties will be sampled in a 20' x 20' grid pattern using direct-push sampling. Borings will be advanced to a depth of at least 12' below ground surface, and soil samples will be collected from the 3', 7', and 12' depths. If soil samples in a grid cell exceed IACLs, solidification/stabilization will be applied to the cell. Solidification/stabilization will be applied according to the following protocol: an exceedance of IACLs in the 3' sample will trigger solidification/stabilization in the 0'-7' interval, an exceedance of IACLs in the 7' sample will trigger solidification/stabilization in the 3'-12' interval, and an exceedance of IACLs in the 12' interval will trigger solidification/stabilization in the 7' – 15' interval.

Following grid sampling, representative soil samples will be collected from the properties for a treatability study to determine the proper combination of solidification/stabilization additives.

Detailed Description – Under this alternative, areas with soil concentrations exceeding IACLs will be defined during preliminary sampling. A treatability study will also be performed on representative soil samples, as determined during the preliminary sampling, to formulate an additive mixture to address cPAH, metals, and dioxin/furan impacts. Areas identified as exceeding IACLs will be solidified/stabilized using an auger/caisson or injector head system.

IACLs will be met throughout the site. Institutional controls are therefore not required for this alternative.

A schematic auger plan/injector head pattern for this alternative is shown on Figure 3-2.

Engineering controls would control exposure pathways during construction.

Although not within the property boundaries of Parcels 4 and 5, the planted strip immediately east of and adjacent to Parcels 4 and 5 must be addressed prior to HOCM and Plaza occupancy. Any exposure risks associated with this area will be assessed by the Port in the RI/FS, and any necessary action to address unacceptable exposures will be part of the final CAP. If there is an unacceptable risk associated with the planted strip but a final remedy acceptable to Ecology has not been implemented for the planted strip, then interim engineering controls will be implemented prior to HOCM and Plaza occupancy to minimize potential exposures.

Threshold Criteria – The solidification/stabilization alternative satisfies the MTCA threshold criteria.

Incremental Cost Evaluation – It is estimated based on cPAH and metals sampling that as much as 60% of the soil on-site may exceed IACLs, particularly the IACL for cPAHs. The volume of soil requiring solidification/stabilization will be unknown until IA sampling; 60% of the total soil is assumed for this analysis. Estimated soil volumes are shown in Table 3-3; remedial costs are estimated in Table 3-4.

It should be noted that the accuracy of the solidification/stabilization soil volume will significantly affect the accuracy of the cost estimate.

Restoration Timeframe – The Solidification and Stabilization alternative would be implemented immediately prior to or as part of construction of the Plaza and HOCM in early summer 2010. The approximate timeframe for completion of HOCM construction is late 2011. However, solidification/stabilization would be completed sooner, approximately late 2010.

Consideration of Public Concerns – The alternative will be subject to the AO public comment process to take into consideration public concerns.

3.4.3 Multilayer Cap with Controls

This alternative addresses the soil to surface water via groundwater pathway with excavation and disposal of hot spots and direct contact pathways through capping and institutional controls.

Exposure Pathways – Exposure pathways are addressed as follows:

Direct contact pathways for construction phase receptors will be addressed through the use of engineering controls. Direct contact pathways for all future receptors except utility and construction workers will be addressed through the use of an impermeable cap and through institutional controls. Direct contact pathways for future utility and construction workers will be addressed through institutional controls. Institutional controls will be implemented in the final CAP. It is expected that institutional controls will include a land use restriction regulating the excavation of any soils left in place on site with COPC concentrations that may exceed IACLs, and that the land use restriction will be implemented by a restrictive covenant.

The soil to surface water via groundwater pathway will be addressed through excavation and disposal of soils exceeding IARLs.

Hotspot Excavation and Sampling – A total of five locations exceed IARLs and will be excavated: TP-02, DP-11, -17, -18, and -21. Samples will be collected during excavation both to delineate excavated areas and to characterize excavated material stockpiled on-site. Table 3-5 shows planned sample depths and analytical constituents. Hotspots will be initially excavated in 20-foot by 20-foot excavation cells. The excavation cells may be made smaller with permission from Ecology, but not larger. The first excavation cells will be centered at the coordinates of the samples with concentrations exceeding IARLS (DP-17 and DP-21 for arsenic, DP-11 for lead, DP-18 for TPH-HO, and TP-02 for dioxins/furans). After the first cell is excavated, adjacent 20-foot by 20-foot cells may be excavated based on field screening results. These excavations will constitute the first excavation round. Initial excavated areas are shown in Figure 3-4. Confirmation samples will be collected during the first excavation round. Vertical sets of confirmation samples will be collected in each sidewall of each excavation cell at the depths are shown in Table 3-5. A vertical set will include one sample from each lithologic layer. Samples from depths less than 4 feet will be collected by hand directly from the sidewall of the excavation. Samples from depths greater than 4 feet will be collected by using the excavator bucket. A floor sample in the center of each cell will also be collected by using the excavator bucket. Sample collection is shown schematically in Figure 3-3.

Adjacent cells may be excavated in a second excavation round following the first set of sample collection. An adjacent cell will be excavated of any sample from the adjoining wall exceeds IARLs. If necessary, the City and LOTT will continue the excavation of areas known to exceed IARLS (as identified in Figures 3-4 and 3-7) beyond the property boundaries of Parcel 4 and 5. These areas will be excavated until COPC concentrations in confirmation samples collected per the Sampling and Analysis Plan (SAP) and Table x-x are below the IARLs.

Although not within the property boundaries of Parcels 4 and 5, the planted strip immediately east of and adjacent to Parcels 4 and 5 must be addressed prior to HOCM and Plaza occupancy. Any exposure risks associated with this area will be assessed by the Port in the RI/FS, and any necessary action to address unacceptable exposures will be part of the final CAP. If there is an unacceptable risk associated with the planted strip but a final remedy acceptable to Ecology has not been implemented for the planted strip, then interim engineering controls will be implemented prior to HOCM and Plaza occupancy to minimize potential exposures.

Detailed Description – Existing soil, with the exception of the known arsenic, lead, TPH-HO, and dioxin/furan hot spots on Parcels 4 and 5, would be left in place on site in areas underneath buildings, hardscaped or paved outdoor areas, parking areas or roads, or a multilayer cap consisting of compacted clean soil placed over an impervious geomembrane. For multilayer cap areas, existing soil would be excavated to a depth of 3-feet below the finished grade and an impervious geomembrane placed on top of the remaining native soil. Permeable geotextile will also be used to line the extent of the hotspot excavations. Clean soil would be placed on top of the geomembrane and compacted; a layer of drainage/bedding material and a geomembrane may be placed between the soil and impervious membrane, depending on the surfacing requirements. The 3-foot depth is selected to minimize excavation while still providing sufficient soil for landscape plantings and sufficient space for a drainage system on top of the geomembrane.

The impervious geomembrane is the primary barrier for direct contact. The soil cover thickness is selected to facilitate planting and provide sufficient soil to protect the geomembrane from damage. While the soil itself is not the primary means of direct contact prevention in the multilayer cap areas, the 3-foot depth is consistent with clean soil cover remedial solutions implemented statewide, and is sufficiently deep to be protective for direct contact; a review of soil cover depths for state-managed remediation projects is included as Appendix E.

The hardscaping or multilayer cap will serve as a barrier to direct contact for all receptors except future utility and construction workers. In areas surfaced with hardscape materials, the hardscape or pavement will serve as the barrier. In areas surfaced by the multilayer cap, the geomembrane and clean soil will serve as the barrier. The compacted soil placed on top of the barrier will also protect the geomembrane from damage as a result of activities at the surface. The cap will address direct contact for all future direct contact receptors except utility and construction workers. The hardscape materials would overlap the geomembrane at the boundaries between areas with a hardscape cap and areas with a multilayer cap. Additionally, a drainage system would need to be constructed on top of the geomembrane below the clean soil, as these areas would effectively be basins that would collect infiltrating rainwater.

The primary purpose of the impermeable cap is to prevent direct contact. Because the cap will apply impermeable materials over the entire property, the infiltration of rainwater will be eliminated. However, limited excavation of the arsenic, lead, TPH-HO and dioxin/furan hot spots will still be necessary. Dioxins/furan IARLs are driven by direct contact for utility workers, and the arsenic, lead, and TPH-HO hot spots are located in the saturated zone and may be subject to leaching.

This alternative includes an institutional control component. Institutional controls will address direct contact for all future direct contact pathway receptors. The institutional controls would ensure that the integrity of the cap is maintained during future use and development, ensure that no unplanned or unmitigated excavation of the properties takes place, and ensure that no drinking water wells are installed within the property boundary. The City and LOTT would implement and maintain institutional controls for perpetuity.

An excavation plan for this alternative is shown on Figure 3-4, and a schematic cross section of the cap is shown on Figure 3-5. A surfacing plan is shown on Figure 3-6.

Engineering controls would control exposure pathways during construction.

Threshold Criteria – The Multilayer Cap with Controls option satisfies the MTCA threshold criteria.

Incremental Cost Evaluation – Estimated excavation volumes were developed based on the excavation areas and depths as shown in Figure 3-4. Excavation takeoffs are included as Appendix F (note that the Appendix F takeoffs are for a 6' excavation depth; half of the quantities in these estimates were used for this alternative). These volumes are shown in Table 3-6. An estimated cost was calculated based on these excavation volumes. Estimated costs are shown in Table 3-7. An incremental cost evaluation of this alternative relative to the group of alternatives is discussed in Section 3.5.

Restoration Timeframe – The Multilayer Cap with Controls alternative would be implemented immediately prior to or as part of construction of the Plaza and HOCM in early summer 2010. The excavation and screening of soils and construction of the functional elements of the cap would be completed by late 2010. The approximate timeframe for completion of HOCM construction is late 2011. The institutional controls would be maintained in perpetuity.

Consideration of Public Concerns – The alternative will be subject to the AO public comment process to take into consideration public concerns.

3.4.4 Capping with Partial Excavation and Controls

This alternative addresses the soil to surface water via groundwater pathway with excavation and disposal and direct contact pathways through capping and institutional controls.

Exposure Pathways – Exposure pathways are addressed as follows:

Direct contact pathways for construction phase receptors will be addressed through the use of engineering controls. Direct contact and soil to surface water via groundwater pathways for all future receptors except utility and construction workers will be addressed in hardscaped areas through the use of an impermeable cap, excavation and disposal of areas exceeding IARLS, and through institutional controls. These pathways will be addressed in permeable areas through excavation and disposal and the use of a clean soil cover. Direct contact pathways for future utility and construction workers will be addressed through institutional controls. Institutional controls will be implemented as part of the IA. It is expected that institutional controls will include a land use restriction regulating the excavation of any soils left in place on site with COPC concentrations that may exceed IACLs or future cleanup levels developed as part of the final CAP, and that the land use restriction will be implemented by a restrictive covenant or other legal or administrative instrument.

Interim Action Sampling/Hot Spot Excavation and Disposal– As described previously, a total of five locations exceed IARLs and will be excavated: TP-02, DP-11, -17, -18, and -21. Samples will be collected during excavation both to delineate excavated areas and to characterize excavated material stockpiled on-site. Table 3-5 shows planned sample depths and analytical constituents. Hotspots will initially be excavated in 20-foot by 20-foot excavation cells. The excavation cells may be made smaller with permission from Ecology, but not larger. The first excavation cells will be centered at the coordinates of the samples with concentrations exceeding IARLS (DP-17 and DP-21 for arsenic, DP-11 for lead, DP-18 for TPH-HO, and TP-02 for dioxins/furans). After the first cell is excavated, adjacent 20-foot by 20-foot cells may be excavated based on field screening results. These excavations will constitute the first excavation round. Initial excavated areas are shown in Figure 3-7.

Confirmation samples will be collected following the first excavation round. Vertical sets of confirmation samples will be collected in each sidewall of each excavation cell at the depths are shown in Table 3-5. A vertical set will include one sample from each lithologic layer. Samples from depths less than 4 feet will be collected by hand directly from the sidewall of the excavation. Samples from depths greater than 4 feet will be collected by using the excavator bucket. A floor sample in the center of each cell will also be collected by using the excavator bucket. Sample collection is shown schematically in Figure 3-3.

Adjacent cells may be excavated in a second excavation round following the first set of sample collection. An adjacent cell will be excavated of any sample from the adjoining wall exceeds IARLs. If necessary, the City and LOTT will continue the excavation of areas known to exceed IARLS (as identified in Figures 3-4 and 3-7) beyond the property boundaries of Parcel 4 and 5. These areas will be excavated until COPC concentrations in confirmation samples collected per the Sampling and Analysis Plan (SAP) and Table 3-5 are below the IARLs.

Although not within the property boundaries of Parcels 4 and 5, the planted strip immediately east of and adjacent to Parcels 4 and 5 must be addressed prior to HOCM and Plaza occupancy. Any exposure risks associated with this area will be assessed by the Port in the RI/FS, and any necessary action to address unacceptable exposures will be part of the final CAP. If there is an unacceptable risk associated with the planted strip but a final remedy acceptable to Ecology has not been implemented for the planted strip, then interim engineering controls will be implemented prior to HOCM and Plaza occupancy to minimize potential exposures.

Detailed Description – Under this alternative, areas known to exceed IARLs will be remediated through excavation and disposal as described above. Remaining soil would be left in place on site in areas underneath buildings, hardscaped or paved outdoor areas, and parking areas. For softscaped areas, existing soil would be excavated to a depth of 6 feet below the finished grade, or until contact with groundwater. This depth is selected to provide a barrier to direct contact for all future receptors except utility or construction workers working below the 6-foot depth. A permeable geotextile will be placed at the bottom of the 6-foot excavation. Permeable geotextile will also be used to line the extent of the hotspot excavations. This geotextile will serve as a marker of excavation depth and extent if portions of the site are redeveloped in the future. Groundwater contours developed by PIONEER Technologies based on the September 2009 groundwater elevations are included in Appendix G. Final site grades have not been determined, but will be at minimum 1.5 feet higher than the existing grades. It is therefore estimated that the 6-foot excavation depth can be met over the property.

The 6-foot depth for the clean soil cover is sufficient to prevent direct contact with soil left in place. A review of soil cover depths for state-managed remediation projects is included as Appendix E. The City and LOTT understand that a shallower soil cover may still be suitable for the prevention of direct contact exposure. However, the 6-foot excavation depth will provide a measure of protection for terrestrial ecological receptors. WAC 173-340-7490(4)(a) establishes a default presumption that the biologically active zone in soil extends to a depth of six feet. The 6 foot excavation depth would meet the default conditional POC for terrestrial ecological receptors if final cleanup action levels are revised based on ecological considerations.

Clean soil placed below the level of groundwater may be at risk for recontamination from off-property sources, and is not likely to be suitable habitat for terrestrial organisms. Therefore, the replacement of soils below the depth of groundwater is therefore limited to areas where COPCs may be subject to leaching (arsenic, lead, and TPH-HO) or where COPC concentrations exceed IARLs based on direct contact for utility workers (dioxins/furans). The clean soil cover will protect all future direct contact receptors except utility and construction workers.

Excavation spoils from softscaped area excavations, utility installation, or building structural work would be stockpiled on site, tested, and categorized as material suitable for general reuse on site (if stockpile concentrations do not exceed the IACLs), material suitable for reuse under hardscaped surfaces (if stockpile concentrations exceed IACLs but do not exceed IARLS), or material for offsite disposal (if stockpile samples exceed the IARLs). Excavations will be backfilled with stockpiled material suitable for on-site reuse or with imported fill. Reusable material sourced from on-site will be preferentially used under hardscaped surfaces, and will only be reused in softscaped areas if a surplus of material exists. Based on current development plans for the properties, it is estimated that there is capacity for the reuse of 8,400 cubic yards of material under hardscaped surfaces.

This alternative includes an institutional control component. Institutional controls will address direct contact for all future direct contact pathway receptors. The institutional controls would ensure that the integrity of the cap is maintained during future use and development, ensure that no unplanned or unmitigated excavation of the properties takes place, and ensure that no drinking water wells are installed within the property boundary. The City and LOTT would implement and maintain institutional controls for perpetuity.

Institutional controls will be implemented as part of the IA and prior to use of the properties by the public. The IA Report will include documentation of the institutional control instrument (an environmental covenant or another legal or administrative instrument enforcing the institutional controls). A draft copy of the institutional control instrument will be prepared and submitted to Ecology for review and approval prior to execution.

An excavation plan for this alternative is shown on Figure 3-7, and a schematic cross section is shown on Figure 3-8. Excavation takeoffs are included as Appendix F. A surfacing plan is shown on Figure 3-9.

Engineering controls would control exposure pathways during construction.

Threshold Criteria – The Capping with Partial Excavation and Controls option satisfies the MTCA threshold criteria.

Incremental Cost Evaluation – Estimated excavation volumes were developed based on the excavation areas and depths as shown in Figure 3-7. Excavation takeoffs are included as Appendix F. These volumes are shown in Table 3-8. An estimated cost was calculated based on these excavation volumes. Estimated costs are shown in Table 3-9. An incremental cost evaluation of this alternative relative to the group of alternatives is discussed in Section 3.5.

Restoration Timeframe – The Capping with Partial Excavation and Controls alternative would be implemented immediately prior to or as part of construction of the Plaza and HOCM in early summer 2010. The excavation and screening of soils and construction of the functional elements of the cap would be completed by late 2010. The approximate timeframe for completion of HOCM construction is late 2011. The institutional controls would be maintained in perpetuity.

Consideration of Public Concerns – The alternative will be subject to the AO public comment process to take into consideration public concerns.

regardless of the surfacing materials. Excavation and disposal will protect all future receptors for both the direct contact and soil to surface water via groundwater pathways.

Excavation spoils would be stockpiled on site, tested, and categorized as material suitable for reuse on site (if stockpile samples do not exceed the IACLs) or material for offsite disposal (if stockpile samples exceed the IACLs). Excavations will be backfilled with stockpiled material suitable for on-site reuse or with imported fill.

Because the most restrictive direct contact driven levels will be met at the POC, no institutional control component is necessary for this alternative.

Engineering controls would control exposure pathways during construction.

Threshold Criteria – The Excavation and Disposal option satisfies the MTCA threshold criteria.

Incremental Cost Evaluation – Estimated excavation volumes are shown in Table 3-10. An estimated cost was calculated based on these excavation volumes. Estimated costs are shown in Table 3-11. An incremental cost evaluation of this alternative relative to the group of alternatives is discussed in Section 3.5.

Restoration Timeframe – The Excavation and Disposal alternative would be implemented immediately prior to construction of the Plaza and HOCM in early summer 2010. Excavation and disposal of soils would be completed during the summer of 2010.

Consideration of Public Concerns – The alternative will be subject to the AO public comment process to take into consideration public concerns.

3.5 Alternatives Evaluation

3.5.1 Threshold Criteria

Threshold criteria for Cleanup Actions (WAC 173-340-360(2)(a)) require that the selected action protect human health and the environment, comply with cleanup standards, comply with applicable state and federal laws, and provide for compliance monitoring. In addition to these requirements, IAs must be consistent with the final Cleanup Action, if known. If the final Cleanup Action is not known, the IA must not foreclose reasonable alternatives for the final Cleanup Action (WAC 173-340-430(3)). All of the alternatives discussed except the 'No Action' alternative meet these criteria.

3.5.2 Disproportionate Cost Analysis

WAC 173-340-360(3)(e) defines a procedure for conducting a disproportionate cost analysis of cleanup alternatives. Costs are considered disproportionate to benefits when the incremental costs of an alternative exceed the incremental benefits of an alternative relative to the next lowest cost alternative. Comparison of costs and benefits may be quantitative, but is often qualitative and requires the use of best professional judgment. Disproportionate cost analysis criteria are listed at the start of this section and are summarized below.

- Protectiveness: Overall protectiveness of human health and the environment, including the degree to which existing risks are reduced, time required to reduce the risk at the facility and attain cleanup standards, on-site and off-site risks resulting from implementing the alternative, and improvement of the overall environmental quality.
- Permanence: The degree to which the alternative permanently reduces the toxicity, mobility, or volume of hazardous substances.
- Cost: The cost to implement the alternative, including the cost of construction, the net present value of any long-term costs, and the agency oversight costs that are cost recoverable.
- Effectiveness over the long term: Long term effectiveness includes the degree of certainty that the alternative will be successful, the reliability of the alternative during the period of time hazardous substances are expected to remain on-site at concentrations that exceed CLs, the magnitude of the residual risk with the alternative in place, and the effectiveness of controls required to manage treatment residues or remaining wastes. Guidance for the relative degree of long term effectiveness for various classes of alternatives is provided in WAC 173-340-360(3)(e).
- Management of short-term risks: The risk to human health and the environment associated with the alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.
- Technical and administrative implementability: Ability to be implemented including consideration of whether the alternative is technically possible, availability of necessary off-site facilities, services and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for construction operations and monitoring, and integration with existing facility operations or potential remedial actions.
- Consideration of public concerns: Whether the community has concerns regarding the alternative and, if so, the extent to which the alternative addresses those concerns.

Under WAC 1733-340-360(3)(e)(ii)(B), the most practicable permanent alternative is the baseline to which other alternatives are compared. Alternatives were assigned a score of 1 to 5 (5 being superior, 1 being the lowest) for each criteria. Scoring is discussed below.

Cost – The estimated project cost for Solidification and Stabilization is $3,680,000. The estimated project cost for the Multilayer Cap with Controls is $853,000. The estimated project cost for Capping with Partial Excavation and Controls is $796,000. The estimated project cost for Excavation and Disposal is $4,688,000.

Protectiveness – All alternatives remove contaminated material or eliminate exposure pathways for recreators and commercial workers and for aquatic receptors. The Multilayer Cap with Controls and Capping with Partial Excavation and Controls alternatives remove exposure pathways for future utility workers in areas known to be impacted, but may not eliminate this pathway in all capped areas of the properties. The Partial Excavation and Controls alternative is assigned a score of 3. The Capping with Partial Excavation and Controls alternative will remove all contaminated material in the portions of the site where direct contact exposure is most likely to occur. Additionally, the alternative is likely to be protective of terrestrial ecological receptors if these pathways are determined to be complete in the future. It is was therefore determined to be more protective and assigned a score of 4.

The Solidification/Stabilization alternative eliminates all pathways for all receptors, but it relies on the immobilization of COPCs. It is protective only so long as solidified/stabilized material remains immobile. Also, the alternative will in fact leave more material in place than the Capping with Partial Excavation and Controls alternative. This alternative was assigned a score of 3

The Excavation and Disposal eliminates all pathways for all receptors and is assigned a score of 5.

Permanence – Because Excavation and Disposal does not require institutional controls, it is considered the alternative most likely to be permanent and is assigned a score of 5. It should be noted that the disposal of impacted soils may entail either destruction of the soils or long-term storage and management in a regulated landfill or other facility. While still protective of human health and the environment, in the case of the latter the burden of management of impacted material is shifted to but not eliminated. In this case disposal is permanent only so long as disposal facility is operated and managed in good condition.

The Capping with Controls, Multilayer Cap with Controls, and Capping with Partial Excavation and Controls alternatives are likely to be permanent provided institutional controls are maintained and are assigned scores of 4.

Solidification/stabilization is does not require institutional controls, but its permanence depends on the long-term ability of the solidification/stabilization additives to eliminate COPC mobility. It is assigned a score of 3. There is a significant risk that this will degrade over time.

Effectiveness over the long term – WAC 173-340-360(3)(f)(iv) provides ranking criteria for long term effectiveness. Off-site disposal is considered more effective long term than alternatives relying on isolation or containment (capping) or institutional controls. Based on this guidance, the Excavation and Disposal Alternative is assigned a score of 5.

The Capping with Partial Excavation and Controls alternative will remove a significant portion of the impacted material from the properties. It is assigned a score of 4.

The Solidification/Stabilization alternative leaves all contaminated material in place and relies on reduced mobility. This can degrade over time; the alternative is assigned a score of 3.

The Multilayer Cap with Controls alternative leaves all contaminated material in place and relies on maintenance of the cap over the entire area for long term effectiveness. In addition to cap maintenance considerations, the cap drainage system may require significant modifications if sea level rise results in groundwater levels higher than the impervious geomembrane. The alternative is assigned a score of 3.

Management of short term risks – Short term risks can be reduced by minimizing the amount of potentially impacted material that must be handled. The Solidification/stabilization alternative requires minimal handling of excavated toxic material and is assigned a score of 5.

The Multilayer Cap with Controls and Capping with Partial Excavation and Controls alternatives retain the bulk of material on site, although excavation and handling of potentially contaminated material is required. These alternatives are each assigned a score of 4.

Excavation and Disposal requires a significant increase in the amount of material handling, nearly seven times as much material as the Capping with Partial Excavation and Controls alternative. It will also significantly increase the potential complications resulting from dewatering. This alternative is assigned a score of 3.

Technical and administrative implementability – There are significant implementability concerns with the Solidification/Stabilization alternative. First, the treatment volume necessary relies on pre-IA sampling for quantification, making scoping of the remediation portion of the project difficult. Second, a treatability study to determine the appropriate additive mix has not been completed; treatability difficulties would be a significant barrier to implementation. Third, buried wood and concrete debris has been encountered in multiple locations at the properties. This presents a technical barrier to the use of auger-caisson or injector head type systems. Fifth, it has not been established how conflicts between areas requiring solidification and areas with utilities planned as part of the development would be addressed. Solidified areas may also conflict with the proposed building foundation. For these reasons, Solidification/Stabilization is assigned a score of 1.

The Multilayer Cap with Controls and Capping with Partial Excavation and Controls rely on established and easy to implement methods (geomembrane or soil covers) and are each assigned a score of 3; the most significant challenge with these alternatives will be the management of excavated material on the properties.

Excavation and Disposal will require properly designed sheeting and shoring due to the depth of excavation. It will also require complex construction sequencing to allow stockpiling space on site for the large volume of soil that must be managed. Finally, it may require a complex dewatering system to address groundwater issues resulting from deep excavation. Because of these issues technical implementability issues, it is assigned a score of 1.

Consideration of public concerns – No scores were assigned for this criterion because the IAWP has not been submitted for public comment. All alternatives will be subject to comment through the AO process.

3.5.3 Practicable Solution

The Solidification/Stabilization and Excavation and Disposal alternatives cost significantly more than the Multilayer Cap with Controls and Capping with Partial Excavation and Controls alternatives. Additionally, they present significant implementability challenges. These alternatives were therefore determined not to be practicable alternatives.

3.5.4 Remedy Permanent to the Maximum Extent Practicable

The Excavation and Disposal is considered permanent.

While the Capping with Excavation and Controls and Multilayer Cap with Controls alternatives require institutional controls, they are considered permanent to the maximum extent practicable because of the practicability concerns with the permanent alternative for the properties.

Solidification/Stabilization is not a permanent alternative, since material remains in place on site and may be remobilized if the performance of the remedial solution degrades over time. Because the cost of this alternative was comparable to the permanent alternative, Excavation and Disposal, it was not considered permanent to the maximum extent practicable.

3.5.5 Cost Disproportionate to Benefits

Because of their significant cost, Solidification/Stabilization and Excavation and Disposal were considered to have costs disproportionate to benefits.

The two capping alternatives were found to have similar costs, and cost was not considered a differentiating factor between these two alternatives. Because the Multilayer Cap with Controls was less protective and less effective over the longer term, it was determined to have costs disproportionate to benefits.

Costs were proportional to benefits for the Partial Excavation with Capping and Controls alternative.

3.5.6 Restoration Timeframe

All alternatives provide for a reasonable restoration timeframe. Restoration timeframe was considered similar for the Multilayer Cap with Controls, Capping with Partial Excavation and Controls, and Excavation and Disposal alternatives. Solidification/Stabilization was estimated to have a timeframe of up to a year for implementation as a result of the data requirements and specialized nature of the equipment and contracting firms required. Restoration timeframe was not considered a differentiating factor for the Multilayer Cap with Controls, Capping with Partial Excavation and Controls, and Excavation and Disposal Alternatives. Implementation timeframe is a consideration with Solidification/Stabilization.

3.5.7 Consideration of Public Concerns

Community concerns will be assessed following public comment on the draft IAWP.

3.5.8 Alternative Selection

Alternatives were ranked based on the selection criteria and a preferred alternative selected based on this ranking. Scoring is summarized in Table 3-12.

Based on the selection criteria, the Capping with Partial Excavation and Controls alternative was selected as the IA. This alternative scored higher than the Solidification/Stabilization and the Multilayer Cap with Controls alternatives, and was also less costly than these alternatives. The scores for Capping with Partial Excavation and Controls and Excavation and Disposal were the same, with Capping with Partial Excavation and Controls costing significantly less.

4. INTERIM ACTION ACTIVITIES

Specific activities for completion of the IA for Parcels 4 and 5 are listed and discussed below. It is anticipated that these activities will be further developed in preparation of plans and specifications for a bid package to implement the IA.

4.1 Site Access

Site access during the IA will be controlled by the general contractor if the IA is incorporated into the HOCM and Plaza construction project, or by the remediation contractor if carried out as a separate project. Site access controls will include:

- Installation and maintenance of a fence with a locking gate to limit access during work and off-work hours.
- Implementation of appropriate traffic control measures.
- Maintenance of site control to ensure that only authorized personnel are on the site during work hours.

4.2 Well Decommissioning

As discussed in Section 2.5.1, the current status of MW-17 is unknown. MW-17 will be located and decommissioned by a licensed driller as part of the IA activities.

Other monitoring wells on site will be protected during construction and raised to the final site grade, or will be decommissioned by a licensed driller and reinstalled at the conclusion of remediation and construction activities at the site. Wells may be decommissioned if it is determined that activities at the site present a risk of direct discharge to wells or damage to wells as a result of excavation or other heavy equipment operation at the site. The decision to protect/raise or decommission/reinstall wells shall rest with the construction manager. Ecology will be notified of the decision to decommission wells prior to any field activities.

4.3 Soil Excavation, Stockpiling, and Screening

Soils will be excavated as described in Section 3.4.4.

Soils will be stockpiled on-site for screening. Stockpiled soils will be placed on top of a plastic liner or other impervious surface, and will be covered with secured plastic sheeting. Stockpiled soils will be sampled for COPCs. The sampling protocol is described in the Sampling and Analysis Plan, included as Appendix H.

In addition to sampling for COPCs, stockpiled excavated soils will be evaluated for their suitability for reuse as fill.

4.4 Soil Disposal

All soils that are either unsuitable for reuse as fill or that have concentrations of COPCs exceeding the IARLs in this memorandum will be transported off property and disposed of at an appropriate disposal site.

4.5 Soil Reuse

Soils that are suitable for reuse as fill and that have COPC concentrations below IARLs but above IACLs may be reused on-property. Reuse will be limited to areas covered by buildings, paving, or hardscaping.

Soils that are suitable for reuse as fill and that have COPC concentrations below IACLs may be reused on-property in any location.

4.6 Capping

Per the site development plans, certain areas of the property will be covered by buildings, pavement, parking areas, or hardscaped landscaping. The impervious materials will serve as a cap in these areas.

4.7 Particulate Control

The general contractor or remediation contractor will implement best management practices for particulate control.

4.8 Dewatering and Stormwater Control

The general contractor or remediation contractor will implement best management practices for stormwater management and erosion control. Stormwater will be treated on-site, (if required by LOTT), before discharging to the LOTT Budd Inlet Treatment Plant.

Because some of the areas targeted for excavation and disposal are below the anticipated groundwater elevation, dewatering may be required. Excavation in these areas will be scheduled, to the extent possible, to take place during favorable groundwater conditions. If dewatering is necessary, a dewatering system will be designed and implemented by the contractor. It is expected that the system will include direct pumping of excavations or pumping of dewatering wells to control groundwater in the vicinity of the excavation, cloth bag filters and/or carbon filters to control COPC concentrations and suspended solids, and Baker-type tanks for settling and storage.

Wastes derived from filtration and treatment of water, such as spent filters, will be stored temporarily on site separately from general construction waste and disposed off-site at the facility approved for soil disposal. If the soil disposal facility cannot accept these wastes, the contractor will identify an alternate facility subject to the approval of Ecology and the Construction Manager.

Soils that accumulate in Baker-type tanks will be disposed off-site at the soil disposal facility.

Total quantities (groundwater and stormwater) of up to 25,000 gallons per day may be discharged to the plant. Stormwater quantities in excess of this amount will be stored on-site in Baker-type tanks and metered to the plant at a rate not exceeding 25,000 gallons per day.

5. INTERIM ACTION IMPLEMENTATION

5.1 Plans and Specifications

IA tasks will be used as a basis to develop plans and specifications for the handling, testing, disposal, and reuse of soil. Plans and specifications will also define the capped areas and the areas requiring excavation. These plans and specifications may be integrated into the bid documents for the Plaza and HOCM and implemented, with appropriate oversight, by the general contractor or their subcontractor for construction of the Plaza and HOCM.

5.2 Sampling and Analysis Plan

A Sampling and Analysis Plan is included as Appendix H.

5.3 Health and Safety Plan

A Health and Safety Plan is included as Appendix I.

5.4 Quality Assurance Project Plan

A Quality Assurance Project Plan is included as Appendix J.

5.5 Standard Operating Procedures

Standard operating procedures (SOPs) are included as Appendix K.

5.6 Compliance Monitoring

Because the final cleanup action is not known, proper compliance monitoring actions cannot be determined at this time. A Compliance Monitoring Plan will be developed in consultation with Ecology after determination of the final cleanup action.

5.7 Interim Action Reporting

An IA Report will be completed following implementation of the IA. If requested by Ecology, interim letter reports or other informal communications may be submitted at regular intervals to summarize progress and sampling results.

The IA Report will include, at minimum:

- A description of soil management activities, including a timeline and volumes of soil excavated, segregated, stockpiled, reused, and disposed off-site. The narrative will include descriptions of locations on site where excavated soils were reused.
- A description of engineering control implementation.
- A description of compliance monitoring sampling and results.

- A discussion of the quantitative sampling results from soil stockpile sampling and confirmation sampling.
- A discussion of QA/QC review results per the procedures described in the QAPP.
- A discussion of any deviations from the IA Work Plan.
- Figures summarizing soil excavation locations and dimensions, soil stockpile locations, soil reuse locations, and compliance monitoring sampling locations and results.
- Tables summarizing volumes of soil excavated, stockpiled, reused, and disposed off site.
- Tables summarizing stockpile sampling results and compliance monitoring results.
- Copies of daily reports, and field notes (including field screening logs and sample data sheets) and photographs.
- Copies of waste disposal documentation, including manifests, weight slips, and receipts.
- Copies of laboratory analytical results and chain-of-custodies.

REFERENCES

Brown and Caldwell, 2007a. *Draft Phase II Environmental Site Assessment, East Bay Port of Olympia Property*. Prepared by Brown and Caldwell for the LOTT Alliance, March 15, 2007

Brown and Caldwell, 2007b. *Environmental Investigation, East Bay Port of Olympia Property.* Prepared by Brown and Caldwell for the LOTT Alliance, March 15, 2007.

Brown and Caldwell, 2009. *Summary Report, East Bay Redevelopment Parcel 4 and 5 Subsurface Investigation*. Prepared by Brown and Caldwell for the LOTT Alliance and the City of Olympia, October 16, 2009.

Bussey, 2009. Email communication from Troy Bussey, Pioneer Technologies Corporation, to Josh Johnson, Brown and Caldwell, July 31, 2009. Included in Appendix L.

Bussey, 2010a. Email communication from Troy Bussey, Pioneer Technologies Corporation, to Josh Johnson, Brown and Caldwell, April 12, 2010. Included in Appendix L.

Bussey, 2010b. Email communication from Troy Bussey, Pioneer Technologies Corporation, to Josh Johnson, Brown and Caldwell, May 26, 2010. Included in Appendix L.

Ecology, 2008. Department of Ecology VCP Opinion Letter, July 25, 2008.

Ecology, 2009. *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action*. October 2009. Ecology Publication 09-09-047.

Ecology, 2010. Department of Ecology CLARC Database. Web: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx. February 2010.

FRTR, 2010. Federal Remediation Technologies Roundtable. Web: http://www.frtr.gov. April 2010.

GeoEngineers, 2007a. *Phase I ESA, Port of Olympia East Bay Redevelopment*. Prepared by GeoEngineers, Inc. for the Port of Olympia. March 14, 2007

GeoEngineers, 2007b. *RI/FS and Conceptual CAP* [now known as the RI/FS IA], *Port of Olympia East Bay Redevelopment, City Hall lot*. Prepared by GeoEngineers, Inc. for The Rants Group. April 24, 2007.

GeoEngineers, 2007c. *Supplemental Site Use History and Soil and Groundwater Sampling Clarifications, Port of Olympia East Bay Redevelopment*. Prepared by GeoEngineers, Inc. for the Port of Olympia. August 3, 2007.

GeoEngineers, 2007d. *Voluntary Cleanup Program (VCP) Draft Remedial Investigation and Feasibility Study and Conceptual Cleanup Action Plan, East Bay Redevelopment, Port of Olympia*. Prepared by GeoEngineers Inc. for the Port of Olympia. December 20, 2007.

GeoEngineers/PIONEER, 2008, 2009. *Remedial Investigation Work Plan, East Bay Redevelopment, Port of Olympia*. Prepared by GeoEngineers, Inc, and Pioneer Technologies Corporation for the Port of Olympia. October 22, 2008, amended January 30, 2009.

PIONEER, 2008. *East Bay Remedial Investigation Phase 1 Summary*. Prepared by Pioneer Technologies Corporation for the Port of Olympia. December 2008.

PIONEER, 2009. *Final Interim Action Work Plan, East Bay Redevelopment, Port of Olympia*. Prepared by Pioneer Technologies Corporation for the Port of Olympia. May 2009.

PIONEER, 2010a. *Draft Empirical Evaluation of the Potential for Soil Constituents to Migrate to Surface Water via Groundwater at the Port of Olympia's East Bay Redevelopment Site*. Prepared by Pioneer Technologies Corporation for the Port of Olympia. February 2010.

PIONEER, 2010b. *Infrastructure Interim Action Report for East Bay Redevelopment Site*. Prepared by Pioneer Technologies Corporation for the Port of Olympia. June 2010.

San Juan, 1994. *Natural Background Soil Metals Concentrations in Washington State*. Charles San Juan, October 1994. Ecology Publication 94-115.

Teel, 2010. Email communication to Troy Bussey of Concise Explanatory Statement for calculation methodology for equivalent concentration. March 4, 2010.

TABLES

Table 2-1: Hardscaped and Planted Areas

Surface Type	Area (square feet)						
	Parking Lot	Building	Access Road	Outdoor Hardscape	Paved / Building / Hardscape Total	Planted Total	Total
Parcel 4	29,093	12,520	5,998	19,245	68,856	15,916	82,772
Parcel 5	0	0	0	17,992	17,992	14,611	32,063
Parcel 4 and 5 Total	29,093	12,520	5,998	37,237	84,848	30,527	115,835

Table 2-2: Groundwater Elevations (ft)

Monitoring Well	Jan-07 (1)	Jun-07 (1)	Jul-07 (1)	Aug-07 (1)	Jul-08 Low Tide (1)	Jul-08 High Tide (1)	Jun-09 (1)	Sep-09 (1)	Nov-09 (1)	Dec-09 (1)	Mar-10 (2)
MW-01	6.64	6.34	6.48	6.23	6.38	6.39	6.60	5.95	8.70	6.69	5.95
MW-02	6.93	6.53	6.71	6.49	6.76	6.71	6.92	NM	NM	NM	NM
MW-02R	NM	NM	NM	NM	NM	NM	NM	6.07	7.22	6.42	6.07
MW-03	6.77	6.23	6.41	6.13	6.26	5.27	6.47	5.94	7.92	6.98	5.94
MW-04	6.37	5.33	6.30	5.24	6.01	6.05	6.21	5.41	7.38	6.28	5.41
MW-16	NM	NM	NM	5.05	6.08	5.41	6.19	5.89	7.04	6.90	5.89
MW-17	NM	NM	NM	6.72	7.43	7.35	NM	NM	NM	NM	NM
MW-18	NM	NM	NM	3.58	0.81	6.56	3.33	1.50	4.76	6.71	1.50
MW-19	NM	NM	NM	5.91	5.60	3.68	NM	NM	NM	NM	NM
MW-21S	NM	NM	NM	NM	NM	NM	5.61	5.50	NM	NM	5.50
MW-23S	NM	NM	NM	NM	NM	NM	6.61	6.10	7.44	6.67	6.10

NM – not measured

(1) PIONEER, 2010a.

(2) Bussey, 2010b.

Table 2-3: Summary of Arsenic Concentrations in Soil

Sample Location	Date	Top [(1)(2)] (feet bgs)	Bottom [(1)(2)] (feet bgs)	Arsenic Concentration [(1)(2)] (mg/Kg)
DP-11	1/2/2007	0	2	2.8
DP-11	1/2/2007	8	10	14
DP-12	1/2/2007	0	2	4.1
DP-12	1/2/2007	8	10	4.1
DP-17	8/3/2007	4	6	14 U
DP-17	8/3/2007	10	12	84
DP-18	8/3/2007	2	4	4.3 U
DP-18	8/3/2007	10	12	8.8 U
DP-20	8/3/2007	2	4	3.6 U
DP-20	8/3/2007	10	12	5.8 U
DP-21	8/3/2007	6	8	72
DP-21	8/3/2007	10	12	11 U
DP-26	6/10/2009	1	2	9.75
DP-26	6/10/2009	7	8	3.81
DP-29	6/10/2009	3	4	5.89
DP-29	6/10/2009	7	8	3.57
DP-42	6/10/2009	1	2	2.97
DP-42	6/10/2009	5	6	4.15
DP-42	6/10/2009	7	8	3.66
MW-01	1/2/2007	4	6	1.9
MW-01	1/2/2007	10	12	2
MW-03	1/2/2007	4	6	1.8
MW-03	1/2/2007	8	10	1.8
MW-04	1/2/2007	2	4	3.4
MW-04	1/2/2007	14	16	2.4
MW-16	7/31/2007	4	6	3.3 U
MW-16	7/31/2007	16	18	6.4
MW-23S	6/12/2009	5	6	0.25 U
MW-23S	6/12/2009	9	11	8.55

U – Constituent was not detected at the reporting limit / method detection limit shown

Screening level = 20 mg/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-26, DP-29, DP-42, MW-23S

Table 2-4: Summary of Cadmium Concentrations in Soil

Sample Location	Date	Top (1)(2) (feet bgs)	Bottom (1)(2) (feet bgs)	Cadmium Concentration (1)(2) (mg/Kg)
DP-11	1/2/2007	0	2	0.25 U
DP-11	1/2/2007	8	10	1.2 U
DP-12	1/2/2007	0	2	0.26 U
DP-12	1/2/2007	8	10	0.34 U
DP-17	8/3/2007	4	6	2.4 U
DP-17	8/3/2007	10	12	1.8 U
DP-18	8/3/2007	2	4	0.72 U
DP-18	8/3/2007	10	12	1.5 U
DP-20	8/3/2007	2	4	0.6 U
DP-20	8/3/2007	10	12	0.96 U
DP-21	8/3/2007	6	8	0.8 U
DP-21	8/3/2007	10	12	1.9 U
DP-26	6/10/2009	1	2	0.37
DP-26	6/10/2009	7	8	0.30
DP-29	6/10/2009	3	4	0.69
DP-29	6/10/2009	7	8	0.32
DP-42	6/10/2009	1	2	0.40
DP-42	6/10/2009	5	6	0.56
DP-42	6/10/2009	7	8	0.57
MW-01	1/2/2007	4	6	0.24 U
MW-01	1/22007	10	12	0.22 U
MW-03	1/2/2007	4	6	0.25 U
MW-03	1/2/2007	8	10	0.27 U
MW-04	1/2/2007	2	4	0.12 J
MW-04	1/2/2007	14	16	0.28 U
MW-16	7/31/2007	4	6	0.55 U
MW-16	7/31/2007	16	18	0.8 U
MW-23S	6/12/2009	5	6	0.65
MW-23S	6/12/2009	9	11	0.45

U – Constituent was not detected at the reporting limit / method detection limit shown

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

Screening level = 2 mg/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-26, DP-29, DP-42, MW-23S

Table 2-5: Summary of Lead Concentrations in Soil

Sample Location	Date	Top [(1)(2)] (feet bgs)	Bottom [(1)(2)] (feet bgs)	Lead Concentration [(1)(2)] (mg/Kg)
DP-11	1/2/2007	0	2	8.2
DP-11	1/2/2007	8	10	2500
DP-12	1/2/2007	0	2	17
DP-12	1/2/2007	8	10	17
DP-17	8/3/2007	4	6	17
DP-17	8/3/2007	10	12	110
DP-18	8/3/2007	2	4	4.5
DP-18	8/3/2007	10	12	10
DP-20	8/3/2007	2	4	1.8
DP-20	8/3/2007	10	12	140
DP-21	8/3/2007	6	8	30
DP-21	8/3/2007	10	12	5.7 U
DP-26	6/10/2009	1	2	13.4
DP-26	6/10/2009	7	8	2.42
DP-29	6/10/2009	3	4	8.69
DP-29	6/10/2009	7	8	32.4
DP-42	6/10/2009	1	2	12.1
DP-42	6/10/2009	5	6	13.7
DP-42	6/10/2009	7	8	2.54
MW-01	1/2/2007	4	6	2.7
MW-01	1/2/2007	10	12	4.2
MW-03	1/2/2007	4	6	1.8
MW-03	1/2/2007	8	10	1.4
MW-04	1/2/2007	2	4	85
MW-04	1/2/2007	14	16	1.8
MW-16	7/31/2007	4	6	1.6 U
MW-16	7/31/2007	16	18	2.4 U
MW-23S	6/12/2009	5	6	0.46
MW-23S	6/12/2009	9	11	71.2

U – Constituent was not detected at the reporting limit / method detection limit shown

Screening level = 250 mg/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-26, DP-29, DP-42, MW-23S

Table 2-6: Summary of Gasoline Range Total Petroleum Hydrocarbon (TPH-G) Concentrations in Soil

Sample Location	Date	Top (1)(2)(3) (feet bgs)	Bottom (1)(2)(3) (feet bgs)	TPH-G Concentration (1)(2)(3) (mg/Kg)
DP-11	1/2/2007	0	2	7.6 J
DP-11	1/2/2007	8	10	13 J
DP-12	1/2/2007	0	2	0.92 UJ
DP-12	1/2/2007	8	10	1.0 UJ
DP-17	8/3/2007	4	6	72 U
DP-17	8/3/2007	10	12	51 U
DP-18	8/3/2007	2	4	11
DP-18	8/3/2007	10	12	37 U
DP-20	8/3/2007	2	4	8.5 U
DP-20	8/3/2007	10	12	23 U
DP-21	8/3/2007	6	8	11 U
DP-21	8/3/2007	10	12	53 U
DP-27	11/4/2008	3	4	5.0 U
MW-01	1/2/2007	4	6	5.4 U
MW-01	1/2/2007	10	12	5.6 U
MW-03	1/2/2007	4	6	4.6 U
MW-03	1/2/2007	8	10	1.3 UJ
MW-04	1/2/2007	2	4	3.0 UJ
MW-04	1/2/2007	14	16	0.73 UJ
MW-16	7/31/2007	4	6	7.8 U
MW-16	7/31/2007	16	18	10 U
MW-23S	6/12/2009	5	6	5.0 U
MW-23S	6/12/2009	9	11	5.0 U

U – Constituent was not detected at the reporting limit / method detection limit shown

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

Screening level = 100 mg/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples reported in PIONEER, 2008: DP-27

(3) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: MW-23S

Table 2-7: Summary of Benzene Concentrations in Soil

Sample Location	Date	Top [(1)(2)] (feet bgs)	Bottom [(1)(2)] (feet bgs)	Benzene Concentration [(1)(2)] (ug/Kg)
DP-11	1/2/2007	0	2	6.0 J
DP-11	1/2/2007	8	10	67 U
DP-12	1/2/2007	0	2	8.0 U
DP-12	1/2/2007	8	10	10 U
DP-17	8/3/2007	4	6	140 U
DP-17	8/3/2007	10	12	100 U
DP-18	8/3/2007	2	4	22 U
DP-18	8/3/2007	10	12	75 U
DP-20	8/3/2007	2	4	17 U
DP-20	8/3/2007	10	12	46 U
DP-21	8/3/2007	6	8	22 U
DP-21	8/3/2007	10	12	110 U
MW-01	1/2/2007	4	6	11 U
MW-01	1/2/2007	10	12	11 U
MW-03	1/2/2007	4	6	9.0 U
MW-03	1/2/2007	8	10	13 U
MW-04	1/2/2007	2	4	12 U
MW-04	1/2/2007	14	16	11 U
MW-16	7/31/2007	4	6	16 U
MW-16	7/31/2007	14	16	41 U
MW-16	7/31/2007	16	18	21 U
MW-23S	6/12/2009	5	6	50 U
MW-23S	6/12/2009	9	11	50 U

U – Constituent was not detected at the reporting limit / method detection limit shown

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

Screening level = 30 ug/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: MW-23S

Table 2-8: Summary of Toluene Concentrations in Soil

Sample Location	Date	Top (1)(2) (feet bgs)	Bottom (1)(2) (feet bgs)	Toluene Concentration (1)(2) (ug/Kg)
DP-11	1/2/2007	0	2	17 J
DP-11	1/2/2007	8	10	330 U
DP-12	1/2/2007	0	2	41 U
DP-12	1/2/2007	8	10	51 U
DP-17	8/3/2007	4	6	720 U
DP-17	8/3/2007	10	12	510 U
DP-18	8/3/2007	2	4	110 U
DP-18	8/3/2007	10	12	370 U
DP-20	8/3/2007	2	4	85 U
DP-20	8/3/2007	10	12	230 U
DP-21	8/3/2007	6	8	110 U
DP-21	8/3/2007	10	12	530 U
MW-01	1/2/2007	4	6	54 U
MW-01	1/2/2007	10	12	56 U
MW-03	1/2/2007	4	6	46 U
MW-03	1/2/2007	8	10	65 U
MW-04	1/2/2007	2	4	43 J
MW-04	1/2/2007	14	16	56 U
MW-16	7/31/2007	4	6	78 U
MW-16	7/31/2007	14	16	200 U
MW-16	7/31/2007	16	18	100 U
MW-23S	6/12/2009	5	6	100 U
MW-23S	6/12/2009	9	11	100 U

U – Constituent was not detected at the reporting limit / method detection limit shown

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

Screening level = 700 ug/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: MW-23S

Table 2-9: Summary of Ethylbenzene Concentrations in Soil

Sample Location	Date	Top $^{(1)(2)}$ (feet bgs)	Bottom $^{(1)(2)}$ (feet bgs)	Ethylbenzene Concentration $^{(1)(2)}$ (ug/Kg)
DP-11	1/2/2007	0	2	51 U
DP-11	1/2/2007	8	10	330 U
DP-12	1/2/2007	0	2	41 U
DP-12	1/2/2007	8	10	51 U
DP-17	8/3/2007	4	6	720 U
DP-17	8/3/2007	10	12	510 U
DP-18	8/3/2007	2	4	110 U
DP-18	8/3/2007	10	12	370 U
DP-20	8/3/2007	2	4	85 U
DP-20	8/3/2007	10	12	230 U
DP-21	8/3/2007	6	8	110 U
DP-21	8/3/2007	10	12	530 U
MW-01	1/2/2007	4	6	54 U
MW-01	1/2/2007	10	12	56 U
MW-03	1/2/2007	4	6	46 U
MW-03	1/2/2007	8	10	65 U
MW-04	1/2/2007	2	4	61 U
MW-04	1/2/2007	14	16	56 U
MW-16	7/31/2007	4	6	78 U
MW-16	7/31/2007	14	16	200 U
MW-16	7/31/2007	16	18	100 U
MW-23S	6/12/2009	5	6	100 U
MW-23S	6/12/2009	9	11	100 U

U – Constituent was not detected at the reporting limit / method detection limit shown

Screening level = 600 ug/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: MW-23S

Table 2-10: Summary of Total Xylenes Concentrations in Soil

Sample Location	Date	Top (1)(2) (feet bgs)	Bottom (1)(2) (feet bgs)	Total Xylenes Concentration (1)(2) (ug/Kg)
DP-11	1/2/2007	0	2	102 U
DP-11	1/2/2007	8	10	660 U
DP-12	1/2/2007	0	2	82 U
DP-12	1/2/2007	8	10	102 U
DP-17	8/3/2007	4	6	1440 U
DP-17	8/3/2007	10	12	1020 U
DP-18	8/3/2007	2	4	220 U
DP-18	8/3/2007	10	12	740 U
DP-20	8/3/2007	2	4	170 U
DP-20	8/3/2007	10	12	460 U
DP-21	8/3/2007	6	8	220 U
DP-21	8/3/2007	10	12	1060 U
MW-01	1/2/2007	4	6	108 U
MW-01	1/2/2007	10	12	112 U
MW-03	1/2/2007	4	6	92 U
MW-03	1/2/2007	8	10	130 U
MW-04	1/2/2007	2	4	122 U
MW-04	1/2/2007	14	16	112 U
MW-16	7/31/2007	4	6	156 U
MW-16	7/31/2007	14	16	400 U
MW-16	7/31/2007	16	18	200 U
MW-23S	6/12/2009	5	6	200 U
MW-23S	6/12/2009	9	11	200 U

U – Constituent was not detected at the reporting limit / method detection limit shown

Screening level = 900 ug/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: MW-23S

Table 2-11: Summary of Diesel Range Total Petroleum Hydrocarbons (TPH-D) Concentrations in Soil

Sample Location	Date	Top (1)(2) (feet bgs)	Bottom (1)(2) (feet bgs)	TPH-D Concentration (1)(2) (mg/Kg)
DP-11	1/2/2007	0	2	51 J
DP-11	1/2/2007	8	10	220 J
DP-12	1/2/2007	0	2	43 UJ
DP-12	1/2/2007	8	10	36 U
DP-17	8/3/2007	4	6	130
DP-17	8/3/2007	10	12	88 U
DP-18	8/3/2007	2	4	580
DP-18	8/3/2007	10	12	960
DP-20	8/3/2007	2	4	29 U
DP-20	8/3/2007	10	12	600
DP-21	8/3/2007	6	8	87
DP-21	8/3/2007	10	12	110
DP-29	6/10/2009	13	14	25 U
DP-29	6/10/2009	7	8	25 U
MW-01	1/2/2007	4	6	25 U
MW-01	1/2/2007	10	12	27 U
MW-03	1/2/2007	4	6	27 U
MW-03	1/2/2007	8	10	27 U
MW-04	1/2/2007	2	4	110 J
MW-04	1/2/2007	14	16	29 U
MW-16	7/31/2007	4	6	28 J
MW-16	7/31/2007	16	18	48 J
MW-23S	6/12/2009	5	6	1160
MW-23S	6/12/2009	9	11	25 U

U – Constituent was not detected at the reporting limit / method detection limit shown

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

Screening level = 2,000 mg/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-29, MW-23S

Table 2-12: Summary of Heavy Oil Range Petroleum Hydrocarbon (TPH-HO) Concentrations in Soil

Sample Location	Date	Top[(1)(2)] (feet bgs)	Bottom[(1)(2)] (feet bgs)	TPH-HO Concentration [(1)(2)] (mg/Kg)
DP-11	1/2/2007	0	2	160
DP-11	1/2/2007	8	10	1000
DP-12	1/2/2007	0	2	290
DP-12	1/2/2007	8	10	69 J
DP-17	8/3/2007	4	6	230 U
DP-17	8/3/2007	10	12	490
DP-18	8/3/2007	2	4	730
DP-18	8/3/2007	10	12	4600
DP-20	8/3/2007	2	4	59 U
DP-20	8/3/2007	10	12	97 U
DP-21	8/3/2007	6	8	650
DP-21	8/3/2007	10	12	230
DP-29	6/10/2009	13	14	100 U
DP-29	6/10/2009	7	8	100 U
MW-01	1/2/2007	4	6	7.1 J
MW-01	1/2/2007	10	12	54 U
MW-03	1/2/2007	4	6	22 J
MW-03	1/2/2007	8	10	55 U
MW-04	1/2/2007	2	4	730
MW-04	1/2/2007	14	16	15 J
MW-16	7/31/2007	4	6	53 UJ
MW-16	7/31/2007	16	18	91 J
MW-23S	6/12/2009	5	6	100 U
MW-23S	6/12/2009	9	11	100 U

U – Constituent was not detected at the reporting limit / method detection limit shown

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

Screening level = 2,000 mg/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-29, MW-23S

Table 2-13: Summary of Total Naphthalene Concentrations in Soil

Sample Location	Date	Top (1)(2)(3) (feet bgs)	Bottom (1)(2)(3) (feet bgs)	Concentration(1)(2)(3) (ug/Kg)			
				1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Total naphthalene (4)
DP-11	1/2/2007	0	2	99	150	210	460
DP-11	1/2/2007	8	10	48	89	260 J	400
DP-12	1/2/2007	0	2	18	49	22	89
DP-12	1/2/2007	8	10	4.2 U	2.8 U	2.8 U	4.9
DP-17	8/3/2007	4	6	140 U	93 U	93 U	160
DP-17	8/3/2007	10	12	100 U	69 U	510 U	340
DP-18	8/3/2007	2	4	42 U	28 U	110 U	90
DP-18	8/3/2007	10	12	86 U	57 U	370 U	260
DP-20	8/3/2007	2	4	35 U	23 U	39 U	49
DP-20	8/3/2007	10	12	59 U	39 U	39 U	69
DP-21	8/3/2007	6	8	48 U	32 U	11 J	46
DP-21	8/3/2007	10	12	110 U	73 U	73 U	130
DP-26	6/10/2009	1	2	10	10	10	30
DP-26	6/10/2009	3	4	10	10	10	30
DP-29	6/10/2009	1	2	10	20	50	80
DP-29	6/10/2009	13	14	10 U	10 U	10 U	15
DP-29	6/10/2009	7	8	50	140	390	580
DP-43	9/16/2009	2	3	250 U	250 U	250 U	380
DP-43	9/16/2009	6	7	250 U	250 U	250 U	380
DP-43	9/16/2009	9	10	600	750	250	1600
DP-44	9/16/2009	2	3	250 U	250 U	250 U	380
DP-44	9/16/2009	6	7	250 U	250 U	250 U	380
DP-44	9/16/2009	9	10	250 U	250 U	250 U	380
DP-45	9/16/2009	1	2	250 U	250 U	250 U	380
DP-45	9/16/2009	6	7	250 U	250 U	250 U	380
DP-45	9/16/2009	9	10	250 U	250 U	250 U	380
MW-01	1/2/2007	4	6	3.3 U	2.2 U	2.2 U	3.9
MW-01	1/2/2007	10	12	3.1 U	2 U	2 U	3.6
MW-03	1/2/2007	4	6	3.1 U	2.1 U	2.1 U	3.7
MW-03	1/2/2007	8	10	3.5 U	2.3 U	2.3 U	4.1
MW-04	1/2/2007	2	4	4.7	8	39	52
MW-04	1/2/2007	14	16	3.7 U	2.5 U	2.5 U	4.4
MW-16	7/31/2007	4	6	3.3 U	2.2 U	2.2 U	3.9
MW-16	7/31/2007	14	16	---	---	200 U	100 (5)
MW-16	7/31/2007	16	18	4.8 U	3.2 U	100 U	54
MW-23S	6/12/2009	5	6	10 U	10 U	10 U	15

Table 2-13: Summary of Total Naphthalene Concentrations in Soil

Sample Location	Date	Top (1)(2)(3) (feet bgs)	Bottom (1)(2)(3) (feet bgs)	Concentration(1)(2)(3) (ug/Kg)			
				1-Methyl naphthalene	2-Methyl naphthalene	Naphthalene	Total naphthalene (4)
MW-23S	6/12/2009	9	11	140	140	10 U	290

U – Constituent was not detected at the reporting limit / method detection limit shown

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

Screening level = 5,000 ug/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-26, DP-29, MW-23S

(3) Sample depth and concentration for the following samples reported in Brown and Caldwell, 2009: DP-43, DP-44, DP45

(4) Calculated per Teel, 2010. For congeners detected on site, concentration = ½ RL for results below reporting limit.

(5) No reported value for 1-methylnaphthalene and 2-methylnaphthalene. Value shown is ½ RL for naphthalene

Table 2-14: Summary of Carcinogenic Polynuclear Aromatic Hydrocarbon (cPAH) Toxicity Equivalent (TEQ) Concentrations in Soil

Sample Location	Top (1)(2)(3) (feet bgs)	Bottom (1)(2)(3) (feet bgs)	Date	Concentration (1)(2)(3) (ug/Kg)							
				Benzo(a) pyrene	Benzo(a) anthracene	Benzo(b) fluoranthene	Benzo(k) fluoranthene	Chrysene	Dibenz(a,h,) anthracene	Indeno(1,2,3-cd)pyrene	cPAH TEQ(4)
DP-11	0	2	1/2/2007	780	740	710	220	750	67	460	1000
DP-11	8	10	1/2/2007	120	110	240	54	170	21 U	100	170
DP-12	0	2	1/2/2007	30	24	42	13	32	11	25	42
DP-12	8	10	1/2/2007	6.1	4.7	4.4	3.5 U	4.2	5.6	5.6	8.3
DP-17	4	6	8/3/2007	140 U	120 U	93 U	120 U	120 U	190 U	190 U	110 U
DP-17	10	12	8/3/2007	100 U	95	69 U	86 U	89	140 U	140 U	82
DP-18	2	4	8/3/2007	42 U	35 U	28 U	35 U	35 U	56 U	56 U	32 U
DP-18	10	12	8/3/2007	130	91	57 U	72 U	80	110 U	110 U	160
DP-20	2	4	8/3/2007	35 U	29 U	23 U	29 U	29 U	47 U	47 U	26 U
DP-20	10	12	8/3/2007	59 U	49 U	39 U	49 U	49 U	78 U	78 U	44 U
DP-21	6	8	8/3/2007	48 U	40 U	32 U	40 U	40 U	64 U	64 U	36 U
DP-21	10	12	8/3/2007	110 U	91 U	73 U	91 U	91 U	150 U	150 U	83 U
DP-29	1	2	6/10/2009	300	230	130	80	230	120	310	390
DP-29	13	14	6/10/2009	180	40	10 U	10 U	10 U	160	10 U	200
DP-29	7	8	6/10/2009	190	50	10 U	20	50	10 U	10 U	200
DP-43	2	3	9/16/2009	50 U	50 U	500 U	500 U	500 U	250 U	100 U	98 U
DP-43	6	7	9/16/2009	50 U	50 U	500 U	500 U	500 U	250 U	100 U	98 U
DP-43	9	10	9/16/2009	50 U	60	500 U	500 U	500 U	290	100 U	120
DP-44	2	3	9/16/2009	50 U	50 U	500 U	500 U	500 U	250 U	100 U	98 U
DP-44	6	7	9/16/2009	50 U	50 U	500 U	500 U	500 U	250 U	100 U	98 U
DP-44	9	10	9/16/2009	110	130	500 U	500 U	500 U	250 U	100 U	190
DP-45	1	2	9/16/2009	50 U	50 U	500 U	500 U	500 U	250 U	100 U	98 U
DP-45	6	7	9/16/2009	50 U	50 U	500 U	500 U	500 U	250 U	100 U	98 U
DP-45	9	10	9/16/2009	50 U	50 U	500 U	500 U	500 U	250 U	100 U	98 U
MW-01	4	6	1/2/2007	3.1 U	3.9 U	8.5 U	6.0 U	4.9 U	4.1 U	4.8 U	2.9 U
MW-01	10	12	1/2/2007	6.1 U	3.9 U	5.3 U	2.8 U	4.5 U	4.5 U	4.5 U	4.1 U
MW-03	4	6	1/2/2007	14.0	12.0	14.0	4.5	11.0	4.1	8.1	18
MW-03	8	10	1/2/2007	3.5 U	2.9 U	2.3 U	2.9 U	2.9 U	4.6 U	4.6 U	2.6 U
MW-04	2	4	1/2/2007	82	53	98	37	57	4.8 U	66	110
MW-04	14	16	1/2/2007	3.7 U	3.1 U	2.5 U	3.1 U	3.1 U	4.9 U	4.9 U	2.8 U
MW-16	4	6	7/31/2007	4.1	4.2	4.6	2.8	4.3	4.4	4.4	6.2
MW-16	16	18	7/31/2007	4.8	4.0	3.2	4.0	4.0	6.4	6.4	7.2

MW-23S	5	6	6/12/2009	130	30	10	10	10	120	280	180
MW-23S	9	11	6/12/2009	460	330	340	190	430	190	550	620

U – Constituent was not detected at the reporting limit / method detection limit shown

Screening level = 100 ug/Kg

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: DP-11. DP-12, DP-17, DP-18, DP-20, DP-21, MW-01, MW-03, MW-04, MW-16

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-26, DP-29, MW-23S

(3) Sample depth and concentration for the following samples reported in Brown and Caldwell, 2009: DP-43, DP-44, DP45

(4) Calculated per Teel, 2010. For congeners detected on site, concentration = ½ RL for results below reporting limit.

Table 2-15: Summary of Dioxin / Furan Concentrations in Soil

Sample Location	Date	Top (1)(2)(3)(4) (feet bgs)	Bottom (1)(2)(3) (feet bgs)	Dioxin / Furan Concentration (1)(2)(3)(4) (pg/g)
DP-26	6/10/2009	1	2	45
DP-26	6/10/2009	3	4	4.9
DP-26	6/10/2009	7	8	2.3
DP-29	6/10/2009	1	2	3.5
DP-42	6/10/2009	1	2	31
DP-42	6/10/2009	5	6	4.7
DP-42	6/10/2009	7	8	160
DP-43	9/16/2009	2	3	0.52
DP-43	9/16/2009	6	7	0.36
DP-43	9/16/2009	9	10	2.2
DP-44	9/16/2009	2	3	1.3
DP-44	9/16/2009	6	7	0.26
DP-44	9/16/2009	9	10	0.28
DP-45	9/16/2009	1	2	6.1
DP-45	9/16/2009	6	7	0.71
DP-45	9/16/2009	9	10	4.0
MW-23S	6/12/2009	5	6	1.1
TP-01	10/4/2007	2	3	430
TP-02	10/4/2007	2	3	650

Screening level = 9.8 pg/g

(1) Sample depth and concentration for the following samples reported in GeoEngineers, 2007b: TP-01, TP-02

(2) Sample depth and concentration for the following samples by PIONEER Technologies Corporation for the Port of Olympia per Bussey, 2009 and included as Appendix B: DP-26, DP-29, MW-23S

(3) Sample depth and concentration for the following samples reported in PIONEER, 2008: DP-30

(4) Sample depth and concentration for the following samples reported in Brown and Caldwell, 2009: DP-43, DP-44, DP45

(5) Calculated per Teel, 2010. For congeners detected on site, concentration = ½ RL for results below reporting limit.

Table 2-16: Arsenic Groundwater Sampling Summary

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Total Arsenic Concentration (ug/L) (1)(2)	MW-01	1.3 J	4.1	NS	3.2	1.1	1.0 U	1.2	1.0 U
	MW-02	2.0 U	2.0 U	NS	1.1	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	9.8	8.0	7.5	10.3
	MW-03	2.0 U	2.0 U	NS	7.3	2.7	2.7	4.6	2.2
	MW-04	16	13	NS	9.5	8.0	7.3	5.3	5.2
	MW-16	NS	2.0 U	2.0 U	2.0	0.91	1.0 U	1.0 U	1.4
	MW-17	NS	140	NS	NS	NS	NS	NS	NS
	MW-18	NS	2.0 U	NS	2.2	1.3	1.0 U	1.0 U	1.0 U
	MW-19	NS	2.0 U	NS	1.6	0.5 U	2.4	2.6	NS
	MW-21S	NS	NS	NS	4.8	4.6	NS	NS	3.2
	MW-23S	NS	NS	NS	0.9	0.56	2.9	1.6	1.0 U

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Dissolved Arsenic Concentration (ug/L) (1)(2)	MW-01	NS	NS	NS	NS	4.7 BJ	1.0 U	1.0 U	1.0 U
	MW-02	NS	NS	NS	5.4 BJ	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	13 BJ	1.6	1.0 U	1.3
	MW-03	NS	NS	NS	10 BJ	9.7 BJ	3.0	4.0	2.3
	MW-04	NS	NS	NS	8.7 BJ	9.9 BJ	1.8	1.0 U	1.0 U
	MW-16	NS	NS	NS	4.4 BJ	4.7 BJ	1.0 U	1.0 U	1.0 U
	MW-17	NS	NS	NS	NS	NS	NS	NS	NS
	MW-18	NS	NS	NS	6.2 BJ	3.6 BJ	1.0 U	1.0 U	1.0 U
	MW-19	NS	NS	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	5.1 BJ	5.9 BJ	NS	NS	1.0 U
	MW-23S	NS	NS	NS	NS	3.9 BJ	1.9	1.0 U	1.0 U

B – Analyte detected in method blank

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 5.0 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-17: Total Cadmium Groundwater Sampling Summary

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Concentration (1)(2) (ug/L)	MW-01	2.0 U	2.0 U	NS	0.5 U	0.5 U	NS	1.0 U	NS
	MW-02	2.0 U	2.0 U	NS	0.5 U	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	0.5 U	NS	1.0 U	NS
	MW-03	2.0 U	2.0 U	NS	0.5 U	0.5 U	NS	1.0 U	NS
	MW-04	2.0 U	2.0 U	NS	0.5 U	0.5 U	NS	1.0 U	NS
	MW-16	NS	2.0 U	2.0 U	0.5 U	0.5 U	NS	1.0 U	NS
	MW-17	NS	2.0 U	NS	NS	NS	NS	NS	NS
	MW-18	NS	2.0 U	NS	0.69	0.5 U	NS	1.0 U	NS
	MW-19	NS	2.0 U	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	0.5 U	0.5 U	NS	NS	NS
	MW-23S	NS	NS	NS	0.5 U	0.5 U	NS	1.0 U	NS

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 8.8 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-18: Lead Groundwater Sampling Summary

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Total Lead Concentration (1)(2) (ug/L)	MW-01	0.025 U	2.0 U	NS	1.1	2.7	1.0 U	1.0 U	1.0 U
	MW-02	5.1 J	2.0 U	NS	1.0	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	45	9.3	7.0	7.5
	MW-03	0.24 UJ	2.0 U	NS	1.9	0.5 U	1.0 U	1.0 U	1.0 U
	MW-04	0.04 J	2.0 U	NS	1.9	0.61	1.0 U	1.0 U	1.0 U
	MW-16	NS	2.0 U	0.76	4.8	2.9	1.0 U	1.0 U	2.5
	MW-17	NS	2.0 U	NS	NS	NS	NS	NS	NS
	MW-18	NS	2.0 U	NS	0.5 U	0.5 U	1.0 U	1.0 U	1.0 U
	MW-19	NS	2.0 U	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	0.5 U	0.5 U	NS	NS	1.0 U
	MW-23S	NS	NS	NS	2.9	1.8	1.6	1.0 U	1.2

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Dissolved Lead Concentration (1)(2) (ug/L)	MW-01	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U
	MW-02	NS	NS	NS	0.5 U	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U
	MW-03	NS	NS	NS	0.5 U	NS	1.0 U	1.0 U	1.0 U
	MW-04	NS	NS	NS	0.7 BJ	NS	1.0 U	1.0 U	NS
	MW-16	NS	NS	NS	1.4 BJ	NS	1.0 U	1.0 U	1.0 U
	MW-17	NS	NS	NS	NS	NS	NS	NS	NS
	MW-18	NS	NS	NS	0.5 U	NS	1.0 U	1.0 U	1.0 U
	MW-19	NS	NS	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	0.5 U	NS	NS	NS	1.0 U
	MW-23S	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U

B – Analyte detected in method blank

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 8.1 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a
(2) March 2010 per Bussey 2010a

Table 2-19: Copper Groundwater Sampling Summary

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Total Copper Concentration (1)(2) (ug/L)	MW-01	NS	NS	NS	2.4 BJ	**2.5 BJ**	1.1	1.0	2.1
	MW-02	NS	NS	NS	1.5 BJ	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	**3.4 BJ**	1.5	1.0 U	1.5
	MW-03	NS	NS	NS	**4.6 BJ**	0.91 BJ	1.0 U	2.4	1.0 U
	MW-04	NS	NS	NS	**8.4 BJ**	1.3 BJ	1.4	1.2	2.6
	MW-16	NS	NS	NS	**5.4 BJ**	**2.6 BJ**	1.0 U	1.0 U	4.7
	MW-17	NS	NS	NS	NS	NS	NS	NS	NS
	MW-18	NS	NS	NS	**3.6 BJ**	2.2 BJ	2.2	4.5	3.7
	MW-19	NS	NS	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	0.5 BJ	0.62 BJ	NS	NS	1.0
	MW-23S	NS	NS	NS	**2.9 BJ**	0.95 BJ	2.4	1.0 U	1.6

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Dissolved Copper Concentration (1)(2) (ug/L)	MW-01	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U
	MW-02	NS	NS	NS	**2.7 BJ**	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U
	MW-03	NS	NS	NS	2.3 BJ	NS	1.0 U	1.0 U	1.0 U
	MW-04	NS	NS	NS	0.7 BJ	NS	1.0 U	1.0 U	1.0 U
	MW-16	NS	NS	NS	1.7 BJ	NS	1.0 U	1.0 U	1.0 U
	MW-17	NS	NS	NS	NS	NS	NS	NS	NS
	MW-18	NS	NS	NS	0.5 U	NS	2.0	3.8	1.2
	MW-19	NS	NS	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	0.8 BJ	NS	NS	NS	1.0 U
	MW-23S	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U

B – Analyte detected in method blank

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 2.4 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-20: Nickel Groundwater Sampling Summary

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Total Nickel Concentration (1)(2) (ug/L)	MW-01	NS	NS	NS	1.5	1.5 BJ	1.0 U	1.0 U	1.0 U
	MW-02	NS	NS	NS	0.5 U	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	0.73 BJ	1.0 U	1.0 U	1.0 U
	MW-03	NS	NS	NS	5.6	1.0 BJ	1.0 U	1.9	1.0 U
	MW-04	NS	NS	NS	2.8	1.5 BJ	1.4	1.0 U	1.0 U
	MW-16	NS	NS	NS	2.8	1.4 BJ	1.0 U	1.0 U	2.5
	MW-17	NS	NS	NS	NS	NS	NS	NS	NS
	MW-18	NS	NS	NS	2.3	1.2 BJ	1.2	1.4	1.6
	MW-19	NS	NS	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	1.1	0.92 BJ	NS	NS	1.0 U
	MW-23S	NS	NS	NS	0.7	0.51 BJ	1.4	1.0 U	1.2

	Monitoring Well	Date							
		Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
Dissolved Nickel Concentration (1)(2) (ug/L)	MW-01	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U
	MW-02	NS	NS	NS	0.5 U	NS	NS	NS	NS
	MW-02R	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U
	MW-03	NS	NS	NS	1.7 BJ	NS	1.0 U	1.0 U	1.0 U
	MW-04	NS	NS	NS	1.1 BJ	NS	1.0 U	1.0 U	1.0 U
	MW-16	NS	NS	NS	0.8 BJ	NS	1.0 U	1.0 U	1.0 U
	MW-17	NS	NS	NS	NS	NS	NS	NS	NS
	MW-18	NS	NS	NS	0.5 U	NS	1.0 U	1.0 U	1.0 U
	MW-19	NS	NS	NS	NS	NS	NS	NS	NS
	MW-21S	NS	NS	NS	1.1 BJ	NS	NS	NS	1.0 U
	MW-23S	NS	NS	NS	NS	NS	1.0 U	1.0 U	1.0 U

B – Analyte detected in method blank

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 8.2 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-21: TPH-G Groundwater Sampling Summary

Monitoring Well	Concentration (1)(2) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	16 J	50 U	NS	50 U	50 U	NS	500 U	250 U
MW-02	11 J	50 U	HS	50 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	50 U	NS	500 U	250 U
MW-03	21 J	50 U	NS	50 U	50 U	NS	500 U	250 U
MW-04	44 J	79	NS	50 U	50 U	NS	500 U	250 U
MW-16	NS	50 U	NS	50 U	50 U	NS	500 U	250 U
MW-17	NS	50 U	NS	NS	NS	NS	NS	NS
MW-18	NS	50 U	NS	50 U	50 U	NS	500 U	250 U
MW-19	NS	50 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	50 U	50 U	NS	500 U	250 U
MW-23S	NS	NS	NS	50 U	50 U	NS	500 U	250 U

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 1,000 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-22: Benzene Groundwater Sampling Summary

Monitoring Well	Concentration $^{(1)(2)}$ (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	1.0 U	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-02	1.0 U	1.0 U	NS	0.5 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	0.5 U	NS	0.5 U	0.5 U
MW-03	1.0 U	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-04	1.0 U	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-16	NS	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-17	NS	1.0 U	NS	NS	NS	NS	NS	NS
MW-18	NS	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-19	NS	1.0 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	0.5 U	0.5 U	NS	NS	0.5 U
MW-23S	NS	NS	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 23 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-23: Toluene Groundwater Sampling Summary

Monitoring Well	Concentration (1)(2) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	1.0 U	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-02	0.075 J	1.0 U	NS	0.5 U	NS	NS	NS	NS
MW-02R	Ns	NS	NS	NS	0.5 U	NS	0.5 U	0.5 U
MW-03	0.076 J	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-04	0.26 J	0.12 J	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-16	NS	0.078 J	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-17	NS	1.0 U	NS	NS	NS	NS	NS	NS
MW-18	NS	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-19	NS	1.0 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	0.5 U	0.5 U	NS	NS	0.5 U
MW-23S	NS	NS	NS	0.5 U	0.59	NS	0.5 U	0.5 U

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 15,000 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-24: Ethylbenzene Groundwater Sampling Summary

Monitoring Well	Concentration (1)(2) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	1.0 U	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-02	1.0 U	1.0 U	NS	0.5 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	0.5 U	NS	0.5 U	0.5 U
MW-03	1.0 U	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-04	1.0 U	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-16	NS	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-17	NS	1.0 U	NS	NS	NS	NS	NS	NS
MW-18	NS	1.0 U	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U
MW-19	NS	1.0 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	0.5 U	0.5 U	NS	NS	0.5 U
MW-23S	NS	NS	NS	0.5 U	0.5 U	NS	0.5 U	0.5 U

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 2,100 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-25: Total Xylenes Groundwater Sampling Summary

Monitoring Well	Concentration (1)(2) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	3.0 U	1.0 U	NS	1.0 U	1.0 U	NS	0.5 U	1.5 U
MW-02	3.0 U	1.0 U	NS	1.0 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	1.0 U	NS	0.5 U	1.5 U
MW-03	3.0 U	1.0 U	NS	1.0 U	1.0 U	NS	0.5 U	1.5 U
MW-04	3.0 U	1.0 U	NS	1.0 U	1.0 U	NS	0.5 U	1.5 U
MW-16	NS	0.99 J	NS	1.0 U	1.0 U	NS	0.5 U	1.5 U
MW-17	NS	1.0 U	NS	NS	NS	NS	NS	NS
MW-18	NS	0.37 J	NS	1.0 U	1.0 U	NS	0.5 U	1.5 U
MW-19	NS	0.73 J	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	1.0 U	1.0 U	NS	NS	1.5 U
MW-23S	NS	NS	NS	1.0 U	1.0 U	NS	0.5 U	1.5 U

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 1,000 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

Table 2-26: TPH-D Groundwater Sampling Summary

Monitoring Well	Concentration [(1)(2)] (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	41 J	120 U	NS	250 U	250 U	NS	340	100 U
MW-02	120 U	120 U	NS	250 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	250 U (3)	NS	100 U	104
MW-03	130 U	120 U	NS	250 U	250 U	NS	100 U	100 U
MW-04	77 J	120 UJ	NS	250 U	250 U	NS	100 U	100 U
MW-16	NS	120 U	NS	250 U	250 U	NS	160	100 U
MW-17	NS	120 U	NS	NS	NS	NS	NS	NS
MW-18	NS	120 U	NS	250 U	250 U	NS	1060	100 U
MW-19	NS	120 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	250 U	250 U	NS	NS	100 U
MW-23S	NS	NS	NS	250 U	250 U	NS	170	100 U

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 500 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

(3) The TPH-HO value for the sample collected from MW02R in September 2009 was rejected by the primary laboratory. As a result, MW02R was re-sampled in October and re-analyzed for TPH-D and TPH-HO by the primary and secondary laboratories. The concentration shown for MW02R is the original September 2009 sample analyzed by the primary laboratory. The TPH-D concentrations reported by the primary laboratory and secondary laboratory for the October re-sample were 250 U ug/L and 480 ug/L, respectively (PIONEER, 2010a).

Table 2-27: TPH-HO Groundwater Sampling Summary

Monitoring Well	Concentration (1)(2) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	250 U	240 U	NS	500 U	500 U	NS	500 U	500 U
MW-02	250 U	240 U	NS	500 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	500 U(3)	NS	620	500 U
MW-03	250 U	240 U	NS	500 U	500 U	NS	960	500 U
MW-04	250 U	260 U	NS	500 U	500 U	NS	500 U	500 U
MW-16	NS	240 U	NS	500 U	500 U	NS	500 U	500 U
MW-17	NS	240 U	NS	NS	NS	NS	NS	NS
MW-18	NS	230 U	NS	500 U	500 U	NS	690	500 U
MW-19	NS	240 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	500 U	500 U	NS	NS	500 U
MW-23S	NS	NS	NS	500 U	500 U	NS	500 U	500 U

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 500 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

(3) The TPH-HO value for the sample collected from MW02R in September 2009 was rejected by the primary laboratory. As a result, MW02R was re-sampled in October and re-analyzed for TPH-D and TPH-HO by the primary and secondary laboratories. The concentration shown for MW02R is the original September 2009 sample analyzed by the primary laboratory. The TPH-D concentrations reported by the primary laboratory and secondary laboratory for the October re-sample were 250 U ug/L and 480 ug/L, respectively (PIONEER, 2010a).

Table 2-28: Total Naphthalenes Groundwater Sampling Summary

Monitoring Well	Concentration (1)(2)(3) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	0.031 J	0.55 U	NS	0.015 U	0.015 U	0.01 U	0.01 U	0.039
MW-02	0.026 J	0.55 U	NS	0.015 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	0.015 U	0.01 U	0.01 U	0.01 U
MW-03	0.22	0.25	NS	0.2	0.015 U	0.01 U	.018	0.01 U
MW-04	0.065 J	0.55 U	NS	0.015 U	0.015 U	0.13	0.042	0.038
MW-16	NS	0.32 J	0.021	0.015 U	0.015 U	0.076	0.016	0.025
MW-17	NS	0.55 U	NS	NS	NS	NS	NS	NS
MW-18	NS	0.55 U	NS	0.015 U	0.015 U	0.01 U	0.01 U	0.01 U
MW-19	NS	0.55 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	0.015 U	0.015 U	NS	NS	0.01 U
MW-23S	NS	NS	NS	0.015 U	0.015 U	0.41	0.01 U	0.021

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 4,300 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey 2010a

(3) Calculated per Teel, 2010. For congeners detected on site, concentration = ½ RL for results below reporting limit.

Table 2-29: cPAH TEQ Groundwater Sampling Summary

Monitoring Well	Concentration (1)(2)(5) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09 (3,4)	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	0.018 U	0.016U	NS	0.38 JN	0.0075 U	0.0075 U	0.0075 U	0.0075 U
MW-02	0.033	0.016 U	NS	0.0076 U	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	0.0075 U	0.0075 U	0.0075 U	0.0075 U
MW-03	0.18 U	0.016 U	NS	0.20 JN	0.0075 U	0.0075 U	0.035	0.0075 U
MW-04	0.017 J	0.016 U	NS	0.20 JN	0.0075 U	0.0075 U	0.0075 U	0.0075 U
MW-16	NS	0.018 U	0.018 U	0.38 JN	0.0075 U	0.0075 U	0.0075 U	0.0075 U
MW-17	NS	0.017 U	NS	NS	NS	NS	NS	NS
MW-18	NS	0.017 U	NS	0.19 JN	0.0075U	0.0075 U	0.0075 U	0.0075 U
MW-19	NS	0.017 U	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	0.19 JN	0.0075 U	NS	NS	0.0075 U
MW-23S	NS	NS	NS	0.027 JN	0.0075 U	0.0097	0.0075 U	0.0075 U

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

N – Tentatively identified compound

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 0.018 ug/L

(1) January 2007 through December 2009 reported in PIONEER, 2010a

(2) March 2010 per Bussey, 2010a

(3) The detections by the primary laboratory used for the June 2009 and September 2009 events are highly suspect and have been assigned a JN-flag per PIONEER, 2010a.

(4) Split samples were collected from all monitoring wells that were sampled during the September 2009, November 2009, and December 2009 events and submitted to the secondary laboratory for cPAH analysis. No cPAH constituents were detected in any of the split PAH samples at practical quantitation limits ranging from 0.041 ug/L to 0.047 ug/L, which were the lowest quantitation limits the secondary laboratory could achieve (PIONEER, 2010a).

(5) Calculated per Teel, 2010. For congeners detected on site, concentration = ½ RL for results below reporting limit.

Table 2-30: Dioxin / Furan Groundwater Sampling Summary

Monitoring Well	Concentration (1) (ug/L)							
	Date							
	Jan-07	Jun-07 – Aug-07	Jul-08	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW-01	NS	NS	NS	NS	NS	NS	NS	NS
MW-02	NS	NS	NS	NS	NS	NS	NS	NS
MW-02R	NS	NS	NS	NS	NS	NS	NS	NS
MW-03	NS	NS	NS	NS	NS	NS	NS	NS
MW-04	NS	NS	NS	NS	NS	NS	NS	NS
MW-16	NS	NS	1.0E-6	2.8E-6	3.2E-6	NS	6.5 E-6 U	NS
MW-17	NS	NS	NS	NS	NS	NS	NS	NS
MW-18	NS	NS	NS	NS	NS	NS	NS	NS
MW-19	NS	NS	NS	NS	NS	NS	NS	NS
MW-21S	NS	NS	NS	NS	NS	NS	NS	NS
MW-23S	NS	NS	NS	NS	NS	NS	NS	NS

J – Reported value is greater than the method detection limit but less than the reporting limit. Value shown is estimated.

U – Constituent was not detected at the reporting limit / method detection limit shown

NS – Not sampled

Surface water screening level = 1.0E-05 ug/L

(1) Reported in PIONEER, 2010a

(2) Calculated per Teel, 2010. For congeners detected on site, concentration = ½ RL for results below reporting limit.

Table 3-1: Remedial Alternative Screening Matrix

General Action Type	Remediation Technology	Process Option	Description	Effectiveness	Implementability	Timeframe (years)	Cost(1)	Applicable Areas	Summary of Screening
In-Situ	Biological Treatment	Bioventing	Oxygen is supplied to the soil through pneumatic equipment and air injection wells. The enhanced oxygen supply stimulates biodegradation by naturally occurring organisms.	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels Not typically effective for metals. Bioremediation can change the oxidation state of metals to increase adsorption, but these treatments are largely experimental.	Air transmissitvity of soil at East Bay is not known. Concentration of hydrocarbon – degrading microorganisms is not known. Pilot testing likely required. Final site would require footprint for bioventing equipment.	1-3	Heavily dependent on site size; $60/CY - $85/CY for large sites	Applicable to parcelwide cPAHs and TPH hot spots; other technology would be required for metals hot spots.	Screened from further analysis due to limited effectiveness for target COPCs and relatively long timeframe.
In-Situ	Biological Treatment	Enhanced Bioremediation	Indigenous or introduced microorganisms degrade soil constituents. Nutrients or oxygen may be supplied.	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels Not typically effective for metals. Bioremediation can change the oxidation state of metals to increase adsorption, but these treatments are largely experimental.	Concentration of hydrocarbon – degrading microorganisms is not known. Pilot testing likely required.	1-3	$20/CY - $85/CY	Applicable to parcelwide cPAHs and TPH hot spots; other technology would be required for metals hot spots.	Screened from further analysis due to limited effectiveness for target COPCs and relatively long timeframe.
In-Situ	Biological Treatment	Phytoremediation	Plants are selected to remove, transfer, stabilize, and / or destroy constituents.	Limited effectiveness for SVOCs / cPAHs Limited effectiveness for TPH / fuels Limited effectiveness for metals	Additional soil data required for design. Pilot testing likely required. Depth limited to shallow soils.	>3	Heavily dependent on site size, COPCs, and plant selection; $110/CY - $370/CY.	Sitewide	Screened from further analysis due to limited effectiveness for target COPCs and relatively long timeframe.
In-Situ	Physical / Chemical	Electrokinetic Separation	An electrochemical / electrokinetic process desorbs and separates metals and polar organics from soil.	Limited effectiveness for SVOCs / cPAHs No demonstrated effectiveness for TPH / fuels Typically effective for metals	Additional soil data required for design. Primarily a separation process; a secondary remediation process is often required to remove contaminants. Effectiveness is heavily influenced by permeability, saturation, and electrochemical properties of soils. Pilot testing likely required. Partially experimental; technology is not widely used in the United States.	1-3	Unknown; experimental technology with limited cost data available	Applicable for metals hot spots and property-wide for metals. Other technology will be required for TPH; other technology likely required for cPAHs and dioxins / furans.	Screened from further analysis due to limited effectiveness for target COPCs and relatively long timeframe. Additionally, more hydrogeological information would be required to design system.
In-Situ	Physical / Chemical	Soil Vapor Extraction	Vacuum is applied to extraction wells to vaporize and remove volatile compounds.	No demonstrated effectiveness for SVOCs / cPAHs Typically effective for TPH / fuels No demonstrated effectiveness for metals	Additional soil data required for design. Typically less effective for heavy-fraction TPH (diesel and heavy oil). Not effective in the saturated zone. Requires site footprint for long-term pneumatic equipment.	1-3	Heavily dependent on COPCs and hydrogeology; $300/CY - $720/CY	Limited to TPH-impacted area on Parcel 4. Other areas would require different remedial actions.	Screened from further analysis due to limited effectiveness for target COPCs, cost, and relatively long timeframe.
In-Situ	Physical / Chemical	Solidification / Stabilization	Contaminants are physically bound or chemically reacted in-situ to reduce mobility.	Limited effectiveness for SVOCs / cPAHs No demonstrated effectiveness for TPH / fuels	Additional soil data required to determine solidification / stabilization target areas. Pilot testing or treatability testing likely required.	<1	$50/CY- $80/CY	Sitewide. Separate treatment would be required for TPH-impacted areas on	Selected for further analysis

Table 3-1: Remedial Alternative Screening Matrix

General Action Type	Remediation Technology	Process Option	Description	Effectiveness	Implementability	Timeframe (years)	Cost (1)	Applicable Areas	Summary of Screening
				Typically effective for metals				Parcel 4.	
In-Situ	Thermal Treatment	Thermal Treatment	Steam, hot air, electrical resistance, or another heating method is applied to soil to increase the volatilization rate and facilitate extraction	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels No demonstrated effectiveness for metals	Additional soil data required for design. Pilot testing likely required. Primarily enhances transport, so a second remedial technology such as SVE would likely be required to remove COPCs. Off gassing may result in air contamination concerns or air permitting requirements.	<1	$30/CY-$40/CY, excluding vapor capture and treatment	Applicable to TPH impacted areas and property-wide for cPAHs; separate technology would be required for metals treatment.	Screened from further analysis due to limited effectiveness for target COPCs. Additionally, the need for a vapor treatment system to limit off-gassing in a residential / commercial area would result in a high-cost solution.
Ex-Situ	Biological Treatment	Biopiles	Excavated soils are mixed with additives and placed in above-grade enclosures. Piles are aerated to enhance biodegradation	Limited effectiveness for SVOCs / cPAHs Typically effective for TPH / fuels Not typically effective for metals.	Requires excavation. Requires treatability testing to determine nutrient and oxygen loading rates. May require pilot testing. May require off-gassing control or air permitting.	0.5-1	$30/CY-$60/CY	Limited to TPH-impacted area on Parcel 4. Other areas would require different remedial actions.	Screened from further analysis due to limited effectiveness for target COPCs. Additionally, off-gassing in a commercial / residential area may be a concern.
Ex-Situ	Biological Treatment	Composting	Contaminated soil is excavated and mixed with bulking agents and organic amendments (i.e., wood chips, hay, biological or vegetative wastes). Amendments ensure porosity and provide carbon and nitrogen to enhance microbial activity.	Limited effectiveness for SVOCs / cPAHs Typically effective for TPH / fuels No demonstrated effectiveness for metals	Requires excavation. Substantial space requirements. Addition of amendments results in an increase in material volume; the increased material volume will need to be addressed. Metals are diluted through the added volume of material, but are not treated. Treatability studies or pilot testing may be required.	0.5-1	$480/CY-$550/CY	Sitewide if effective treatment for cPAHs is developed; limited to TPH-impacted areas of Parcel 4 otherwise. Separate treatment required for metals.	Screened from further analysis due to limited effectiveness for target COPCs, space requirements, cost, and increase in material volume.
Ex-Situ	Biological Treatment	Landfarming	Contaminated soils are excavated and applied into lined beds. Beds are periodically turned or tilled to provide aeration.	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels No demonstrated effectiveness for metals	Requires excavation. Substantial space requirements. Treatability studies or pilot testing may be required. Requires measures to control leaching from landfarmed soils.	1-3	~$75/CY	Sitewide for cPAHs and TPH. Separate treatment required for metals.	Screened from further analysis due to limited effectiveness for COPCs, space requirements, and timeframe.
Ex-Situ	Biological Treatment	Slurry-Phase Biological Treatment	An aqueous slurry is created by mixing excavated soil with water and additives to enhance biodegradation. The slurry is mixed in a bioreactor to suspend solids and to maintain contact between biologically active microbes and contaminants. The slurry is dewatered upon completion of remediation.	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels May be effective for metals, dependent on specific constituent and application	Requires excavation. Treatability or pilot studies likely required. Increases the volume of material by creating a secondary aqueous waste stream. Off-gas from slurry reactor may result in air contamination or require permitting.	0.5-1	$130/CY-$200/CY	Applicable property-wide. Secondary treatment may be required for metals.	Screened from further analysis due to uncertainty of applicability for metals, secondary waste stream concerns, and cost.

Table 3-1: Remedial Alternative Screening Matrix

General Action Type	Remediation Technology	Process Option	Description	Effectiveness	Implementability	Timeframe (years)	Cost (1)	Applicable Areas	Summary of Screening
Ex-Situ	Physical / Chemical	Chemical Extraction	Excavated soils are mixed with acids or solvents in an extractor. The fluids are then transferred to a separator, where contaminants are separated for further treatment or disposal.	Typically effective for SVOCs / cPAHs Limited effectiveness for TPH / fuels Typically effective for metals	Requires excavation. Requires acid or solvent handling. May require pilot testing or treatability study. Results in secondary waste stream that requires treatment or disposal.	0.5-1	~$275/CY; excluding treatment / disposal of extracted waste	Property-wide. TPH impacts on Parcel 4 may require separate technology.	Screened from further analysis due to cost, chemical handling concerns in commercial / residential area, and cost.
Ex-Situ	Physical / Chemical	Reduction / Oxidation	Excavated soils are reacted with reducing or oxidizing agents. Contaminants are converted to non-hazardous, less toxic, less mobile, and/or inert compounds,	Limited effectiveness for SVOCs / cPAHs Limited effectiveness for TPH / fuels Typically effective for metals	Requires excavation. Requires handling of large quantities of reducing / oxidizing agents on-site. Incomplete reaction may result in secondary contamination.	< 0.5	$150/CY - $500/CY	May be applicable property-wide for metals. Separate technology would be required for cPAHs and TPH.	Screened from further analysis due to limited effectiveness for target COPCs, chemical handling concerns in a commercial / residential area, and cost.
Ex-Situ	Physical / Chemical	Separation	Excavated soils are processed to remove contaminants through physical means. Alternatives include gravity separation, magnetic separation, and sieving or physical separation.	Limited effectiveness for SVOCs / cPAHs Limited effectiveness for TPH / fuels Limited effectiveness for metals	Requires excavation. Results in secondary waste stream (extracted contaminants), typically aqueous, that must be treated or disposed of. Typically most applicable when contamination is concentrated in fine soil fraction.	< 0.5	Variable, depending on separation technology.	Dependent on process selected. It is unlikely that one separation technology will address all COPCs; separate technologies likely required.	Screened from further analysis due to unknown effectiveness for target COPCs and secondary waste stream management concerns.
Ex-Situ	Physical / Chemical	Solidification / Stabilization	Soils are excavated and mixed with additives. Contaminants are physically bound or chemically reacted to reduce mobility.	Limited effectiveness for SVOCs / cPAHs No demonstrated effectiveness for TPH / fuels Typically effective for metals	Requires excavation. Results in secondary media that must be managed. For the COPCs on the site, asphalt / Portland cement may be produced. Off-gassing may result in air contamination and air permitting requirements. Mobile treatment systems (such as asphalt or batch concrete plants) may have pollution / noise issues. Treatability or pilot studies may be required.	< 0.5	$95/CY - $145/CY	Potentially applicable property-wide. TPH-impacted areas may require separate treatment	Screened from further analysis due to secondary media management concerns and implementability concerns for mobile facility in commercial / residential areas.
Ex-Situ	Thermal Treatment	Incineration	Soils are excavated and combusted on-site at high temperatures (1,600 deg F – 2,200 deg F) to destroy organic contaminants.	Typically effective for SVOCs / cPAHs Typically effective for THP / fuels No demonstrated effectiveness for metals	Requires excavation. Incineration of chlorinated solvents, PCBs, or dioxins is generally not permitted. Results in secondary waste stream (ash) that must be managed. Metals will be concentrated in the ash. Some metals may leave in the flue gas stream, resulting in air pollution. Metals may react with combustion products, resulting in chemicals with increased toxicity. Results in off-gassing; air permit likely required.	< 0.5	$700/CY - $1,100/CY	Sitewide for cPAHs and TPH.	Screened from further analysis. Incineration is not an acceptable alternative for metals or dioxin containing soil, and is not generally implementable in a commercial / residential area.

Table 3-1: Remedial Alternative Screening Matrix

General Action Type	Remediation Technology	Process Option	Description	Effectiveness	Implementability	Timeframe (years)	Cost$^{(1)}$	Applicable Areas	Summary of Screening
					Mobile treatment systems will likely have pollution / noise issues.				
Ex-Situ	Thermal Treatment	Pyrolysis	Soils are excavated and heated in the absence of oxygen. Organic contaminants are gassified and removed. The process results in a solid coke residue containing fixed carbon and ash.	Typically effective for SVOCs / cPAHs Limited effectiveness for TPH / fuels No demonstrated effectiveness for metals	Requires excavation. Thermal treatment of chlorinated solvents, PCBs, or dioxins must be carefully managed to avoid the production of compounds with increased toxicity. Results in secondary waste stream (coke) that must be managed. Metals will be concentrated in the coke. Some metals may leave in the flue gas stream, resulting in air pollution. Results in off-gassing; air permit likely required. Mobile treatment systems will likely have pollution / noise issues.	< 0.5	$300/CY	Sitewide for cPAHs and TPH. Additional treatment would be required for metals.	Screened from further analysis. Pyrolysis is not generally implementable in a commercial / residential area and results in secondary waste management concerns.
Ex-Situ	Thermal Treatment	Thermal Desorption	Soils are excavated and heated to volatilize organic contaminants. A gas extraction system removed vapor.	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels No demonstrated effectiveness for metals	Requires excavation. TPHs and SVOCs have different thermal desorption requirements; may be more effective to treat TPH with a separate technology. Pilot testing or treatability studies may be required. Results in off-gassing; air permit or gas collection and treatment system likely required. Mobile treatment systems will likely have pollution / noise issues.	< 0.5	$40/CY - $100/CY	Property wide. Additional treatment will be required for metals.	Screened from further analysis due to limited effectiveness for target COPCs and implementability issues in a commercial / residential area.
Containment	---	Capping	Physical barriers to prevent the mobility of contaminants or to prevent contact between receptors and contaminants are installed.	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels Typically effective for metals	Prevents mobility of COPCs, but does not reduce volume or toxicity; material left in place must be managed with Institutional Controls. Quality assurance in construction is critical. Cannot prevent horizontal flow of groundwater through waste, only vertical infiltration of rainwater.	< 0.5	$5/SF - $25/SF	Property-wide	Considered for further evaluation.
Excavation / Disposal	---	Excavation / Disposal	Soils are excavated and removed from the site. Removed soils may be landfilled or treated using one of the ex-situ technologies described above.	Typically effective for SVOCs / cPAHs Typically effective for TPH / fuels Typically effective for metals	Requires excavation. Large quantities disposed off-site create significant tuck traffic. Disposal may incorporate off-site ex-situ methods (incineration, solidification / stabilization)	< 0.5	$65/CY - $105/CY$^{(2)}$	Property-wide	Considered for further evaluation

Table 3-1: Remedial Alternative Screening Matrix

General Action Type	Remediation Technology	Process Option	Description	Effectiveness	Implementability	Timeframe (years)	Cost(1)	Applicable Areas	Summary of Screening

Alternatives selected for further analysis shown in bold.

(1) Screening costs per FRTF, 2010.
(2) Engineer's estimate based on area bid prices

Table 3-2: Interim Action Cleanup Level (IACLs) and Interim Action Remediation Levels (IARLs)

COC	IACL (mg/Kg)	IARL (mg/Kg)
Arsenic (1)	20	20
Cadmium	72(2)	1,300(3)
Lead (1)	250	250
Copper (4)	2,700	2,700
Nickel (4)	1,400	1,400
TPH-G (1)	100	100
Benzene (5)	0.22	0.22
Toluene (5)	240	240
Ethylbenzene (5)	43	43
Total Xylenes (5)	23	23
TPH-D (1)	2,000	2,000
TPH-HO (1)	2,000	2,000
Total Naphthalenes (5)	160	160
Total cPAH TEQ	0.10(2)	3.4(3)
Total Dioxin / Furan TEQ	9.8E-6(2)	5.1E-4(3)

(1) Per MTCA Method A, WAC 173-340-900 Table 740-1

(2) Per PIONEER, 2009, with soil to surface water via groundwater pathway incomplete per Ecology, 2010b. Calculations included in Appendix D.

(3) Level for utility workers per PIONEER, 2009, with soil to surface water pathway incomplete per Ecology, 2010b. Calculations included in Appendix D.

(4) Calculations included in Appendix C, Levels based on direct contact for unrestricted land use. Levels are justified based on the criteria for Interim Actions under MTCA (WAC 173-340-430(2)) and the absence of soil data for the Site. Soil data for these COPCs will be collected during the IA for comparison to available area background data.

(5) Levels per PIONEER, 2009.

Table 3-3: Solidification / Stabilization Volume Tabulation

Volume	Area (square feet)	Depth (feet)	Volume (cubic yards)
Total soil volume	116,000	6	25,800
Volume exceeding IACLs (*assumed at 60% based on available soil data)*	---	---	15,500

Table 3-4: Solidification / Stabilization Opinion of Probable Cost

Item	Unit Cost	Units	Quantity	Total Cost
Pre-IA Sampling – Direct Push Rig	$2,000	Days	10	$20,000
Pre-IA Sampling – Analytical Costs	$1,250	Sample	870	$1,088,000
Treatability Study	$75,000	LS	1	$75,000
Solidification / Stabilization[(1)]	$65	CY	15,500	$1,008,000
Subtotal - Base Construction Cost				$2,191,000
Contractor Overhead and Profit	18%			$394,000
Subtotal				$ 2,585,000
Engineering	$120	Hours	360	$ 43,000
Subtotal				$ 2,628,000
Allied Costs (Management, Legal, and Administrative)	20%			$ 526,000
Contingency	20%			$ 526,000
Total				$ 3,680,000

(1) Quantity based on assumption that 60% of soil exceeds IACLs

Table 3-5: Sample Locations and Analytical Constituents

Location	Sample Type	Depth of Contamination (feet)	Hotspot Constituent	Initial Excavation Depth (feet)	Initial Sidewall Sample Depths (feet)	Analytical Constituents
TP-02	Sidewall and Bottom Confirmation Samples	2	Dioxins/Furans	10	0-2, 2-3, 3-4, 7-8*	Dioxins/Furans
DP-11	Sidewall and Bottom Confirmation Samples	8-10	Lead	12	8-10*	Arsenic, Lead, Copper, and Nickel
DP-17	Sidewall and Bottom Confirmation Samples	10-12	Arsenic	15	10-12*	Arsenic, Lead, Copper, and Nickel
DP-18	Sidewall and Bottom Confirmation Samples	10-12	TPH-HO	15	10-12*	TPH-D, TPH-HO, BTEX, and lead
DP-21	Sidewall and Bottom Confirmation Samples	6-8	Arsenic	10	6-8*	Arsenic, Lead, Copper, and Nickel
Stockpiles	Stockpile samples	NA	NA	NA	NA	All Constituents of Concern (See Table 3-2).

Notes:

* Samples will be collected from the depth interval shown and including each lithologic unit.

NA - Not Applicable

See Sampling and Analysis Plan Table 2-1 for quantity of stockpile samples.

Soil from the excavations of locations TP-02, DP-11, DP-17, and DP-21 will be field screened for the presence of TPH. Analyses for TPH (all ranges) and BTEX will be added if field screening indicates potential TPH presence.

Table 3-6: Multilayer Cap with Controls Excavation Volume Tabulation

Parcel 4	
Surface	Volume (cubic yards)
Planted Areas(1)	2,300
Hot spot excavation allowance(2)	90
Utility allowance	160
Water feature cut	220
Water feature reservoir and equipment	220
Parcel 4 Total	3,000
Parcel 5	
Surface	Volume (cubic yards)
Planted Areas	1,800
Utility allowance	490
Parcel 5 Total	2,300
Parcel 4 / Parcel 5 Total	Volume (cubic yards)
Total Excavation Volume	5,300

(1) Per Appendix D

(2) Assumes excavation of one 20’x20’ cell

Table 3-7: Multilayer Cap with Controls Opinion of Probable Cost				
Item	Unit Cost	Units	Quantity	Total Cost
Excavation and Material Handling	$22.00	CY	5,300	$ 117,000
Stockpile Sampling	$12.50	CY	5,300	$ 66,000
Confirmation Sampling	$1,250	Samples	13	$ 16,000
Hauling and Off Site Disposal (1)	$85.00	CY	530	$45,000
Multilayer Cap – Impervious Geomembrane	$4.00	SF	30,527	$ 122,000
Multilayer Cap – Drain Rock	$ 35.00	CY	850	$ 30,000
Multilayer Cap - Geotextile	$ 1.00	SF	30,527	$ 31,000
Multilayer Cap – Top soil	$ 19.00	CY	2,540	$ 48,000
Multilayer Cap – Drainage System	$ 5,000	LS	1	$ 5,000
Subtotal - Base Construction Cost				$ 480,000
Contractor Overhead and Profit	18%			$ 86,000
Subtotal				$ 566,000
Engineering	$ 120	Hours	360	$ 43,000
Subtotal				$ 609,000
Allied Costs (Management, Legal, and Administrative)	20%			$ 122,000
Contingency	20%			$ 122,000
Total				$ 853,000

(1) Estimated volume unsuitable for reuse due to COPC concentrations and geotechnical considerations equals 10% of total excavation volume

Table 3-8: Capping with Partial Excavation and Controls Excavation Volume Tabulation

Parcel 4	
Surface	Volume (cubic yards)
Planted Areas(1)	4,700
Hot spot excavation allowance(2)	90
Utility allowance	160
Water feature cut	220
Water feature reservoir and equipment	220
Parcel 4 Total	5,390
Parcel 5	
Surface	Volume (cubic yards)
Planted Areas(1)	3,600
Building Footings	490
Utility allowance	490
Parcel 5 Total	4,580
Parcel 4 / Parcel 5 Total	Volume (cubic yards)
Total Excavation Volume	9,970

(1) Per Appendix D

(2) Assumes excavation of one 20’x20’ cell

Table 3-9: Capping with Partial Excavation and Controls Opinion of Probable Cost

Item	Unit Cost	Units	Quantity	Total Cost
Excavation and Material Handling	$22.00	CY	9,970	$ 219,000
Stockpile Sampling	$12.50	CY	9,970	$125,000
Confirmation Sampling	$1,250	Samples	13	$ 16,000
Hauling and Off Site Disposal (1)	$85.00	CY	1000	$ 85,000
Subtotal - Base Construction Cost				$445,000
Contractor Overhead and Profit	18%			$ 80,000
Subtotal				$ 525,000
Engineering	$ 120	Hours	360	$ 43,000
Subtotal				$ 568,000
Allied Costs (Management, Legal, and Administrative)	20%			$ 114,000
Contingency	20%			$ 114,000
Total				$796,000

Table 3-10: Excavation and Disposal Excavation Volume Tabulation

Surface	Area (square feet)	Depth (feet)	Volume (cubic yards)
Parcel 4and 5 Total	116,000	6	25,800

Table 3-11: Excavation and Disposal Opinion of Probable Cost

Item	Unit Cost	Units	Quantity	Total Cost
Excavation and Material Handling	$22.00	CY	25,800	$ 568,000
Stockpile Sampling	$12.50	CY	25,800	$ 323,000
Confirmation Sampling	$1,250	Sample	250	$ 313,000
Hauling and Off Site Disposal (1)	$85.00	CY	15,500	$ 1,318,000
Imported Fill	$ 19.00	CY	15,500	$ 295,000
Subtotal - Base Construction Cost				$ 2,817,,000
Contractor Overhead and Profit	18%			$ 507,000
Subtotal				$ 3,324,,000
Engineering	$ 120	Hours	700	$ 84,000
Subtotal				$ 3,408,000
Allied Costs (Management, Legal, and Administrative)	20%			$ 682,000
Contingency	20%			$ 682,000
Total				$ 4,688,000

(1) Assumes COPC concentrations exceed IACLs in 60% of stockpiled material

Table 3-12: Cost Summary and Disproportionate Cost Analysis

Alternative	Compliance with Threshold Criteria	Disproportionate Cost Analysis Criteria (1)							Practicable Solution?	Permanent to the Maximum Extent Practicable? (2)	Costs Disproportionate to Benefits? (3)	Restoration Timeframe
		Cost	Protectiveness	Permanence	Long-Term Effectiveness	Short Term Risk	Implementability	Total				
No Action	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Solidification / Stabilization	Yes	$ 3,680,000	3	3	3	5	1	15	No	No	Yes	6 – 12 months
Multilayer Cap with Controls	Yes	$ 853,000	3	4	3	4	3	17	Yes	Yes	Yes	< 6 months
Capping with Partial Excavation and Controls	Yes	$ 796,000	4	4	4	4	3	19	Yes	Yes	No	< 6 months
Excavation and Disposal	Yes	$ 4,688,000	5	5	5	3	1	19	No	Yes	Yes	< 6 months

(1) Alternatives were assigned a score between 1 and 5 for the criteria in WAC 173-340-360(3)(f), with 5 being superior. Evaluation criteria are defined in WAC 173-340-360(3)(e)

(2) Criteria for 'Permanent to the Maximum Extent Practicable' defined in WAC 173-340-360(3)

(3) Criteria for Costs Disproportionate to Benefits defined in WAC 173-340-360(3)(e)

FIGURES

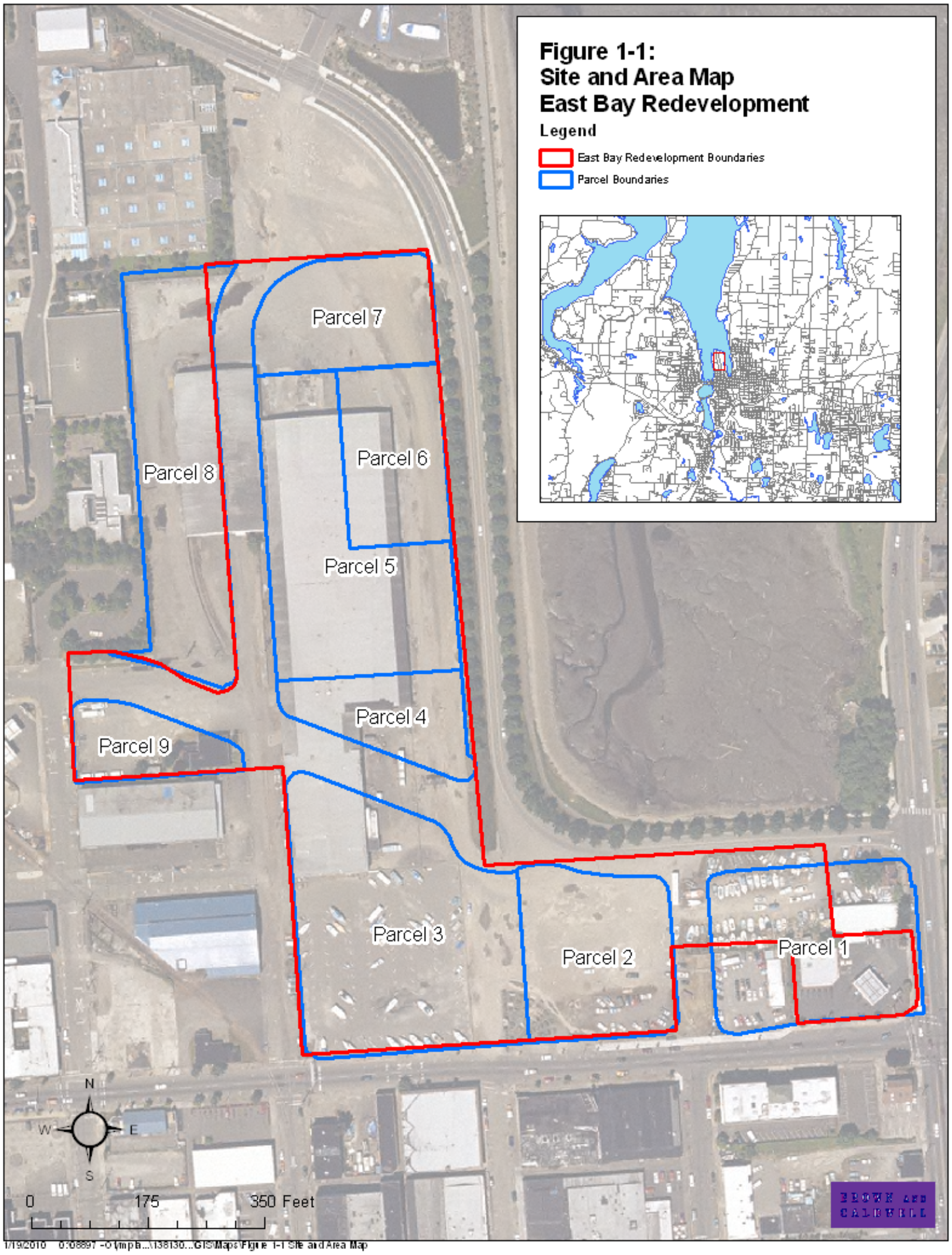

Figure 1-1:
Site and Area Map
East Bay Redevelopment

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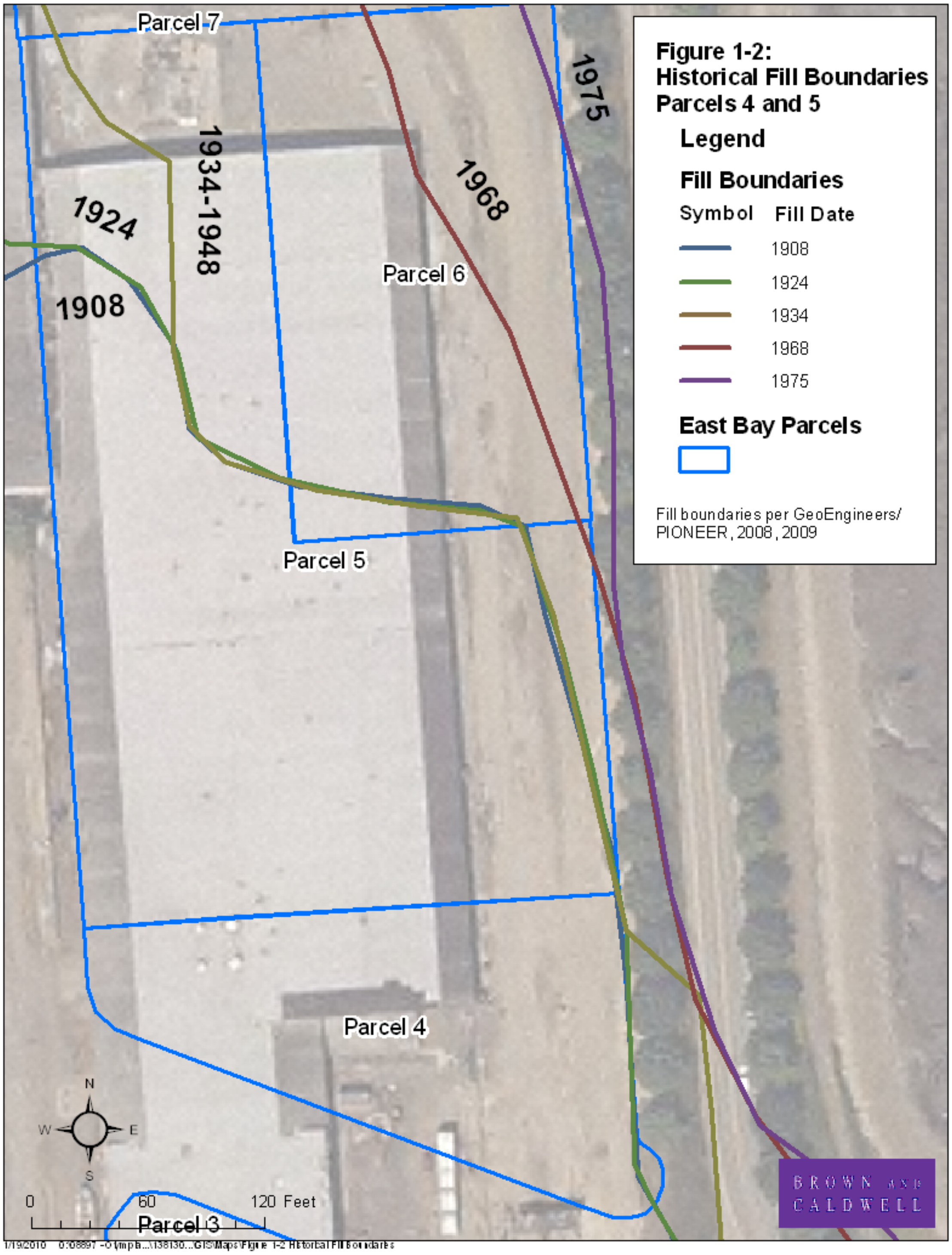

Figure 1-2: Historical Fill Boundaries Parcels 4 and 5

Fill boundaries per GeoEngineers/ PIONEER, 2008, 2009

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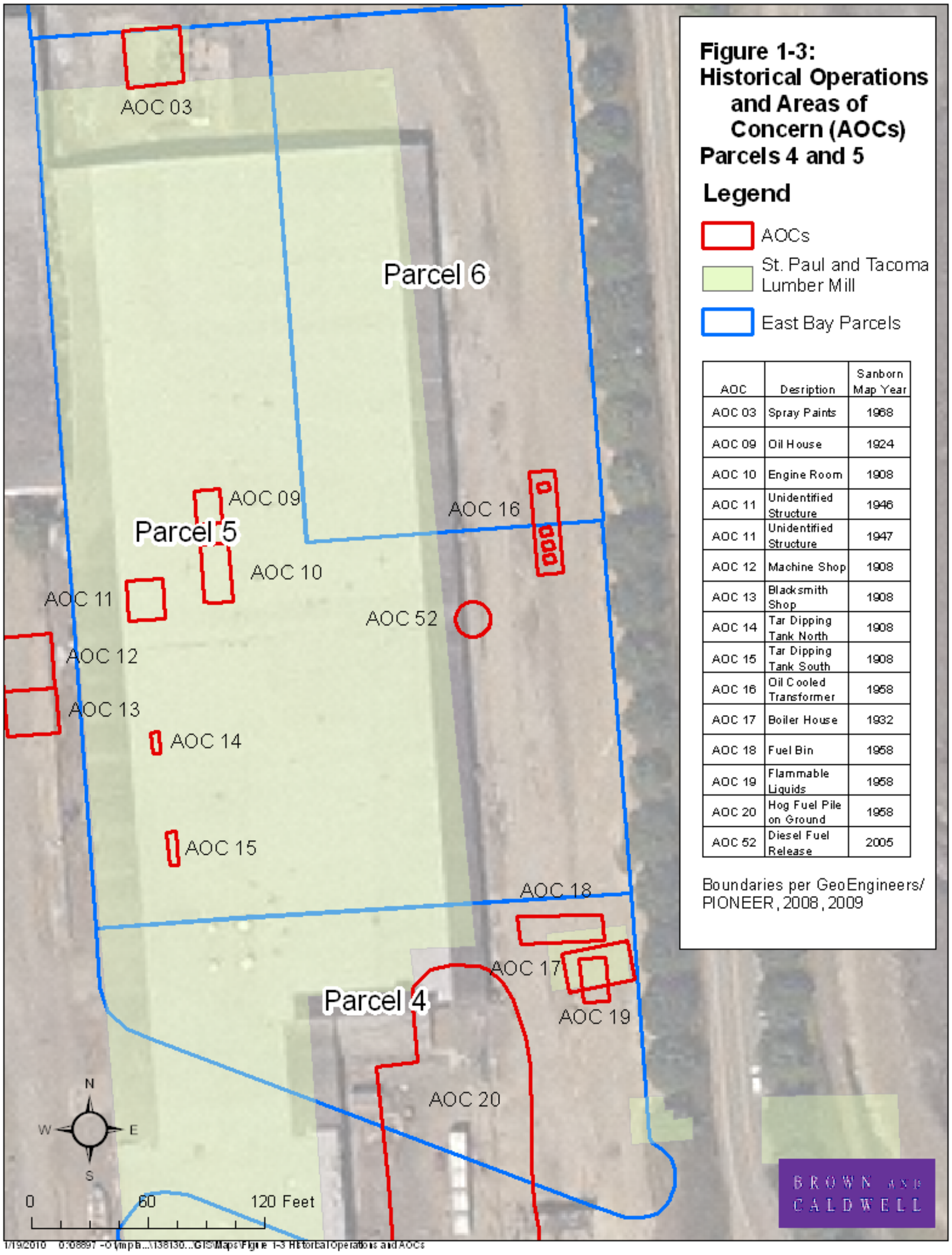

Figure 1-3: Historical Operations and Areas of Concern (AOCs) Parcels 4 and 5

Legend

- 🟥 AOCs
- 🟩 St. Paul and Tacoma Lumber Mill
- 🟦 East Bay Parcels

AOC	Desription	Sanborn Map Year
AOC 03	Spray Paints	1968
AOC 09	Oil House	1924
AOC 10	Engine Room	1908
AOC 11	Unidentified Structure	1946
AOC 11	Unidentified Structure	1947
AOC 12	Machine Shop	1908
AOC 13	Blacksmith Shop	1908
AOC 14	Tar Dipping Tank North	1908
AOC 15	Tar Dipping Tank South	1908
AOC 16	Oil Cooled Transformer	1958
AOC 17	Boiler House	1932
AOC 18	Fuel Bin	1958
AOC 19	Flammable Liquids	1958
AOC 20	Hog Fuel Pile on Ground	1958
AOC 52	Diesel Fuel Release	2005

Boundaries per GeoEngineers/ PIONEER, 2008, 2009

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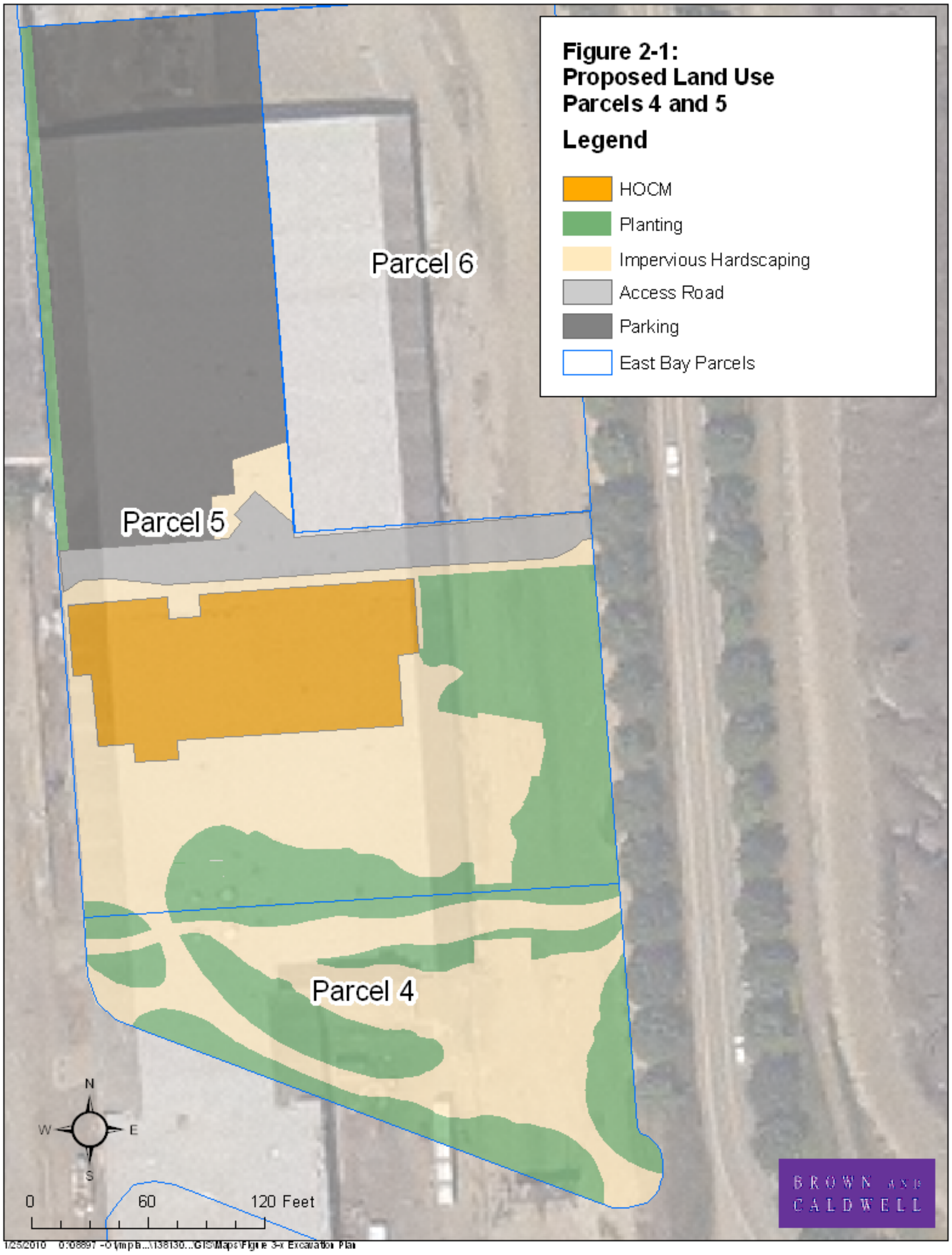

Figure 2-1:
Proposed Land Use
Parcels 4 and 5

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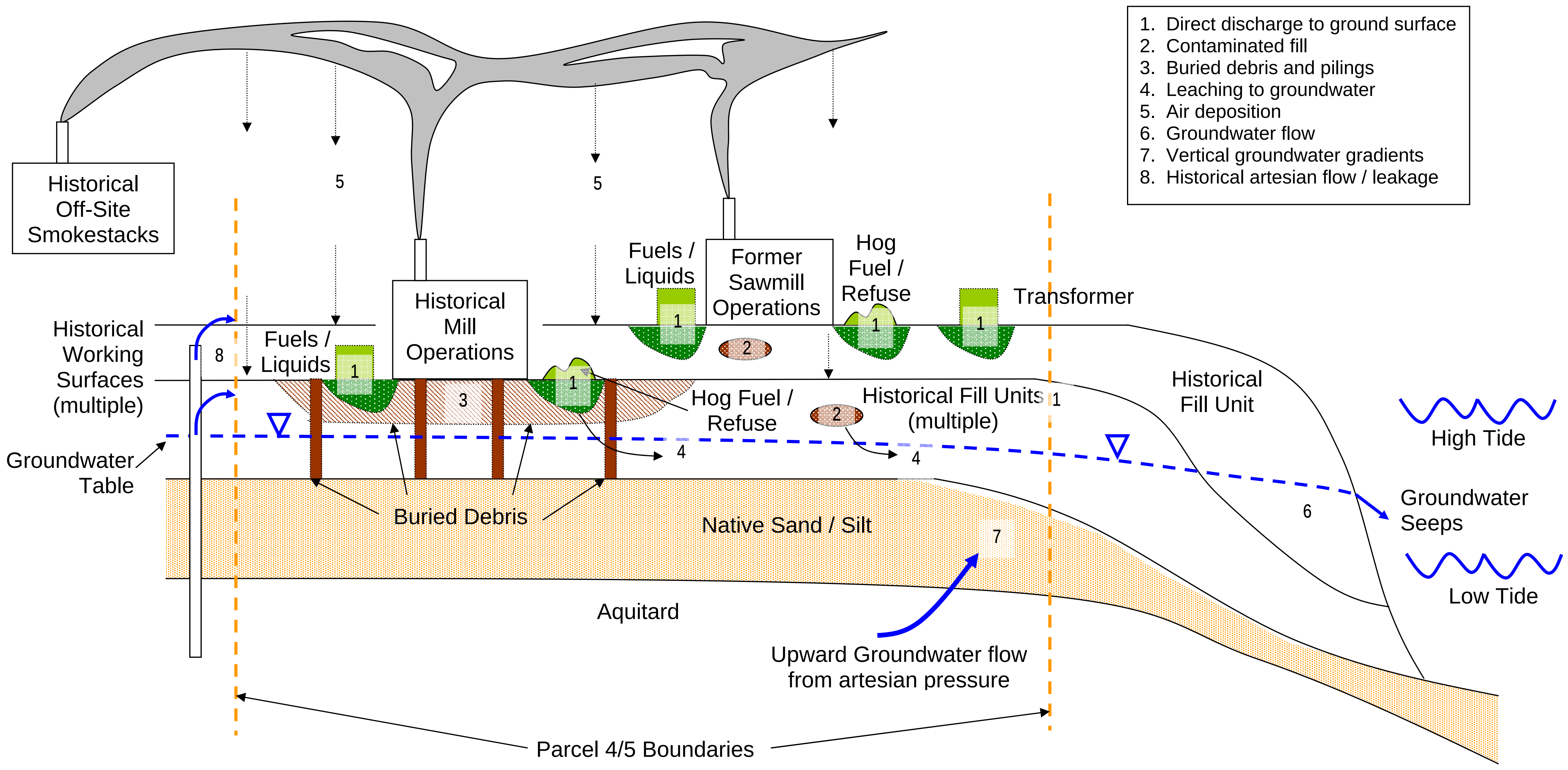

1. Direct discharge to ground surface
2. Contaminated fill
3. Buried debris and pilings
4. Leaching to groundwater
5. Air deposition
6. Groundwater flow
7. Vertical groundwater gradients
8. Historical artesian flow / leakage

Figure 2-2: Conceptual Site Contaminant Transport Model

Fate and Transport Pathways GeoEngineers/Pioneer, 2008, 2009

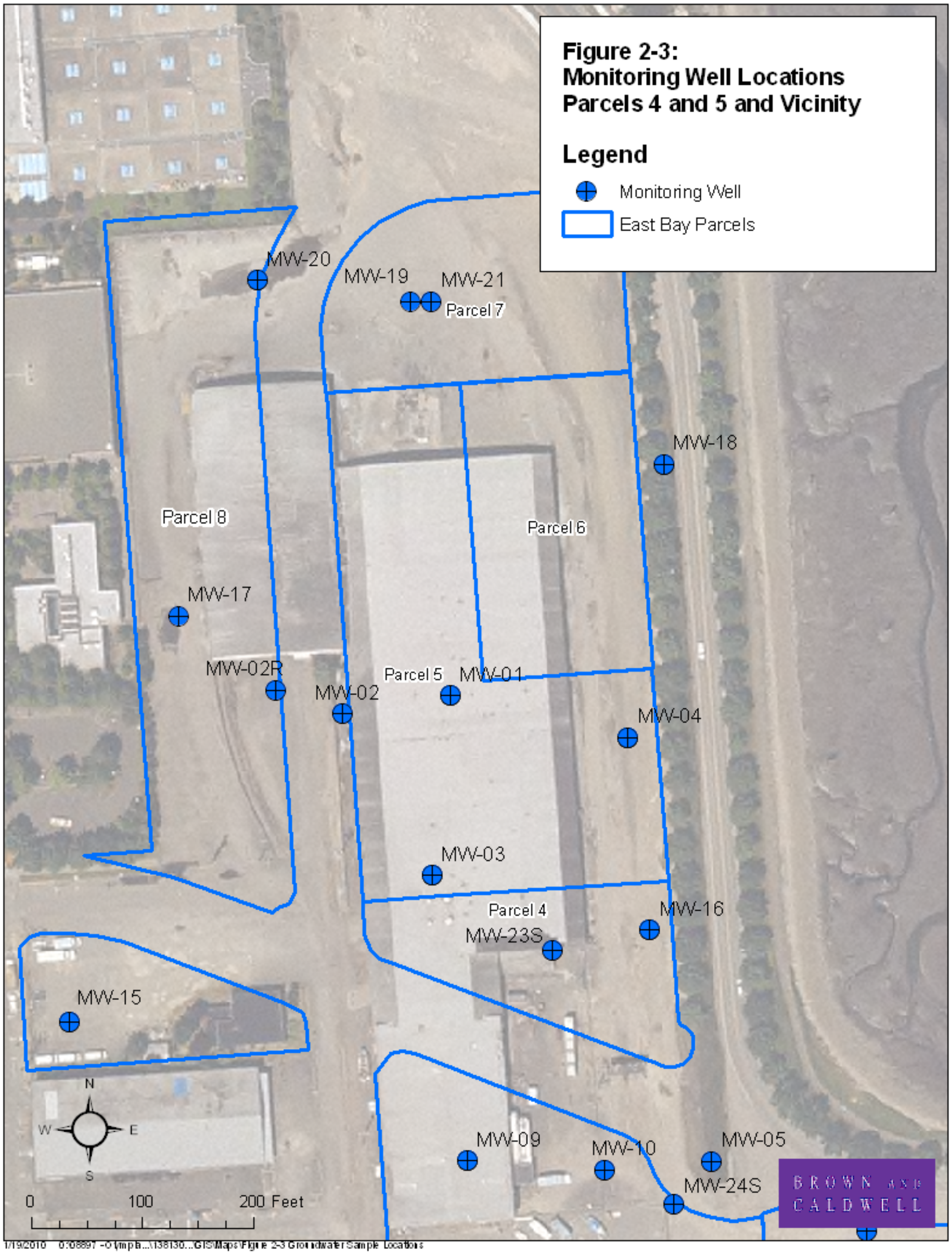

Figure 2-3:
Monitoring Well Locations
Parcels 4 and 5 and Vicinity

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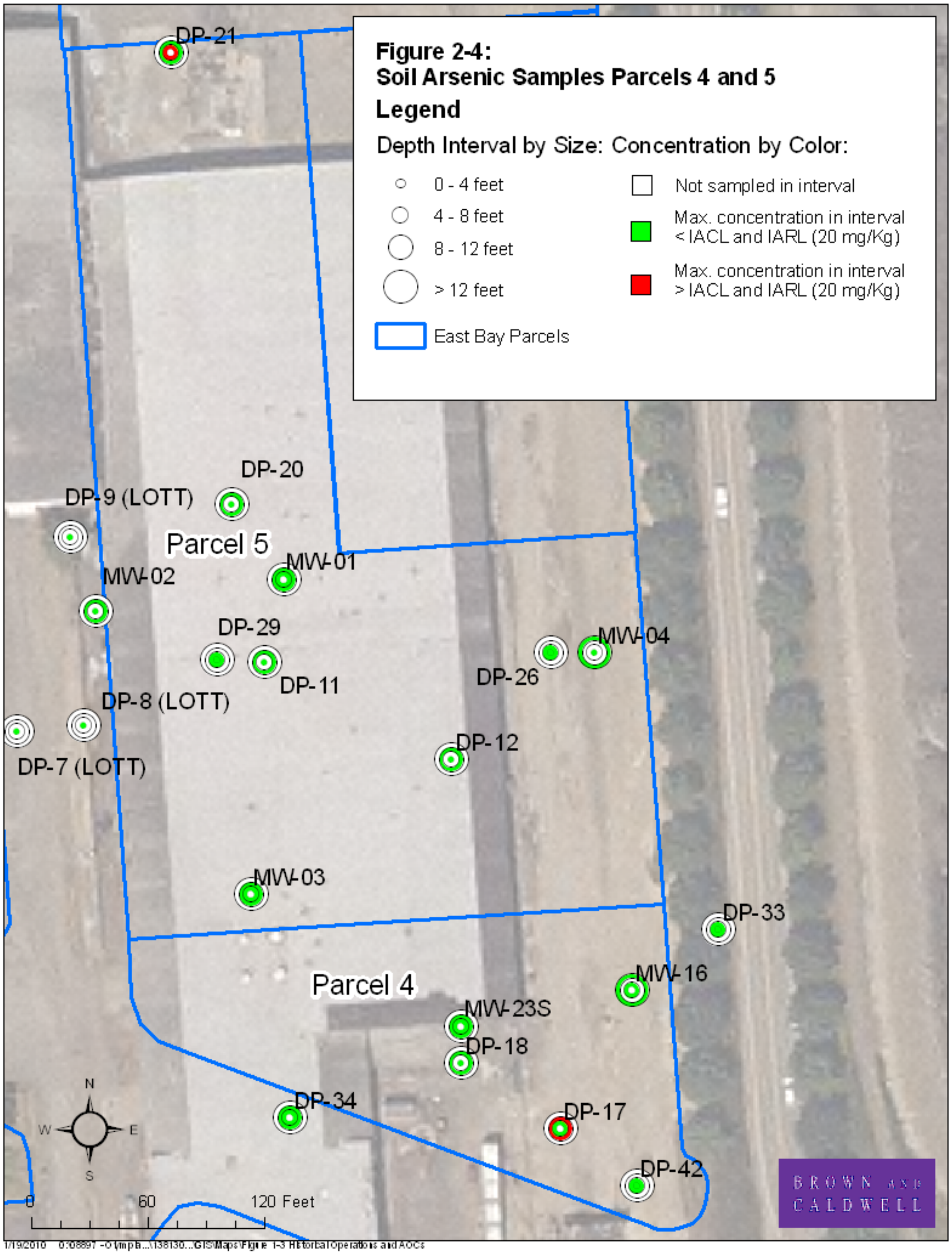

Figure 2-4:
Soil Arsenic Samples Parcels 4 and 5

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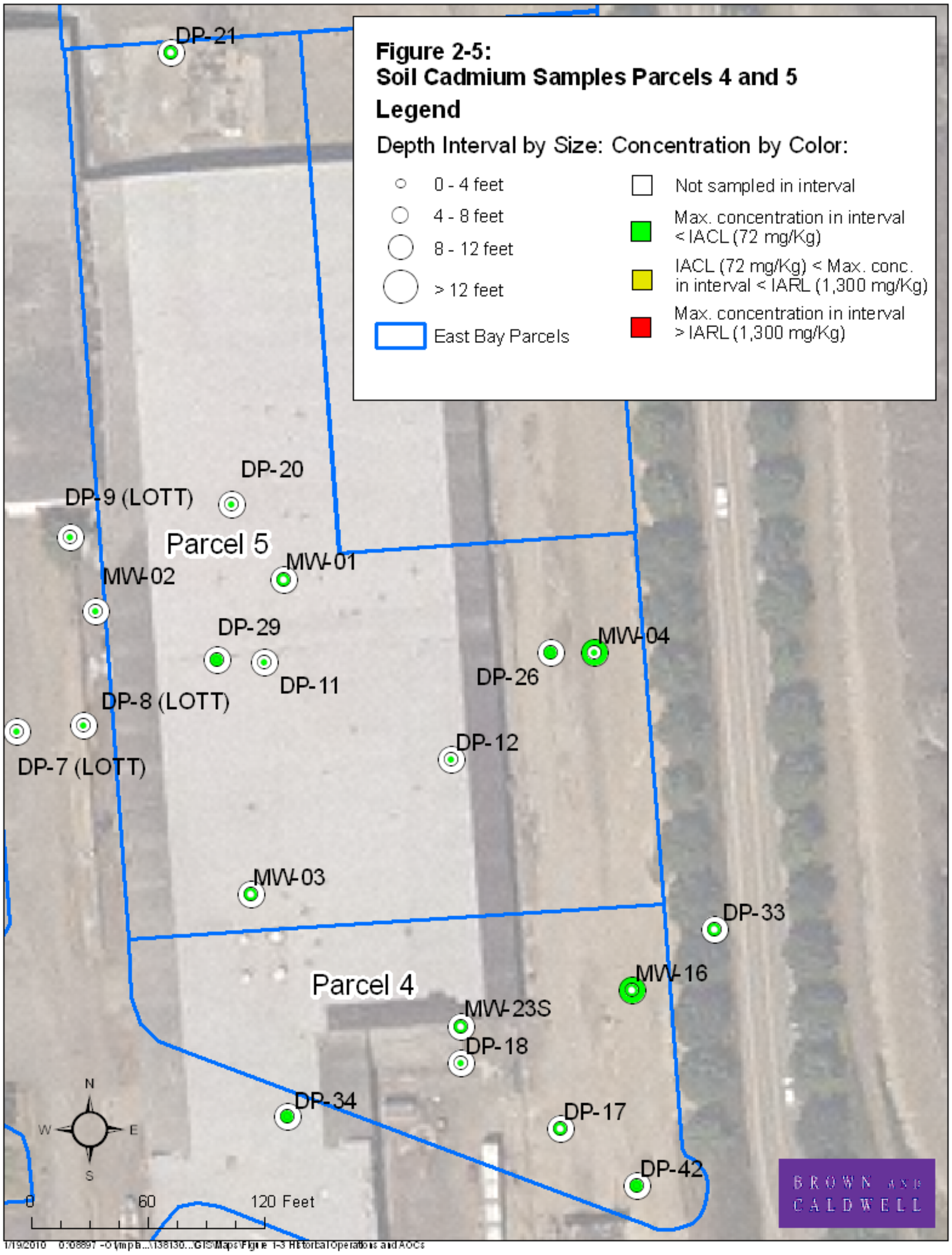

Figure 2-5:
Soil Cadmium Samples Parcels 4 and 5

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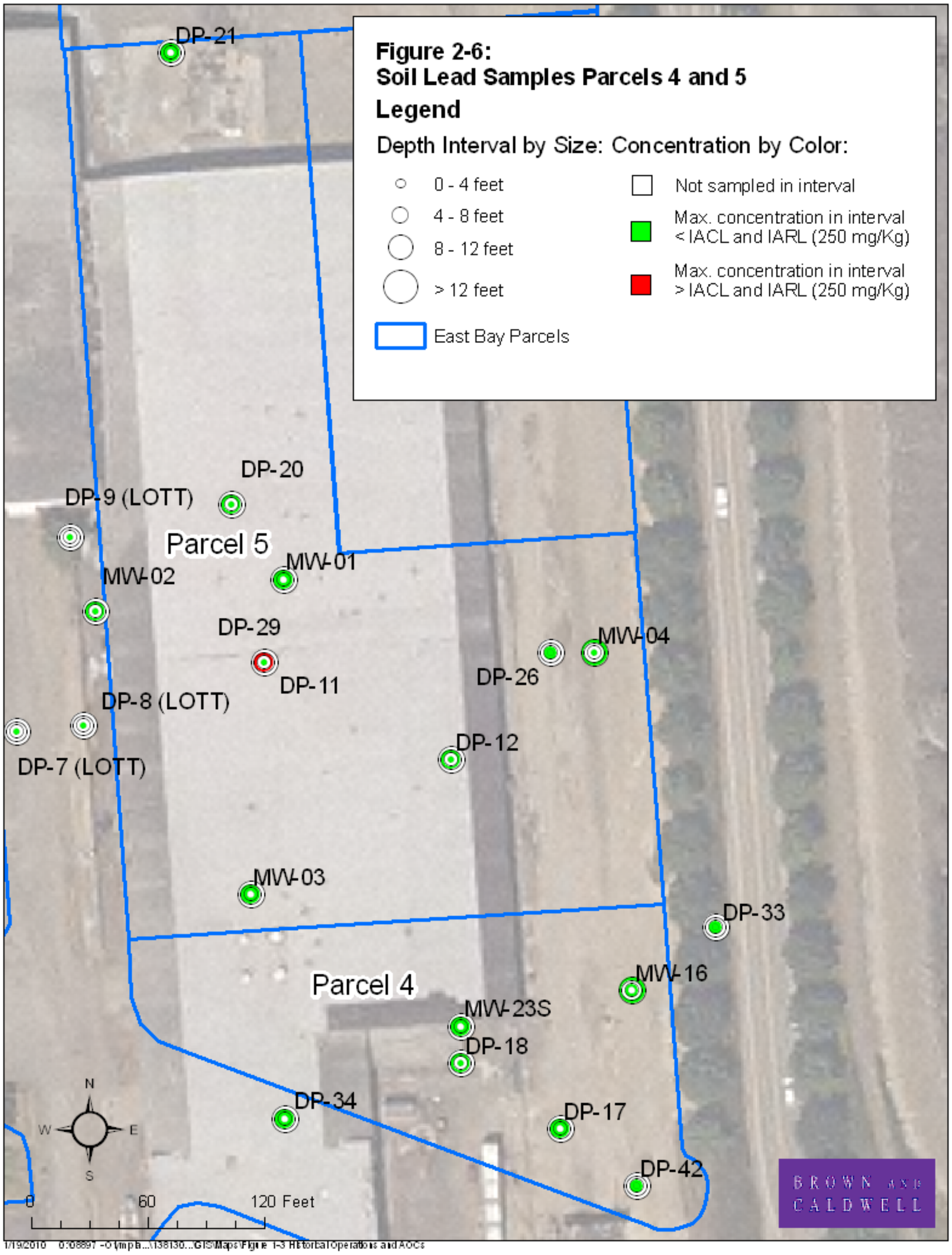

Figure 2-6:
Soil Lead Samples Parcels 4 and 5

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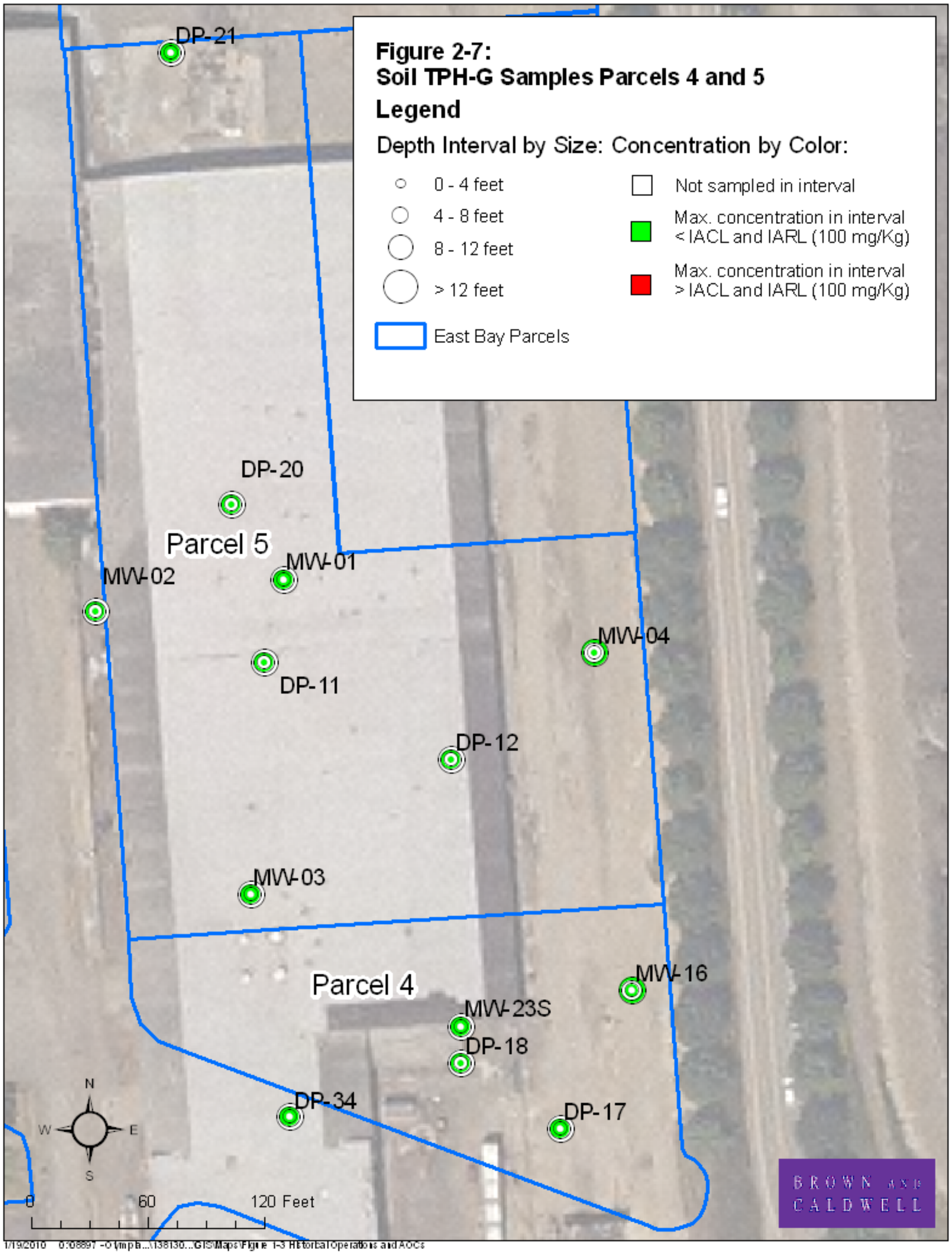

Figure 2-7:
Soil TPH-G Samples Parcels 4 and 5

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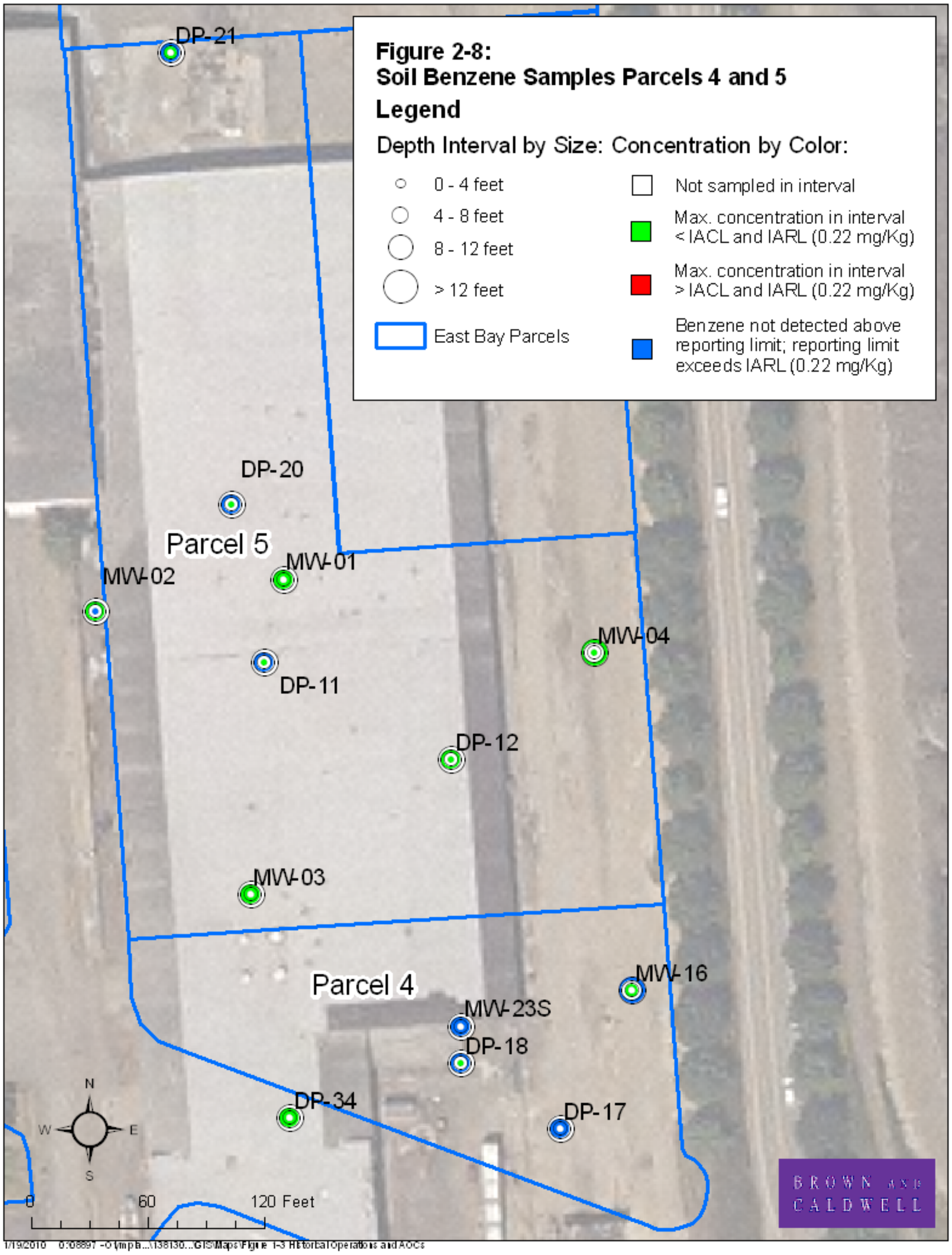

Figure 2-8:
Soil Benzene Samples Parcels 4 and 5

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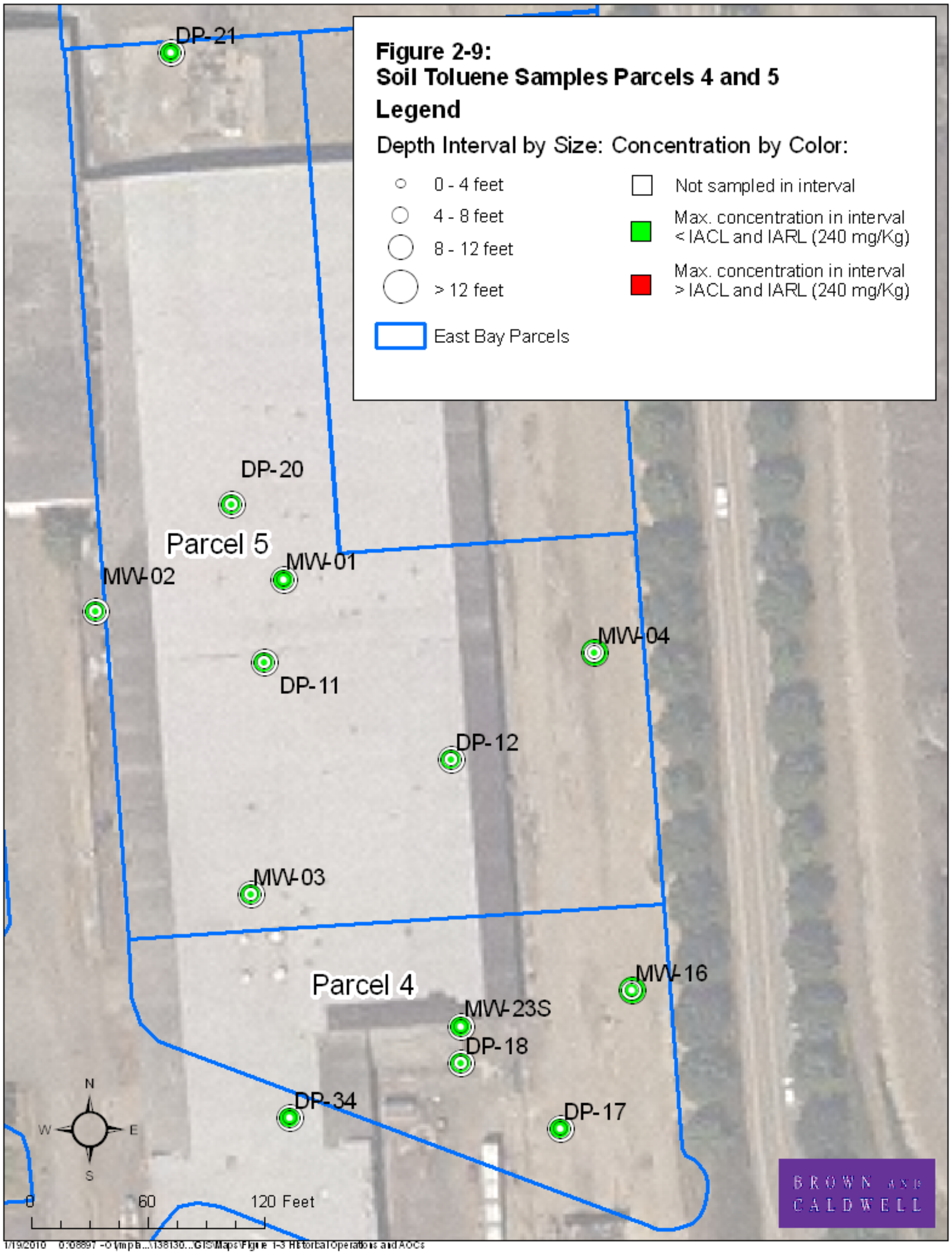

Figure 2-9:
Soil Toluene Samples Parcels 4 and 5

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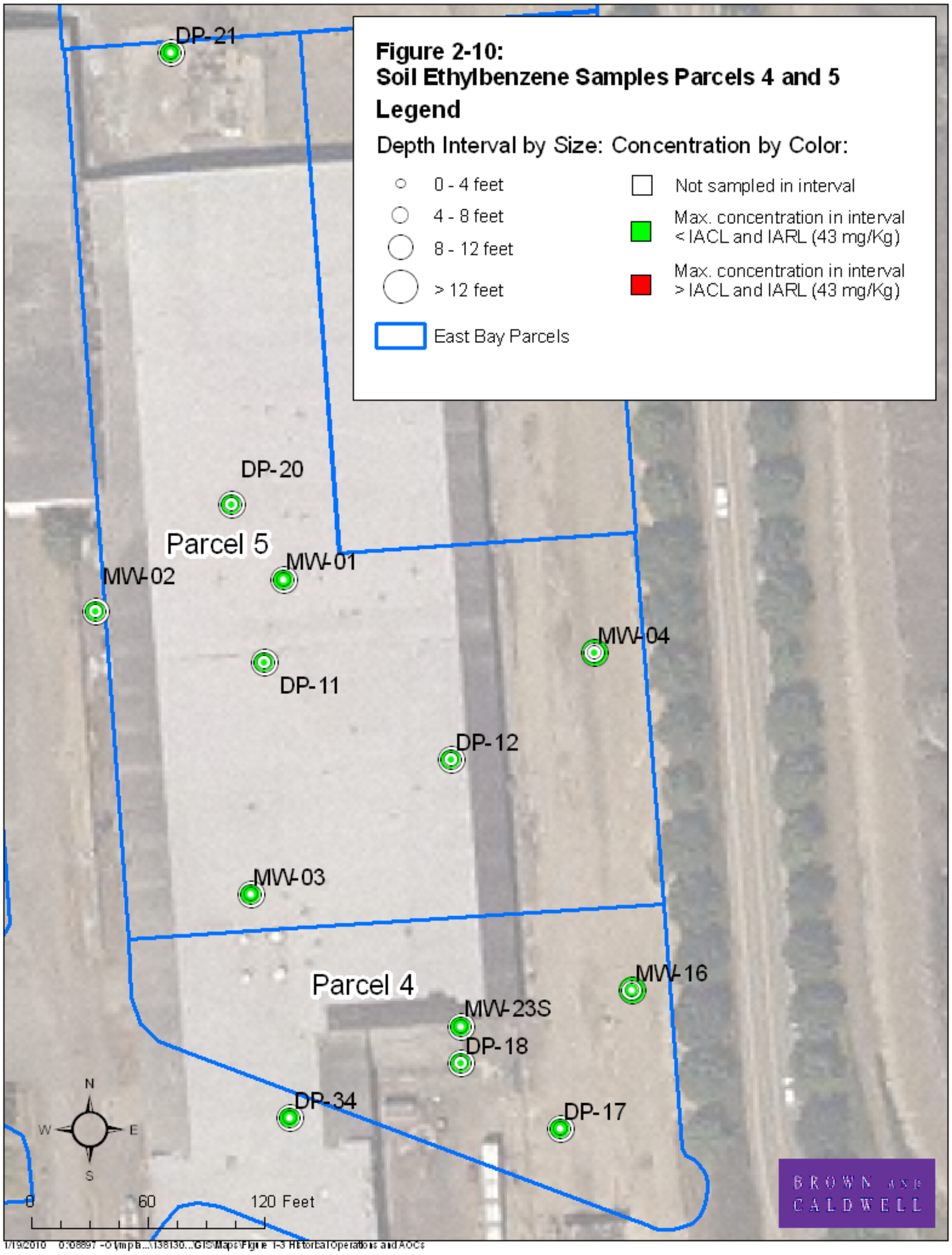

Figure 2-10:
Soil Ethylbenzene Samples Parcels 4 and 5

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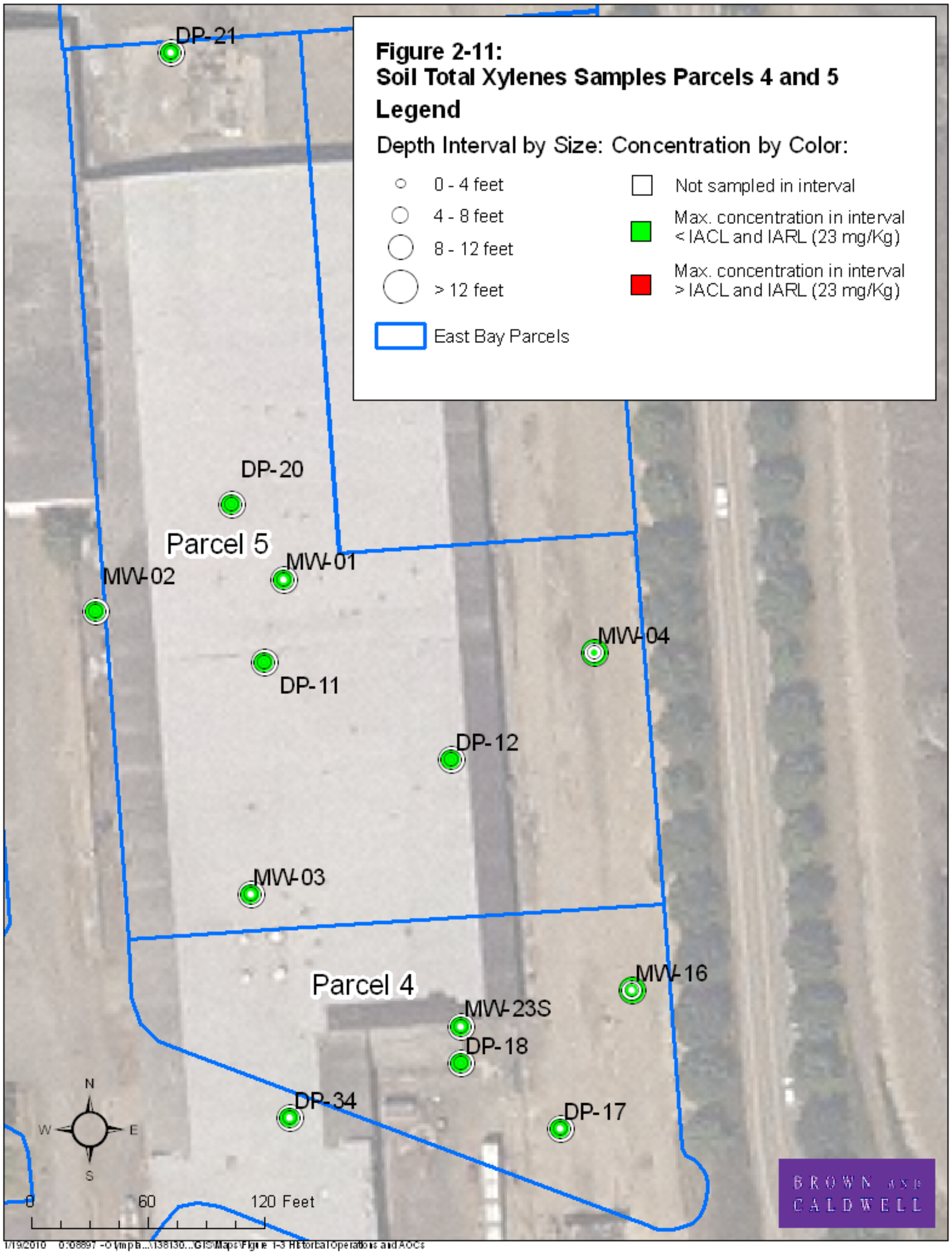

Figure 2-11:
Soil Total Xylenes Samples Parcels 4 and 5

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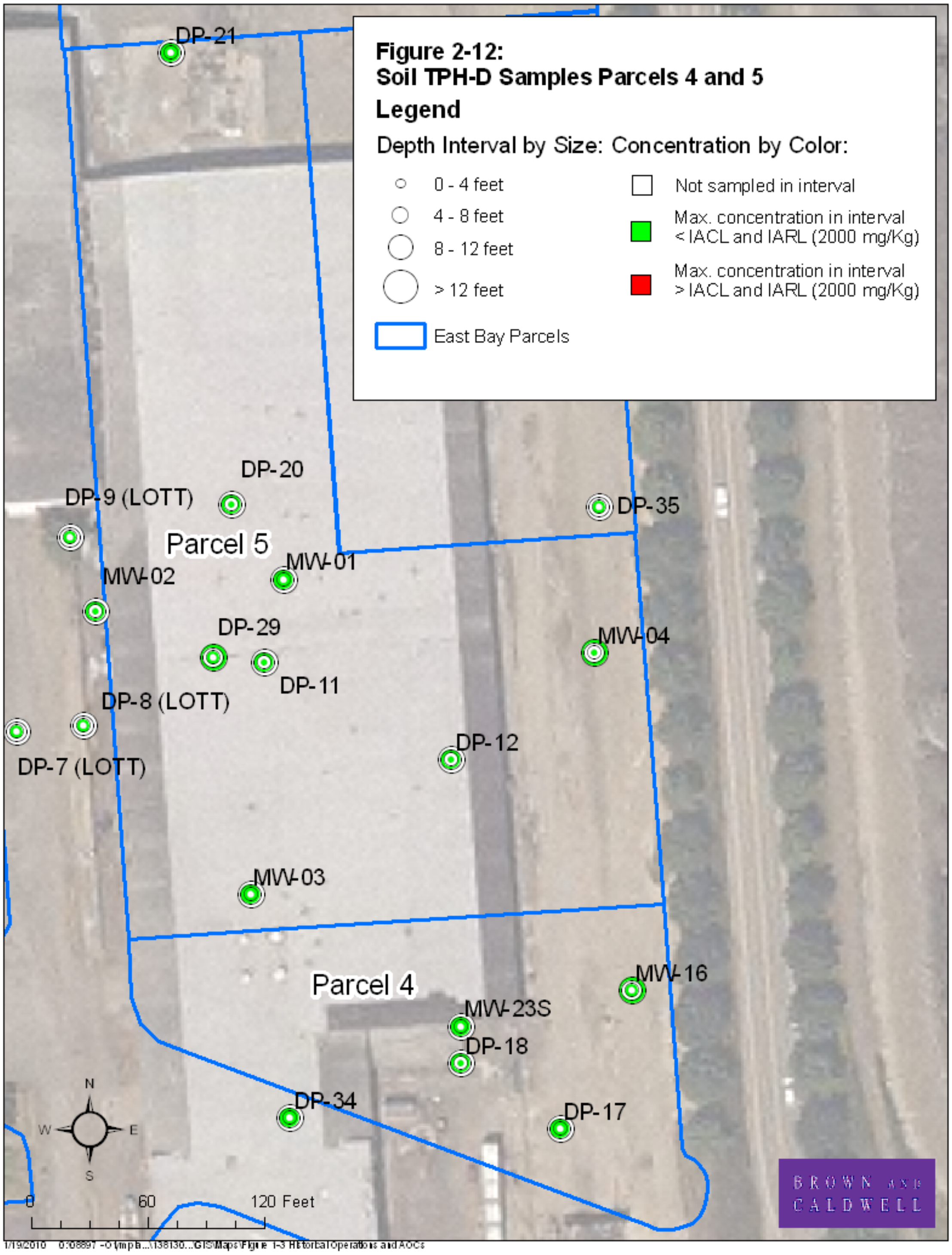

Figure 2-12:
Soil TPH-D Samples Parcels 4 and 5

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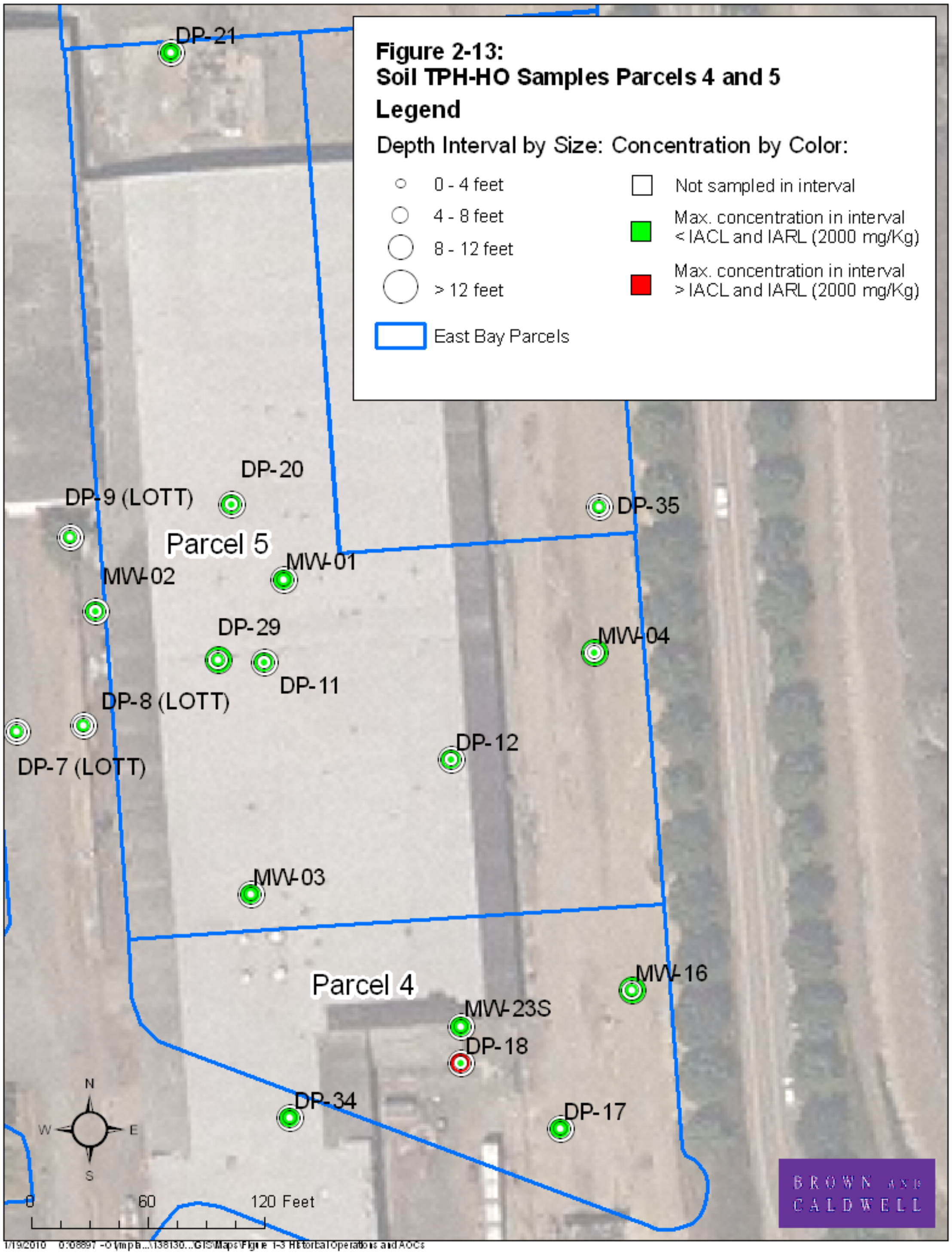

Figure 2-13:
Soil TPH-HO Samples Parcels 4 and 5

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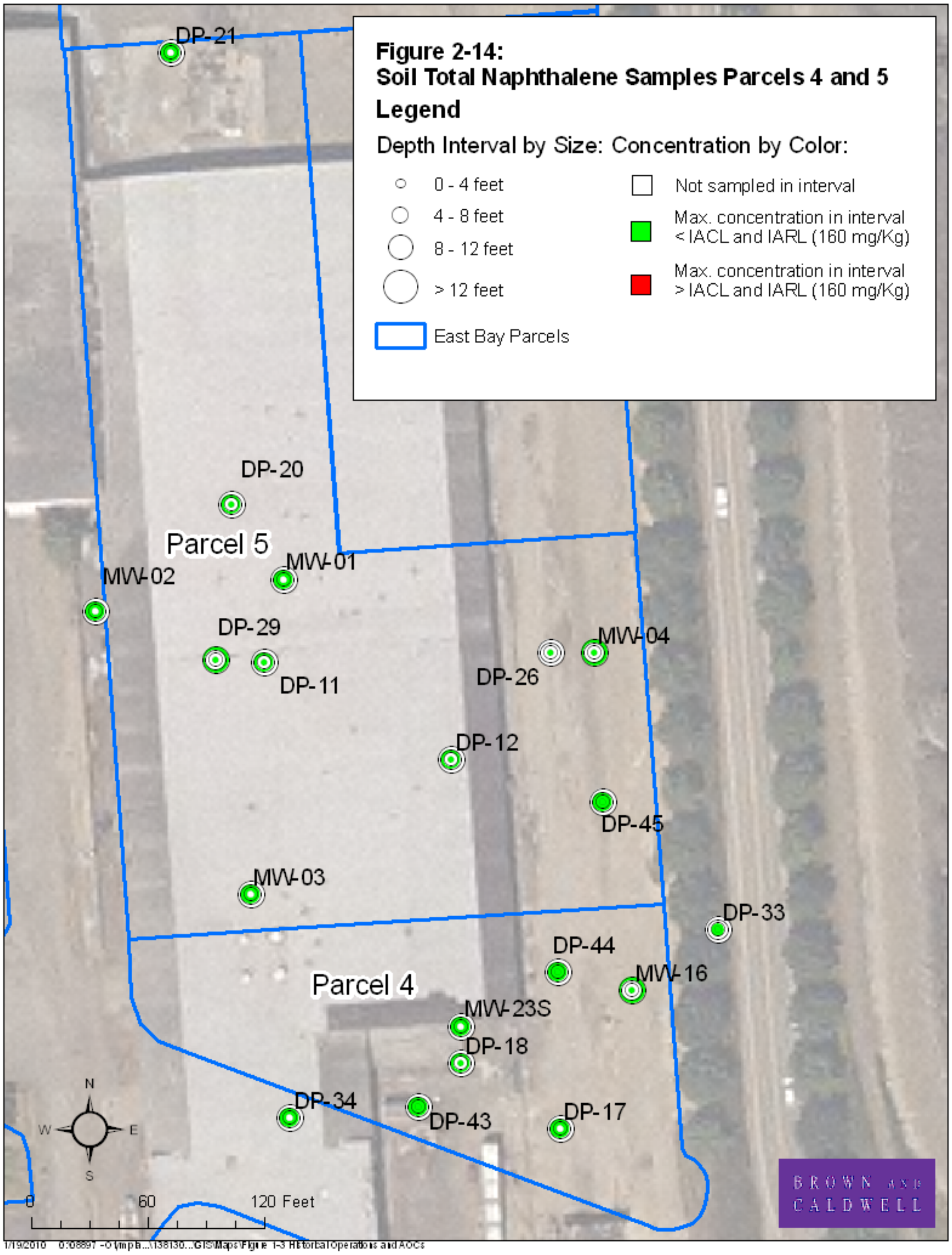

Figure 2-14:
Soil Total Naphthalene Samples Parcels 4 and 5

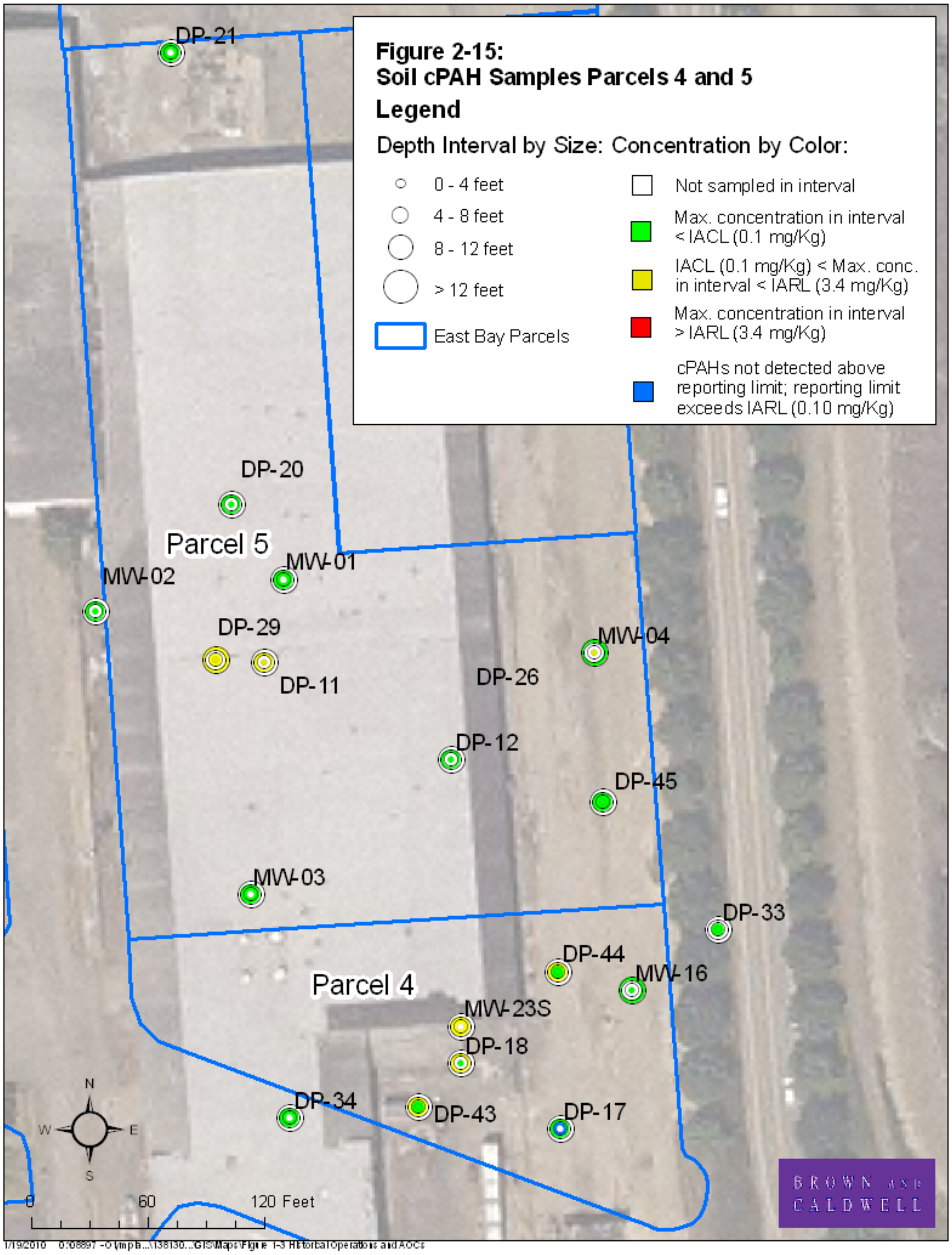

Figure 2-15:
Soil cPAH Samples Parcels 4 and 5

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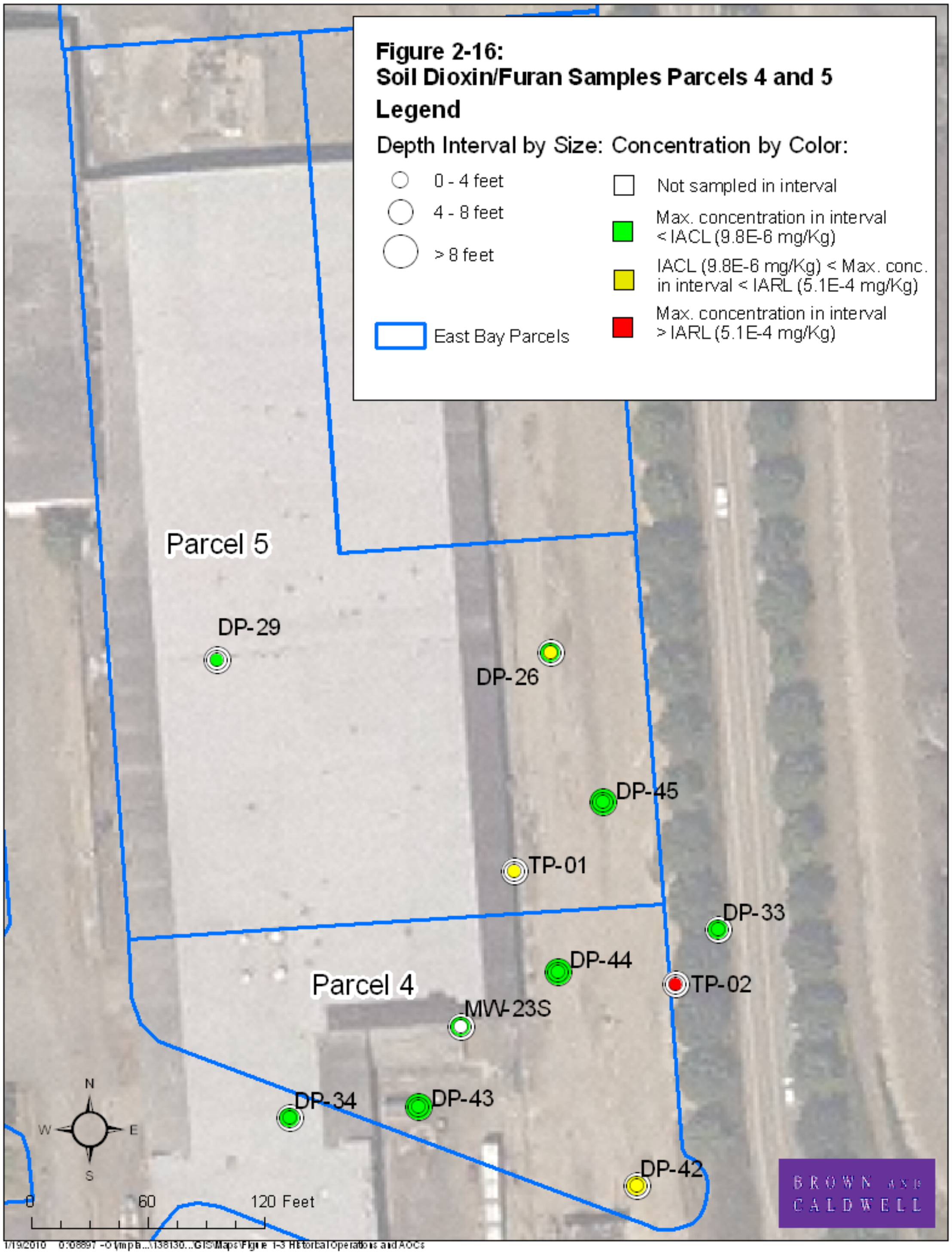


Figure 2-16:
Soil Dioxin/Furan Samples Parcels 4 and 5

1/19/2010 0:08897 -0 \mpla...\138130...\GIS\Maps\Figure 1-3 HistoricalOperations and AOCs

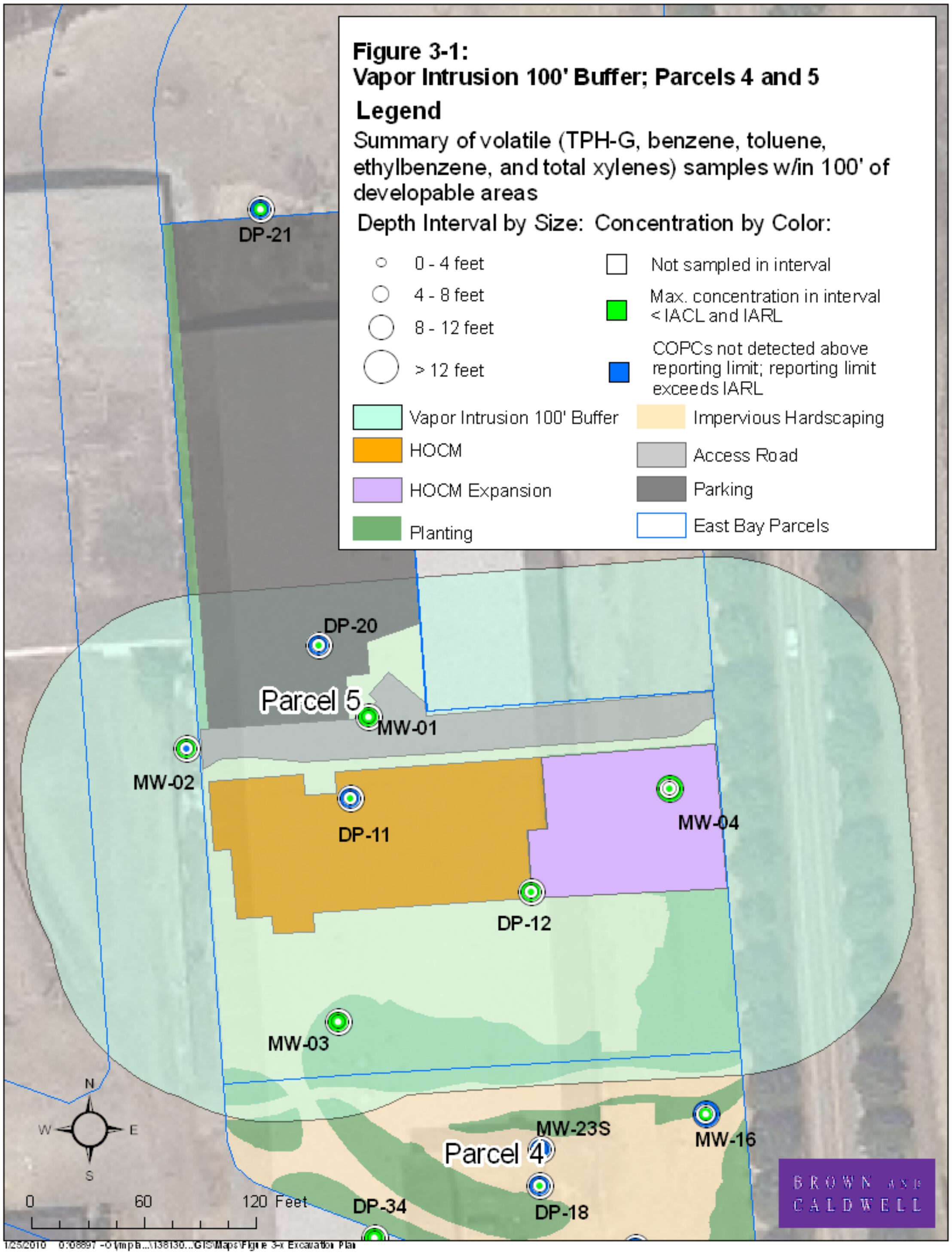


Figure 3-1:
Vapor Intrusion 100' Buffer; Parcels 4 and 5

1/25/2010 0:08897 -Olympia...\138130...\GIS\Maps\Figure 3-x Excavation Plan

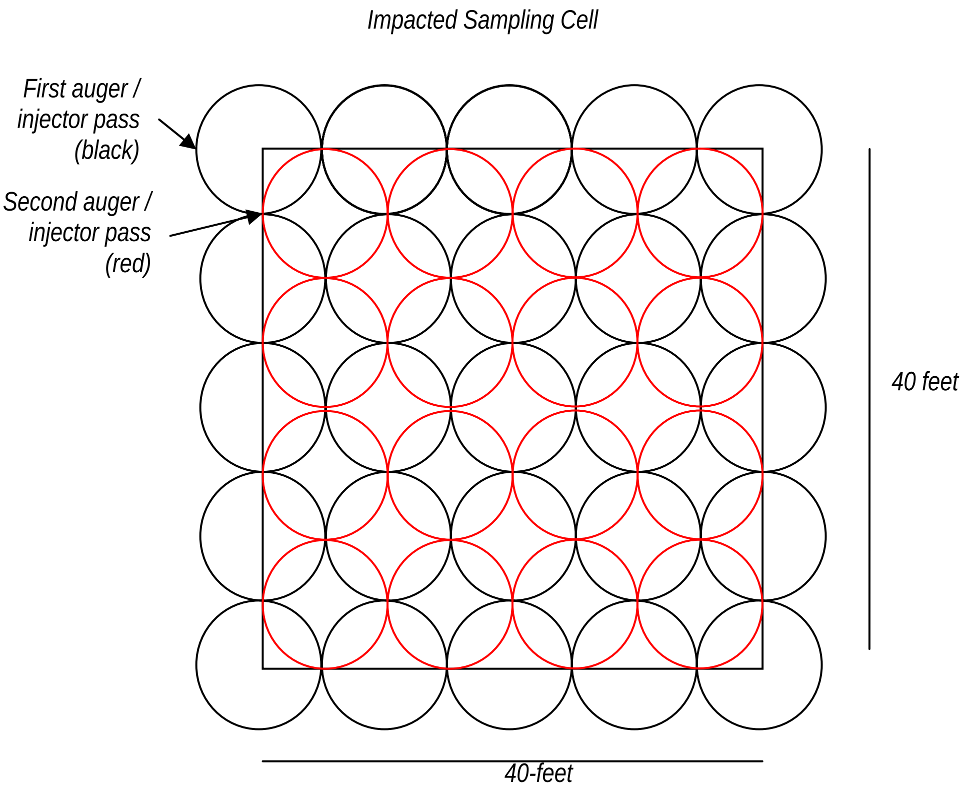
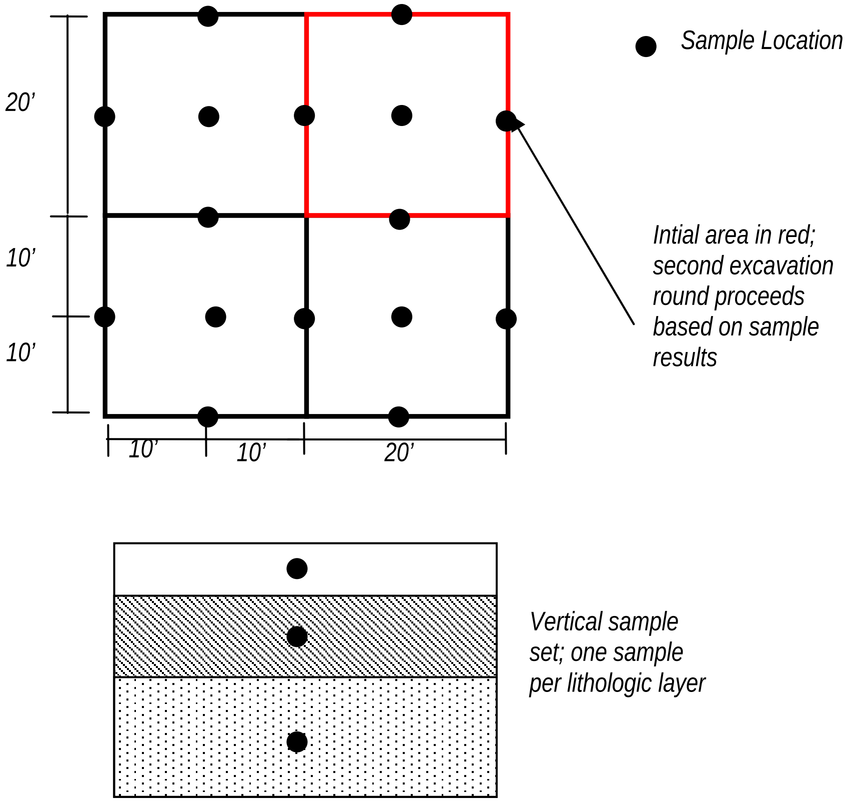


Figure 3-2: Schematic Auger / Injector Plan



● Sample Location

Intial area in red; second excavation round proceeds based on sample results

Vertical sample set; one sample per lithologic layer

Figure 3-3: Schematic Compliance Sampling Plan

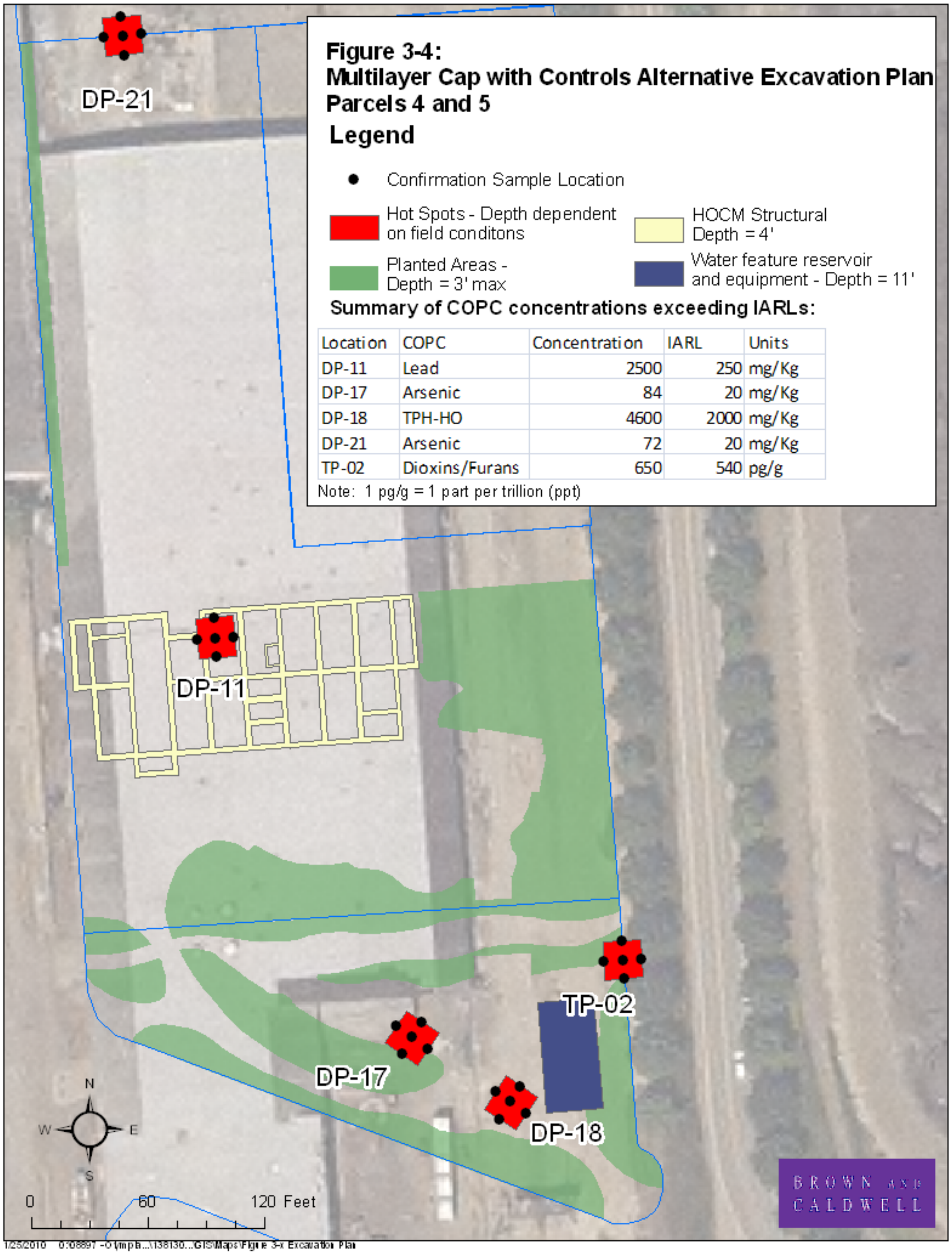


Figure 3-4:
Multilayer Cap with Controls Alternative Excavation Plan
Parcels 4 and 5

Legend

● Confirmation Sample Location

🟥	Hot Spots - Depth dependent on field conditons	🟨	HOCM Structural Depth = 4'
🟩	Planted Areas - Depth = 3' max	🟦	Water feature reservoir and equipment - Depth = 11'

Summary of COPC concentrations exceeding IARLs:

Location	COPC	Concentration	IARL	Units
DP-11	Lead	2500	250	mg/Kg
DP-17	Arsenic	84	20	mg/Kg
DP-18	TPH-HO	4600	2000	mg/Kg
DP-21	Arsenic	72	20	mg/Kg
TP-02	Dioxins/Furans	650	540	pg/g

Note: 1 pg/g = 1 part per trillion (ppt)

1/25/2010 0:08897 -O\mpla...\138130...\GIS\Maps\Figure 3-x Excavation Plan

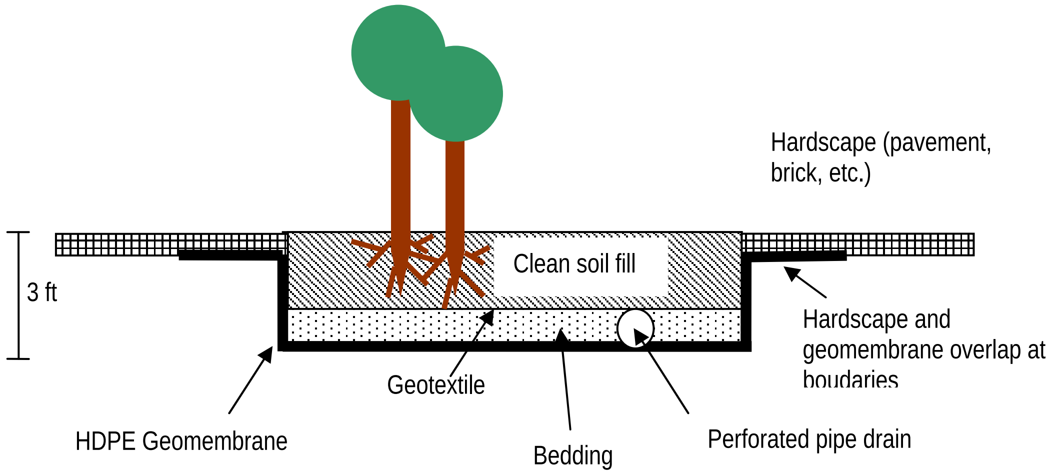
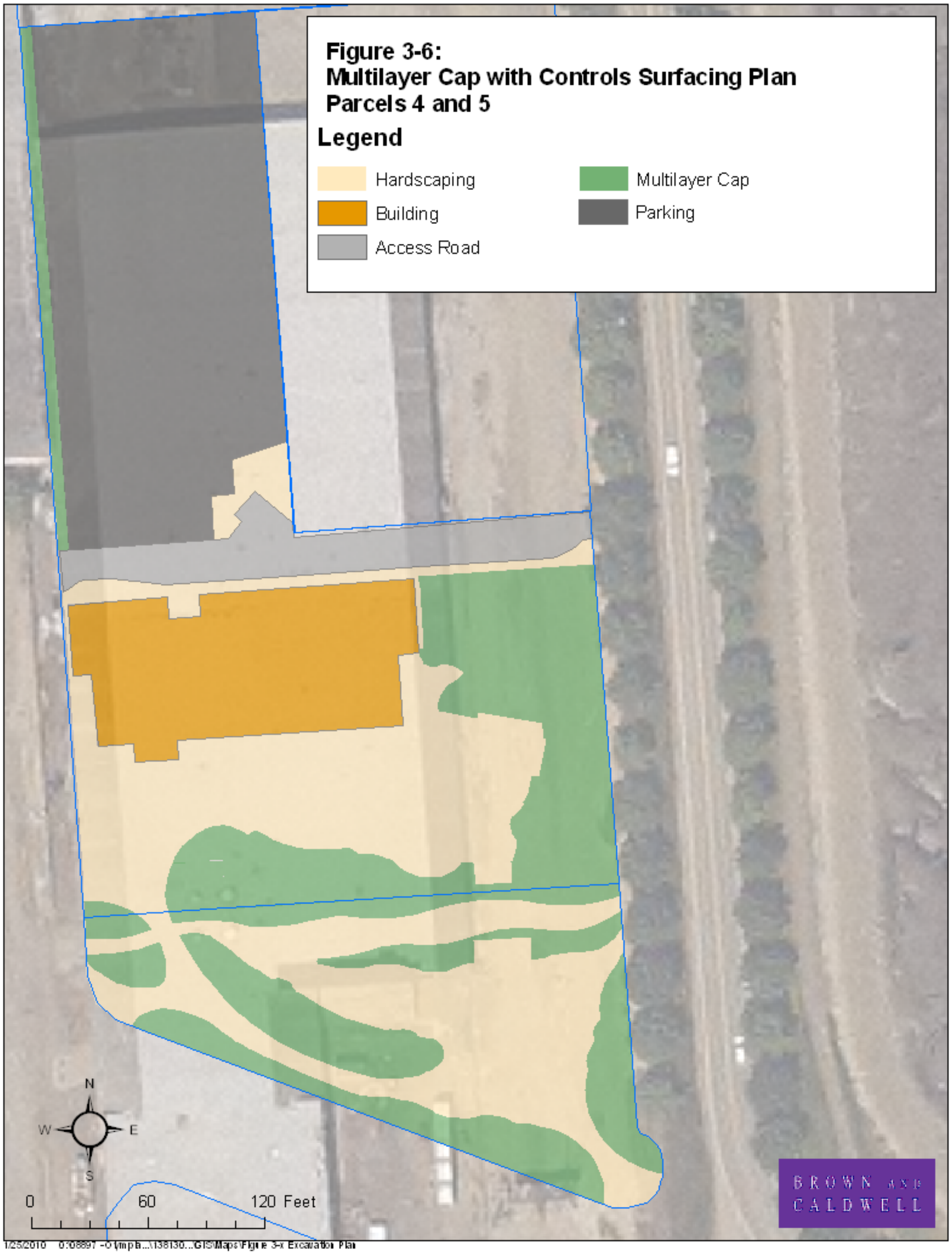


Figure 3-5: Multilayer Cap Cross Section



1/25/2010 0:08897 -0 \mpla...\138130...GIS\Maps\Figure 3-x Excavation Plan

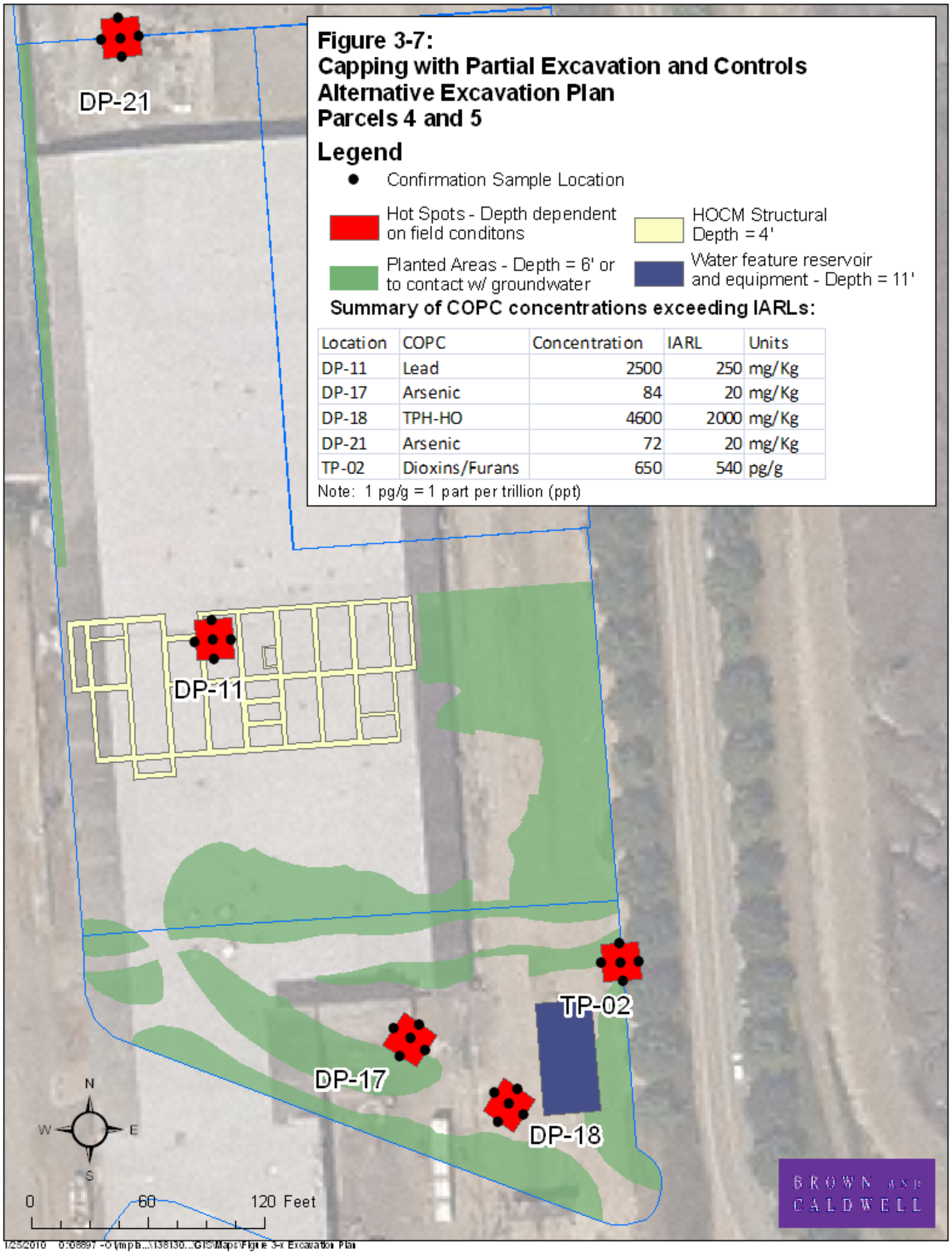


Figure 3-7:
Capping with Partial Excavation and Controls
Alternative Excavation Plan
Parcels 4 and 5

Legend

- ● Confirmation Sample Location
- 🟥 Hot Spots - Depth dependent on field conditons
- 🟨 HOCM Structural Depth = 4'
- 🟩 Planted Areas - Depth = 6' or to contact w/ groundwater
- 🟦 Water feature reservoir and equipment - Depth = 11'

Summary of COPC concentrations exceeding IARLs:

Location	COPC	Concentration	IARL	Units
DP-11	Lead	2500	250	mg/Kg
DP-17	Arsenic	84	20	mg/Kg
DP-18	TPH-HO	4600	2000	mg/Kg
DP-21	Arsenic	72	20	mg/Kg
TP-02	Dioxins/Furans	650	540	pg/g

Note: 1 pg/g = 1 part per trillion (ppt)

1/25/2010 0:08897 –O\mpls...\138130...\GIS\Maps\Figure 3-x Excavation Plan

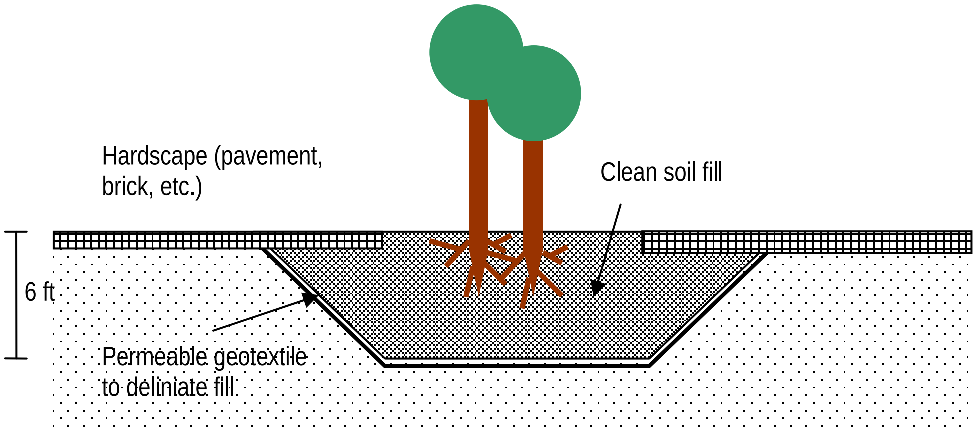


Figure 3-8: Capping with Partial
Excavation and Controls Cross Section

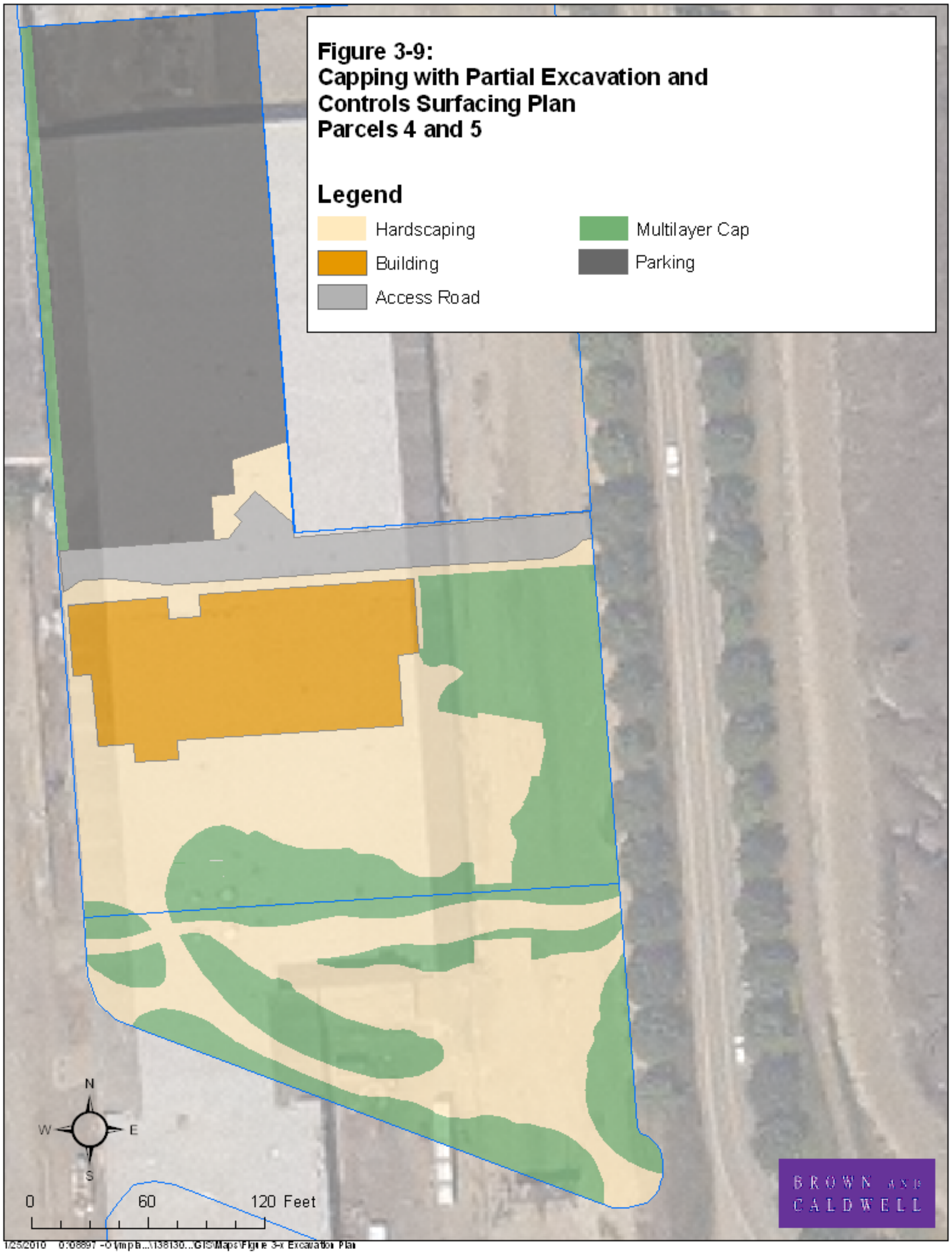
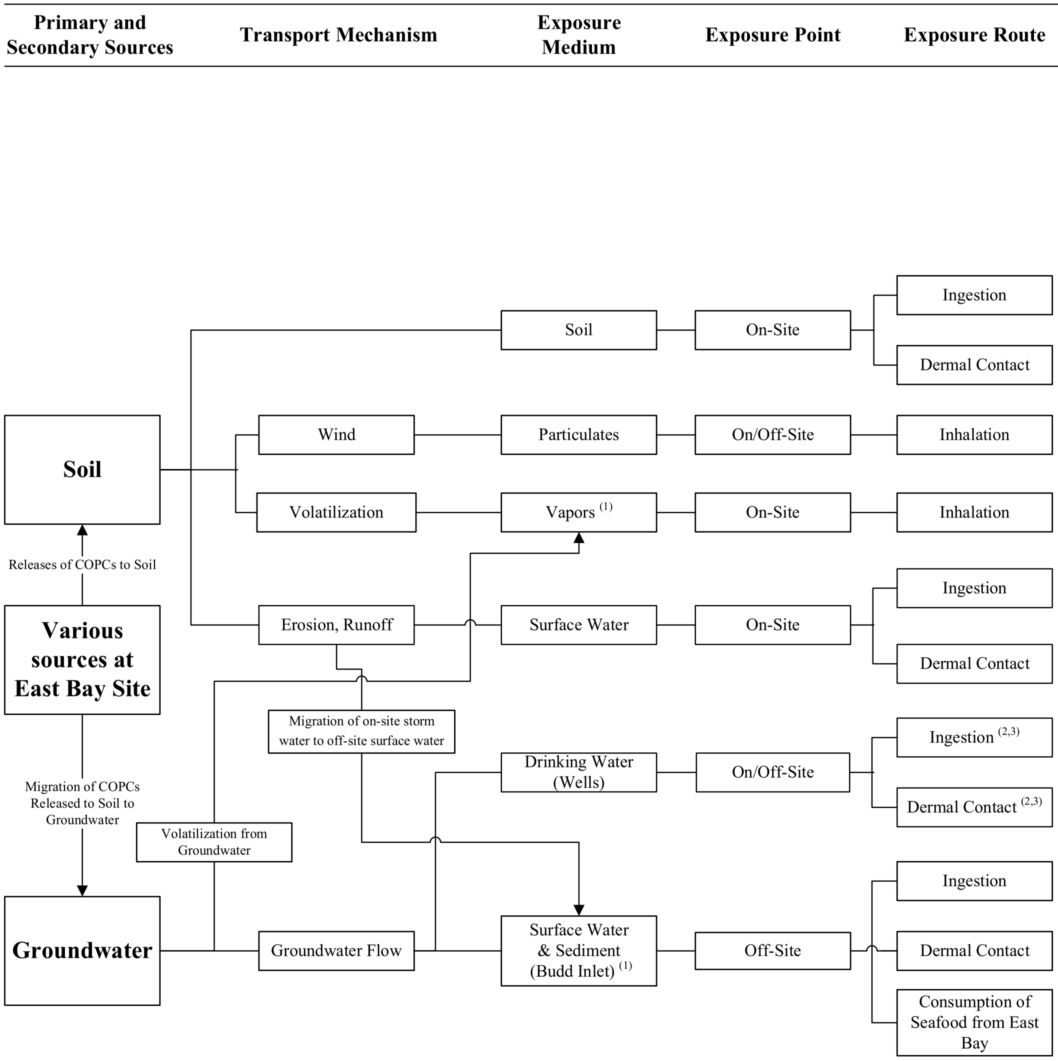


Figure 3-9:
Capping with Partial Excavation and Controls Surfacing Plan
Parcels 4 and 5

1/25/2010 0:08897 -Olympia...\138130...GIS\Maps\Figure 3-x Excavation Plan

APPENDIX A – CONCEPTUAL SITE EXPOSURE MODEL



Exposure Medium	Exposure Point	Exposure Route	Current Land Use (Pre-construction): Residents	Current Land Use (Pre-construction): Commercial / Industrial Workers	Current Land Use (Pre-construction): Trespassers (4)	Current Land Use (Pre-construction): Recreators (4,5)	Construction Phase: Utility Installation Workers (4)	Construction Phase: Utility Installation Trespassers (4)	Construction Phase: Building Construction Workers (4)	Construction Phase: Building Construction Trespassers (4)	Construction Phase: Recreators and Subsistence Fishers (4,5)	Future Land Use: Urban Residents (4,6)	Future Land Use: Commercial Workers (6)	Future Land Use: Utility Maintenance Workers (4)	Future Land Use: Recreators and Subsistence Fishers (4,6)	Ecological: Terrestrial Organisms	Ecological: Aquatic Organisms
Soil	On-Site	Ingestion	○	○	◈	○	●	●	●	●	○	◈	◈	●	◈	◈	○
		Dermal Contact	○	○	◈	○	●	●	●	●	○	◈	◈	●	◈	◈	○
Particulates	On/Off-Site	Inhalation	○	○	○	○	●	●	●	●	○	◈	◈	●	◈	◈	○
Vapors (1)	On-Site	Inhalation	○	○	◈	○	◈	◈	◈	◈	○	◈	◈	◈	◈	◈	○
Surface Water	On-Site	Ingestion	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Dermal Contact	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Drinking Water (Wells)	On/Off-Site	Ingestion (2,3)	○	○	○	○	○	○	○	○	○	◈	◈	◈	◈	◈	○
		Dermal Contact (2,3)	○	○	◈	○	◈	◈	○	○	○	◈	◈	◈	○	◈	○
Surface Water & Sediment (Budd Inlet) (1)	Off-Site	Ingestion	○	○	○	◈	○	○	○	○	◈	○	○	○	◈	○	◈
		Dermal Contact	○	○	○	◈	○	○	○	○	◈	○	○	○	◈	○	◈
		Consumption of Seafood from East Bay	○	○	○	◈	○	○	○	○	◈	○	○	○	◈	○	◈

Figure C-1

Conceptual Site Exposure Model
Port of Olympia East Bay Site

PIONEER
TECHNOLOGIES CORPORATION

File: IAWP App C_Figure C-1.vsd

Key
- ● Complete Exposure Pathway
- ◈ Potentially Complete Exposure Pathway (pending further evaluation)
- ○ Incomplete Exposure Pathway

NOTES:

[1] Although this pathway is likely not complete based on existing data, it is considered potentially complete for all relevant receptors pending further evaluation.

[2] Even though there are no current drinking water wells that are impacted by releases to site soil and it is unlikely that a suitable future water well could be installed in the shallow groundwater at the site, use of shallow groundwater as a future drinking water source is considered potentially complete for all relevant receptors pending further evaluation.

[3] Also applies to suspected ponded groundwater during current land use and shallow groundwater in a utility excavation during the construction phase and/or future land use.

[4] This exposure scenario is a reasonable maximum exposure scenario and is more conservative and therefore protective of other similar exposure scenarios. For instance, the exposure assumptions for current trespassers are more conservative than other current exposure scenarios, such as a scenario for people who access boats stored on-site. Likewise, all three off-site recreator scenarios are more conservative than other off-site human exposure scenarios; the two on-site worker and two on-site trespasser scenarios during the construction phase are more conservative than other on-site construction phase exposure scenarios; the future urban residential scenario is more conservative than the hotel guest exposure scenario; the future utility maintenance worker exposure scenario is more conservative than other human exposure scenarios for future subsurface work; etc.

[5] Current and construction-phase recreators are off-site only since there is no current recreational land use on-site and access will be restricted during the construction phase.

[6] Although future soil-based exposures would be incomplete if exposure barriers were installed as necessary in accordance with current development plans, the pathway is considered potentially complete for all relevant receptors pending further evaluation.

APPENDIX B – LABORATORY DATA REPORTS

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF GASOLINE RANGE ORGANICS IN SOIL

Sample Identification	Date Analyzed	Percent Solids (%)	Benzene EPA 8021B (mg/kg)	Toluene EPA 8021B (mg/kg)	Ethylbenzene EPA 8021B (mg/kg)	m&p-Xylene EPA 8021B (mg/kg)	o-Xylene EPA 8021B (mg/kg)	Gasoline NWTPH-Gx (mg/kg)	Surrogate Recovery BFB (%)	Data Flags
Method Blank	6/17/2009	n/a	nd	nd	nd	nd	nd	nd	86.0	
DP28-061009-1-2	6/17/2009	83.7	nd	nd	nd	nd	nd	nd	102	
DP28-061009-3.5-5	6/17/2009	86.2	nd	nd	nd	nd	nd	nd	101	
DP37-061009-2-3.5	6/17/2009	77.9	nd	nd	nd	nd	nd	nd	89.8	
DP37-061009-6-7.5	6/17/2009	63.2	nd	nd	nd	nd	nd	nd	96.0	
DP39-061009-0.5-2	6/17/2009	95.3	nd	nd	nd	nd	nd	nd	102	
DP39-061009-3-5	6/17/2009	82.6	nd	nd	nd	nd	nd	nd	105	
LCS	6/17/2009	n/a	108%	114%	110%	104%	104%	94.9%	n/a	
090617-MS	6/17/2009	n/a	104%	101%	95.3%	110%	96.8%	108%	n/a	
Method Reporting Limits			0.05	0.10	0.10	0.10	0.10	5.0		

WA-DOE-Laboratory Certification No.: C2013
"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.
"n/a" indicates not applicable
Sample results based on dry weight.

Comments and Explanations: None

Analyst: T. McCall
Data reviewed by:

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF FUEL IN SOIL

Sample Identification	Date Analyzed	Percent Solids (%)	Diesel Fuel #2 NWTPH-Dx (mg/kg)	Heavy Oil NWTPH-Dx (mg/kg)	Surrogate Recovery 2-FBP (%)	Data Flags
Method Blank	6/12/2009	n/a	nd	nd	72.1	
DP28-061009-1-2	6/12/2009	83.7	nd	nd	110	
DP28-061009-3.5-5	6/12/2009	86.2	nd	nd	115	
DP29-061009-7-8	6/12/2009	23.3	nd	nd	108	
DP29-061009-13-14	6/12/2009	20.9	nd	nd	67.7	
DP31-061009-3-4	6/12/2009	77.4	nd	nd	114	
DP35-061009-5-6	6/12/2009	95.3	nd	nd	80.2	
DP37-061009-2-3.5	6/12/2009	77.9	nd	nd	86.7	
DP37-061009-6-7.5	6/12/2009	63.2	nd	nd	89.7	
DP37-061009-6-7.5 Dup.	6/12/2009	63.2	nd	nd	94.5	
DP39-061009-0.5-2	6/12/2009	95.3	nd	nd	82.5	
DP39-061009-3-5	6/12/2009	82.6	nd	**440**	82.4	
LCS	6/12/2009	n/a	105%	n/a	n/a	
090612-MS	6/12/2009	n/a	121%	n/a	n/a	
090612-MSD	6/12/2009	n/a	110%	n/a	n/a	
Method Reporting Limits			25	100		

WA-DOE-Laboratory Certification No.: C2013

"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.

"n/a" indicates not applicable

Sample results based on dry weight.

Comments and Explanations: None

Analyst: T. McCall
Data reviewed by:

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF SEMI-VOLATILE COMPOUNDS IN SOIL BY EPA METHOD 8270

Sample Identification			Blank	DP26-061009-1 2	DP26-061009-3 4	DP28-061009-1 2	DP28-061009- 3.5-5	DP29-061009-1 2	DP29-061009-7 8
Percent Solids (%)			n/a	90.5	93.2	83.7	86.2	83.9	23.3
Date Extracted	CAS	MRL	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009
Date Anlayzed	Number	(mg/kg)	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Benzo(a)anthracene	56-55-3	0.01	nd	**0.07**	**0.02**	**0.03**	**0.06**	**0.23**	**0.05**
Benzo(a)pyrene	50-32-8	0.01	nd	**0.14**	**0.11**	nd	nd	**0.30**	**0.19**
Benzo(b)fluoranthene	205-99-2	0.01	nd	nd	nd	nd	nd	**0.13**	nd
Benzo(k)fluoranthene	207-08-9	0.01	nd	**0.02**	nd	**0.01**	**0.02**	**0.08**	**0.02**
Chrysene	218-01-9	0.01	nd	**0.04**	nd	nd	**0.05**	**0.23**	**0.05**
Dibenzo(a,h)anthracene	53-70-3	0.01	nd	**0.10**	nd	**0.10**	**0.10**	**0.12**	nd
Ideno(1,2,3-cd)pyrene	193-39-5	0.01	nd	**0.25**	**0.23**	**0.26**	**0.27**	**0.31**	nd
1-Methylnaphthalene	90-12-0	0.01	nd	**0.01**	**0.01**	nd	**0.01**	**0.01**	**0.05**
2-Methylnaphthalene	91-57-6	0.01	nd	**0.01**	**0.01**	**0.01**	**0.02**	**0.02**	**0.14**
Naphthalene	91-20-3	0.01	nd	**0.01**	**0.01**	**0.01**	**0.06**	**0.05**	**0.39**
Surrogate Recovery (%)									
2-Fluorophenol			117	127	121	121	123	121	116
Phenol-d6			126	140	133	134	134	130	127
Nitrobenzene-d5			83.3	110	107	109	100	106	106
2-Fluorobiphenol			102	90.4	88.4	90.2	84.8	89.3	88.2
2,4,6-Tribromophenol			124	70.3	128	117	135	124	123
Terphenyl-d14			108	101	100	103	94.9	103	99.1
Data Flags									

WA-DOE-Laboratory Certification No.: C2013
"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.
"n/a" indicates not applicable
Sample results based on dry weight.
Comments and Explanations: None

Analyst: T. McCall
Data reviewed by:

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF SEMI-VOLATILE COMPOUNDS IN SOIL BY EPA METHOD 8270

Sample Identification			DP29-061009-13-14	DP37-061009-2 3.5	DP39-061009-0.5-2	DP39-061009-3 5	LCS	090618-MS	090618-MSD
Percent Solids (%)			20.9	77.9	95.3	82.6	n/a	n/a	n/a
Date Extracted	CAS	MRL	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009
Date Anlayzed	Number	(mg/kg)	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Benzo(a)anthracene	56-55-3	0.01	**0.04**	**0.02**	**0.04**	**0.89**	105%	107%	106%
Benzo(a)pyrene	50-32-8	0.01	**0.18**	**0.12**	**0.14**	**0.81**	n/a	n/a	n/a
Benzo(b)fluoranthene	205-99-2	0.01	nd	nd	**0.01**	**1.14**	n/a	n/a	n/a
Benzo(k)fluoranthene	207-08-9	0.01	nd	nd	**0.02**	**0.39**	n/a	n/a	n/a
Chrysene	218-01-9	0.01	nd	nd	**0.04**	**0.94**	109%	113%	112%
Dibenzo(a,h)anthracene	53-70-3	0.01	**0.16**	nd	**0.10**	**0.19**	n/a	n/a	n/a
Ideno(1,2,3-cd)pyrene	193-39-5	0.01	nd	nd	**0.23**	**0.54**	75.8%	77.4%	72.6%
1-Methylnaphthalene	90-12-0	0.01	nd	nd	nd	**0.05**	n/a	n/a	n/a
2-Methylnaphthalene	91-57-6	0.01	nd	nd	nd	**0.05**	n/a	n/a	n/a
Naphthalene	91-20-3	0.01	nd	**0.05**	**0.01**	**0.08**	n/a	n/a	n/a
Surrogate Recovery (%)									
2-Fluorophenol			116	119	128	121	119	126	126
Phenol-d6			128	128	135	122	126	133	133
Nitrobenzene-d5			109	103	119	107	107	104	103
2-Fluorobiphenol			89.4	87.9	97.3	94.1	82.7	81.6	81.9
2,4,6-Tribromophenol			126	142	126	119	128	125	124
Terphenyl-d14			100	103	112	103	108	107	106
Data Flags									

WA-DOE-Laboratory Certification No.: C2013

"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.

"n/a" indicates not applicable

Sample results based on dry weight.

Comments and Explanations: None

Analyst: T. McCall
Data reviewed by:

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF HEAVY METALS IN SOIL BY EPA METHOD 6020 A

Sample Identification	Date Analyzed	Percent Solids	Arsenic (As)	Cadmium (Cd)	Lead (Pb)
Chemical Abstract Number (CAS)			7440-38-2	7440-43-9	7439-92-1
Units		(%)	(mg/kg)	(mg/kg)	(mg/kg)
Method Blank	6/18/2009	n/a	nd	nd	nd
DP26-061009-1-2	6/18/2009	90.5	**9.75**	**0.37**	**13.4**
DP26-061009-7-8	6/18/2009	83.7	**3.81**	**0.30**	**2.42**
DP28-061009-1-2	6/18/2009	83.7	**6.06**	**2.58**	**131**
DP28-061009-3.5-5	6/18/2009	86.2	**3.84**	**0.47**	**7.60**
DP29-061009-7-8	6/18/2009	23.3	**3.57**	**0.32**	**32.4**
DP29-061009-3-4	6/18/2009	79.3	**5.89**	**0.69**	**8.69**
DP31-061009-3-4	6/18/2009	77.4	**7.26**	**0.39**	**3.09**
DP37-061009-2-3.5	6/18/2009	77.9	**3.94**	**0.46**	**10.5**
DP37-061009-6-7.5	6/18/2009	63.2	**6.74**	**1.23**	**8.17**
DP39-061009-0.5-2	6/18/2009	95.3	**4.94**	**0.47**	**15.3**
DP39-061009-3-5	6/18/2009	82.6	**3.31**	**0.52**	**17.5**
DP41-061009-3-4	6/18/2009	95.3	**3.14**	**0.35**	**3.41**
DP42-061009-1-2	6/18/2009	86.8	**2.97**	**0.4**	**12.1**
DP42-061009-5-6	6/18/2009	80.3	**4.15**	**0.56**	**13.7**
DP42-061009-7-8	6/18/2009	40.8	**3.66**	**0.57**	**2.54**
LCS	6/18/2009	n/a	104%	101%	104%
090618-MS	6/18/2009	n/a	MI	99.2%	MI
090618-MSD	6/18/2009	n/a	MI	97.9%	MI
Method Reporting Limits			0.25	0.25	0.25

WA-DOE-Laboratory Certification No.: C2013
"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.
"n/a" indicates not applicable
"MI" indicates Matrix Interference
Sample results based on dry weight.
Comments and Explanations: None

Analyst: T. McCall
Data reviewed by:

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF PCB's IN SOIL BY EPA METHOD 8082

Sample Identification	Date Analyzed	Percent Solids (%)	Aroclor 1016 (mg/kg)	Aroclor 1221 (mg/kg)	Aroclor 1232 (mg/kg)	Aroclor 1248 (mg/kg)	Aroclor 1254 (mg/kg)	Aroclor 1260 (mg/kg)	Surrogate Recovery TCMX (%)	Surrogate Recovery DCBP (%)	Data Flags
Method Blank	6/15/2009	n/a	nd	nd	nd	nd	nd	nd	115	118	
DP35-061009-5-6	6/15/2009	95.3	nd	nd	nd	nd	nd	nd	110	97.6	
DP37-061009-2-3.5	6/15/2009	77.9	nd	nd	nd	nd	nd	nd	85.5	81.8	
DP37-061009-2-3.5 Dup.	6/15/2009	77.9	nd	nd	nd	nd	nd	nd	114	98.7	
DP37-061009-6-7.5	6/15/2009	63.2	nd	nd	nd	nd	nd	nd	103	94.5	
LCS	6/15/2009	n/a	87.4	n/a	n/a	n/a	n/a	95.6	n/a	n/a	
090615-MS	6/15/2009	n/a	99.3	n/a	n/a	n/a	n/a	91.8	n/a	n/a	
090615-MSD	6/15/2009	n/a	99.4	n/a	n/a	n/a	n/a	94.1	n/a	n/a	
Method Reporting Limits			0.025	0.025	0.025	0.025	0.025	0.025			

WA-DOE-Laboratory Certification No.: C2013

"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.

"n/a" indicates not applicable

All results based on dry weight.

Comments and Explanations: None

Analyst: T. McCall
Data reviewed by: R. Lewis

525 McKenzie Rd SW

DRAGON
Analytical Laboratory

RCRA CHAIN OF CUSTODY RECORD

2818 Madrona Beach Rd. NW, Olympia, WA 98502
Phone: (360) 866-0543 Fax: (360) 866-0556
Email: DragonLab@comcast.net

Page 1 of 3

Samples Collected By: TB
Contact Number:

Client: PTC
Address: 2612 Yelm Hwy SE, Ste B
Oly, WA 98501
Phone: 570-1700
Fax:
Email: busseyt@uspioneer
Project Name: East Bay PH2 RI
Project Location: —
Project Number: —
Project P.O.:
Contact Person: Troy Bussey
DAL Project No.: 090610-08

NOTE: HOLD ALL SAMPLES FOR POSSIBLE SUBSEQUENT ANALYSES. SEE RL EXPECTATIONS PREVIOUSLY EMAILED

Matrix Code:
WW = wastewater GW = groundwater S = soil or solid
SL = sludge V = vapor O = other

Heavy Metals: As, Cd, and Pb only

Sample Identification	Sample Matrix	Date Sampled	Time Sampled	Container Type	~~MTBE~~/BTEX (EPA 8021b)	Gasoline (NWTPH-Gx)	Diesel (NWTPH-Dx)	Diesel & Oil (NWTPH-Dx)	Fuel Scan (NWTPH-HCID)	VOC's (EPA 8021b)	Organochlorine Pesticides (EPA 8081)	PCB's (EPA 8082)	Volatiles (EPA 8260)	PAH's (EPA 8100 or 8270/8270SIM)	Semi-Volatiles (EPA 8270)	Ignitability (EPA 1010)	Oil and Grease (EPA 1664 HEM)	pH (EPA 9040/9045)	Specific Conductance (EPA 9050)	Paint Filter Test (EPA 9095)	Heavy Metals* (EPA 7000 Series)	Biogenic Gases (EPA 3C)	Natural Attenuation Indicators	Gross Alpha Radioactivity (EPA 900)	Gross Beta Radioactivity (EPA 900)
DP26-061009-1-2	S	06/10/09	0900	1 4oz										X							X				
DP26-061009-3-4	↓	↓	0905	2 4oz										X											
DP26-061009-~~7-8~~ 5-6			0910	↓																					
DP26-061009-7-8			0915											TB							X				
DP26-061009-8-9			0920	↓				TB																	
DP28-061009-1-2			1115	3 Encore 1 4oz	X	X		X						X							X				
DP28-061009-3.5-5			1120	3 Encore 2 4oz	X	X		X						X							X				
DP29-061009-1-2			1150	2 4oz										X											
DP29-061009-3-4			1155	↓																	X				
DP29-061009-5.5-6.5			1200																						
DP29-061009-7-8			1205	↓				X						X							X				
DP29-061009-8.5-9.5			1210	1 4oz																					
DP29-061009-13-14	↓	↓	1215	2 4oz				X						X											

Relinquished by (Signature): Troy Bussey
Date/Time: 6/10/09 1700
Received by (Signature): McCall
Date/Time: 6/10/09 545

Relinquished by (Signature):
Date/Time:
Received by (Signature):
Date/Time:

Sample Disposal Instructions: ☐ DAL Disposal @ $2.50 per Container ☐ Return ☐ Pickup

Turn-Around-Time
☐ Same Day
☐ 24 Hour
☐ 48 Hour
☐ 5 Day
☒ 10 Day
☐ Other:

***Heavy Metals:** Please circle the desired analytes.

Ag Al [✓ As] Ba Be [✓ Cd] Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni [✓ Pb] Sb Se Tl V Zn - Total
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - Dissolved
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - TCLP

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Page 2 of 3

Samples Collected By: TB
Contact Number:

Client: PTC
Address: 2612 Yelm Highway SE, Suite B
Oly, WA 98501
Phone: 570-1700
Fax:
Email: busseyt@uspioneer.com
Project Name: East Bay PH2 RI
Project Location:
Project Number:
Project P.O.:
Contact Person: Troy Bussey
DAL Project No.: 090610-08

NOTE: HOLD ALL SAMPLES FOR POSSIBLE SUBSEQUENT ANALYSIS. SEE RL EXPECTATIONS PREVIOUSLY EMAILED

Matrix Code:
WW = wastewater GW = groundwater S = soil or solid
SL = sludge V = vapor O = other

Heavy Metals*: As, Cd, Pb only

Sample Identification	Sample Matrix	Date Sampled	Time Sampled	Container Type	~~MTBE~~/BTEX (EPA 8021b)	Gasoline (NWTPH-Gx)	Diesel (NWTPH-Dx)	Diesel & Oil (NWTPH-Dx)	Fuel Scan (NWTPH-HCID)	VOC's (EPA 8021b)	Organochlorine Pesticides (EPA 8081)	PCB's (EPA 8082)	Volatiles (EPA 8260)	PAH's (EPA 8100 or 8270/8270SIM)	Semi-Volatiles (EPA 8270)	Ignitability (EPA 1010)	Oil and Grease (EPA 1664 HEM)	pH (EPA 9040/9045)	Specific Conductance (EPA 9050)	Paint Filter Test (EPA 9095)	Heavy Metals* (EPA 7000 Series)	Biogenic Gases (EPA 3C)	Natural Attenuation Indicators	Gross Alpha Radioactivity (EPA 900)	Gross Beta Radioactivity (EPA 900)
DP31-061009-1-2	S	6/10/09	1040	2 4oz																					
DP31-061009-3-4			1050					X													X				
DP31-061009-4.5-5.5			1100																						
DP35-061009-1-2			1000																						
DP35-061009-3-4			1020																						
DP35-061009-5-6			1030					X				X													
DP37-061009-0.5-2			1450	2 4oz 3 Encore																					
DP37-061009-2-3.5			1500		X	X		X				X		X							X				
DP37-061009-6-7.5			1510		X	X		X				X									X				
DP37-061009-9-11			1520																						
DP39-061009-0.5-2			1340		X	X		X						X							X				
DP39-061009-3-5			1350		X	X		X						X							X				

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
Ty Bussey	6/10/09 1700	Jim McCall	6/10/09 543

Turn-Around-Time
☐ Same Day
☐ 24 Hour
☐ 48 Hour
☐ 5 Day
☒ 10 Day
☐ Other:

*Heavy Metals: Please circle the desired analytes.
Ag Al [✓ As] Ba Be [✓ Cd] Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni [✓ Pb] Sb Se Tl V Zn - Total
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - Dissolved
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - TCLP

Sample Disposal Instructions: ☐ DAL Disposal @ $2.50 per Container ☐ Return ☐ Pickup

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Page 3 of 3

Samples Collected By: TB
Contact Number:

Client: PTZ
Address: 2612 Yelm Hwy SE, Suite 3
OLY, WA 98501
Phone: 570-1700
Fax:
Email: bussey t@uspioneer.com
Project Name: East Bay PH2 RI
Project Location:
Project Number:
Project P.O.:
Contact Person: Troy Bussey
DAL Project No.: 090610-08

NOTE: Hold all samples for possible analyses. See RC expectations previously emailed

Matrix Code:
WW = wastewater GW = groundwater S = soil or solid
SL = sludge V = vapor O = other

Sample Identification	Sample Matrix	Date Sampled	Time Sampled	Container Type	MtBE/BTEX (EPA 8021b)	Gasoline (NWTPH-Gx)	Diesel (NWTPH-Dx)	Diesel & Oil (NWTPH-Dx)	Fuel Scan (NWTPH-HCID)	VOC's (EPA 8021b)	Organochlorine Pesticides (EPA 8081)	PCB's (EPA 8082)	Volatiles (EPA 8260)	PAH's (EPA 8100 or 8270/8270SIM)	Semi-Volatiles (EPA 8270)	Ignitability (EPA 1010)	Oil and Grease (EPA 1664 HEM)	pH (EPA 9040/9045)	Specific Conductance (EPA 9050)	Paint Filter Test (EPA 9095)	Heavy Metals* (EPA 7000 Series)	Biogenic Gases (EPA 3C)	Natural Attenuation Indicators	Gross Alpha Radioactivity (EPA 900)	Gross Beta Radioactivity (EPA 900)
DP41-061009-1-2	S	6/10/09	1420	2 4oz																					
DP41-061009-3-4	↓	↓	1425	1 4oz																	X				
DP41-061009-5-6			1430	2 4oz																					
DP42-061009-1-2			1300	↓																	X				
DP42-061009-3-4			1305	↓																					
DP42-061009-5-6			1310	1 4oz																	X				
DP42-061009-7-8	↓	↓	1315	2 4oz																	X				

As, Cd, Pb only

Relinquished by (Signature) Ty Bussey Date/Time 6/10/09 1700 Received by (Signature) McCall Date/Time 6/10/09 543
Relinquished by (Signature) Date/Time Received by (Signature) Date/Time

Sample Disposal Instructions: ☐ DAL Disposal @ $2.50 per Container ☐ Return ☐ Pickup

Turn-Around-Time
☐ Same Day
☐ 24 Hour
☐ 48 Hour
☐ 5 Day
☒ 10 Day
☐ Other:

***Heavy Metals**: Please circle the desired analytes.

Ag Al [✓ As] Ba Be [✓ Cd] Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni [✓ Pb] Sb Se Tl V Zn - Total
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - Dissolved
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - TCLP

Pace Analytical™
www.pacelabs.com

Pace Analytical Services, Inc.
1700 Elm Street
Minneapolis, MN 55414
Phone: 612.607.1700
Fax: 612.607.6444

Report Prepared for:

Troy Bussey
Pioneer Technologies Corporation
2612 Yelm Highway S.E.
Suite B
Olympia WA 98501-4826

REPORT OF LABORATORY ANALYSIS FOR PCDD/PCDF

Report Prepared Date:

July 1, 2009

Report Information:

Pace Project #: 1097162
Sample Receipt Date: 06/12/2009
Client Project #: East Bay PH2 RI
Client Sub PO #: N/A
State Cert #: C218

Invoicing & Reporting Options:

The report provided has been invoiced as a Level 2 PCDD/PCDF Report. If an upgrade of this report package is requested, an additional charge may be applied.

Please review the attached invoice for accuracy and forward any questions to Scott Unze, your Pace Project Manager.

This report has been reviewed and prepared by:

Scott Unze, Project Manager
(612) 607-6383
(612) 607-6444 (fax)
scott.unze@pacelabs.com

ACCREDITED IN ACCORDANCE WITH nelac

Report of Laboratory Analysis

This report should not be reproduced, except in full, without the written consent of Pace Analytical Services, Inc.

The results relate only to the samples included in this report.

DISCUSSION

This report presents the results from the analyses performed on twelve samples submitted by a representative of Pioneer Technologies Corporation. The samples were analyzed for the presence or absence of polychlorodibenzo-p-dioxins (PCDDs) and polychlorodibenzofurans (PCDFs) using a modified version of USEPA Method 8290. Reporting limits were based on signal-to-noise calculations. The samples were received outside of the recommended temperature range of 0-6 degrees Celsius.

The recoveries of the isotopically-labeled PCDD/PCDF internal standards in the sample extracts ranged from 17-130%. With the exceptions of eleven low values, which were flagged "P" on the results tables, the labeled standard recoveries obtained for this project were within the 40-135% target range specified in Method 8290. Also, since the quantification of the native 2,3,7,8-substituted congeners was based on isotope dilution, the data were automatically corrected for variation in recovery and accurate values were obtained.

In some cases, interfering substances impacted the determinations of PCDD or PCDF congeners. The affected values were flagged "I" where incorrect isotope ratios were obtained, or "E" where polychlorinated diphenyl ethers were present.

A laboratory method blank was prepared and analyzed with the sample batch as part of our routine quality control procedures. The results show the blank to contain trace levels of selected congeners. These were below the calibration range of the method. Sample levels similar to the corresponding blank levels were flagged "B" on the results tables and may be, at least partially, attributed to the background. It should be noted that levels less than ten times the background are not generally considered to be statistically different from the background.

Laboratory and matrix spike samples were also prepared with the sample batch using clean sand or sample matrix that had been fortified with native standard materials. The results show that the spiked native compounds were generally recovered at 82-115%, with relative percent differences of 0.9-14.4%. These results indicate generally high degrees of accuracy and precision for these determinations. Somewhat variable background-subtracted results were obtained for selected congeners in the matrix spike samples, due to the levels of these compounds in the sample material.

Appendix A

Sample Management

1097162

Anatek Labs, Inc.

Chain of Custody Record

○ 1282 Alturas Drive, Moscow ID 83843 (208) 883-2839 FAX 882-9246 ○
○ 504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999 FAX 838-4433 ○

Anatek Log-In #

Company Name: PTC
Address: 2612 Yelm Hwy SE, Suite B
City: Oly State: WA Zip: 98501
Phone: 360-570-1700
Fax: —

Project Manager: Troy Bussey
Project Name & #: East Bay PH 2 RI
Email Address: busseyt@uspioneer.com
Purchase Order #: — Credit Card
Sampler Name & phone: Same

Turn Around Time & Reporting

Please refer to our normal turn around times at: http://www.anateklabs.com/services/guidelines/reporting.asp

☒ Normal
☐ Next Day*
☐ 2nd Day*
☐ Other*

*All rush order requests must be prior approved.

☐ Phone
☒ Mail (Final)
☐ Fax
☒ Email (Prelim)

Provide Sample Description / List Analyses Requested

Preservative: NA

Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume	Dioxins/Furans 8290
001	DP26-061009-1-2	06/10/09 0900	SOIL	1	4 oz	X
062	DP26-061009-3-4	06/10/09 0905		1		X
⊕	DP26-061009-5-6	06/10/09 0910		1		
003	DP26-061009-7-8	06/10/09 0915		1		X
	DP26-061009-8-9	06/10/09 0920		1		
	DP28-061009-1-2	06/10/09 1115		1		
	DP28-061009-3.5-5	06/10/09 1120		1		
	~~[illegible]~~			1		
①	DP29-061009-1-2	06/10/09 1150		1		
	DP29-061009-3-4	06/10/09 1155		1		
	DP29-061009-5.5-6.5	1200		1		
	DP29-061009-7-8	1205		1		
	DP29-061009-8.5-9.5	1210		1		

Note Special Instructions/Comments

1) Please hold all ~~analyses~~ samples for possible analyses

2) See RI expectations sent previously

	Printed Name	Signature	Company	Date	Time
Relinquished by	Troy Bussey	Troy Bussey	PTC	6/10/09	1630
Received by					
Relinquished by					
Received by	Scott Unze	Scott C. Unze	Pace	6/12/09	0927
Relinquished by					
Received by					

Inspection Checklist

Received Intact?	Y	N
Labels & Chains Agree?	Y	N
Containers Sealed?	Y	N
VOC Head Space?	Y	N

Temperature (°C): 7.6
Preservative:
Date & Time:
Inspected By:

⊕ Received broken. @ 06/12/09 ① Sample taken off hold per Nathan on 06/17/09. @ 06/17/09

1097162

Anatek Labs, Inc.

Chain of Custody Record

○ 1282 Alturas Drive, Moscow ID 83843 (208) 883-2839 FAX 882-9246 ○
○ 504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999 FAX 838-4433 ○

Anatek Log-In #

Company Name: PTC	Project Manager: Troy Bussey
Address: 2612 Yelm Hwy SE SteB	Project Name & #: East Bay PH2 RI
City: Olympia State: WA Zip: 98501	Email Address: Busseyt@uspioneer.com
Phone: 360 570 1700	Purchase Order #: Credit card
Fax: —	Sampler Name & phone: Same

Turn Around Time & Reporting

Please refer to our normal turn around times at:
http://www.anateklabs.com/services/guidelines/reporting.asp

☒ Normal
☐ Next Day*
☐ 2nd Day*
☐ Other*_____

*All rush order requests must be prior approved.

☐ Phone
☒ Mail (Final)
☐ Fax
☒ Email (prelim)

Provide Sample Description / List Analyses Requested

Lab ID	Sample Identification	Sampling Date/Time		Matrix	# of Containers	Sample Volume	Dioxin/Furans 8290
					Preservative:		N/A
	DP29-061009-13-14	06/10/09	1215	Soil	1	4oz	
⊕	DP31-061009-1-2		1040		1		X
004	DP31-061009-3-4		1050		1		X
	DP31-061009-4.5-5.5		1100		1		
	DP35-061009-1-2		1000		1		
	DP35-061009-3-4		1020		1		
	DP35-061009-5-6		1030		1		
	DP37-061009-0.5-2		1450		1		
	DP37-061009-2-3.5		1500		1		
	DP37-061009-6-7.5		1510		1		
⊕	DP37-061009-9-11		1520		1		
005	DP39-061009-0.5-2		1340		1		X
006	DP39-061009-3-5		1350		1		X

Note Special Instructions/Comments

1) Please hold all samples for Possible Analyses.
2) See RL expectations sent previously

	Printed Name	Signature	Company	Date	Time
Relinquished by	TROY BUSSEY		PTC	6/10/09	1630
Received by					
Relinquished by					
Received by	SCOTT UNZE		Pa	6/12/09	0927
Relinquished by					
Received by					

Inspection Checklist

Received Intact? Y N
Labels & Chains Agree? Y N
Containers Sealed? Y N
VOC Head Space? Y N

Temperature (°C): 7.6
Preservative: _____
Date & Time: _____
Inspected By: _____

⊕ Received broken. @ 06/12/09

1097162

Anatek Labs, Inc.

Chain of Custody Record

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○ 504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999 FAX 838-4433 ○

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City: Olympia State: WA Zip: 98501
Phone: 360-570-1700
Fax: —

Project Manager: Troy Bussey
Project Name & #: East Bay Ph 2 RI
Email Address: busseyt@uspioneer.com
Purchase Order #: — Credit card
Sampler Name & phone: Same

Turn Around Time & Reporting

Please refer to our normal turn around times at: http://www.anateklabs.com/services/guidelines/reporting.asp

- X Normal
- __ Next Day*
- __ 2nd Day*
- __ Other*______

*All rush order requests must be prior approved.

- __ Phone
- X Mail (Final)
- __ Fax
- X Email (Prelim)

Provide Sample Description / List Analyses Requested

Lab ID	Sample Identification	Sampling Date/Time		Matrix	# of Containers	Sample Volume	Dioxin/Furans 8290
					Preservative:		N/A
007	DP41-061009-1-2	06/10/09	1420	Soil	1	4oz	X
008	DP41-061009-3-4		1425		1		X
	DP41-061009-5-6		1430		1		
009	DP42-061009-1-2		1300		1		X
	DP42-061009-3-4		1305		1		
010	DP42-061009-5-6		1310		1		X
011	DP42-061009-7-8		1315		1		X

Note Special Instructions/Comments

1) Please hold all samples for possible analyses

2) See RL expectations sent previously

	Printed Name	Signature	Company	Date	Time
Relinquished by	Troy Bussey		PTC	6/10/09	1630
Received by					
Relinquished by					
Received by	SCOTT UNZE		Pace	06/12/09	0927
Relinquished by					
Received by					

Inspection Checklist

Received Intact? Y N
Labels & Chains Agree? Y N
Containers Sealed? Y N
VOC Head Space? Y N

Temperature (°C): 7.6
Preservative:
Date & Time:
Inspected By:

Sample Condition Upon Receipt

PaceAnalytical

Client Name: Pioneer Tech Corp **Project #** 1097162

Courier: ☒ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other ________
Tracking #: 8667 2411 8371

Optional
Proj. Due Date:
Proj. Name:

Custody Seal on Cooler/Box Present: ☐ yes ☒ no Seals intact: ☐ yes ☐ no

Packing Material: ☒ Bubble Wrap ☒ Bubble Bags ☐ None ☐ Other ________ Temp Blank: Yes ____ No X

Thermometer Used 80344042, 179425 **Type of Ice:** Wet Blue None ☐ Samples on Ice, cooling process has begun

Cooler Temperature 7.6 **Biological Tissue is Frozen:** Yes No
Temp should be above freezing to 6°C

Date and Initials of person examining contents: SCU 06/12/09

				Comments:
Chain of Custody Present:	☒ Yes	☐ No	☐ N/A	1.
Chain of Custody Filled Out:	☒ Yes	☐ No	☐ N/A	2.
Chain of Custody Relinquished:	☒ Yes	☐ No	☐ N/A	3.
Sampler Name & Signature on COC:	☐ Yes	☒ No	☐ N/A	4.
Samples Arrived within Hold Time:	☒ Yes	☐ No	☐ N/A	5.
Short Hold Time Analysis (<72hr):	☐ Yes	☒ No	☐ N/A	6.
Rush Turn Around Time Requested:	☐ Yes	☒ No	☐ N/A	7.
Sufficient Volume:	☒ Yes	☐ No	☐ N/A	8.
Correct Containers Used:	☒ Yes	☐ No	☐ N/A	9.
-Pace Containers Used:	☐ Yes	☒ No	☐ N/A	
Containers Intact:	☐ Yes	☒ No	☐ N/A	10. 2 broken, 1 cracked jar
Filtered volume received for Dissolved tests	☐ Yes	☐ No	☒ N/A	11.
Sample Labels match COC:	☐ Yes	☐ No	☐ N/A	12.
-Includes date/time/ID/Analysis Matrix: ________				
All containers needing acid/base preservation have been checked. Noncompliance are noted in 13.	☐ Yes	☐ No	☒ N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☐ Yes	☐ No	☒ N/A	
Exceptions: VOA,Coliform, TOC, Oil and Grease, WI-DRO (water)	☐ Yes	☐ No		Initial when completed / Lot # of added preservative
Samples checked for dechlorination:	☐ Yes	☒ No	☐ N/A	14.
Headspace in VOA Vials (>6mm):	☐ Yes	☐ No	☒ N/A	15.
Trip Blank Present:	☐ Yes	☒ No	☐ N/A	16.
Trip Blank Custody Seals Present	☐ Yes	☐ No	☒ N/A	
Pace Trip Blank Lot # (if purchased): ________				

Client Notification/ Resolution:

Field Data Required? Y / N

Person Contacted: Troy Bussey Date/Time: 06/12/09

Comments/ Resolution: Sample DP29-061009-1-2 removed from hold on 06/17/09.
- Samples "DP26-061009-5-6" and "DP31-061009-1-2" broken.
- Sample "DP32-061009-9-11" container cracked.
- Most ice melted, 2" of water on bottom of cooler.
- Proceed with analysis despite temp.
- WA Requirements ('05 WHO, MB, LODs)

Project Manager Review: NEW 6/12/09 @ Date: 06/12/09

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

Appendix B

Sample Analysis Summary

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP26-061009-1-2		
Lab Sample ID	1097162001		
Filename	F90624A_12		
Injected By	BAL		
Total Amount Extracted	11.0 g	Matrix	Soil
% Moisture	8.3	Dilution	NA
Dry Weight Extracted	10.1 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 14:22

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg	
2,3,7,8-TCDF	5.7	-----	0.096	
Total TCDF	98.0	-----	0.096	
2,3,7,8-TCDD	1.4	-----	0.140	
Total TCDD	260.0	-----	0.140	
1,2,3,7,8-PeCDF	8.1	-----	0.180	
2,3,4,7,8-PeCDF	27.0	-----	0.077	
Total PeCDF	210.0	-----	0.130	
1,2,3,7,8-PeCDD	8.4	-----	0.110	
Total PeCDD	230.0	-----	0.110	
1,2,3,4,7,8-HxCDF	-----	100	0.500	E
1,2,3,6,7,8-HxCDF	18.0	-----	0.410	
2,3,4,6,7,8-HxCDF	20.0	-----	0.380	
1,2,3,7,8,9-HxCDF	11.0	-----	0.450	
Total HxCDF	400.0	-----	0.430	
1,2,3,4,7,8-HxCDD	11.0	-----	0.360	
1,2,3,6,7,8-HxCDD	38.0	-----	0.410	
1,2,3,7,8,9-HxCDD	22.0	-----	0.460	
Total HxCDD	400.0	-----	0.410	
1,2,3,4,6,7,8-HpCDF	230.0	-----	0.570	
1,2,3,4,7,8,9-HpCDF	19.0	-----	0.480	
Total HpCDF	800.0	-----	0.530	
1,2,3,4,6,7,8-HpCDD	880.0	-----	0.210	
Total HpCDD	1600.0	-----	0.210	
OCDF	620.0	-----	0.230	
OCDD	9000.0	-----	0.210	

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	79
2,3,7,8-TCDD-13C	2.00	67
1,2,3,7,8-PeCDF-13C	2.00	81
2,3,4,7,8-PeCDF-13C	2.00	88
1,2,3,7,8-PeCDD-13C	2.00	95
1,2,3,4,7,8-HxCDF-13C	2.00	80
1,2,3,6,7,8-HxCDF-13C	2.00	67
2,3,4,6,7,8-HxCDF-13C	2.00	74
1,2,3,7,8,9-HxCDF-13C	2.00	77
1,2,3,4,7,8-HxCDD-13C	2.00	77
1,2,3,6,7,8-HxCDD-13C	2.00	72
1,2,3,4,6,7,8-HpCDF-13C	2.00	68
1,2,3,4,7,8,9-HpCDF-13C	2.00	73
1,2,3,4,6,7,8-HpCDD-13C	2.00	73
OCDD-13C	4.00	74
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	75

Total 2,3,7,8-TCDD
Equivalence: 45 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
E = PCDE Interference

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP26-061009-3-4		
Lab Sample ID	1097162002		
Filename	F90624A_07		
Injected By	BAL		
Total Amount Extracted	13.2 g	Matrix	Soil
% Moisture	21.8	Dilution	NA
Dry Weight Extracted	10.4 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 10:22

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg	
2,3,7,8-TCDF	2.40	-----	0.11	
Total TCDF	36.00	-----	0.11	
2,3,7,8-TCDD	-----	0.34	0.15	I
Total TCDD	57.00	-----	0.15	
1,2,3,7,8-PeCDF	1.70	-----	0.20	J
2,3,4,7,8-PeCDF	2.40	-----	0.19	J
Total PeCDF	24.00	-----	0.20	
1,2,3,7,8-PeCDD	2.20	-----	0.23	J
Total PeCDD	47.00	-----	0.23	
1,2,3,4,7,8-HxCDF	-----	2.00	0.15	E
1,2,3,6,7,8-HxCDF	1.70	-----	0.11	J
2,3,4,6,7,8-HxCDF	1.70	-----	0.11	J
1,2,3,7,8,9-HxCDF	0.41	-----	0.14	J
Total HxCDF	15.00	-----	0.13	
1,2,3,4,7,8-HxCDD	1.70	-----	0.15	J
1,2,3,6,7,8-HxCDD	3.30	-----	0.21	J
1,2,3,7,8,9-HxCDD	2.80	-----	0.19	J
Total HxCDD	56.00	-----	0.18	
1,2,3,4,6,7,8-HpCDF	9.50	-----	0.18	
1,2,3,4,7,8,9-HpCDF	0.59	-----	0.18	J
Total HpCDF	25.00	-----	0.18	
1,2,3,4,6,7,8-HpCDD	29.00	-----	0.13	
Total HpCDD	51.00	-----	0.13	
OCDF	29.00	-----	0.22	
OCDD	170.00	-----	0.17	

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	70
2,3,7,8-TCDD-13C	2.00	61
1,2,3,7,8-PeCDF-13C	2.00	74
2,3,4,7,8-PeCDF-13C	2.00	79
1,2,3,7,8-PeCDD-13C	2.00	85
1,2,3,4,7,8-HxCDF-13C	2.00	75
1,2,3,6,7,8-HxCDF-13C	2.00	64
2,3,4,6,7,8-HxCDF-13C	2.00	70
1,2,3,7,8,9-HxCDF-13C	2.00	75
1,2,3,4,7,8-HxCDD-13C	2.00	74
1,2,3,6,7,8-HxCDD-13C	2.00	68
1,2,3,4,6,7,8-HpCDF-13C	2.00	66
1,2,3,4,7,8,9-HpCDF-13C	2.00	66
1,2,3,4,6,7,8-HpCDD-13C	2.00	68
OCDD-13C	4.00	56
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	69

Total 2,3,7,8-TCDD
Equivalence: 4.9 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
E = PCDE Interference
I = Interference present

REPORT OF LABORATORY ANALYSIS

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP26-061009-7-8		
Lab Sample ID	1097162003		
Filename	F90624A_08		
Injected By	BAL		
Total Amount Extracted	12.8 g	Matrix	Soil
% Moisture	19.3	Dilution	NA
Dry Weight Extracted	10.3 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 11:10

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	-----	0.18	0.15	I
Total TCDF	0.64	-----	0.15	J
2,3,7,8-TCDD	ND	-----	0.17	
Total TCDD	14.00	-----	0.17	
1,2,3,7,8-PeCDF	-----	0.84	0.18	E
2,3,4,7,8-PeCDF	ND	-----	0.13	
Total PeCDF	6.90	-----	0.15	
1,2,3,7,8-PeCDD	ND	-----	0.11	
Total PeCDD	22.00	-----	0.11	
1,2,3,4,7,8-HxCDF	-----	1.90	0.13	E
1,2,3,6,7,8-HxCDF	ND	-----	0.12	
2,3,4,6,7,8-HxCDF	0.59	-----	0.10	J
1,2,3,7,8,9-HxCDF	ND	-----	0.12	
Total HxCDF	49.00	-----	0.12	
1,2,3,4,7,8-HxCDD	ND	-----	0.16	
1,2,3,6,7,8-HxCDD	4.20	-----	0.17	J
1,2,3,7,8,9-HxCDD	-----	0.46	0.12	I
Total HxCDD	50.00	-----	0.15	
1,2,3,4,6,7,8-HpCDF	16.00	-----	0.33	
1,2,3,4,7,8,9-HpCDF	0.93	-----	0.30	J
Total HpCDF	90.00	-----	0.32	
1,2,3,4,6,7,8-HpCDD	120.00	-----	0.13	
Total HpCDD	200.00	-----	0.13	
OCDF	74.00	-----	0.19	
OCDD	500.00	-----	0.14	

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	75
2,3,7,8-TCDD-13C	2.00	77
1,2,3,7,8-PeCDF-13C	2.00	82
2,3,4,7,8-PeCDF-13C	2.00	89
1,2,3,7,8-PeCDD-13C	2.00	98
1,2,3,4,7,8-HxCDF-13C	2.00	81
1,2,3,6,7,8-HxCDF-13C	2.00	70
2,3,4,6,7,8-HxCDF-13C	2.00	77
1,2,3,7,8,9-HxCDF-13C	2.00	81
1,2,3,4,7,8-HxCDD-13C	2.00	81
1,2,3,6,7,8-HxCDD-13C	2.00	76
1,2,3,4,6,7,8-HpCDF-13C	2.00	72
1,2,3,4,7,8,9-HpCDF-13C	2.00	78
1,2,3,4,6,7,8-HpCDD-13C	2.00	76
OCDD-13C	4.00	71
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	87

Total 2,3,7,8-TCDD
Equivalence: 2.3 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
E = PCDE Interference
I = Interference present

REPORT OF LABORATORY ANALYSIS

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP31-061009-3-4		
Lab Sample ID	1097162004		
Filename	F90624B_05		
Injected By	BAL		
Total Amount Extracted	13.4 g	Matrix	Soil
% Moisture	23.3	Dilution	NA
Dry Weight Extracted	10.3 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90624A_16 & F90624B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 21:35

Native Isomers	**Conc ng/Kg**	**EMPC ng/Kg**	**RL ng/Kg**	
2,3,7,8-TCDF	0.35	-----	0.062	J
Total TCDF	0.58	-----	0.062	J
2,3,7,8-TCDD	ND	-----	0.110	
Total TCDD	ND	-----	0.110	
1,2,3,7,8-PeCDF	ND	-----	0.120	
2,3,4,7,8-PeCDF	ND	-----	0.100	
Total PeCDF	ND	-----	0.110	
1,2,3,7,8-PeCDD	ND	-----	0.093	
Total PeCDD	ND	-----	0.093	
1,2,3,4,7,8-HxCDF	-----	0.11	0.100	I
1,2,3,6,7,8-HxCDF	ND	-----	0.100	
2,3,4,6,7,8-HxCDF	ND	-----	0.088	
1,2,3,7,8,9-HxCDF	ND	-----	0.097	
Total HxCDF	0.67	-----	0.098	J
1,2,3,4,7,8-HxCDD	ND	-----	0.089	
1,2,3,6,7,8-HxCDD	ND	-----	0.072	
1,2,3,7,8,9-HxCDD	ND	-----	0.080	
Total HxCDD	0.26	-----	0.081	J
1,2,3,4,6,7,8-HpCDF	0.93	-----	0.063	J
1,2,3,4,7,8,9-HpCDF	ND	-----	0.094	
Total HpCDF	1.70	-----	0.079	J
1,2,3,4,6,7,8-HpCDD	0.91	-----	0.140	BJ
Total HpCDD	2.50	-----	0.140	J
OCDF	1.60	-----	0.100	J
OCDD	7.70	-----	0.190	BJ

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	72
2,3,7,8-TCDD-13C	2.00	75
1,2,3,7,8-PeCDF-13C	2.00	81
2,3,4,7,8-PeCDF-13C	2.00	88
1,2,3,7,8-PeCDD-13C	2.00	97
1,2,3,4,7,8-HxCDF-13C	2.00	75
1,2,3,6,7,8-HxCDF-13C	2.00	66
2,3,4,6,7,8-HxCDF-13C	2.00	73
1,2,3,7,8,9-HxCDF-13C	2.00	78
1,2,3,4,7,8-HxCDD-13C	2.00	76
1,2,3,6,7,8-HxCDD-13C	2.00	72
1,2,3,4,6,7,8-HpCDF-13C	2.00	69
1,2,3,4,7,8,9-HpCDF-13C	2.00	71
1,2,3,4,6,7,8-HpCDD-13C	2.00	70
OCDD-13C	4.00	61
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	84

Total 2,3,7,8-TCDD
Equivalence: 0.20 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
B = Less than 10x higher than method blank level
I = Interference present

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP39-061009-0.5-2		
Lab Sample ID	1097162005		
Filename	F90624A_10		
Injected By	BAL		
Total Amount Extracted	11.0 g	Matrix	Soil
% Moisture	8.7	Dilution	NA
Dry Weight Extracted	10.1 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 12:46

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	0.91	-----	0.170	J
Total TCDF	7.70	-----	0.170	
2,3,7,8-TCDD	ND	-----	0.180	
Total TCDD	7.80	-----	0.180	
1,2,3,7,8-PeCDF	0.84	-----	0.150	J
2,3,4,7,8-PeCDF	1.40	-----	0.085	J
Total PeCDF	15.00	-----	0.120	
1,2,3,7,8-PeCDD	1.30	-----	0.320	J
Total PeCDD	12.00	-----	0.320	
1,2,3,4,7,8-HxCDF	-----	3.80	0.260	E
1,2,3,6,7,8-HxCDF	1.40	-----	0.350	J
2,3,4,6,7,8-HxCDF	1.50	-----	0.250	J
1,2,3,7,8,9-HxCDF	ND	-----	0.380	
Total HxCDF	25.00	-----	0.310	
1,2,3,4,7,8-HxCDD	1.10	-----	0.320	J
1,2,3,6,7,8-HxCDD	4.40	-----	0.310	J
1,2,3,7,8,9-HxCDD	2.50	-----	0.300	J
Total HxCDD	41.00	-----	0.310	
1,2,3,4,6,7,8-HpCDF	19.00	-----	0.410	
1,2,3,4,7,8,9-HpCDF	-----	0.87	0.540	I
Total HpCDF	42.00	-----	0.470	
1,2,3,4,6,7,8-HpCDD	86.00	-----	0.320	
Total HpCDD	180.00	-----	0.320	
OCDF	48.00	-----	0.640	
OCDD	680.00	-----	0.450	

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	69
2,3,7,8-TCDD-13C	2.00	68
1,2,3,7,8-PeCDF-13C	2.00	70
2,3,4,7,8-PeCDF-13C	2.00	73
1,2,3,7,8-PeCDD-13C	2.00	80
1,2,3,4,7,8-HxCDF-13C	2.00	75
1,2,3,6,7,8-HxCDF-13C	2.00	60
2,3,4,6,7,8-HxCDF-13C	2.00	67
1,2,3,7,8,9-HxCDF-13C	2.00	69
1,2,3,4,7,8-HxCDD-13C	2.00	72
1,2,3,6,7,8-HxCDD-13C	2.00	63
1,2,3,4,6,7,8-HpCDF-13C	2.00	55
1,2,3,4,7,8,9-HpCDF-13C	2.00	51
1,2,3,4,6,7,8-HpCDD-13C	2.00	54
OCDD-13C	4.00	43
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	72

Total 2,3,7,8-TCDD
Equivalence: 4.3 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
E = PCDE Interference
I = Interference present

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP39-061009-3-5		
Lab Sample ID	1097162006		
Filename	F90630B_06		
Injected By	SMT		
Total Amount Extracted	12.2 g	Matrix	Soil
% Moisture	16.5	Dilution	5
Dry Weight Extracted	10.2 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90630A_14 & F90630B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/30/2009 18:44

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg		**Internal Standards**	**ng's Added**	**Percent Recovery**	
2,3,7,8-TCDF	ND	-----	0.40		2,3,7,8-TCDF-13C	2.00	77	
Total TCDF	15.0	-----	0.40		2,3,7,8-TCDD-13C	2.00	74	
					1,2,3,7,8-PeCDF-13C	2.00	51	
2,3,7,8-TCDD	ND	-----	0.56		2,3,4,7,8-PeCDF-13C	2.00	44	
Total TCDD	89.0	-----	0.56		1,2,3,7,8-PeCDD-13C	2.00	46	
					1,2,3,4,7,8-HxCDF-13C	2.00	130	
1,2,3,7,8-PeCDF	10.0	-----	0.40		1,2,3,6,7,8-HxCDF-13C	2.00	110	
2,3,4,7,8-PeCDF	6.9	-----	0.74		2,3,4,6,7,8-HxCDF-13C	2.00	89	
Total PeCDF	49.0	-----	0.57		1,2,3,7,8,9-HxCDF-13C	2.00	78	
					1,2,3,4,7,8-HxCDD-13C	2.00	82	
1,2,3,7,8-PeCDD	8.3	-----	0.31		1,2,3,6,7,8-HxCDD-13C	2.00	103	
Total PeCDD	110.0	-----	0.31		1,2,3,4,6,7,8-HpCDF-13C	2.00	41	
					1,2,3,4,7,8,9-HpCDF-13C	2.00	33	P
1,2,3,4,7,8-HxCDF	-----	72.0	1.10	E	1,2,3,4,6,7,8-HpCDD-13C	2.00	35	P
1,2,3,6,7,8-HxCDF	4.1	-----	1.00	J	OCDD-13C	4.00	20	P
2,3,4,6,7,8-HxCDF	8.6	-----	1.20					
1,2,3,7,8,9-HxCDF	ND	-----	3.10		1,2,3,4-TCDD-13C	2.00	NA	
Total HxCDF	98.0	-----	1.60		1,2,3,7,8,9-HxCDD-13C	2.00	NA	
1,2,3,4,7,8-HxCDD	-----	6.9	1.40	I	2,3,7,8-TCDD-37Cl4	0.20	84	
1,2,3,6,7,8-HxCDD	15.0	-----	1.40					
1,2,3,7,8,9-HxCDD	-----	9.8	1.20	I				
Total HxCDD	210.0	-----	1.30					
1,2,3,4,6,7,8-HpCDF	60.0	-----	3.20					
1,2,3,4,7,8,9-HpCDF	ND	-----	5.30					
Total HpCDF	140.0	-----	4.20					
1,2,3,4,6,7,8-HpCDD	220.0	-----	3.30					
Total HpCDD	440.0	-----	3.30					
OCDF	84.0	-----	3.80					
OCDD	1800.0	-----	4.50					

Total 2,3,7,8-TCDD
Equivalence: 17 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
P = Recovery outside target range
E = PCDE Interference
I = Interference present

REPORT OF LABORATORY ANALYSIS

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Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP41-061009-1-2		
Lab Sample ID	1097162007		
Filename	F90624A_11		
Injected By	BAL		
Total Amount Extracted	10.9 g	Matrix	Soil
% Moisture	5.7	Dilution	NA
Dry Weight Extracted	10.3 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 13:34

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	0.59	-----	0.20	J
Total TCDF	6.00	-----	0.20	
2,3,7,8-TCDD	ND	-----	0.25	
Total TCDD	4.80	-----	0.25	
1,2,3,7,8-PeCDF	0.72	-----	0.19	J
2,3,4,7,8-PeCDF	1.10	-----	0.16	J
Total PeCDF	14.00	-----	0.18	
1,2,3,7,8-PeCDD	0.64	-----	0.15	J
Total PeCDD	8.10	-----	0.15	
1,2,3,4,7,8-HxCDF	-----	4.80	0.26	E
1,2,3,6,7,8-HxCDF	1.20	-----	0.28	J
2,3,4,6,7,8-HxCDF	1.20	-----	0.26	J
1,2,3,7,8,9-HxCDF	-----	0.53	0.23	I
Total HxCDF	39.00	-----	0.26	
1,2,3,4,7,8-HxCDD	0.91	-----	0.20	J
1,2,3,6,7,8-HxCDD	3.10	-----	0.24	J
1,2,3,7,8,9-HxCDD	1.70	-----	0.25	J
Total HxCDD	29.00	-----	0.23	
1,2,3,4,6,7,8-HpCDF	21.00	-----	0.37	
1,2,3,4,7,8,9-HpCDF	1.90	-----	0.30	J
Total HpCDF	87.00	-----	0.33	
1,2,3,4,6,7,8-HpCDD	77.00	-----	0.20	
Total HpCDD	140.00	-----	0.20	
OCDF	110.00	-----	0.32	
OCDD	590.00	-----	0.47	

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	75
2,3,7,8-TCDD-13C	2.00	76
1,2,3,7,8-PeCDF-13C	2.00	79
2,3,4,7,8-PeCDF-13C	2.00	83
1,2,3,7,8-PeCDD-13C	2.00	91
1,2,3,4,7,8-HxCDF-13C	2.00	74
1,2,3,6,7,8-HxCDF-13C	2.00	62
2,3,4,6,7,8-HxCDF-13C	2.00	70
1,2,3,7,8,9-HxCDF-13C	2.00	73
1,2,3,4,7,8-HxCDD-13C	2.00	74
1,2,3,6,7,8-HxCDD-13C	2.00	66
1,2,3,4,6,7,8-HpCDF-13C	2.00	65
1,2,3,4,7,8,9-HpCDF-13C	2.00	67
1,2,3,4,6,7,8-HpCDD-13C	2.00	64
OCDD-13C	4.00	58
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	83

Total 2,3,7,8-TCDD
Equivalence: 3.2 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
E = PCDE Interference
I = Interference present

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP41-061009-3-4		
Lab Sample ID	1097162008		
Filename	F90624B_06		
Injected By	BAL		
Total Amount Extracted	10.7 g	Matrix	Soil
% Moisture	4.2	Dilution	NA
Dry Weight Extracted	10.3 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90624A_16 & F90624B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 22:23

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg		**Internal Standards**	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF	0.21	-----	0.110	J	2,3,7,8-TCDF-13C	2.00	77
Total TCDF	0.41	-----	0.110	J	2,3,7,8-TCDD-13C	2.00	79
					1,2,3,7,8-PeCDF-13C	2.00	84
2,3,7,8-TCDD	ND	-----	0.110		2,3,4,7,8-PeCDF-13C	2.00	93
Total TCDD	ND	-----	0.110		1,2,3,7,8-PeCDD-13C	2.00	103
					1,2,3,4,7,8-HxCDF-13C	2.00	80
1,2,3,7,8-PeCDF	ND	-----	0.110		1,2,3,6,7,8-HxCDF-13C	2.00	71
2,3,4,7,8-PeCDF	ND	-----	0.096		2,3,4,6,7,8-HxCDF-13C	2.00	76
Total PeCDF	ND	-----	0.100		1,2,3,7,8,9-HxCDF-13C	2.00	82
					1,2,3,4,7,8-HxCDD-13C	2.00	84
1,2,3,7,8-PeCDD	ND	-----	0.100		1,2,3,6,7,8-HxCDD-13C	2.00	78
Total PeCDD	ND	-----	0.100		1,2,3,4,6,7,8-HpCDF-13C	2.00	76
					1,2,3,4,7,8,9-HpCDF-13C	2.00	78
1,2,3,4,7,8-HxCDF	ND	-----	0.100		1,2,3,4,6,7,8-HpCDD-13C	2.00	75
1,2,3,6,7,8-HxCDF	ND	-----	0.095		OCDD-13C	4.00	70
2,3,4,6,7,8-HxCDF	ND	-----	0.079				
1,2,3,7,8,9-HxCDF	ND	-----	0.080		1,2,3,4-TCDD-13C	2.00	NA
Total HxCDF	0.28	-----	0.089	J	1,2,3,7,8,9-HxCDD-13C	2.00	NA
1,2,3,4,7,8-HxCDD	ND	-----	0.130		2,3,7,8-TCDD-37Cl4	0.20	82
1,2,3,6,7,8-HxCDD	ND	-----	0.120				
1,2,3,7,8,9-HxCDD	ND	-----	0.130				
Total HxCDD	0.49	-----	0.130	J			
1,2,3,4,6,7,8-HpCDF	0.31	-----	0.087	J			
1,2,3,4,7,8,9-HpCDF	ND	-----	0.089				
Total HpCDF	0.48	-----	0.088	J			
1,2,3,4,6,7,8-HpCDD	-----	1.1	0.170	I			
Total HpCDD	1.20	-----	0.170	BJ			
OCDF	1.10	-----	0.180	J			
OCDD	9.50	-----	0.170	J			

Total 2,3,7,8-TCDD
Equivalence: 0.19 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
B = Less than 10x higher than method blank level
I = Interference present

REPORT OF LABORATORY ANALYSIS

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Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP42-061009-1-2		
Lab Sample ID	1097162009		
Filename	F90630B_08		
Injected By	SMT		
Total Amount Extracted	11.6 g	Matrix	Soil
% Moisture	12.6	Dilution	5
Dry Weight Extracted	10.2 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90630A_14 & F90630B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/30/2009 20:28

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg		Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF	7.8	-----	0.68		2,3,7,8-TCDF-13C	2.00	84
Total TCDF	88.0	-----	0.68		2,3,7,8-TCDD-13C	2.00	81
					1,2,3,7,8-PeCDF-13C	2.00	67
2,3,7,8-TCDD	1.4	-----	0.78		2,3,4,7,8-PeCDF-13C	2.00	63
Total TCDD	130.0	-----	0.78		1,2,3,7,8-PeCDD-13C	2.00	66
					1,2,3,4,7,8-HxCDF-13C	2.00	99
1,2,3,7,8-PeCDF	7.2	-----	0.61		1,2,3,6,7,8-HxCDF-13C	2.00	87
2,3,4,7,8-PeCDF	19.0	-----	0.42		2,3,4,6,7,8-HxCDF-13C	2.00	82
Total PeCDF	130.0	-----	0.52		1,2,3,7,8,9-HxCDF-13C	2.00	73
					1,2,3,4,7,8-HxCDD-13C	2.00	79
1,2,3,7,8-PeCDD	7.5	-----	0.63		1,2,3,6,7,8-HxCDD-13C	2.00	79
Total PeCDD	160.0	-----	0.63		1,2,3,4,6,7,8-HpCDF-13C	2.00	40
					1,2,3,4,7,8,9-HpCDF-13C	2.00	32 P
1,2,3,4,7,8-HxCDF	34.0	-----	1.30		1,2,3,4,6,7,8-HpCDD-13C	2.00	32 P
1,2,3,6,7,8-HxCDF	-----	94.0	0.65	E	OCDD-13C	4.00	18 P
2,3,4,6,7,8-HxCDF	14.0	-----	0.94				
1,2,3,7,8,9-HxCDF	8.4	-----	1.20		1,2,3,4-TCDD-13C	2.00	NA
Total HxCDF	160.0	-----	1.00		1,2,3,7,8,9-HxCDD-13C	2.00	NA
1,2,3,4,7,8-HxCDD	6.9	-----	1.10		2,3,7,8-TCDD-37Cl4	0.20	84
1,2,3,6,7,8-HxCDD	18.0	-----	1.60				
1,2,3,7,8,9-HxCDD	-----	10.0	1.10	I			
Total HxCDD	250.0	-----	1.30				
1,2,3,4,6,7,8-HpCDF	99.0	-----	2.00				
1,2,3,4,7,8,9-HpCDF	-----	8.9	3.00	I			
Total HpCDF	300.0	-----	2.50				
1,2,3,4,6,7,8-HpCDD	470.0	-----	4.10				
Total HpCDD	860.0	-----	4.10				
OCDF	300.0	-----	7.20				
OCDD	5600.0	-----	4.50				

Total 2,3,7,8-TCDD
Equivalence: 31 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
P = Recovery outside target range
E = PCDE Interference
I = Interference present

REPORT OF LABORATORY ANALYSIS

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP42-061009-5-6		
Lab Sample ID	1097162010		
Filename	F90630B_07		
Injected By	SMT		
Total Amount Extracted	14.8 g	Matrix	Soil
% Moisture	31.4	Dilution	5
Dry Weight Extracted	10.2 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90630A_14 & F90630B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/30/2009 19:36

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	ND	-----	2.5	
Total TCDF	7.1	-----	2.5	
2,3,7,8-TCDD	ND	-----	2.2	
Total TCDD	ND	-----	2.2	
1,2,3,7,8-PeCDF	ND	-----	1.7	
2,3,4,7,8-PeCDF	ND	-----	1.7	
Total PeCDF	15.0	-----	1.7	
1,2,3,7,8-PeCDD	-----	2.0	1.8	I
Total PeCDD	16.0	-----	1.8	
1,2,3,4,7,8-HxCDF	ND	-----	3.4	
1,2,3,6,7,8-HxCDF	-----	25.0	3.5	E
2,3,4,6,7,8-HxCDF	ND	-----	3.2	
1,2,3,7,8,9-HxCDF	ND	-----	3.2	
Total HxCDF	13.0	-----	3.3	
1,2,3,4,7,8-HxCDD	ND	-----	3.4	
1,2,3,6,7,8-HxCDD	4.0	-----	3.4	J
1,2,3,7,8,9-HxCDD	ND	-----	2.7	
Total HxCDD	41.0	-----	3.1	
1,2,3,4,6,7,8-HpCDF	-----	27.0	8.2	I
1,2,3,4,7,8,9-HpCDF	ND	-----	9.9	
Total HpCDF	65.0	-----	9.0	
1,2,3,4,6,7,8-HpCDD	70.0	-----	8.5	
Total HpCDD	120.0	-----	8.5	
OCDF	120.0	-----	17.0	
OCDD	530.0	-----	14.0	

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	73
2,3,7,8-TCDD-13C	2.00	72
1,2,3,7,8-PeCDF-13C	2.00	56
2,3,4,7,8-PeCDF-13C	2.00	52
1,2,3,7,8-PeCDD-13C	2.00	53
1,2,3,4,7,8-HxCDF-13C	2.00	106
1,2,3,6,7,8-HxCDF-13C	2.00	81
2,3,4,6,7,8-HxCDF-13C	2.00	80
1,2,3,7,8,9-HxCDF-13C	2.00	67
1,2,3,4,7,8-HxCDD-13C	2.00	89
1,2,3,6,7,8-HxCDD-13C	2.00	73
1,2,3,4,6,7,8-HpCDF-13C	2.00	37 P
1,2,3,4,7,8,9-HpCDF-13C	2.00	28 P
1,2,3,4,6,7,8-HpCDD-13C	2.00	31 P
OCDD-13C	4.00	17 P
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	72

Total 2,3,7,8-TCDD
Equivalence: 4.7 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
P = Recovery outside target range
E = PCDE Interference
I = Interference present

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP42-061009-7-8		
Lab Sample ID	1097162011		
Filename	F90624B_07		
Injected By	BAL		
Total Amount Extracted	27.3 g	Matrix	Soil
% Moisture	63.0	Dilution	NA
Dry Weight Extracted	10.1 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90624A_16 & F90624B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/24/2009 23:11

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg	
2,3,7,8-TCDF	32	-----	0.23	
Total TCDF	540	-----	0.23	
2,3,7,8-TCDD	12	-----	0.18	
Total TCDD	1000	-----	0.18	
1,2,3,7,8-PeCDF	42	-----	0.27	
2,3,4,7,8-PeCDF	51	-----	0.19	
Total PeCDF	660	-----	0.23	
1,2,3,7,8-PeCDD	39	-----	0.21	
Total PeCDD	1100	-----	0.21	
1,2,3,4,7,8-HxCDF	53	-----	0.78	
1,2,3,6,7,8-HxCDF	-----	99	0.69	E
2,3,4,6,7,8-HxCDF	83	-----	0.61	
1,2,3,7,8,9-HxCDF	16	-----	0.71	
Total HxCDF	540	-----	0.70	
1,2,3,4,7,8-HxCDD	42	-----	0.68	
1,2,3,6,7,8-HxCDD	140	-----	1.20	
1,2,3,7,8,9-HxCDD	80	-----	1.00	
Total HxCDD	2000	-----	0.97	
1,2,3,4,6,7,8-HpCDF	1200	-----	1.90	
1,2,3,4,7,8,9-HpCDF	88	-----	1.10	
Total HpCDF	3000	-----	1.50	
1,2,3,4,6,7,8-HpCDD	2500	-----	0.37	
Total HpCDD	4900	-----	0.37	
OCDF	5800	-----	0.60	
OCDD	16000	-----	0.38	

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	77
2,3,7,8-TCDD-13C	2.00	70
1,2,3,7,8-PeCDF-13C	2.00	76
2,3,4,7,8-PeCDF-13C	2.00	81
1,2,3,7,8-PeCDD-13C	2.00	86
1,2,3,4,7,8-HxCDF-13C	2.00	81
1,2,3,6,7,8-HxCDF-13C	2.00	67
2,3,4,6,7,8-HxCDF-13C	2.00	72
1,2,3,7,8,9-HxCDF-13C	2.00	73
1,2,3,4,7,8-HxCDD-13C	2.00	77
1,2,3,6,7,8-HxCDD-13C	2.00	69
1,2,3,4,6,7,8-HpCDF-13C	2.00	61
1,2,3,4,7,8,9-HpCDF-13C	2.00	62
1,2,3,4,6,7,8-HpCDD-13C	2.00	63
OCDD-13C	4.00	58
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	80

Total 2,3,7,8-TCDD
Equivalence: 160 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
E = PCDE Interference

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	DP29-061009-1-2		
Lab Sample ID	1097166004		
Filename	F90624B_11		
Injected By	BAL		
Total Amount Extracted	14.3 g	Matrix	Soil
% Moisture	16.9	Dilution	NA
Dry Weight Extracted	11.9 g	Collected	06/10/2009
ICAL ID	F90501	Received	06/12/2009
CCal Filename(s)	F90624A_16 & F90624B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/25/2009 02:22

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg	
2,3,7,8-TCDF	ND	-----	0.42	
Total TCDF	1.30	-----	0.42	
2,3,7,8-TCDD	ND	-----	0.48	
Total TCDD	0.85	-----	0.48	
1,2,3,7,8-PeCDF	ND	-----	0.57	
2,3,4,7,8-PeCDF	ND	-----	0.45	
Total PeCDF	ND	-----	0.51	
1,2,3,7,8-PeCDD	1.80	-----	0.53	J
Total PeCDD	5.30	-----	0.53	
1,2,3,4,7,8-HxCDF	ND	-----	0.65	
1,2,3,6,7,8-HxCDF	ND	-----	0.64	
2,3,4,6,7,8-HxCDF	ND	-----	0.61	
1,2,3,7,8,9-HxCDF	ND	-----	0.62	
Total HxCDF	2.10	-----	0.63	J
1,2,3,4,7,8-HxCDD	2.80	-----	0.58	J
1,2,3,6,7,8-HxCDD	2.10	-----	0.67	J
1,2,3,7,8,9-HxCDD	1.80	-----	0.94	J
Total HxCDD	41.00	-----	0.73	
1,2,3,4,6,7,8-HpCDF	6.40	-----	0.92	
1,2,3,4,7,8,9-HpCDF	ND	-----	0.87	
Total HpCDF	6.40	-----	0.89	
1,2,3,4,6,7,8-HpCDD	52.00	-----	1.00	
Total HpCDD	130.00	-----	1.00	
OCDF	20.00	-----	2.50	
OCDD	210.00	-----	2.80	

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	71
2,3,7,8-TCDD-13C	2.00	69
1,2,3,7,8-PeCDF-13C	2.00	65
2,3,4,7,8-PeCDF-13C	2.00	68
1,2,3,7,8-PeCDD-13C	2.00	73
1,2,3,4,7,8-HxCDF-13C	2.00	79
1,2,3,6,7,8-HxCDF-13C	2.00	68
2,3,4,6,7,8-HxCDF-13C	2.00	72
1,2,3,7,8,9-HxCDF-13C	2.00	69
1,2,3,4,7,8-HxCDD-13C	2.00	71
1,2,3,6,7,8-HxCDD-13C	2.00	68
1,2,3,4,6,7,8-HpCDF-13C	2.00	49
1,2,3,4,7,8,9-HpCDF-13C	2.00	43
1,2,3,4,6,7,8-HpCDD-13C	2.00	41
OCDD-13C	4.00	27 P
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	83

Total 2,3,7,8-TCDD
Equivalence: 3.5 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
P = Recovery outside target range

Method 8290 Blank Analysis Results

Lab Sample ID	BLANK-20384	Matrix	Solid
Filename	F90624A_04	Dilution	NA
Total Amount Extracted	10.2 g	Extracted	06/19/2009
ICAL ID	F90501	Analyzed	06/24/2009 07:58
CCal Filename(s)	F90623B_15 & F90624A_16	Injected By	BAL

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg	
2,3,7,8-TCDF	ND	-----	0.130	
Total TCDF	ND	-----	0.130	
2,3,7,8-TCDD	ND	-----	0.170	
Total TCDD	ND	-----	0.170	
1,2,3,7,8-PeCDF	ND	-----	0.093	
2,3,4,7,8-PeCDF	ND	-----	0.067	
Total PeCDF	ND	-----	0.080	
1,2,3,7,8-PeCDD	ND	-----	0.120	
Total PeCDD	ND	-----	0.120	
1,2,3,4,7,8-HxCDF	ND	-----	0.079	
1,2,3,6,7,8-HxCDF	ND	-----	0.082	
2,3,4,6,7,8-HxCDF	ND	-----	0.081	
1,2,3,7,8,9-HxCDF	ND	-----	0.097	
Total HxCDF	ND	-----	0.085	
1,2,3,4,7,8-HxCDD	ND	-----	0.140	
1,2,3,6,7,8-HxCDD	ND	-----	0.130	
1,2,3,7,8,9-HxCDD	ND	-----	0.130	
Total HxCDD	ND	-----	0.130	
1,2,3,4,6,7,8-HpCDF	ND	-----	0.070	
1,2,3,4,7,8,9-HpCDF	ND	-----	0.130	
Total HpCDF	ND	-----	0.100	
1,2,3,4,6,7,8-HpCDD	0.13	-----	0.098	J
Total HpCDD	0.13	-----	0.098	J
OCDF	-----	0.16	0.110	I
OCDD	0.89	-----	0.230	J

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	72
2,3,7,8-TCDD-13C	2.00	70
1,2,3,7,8-PeCDF-13C	2.00	76
2,3,4,7,8-PeCDF-13C	2.00	81
1,2,3,7,8-PeCDD-13C	2.00	87
1,2,3,4,7,8-HxCDF-13C	2.00	74
1,2,3,6,7,8-HxCDF-13C	2.00	65
2,3,4,6,7,8-HxCDF-13C	2.00	69
1,2,3,7,8,9-HxCDF-13C	2.00	73
1,2,3,4,7,8-HxCDD-13C	2.00	75
1,2,3,6,7,8-HxCDD-13C	2.00	69
1,2,3,4,6,7,8-HpCDF-13C	2.00	67
1,2,3,4,7,8,9-HpCDF-13C	2.00	69
1,2,3,4,6,7,8-HpCDD-13C	2.00	69
OCDD-13C	4.00	60
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	78

Total 2,3,7,8-TCDD
Equivalence: 0.20 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
I = Interference present

Method 8290 Laboratory Control Spike Results

Lab Sample ID	LCS-20385		
Filename	F90624A_01	Matrix	Solid
Total Amount Extracted	10.2 g	Dilution	NA
ICAL ID	F90501	Extracted	06/19/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Analyzed	06/24/2009 05:34
Method Blank ID	BLANK-20384	Injected By	BAL

Native Isomers	**Qs** (ng)	**Qm** (ng)	% Rec.
2,3,7,8-TCDF	0.20	0.21	104
Total TCDF			
2,3,7,8-TCDD	0.20	0.22	110
Total TCDD			
1,2,3,7,8-PeCDF	1.00	1.04	104
2,3,4,7,8-PeCDF	1.00	1.01	101
Total PeCDF			
1,2,3,7,8-PeCDD	1.00	0.89	89
Total PeCDD			
1,2,3,4,7,8-HxCDF	1.00	0.98	98
1,2,3,6,7,8-HxCDF	1.00	1.04	104
2,3,4,6,7,8-HxCDF	1.00	1.02	102
1,2,3,7,8,9-HxCDF	1.00	1.02	102
Total HxCDF			
1,2,3,4,7,8-HxCDD	1.00	1.02	102
1,2,3,6,7,8-HxCDD	1.00	1.04	104
1,2,3,7,8,9-HxCDD	1.00	1.05	105
Total HxCDD			
1,2,3,4,6,7,8-HpCDF	1.00	1.06	106
1,2,3,4,7,8,9-HpCDF	1.00	1.01	101
Total HpCDF			
1,2,3,4,6,7,8-HpCDD	1.00	1.04	104
Total HpCDD			
OCDF	2.00	2.29	115
OCDD	2.00	2.20	110

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	68
2,3,7,8-TCDD-13C	2.00	62
1,2,3,7,8-PeCDF-13C	2.00	73
2,3,4,7,8-PeCDF-13C	2.00	77
1,2,3,7,8-PeCDD-13C	2.00	77
1,2,3,4,7,8-HxCDF-13C	2.00	71
1,2,3,6,7,8-HxCDF-13C	2.00	61
2,3,4,6,7,8-HxCDF-13C	2.00	67
1,2,3,7,8,9-HxCDF-13C	2.00	71
1,2,3,4,7,8-HxCDD-13C	2.00	72
1,2,3,6,7,8-HxCDD-13C	2.00	65
1,2,3,4,6,7,8-HpCDF-13C	2.00	65
1,2,3,4,7,8,9-HpCDF-13C	2.00	68
1,2,3,4,6,7,8-HpCDD-13C	2.00	64
OCDD-13C	4.00	59
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	68

Qs = Quantity Spiked
Qm = Quantity Measured
Rec. = Recovery (Expressed as Percent)
P = Recovery outside of target range
X = Background subtracted value

Y = RF averaging used in calculations
Nn = Value obtained from additional analysis
NA = Not Applicable
* = See Discussion

Method 8290 Spiked Sample Report

Client - Pioneer Technologies Corporation

Client's Sample ID	DP26-061009-1-2-MS		
Lab Sample ID	1097162001-MS		
Filename	F90624A_13	Matrix	Soil
Total Amount Extracted	11.0 g	Dilution	NA
ICAL ID	F90501	Extracted	06/19/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Analyzed	06/24/2009 15:10
Method Blank ID	BLANK-20384	Injected By	BAL

Native Isomers	**Qs** (ng)	**Qm** (ng)	% Rec.
2,3,7,8-TCDF	0.20	0.29	143
2,3,7,8-TCDD	0.20	0.23	117
1,2,3,7,8-PeCDF	1.00	1.15	115
2,3,4,7,8-PeCDF	1.00	1.27	127
1,2,3,7,8-PeCDD	1.00	1.09	109
1,2,3,4,7,8-HxCDF	1.00	2.02	202
1,2,3,6,7,8-HxCDF	1.00	1.27	127
2,3,4,6,7,8-HxCDF	1.00	1.29	129
1,2,3,7,8,9-HxCDF	1.00	1.17	117
1,2,3,4,7,8-HxCDD	1.00	1.16	116
1,2,3,6,7,8-HxCDD	1.00	1.42	142
1,2,3,7,8,9-HxCDD	1.00	1.31	131
1,2,3,4,6,7,8-HpCDF	1.00	3.39	339
1,2,3,4,7,8,9-HpCDF	1.00	1.33	133
1,2,3,4,6,7,8-HpCDD	1.00	10.26	1026
OCDF	2.00	8.43	422
OCDD	2.00	92.36	4618

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	71
2,3,7,8-TCDD-13C	2.00	71
1,2,3,7,8-PeCDF-13C	2.00	76
2,3,4,7,8-PeCDF-13C	2.00	83
1,2,3,7,8-PeCDD-13C	2.00	91
1,2,3,4,7,8-HxCDF-13C	2.00	72
1,2,3,6,7,8-HxCDF-13C	2.00	61
2,3,4,6,7,8-HxCDF-13C	2.00	66
1,2,3,7,8,9-HxCDF-13C	2.00	71
1,2,3,4,7,8-HxCDD-13C	2.00	72
1,2,3,6,7,8-HxCDD-13C	2.00	67
1,2,3,4,6,7,8-HpCDF-13C	2.00	64
1,2,3,4,7,8,9-HpCDF-13C	2.00	67
1,2,3,4,6,7,8-HpCDD-13C	2.00	67
OCDD-13C	4.00	69
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	78

Qs = Quantity Spiked
Qm = Quantity Measured
Rec. = Recovery (Expressed as Percent)

Results reported on a dry weight basis and are valid to no more than 2 significant figures.

Method 8290 Spiked Sample Report

Client - Pioneer Technologies Corporation

Client's Sample ID	DP26-061009-1-2-MSD		
Lab Sample ID	1097162001-MSD		
Filename	F90624A_14	Matrix	Soil
Total Amount Extracted	11.0 g	Dilution	NA
ICAL ID	F90501	Extracted	06/19/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Analyzed	06/24/2009 15:58
Method Blank ID	BLANK-20384	Injected By	BAL

Native Isomers	**Qs** (ng)	**Qm** (ng)	% Rec.
2,3,7,8-TCDF	0.20	0.27	135
2,3,7,8-TCDD	0.20	0.22	110
1,2,3,7,8-PeCDF	1.00	1.11	111
2,3,4,7,8-PeCDF	1.00	1.22	122
1,2,3,7,8-PeCDD	1.00	1.04	104
1,2,3,4,7,8-HxCDF	1.00	1.86	186
1,2,3,6,7,8-HxCDF	1.00	1.20	120
2,3,4,6,7,8-HxCDF	1.00	1.23	123
1,2,3,7,8,9-HxCDF	1.00	1.12	112
1,2,3,4,7,8-HxCDD	1.00	1.15	115
1,2,3,6,7,8-HxCDD	1.00	1.38	138
1,2,3,7,8,9-HxCDD	1.00	1.29	129
1,2,3,4,6,7,8-HpCDF	1.00	3.06	306
1,2,3,4,7,8,9-HpCDF	1.00	1.24	124
1,2,3,4,6,7,8-HpCDD	1.00	8.88	888
OCDF	2.00	8.06	403
OCDD	2.00	83.39	4170

Internal Standards	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF-13C	2.00	76
2,3,7,8-TCDD-13C	2.00	78
1,2,3,7,8-PeCDF-13C	2.00	84
2,3,4,7,8-PeCDF-13C	2.00	92
1,2,3,7,8-PeCDD-13C	2.00	101
1,2,3,4,7,8-HxCDF-13C	2.00	78
1,2,3,6,7,8-HxCDF-13C	2.00	66
2,3,4,6,7,8-HxCDF-13C	2.00	72
1,2,3,7,8,9-HxCDF-13C	2.00	74
1,2,3,4,7,8-HxCDD-13C	2.00	75
1,2,3,6,7,8-HxCDD-13C	2.00	71
1,2,3,4,6,7,8-HpCDF-13C	2.00	70
1,2,3,4,7,8,9-HpCDF-13C	2.00	75
1,2,3,4,6,7,8-HpCDD-13C	2.00	74
OCDD-13C	4.00	74
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	85

Qs = Quantity Spiked Qm = Quantity Measured Rec. = Recovery (Expressed as Percent)

Results reported on a dry weight basis and are valid to no more than 2 significant figures.

Method 8290 Spike Sample Results

Client - Pioneer Technologies Corporation

Client Sample ID	DP26-061009-1-2			**Dry Weights**	
Lab Sample ID	1097162001	Sample Filename	F90624A_12	Sample Amount	10.1 g
MS ID	1097162001-MS	MS Filename	F90624A_13	MS Amount	10.1 g
MSD ID	1097162001-MSD	MSD Filename	F90624A_14	MSD Amount	10.1 g

						Background Subtracted		
Analyte	**Sample Conc. ng/Kg**	**MS/MSD Qs (ng)**	**MS Qm (ng)**	**MSD Qm (ng)**	**RPD**	**MS % Rec.**	**MSD % Rec.**	**RPD**
2,3,7,8-TCDF	5.747	0.20	0.29	0.27	5.6	114	106	7.2
2,3,7,8-TCDD	1.427	0.20	0.23	0.22	6.3	110	102	6.8
1,2,3,7,8-PeCDF	8.076	1.00	1.15	1.11	3.8	107	103	4.2
2,3,4,7,8-PeCDF	27.395	1.00	1.27	1.22	4.0	99	94	5.4
1,2,3,7,8-PeCDD	8.381	1.00	1.09	1.04	4.2	100	96	4.6
1,2,3,4,7,8-HxCDF	0.000	1.00	2.02	1.86	8.2	99	82	18.5
1,2,3,6,7,8-HxCDF	18.195	1.00	1.27	1.20	5.8	109	102	7.0
2,3,4,6,7,8-HxCDF	20.280	1.00	1.29	1.23	4.4	108	103	5.4
1,2,3,7,8,9-HxCDF	11.043	1.00	1.17	1.12	4.9	106	100	5.6
1,2,3,4,7,8-HxCDD	11.246	1.00	1.16	1.15	1.3	105	103	1.5
1,2,3,6,7,8-HxCDD	38.409	1.00	1.42	1.38	2.8	103	99	4.2
1,2,3,7,8,9-HxCDD	22.365	1.00	1.31	1.29	0.9	108	107	1.2
1,2,3,4,6,7,8-HpCDF	232.763	1.00	3.39	3.06	10.3	105	70	39.8
1,2,3,4,7,8,9-HpCDF	18.613	1.00	1.33	1.24	6.4	114	106	7.6
1,2,3,4,6,7,8-HpCDD	883.318	1.00	10.26	8.88	14.4	138	0	200.0
OCDF	624.768	2.00	8.43	8.06	4.5	108	87	21.6
OCDD	9049.695	2.00	92.36	83.39	10.2	70	0	200.0

Definitions

MS = Matrix Spike
MSD = Matrix Spike Duplicate
Qm = Quantity Measured
Qs = Quantity Spiked
% Rec. = Percent Recovery
RPD = Relative Percent Difference
NA = Not Applicable
NC = Not Calculated

CDD = Chlorinated dibenzo-p-dioxin
CDF = Chlorinated dibenzo-p-furan
T = Tetra
Pe = Penta
Hx = Hexa
Hp = Hepta
O = Octa

Pace Analytical™

www.pacelabs.com

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Report Prepared for:

Troy Bussey
Pioneer Technologies Corporation
2612 Yelm Highway S.E.
Suite B
Olympia WA 98501-4826

REPORT OF LABORATORY ANALYSIS FOR PCDD/PCDF

Report Prepared Date:

July 1, 2009

Report Information:

Pace Project #: 1097191
Sample Receipt Date: 06/13/2009
Client Project #: East Bay PH2 RI
Client Sub PO #: N/A
State Cert #: C218

Invoicing & Reporting Options:

The report provided has been invoiced as a Level 2 PCDD/PCDF Report. If an upgrade of this report package is requested, an additional charge may be applied.

Please review the attached invoice for accuracy and forward any questions to Scott Unze, your Pace Project Manager.

This report has been reviewed and prepared by:

Scott C. Unze

Scott Unze, Project Manager
(612) 607-6383
(612) 607-6444 (fax)
scott.unze@pacelabs.com

ACCREDITED IN ACCORDANCE WITH nelac

Report of Laboratory Analysis

DISCUSSION

This report presents the results from the analyses performed on seven samples submitted by a representative of Pioneer Technologies Corporation. The samples were analyzed for the presence or absence of polychlorodibenzo-p-dioxins (PCDDs) and polychlorodibenzofurans (PCDFs) using a modified version of USEPA Method 8290. Reporting limits were based on signal-to-noise calculations.

The recoveries of the isotopically-labeled PCDD/PCDF internal standards in the sample extracts ranged from 20-111%. With the exceptions of eleven low values, which were flagged "P" on the results tables, the labeled standard recoveries obtained for this project were within the 40-135% target range specified in Method 8290. Also, since the quantification of the native 2,3,7,8-substituted congeners was based on isotope dilution, the data were automatically corrected for variation in recovery and accurate values were obtained.

In some cases, interfering substances impacted the determinations of PCDD or PCDF congeners. The affected values were flagged "I" where incorrect isotope ratios were obtained, or "E" where polychlorinated diphenyl ethers were present.

A laboratory method blank was prepared and analyzed with the sample batch as part of our routine quality control procedures. The results show the blank to contain trace levels of selected congeners. These were below the calibration range of the method. The levels reported for the affected congeners in the field samples were higher than the corresponding blank levels by one or more orders of magnitude. These results indicate that the sample processing steps did not contribute significantly to the levels reported for the field samples.

A laboratory spike sample was also prepared with the sample batch using clean sand that had been fortified with native standard materials. The results show that the spiked native compounds were recovered at 89-115%. These results indicate a high degree of accuracy for these determinations. Matrix spikes were prepared with the sample batch using sample material from a separate project; results from these analyses will be provided upon request.

Appendix A

Sample Management

Anatek Labs, Inc.

Chain of Custody Record

1282 Alturas Drive, Moscow ID 83843 (208) 883-2839 FAX 882-9246
504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999 FAX 838-4433

1097191

Anatek Log-In #

Company Name: PTC
Address: 2612 Yelm Hwy SE
City: Olympia State: WA Zip: 98501
Phone: 360-570-1700
Fax:

Project Manager: Troy Bussey
Project Name & #: East Bay PH2 RI
Email Address: bussey+@uspioneer.com
Purchase Order #: Credit card
Sampler Name & phone: same

Turn Around Time & Reporting

Please refer to our normal turn around times at: http://www.anateklabs.com/services/guidelines/reporting.asp

☒ Normal
☐ Next Day*
☐ 2nd Day*
☐ Other*____

*All rush order requests must be prior approved.

☐ Phone
☒ Mail ~~(final)~~
☐ Fax
☒ Email ~~(confirm)~~

Provide Sample Description / List Analyses Requested

Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume	Dioxin/furan 8290 (Preservative: N/A)	
	[illegible]		Soil	1	4oz		
	MW21s-061209-0.5-1.5	6/12/09 0800		1			001
	MW21s-061209-2.5-4	0810		1			002
	MW21s-061209-4.5-6	0820		1			003
	MW23s-061209-1.5-3	0950		1			004
	MW23s-061209-5-6	1000		1		X	005
	MW23s-061209-9-10.5	1005		1			006
	MW24s-061209-1-2.5	1140		1		X	007
	MW24s-061209-3-4.5	1150		1		X	008
	MW24s-061209-6.5-8	1200		1		X	009
	MW24s-061209 9-10	1210		1		X	010
	MW25s-061209-1-2.5	1300		1			011
	MW25s-061209 3.5-5	1310		1			012

Note Special Instructions/Comments

1. please hold all samples for possible analyses
2. See RL expectations sent previously

	Printed Name	Signature	Company	Date	Time
Relinquished by	Troy Bussey		PTC	6/12/09	1630
Received by	Alex Kulze		Pace	6/13/09	0955
Relinquished by					
Received by					
Relinquished by					
Received by					

Inspection Checklist

Received Intact? [✓ Y] N
Labels & Chains Agree? [✓ Y] N
Containers Sealed? [✓ Y] N
VOC Head Space? Y N

Temperature (°C): 5.0
Preservative:
Date & Time:
Inspected By:

Anatek Labs, Inc.

Chain of Custody Record

○ 1282 Alturas Drive, Moscow ID 83843 (208) 883-2839 FAX 882-9246 ○
○ 504 E Sprague Ste D, Spokane WA 99202 (509) 838-3999 FAX 838-4433 ○

1097191

Anatek Log-In #

Company Name: PTC
Address: 2612 Yelm Hwy SE
City: Olympia State: WA Zip: 98501
Phone: 360-570-1700
Fax:

Project Manager: Troy Bussey
Project Name & #: East Bay P1-12 RI
Email Address: busseyt@uspioneer.com
Purchase Order #: credit card
Sampler Name & phone: same

Turn Around Time & Reporting

Please refer to our normal turn around times at: http://www.anateklabs.com/services/guidelines/reporting.asp

X Normal
__Next Day*
__2nd Day*
__Other*______

*All rush order requests must be prior approved.

__Phone
X Mail (final)
__Fax
X Email (prelim)

Provide Sample Description / List Analyses Requested

Preservative: N/A

Lab ID	Sample Identification	Sampling Date/Time	Matrix	# of Containers	Sample Volume	Dioxin/Furan 8290	
	MW25S-061209-6.5-7.5	6/12/09 1320	soil	1	4oz		013
	MW25S-061209-10.5-12	6/12/09 1330		1	4oz		014
	MW25S-061209-12.5-14	6/12/09 1340		1	4oz		015
	MW22S-061209-0.5-2	6/12/09 1425		1	4oz	X	016
	MW22S-061209-2-4	6/12/09 1430		1	4oz	X	017

Note Special Instructions/Comments

1) please hold all samples for possible analyses
2) see RL expectations sent previously

Inspection Checklist

Received Intact? [✓ Y] N
Labels & Chains Agree? [✓ Y] N
Containers Sealed? [✓ Y] N
VOC Head Space? Y N

Temperature (°C): 5.0
Preservative:______
Date & Time:______
Inspected By:______

	Printed Name	Signature	Company	Date	Time
Relinquished by	Troy Bussey		PTC	6/12/09	1630
Received by	Alex Kulzer		Pace	6/13/09	0955
Relinquished by					
Received by					
Relinquished by					
Received by					

Pace Analytical

Sample Condition Upon Receipt

Client Name: Anatek labs Inc Project # 1097191

Courier: ☒ Fed Ex ☐ UPS ☐ USPS ☐ Client ☐ Commercial ☐ Pace Other ________

Tracking #: 8667-24119389

Optional
Proj. Due Date:
Proj. Name:

Custody Seal on Cooler/Box Present: ☐ yes ☒ no Seals intact: ☐ yes ☒ no

Packing Material: ☐ Bubble Wrap ☒ Bubble Bags ☐ None ☐ Other ________ Temp Blank: Yes ____ No ✓

Thermometer Used ~~80344042~~, 179425 **Type of Ice:** [✓ Wet] Blue None ☐ Samples on ice, cooling process has begun

Cooler Temperature 5.0 **Biological Tissue is Frozen:** Yes No

Temp should be above freezing to 6°C

Date and Initials of person examining contents: 6/13/09

Comments:

Chain of Custody Present:	☒ Yes	☐ No	☐ N/A	1.
Chain of Custody Filled Out:	☒ Yes	☐ No	☐ N/A	2.
Chain of Custody Relinquished:	☒ Yes	☐ No	☐ N/A	3.
Sampler Name & Signature on COC:	☐ Yes	☒ No	☐ N/A	4.
Samples Arrived within Hold Time:	☒ Yes	☐ No	☐ N/A	5.
Short Hold Time Analysis (<72hr):	☐ Yes	☐ No	☒ N/A	6.
Rush Turn Around Time Requested:	☐ Yes	☒ No	☐ N/A	7.
Sufficient Volume:	☒ Yes	☐ No	☐ N/A	8.
Correct Containers Used:	☒ Yes	☐ No	☐ N/A	9.
-Pace Containers Used:	☐ Yes	☒ No	☐ N/A	
Containers Intact:	☒ Yes	☐ No	☐ N/A	10.
Filtered volume received for Dissolved tests	☐ Yes	☐ No	☒ N/A	11.
Sample Labels match COC:	☒ Yes	☐ No	☐ N/A	12.
-Includes date/time/ID/Analysis Matrix: SL				
All containers needing acid/base preservation have been checked. Noncompliance are noted in 13.	☐ Yes	☐ No	☒ N/A	13.
All containers needing preservation are found to be in compliance with EPA recommendation.	☐ Yes	☐ No	☒ N/A	
Exceptions: VOA,Coliform, TOC, Oil and Grease, WI-DRO (water)	☐ Yes	☒ No		Initial when completed / Lot # of added preservative
Samples checked for dechlorination:	☐ Yes	☐ No	☒ N/A	14.
Headspace in VOA Vials (>6mm):	☐ Yes	☐ No	☒ N/A	15.
Trip Blank Present:	☐ Yes	☐ No	☒ N/A	16.
Trip Blank Custody Seals Present	☐ Yes	☐ No	☒ N/A	
Pace Trip Blank Lot # (if purchased): ________				

Client Notification/ Resolution:

Field Data Required? Y / N

Person Contacted: ____________________ Date/Time: ____________

Comments/ Resolution: ____________________

Project Manager Review: ____________________ **Date:** 06/15/09

Note: Whenever there is a discrepancy affecting North Carolina compliance samples, a copy of this form will be sent to the North Carolina DEHNR Certification Office (i.e out of hold, incorrect preservative, out of temp, incorrect containers)

F-ALLC003rev.5, 5Aug2008

Appendix B

Sample Analysis Summary

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	MW23S-061209-5-6		
Lab Sample ID	1097191005		
Filename	F90624B_12		
Injected By	BAL		
Total Amount Extracted	15.1 g	Matrix	Soil
% Moisture	26.7	Dilution	NA
Dry Weight Extracted	11.1 g	Collected	06/12/2009
ICAL ID	F90501	Received	06/13/2009
CCal Filename(s)	F90624A_16 & F90624B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/25/2009 03:10

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	ND	-----	0.48	
Total TCDF	ND	-----	0.48	
2,3,7,8-TCDD	ND	-----	0.64	
Total TCDD	ND	-----	0.64	
1,2,3,7,8-PeCDF	-----	1.9	0.69	E
2,3,4,7,8-PeCDF	ND	-----	0.66	
Total PeCDF	2.1	-----	0.68	J
1,2,3,7,8-PeCDD	ND	-----	0.42	
Total PeCDD	1.0	-----	0.42	J
1,2,3,4,7,8-HxCDF	ND	-----	0.71	
1,2,3,6,7,8-HxCDF	ND	-----	0.71	
2,3,4,6,7,8-HxCDF	ND	-----	0.62	
1,2,3,7,8,9-HxCDF	ND	-----	0.72	
Total HxCDF	7.1	-----	0.69	
1,2,3,4,7,8-HxCDD	ND	-----	0.64	
1,2,3,6,7,8-HxCDD	ND	-----	0.92	
1,2,3,7,8,9-HxCDD	ND	-----	0.61	
Total HxCDD	3.2	-----	0.73	J
1,2,3,4,6,7,8-HpCDF	3.5	-----	0.68	J
1,2,3,4,7,8,9-HpCDF	ND	-----	0.80	
Total HpCDF	9.9	-----	0.74	
1,2,3,4,6,7,8-HpCDD	13.0	-----	1.60	
Total HpCDD	25.0	-----	1.60	
OCDF	10.0	-----	4.80	
OCDD	95.0	-----	4.30	

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	75
2,3,7,8-TCDD-13C	2.00	74
1,2,3,7,8-PeCDF-13C	2.00	68
2,3,4,7,8-PeCDF-13C	2.00	68
1,2,3,7,8-PeCDD-13C	2.00	75
1,2,3,4,7,8-HxCDF-13C	2.00	86
1,2,3,6,7,8-HxCDF-13C	2.00	76
2,3,4,6,7,8-HxCDF-13C	2.00	78
1,2,3,7,8,9-HxCDF-13C	2.00	74
1,2,3,4,7,8-HxCDD-13C	2.00	82
1,2,3,6,7,8-HxCDD-13C	2.00	75
1,2,3,4,6,7,8-HpCDF-13C	2.00	45
1,2,3,4,7,8,9-HpCDF-13C	2.00	29 P
1,2,3,4,6,7,8-HpCDD-13C	2.00	35 P
OCDD-13C	4.00	20 P
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	80

Total 2,3,7,8-TCDD
Equivalence: 1.1 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
P = Recovery outside target range
E = PCDE Interference

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	MW24S-061209-1-2.5		
Lab Sample ID	1097191007		
Filename	F90624B_13		
Injected By	BAL		
Total Amount Extracted	10.5 g	Matrix	Soil
% Moisture	7.8	Dilution	NA
Dry Weight Extracted	9.69 g	Collected	06/12/2009
ICAL ID	F90501	Received	06/13/2009
CCal Filename(s)	F90624A_16 & F90624B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/25/2009 03:58

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg		Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF	ND	-----	0.48		2,3,7,8-TCDF-13C	2.00	66
Total TCDF	ND	-----	0.48		2,3,7,8-TCDD-13C	2.00	67
					1,2,3,7,8-PeCDF-13C	2.00	66
2,3,7,8-TCDD	ND	-----	0.33		2,3,4,7,8-PeCDF-13C	2.00	68
Total TCDD	ND	-----	0.33		1,2,3,7,8-PeCDD-13C	2.00	72
					1,2,3,4,7,8-HxCDF-13C	2.00	70
1,2,3,7,8-PeCDF	ND	-----	0.42		1,2,3,6,7,8-HxCDF-13C	2.00	60
2,3,4,7,8-PeCDF	ND	-----	0.36		2,3,4,6,7,8-HxCDF-13C	2.00	65
Total PeCDF	1.40	-----	0.39	J	1,2,3,7,8,9-HxCDF-13C	2.00	66
					1,2,3,4,7,8-HxCDD-13C	2.00	64
1,2,3,7,8-PeCDD	ND	-----	0.36		1,2,3,6,7,8-HxCDD-13C	2.00	64
Total PeCDD	ND	-----	0.36		1,2,3,4,6,7,8-HpCDF-13C	2.00	48
					1,2,3,4,7,8,9-HpCDF-13C	2.00	43
1,2,3,4,7,8-HxCDF	ND	-----	0.46		1,2,3,4,6,7,8-HpCDD-13C	2.00	42
1,2,3,6,7,8-HxCDF	ND	-----	0.47		OCDD-13C	4.00	26 P
2,3,4,6,7,8-HxCDF	ND	-----	0.43				
1,2,3,7,8,9-HxCDF	ND	-----	0.55		1,2,3,4-TCDD-13C	2.00	NA
Total HxCDF	3.00	-----	0.48	J	1,2,3,7,8,9-HxCDD-13C	2.00	NA
1,2,3,4,7,8-HxCDD	ND	-----	0.50		2,3,7,8-TCDD-37Cl4	0.20	76
1,2,3,6,7,8-HxCDD	1.10	-----	0.67	J			
1,2,3,7,8,9-HxCDD	0.68	-----	0.49	J			
Total HxCDD	4.80	-----	0.55	J			
1,2,3,4,6,7,8-HpCDF	5.00	-----	0.68	J			
1,2,3,4,7,8,9-HpCDF	ND	-----	0.69				
Total HpCDF	5.00	-----	0.68	J			
1,2,3,4,6,7,8-HpCDD	30.00	-----	0.94				
Total HpCDD	76.00	-----	0.94				
OCDF	11.00	-----	2.80				
OCDD	280.00	-----	2.30				

Total 2,3,7,8-TCDD
Equivalence: 1.2 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
P = Recovery outside target range

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	MW24S-061209-3-4.5		
Lab Sample ID	1097191008		
Filename	F90624B_14		
Injected By	BAL		
Total Amount Extracted	10.9 g	Matrix	Soil
% Moisture	7.6	Dilution	NA
Dry Weight Extracted	10.1 g	Collected	06/12/2009
ICAL ID	F90501	Received	06/13/2009
CCal Filename(s)	F90624A_16 & F90624B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/25/2009 04:46

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg	
2,3,7,8-TCDF	2.00	-----	0.27	
Total TCDF	19.00	-----	0.27	
2,3,7,8-TCDD	-----	0.47	0.13	I
Total TCDD	24.00	-----	0.13	
1,2,3,7,8-PeCDF	-----	0.70	0.31	I
2,3,4,7,8-PeCDF	2.50	-----	0.24	J
Total PeCDF	20.00	-----	0.27	
1,2,3,7,8-PeCDD	2.30	-----	0.28	J
Total PeCDD	30.00	-----	0.28	
1,2,3,4,7,8-HxCDF	-----	1.40	0.30	I
1,2,3,6,7,8-HxCDF	2.00	-----	0.37	J
2,3,4,6,7,8-HxCDF	2.10	-----	0.34	J
1,2,3,7,8,9-HxCDF	0.48	-----	0.43	J
Total HxCDF	17.00	-----	0.36	
1,2,3,4,7,8-HxCDD	1.70	-----	0.80	J
1,2,3,6,7,8-HxCDD	4.80	-----	0.40	J
1,2,3,7,8,9-HxCDD	3.40	-----	0.43	J
Total HxCDD	58.00	-----	0.54	
1,2,3,4,6,7,8-HpCDF	25.00	-----	0.66	
1,2,3,4,7,8,9-HpCDF	1.70	-----	1.10	J
Total HpCDF	78.00	-----	0.86	
1,2,3,4,6,7,8-HpCDD	83.00	-----	0.84	
Total HpCDD	150.00	-----	0.84	
OCDF	110.00	-----	1.50	
OCDD	610.00	-----	1.70	

Internal Standards	**ng's Added**	**Percent Recovery**	
2,3,7,8-TCDF-13C	2.00	79	
2,3,7,8-TCDD-13C	2.00	62	
1,2,3,7,8-PeCDF-13C	2.00	77	
2,3,4,7,8-PeCDF-13C	2.00	77	
1,2,3,7,8-PeCDD-13C	2.00	85	
1,2,3,4,7,8-HxCDF-13C	2.00	78	
1,2,3,6,7,8-HxCDF-13C	2.00	66	
2,3,4,6,7,8-HxCDF-13C	2.00	71	
1,2,3,7,8,9-HxCDF-13C	2.00	68	
1,2,3,4,7,8-HxCDD-13C	2.00	72	
1,2,3,6,7,8-HxCDD-13C	2.00	68	
1,2,3,4,6,7,8-HpCDF-13C	2.00	48	
1,2,3,4,7,8,9-HpCDF-13C	2.00	36	P
1,2,3,4,6,7,8-HpCDD-13C	2.00	42	
OCDD-13C	4.00	23	P
1,2,3,4-TCDD-13C	2.00	NA	
1,2,3,7,8,9-HxCDD-13C	2.00	NA	
2,3,7,8-TCDD-37Cl4	0.20	75	

Total 2,3,7,8-TCDD
Equivalence: 6.1 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
P = Recovery outside target range
I = Interference present

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	MW24S-061209-6.5-8		
Lab Sample ID	1097191009		
Filename	F90630B_10		
Injected By	SMT		
Total Amount Extracted	20.8 g	Matrix	Soil
% Moisture	77.0	Dilution	NA
Dry Weight Extracted	4.78 g	Collected	06/12/2009
ICAL ID	F90501	Received	06/13/2009
CCal Filename(s)	F90630A_14 & F90630B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/30/2009 22:14

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg	
2,3,7,8-TCDF	210	-----	1.2	
Total TCDF	2800	-----	1.2	
2,3,7,8-TCDD	76	-----	1.4	
Total TCDD	5700	-----	1.4	
1,2,3,7,8-PeCDF	120	-----	1.4	
2,3,4,7,8-PeCDF	360	-----	1.3	
Total PeCDF	2200	-----	1.3	
1,2,3,7,8-PeCDD	390	-----	2.2	
Total PeCDD	6500	-----	2.2	
1,2,3,4,7,8-HxCDF	430	-----	4.1	
1,2,3,6,7,8-HxCDF	-----	2000	3.4	E
2,3,4,6,7,8-HxCDF	250	-----	4.0	
1,2,3,7,8,9-HxCDF	120	-----	4.1	
Total HxCDF	1100	-----	3.9	
1,2,3,4,7,8-HxCDD	260	-----	3.0	
1,2,3,6,7,8-HxCDD	550	-----	2.4	
1,2,3,7,8,9-HxCDD	400	-----	5.7	
Total HxCDD	8700	-----	3.7	
1,2,3,4,6,7,8-HpCDF	2000	-----	16.0	
1,2,3,4,7,8,9-HpCDF	190	-----	20.0	
Total HpCDF	7800	-----	18.0	
1,2,3,4,6,7,8-HpCDD	13000	-----	24.0	
Total HpCDD	23000	-----	24.0	
OCDF	7400	-----	10.0	
OCDD	85000	-----	15.0	

Internal Standards	**ng's Added**	**Percent Recovery**	
2,3,7,8-TCDF-13C	2.00	85	
2,3,7,8-TCDD-13C	2.00	78	
1,2,3,7,8-PeCDF-13C	2.00	64	
2,3,4,7,8-PeCDF-13C	2.00	59	
1,2,3,7,8-PeCDD-13C	2.00	58	
1,2,3,4,7,8-HxCDF-13C	2.00	111	
1,2,3,6,7,8-HxCDF-13C	2.00	104	
2,3,4,6,7,8-HxCDF-13C	2.00	94	
1,2,3,7,8,9-HxCDF-13C	2.00	81	
1,2,3,4,7,8-HxCDD-13C	2.00	74	
1,2,3,6,7,8-HxCDD-13C	2.00	105	
1,2,3,4,6,7,8-HpCDF-13C	2.00	40	
1,2,3,4,7,8,9-HpCDF-13C	2.00	33	P
1,2,3,4,6,7,8-HpCDD-13C	2.00	33	P
OCDD-13C	4.00	25	P
1,2,3,4-TCDD-13C	2.00	NA	
1,2,3,7,8,9-HxCDD-13C	2.00	NA	
2,3,7,8-TCDD-37Cl4	0.20	81	

Total 2,3,7,8-TCDD
Equivalence: 980 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
P = Recovery outside target range
E = PCDE Interference

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	MW24S-061209-9-10		
Lab Sample ID	1097191010		
Filename	F90630B_09		
Injected By	SMT		
Total Amount Extracted	19.9 g	Matrix	Soil
% Moisture	76.0	Dilution	NA
Dry Weight Extracted	4.77 g	Collected	06/12/2009
ICAL ID	F90501	Received	06/13/2009
CCal Filename(s)	F90630A_14 & F90630B_16	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/30/2009 21:21

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	32.0	-----	1.2	
Total TCDF	590.0	-----	1.2	
2,3,7,8-TCDD	10.0	-----	1.2	
Total TCDD	700.0	-----	1.2	
1,2,3,7,8-PeCDF	25.0	-----	1.5	
2,3,4,7,8-PeCDF	31.0	-----	1.2	
Total PeCDF	240.0	-----	1.3	
1,2,3,7,8-PeCDD	39.0	-----	1.3	
Total PeCDD	730.0	-----	1.3	
1,2,3,4,7,8-HxCDF	17.0	-----	1.7	
1,2,3,6,7,8-HxCDF	15.0	-----	1.5	
2,3,4,6,7,8-HxCDF	16.0	-----	1.8	
1,2,3,7,8,9-HxCDF	6.2	-----	2.4	J
Total HxCDF	180.0	-----	1.8	
1,2,3,4,7,8-HxCDD	20.0	-----	2.9	
1,2,3,6,7,8-HxCDD	31.0	-----	3.0	
1,2,3,7,8,9-HxCDD	28.0	-----	2.7	
Total HxCDD	680.0	-----	2.8	
1,2,3,4,6,7,8-HpCDF	70.0	-----	3.8	
1,2,3,4,7,8,9-HpCDF	8.6	-----	6.3	J
Total HpCDF	190.0	-----	5.1	
1,2,3,4,6,7,8-HpCDD	240.0	-----	7.4	
Total HpCDD	450.0	-----	7.4	
OCDF	170.0	-----	12.0	
OCDD	780.0	-----	11.0	

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	83
2,3,7,8-TCDD-13C	2.00	75
1,2,3,7,8-PeCDF-13C	2.00	61
2,3,4,7,8-PeCDF-13C	2.00	60
1,2,3,7,8-PeCDD-13C	2.00	63
1,2,3,4,7,8-HxCDF-13C	2.00	82
1,2,3,6,7,8-HxCDF-13C	2.00	89
2,3,4,6,7,8-HxCDF-13C	2.00	82
1,2,3,7,8,9-HxCDF-13C	2.00	75
1,2,3,4,7,8-HxCDD-13C	2.00	65
1,2,3,6,7,8-HxCDD-13C	2.00	92
1,2,3,4,6,7,8-HpCDF-13C	2.00	48
1,2,3,4,7,8,9-HpCDF-13C	2.00	38 P
1,2,3,4,6,7,8-HpCDD-13C	2.00	40
OCDD-13C	4.00	24 P
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	77

Total 2,3,7,8-TCDD
Equivalence: 80 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
P = Recovery outside target range

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	MW22S-061209-0.5-2		
Lab Sample ID	1097191016		
Filename	F90630A_06		
Injected By	AE		
Total Amount Extracted	12.5 g	Matrix	Soil
% Moisture	13.7	Dilution	NA
Dry Weight Extracted	10.8 g	Collected	06/12/2009
ICAL ID	F90501	Received	06/13/2009
CCal Filename(s)	F90629A_16 & F90630A_14	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/30/2009 04:53

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	-----	0.49	0.31	I
Total TCDF	2.30	-----	0.31	
2,3,7,8-TCDD	ND	-----	0.23	
Total TCDD	3.20	-----	0.23	
1,2,3,7,8-PeCDF	ND	-----	0.40	
2,3,4,7,8-PeCDF	-----	0.41	0.38	I
Total PeCDF	5.00	-----	0.39	
1,2,3,7,8-PeCDD	0.55	-----	0.35	J
Total PeCDD	1.40	-----	0.35	J
1,2,3,4,7,8-HxCDF	1.20	-----	0.36	J
1,2,3,6,7,8-HxCDF	0.91	-----	0.34	J
2,3,4,6,7,8-HxCDF	0.96	-----	0.34	J
1,2,3,7,8,9-HxCDF	ND	-----	0.44	
Total HxCDF	13.00	-----	0.37	
1,2,3,4,7,8-HxCDD	-----	0.58	0.47	I
1,2,3,6,7,8-HxCDD	3.00	-----	0.55	J
1,2,3,7,8,9-HxCDD	1.80	-----	0.55	J
Total HxCDD	20.00	-----	0.52	
1,2,3,4,6,7,8-HpCDF	17.00	-----	0.36	
1,2,3,4,7,8,9-HpCDF	0.85	-----	0.61	J
Total HpCDF	18.00	-----	0.49	
1,2,3,4,6,7,8-HpCDD	64.00	-----	0.60	
Total HpCDD	120.00	-----	0.60	
OCDF	55.00	-----	1.50	
OCDD	540.00	-----	1.20	

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	73
2,3,7,8-TCDD-13C	2.00	67
1,2,3,7,8-PeCDF-13C	2.00	68
2,3,4,7,8-PeCDF-13C	2.00	70
1,2,3,7,8-PeCDD-13C	2.00	76
1,2,3,4,7,8-HxCDF-13C	2.00	77
1,2,3,6,7,8-HxCDF-13C	2.00	65
2,3,4,6,7,8-HxCDF-13C	2.00	70
1,2,3,7,8,9-HxCDF-13C	2.00	71
1,2,3,4,7,8-HxCDD-13C	2.00	76
1,2,3,6,7,8-HxCDD-13C	2.00	69
1,2,3,4,6,7,8-HpCDF-13C	2.00	58
1,2,3,4,7,8,9-HpCDF-13C	2.00	53
1,2,3,4,6,7,8-HpCDD-13C	2.00	55
OCDD-13C	4.00	41
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	75

Total 2,3,7,8-TCDD
Equivalence: 2.6 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).	ND = Not Detected
EMPC = Estimated Maximum Possible Concentration	NA = Not Applicable
RL = Reporting Limit.	NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
I = Interference present

REPORT OF LABORATORY ANALYSIS

Method 8290 Sample Analysis Results

Client - Pioneer Technologies Corporation

Client's Sample ID	MW22S-061209-2-4		
Lab Sample ID	1097191017		
Filename	F90630A_07		
Injected By	AE		
Total Amount Extracted	12.5 g	Matrix	Soil
% Moisture	12.0	Dilution	NA
Dry Weight Extracted	11.0 g	Collected	06/12/2009
ICAL ID	F90501	Received	06/13/2009
CCal Filename(s)	F90629A_16 & F90630A_14	Extracted	06/19/2009
Method Blank ID	BLANK-20384	Analyzed	06/30/2009 05:43

Native Isomers	**Conc** ng/Kg	**EMPC** ng/Kg	**RL** ng/Kg		**Internal Standards**	**ng's Added**	**Percent Recovery**
2,3,7,8-TCDF	0.30	-----	0.16	J	2,3,7,8-TCDF-13C	2.00	66
Total TCDF	0.30	-----	0.16	J	2,3,7,8-TCDD-13C	2.00	68
					1,2,3,7,8-PeCDF-13C	2.00	70
2,3,7,8-TCDD	ND	-----	0.15		2,3,4,7,8-PeCDF-13C	2.00	72
Total TCDD	ND	-----	0.15		1,2,3,7,8-PeCDD-13C	2.00	80
					1,2,3,4,7,8-HxCDF-13C	2.00	74
1,2,3,7,8-PeCDF	ND	-----	0.15		1,2,3,6,7,8-HxCDF-13C	2.00	62
2,3,4,7,8-PeCDF	ND	-----	0.14		2,3,4,6,7,8-HxCDF-13C	2.00	67
Total PeCDF	0.21	-----	0.15	J	1,2,3,7,8,9-HxCDF-13C	2.00	70
					1,2,3,4,7,8-HxCDD-13C	2.00	74
1,2,3,7,8-PeCDD	ND	-----	0.16		1,2,3,6,7,8-HxCDD-13C	2.00	67
Total PeCDD	ND	-----	0.16		1,2,3,4,6,7,8-HpCDF-13C	2.00	65
					1,2,3,4,7,8,9-HpCDF-13C	2.00	62
1,2,3,4,7,8-HxCDF	ND	-----	0.17		1,2,3,4,6,7,8-HpCDD-13C	2.00	63
1,2,3,6,7,8-HxCDF	ND	-----	0.22		OCDD-13C	4.00	48
2,3,4,6,7,8-HxCDF	ND	-----	0.15				
1,2,3,7,8,9-HxCDF	ND	-----	0.19		1,2,3,4-TCDD-13C	2.00	NA
Total HxCDF	0.37	-----	0.18	J	1,2,3,7,8,9-HxCDD-13C	2.00	NA
1,2,3,4,7,8-HxCDD	ND	-----	0.19		2,3,7,8-TCDD-37Cl4	0.20	81
1,2,3,6,7,8-HxCDD	ND	-----	0.18				
1,2,3,7,8,9-HxCDD	ND	-----	0.25				
Total HxCDD	ND	-----	0.21				
1,2,3,4,6,7,8-HpCDF	0.37	-----	0.26	J			
1,2,3,4,7,8,9-HpCDF	ND	-----	0.31				
Total HpCDF	1.00	-----	0.28	J			
1,2,3,4,6,7,8-HpCDD	1.40	-----	0.36	J			
Total HpCDD	1.40	-----	0.36	J			
OCDF	1.10	-----	0.69	J			
OCDD	9.60	-----	0.65				

Total 2,3,7,8-TCDD
Equivalence: 0.30 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit.

ND = Not Detected
NA = Not Applicable
NC = Not Calculated

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range

Method 8290 Blank Analysis Results

Lab Sample ID	BLANK-20384	Matrix	Solid
Filename	F90624A_04	Dilution	NA
Total Amount Extracted	10.2 g	Extracted	06/19/2009
ICAL ID	F90501	Analyzed	06/24/2009 07:58
CCal Filename(s)	F90623B_15 & F90624A_16	Injected By	BAL

Native Isomers	Conc ng/Kg	EMPC ng/Kg	RL ng/Kg	
2,3,7,8-TCDF	ND	-----	0.130	
Total TCDF	ND	-----	0.130	
2,3,7,8-TCDD	ND	-----	0.170	
Total TCDD	ND	-----	0.170	
1,2,3,7,8-PeCDF	ND	-----	0.093	
2,3,4,7,8-PeCDF	ND	-----	0.067	
Total PeCDF	ND	-----	0.080	
1,2,3,7,8-PeCDD	ND	-----	0.120	
Total PeCDD	ND	-----	0.120	
1,2,3,4,7,8-HxCDF	ND	-----	0.079	
1,2,3,6,7,8-HxCDF	ND	-----	0.082	
2,3,4,6,7,8-HxCDF	ND	-----	0.081	
1,2,3,7,8,9-HxCDF	ND	-----	0.097	
Total HxCDF	ND	-----	0.085	
1,2,3,4,7,8-HxCDD	ND	-----	0.140	
1,2,3,6,7,8-HxCDD	ND	-----	0.130	
1,2,3,7,8,9-HxCDD	ND	-----	0.130	
Total HxCDD	ND	-----	0.130	
1,2,3,4,6,7,8-HpCDF	ND	-----	0.070	
1,2,3,4,7,8,9-HpCDF	ND	-----	0.130	
Total HpCDF	ND	-----	0.100	
1,2,3,4,6,7,8-HpCDD	0.13	-----	0.098	J
Total HpCDD	0.13	-----	0.098	J
OCDF	-----	0.16	0.110	I
OCDD	0.89	-----	0.230	J

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	72
2,3,7,8-TCDD-13C	2.00	70
1,2,3,7,8-PeCDF-13C	2.00	76
2,3,4,7,8-PeCDF-13C	2.00	81
1,2,3,7,8-PeCDD-13C	2.00	87
1,2,3,4,7,8-HxCDF-13C	2.00	74
1,2,3,6,7,8-HxCDF-13C	2.00	65
2,3,4,6,7,8-HxCDF-13C	2.00	69
1,2,3,7,8,9-HxCDF-13C	2.00	73
1,2,3,4,7,8-HxCDD-13C	2.00	75
1,2,3,6,7,8-HxCDD-13C	2.00	69
1,2,3,4,6,7,8-HpCDF-13C	2.00	67
1,2,3,4,7,8,9-HpCDF-13C	2.00	69
1,2,3,4,6,7,8-HpCDD-13C	2.00	69
OCDD-13C	4.00	60
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	78

Total 2,3,7,8-TCDD
Equivalence: 0.20 ng/Kg
(Using 2005 WHO Factors - Using PRL/2 where ND)

Conc = Concentration (Totals include 2,3,7,8-substituted isomers).
EMPC = Estimated Maximum Possible Concentration
RL = Reporting Limit

Results reported on a dry weight basis and are valid to no more than 2 significant figures.
J = Value below calibration range
I = Interference present

Method 8290 Laboratory Control Spike Results

Lab Sample ID	LCS-20385		
Filename	F90624A_01	Matrix	Solid
Total Amount Extracted	10.2 g	Dilution	NA
ICAL ID	F90501	Extracted	06/19/2009
CCal Filename(s)	F90623B_15 & F90624A_16	Analyzed	06/24/2009 05:34
Method Blank ID	BLANK-20384	Injected By	BAL

Native Isomers	Qs (ng)	Qm (ng)	% Rec.
2,3,7,8-TCDF	0.20	0.21	104
Total TCDF			
2,3,7,8-TCDD	0.20	0.22	110
Total TCDD			
1,2,3,7,8-PeCDF	1.00	1.04	104
2,3,4,7,8-PeCDF	1.00	1.01	101
Total PeCDF			
1,2,3,7,8-PeCDD	1.00	0.89	89
Total PeCDD			
1,2,3,4,7,8-HxCDF	1.00	0.98	98
1,2,3,6,7,8-HxCDF	1.00	1.04	104
2,3,4,6,7,8-HxCDF	1.00	1.02	102
1,2,3,7,8,9-HxCDF	1.00	1.02	102
Total HxCDF			
1,2,3,4,7,8-HxCDD	1.00	1.02	102
1,2,3,6,7,8-HxCDD	1.00	1.04	104
1,2,3,7,8,9-HxCDD	1.00	1.05	105
Total HxCDD			
1,2,3,4,6,7,8-HpCDF	1.00	1.06	106
1,2,3,4,7,8,9-HpCDF	1.00	1.01	101
Total HpCDF			
1,2,3,4,6,7,8-HpCDD	1.00	1.04	104
Total HpCDD			
OCDF	2.00	2.29	115
OCDD	2.00	2.20	110

Internal Standards	ng's Added	Percent Recovery
2,3,7,8-TCDF-13C	2.00	68
2,3,7,8-TCDD-13C	2.00	62
1,2,3,7,8-PeCDF-13C	2.00	73
2,3,4,7,8-PeCDF-13C	2.00	77
1,2,3,7,8-PeCDD-13C	2.00	77
1,2,3,4,7,8-HxCDF-13C	2.00	71
1,2,3,6,7,8-HxCDF-13C	2.00	61
2,3,4,6,7,8-HxCDF-13C	2.00	67
1,2,3,7,8,9-HxCDF-13C	2.00	71
1,2,3,4,7,8-HxCDD-13C	2.00	72
1,2,3,6,7,8-HxCDD-13C	2.00	65
1,2,3,4,6,7,8-HpCDF-13C	2.00	65
1,2,3,4,7,8,9-HpCDF-13C	2.00	68
1,2,3,4,6,7,8-HpCDD-13C	2.00	64
OCDD-13C	4.00	59
1,2,3,4-TCDD-13C	2.00	NA
1,2,3,7,8,9-HxCDD-13C	2.00	NA
2,3,7,8-TCDD-37Cl4	0.20	68

Qs = Quantity Spiked
Qm = Quantity Measured
Rec. = Recovery (Expressed as Percent)
P = Recovery outside of target range
X = Background subtracted value

Y = RF averaging used in calculations
Nn = Value obtained from additional analysis
NA = Not Applicable
* = See Discussion

DRAGON
Analytical Laboratory

RCRA CHAIN OF CUSTODY RECORD

2818 Madrona Beach Rd. NW, Olympia, WA 98502
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Page 1 of 2

Samples Collected By: TB
Contact Number:

Client: PTC
Address: 2612 Yelm Hwy SE, Suite B
Oly, WA 98501
Phone: 570-1700
Fax:
Email: busseyt@uspioneer.com
Project Name: East Bay Ph2 RI
Project Location:
Project Number:
Project P.O.:
Contact Person: Troy Bussey
DAL Project No.: 090610-08

* please hold all samples for possible analyses

Matrix Code:
WW = wastewater GW = groundwater S = soil or solid
SL = sludge V = vapor O = other

Sample Identification	Sample Matrix	Date Sampled	Time Sampled	Container Type	~~MTBE~~/BTEX (EPA 8021b)	Gasoline (NWTPH-Gx)	Diesel (NWTPH-Dx)	Diesel & Oil (NWTPH-Dx)	Fuel Scan (NWTPH-HCID)	VOC's (EPA 8021b)	Organochlorine Pesticides (EPA 8081)	PCB's (EPA 8082)	Volatiles (EPA 8260)	PAH's (EPA 8100 or 8270/8270SIM)	Semi-Volatiles (EPA 8270)	Ignitability (EPA 1010)	Oil and Grease (EPA 1664 HEM)	pH (EPA 9040/9045)	Specific Conductance (EPA 9050)	Paint Filter Test (EPA 9095)	Heavy Metals* (EPA 7000 Series)	Biogenic Gases (EPA 3C)	Natural Attenuation Indicators	Gross Alpha Radioactivity (EPA 900)	Gross Beta Radioactivity (EPA 900)	Sample container note	3 Encores/Sample ID
MW21S-061209-0.5-1.5	S	06/12/09	0800	1-4oz										X													
MW21S-061209-2.5-4			0810	2-4oz	X	X																					
MW21S-061209-4.5-6			0820																								
MW23S-061209-1.5-3			0950																								
MW23S-061209-5-6			1010		X	X		X						X							X						
MW23S-061209-9-10.5			1005		X	X		X						X							X						
MW24S-061209-1-2.5			1140																								
MW24S-061209-3-4.5			1150																								
MW24S-061209-6.5-8			1200		X	X		X						X							X						
MW24S-061209-9-10			1210		X	X		X						X							X						
MW25S-061209-1-2.5			1300	1-4oz																							
MW25S-061209-3.5-5			1310	2-4oz																							
MW25S-061209-6.5-7.5			1320	2-4oz	X	X		X						X							X						

Relinquished by (Signature): Troy Bussey Date/Time: 6/12/09 1630
Received by (Signature): Jim McCall Date/Time: 6/14/9 906
Relinquished by (Signature): Date/Time:
Received by (Signature): Date/Time:

Sample Disposal Instructions: ☐ DAL Disposal @ $2.50 per Container ☐ Return ☐ Pickup

Turn-Around-Time
☐ Same Day
☐ 24 Hour
☐ 48 Hour
☐ 5 Day
☒ 10 Day
☐ Other: ______

***Heavy Metals**: Please circle the desired analytes.

rec'd 7C

Ag Al [✓ As] Ba Be [✓ Cd] Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni [✓ Pb] Sb Se Tl V Zn - Total
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - Dissolved
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - TCLP

DRAGON
Analytical Laboratory

RCRA CHAIN OF CUSTODY RECORD

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Website: dragonlaboratory.com

Page 2 of 2
Samples Collected By: TB
Contact Number:

Client: PTC
Address: 2612 Yelm Hwy SE Suite B Olympia, WA 98501
Phone: 570-1700
Fax:
Email: busseyt@uspioneer.com
Project Name: East Bay PH2 RI
Project Location:
Project Number:
Project P.O.:
Contact Person: Troy Bussey
DAL Project No.: 090610-08

*please hold all samples for possible anayses

Matrix Code:
WW = wastewater GW = groundwater S = soil or solid
SL = sludge V = vapor O = other

Sample Identification	Sample Matrix	Date Sampled	Time Sampled	Container Type	MtBE/BTEX (EPA 8021b)	Gasoline (NWTPH-Gx)	Diesel (NWTPH-Dx)	Diesel & Oil (NWTPH-Dx)	Fuel Scan (NWTPH-HCID)	VOC's (EPA 8021b)	Organochlorine Pesticides (EPA 8081)	PCB's (EPA 8082)	Volatiles (EPA 8260)	PAH's (EPA 8100 or 8270/8270SIM)	Semi-Volatiles (EPA 8270)	Ignitability (EPA 1010)	Oil and Grease (EPA 1664 HEM)	pH (EPA 9040/9045)	Specific Conductance (EPA 9050)	Paint Filter Test (EPA 9095)	Heavy Metals* (EPA 7000 Series)	Biogenic Gases (EPA 3C)	Natural Attenuation Indicators	Gross Alpha Radioactivity (EPA 900)	Gross Beta Radioactivity (EPA 900)	Sample container 3 Encores Per Sample "							
MW25s-061209-10.5-12	S	6/12/09	1330	2-4oz	X	X		X						X							X					X							
MW25s-061209-12.4-14	S	6/12/09	1340	2-4oz	X	X		X						X							X												
MW22s-061209-0.5-2	S	6/12/09	1405	2-4oz																								No Encores					
MW22s-061209-2.4	S	6/12/09	1430	2-4oz																													

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time
	6/12/09 1630	Jim McCall	6/12/09 5.0c
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time

Sample Disposal Instructions: ☐ DAL Disposal @ $2.50 per Container ☐ Return ☐ Pickup

Turn-Around-Time
☐ Same Day
☐ 24 Hour
☐ 48 Hour
☐ 5 Day
☒ 10 Day
☐ Other: ______

Rec'd 7C

***Heavy Metals**: Please circle the desired analytes.

Ag Al [✓ As] Ba Be [✓ Cd] Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni [✓ Pb] Sb Se Tl V Zn - Total
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - Dissolved
Ag Al As Ba Be Cd Cr Cr-VI Co Cu Fe Hg Li Mg Mn Mo Ni Pb Sb Se Tl V Zn - TCLP

DRAGON ANALYTICAL LABORATORY

2818 Madrona Beach Rd NW, Olympia WA 98502
(360) 866-0543

Hazardous Waste, Microbiology, NPDES, Potable and Non-potable Water
Mobile Environmental Laboratory

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF SEMI-VOLATILE COMPOUNDS IN SOIL BY EPA METHOD 8270

Sample Identification	CAS Number	MRL (mg/kg)	Blank	MW21S-061209-0.5-1.5	MW23S-061209-5-6	MW23S-061209-9-10.5	MW24S-061209-6.5-8	MW24S-061209-6.5-8 Dup.	MW24S-061209-9-10	MW25S-061209-6.5-7.5
Percent Solids (%)			n/a	88.5	71.9	39.9	23.2	23.2	49.0	52.3
Date Extracted			6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009
Date Anlayzed			6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Benzo(a)anthracene	56-55-3	0.01	nd	**0.03**	**0.03**	**0.33**	**0.50**	**0.50**	**0.08**	**0.33**
Benzo(a)pyrene	50-32-8	0.01	nd	**0.13**	**0.13**	**0.46**	**0.70**	**0.71**	**0.20**	**0.42**
Benzo(b)fluoranthene	205-99-2	0.01	nd	nd	nd	**0.34**	**0.42**	**0.44**	**0.02**	**0.35**
Benzo(k)fluoranthene	207-08-9	0.01	nd	nd	nd	**0.19**	**0.21**	**0.21**	**0.03**	**0.11**
Chrysene	218-01-9	0.01	nd	nd	nd	**0.43**	**0.58**	**0.58**	**0.06**	**0.48**
Dibenzo(a,h)anthracene	53-70-3	0.01	nd	nd	**0.12**	**0.19**	**0.21**	**0.21**	**0.14**	**0.15**
Ideno(1,2,3-cd)pyrene	193-39-5	0.01	nd	**0.26**	**0.28**	**0.55**	**0.60**	**0.60**	**0.36**	**0.45**
1-Methylnaphthalene	90-12-0	0.01	nd	**0.03**	nd	**0.14**	**0.02**	**0.02**	**0.02**	**0.01**
2-Methylnaphthalene	91-57-6	0.01	nd	**0.06**	nd	**0.14**	**0.04**	**0.04**	**0.03**	**0.03**
Naphthalene	91-20-3	0.01	nd	**0.05**	nd	nd	**0.05**	**0.05**	**0.15**	**0.19**
Surrogate Recovery (%)										
2-Fluorophenol			96.8	120	76.1	126	73.9	73.4	55.2	74.8
Phenol-d6			107	128	81.4	133	79.1	78.1	60	80.6
Nitrobenzene-d5			85.5	119	62.4	123	60.8	68.4	63.8	59.9
2-Fluorobiphenol			103	119	62.3	120	61.7	66.0	60.9	58.0
2,4,6-Tribromophenol			111	124	99.3	130	91.5	92.1	75.7	99.1
Terphenyl-d14			118	120	65.6	124	63.5	63.5	63.1	58.6
Data Flags										

WA-DOE-Laboratory Certification No.: C2013
"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.
"n/a" indicates not applicable
Sample results based on dry weight.
Comments and Explanations: None

Analyst: T. McCall
Data reviewed by: R Lewis

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF SEMI-VOLATILE COMPOUNDS IN SOIL BY EPA METHOD 8270

Sample Identification			MW25S-061209-10.5-12	MW25S-061209- 12.4-14	LCS	090618-MS	090618-MSD	MW24S-061209-6.5-8 Dup.
Percent Solids (%)			64.4	84.4	n/a	n/a	n/a	23.2
Date Extracted	CAS	MRL	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009	6/15/2009
Date Anlayzed	Number	(mg/kg)	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009	6/18/2009
Benzo(a)anthracene	56-55-3	0.01	**0.07**	**0.02**	105%	107%	106%	**0.50**
Benzo(a)pyrene	50-32-8	0.01	nd	**0.12**	n/a	n/a	n/a	**0.71**
Benzo(b)fluoranthene	205-99-2	0.01	nd	nd	n/a	n/a	n/a	**0.44**
Benzo(k)fluoranthene	207-08-9	0.01	**0.02**	nd	n/a	n/a	n/a	**0.21**
Chrysene	218-01-9	0.01	**0.10**	nd	104%	113%	112%	**0.58**
Dibenzo(a,h)anthracene	53-70-3	0.01	nd	**0.10**	n/a	n/a	n/a	**0.21**
Ideno(1,2,3-cd)pyrene	193-39-5	0.01	**0.34**	nd	75.8%	77.4%	72.6%	**0.60**
1-Methylnaphthalene	90-12-0	0.01	nd	nd	n/a	n/a	n/a	**0.02**
2-Methylnaphthalene	91-57-6	0.01	**0.02**	nd	n/a	n/a	n/a	**0.04**
Naphthalene	91-20-3	0.01	**0.02**	nd	n/a	n/a	n/a	**0.05**
Surrogate Recovery (%)								
2-Fluorophenol			76.9	66.1	119	126	126	73.4
Phenol-d6			82.0	70.7	126	133	133	78.1
Nitrobenzene-d5			63.1	67.1	107	104	103	68.4
2-Fluorobiphenol			61.5	65.0	82.7	81.6	81.9	66.0
2,4,6-Tribromophenol			95.9	84.6	128	125	124	92.1
Terphenyl-d14			63.0	69.7	108	107	106	63.5
Data Flags								

WA-DOE-Laboratory Certification No.: C2013
"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.
"n/a" indicates not applicable
Sample results based on dry weight.
Comments and Explanations: None

Analyst: T. McCall
Data reviewed by: R Lewis

DRAGON ANALYTICAL LABORATORY
2818 Madrona Beach Rd NW, Olympia WA 98502
(360) 866-0543

Hazardous Waste, Microbiology, NPDES, Potable and Non-potable Water
Mobile Environmental Laboratory

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF FUEL IN SOIL

Sample Identification	Date Analyzed	Percent Solids (%)	Diesel NWTPH-Dx (mg/kg)	Heavy Oil NWTPH-Dx (mg/kg)	Surrogate Recovery 2-FBP (%)	Data Flags
Method Blank	6/15/2009	n/a	nd	nd	100	
MW23S-061209-5-6	6/15/2009	71.9	**1160**	nd	120	(1)
MW23S-061209-9-10.5	6/15/2009	39.9	nd	nd	112	
MW24S-061209-6.5-8	6/15/2009	23.2	nd	**494**	113	
MW24S-061209-9-10	6/15/2009	49.0	nd	**418**	110	
MW25S-061209-6.5-7.5	6/15/2009	52.3	nd	**2020**	99.3	
MW25S-061209-10.5-12	6/15/2009	64.4	nd	**1070**	101	
MW25S-061209-12.4-14	6/15/2009	84.4	nd	nd	98.3	
LCS	6/15/2009	n/a	105%	n/a	n/a	
090615-MS	6/15/2009	n/a	121%	n/a	n/a	
090615-MSD	6/15/2009	n/a	110%	n/a	n/a	
Method Reporting Limits			25	100		

WA-DOE-Laboratory Certification No.: C2013

"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.

"n/a" indicates not applicable

Sample results based on dry weight.

Comments and Explanations: (1) indicates atypical diesel pattern.

Analyst: T. McCall
Data reviewed by: R. Lewis

DRAGON ANALYTICAL LABORATORY
2818 Madrona Beach Rd NW, Olympia WA 98502
(360) 866-0543

Hazardous Waste, Microbiology, NPDES, Potable and Non-potable Water
Mobile Environmental Laboratory

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF GASOLINE RANGE ORGANICS IN SOIL

Sample Identification	Date Analyzed	Percent Solids (%)	Benzene EPA 8021B (mg/kg)	Toluene EPA 8021B (mg/kg)	Ethylbenzene EPA 8021B (mg/kg)	m&p-Xylene EPA 8021B (mg/kg)	o-Xylene EPA 8021B (mg/kg)	Gasoline NWTPH-Gx (mg/kg)	Surrogate Recovery BFB (%)	Data Flags
Method Blank	6/16/2009	n/a	nd	nd	nd	nd	nd	nd	97.7	
Method Blank	6/17/2009	n/a	nd	nd	nd	nd	nd	nd	86.0	
MW21S-061209-2.5-4	6/16/2009	81.5	nd	nd	nd	nd	nd	nd	76.8	
MW23S-061209-5-6	6/16/2009	71.9	nd	nd	nd	nd	nd	nd	81.6	
MW23S-061209-9-10.5	6/16/2009	39.9	nd	nd	nd	nd	nd	nd	68.6	
MW24S-061209-6.5-8	6/16/2009	23.2	nd	nd	nd	nd	nd	nd	87.2	
MW24S-061209-9-10	6/16/2009	49.0	nd	nd	nd	nd	nd	nd	87.8	
MW25S-061209-6.5-7.5	6/17/2009	52.3	nd	nd	nd	nd	nd	nd	66.5	
MW25S-061209-10.5-12	6/17/2009	64.4	nd	nd	nd	nd	nd	nd	102	
MW25S-061209-12.4-14	6/17/2009	84.4	nd	nd	nd	nd	nd	nd	83.1	
090616-LCS	6/16/2009	n/a	108%	122%	120%	98.9%	105%	94.9%	n/a	
090617-MS	6/17/2009	n/a	104%	101%	95.2%	110%	97.3%	108%	n/a	
Method Reporting Limits			0.05	0.10	0.10	0.10	0.10	5.0		

WA-DOE-Laboratory Certification No.: C2013
"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.
"n/a" indicates not applicable
Sample results based on dry weight.

Comments and Explanations: None

Analyst: T. McCall
Data reviewed by: R Lewis

DRAGON ANALYTICAL LABORATORY
2818 Madrona Beach Rd NW, Olympia WA 98502
(360) 866-0543

Hazardous Waste, Microbiology, NPDES, Potable and Non-potable Water
Mobile Environmental Laboratory

Pioneer Technologies Corporation
Project: East Bay PH2 RI

DAL Number: 090610-08

ANALYTICAL RESULTS FOR THE ANALYSIS OF HEAVY METALS IN SOIL BY EPA METHOD 6020 A

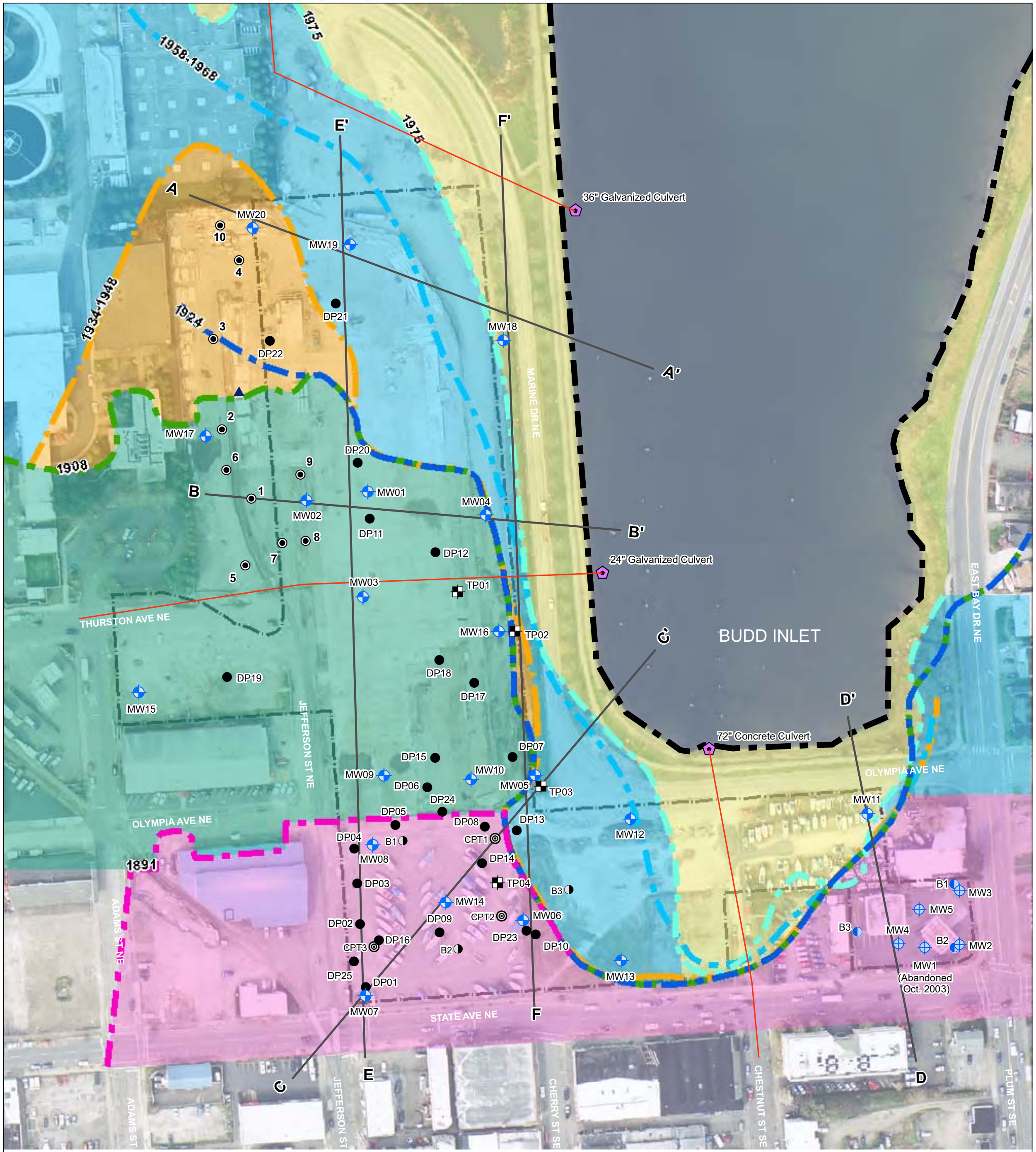
Sample Identification	Date Analyzed	Percent Solids	Arsenic (As)	Cadmium (Cd)	Lead (Pb)
Chemical Abstract Number (CAS)			7440-38-2	7440-43-9	7439-92-1
Units		(%)	(mg/kg)	(mg/kg)	(mg/kg)
Method Blank	6/18/2009	n/a	nd	nd	nd
MW23S-061209-5-6	6/26/2009	71.9	**nd**	**0.65**	**0.46**
MW23S-061209-9-10.5	6/18/2009	39.9	**8.55**	**0.45**	**71.2**
MW24S-061209-6.5-8	6/18/2009	23.2	**1.76**	**0.76**	**53.5**
MW24S-061209-9-10	6/18/2009	49.0	**4.79**	**0.54**	**34.3**
MW25S-061209-6.5-7.5	6/18/2009	52.3	**4.10**	**0.75**	**108**
MW25S-061209-10.5-12	6/18/2009	64.4	**4.85**	**0.52**	**17.4**
MW25S-061209-12.4-14	6/18/2009	84.4	**3.07**	**0.32**	**2.54**
LCS	6/18/2009	n/a	104%	101%	104%
090618-MS	6/18/2009	n/a	MI	99.2%	MI
090618-MSD	6/18/2009	n/a	MI	97.9%	MI
Method Reporting Limits			0.25	0.25	0.25

WA-DOE-Laboratory Certification No.: C2013
"nd" indicates the analyte was not detected at or above the listed Method Reporting Limit.

"n/a" indicates not applicable
"MI" indicates Matrix Interference
Sample results based on dry weight.
Comments and Explanations: None

Analyst: T. McCall
Data reviewed by: R Lewis

APPENDIX C – FILL CROSS SECTIONS



■ Test Pit (GeoEngineers, Inc. - Oct. 2007)

⊕ Monitoring Well (GeoEngineers, Inc. - Jan. & July 2007)

● Direct-Push Boring (GeoEngineers, Inc. - Sept. 2006, Jan. & July 2007)

◉ Direct-Push Boring (Brown and Caldwell - Nov. 2006, Jan. & Feb. 2007)

▲ Artesian Well (Maintained by Port)

⬟ Outfall Locations

⊕ Monitoring Well (Delta Environmental - June 2003)

◐ Direct-Push Boring (Northwest Testing Company, Oct. 2006)

◎ Cone Penotrometer Test (Landau - May 2007)

◑ Boring (Landau - May 2007)

Storm Drainage System

East Bay Redevelopment Project Area

A —— A' Cross-Section Location

Approximate Current Shoreline

Approximate Historic Shoreline

1975

1958-1968

1934-1948

1924

1908

1891

Historic Shoreline - Fill Areas

Post-1975

1948 - 1975

1908 - 1948

1891 - 1908

Pre-1891

Reference: Artesian Well locations and Storm Drainage data are based on information provided by the Port of Olympia. Historic shoreline (1975) from "Proposed Dredging, Fill & Marina Facilities in Budd Inlet, Plate No. 1," revised April 7, 1975. Historic shorelines (1888, 1908, 1924, 1958 and 1968) digitized from Sanborn maps. Aerial photo (dated April 2008) from Skillings Connolly.

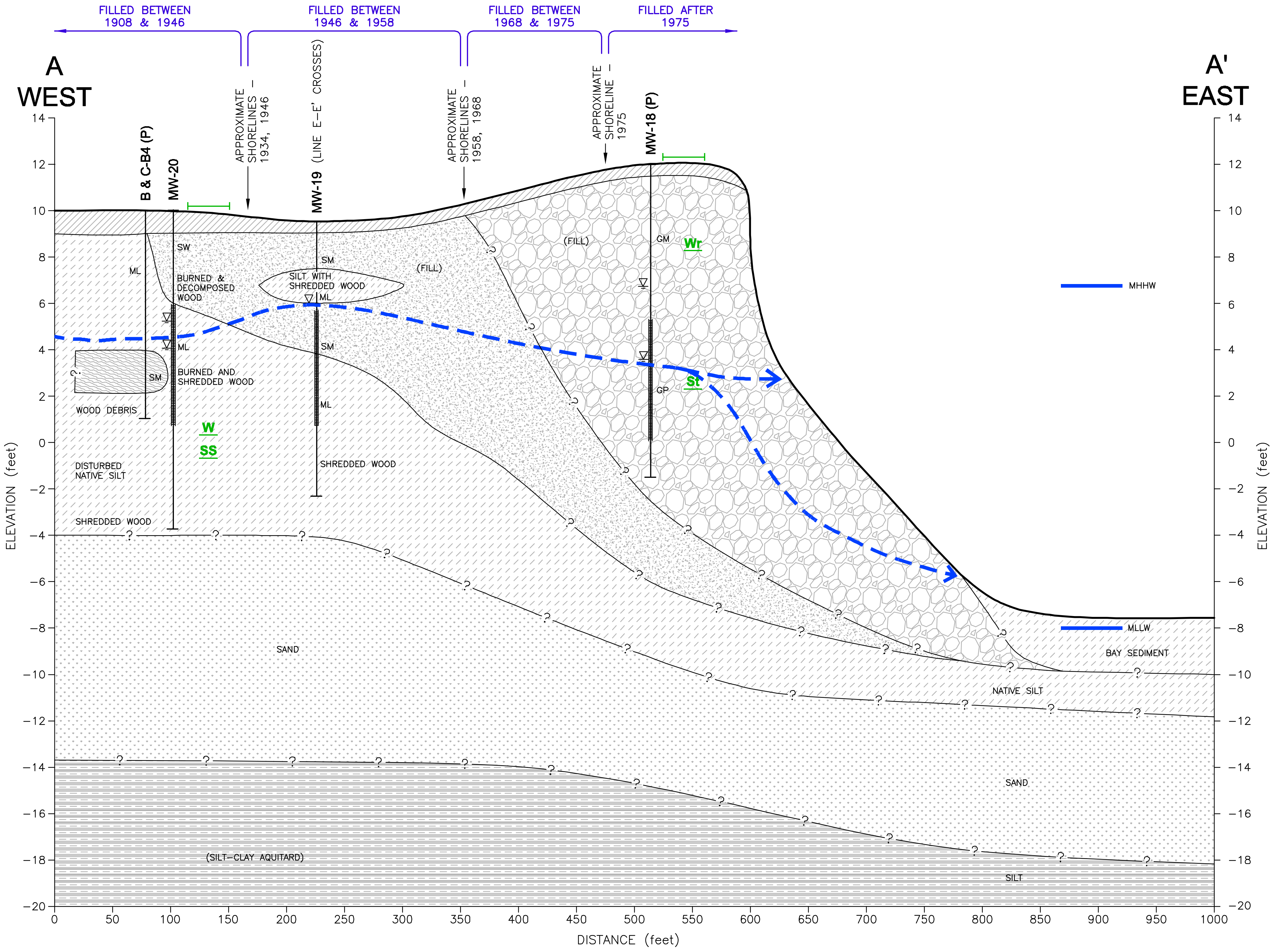
Notes: 1. The locations of all features shown are approximate.
2. This drawing is for infomation purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Site Plan, Historic Shorelines, Cross-Section Locations

East Bay Redevelopment Project Area
Olympia, Washington

GEOENGINEERS

Figure 6



PROPOSED UTILITY LINES

- ├──┤ = Approximate Location of Infrastructure Corridor
- **Wr** = Water (Reclaimed Line)
- **W** = Water
- **SS** = Sanitary Sewer
- **St** = Storm
- — = Approximate Depth of Proposed Utility

LEGEND

FILL
- ▨ – Pavement Surface (Gravel, Asphalt, Concrete)
- ▒ – Sand (Light Colored with Construction Debris)
- ▤ – Wood Debris
- ▦ – Gravel

- ▧ – Silt

NATIVE
- ░ – Sand (Native)
- ☰ – Clay

(P) = Projected
∇ = DTW During Drilling
∇ = DTW (MWs) – Aug 07
▬ ▬ = Interpreted Groundwater Table

EXPLANATION

DP18 BORING NUMBER AND APPROXIMATE LOCATION

Soil Contact

Well Screen

Tidal Elevations Provided by Port of Olympia

MHHW = Mean High High Water (El. 6.83)

MLLW = Mean Low Low Water (El. −7.73)

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Drawing created from sketch provided by GeoEngineers' personnel.

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION: 20X

Cross Section A-A'

East Bay Redevelopment Project
Olympia, Washington

GEOENGINEERS

Figure 7A

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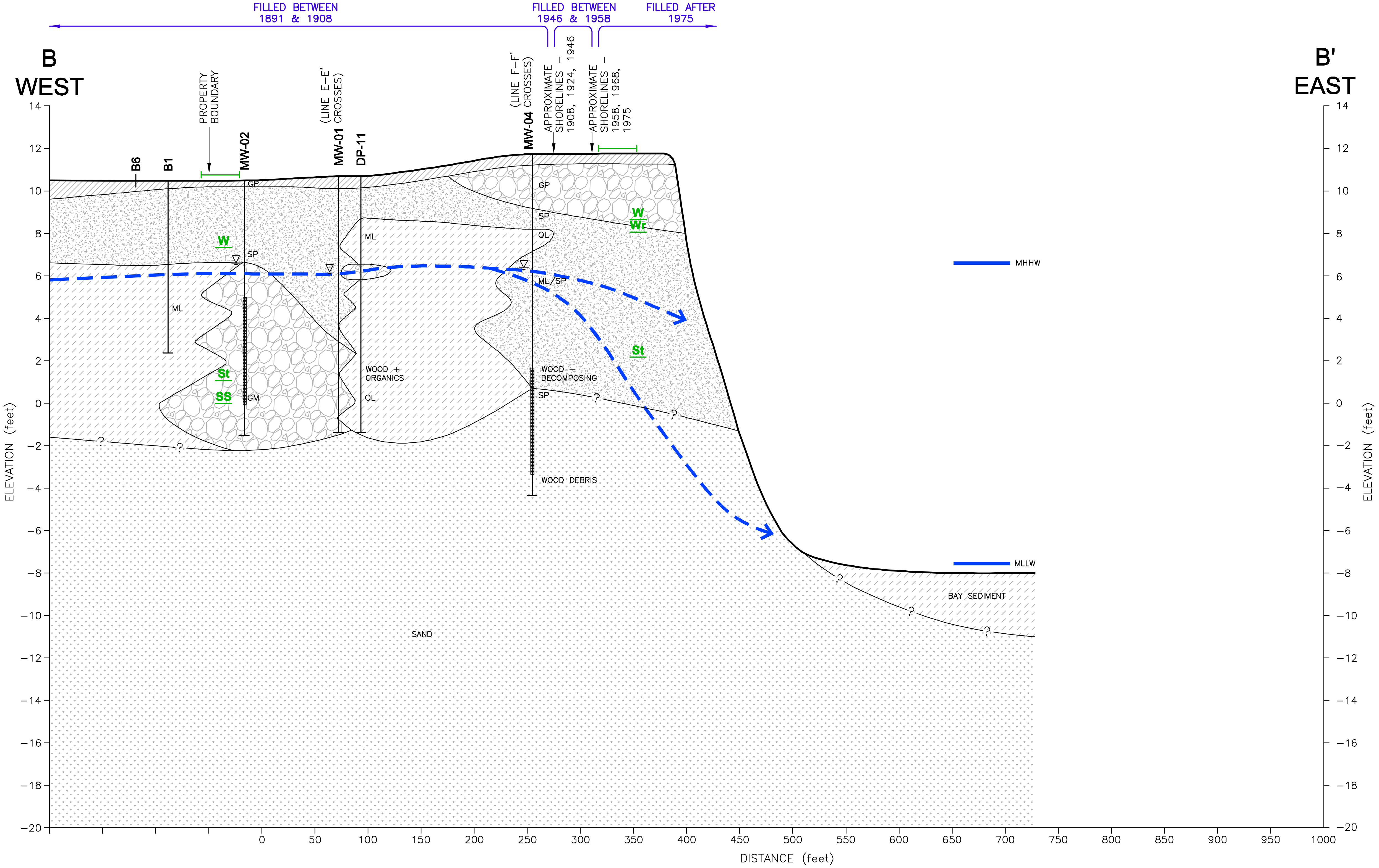

PROPOSED UTILITY LINES

├─┤ = Approximate Location of Infrastructure Corridor
Wr = Water (Reclaimed Line)
W = Water
SS = Sanitary Sewer
St = Storm
— = Approximate Depth of Proposed Utility

LEGEND

FILL
▨ – Pavement Surface (Gravel, Asphalt, Concrete)
▨ – Sand (Light Colored with Construction Debris)
▨ – Gravel
▨ – Silt (Disturbed)

NATIVE
▨ – Sand (Native)
▨ – Clay

(P) = Projected
▽ = DTW During Drilling
▽ = DTW (MWs) – Aug 07
– – = Interpreted Groundwater Table

EXPLANATION

DP18 BORING NUMBER AND APPROXIMATE LOCATION
Soil Contact
Well Screen

Tidal Elevations Provided by Port of Olympia
MHHW = Mean High High Water (El. 6.83)
MLLW = Mean Low Low Water (El. −7.73)

Notes:
1. The locations of all features shown are approximate.
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Reference: Drawing created from sketch provided by GeoEngineers' personnel.

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION: 20X

Cross Section B-B'

East Bay Redevelopment Project
Olympia, Washington

GEOENGINEERS

Figure 7B

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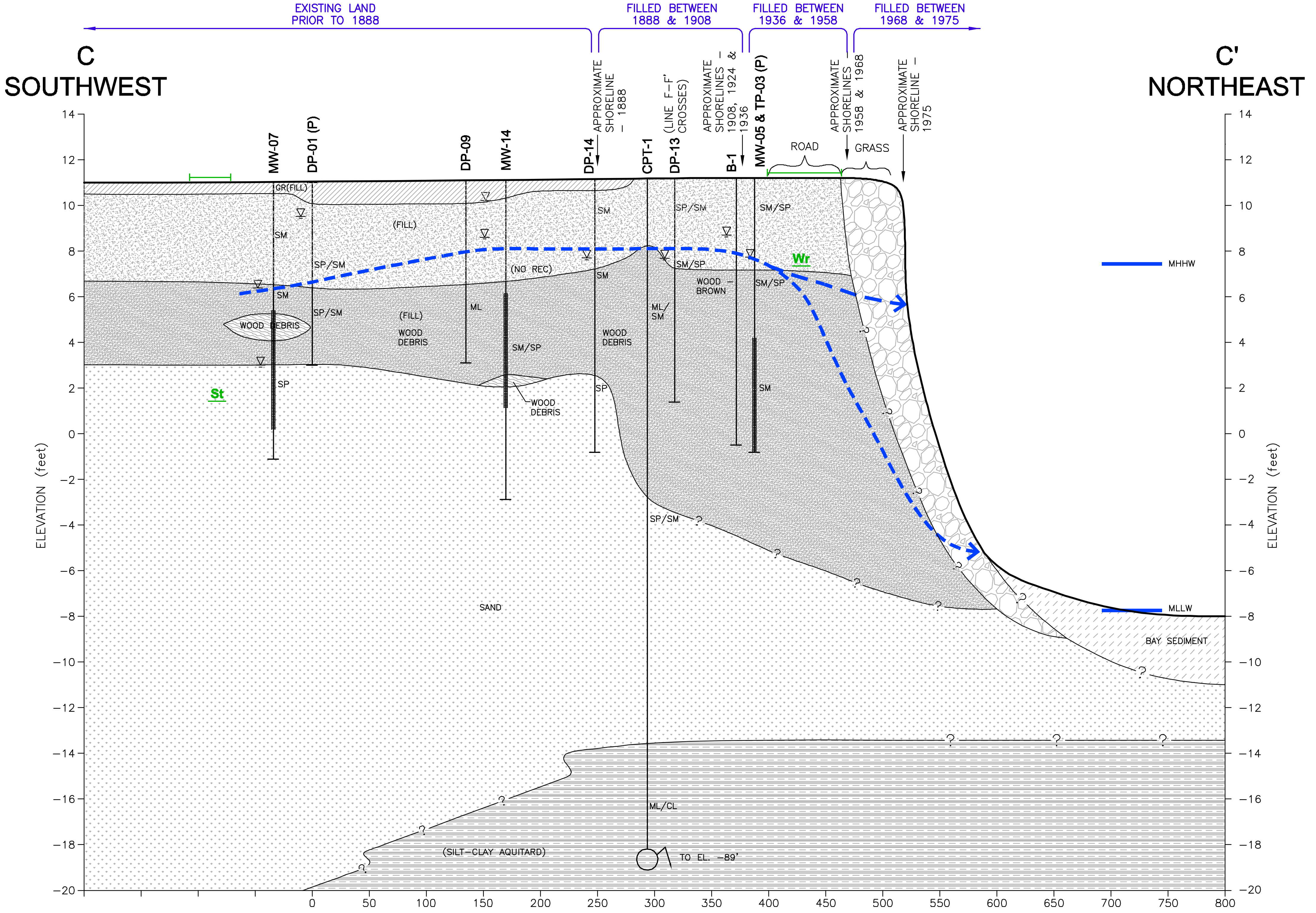

PROPOSED UTILITY LINES

- 🟩 = Approximate Location of Infrastructure Corridor
- **Wr** = Water (Reclaimed Line)
- **W** = Water
- **SS** = Sanitary Sewer
- **St** = Storm
- — = Approximate Depth of Proposed Utility

LEGEND

FILL
- ▨ – Pavement Surface (Gravel, Asphalt, Concrete)
- ▨ – Sand (Light Colored with Construction Debris)
- ▨ – Sand (Black to Dark Brown Colored with Wood Debris)
- ▨ – Wood Debris
- ▨ – Gravel

NATIVE
- ▨ – Silt
- ▨ – Sand (Native)
- ▨ – Clay

(P) = Projected
▽ = DTW During Drilling
▽ = DTW (MWs) – Aug 07
– – = Interpreted Groundwater Table

EXPLANATION

DP18 BORING NUMBER AND APPROXIMATE LOCATION

Soil Contact

Well Screen

Tidal Elevations Provided by Port of Olympia

MHHW = Mean High High Water (El. 6.83)

MLLW = Mean Low Low Water (El. –7.73)

Notes:
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Reference: Drawing created from sketch provided by GeoEngineers' personnel.

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION: 20X

Cross Section C-C'

East Bay Redevelopment Project
Olympia, Washington

GEOENGINEERS

Figure 7C

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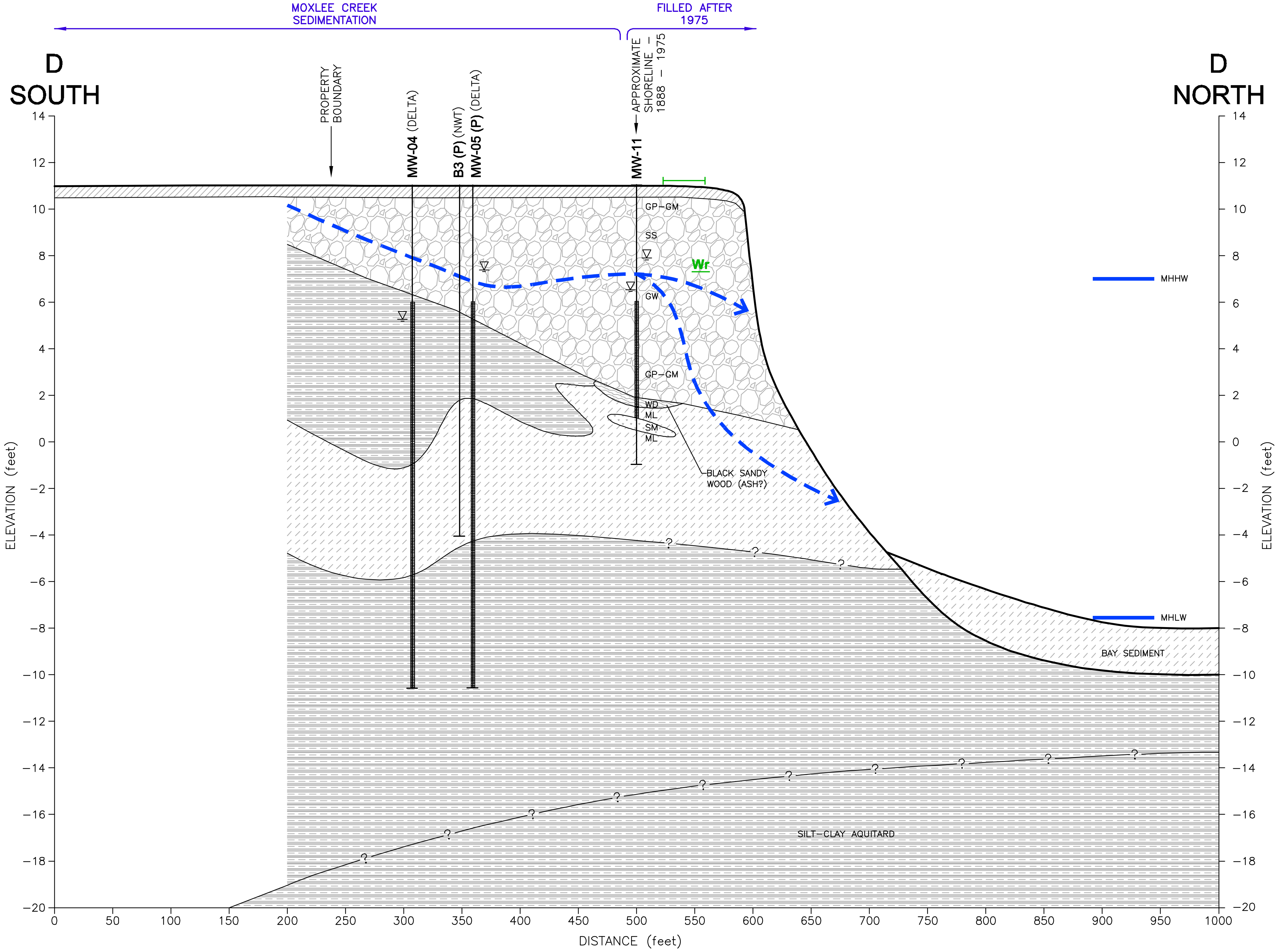


PROPOSED UTILITY LINES

├──┤ = Approximate Location of Infrastructure Corridor
Wr = Water (Reclaimed Line)
W = Water
SS = Sanitary Sewer
St = Storm
— = Approximate Depth of Proposed Utility

LEGEND

FILL
▨ – Pavement Surface (Gravel, Asphalt, Concrete)
▤ – Wood Debris
▦ – Gravel

NATIVE
▨ – Silt
░ – Sand (Native)
▤ – Clay

(P) = Projected
⊽ = DTW During Drilling
⊽ = DTW (MWs) – Aug 07
— — = Interpreted Groundwater Table

EXPLANATION

DP18 BORING NUMBER AND APPROXIMATE LOCATION
Soil Contact
Well Screen

Tidal Elevations Provided by Port of Olympia

MHHW = Mean High High Water (El. 6.83)

MLLW = Mean Low Low Water (El. –7.73)

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Drawing created from sketch provided by GeoEngineers' personnel.

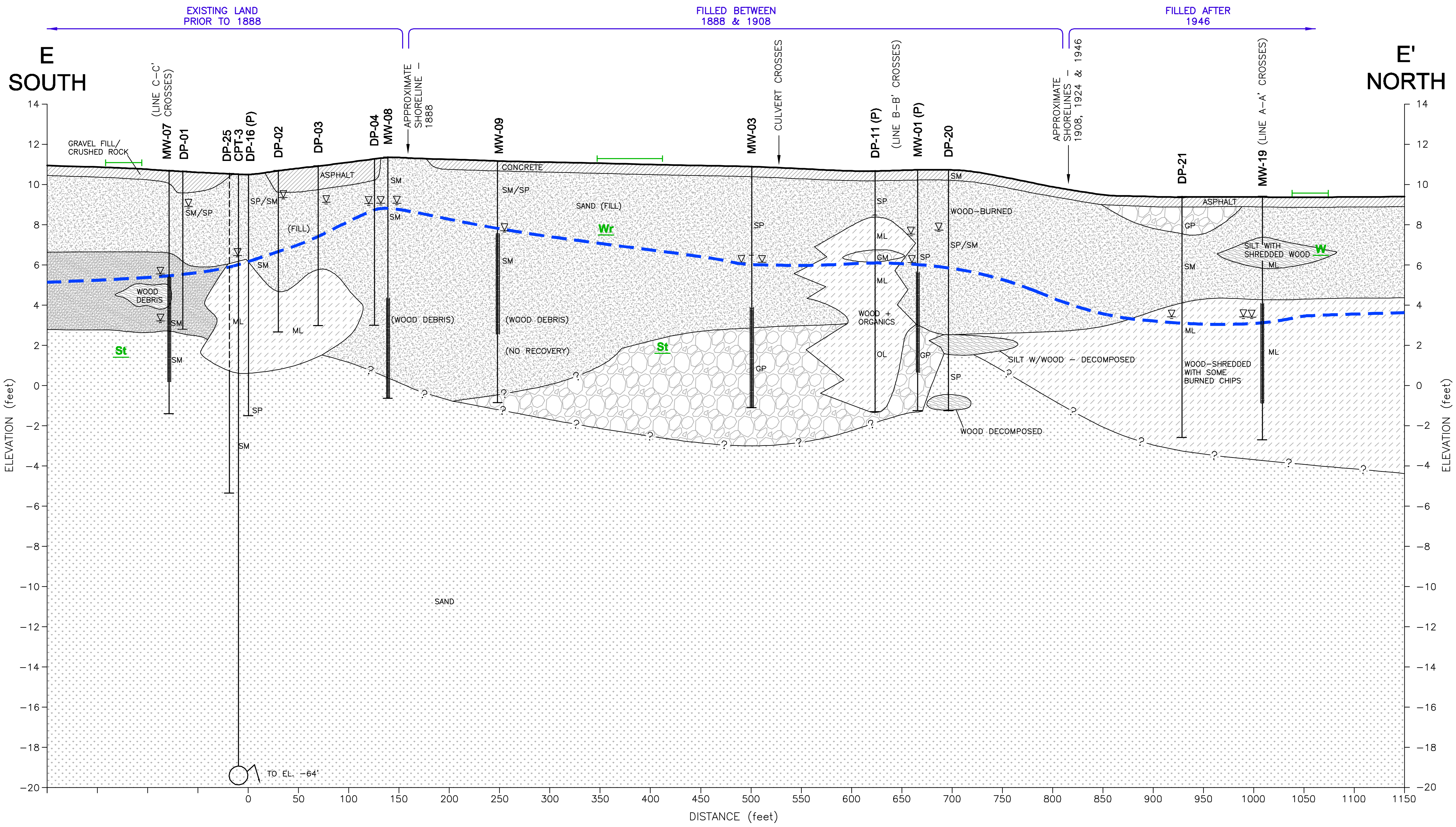
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION: 20X

Cross Section D-D'

East Bay Redevelopment Project
Olympia, Washington

GEOENGINEERS

Figure 7D



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Drawing created from sketch provided by GeoEngineers' personnel.

LEGEND

FILL
- ▨ - Pavement Surface (Gravel, Asphalt, Concrete)
- ▨ - Sand (Light Colored with Construction Debris)
- ▨ - Sand (Black to Dark Brown Colored with Wood Debris)
- ▨ - Wood Debris
- ▨ - Gravel

- ▨ - Silt (Disturbed Native)

NATIVE
- ▨ - Sand (Native)
- ▨ - Clay

(P) = Projected
∇ = DTW During Drilling
∇ = DTW (MWs) - Aug 07
— — = Interpreted Groundwater Table

EXPLANATION

DP18 BORING NUMBER AND APPROXIMATE LOCATION
Soil Contact
Well Screen

Tidal Elevations Provided by Port of Olympia
MHHW = Mean High High Water (El. 6.83)
MLLW = Mean Low Low Water (El. -7.73)

PROPOSED UTILITY LINES
|—| = Approximate Location of Infrastructure Corridor
Wr = Water (Reclaimed Line)
W = Water
SS = Sanitary Sewer
St = Storm
— = Approximate Depth of Proposed Utility

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION: 20X

Cross Section E-E'

East Bay Redevelopment Project
Olympia, Washington

GEOENGINEERS

Figure 7E

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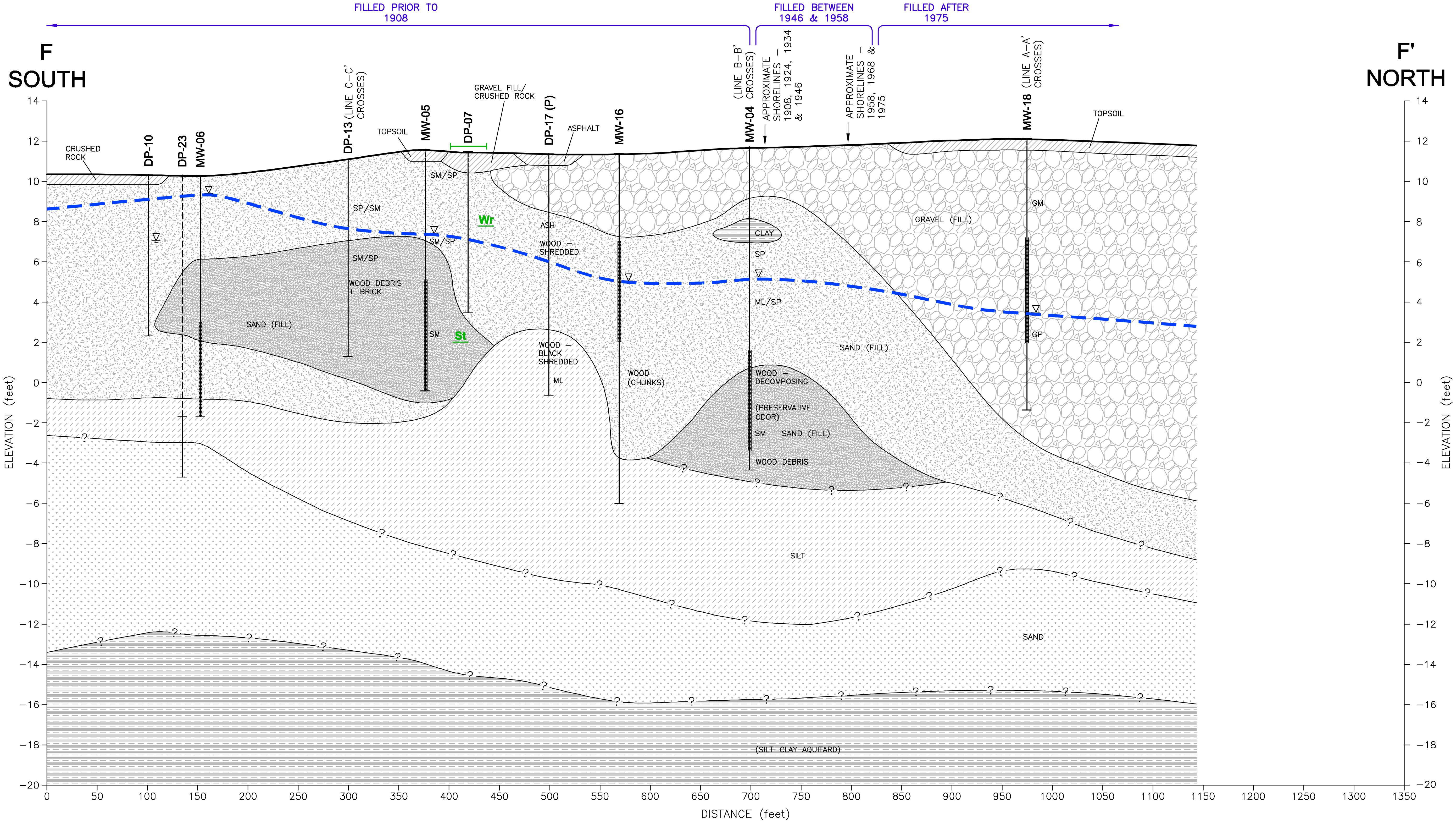

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Reference: Drawing created from sketch provided by GeoEngineers' personnel.

LEGEND

FILL
- ▨ – Pavement Surface (Gravel, Asphalt, Concrete)
- ▨ – Sand (Light Colored with Construction Debris)
- ▨ – Sand (Black to Dark Brown Colored with Wood Debris)
- ▨ – Gravel

NATIVE
- ▨ – Silt
- ▨ – Sand (Native)
- ▨ – Clay

(P) = Projected
▽ = DTW During Drilling
▽ = DTW (MWs) – Aug 07
– – = Interpreted Groundwater Table

EXPLANATION

DP18 BORING NUMBER AND APPROXIMATE LOCATION
Soil Contact
Well Screen

Tidal Elevations Provided by Port of Olympia
MHHW = Mean High High Water (El. 6.83)
MLLW = Mean Low Low Water (El. −7.73)

PROPOSED UTILITY LINES

├─┤ = Approximate Location of Infrastructure Corridor
Wr = Water (Reclaimed Line)
W = Water
SS = Sanitary Sewer
St = Storm
— = Approximate Depth of Proposed Utility

HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: 1" = 5'
VERTICAL EXAGGERATION: 20X

Cross Section F-F'

East Bay Redevelopment Project
Olympia, Washington

GEOENGINEERS

Figure 7F

W:\SEATTLE\PROJECTS\0\0615034\07\WORKING\RI WKPL AUG 08\FIGURES-CAD\CROSS SECTIONS-VERSION2.DWG\TAB:F MODIFIED BY LKNOWLTON ON OCT 20, 2008 - 11:00

APPENDIX D – CLEANUP LEVEL CALCULATIONS

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date:	5/21/2010
Site Name:	East Bay Redevelopment - Parcels 4 and 5
Evaluator:	Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

^{1}Soil ingestion only; ^{2}Soil dermal contact; ^{3}Soil to Ground Water; ^{4}Ground Water ingestion; ^{5}Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Arsenic**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s	20	mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose$^{1, 3}$	RfD_o	3.00E-04	mg/kg-day
2.2 Oral Carcinogenic Potency Factor$^{1, 3}$	CPF_o	1.50E+00	kg-day/mg
2.3 Inhalation Reference Dose^5	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor^5	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)^4	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")^5	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")$^{1, 2}$	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")^2	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)^2	ABS_d	0.01	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)^2	GI	0.2	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	2.900E+01	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	0.000E+00	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S		mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**5.00E+00**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	1	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

---

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Arsenic

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.920E+00	mg/kg
Natural Background concentration for Soil:	20	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.000E+01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	0.000E+00	mg/kg

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	102.2	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

<table>
<tr><th colspan="7">Summary by Exposure Pathway</th></tr>
<tr><td rowspan="6">Soil Direct Contact</td><td colspan="2" rowspan="2"></td><td colspan="2"><i><u>Method B</u></i>
<i>Unrestricted Land Use</i>
@ HQ=1.0; RISK =1.0E-6</td><td colspan="2"><i><u>Method C</u></i>
<i>Industrial Land Use</i>
@ HQ=1.0; RISK =1.0E-5</td></tr>
<tr><td>Ingestion only</td><td>Ingestion & Dermal</td><td>Ingestion only</td><td>Ingestion & Dermal</td></tr>
<tr><td rowspan="2">Under the Current Condition</td><td>HQ? @ Exposure Point</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>RISK? @ Exposure Point</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="2">Target Soil CUL? mg/kg</td><td>@HQ=1.0</td><td>2.400E+01</td><td>2.162E+01</td><td>1.050E+03</td><td>4.000E+02</td></tr>
<tr><td>@RISK =1.0E-6 or 1.0E-5</td><td>6.667E-01</td><td>6.006E-01</td><td>8.750E+01</td><td>3.333E+01</td></tr>
<tr><td rowspan="6">Protection of Potable Ground Water</td><td colspan="2"></td><td colspan="2"><i><u>Method B</u></i>
@ HQ=1.0; RISK =1.0E-6</td><td colspan="2"><i><u>Method C</u></i>
@ HQ=1.0; RISK =1.0E-5</td></tr>
<tr><td rowspan="3">Under the Current Condition</td><td>Predicted Ground Water Conc? ug/l</td><td colspan="4">N/A</td></tr>
<tr><td>HQ? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>RISK? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td colspan="2">Target Ground Water CUL? ug/l</td><td colspan="4">5.000E+00</td></tr>
<tr><td colspan="2">Target Soil CUL? mg/kg</td><td colspan="4">2.920E+00</td></tr>
<tr><td rowspan="8">Protection of Air Quality
<i>(for informational purpose only)</i></td><td colspan="2"></td><td colspan="2"><i><u>Method B</u></i>
@ HQ=1.0; RISK =1.0E-6</td><td colspan="2"><i><u>Method C</u></i>
@ HQ=1.0; RISK =1.0E-5</td></tr>
<tr><td rowspan="3">Under the Current Condition</td><td>Predicted Air Conc? ug/m^3 @Exposure Point</td><td colspan="4">N/A</td></tr>
<tr><td>HQ? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>RISK? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="2">Target Air CUL? ug/m^3</td><td>@ HQ=1.0</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>@ RISK=1.0E-6 or 1.0E-5</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="2">Target Soil CUL? mg/kg</td><td>@ HQ=1.0</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>@ RISK=1.0E-6 or 1.0E-5</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
</table>

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date:	5/21/2010
Site Name:	East Bay Redevelopment - Parcels 4 and 5
Evaluator:	Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

^{1}Soil ingestion only; ^{2}Soil dermal contact; ^{3}Soil to Ground Water; ^{4}Ground Water ingestion; ^{5}Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Cadmium**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s	2	mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose$^{1, 3}$	RfD_o	1.00E-03	mg/kg-day
2.2 Oral Carcinogenic Potency Factor$^{1, 3}$	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose^5	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor^5	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)^4	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")^5	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")$^{1, 2}$	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")^2	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)^2	ABS_d	0.01	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)^2	GI	0.2	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	6.700E+00	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	0.000E+00	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	**S**		mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**8.80E+00**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	**n**	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	1	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	**DF**	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	**VAF**		unitless

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B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Cadmium

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.214E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	2	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.000E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	0.000E+00	mg/kg

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	24.4	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway

			Method B *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
Soil Direct Contact			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	8.000E+01	7.207E+01	3.500E+03	1.333E+03
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		8.800E+00			
	Target Soil CUL? mg/kg		1.214E+00			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 5/21/2010
Site Name: East Bay Redevelopment - Parcels 4 and 5
Evaluator: Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

^{1}Soil ingestion only; ^{2}Soil dermal contact; ^{3}Soil to Ground Water; ^{4}Ground Water ingestion; ^{5}Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Lead (soil to SW)**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose$^{1, 3}$	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor$^{1, 3}$	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose^5	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor^5	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)^4	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")^5	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")$^{1, 2}$	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")^2	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)^2	ABS_d	0.01	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)^2	GI	0.2	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.000E+04	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	0.000E+00	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	**S**		mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**8.10E+00**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	1	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	**DF**	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	**VAF**		unitless

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B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Lead (soil to SW)

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.620E+03	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.620E+03	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	0.000E+00	mg/kg

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	34,884.7	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		8.100E+00			
	Target Soil CUL? mg/kg		1.620E+03			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 5/21/2010
Site Name: East Bay Redevelopment - Parcels 4 and 5
Evaluator: Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Copper**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	3.70E-02	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.01	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.2	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	2.200E+01	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	0.000E+00	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	**S**		mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	**C_w**		ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	**n**	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	1	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	**DF**	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	**VAF**		unitless

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B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Copper

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	4.933E+04	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	4.933E+04	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	0.000E+00	mg/kg

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	77.7	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway

			Method B *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
Soil Direct Contact			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	2.960E+03	2.667E+03	1.295E+05	4.933E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		N/A			
	Target Soil CUL? mg/kg		N/A			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

· Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
· Soil residual saturation (see WAC 173-340-747(10));
· Ecological impacts (see WAC 173-340-7490 through 7494); and
· Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

· Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
· Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
· Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date:	5/21/2010
Site Name:	East Bay Redevelopment - Parcels 4 and 5
Evaluator:	Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Nickel**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS_d, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	2.00E-02	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	***INH***	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	***AB1***	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	***AF***	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.01	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	***GI***	0.2	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	6.500E+01	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	0.000E+00	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	***H***	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13 ^{o}C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	***S***		mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w		ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	1	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	***DF***	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	***VAF***		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Nickel

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.667E+04	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.667E+04	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	0.000E+00	mg/kg

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	227.7	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	1.600E+03	1.441E+03	7.000E+04	2.667E+04
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		N/A			
	Target Soil CUL? mg/kg		N/A			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 5/21/2010
Site Name: East Bay Redevelopment - Parcels 4 and 5
Evaluator: Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Benzene**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	4.00E-03	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	5.50E-02	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	*INH*	2	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	*AB1*	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	*AF*	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.0005	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	*GI*	0.8	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	6.200E+01	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.300E-01	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	*H*	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.800E+03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**2.30E+01**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.004	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Benzene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.152E-01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.152E-01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	8.423E+02	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	1.9	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway

Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	3.200E+02	3.196E+02	1.400E+04	7.950E+03
		@RISK =1.0E-6 or 1.0E-5	1.818E+01	1.816E+01	2.386E+03	1.355E+03
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		2.300E+01			
	Target Soil CUL? mg/kg		2.152E-01			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- · Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- · Soil residual saturation (see WAC 173-340-747(10));
- · Ecological impacts (see WAC 173-340-7490 through 7494); and
- · Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- · Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- · Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- · Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 5/21/2010
Site Name: East Bay Redevelopment - Parcels 4 and 5
Evaluator: Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

^{1}Soil ingestion only; ^{2}Soil dermal contact; ^{3}Soil to Ground Water; ^{4}Ground Water ingestion; ^{5}Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Toluene**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose$^{1, 3}$	RfD_o	8.00E-02	mg/kg-day
2.2 Oral Carcinogenic Potency Factor$^{1, 3}$	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose^5	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor^5	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)^4	INH	2	unitless
3.2 Inhalation Absorption Fraction (default = "1")^5	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")$^{1, 2}$	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")^2	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)^2	ABS_d	0.03	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)^2	GI	0.8	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.400E+02	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.700E-01	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	***S***	5.300E+02	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**1.50E+04**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.004	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	***DF***	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	***VAF***		unitless

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Toluene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.350E+02	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.350E+02	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	4.152E+02	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	3.0	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway

			Method B *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
Soil Direct Contact			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	6.400E+03	5.912E+03	2.800E+05	1.164E+05
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.500E+04			
	Target Soil CUL? mg/kg		2.350E+02			
Protection of Air Quality *(for informational purpose only)*			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 5/21/2010
Site Name: East Bay Redevelopment - Parcels 4 and 5
Evaluator: Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Ethylbenzene**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	1.00E-01	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	2	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.03	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.8	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	2.000E+02	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	3.200E-01	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	S	1.700E+02	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**2.10E+03**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.004	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

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B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Ethylbenzene

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	4.316E+01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	4.316E+01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	1.747E+02	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	3.8	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway

			Method B *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
Soil Direct Contact			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	8.000E+03	7.390E+03	3.500E+05	1.455E+05
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		2.100E+03			
	Target Soil CUL? mg/kg		4.316E+01			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date: 5/21/2010
Site Name: East Bay Redevelopment - Parcels 4 and 5
Evaluator: Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Total Xylenes**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	2.00E-01	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	2	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.03	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.8	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	2.300E+02	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.800E-01	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	***S***	1.700E+02	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**1.00E+03**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	***n***	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.004	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	***DF***	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	***VAF***		unitless

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B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Total Xylenes

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	2.289E+01	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	2.289E+01	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	1.945E+02	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	4.2	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	1.600E+04	1.478E+04	7.000E+05	2.909E+05
		@RISK =1.0E-6 or 1.0E-5	N/A	N/A	N/A	N/A
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.000E+03			
	Target Soil CUL? mg/kg		2.289E+01			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date:	5/21/2010
Site Name:	East Bay Redevelopment - Parcels 4 and 5
Evaluator:	Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**cPAH TEQ**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS_d, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o	7.30E+00	kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	*INH*	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	*AB1*	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	*AF*	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	*GI*	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	9.700E+05	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	4.600E-05	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	*H*	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13 °C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	***S***	1.600E-03	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**1.80E-02**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.004	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	***DF***	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	***VAF***		unitless

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B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: cPAH TEQ

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	1.397E+00	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	1.397E+00	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat}:	6.208E+00	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	13,535.9	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway

			Method B *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
Soil Direct Contact			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.370E-01	9.513E-02	1.798E+01	3.425E+00
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.800E-02			
	Target Soil CUL? mg/kg		1.397E+00			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date:	5/21/2010
Site Name:	East Bay Redevelopment - Parcels 4 and 5
Evaluator:	Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

[1]Soil ingestion only; [2]Soil dermal contact; [3]Soil to Ground Water; [4]Ground Water ingestion; [5]Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Total Naphthalenes**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose[1, 3]	RfD_o	2.00E-02	mg/kg-day
2.2 Oral Carcinogenic Potency Factor[1, 3]	CPF_o		kg-day/mg
2.3 Inhalation Reference Dose[5]	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor[5]	CPF_i		kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)[4]	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")[5]	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")[1, 2]	$AB1$	1	unitless
3.4 Adherence Factor (default = "0.2")[2]	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)[2]	ABS_d	0.1	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)[2]	GI	0.5	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	1.200E+03	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	2.000E-02	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	**S**	3.100E+01	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**4.90E+03**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	**n**	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.004	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	**DF**	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	**VAF**		unitless

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B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Total Naphthalenes

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	4.902E+02	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	4.902E+02	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	1.551E+02	mg/kg

Warning: Soil Cleanup Level is higher than Soil Saturation Limit!

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	17.7	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

<table>
<tr><th colspan="7">Summary by Exposure Pathway</th></tr>
<tr><td rowspan="6">Soil Direct Contact</td><td colspan="2" rowspan="2"></td><td colspan="2"><i><u>Method B</u></i>
<i>Unrestricted Land Use</i>
@ HQ=1.0; RISK =1.0E-6</td><td colspan="2"><i><u>Method C</u></i>
<i>Industrial Land Use</i>
@ HQ=1.0; RISK =1.0E-5</td></tr>
<tr><td>Ingestion only</td><td>Ingestion & Dermal</td><td>Ingestion only</td><td>Ingestion & Dermal</td></tr>
<tr><td rowspan="2">Under the Current Condition</td><td>HQ? @ Exposure Point</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td>RISK? @ Exposure Point</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="2">Target Soil CUL? mg/kg</td><td>@HQ=1.0</td><td>1.600E+03</td><td>1.111E+03</td><td>7.000E+04</td><td>1.333E+04</td></tr>
<tr><td>@RISK =1.0E-6 or 1.0E-5</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td></tr>
<tr><td rowspan="6">Protection of Potable Ground Water</td><td colspan="2"></td><td colspan="2"><i><u>Method B</u></i>
@ HQ=1.0; RISK =1.0E-6</td><td colspan="2"><i><u>Method C</u></i>
@ HQ=1.0; RISK =1.0E-5</td></tr>
<tr><td rowspan="3">Under the Current Condition</td><td>Predicted Ground Water Conc? ug/l</td><td colspan="4">N/A</td></tr>
<tr><td>HQ? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>RISK? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td colspan="2">Target Ground Water CUL? ug/l</td><td colspan="4">4.900E+03</td></tr>
<tr><td colspan="2">Target Soil CUL? mg/kg</td><td colspan="4">4.902E+02</td></tr>
<tr><td rowspan="8">Protection of Air Quality
<i>(for informational purpose only)</i></td><td colspan="2"></td><td colspan="2"><i><u>Method B</u></i>
@ HQ=1.0; RISK =1.0E-6</td><td colspan="2"><i><u>Method C</u></i>
@ HQ=1.0; RISK =1.0E-5</td></tr>
<tr><td rowspan="3">Under the Current Condition</td><td>Predicted Air Conc? ug/m^3 @Exposure Point</td><td colspan="4">N/A</td></tr>
<tr><td>HQ? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>RISK? @ Exposure Point</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="2">Target Air CUL? ug/m^3</td><td>@ HQ=1.0</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>@ RISK=1.0E-6 or 1.0E-5</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td rowspan="2">Target Soil CUL? mg/kg</td><td>@ HQ=1.0</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
<tr><td>@ RISK=1.0E-6 or 1.0E-5</td><td colspan="2">N/A</td><td colspan="2">N/A</td></tr>
</table>

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

Worksheet for Calculating Soil Cleanup Levels for Unrestricted & Industrial Land Use

Date:	5/21/2010
Site Name:	East Bay Redevelopment - Parcels 4 and 5
Evaluator:	Josh Johnson

Refer to WAC 173-340-720, 740, 745, 747 and 750 for details.

^{1}Soil ingestion only; ^{2}Soil dermal contact; ^{3}Soil to Ground Water; ^{4}Ground Water ingestion; ^{5}Vapor exposure pathway

A. INPUT PARAMETERS FOR SOIL CLEANUP LEVEL CALCULATIONS

Note: If no data is available for any of the following inputs, then leave the input box blank

Item	Symbol	Value	Units
1. General information			
1.1 Name of Chemical:		**Total Dioxins / Furans**	
1.2 Measured Soil Concentration, if any:	C_s		mg/kg
1.3 Natural Background Concentration for Soil, if any:	NB_s		mg/kg
1.4 Practical Quantitation Limit for Soil, if any:	PQL_s		mg/kg
* To evaluate the ingestion and dermal pathways concurrently, check here and input values for ***AF, ABS$_d$, GI***:	☑		
2. Toxicological Properties of the Chemical: Chemical-Specific			
2.1 Oral Reference Dose$^{1, 3}$	RfD_o		mg/kg-day
2.2 Oral Carcinogenic Potency Factor$^{1, 3}$	CPF_o	1.50E+05	kg-day/mg
2.3 Inhalation Reference Dose^5	RfD_i		mg/kg-day
2.4 Inhalation Carcinogenic Potency Factor^5	CPF_i	1.50E+05	kg-day/mg
3. Exposure Parameters			
3.1 Inhalation Correction Factor (default = "2" for volatiles; "1" for all others)^4	INH	1	unitless
3.2 Inhalation Absorption Fraction (default = "1")^5	ABS_i	1	unitless
3.3 Gastrointestinal Absorption Fraction (default = "1")$^{1, 2}$	$AB1$	0.6	unitless
3.4 Adherence Factor (default = "0.2")^2	AF	0.2	mg/cm^2-day
3.5 Dermal Absorption Fraction (chemical-specific or defaults)^2	ABS_d	0.03	unitless
3.6 Gastrointestinal Absorption Conversion Factor (chemical-specific or defaults)^2	GI	0.8	unitless
4. Physical and Chemical Properties of the Chemical: Chemical-Specific			
Soil Organic Carbon-Water Partitioning Coefficient: for metals, enter K_d value here and enter "1" for f_{oc} value	K_{oc}	3.900E+06	l/kg
Henry's Law Constant: for the evaluation of ground water and vapor exposure pathway	H_{cc}	0.000E+00	unitless
**If the value for Henry's Law Constant is given in the unit of "atm.m^3/mol", enter value here:*	H	*0.000E+00*	atm.m^3/mol
**Converted unitless form of H_{cc} @13^o C: (Enter this converted value into "H_{cc} input Box" above for a calculation)*	H_{cc}	*0.000E+00*	unitless

Solubility of the Chemical in Water: for the calculation of soil saturation limit	**S**	1.930E-05	mg/l

5. Target Ground Water Cleanup Level

Target Ground Water Cleanup Level applicable for a soil cleanup level calculation: **Results from the Ground Water Cleanup Level Worksheet are not automatically transferred into this worksheet.*	C_w	**1.00E-05**	ug/l

6. Site-Specific Hydrogeological Characteristics

Total Soil Porosity (default = "0.43"):	n	0.43	unitless
Volumetric Water Content (default = "0.30"):	Θ_w	0.3	unitless
Volumetric Air Content (default = "0.13"):	Θ_α	0.13	unitless
Dry Soil Bulk Density (default = "1.50"):	ρ_b	1.5	kg/l
Fraction Soil Organic Carbon (default = "0.001"): for metals, enter "1" for f_{oc} value here	f_{oc}	0.004	unitless
Dilution Factor (default = "20" for unsaturated zone soil; "1" for saturated zone soil; or site-specific)	DF	20	unitless

7. Vapor Attenuation Factor due to Advection (building structure) & Diffusion (soil layer) Mechanisms

** Vapor Attenuation Factor is the ratio of air concentration at the exposure point (e.g., within the building) to the vapor-phase contaminant concentration within the soil at the source*

Enter Vapor Attenuation Factor: for the evaluation of vapor exposure pathway	VAF		unitless

---

B. SUMMARY OF SOIL CLEANUP LEVEL CALCULATIONS

Chemical of Concern: Total Dioxins / Furans

1. Summary of Results

To calculate a soil cleanup level based on Industrial Land Use (Method C) for Direct Soil Contact, check here: ☑

To calculate a soil concentration based on Method C vapor pathway, check here: ☐

Basis for Soil Concentration	Conc	Units
Most stringent soil concentration based on Soil Direct Contact & Ground Water Protection:	5.128E-04	mg/kg
Natural Background concentration for Soil:	N/A	mg/kg
Practical Quantitation Limit for Soil:	N/A	mg/kg
Soil Cleanup Level (not considering vapor pathway):	5.128E-04	mg/kg
Warning! Soil Cleanup Level above may not be protective of vapor exposure pathway - evaluate vapor pathway further.		
Soil concentration based on Vapor Pathway (informational purposes only):	0.000E+00	mg/kg
Soil Saturation Limit, C_{sat} :	3.011E-01	mg/kg

C_{sat} corresponds to the total soil chemical concentration saturated in soil.

R is the ratio of the ground water flow velocity to the contaminant migration velocity in saturated zone

Retardation Factor, ***R*** :	54,419.6	unitless

contaminant migration velocity in saturated zone.

2. Summary of Calculation for each Exposure Pathway

Summary by Exposure Pathway						
Soil Direct Contact			*Method B* *Unrestricted Land Use* @ HQ=1.0; RISK =1.0E-6		*Method C* *Industrial Land Use* @ HQ=1.0; RISK =1.0E-5	
			Ingestion only	Ingestion & Dermal	Ingestion only	Ingestion & Dermal
	Under the Current Condition	HQ? @ Exposure Point	N/A	N/A	N/A	N/A
		RISK? @ Exposure Point	N/A	N/A	N/A	N/A
	Target Soil CUL? mg/kg	@HQ=1.0	N/A	N/A	N/A	N/A
		@RISK =1.0E-6 or 1.0E-5	1.111E-05	9.768E-06	1.458E-03	5.128E-04
Protection of Potable Ground Water			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Ground Water Conc? ug/l	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Ground Water CUL? ug/l		1.000E-05			
	Target Soil CUL? mg/kg		3.120E-03			
Protection of Air Quality ***(for informational purpose only)***			*Method B* @ HQ=1.0; RISK =1.0E-6		*Method C* @ HQ=1.0; RISK =1.0E-5	
	Under the Current Condition	Predicted Air Conc? ug/m^3 @Exposure Point	N/A			
		HQ? @ Exposure Point	N/A		N/A	
		RISK? @ Exposure Point	N/A		N/A	
	Target Air CUL? ug/m^3	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	5.833E-08		5.833E-07	
	Target Soil CUL? mg/kg	@ HQ=1.0	N/A		N/A	
		@ RISK=1.0E-6 or 1.0E-5	N/A		N/A	

NOTES: "CUL" = Cleanup Level; "Conc" = concentration; "HQ" = hazard quotient; "RISK" = carcinogenic risk.

CAUTION: The requirements and procedures for establishing soil cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-740, 173-340-745, 173-340-747 and 173-340-7490 through 173-340-7494). The use of this Workbook is not sufficient to establish soil cleanup levels under the regulation. Specifically, the soil cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-740(3)(b)(i) and 173-340-745(5)(b)(i));
- Soil residual saturation (see WAC 173-340-747(10));
- Ecological impacts (see WAC 173-340-7490 through 7494); and
- Total site risk (see WAC 173-340-740(5)(a) and 173-340-745(6)(a)).

Other exposure pathways may also need to be evaluated on a site-specific basis to establish soil cleanup levels.

CAUTION: The requirements and procedures for establishing air cleanup levels that are protective of human health and the environment are specified in the MTCA Cleanup Regulation (see WAC 173-340-750). The use of this Workbook may not be sufficient to establish air cleanup levels under the regulation. Specifically, the air cleanup levels derived using this Workbook do not account for the following:

- Concentrations based on applicable state and federal laws (see WAC 173-340-750(3)(b)(i) and (4)(b)(i));
- Concentrations based on natural background and the practical quantitation limit (see WAC 173-340-750(5)(c));
- Total site risk (see WAC 173-340-750(5)(a)).

APPENDIX E – CLEAN SOIL COVER PROJECT SURVEY

Table E-1 presents a listing of selected remediation Interim Actions or Cleanup Actions incorporating a clean soil cap for the prevention of direct contact:

Table E-1: Selected Projects Incorporating a Clean Soil Cap for Prevention of Direct Contact

Site Name	Location	Constituents of Concern	Soil Cover Depth (ft)	Final Land Use
Kissel Park	Yakima, WA	Arsenic, Lead	0.5	City Park
Seattle Art Museum Olympic Sculpture Park – Lower Yard Area	Seattle, WA	TPH	3	Sculpture Park
Gas Works Park	Seattle, WA	Benzene, Naphthalene, cPAHs	1.5	City Park
Solid Wood / West Bay Park	Olympia, WA	cPAHs	1	City Park
Thomas Oil / Northwest Maritime Center	Port Townsend, WA	TPH, Benzene, Toluene, Ethylbenzene, Xylenes, cPAHs, metals	Variable	Sailing Center / Boat Shop
Irondale Iron and Steel	Irondale, WA	Metals	2	Recreation Area
Former DuPont Works Site	DuPont, WA	Arsenic, Lead	1.5	Golf Course
Eddon Boat Park	Gig Harbor, WA	TPH, cPAHs, Lead	3	Park
Bellfield Office Park	Bellvue, WA	TPH, PCBs, cPAHs	3	Commercial Use
Former Scott Paper Co	Anacortes, WA	TPH, PCBs, cPAHs, Metals, Dioxins / Furans	2-6*	Park
North Omak Elementary	Omak, WA	Lead, Arsenic	0.75	Elementary School

* - 6’ depth driven by soil biota concerns

APPENDIX F – EXCAVATION QUANTITY TAKEOFFS

Job: Hands On Museum BLDG MOD
Units: Ft-CY
Thu Apr 29, 2010 16:13:05 Page 1

Volume Report
Subgrade vs. Existing

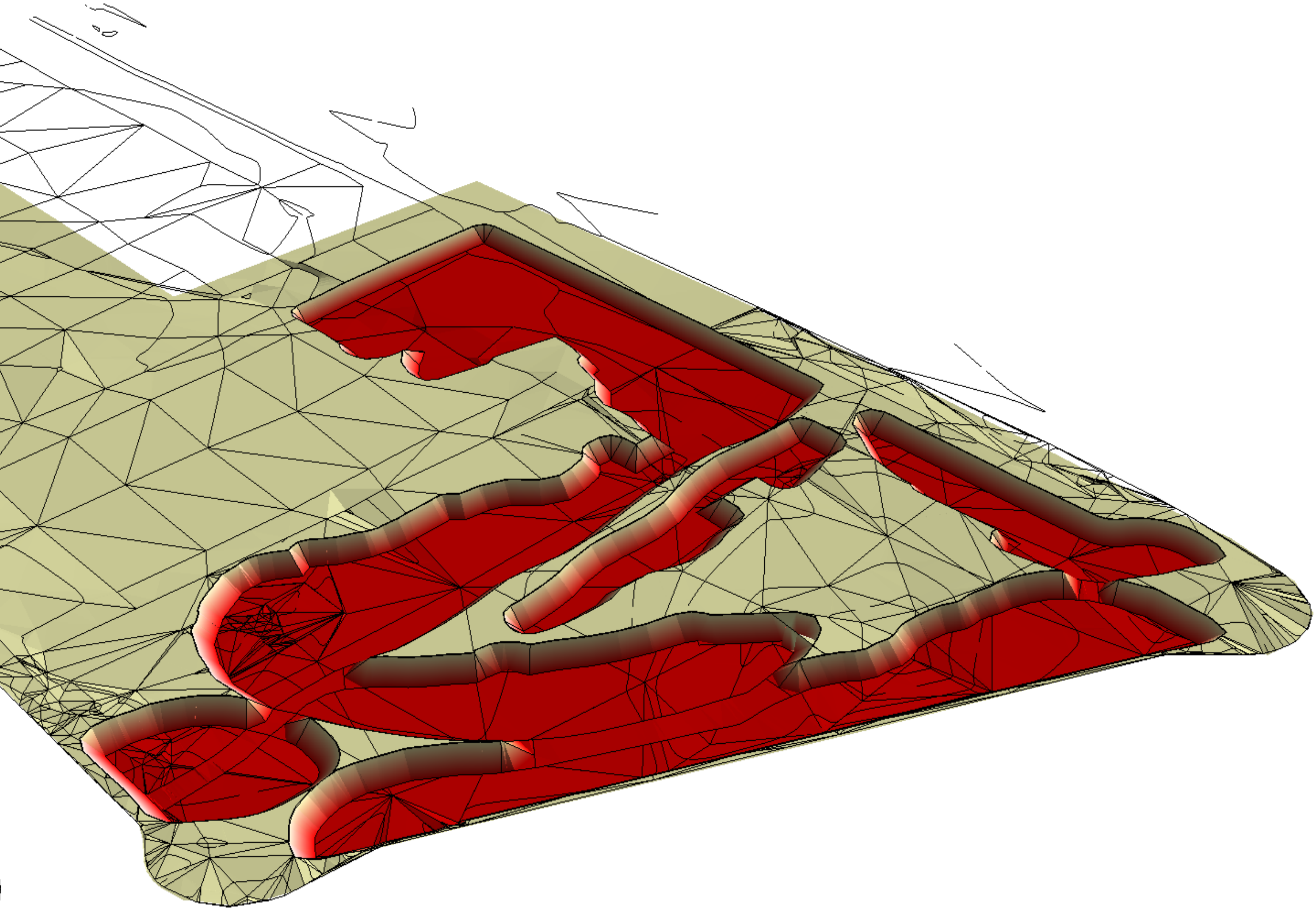
		Area			Volume		Comp/Ratio		Compact		Export	Change
	Total	**Cut**	**Fill**	**OnGrade**	**Cut**	**Fill**	**Cut**	**Fill**	**Cut**	**Fill**	**-Import**	**Per .1 Ft**
BUILDING	11,332	0	11,332	0	0	736	1.00	1.00	0	736	-736	42
PAVING	35,365	422	34,281	662	5	2,191	1.00	1.00	5	2,191	-2,186	131
Regions Total	**46,697**	**422**	**45,613**	**662**	**5**	**2,927**			**5**	**2,927**	**-2,922**	**173**
Unspecified	34,423	2,872	25,639	5,912	23	1,207	1.00	1.00	23	1,207	-1,184	127
Job Total	**81,120**	**3,294**	**71,252**	**6,574**	28	4,134			28	4,134	-4,106	300

Sectional Qtys	**Plane Area**	**Slope Area**	**Depth**	**Volume**
BUILDING	11,332	11,367	0.667	281
PAVING	35,365	35,463	0.500	657
Sectional Total	**46,697**	**46,830**		**938**

Job: Hands On Museum EXC
Units: Ft-CY
Thu Apr 29, 2010 15:23:23 Page 1

Volume Report
Design vs. Existing

			Area		Volume		Comp/Ratio		Compact		Export	Change
	Total	**Cut**	**Fill**	**OnGrade**	**Cut**	**Fill**	**Cut**	**Fill**	**Cut**	**Fill**	**-Import**	**Per .1 Ft**
LOT 5	18,242	18,181	0	61	3,589	0	1.00	1.00	3,589	0	3,589	68
Unspecified	26,207	26,049	0	158	4,686	0	1.00	1.00	4,686	0	4,686	97
Job Total	**44,449**	**44,230**	**0**	**219**	8,275	0			8,275	0	8,275	165



APPENDIX G – GROUNDWATER CONTOURS, SEPTEMBER 2009

Legend

- Measured Monitoring Well and Groundwater Depth (feet)
- Monitoring Well Not Measured During Event
- Groundwater Depth Contours
- East Bay Redevelopment Project Area
- Proposed Right-of-Way
- Port of Olympia Parcel Boundaries
- Lott Alliance Parcel 8

Notes:

NM = Not Measured

Groundwater depths are based on measurements from the top of monitoring well casings. The top of each casing is roughly equal to ground surface.

N
W E
S

0 50 100 200
Feet

Groundwater Depth Contours
from September 2009 Monitoring Event

Port of Olympia
March 2010

Figure 1

APPENDIX H – SAMPLING AND ANALYSIS PLAN

PARCEL 4 AND 5 IA

SAMPLING AND ANALYSIS PLAN

Prepared for
The City of Olympia and the LOTT Alliance
Olympia, WA
6/23/2010

THE CITY OF OLYMPIA / THE LOTT ALLIANCE PARCEL 4 AND 5 INTERIM ACTION SAMPLING AND ANALYSIS

Prepared for

The City of Olympia and the LOTT Alliance

Olympia, WA
6/23/2010

Brown and Caldwell

724 Columbia Street NW, Suite 420

Olympia, WA 98501

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

BC	Brown and Caldwell
˚C	degrees Celsius
CCL	contaminant candidate list
COPC	constituent of potential concern
CRM	certified reference materials
DI	Deionized water
DO	dissolved oxygen
DOC	dissolved organic carbon
DRL	detection limits for purposes of reporting (Title 22)
DQO	data quality objective
EC	electrical conductivity
Ecology	Washington State Department of Ecology
EDD	electronic database deliverable
EDMS	environmental database management system
EPA	United States Environmental Protection Agency
GC/MS	gas chromatography/mass spectrometry
HPLC	high performance liquid chromatography
ICP/MS	inductively coupled plasma mass spectrometry
IS	internal standard
LCM	laboratory control material
LCS	laboratory control spike
LCSD	laboratory control spike duplicate
MCL	maximum contaminant levels
MDL	method detection limit
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
mg/L	milligrams per liter
MP	Monitoring Plan
MPN	most probable number
MS	matrix spike
MSD	matrix spike duplicate
N	nitrogen
NIST	National Institute of Standards and Technology
P	phosphorus
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SM	Standard Methods for the Examination of Water and Wastewaterr
SOP	standard operating procedure
SWAMP	Surface Water Ambient Monitoring Program
TOC	total organic cargon
TRL	target reporting limit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WQ	water quality

1. PROJECT MANAGEMENT

1.1 Monitoring Program Task Organization

Organization of the Project team for the Parcel 4 and 5 Interim Action and associated tasks are described in the following sections.

1.1.1 Involved Parties and Roles.

This Sampling and Analysis Plan (SAP) has been prepared for the Parcel 4 and 5 Interim Action. Within this SAP are descriptions of methods and functional activities employed to collect monitoring data collected for Parcel 4 and 5 Interim Action. Specific details regarding the quality assurance for data collected are not included herein, but are discussed separately in the Quality Assurance Project Plan. Together, these two documents serve to completely describe the data collection and quality assurance / quality control (QA/QC) program that will be implemented as part of the Interim Action.

Table 1-1 Staff

Name	Affiliation	Title	Contact Information
Steve Teel	Washington State Department of Ecology	Site Manager	ph:(360) 407-6247 stee461@ecy.wa.gov
Rick Dougherty	City of Olympia	Project Manager	ph:(360) 753-8485 rdougher@ci.olympia.wa.us
Eric Hielema	LOTT Alliance	Project Manager	ph:(360) 528-5705 erichielema@lottonline.org
TBD	Brown and Caldwell	Project Manager	ph:(360) 943-7525
TBD	Brown and Caldwell	QA Officer	ph:(360) 943-7525
TBD	Brown and Caldwell	Data Management Coordinator	TBD
TBD	Contact Analytical Lab (TBD)	Laboratory Director	TBD
Kate Green	Brown and Caldwell	Sampling Support	ph:(360) 943-7525 kgreen@brwncald.com
John Turk	Brown and Caldwell	Technical Advisor	ph:(360) 943-7525 jturk@brwncald.com

Notes:
QA = Quality Assurance
BC = Brown and Caldwell

1.1.2 Project Manager Role

The project manager is assigned primary oversight for data collection.

The QA Officer is responsible for performing samplle collection activities, coordinaing sample analysis and data validation, performing sample data verification / validation, perparing draft, final draft, and final reports, ensuring that project work performed meets the requirements of the SAP, responding to requested deviations from the SAP, reporting on QA matters to the Client Project Manger and Ecology, obtaining approvals, as needed, for all phases of work, and communicating with the Client Project Manager on matters relating to the project. Key personnel assigned to the project will have reviewed the QAPP and SAP, and will be instructed by the Project Manager regarding the requirements of the data collection program. The Project Manager will work with the Client Project Manager and Department of Ecology to ensure that SAP objectives are being met and the team will continually assess the effectiveness of the data collection program and recommend modifications, as needed.

1.1.3 Persons Responsible for SAP Update and Maintenance

If necessary, the Project Manager, with concurrence from the Client Project Manager, may revise and update the SAP after presenting the evidence for such changes and obtaining the approval from

Department of Ecology. Revisions that occur after the original SAP is approved will be indicated on the SAP title page and will be distributed to all parties listed in Table 1-1.

1.2 Problem Definition

Samples will be collected to confirm the extent of contaminated areas and to classify stockpiled soils as suitable for general reuse, suitable for reuse in capped areas, or to designate soil from disposal. Sample results for soils designated for disposal will be communicated to the disposal facility.

1.3 Regulatory Agencies and Applicable Regulatory Limits

The project is under the oversight of the Washington State Department of Ecology. Cleanup Levels and Remediation Levels for the project are established under the Model Toxics Cleanup Act (MTCA) and defined in the Interim Action Work Plan.

1.4 Project Description

The project was designed to remove contaminated soil from the site and to classify soils remaining on the site as suitable for general reuse or suitable for reuse in capped areas. A detailed description of the constituents to be monitored and the information used to develop the list of constituents is discussed in the Interim Action Work Plan and the SAP.

1.5 Project Schedule

The anticipated schedule for tasks associated with Parcel 4 and 5 Interim Action is shown in Table 1-2 below. Specific project schedules will be described in the SAPs.

Table 1-2. Program Timeline

Task	Anticipated Date of Initiation	Anticipated Date of Completion	Deliverable
Draft IA Work Plan, SAP, and QAPP		6/9/2010	Draft SAP and QAPP
Final IA Work Plan, SAP and QAPP	7/6/2010	8/6/2010	Final SAP and QAPP
Implement Parcels 4 and 5 Interim Action	September 9, 2010	November 30, 2010	
Draft Parcels 4 and 5 Interim Action Report	September 9, 2010	Within 60 days after field work is completed	Draft Parcels 4 and 5 Interim Action Report
Incorporate Ecology's written comments on the Draft IA Report	Upon receipt of Ecology's written comments.	Within 30 days after receipt of Ecology's written comments on the draft report	Final IA Report

1.6 Sampling Constraints

Sampling constraints typically encountered during sampling include safety of sampling personnel and cost considerations.

Sampling results must be complete before major earth-moving activities (stockpile disposal, excavation backfill, etc.). Timing constraints or missed events are therefore not anticipated.

1.7 Sampling Objectives

Sampling activities at the site will consist of confirmation soil sampling and stockpile soil sampling. The objective of confirmation soil sampling will be to deliniate the extent of contamination in areas suspected to exceed Interim Action Remediation Levels (IARLs). The objective of stockpile soil sampling will be to classifiy stockpiled material as suitable for general reuse, suitable for reuse in capped areas, or designated for disposal. Descriptions of sampling procedures are provided in Section 2. Constituents of Potential Concern (COPCs) and proposed sampling methods are summarized in Table 1-3.

Table 1-3. Parcel 4 and 5 COPCs

Group	COPC	Proposed Methods	Reporting Limits
Metals	Arsenic	EPA 6020A	0.2 mg/Kg
	Cadmium	EPA 6020A	0.2 mg/Kg
	Lead	EPA 6020A	1 mg/Kg
	Copper	EPA 6020A	0.2 mg/Kg
	Nickel	EPA 6020A	0.5 mg/Kg
PAHs	cPAHs	EPA 8270C / EPA 8270C-SIM	0.01 mg/Kg
Dioxins / Furans	Dioxins / Furans	EPA 1613 / EPA 8290	3 pg/g
Petroleum Hydrocarbons	TPH-D	NWTPH-Dx	25 mg/Kg
	TPH-HO	NWTPH-Dx	25 mg/Kg
	TPH-G	NWTPH-Gx	10 mg/Kg
VOCs	Benzene	EPA 8260B	0.01 mg/Kg
	Toluene	EPA 8260B	0.01 mg/Kg
	Ethylbenzene	EPA 8260B	0.01 mg/Kg
	Total Xylenes	EPA 8260B	0.03 mg/Kg
SVOCs	Total Naphthalenes	EPA 8270C / EPA 8270C-SIM	0.3 mg/Kg

1.8 Quality Control Limits

Data Quality Objectives, project quality, objectives, and the measurement performance criteria for sampling are provided in the QAPP.

1.9 Training and Certification

Field personnel that participate in sampling will have reviewed the QAPP and SAP for the specific Site project, and will be instructed by the Project Manger. Training will occur prior to the beginning of the program and semi-annually thereafter through QC sessions, where field procedures will be reviewed; new personnel will be trained prior to performing any work in the program. Field personnel will have been trained prior to the first sampling event in sample collection procedures (including QA/QC, grab sampling techniques, completing laboratory chain-of-custody forms, and proper handling of water samples), and field analysis (including instrument calibration, data recording procedures, and interpretation of collected data).

All laboratories utilized to perform analytical services will be certified by the NELAC. Laboratory personnel will be certified and trained as required by the laboratory's quality assurance manuals. The laboratory director of the primary analytical lab will be provided a copy of the QAPP.

Documentation of training for field staff will be maintained by Brown and Caldwell. Documentation will include a record of the training topic, training date, name and title of instructor, whether the class was an initial training or a refresher course, and whether the course was completed satisfactorily.

1.10 Documents and Records

1.10.1 Project Documents, Records, and Electronic Files

The documents and records that will be generated during this project include the following:

Quality Assurance Project Plan: The QAPP (this document) contains details on the QA and QC procedures that will be implemented throughout the project.

Sampling and Analysis Plans: The SAPs contain information regarding sampling locations, frequencies, and sample collection methods.

Field Records. The Brown and Caldwell Project Manager or other designee will maintain all field records, including field data sheets documenting results of field analyses and QC samples, a logbook documenting equipment maintenance and calibration, and sample collection and handling documentation (copies of chain-of-custody forms, shipping receipts, etc.).

Laboratory Records. Analytical labs will maintain sample receipt and storage documentation, instrument calibration logs, raw data and QC sample records.

Data validation records. Field data sheets, field QC results, chain-of-custody forms, and lab reports from each sampling event will be reviewed by the QA Officer and a data validation record will be generated which summarizes the quality of the collected data.

Project database: The Brown and Caldwell Olympia, WA office will be used to store all laboratory and field data gathered during this project. The database will be continually updated and managed as described in Section 2.9. At the completion of the project, data may be electronically submitted to the City of Olympia and the LOTT Alliance upon request.

1.10.2 Retention of Project Documentation

The original data sheets, equipment maintenance/calibration logs, chain-of-custody forms, lab reports, field records, training documents and data validation records will be stored by Brown and Caldwell until the end of the project. All records will be maintained by Brown and Caldwell and analytical labs for five years after project completion.

1.10.3 Distribution of SAP Revisions

Revisions that occur after the original SAP is approved will be indicated on the SAP title page and will be distributed by the Project Manager to all parties listed in Table 1-1.

2. DATA GENERATION AND ACQUISITION

2.1 Sampling Process Design

The individual Site SAPs will provide a detailed description of the sampling approach and rationale that was used to select sampling locations, sampling frequencies, and constituents that will be analyzed.

2.2 Sampling Methods

Proper sample collection procedures are essential to ensure that representative and reliable data are being collected. Sample collection will be performed according to the SOP for Sample Collection, Documentation, and Delivery, included as Appendix I to the IA Work Plan. In general, the QA procedures that will be followed during sample collection include the following:

- Samples from depths less than 4 feet will be collected by hand directly from the sidewall of the excavation. Samples from depths greater than 4 feet will be collected by using the excavator bucket. .
- Sample collection will be performed in such a manner as to minimize disturbance of surrounding soils.
- Soil grab samples will be transferred to sample jars carefully to minimize exposure to external influences such as wind, dust, or rain.
- Sample jars will be labeled (e.g., date, time, location, method) immediately after collection.
- Sampling date and time and sampler's initials will be added to the chain of custody form immediately after sampling.
- If problems occur during sampling, the QA Officer will be notified. The source of the problem will be identified and the appropriate corrective action taken. These incidents will be documented in the project folder and filed with the appropriate data package. If the problem compromised the quality of collected data, the data will be flagged within the database.

2.3 Confirmation Sampling

Samples will be collected during excavation both to delineate excavated areas and to characterize excavated material stockpiled on-site. A total of five locations exceed IARLs and will be excavated: TP-02, DP-11, -17, -18, and -21. Table 2-1 shows planned sample depths and analytical constituents. Hotspots will be initially excavated in 20-foot by 20-foot excavation cells. The excavation cells may be made smaller with permission from Ecology, but not larger. The first excavation cells will be centered at the coordinates of the samples with concentrations exceeding IARLS (DP-17 and DP-21 for arsenic, DP-11 for lead, DP-18 for TPH-HO, and TP-02 for dioxins/furans. After the first cell is excavated, adjacent 20-foot by 20-foot cells may be excavated based on field screening results. These excavations will constitute the first excavation round.

Confirmation samples will be collected during the first excavation round. Vertical sets of confirmation samples will be collected in each sidewall of each excavation cell at the depths shown in Table 2-1. A vertical set will include one sample from each lithologic layer. Samples from depths less than 4 feet will be collected by hand directly from the sidewall of the excavation. Samples from depths greater than 4 feet will be collected by using the excavator bucket. A floor sample in the center of each cell will also be collected by using the excavator bucket. Sample collection is shown schematically in Figure 2-1.

Table 2-1. Sample Locations and Analytical Constituents

Location	Sample Type	Depth of Contamination (feet)	Hotspot Constituent	Initial Excavation Depth (feet)	Initial Sidewall Sample Depths (feet)	Analytical Constituents
TP-02	Sidewall and Bottom Confirmation Samples	2	Dioxins/Furans	10	0-2, 2-3, 3-4, 7-8*	Dioxins/Furans
DP-11	Sidewall and Bottom Confirmation Samples	8-10	Lead	12	8-10*	Arsenic, Lead, Copper, and Nickel
DP-17	Sidewall and Bottom Confirmation Samples	10-12	Arsenic	15	10-12*	Arsenic, Lead, Copper, and Nickel
DP-18	Sidewall and Bottom Confirmation Samples	10-12	TPH-HO	15	10-12*	TPH-D, TPH-HO, BTEX, and lead
DP-21	Sidewall and Bottom Confirmation Samples	6-8	Arsenic	10	6-8*	Arsenic, Lead, Copper, and Nickel
Stockpiles	Stockpile samples	NA	NA	NA	NA	All Constituents of Concern (See Table 3-2).

Notes:

* Samples will be collected from the depth interval shown and including each lithologic unit.

NA - Not Applicable

See Sampling and Analysis Plan Table 2-1 for quantity of stockpile samples.
Soil from the excavations of locations TP-02, DP-11, DP-17, and DP-21 will be field screened for the presence of TPH. Analyses for TPH (all ranges) and BTEX will be added if field screening indicates potential TPH presence.

Adjacent cells may be excavated in a second excavation round following the first set of sample collection. An adjacent cell will be excavated of any sample from the adjoining wall exceeds IARLs.

If necessary, the City and LOTT will continue the excavation of areas known to exceed IARLS (as identified in Figures 3-4 and 3-7) beyond the property boundaries of Parcel 4 and 5. These areas will be excavated until COPC concentrations in confirmation samples collected per Table 2-1 are below the IARLs.

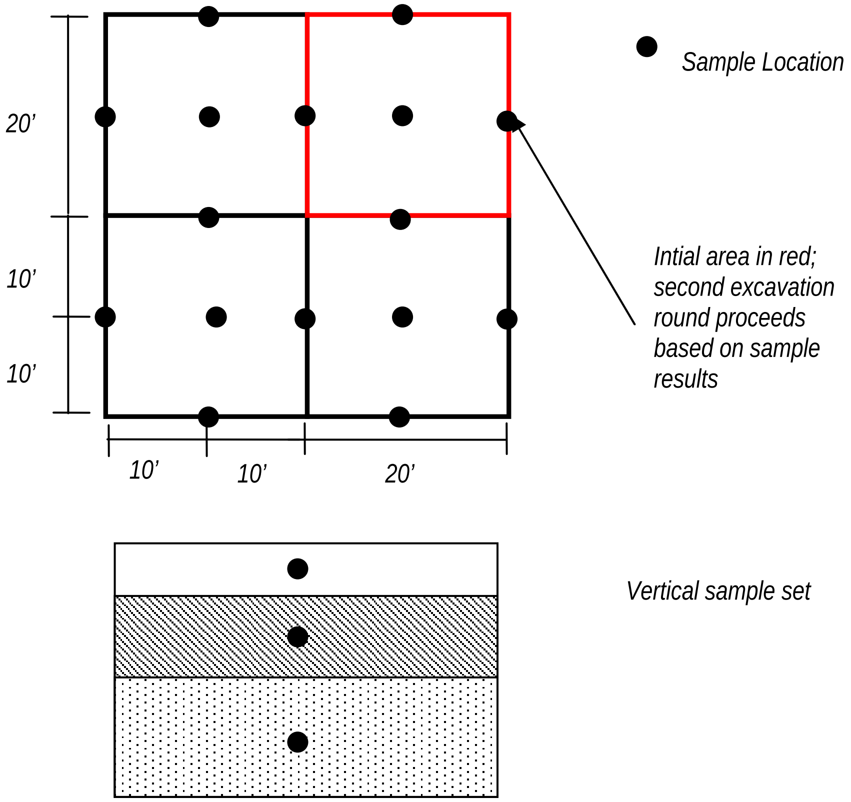


Figure 2-1: Compliance Sampling Plan

2.4 Stockpile Sampling

Separation of material into stockpiles will be directed by the BC PM or their designee. Stockpiles comprised of material from Parcel 4 will be kept distinct from stockpiles comprised of material from Parcel 5. The BC PM or their designee will segregate material into stockpiles based on field screening analysis methods, including PID headspace analysis, sheen testing, visual and olofactory observations, or other appropriate criteria. In addition, the BC PM or their designee will attempt, to the extent practicable, to segrate material so that distict lithologic units are kept separate. Time constraints or site constraints may not always allow for separation by lithology.

Samples will be colleted from stockpiles based on stockpile size. Stockpile dimensions will be measured and stockpile size estimated to facilitate both sample collection and measurement and payment during project implementation. The estimator will be a BC or contracted professional and will estimate stockpile size using current local, state, or national standard methods. The estimator will also conduct Proctor testing to estimate the dry density, optimum moisture, and maximum acheivable compaction. The stockpile sampling schedule is summarized in Table 2-2. Stockpile samples will be analyzed for all of the constituents of concern (see Interim Action Work Plan Table 3-2).

Table 2-2. Stockpile Sample Quantity Guide

Stockpile Size (Cubic Yards)	Sample Quantity
0 – 100	3
101 – 500	5
501 – 1000	7
1001 – 2000	10
> 2000	10 + 1 for each additional 500 CY soil

Samples will be collected such that they are spatially distributed around the stockpile. Samples will be collected from the dominant lithology in the stockpile. The BC PM or their designee may collect additional stockpile samples if, in the opinion of the BC PM or the Client, additional samples are warranted based on field conditions.

Stockpiles will be marked with a placard system to designate their usage. A separate placard color will denote unsampled stockpiles, stockpiles sampled and awaiting analytical results, stockpiles with no sample results exceeding IACLs (soils suitable for general reuse), stockpiles with sample results exceeding IACLs but no sample results exceeding IARLs (soils suitable for reuse in capped areas), and stockpiles with sample results exceeding IARLs (soils for off-site disposal). Newly excavated material may only be added to stockpiles that have not been sampled. Stockpile information will be recorded on the placards, including the stockpile number, the date(s) of excavation, stockpile size, the stockpile sample number(s), the date of sampling, the concentrations of any COPCs exceeding IACLs, the concentrations of any COPCs exceeding IARLs, the stockpile status, and the date that the stockpile is authorized for reuse or disposal.

2.5 Sample Designation and Labeling

Each sample collected will be identified by confirmation excavation or stockpile number, location number, and by depth in feet if appropriate. Confirmation sample numbers will begin with the "CNF" designation, while stockpile samples will begin with the "SPL" designation. Location numbers for each sample will be clearly recorded on sketches in the logbooks and sample data sheets.

For instance, a soil sample collected from Confirmation Excavation 1, location 1 at a depth of 7 feet would be identfied as "CNF-1-1-7". The fifth sample from stockpile one would be identified as "SPL-1-5".

Each sample container will be individually labeled with the label affixed directly to the sample container. Information that will be included on the label in the field includes preservation, analysis required, date and time of collection, location, and the sampler's initials. All of these data will be written with indelible waterproof ink. Any additional information regarding the sample collection will be noted in the field logbook; this additional information can include notations if the samples are composite samples or if preservatives were added in the field, for example.

3. SAMPLE HANDLING AND CUSTODY

3.1 Sample Handling

Once sample containers have been filled they will be labeled, placed in re-sealable plastic bags (e.g. *Ziploc* ®), and stored in a cooler on ice to maintain a temperature of approximately 4º C. Identification information for each sample will be recorded in the field logbook when the sample is collected.

3.2 Sample Collection Documentation

The field logbooks used during sampling procedures will include the following information:

- initials of person making entry
- date and time of sample collection
- sampling location
- analyses to be performed
- preservation method
- field meter or screening information, if applicable
- general remarks (weather conditions, etc.)

All entries will be made in indelible ink with a ballpoint pen and will be written legibly. Entry errors will be crossed out with a single line, dated, and initialed by the person making the correction. Field logbooks will be reviewed periodically by the BC Project QA Officer, as appropriate. Additionally, a field sampling data sheet will be completed for each sample.

3.3 Custody

A chain-of-custody form will be completed at the time of sample collection and prior to sample shipment or release. The samples will be transported or shipped to the analytical lab in insulated containers within the appropriate holding time and will be accompanied by a chain-of-custody form that identifies the sample bottles, date and time of sample collection, and analyses requested. If shipment is needed, the samples will be packaged and shipped in accordance with U.S. Department of Transportation standards. The original chain-of-custody will be given to the lab with the samples and Brown and Caldwell will retain a copy for their records. Once received by the laboratory, a sample receipt and storage record will be generated. The recommended sample container type and volume, initial preservative and holding time for analytes that may be tested is shown in Table 3-1.

The turn around time for the analytical laboratory will typically be within ten days from the sampling date. After analyses, all samples will be disposed of in accordance with federal, state, and local requirements.

Table 3-1. Sample Handling and Custody

Group	Parameter	Container[a]	Initial Preservative[a]	Max Allowable Holding Time	
				Extraction[b]	Analysis[c]
Metals	Arsenic	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Lead	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Cadmium	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Copper	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Nickel	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
Semi-Volatiles	cPAHs	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	14 days	40 days
	Total Naphthalenes	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	14 days	40 days
Dioxins / Furans	Dioxins / Furans	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	28 days	40 days
TPH	TPH-G	EnCore Sampler	Ice to 4° C, preserve w/ methanol w/ in 48 hours	---	14 days
	TPH-D	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	28 days
	TPH-HO	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	28 days
Volatiles	Benzene	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days
	Toluene	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days
	Ethylbenzene	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days
	Total Xylenes	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days

[a] Sample containers, volumes, and preservatives will be reevaluated once contract laboratories are chosen and may be changed based on recommendations from the lab(s).

[b] Starting from the date of collection

[c] Starting from the date of extraction; if no extraction, starting from the date of collection

3.4 Laboratory Chain-of-Custody Procedures

Laboratory COC procedures for sample receiving and log-in, sample storage, tracking during sample preparation and analysis, and storage of data will be described in the laboratory SOPs and laboratory Quality Manuals of the selcted laboratory. Minimum requirements are described below.

On arrival at the laboratory, all samples will be inspected thoroughly to confirm that the integrity of the samples and containers has not been compromised. The cooler custody seals will be inspected to verify that they are still intact and were properly signed and dated by the field sampling team. The temperature of the cooler temperature blank will be determined and recorded. If the temperature of the cooler blank does not fall into the range of 4 ± 2 °C the Project Manager will be notified immediately. The exception to this will be if samples are delivered from the Site same-day to the laboratory. In this circumstance, the cooler temperature blank and samples may not have cooled during transport and elevated temperatures will be considered acceptable as long as ice is present in the cooler. The individual sample containers will be inspected to verify that each has a sample label. The condition of the samples will be noted on the COC form.

The sample containers will be checked against the accompanying COC to verify that the cooler contents are identical to the samples described on the COC documents. If discrepancies exist, they will be reported to the Laboratory QA Officer, who will immediately notify the BC PM. The problem will be resolved, in writing, before analytical work begins. After the Laboratory Sample Custodian has determined that the samples are in satisfactory condition and the documents are in order, a sample log-in sheet will be initiated and will serve as documentation of the condition of the samples upon receipt and their assigned laboratory numbers.

The sample log-in sheet will include information from field notes from the COC forms that reflect any special care or concerns that should be taken with the sample (e.g., the sampler suspects high concentration of an analyte due to field observations or historical concentration).

After the samples have been entered into the laboratory tracking system, copies of the log-in forms and COC records will be sent to the BC Project QA Officer, who will verify that the specified samples and parameters correspond to the samples and parameters identified in the SAP. The samples will be placed in a secured storage area, under the conditions called for by the analytical method, until removed for analysis.

Samples delivered on Saturday will be received by the Laboratory Sample Custodian and placed in a secure location until they can be logged in on the next business day.

3.5 Analytical Methods

Field measurements will be conducted by Brown and Caldwell staff using portable meters and field test kits that employ EPA-approved methods. Field measurements will be taken using the procedures recommended by the manufacturer of the meter or test kit and procedures discussed in the SOP for Field Data Collection, where applicable. Results of all field measurements will be recorded in field logbooks and on field data sheets.

Laboratory analyses will be conducted by NELAC-certified analytical laboratories using methods approved by the EPA and Washington State. Proposed analytical methods are provided in Table 1-

3. Alternative methods may be requested by the laboratories performing analyses. These alternative methods may be used only upon written approval from the QA Officer. Major laboratory equipment or instruments that will be utilized include a gas chromatography/mass spectrometer (GC/MS), inductively coupled plasma mass spectrometer (ICP-MS), high performance liquid chromatography (HPLC), automated colorimeter, ion chromatograph, and a carbon detector. If any instrument failures occur, the laboratory will take immediate corrective action and notify the QA Officer if the quality of sample results was compromised.

3.6 Sample Archival

Samples and sample extracts for all analyses will be held under custody at 4 ± 2 °C by the laboratory for a minimum of 60 days after the laboratory's final report is issued.

4. DOCUMENTATION, RECORDS, AND DATA PACKAGES

This section presents the procedures for documentation, records, and data management for the IA sampling.

4.1 Project Documentation and Records

Project documents will be controlled through an organized project filing system. Project and task numbers will be printed on each document. Analytical/technical files will include work products generated during the project. Field books, field observations, photographs, and other field related documents will be prepared and will also be placed in the project files. Laboratory sample results will be controlled, reviewed, and validated as required by the SAP. Original incoming documents will be date-stamped upon arrival and will be placed in the files.

The project manager will contact the analytical laboratories, subcontractor, or private sources prior to receiving the data report to review the report status. This will provide an opportunity to identify potential QA issues or potential delivery delays. This will also provide an opportunity to implement corrective actions when most appropriate.

Data received from the field, analytical laboratories, subcontractors, or private sources will be tabulated on a spreadsheet or database and will be subjected to QC procedures, including comparing raw data to the original source, verifying calculations, and confirming data summaries. Data distribution will not occur until data review has been completed.

Work products will be checked before final use. This includes checking calculations, reports, plans, etc. with various levels of review. The BC PM will be responsible for the review of work as an element of his project responsibilities and for the overall quality of the work. One or more discipline-specific Technical Director(s) may be assigned by the PM. Further, assignments may be made outside the project team, as needed, for QC purposes.

4.2 Laboratory Data Package Deliverables

The laboratory will provide one paper-copy original and one electronic copy (pdf format) of each laboratory data report to the BC PM. EDDs will also be required for the project database. Laboratory deliverables are required within 15 calendar days of receiving samples.

4.2.1 Paper Copy Data Package

The data package shall consist of the following, at a minimum:

Detailed Case Narrative:

- Date of issuance.

- Laboratory analyses performed, modifications to the methods, and impact on the data.
- Any deviations from intended analytical strategy.
- Laboratory batch number.
- Numbers of samples and respective matrices.
- QC procedures utilized and also references to the acceptance criteria.
- Laboratory report contents.
- Project name and number.
- Condition of samples 'as-received'.
- Discussion of whether or not sample holding times were met, and if holding times were not met, a demonstration of the validity of the data.
- Discussion of technical problems or other observations which may have created analytical difficulties.
- Discussion of any laboratory QC checks which failed to meet project criteria and the effect on the data.
- Signature of the Laboratory QA Officer and/or Laboratory Director or designee.
- Description of laboratory data qualifiers used.
- Definitions of acronyms and qualifiers.

Chemistry Data Package:

- Report of analysis with units clearly labeled with supporting raw data and expressed to the appropriate number of significant figures.
- Results of method blanks with supporting raw data.
- Summary table showing relationship of field samples to QC samples.
- Surrogate recovery summaries.
- Laboratory control sample summary with supporting raw data.
- Matrix spike summary with supporting raw data.
- Laboratory duplicate summary with supporting raw data (where applicable).
- Matrix spike duplicate summary with supporting raw data (where applicable).
- Tune summary for gas chromatography/mass spectrometry.
- Initial calibration summary and supporting raw data.
- Continuing calibration summary and supporting raw data.
- Internal standard summary.
- Instrument sensitivity check (CRI or equivalent).
- Interference check sample summary.
- Run logs.
- Sample preparation logs.
- Laboratory method detection limits.
- ICP linear ranges.
- Laboratory acceptance limits for QC samples.
- Internal and external chains of custody.
- Sample raw data.

4.2.2 Electronic Data Deliverable (EDD)

The laboratory shall furnish an EDD for all analyses. The electronic deliverable shall be provided in a flat-file database table populated, but not limited to the following fields:

- FACILITY_ID
- LABNAME
- LAB_SAMP
- FIELD_SAMP
- MEDIUM
- SAMP_DATE
- SAMP_TIME
- PARAM
- CAS_NO
- DL_FLAG
- CONC
- UNITS
- QUAL
- DILUTION
- METH_ID
- MDL
- PQL
- PROJ_QL
- REC_DATE
- EXTR_DATE
- ANALY_DATE

The EDD should include both the results of samples collected in the field and the results of those performed as part of laboratory QA/QC including internal duplicates, check standards, internal spikes, and MS/MSD samples. Results in the EDD shall include surrogate recoveries for each sample expressed as percent (%) recovered. In accordance with WAC 173-340-840(5) and Ecology Toxics Cleanup Program Policy 840 (Data Submittal Requirements), data generated shall be submitted to Ecology in both a written and electronic format. All data collected for the Interim Action will be entered into Ecology's Environmental Information Management (EIM) database.

4.3 Data Tracking, Storage, and Control

The final project files will be maintained by the BC PM. The content of the project file will include, at a minimum, all relevant records, reports, correspondence, logs, field logbooks, laboratory sample preparation and analysis raw data, original laboratory data packages, pictures, subcontractor's reports including data validation reports, assessment reports, progress reports, and chain-of-custody (COC) records/forms. Specific data storage and control requirements are described in the QAPP.

5. LIMITATIONS

Report Limitations

This document was prepared solely for the City of Olympia and the LOTT Alliance in accordance with professional standards at the time the services were performed and in accordance with the contract between Brown and Caldwell and the City of Olympia dated September 4, 2009, and the contract between Brown and Caldwell and the LOTT Alliance dated June 18, 2008. This document is governed by the specific scope of work authorized by the City of Olympia and the LOTT Alliance; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the the City of Olympia, the LOTT Alliance and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

REFERENCES

REFERENCES

EPA 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA 540/R-99/008. United States Environmental Protection Agency Office of Emergency and Remedial Response. October.

EPA 2000. U.S. Environmental Protection Agency.

EPA 2002. United States Environmental Protection Agency. 2002. *Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8), November.

EPA 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA 540-R-04-004. Office of Superfund Remediation and Technology Innovation (OSRTI), United States Environmental Protection Agency. October.

SM 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998. American Public Health Association, American Water Works Association, and Water Environment Federation.

APPENDIX I – HEALTH AND SAFETY PLAN

Health and Safety Plan for Soil Remediation

305 Jefferson Street NW
Olympia, WA

5/22/2010

BC Project Number: 135894 / 138130

Prepared by:

BROWN AND CALDWELL

724 Columbia Street NW, Suite 420
Olympia, WA 98501

Prepared for:

The City of Olympia
PO Box 1967
Olympia, WA 98507-1967

The LOTT Alliance
111 Market Street NE, Suite 250
Olympia, WA 98501

Approval Page

This Health and Safety Plan (HASP) has been prepared and reviewed by the following Brown and Caldwell (BC) personnel for use at: Parcel 4 and 5 (135894 / 138130).

	Name	**Signature**	**Title**	**Date**
Prepared By:	Joshua Johnson		Engineer III	
Reviewed By:	Joshua Johnson		Site Safety Officer	
Reviewed By:			Project Manager	
Reviewed By:	Jim Bucha		Regional Safety Unit Manager	
Effective Dates:	7/6/2010	through	7/6/2011	

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LIST OF APPENDICES

CRITICAL PROJECT INFORMATION

Primary Known Compound of Concern: Arsenic, Lead, Cadmium, Copper, Nickel, cPAHs, PCBs, Dioxins / Furans, TPH-D, TPH-G, TPH-HO, Benzene, Toluene, Ethylbenzene, Xylenes, Naphthalenes

Minimum Level of Respiratory Protection: ☒ Level D ☐ Level C

PPE: steel-toed work boots, hard had, eye protection, hearing protection, traffic safety vest, long-sleeved shirt and pants, nitrile gloves

SEE SECTION 10 FOR SITE EMERGENCY CONTINGENCY PROCEDURES

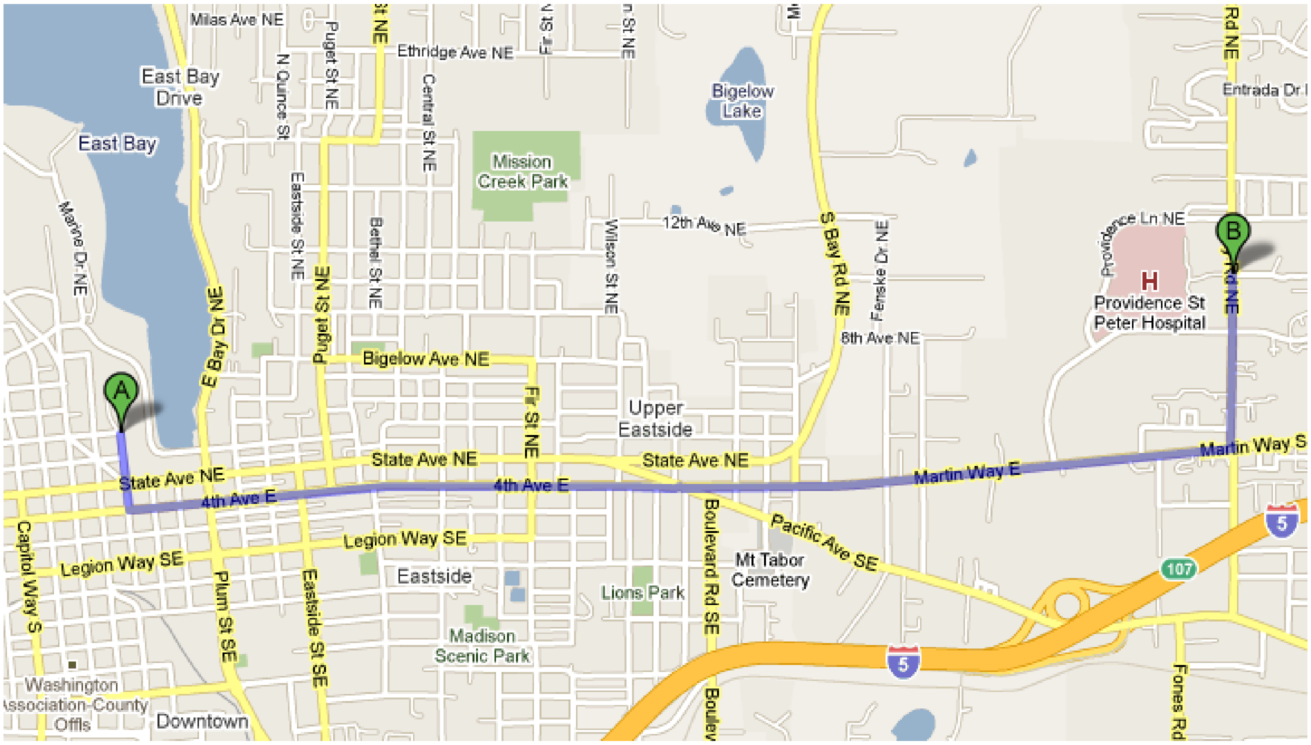
Do not endanger your own life. Survey the situation before taking any action.

BC Office Telephone	**360-943-7525**
Site Location Address	**305 Jefferson Street NW, Olympia, WA**

EMERGENCY PHONE NUMBERS: In the event of emergency, contact the Project Manager and/or Regional Safety Unit Manager.

Emergency Services (Ambulance, Fire, Police)	**911**
Poison Control	**(800) 876-4766 or (800) 222-1222**
Hospital Name	**Providence St. Peter Hospital**
Hospital Phone Number	**360-491-9480**
BC Project Manager (PM;)	**Office: 360-943-7525** **Cell:**
BC Site Safety Officer (SSO; Joshua Johnson)	**Office: 360-943-7525** **Cell: 805-637-8258**
BC Regional Safety Unit Manager (Jim Bucha)	**Office: 916-853-5308** **Cell: 916-216-6374**
Corporate Risk Management	**Property Loss** **Blythe Buetzow: (925) 210-2470** **Injury** **Angela Hernandez: (925) 210-2218**
Contractor Contact ( )	**Office:** **Cell:**
Client Contact (Eric Hielema)	**Office: 360-528-5705** **Cell:**
Client Contact (Rick Dougherty)	**Office: 360-753-8485** **Cell:**
OTHER CONTACT(s) (OTHER CONTACT NAME)	**OTHER tel#**

HOSPITAL LOCATION MAP



HOSPITAL DIRECTIONS:

Thurston Ave NE & Jefferson St NEOlympia, WA 98501

1. **Head south on Jefferson St NE toward Olympia Ave NE 0.2 mi**
2. **Turn left at 4th Ave E 1.5 mi**
3. **Continue onto Martin Way E 1.0 mi**
4. **Turn left at Lilly Rd NE**
5. **Destination will be on the left 0.4 mi**

413 Lilly Rd NEOlympia, WA 9850

HOSPITAL INFORMATION:

Providence St. Peter Hospital
413 Lilly Road Northeast
Olympia, WA 98506

Phone: 360-491-9480

EMERGENCY FIRST AID PROCEDURES

THE RESPONDER SHOULD HAVE APPROPRIATE TRAINING TO ADMINISTER FIRST AID OR CPR

1. Survey the situation. Do not endanger your own life. DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME. ENSURE ALL PROTOCOLS ARE FOLLOWED INCLUDING THAT A STANDBY PERSON IS PRESENT. IF APPLICABLE, REVIEW MSDSs TO EVALUATE RESPONSE ACTIONS FOR CHEMICAL EXPOSURES.
2. Call 911 (if available) or the fire department **IMMEDIATELY**. Explain the physical injury, chemical exposure, fire, or release.
3. Decontaminate the victim if it can be done without delaying life-saving procedures or causing further injury to the victim.
4. If the victim's condition appears to be non-critical, but seems to be more severe than minor cuts, he/she should be transported to the nearest hospital by the SSO or designated personnel: let the doctor assume the responsibility for determining the severity and extent of the injury. If the condition is obviously serious, contact emergency medical services (EMS) for transport or appropriate actions.

Notify the PM and Regional Safety Unit Manager immediately and complete the appropriate incident investigation reports as soon as possible.

STOP BLEEDING AND CPR GUIDELINES	
To Stop Bleeding	**CPR**
1. Give medical statement by indicating you are trained in 1st Aid. 2. Assure: airway, breathing and circulation. 3. Use **DIRECT PRESSURE** over the wound with clean dressing or your hand (use non-permeable gloves). Direct pressure will control most bleeding. 4. Bleeding from an artery or several injury sites may require **DIRECT PRESSURE** on a **PRESSURE POINT**. Use pressure points for 30 -60 seconds to help control severe bleeding. 5. Continue primary care and seek medical aid as needed.	1. Give medical statement by indicating you are trained in CPR. 2. Arousal: Check for consciousness. 3. Call out for help, either call 911 yourself or instruct someone else to do so. It is very important to call for emergency assistance prior to initiating CPR. 4. Open airway with chin-lift. 5. Look, listen and feel for breathing. 6. If breathing is absent, give 2 slow, full rescue breaths. 7. Look, listen and feel for breathing. 8. If breathing is absent, initiate CPR; 30 compressions for each two breaths. 9. If an automated external defibrillator (AED) is available, use it in accordance with the AED instructions.

1. INTRODUCTION

Brown and Caldwell (BC) has prepared this Health and Safety Plan (HASP) for use during the soil remediation activities to be conducted at Parcel 4 and 5 located at 305 Jefferson Street NE, Olympia, WA ("the Site"). Activities conducted under BC's direction at the Site will be in compliance with applicable Occupational Safety and Health Administration (OSHA) regulations, particularly those in Title 29 of the Code of Federal Regulations, Part 1910.120 (29 CFR 1910.120), and other applicable federal, state, and local laws, regulations, and statutes. A copy of this HASP will be kept on site during scheduled field activities.

This HASP addresses the identified hazards associated with planned field activities at the Site. It presents the minimum health and safety requirements for establishing and maintaining a safe working environment during the course of work. In the event of conflicting requirements, the procedures or practices that provide the highest degree of personnel protection will be implemented. If scheduled activities change or if site conditions encountered during the course of the work are found to differ substantially from those anticipated, the Regional Safety Unit Manager and Project Manager will be informed immediately upon discovery, and appropriate changes will be made to this HASP.

BC's health and safety programs and procedures, including medical monitoring, respiratory protection, injury and illness prevention, hazard communication, and personal protective equipment (PPE), are documented in the BC Health & Safety Manual. The Health & Safety Manual is readily accessible to BC employees via the BC Pipeline. These health and safety procedures are incorporated herein by reference, and BC employees will adhere to the procedures specified in the manual.

BC's HASP has been prepared specifically for this project and is intended to address health and safety issues solely with respect to the activities of BC's own employees at the site. A copy of BC's HASP may be provided to subcontractors in an effort to help them identify expected conditions at the site and general site hazards. The subcontractor shall remain responsible for identifying and evaluating hazards at the site as they pertain to their activities and for taking appropriate precautions. For example, BC's HASP does not address specific hazards associated with tasks and equipment that are particular to the subcontractor's scope of work and site activities (e.g., operation of a drill rig, excavator, crane or other equipment). Subcontractors are not to rely on BC's HASP to identify all hazards that may be present at the Site.

Subcontractors are responsible for developing, maintaining, and implementing their own health and safety programs, policies, procedures and equipment as necessary to protect their workers, and others, from their activities. Subcontractors shall operate equipment in accordance with their standard operating procedures as well as manufacturer's specifications. Any project monitoring activities conducted by BC at the Site shall not in any way relieve subcontractors of their critical obligation to monitor their operations and employees for the determination of exposure to hazards that may be present at the Site and to provide required guidance and protection. If requested, subcontractors will provide BC with a copy of their own HASP for this project or other health and safety program documents for review.

1.1 Site History

The areas within the Parcel 4 and 5 boundaries lie within the original tideflat of Budd Inlet, and are situated on fill material. Fill operations on the Site began as early as the late 1800s and continued until as late as the 1970s. Much of the fill on the site appears to be marine dredge spoils from dredging operations in the East and West Bays of Budd Inlet. In addition, fill has been found to contain wood debris, construction debris, and roadway fill.

Lumber milling operations were located on the Site as early as 1888 and operated until 1968. Various support facilities and services accompanied the lumber milling operations. Log booming operations also took place in the adjacent East Bay of Budd Inlet. Following cessation of lumber milling activities in 1968, the area was used for commercial and light industrial activities and warehousing. Warehousing and light industry ceased in 2008 as the Site was cleared of tenants and operators in preparation for redevelopment.

1.2 Site Description

The site is presently undeveloped.

1.3 Scope of Work

Work includes the excavation, stockpiling, testing, and disposal of potentially contaminated soil. Work will also include confirmational sampling of soil excavations.

2. KEY BC PROJECT PERSONNEL AND RESPONSIBILITES

PM NAME is the Project Manager (PM). Jim Bucha is the Regional Safety Unit Manager (RSUM). Joshua Johnson is has been designated as the BC Site Safety Officer (SSO) for this project. The BC project field staff have completed 40 hours of comprehensive health and safety training, which meets the requirements of 29 CFR 1910.120.

The responsibilities of key BC project personnel are presented below.

2.1 Project Manager

The PM is responsible for evaluating hazards anticipated at the Site and working with designated field staff and the RSUM to prepare this HASP to address the identified hazards. The PM is also responsible for the following.

- Informing project participants of safety and health hazards identified at the Site.
- Providing a copy of this HASP to BC project participants and a copy to each BC subcontractor prior to the start of field activities.
- Ensuring that the BC project team is adequately trained and perform safety briefings in accordance with this HASP.
- Providing the resources necessary for maintaining a safe and healthy work environment for BC personnel.
- Communicating project safety concerns to the RSUM for determining corrective actions.

2.2 Site Safety Officer

The SSO has on-Site responsibility for verifying that BC team members, including subcontractors, comply with the provisions of this HASP. The SSO has the authority to monitor and correct health and safety issues as noted on-Site. The SSO is responsible for the following.

- Reporting unforeseen or unsafe conditions or work practices at the Site to the PM or RSUM.
- Stopping operations that threaten the health and safety of BC field team or members of the surrounding community.
- Monitoring the safety performance of Site personnel to evaluate the effectiveness of health and safety procedures.
- Performing air monitoring, as necessary, as prescribed in this HASP.
- Documenting field team compliance with this HASP by completing the appropriate BC forms contained in the Appendices of this document.
- Conducting daily tailgate safety meetings and assuring that project personnel understand the requirements of this HASP (as documented by each BC field team member's signature on the Signature Page).

- Limiting access to BC work areas on the Site to BC field team members and authorized personnel.
- Enforcing the "buddy system" as appropriate for Site activities.
- Performing periodic inspections to evaluate safety practices at the Site.
- Identifying the location and route to nearby medical facility and emergency contact information and coordinating appropriate responses in the event of emergency.

2.3 Regional Safety Unit Manager

The RSUM is responsible for final review and modification of this HASP. Modifications to this HASP that result in less protective measures than those specified may not be employed by the PM or SSO without the approval of the RSUM. In addition, the RSUM has the following responsibilities.

- Developing and coordinating the overall BC health and safety program.
- Advising the PM and SSO on matters relating to health and safety on this project.
- Recommending appropriate safeguards and procedures.
- Modifying this HASP, if necessary, and approving changes in health and safety procedures at the Site.

2.4 BC Team Members

BC employees and subcontractors are responsible for familiarizing themselves with health and safety aspects of the project and for conducting their activities in a safe manner. This includes attending site briefings, communicating health and safety observations and concerns to the SSO, maintaining current medical and training status and maintaining and using proper tools, equipment and PPE. Proper work practices are part of ensuring a safe and healthful working environment. Safe work practices are essential and it is the responsibility of BC employees and team members to follow safe work practices when conducting scheduled activities. Safe work practices to be employed during the entire duration of fieldwork include, but are not limited to, the following.

- Following the provisions of this HASP, company health and safety procedures and regulatory requirements.
- Reviewing safety-related information from other parties (i.e., client or contractors) as it relates to BC's activities.
- Inspecting personal protective equipment (PPE) before on-site use, using only intact protective clothing and related gear, and changing suits, gloves, etc. if they are damaged or beyond their useful service life.
- Set up, assemble, and check out all equipment and tools for integrity and proper function before starting work activities.
- Assisting in and evaluating the effectiveness of Site procedures (including decontamination) for personnel, protective equipment, sampling equipment and containers, and heavy equipment and vehicles.
- Practice the "buddy system" as appropriate for site activities.

- Do not use faulty or suspect equipment.
- Do not use hands to wipe sweat away from face. Use a clean towel or paper towels.
- Practice contamination avoidance whenever possible.
- Do not smoke, eat, drink, or apply cosmetics while in chemically-affected areas of the site or before proper decontamination.
- Wash hands, face and arms before taking rest and lunch breaks and before leaving the site and the end of the workday.
- Check in and out with the SSO upon arrival and departure from the site.
- Perform decontamination procedures as specified in this HASP.
- Notify the SSO immediately if there is an incident that causes an injury, illness or property loss. Incidents that could have resulted in injury, illness or property loss (close call) will also be reported to the SSO.
- Do no approach or enter an area where a hazardous environment (i.e., oxygen deficiency, toxic or explosive) may exist without employing necessary engineering controls, proper PPE and appropriate support personnel.
- Use respirators correctly and as required for the Site; check the fit of the respirator with a negative or positive pressure test; do not wear respirator with facial hair or other conditions that prevent a face-to-facepiece seal.
- Confined spaces will not be entered without appropriate evaluation, equipment, training and support personnel.

2.5 Subcontractors

Subcontractor personnel are expected to comply fully with subcontractor's HASP and to observe the minimum safety guidelines applicable to their activities which may be identified in the BC HASP. Failure to do so may result in the removal of the subcontractor or any of the subcontractor’s workers from the job site.

3. HAZARD ANALYSIS

Hazards at the Site may include physical hazards, chemical hazards or biological hazards. Each type of identified hazard is addressed in the following sections. Hazards that are the specialty of a subcontractor (i.e., operation of a drill rig or excavator) are not addressed in this HASP. Subcontractors are responsible for identifying potential hazards associated with their activities and implementing proper controls.

3.1 Chemical Hazards

Exposure pathways of concern for chemical compounds that may be present at the Site are inhalation of airborne contaminants, direct skin contact with contaminated materials, and incidental ingestion of affected media. Wearing protective equipment and following decontamination procedures listed in Section 7 can minimize dermal contact and incidental ingestion. To minimize inhalation hazards, dust or vapor control measures will be implemented, where necessary, and action levels will be observed during scheduled activities. Site-specific action levels and air monitoring requirements are presented in Section 5.

Known or Suspected Compounds	Source (soil/water/sludge, etc.)	Known Concentration Range (ppm, mg/kg, mg/l)	
		Lowest	Highest
Arsenic	Soil / Groundwater	ND	84 mg/Kg (soil), 10.3 ug/L (groundwater)
Lead	Soil / Groundwater	ND	2.4 mg/Kg (soil), 9.3 ug/L (groundater)
Cadmium	Soil / Groundwater	ND	2500 mg/Kg (soil), 2 ug/L (groundwater)
Copper	Soil / Groundwater	ND	NA (soil), 8.4 ug/L (groundwater)
Nickel	Soil / Groundwater	ND	NA (soil), 5.6 ug/L (groundwater)
cPAHs	Soil / Groundwater	ND	624 ug/Kg (soil), 0.36 ug/L (groundwater)
Dioxins / Furans	Soil / Groundwater	ND	646 pg/g (soil), NA (groundwater)
PCBs	Soil / Groundwater	ND	3.29 mg/Kg (soil), 3.6 ug/L (groundwater)
TPH-G	Soil / Groundwater	ND	100 mg/Kg (soil), 500 ug/L (groundwater)
TPH-HO	Soil / Groundwater	ND	4600 mg/Kg (soil), 500 ug/L (groundwater)
TPH-D	Soil / Groundwater	ND	1160 mg/Kg (soil), 250 ug/L (groundwater)
Benzene	Soil / Groundwater	ND	140 ug/Kg (soil), 1 ug/L (groundwater)
Toluene	Soil / Groundwater	ND	720 ug/Kg (soil), 1 ug/L (groundwater)
Ethylbenzene	Soil / Groundwater	ND	720 ug/Kg (soil), 1 ug/L (groundwater)
Xylenes	Soil / Groundwater	ND	1440 ug/Kg (soil), 3 ug/L (groundwater)
Naphthalenes	Soil / Groundwater	ND	1600 ug/Kg (soil), 1.1 ug/L (groundwater)

Chemical descriptions of chemicals of concern, including health effects and exposure limits, are presented in the following paragraphs. Each chemical description includes physical and odor recognition characteristics, the health effects associated with exposure, and exposure limits expressed as an 8-hour time-weighted average (TWA). Provided are federal OSHA (OSHA) permissible exposure limits (PELs; located in 29 CFR 1910.1000); California OSHA (Cal/OSHA) PELs (located in 8 CCR 5155); and the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs). For sites outside California, Cal/OSHA PELs are included as an additional reference.

ARSENIC

Metallic arsenic is most commonly a gray, brittle, crystalline solid. It can also be in a black or yellow amorphous form. Arsenic is also commonly found in its volatile white trioxide form. Arsenic is used in several insecticides, herbicides, defoliants, desiccants, and rodenticides and appears in a variety of forms. It is also used in tanning, pigment production, glass manufacturing, wood preservation, and anti-fouling coatings. Arsenic is classified as a known carcinogen.

Short-term exposure to arsenic can cause marked irritation of the stomach and intestines with nausea, vomiting, and diarrhea. In severe cases the vomiting and stools are bloody and the exposed individual goes into collapse and shock with weak, rapid pulse, cold sweats, coma, and death. Inorganic arsenicals are more toxic than organic arsenicals, and the trivalent form is more toxic than the pentavalent form. Acute arsenic poisoning usually results from ingestion exposures. Blood cell changes, blood vessel damage, and impaired nerve function can also result from chronic arsenic ingestion. Other effects include skin changes, irritation of the throat, increased risk of cancer of the liver, bladder, kidney, and lung.

- The OSHA PEL is listed as 0.01 mg/m3 for inorganic forms of arsenic and 0.5 mg/m3 for organic forms.
- The Cal/OSHA PEL is listed as 0.01 mg/m3 for inorganic forms of arsenic and 0.2 mg/m3 for organic forms.
- The TLV is listed as 0.01 mg/m3 for arsenic and inorganic arsenic compounds.

WARNING: This chemical is known to the State of California to cause cancer.

WARNING: This chemical is known to the State of California to cause birth defects or other reproductive harm.

LEAD

Lead (inorganic) is a bluish-white, silver or gray odorless solid. Short-term exposure to lead can cause decreased appetite, insomnia, headache, muscle and joint pain, colic, and constipation. Considerable data exist on the effects of lead exposure in humans. It is a poison by ingestion and a suspected human carcinogen of the lungs and kidneys. There are data to suggest that lead is a mutagen and can cause reproductive effects. Human systemic effects by ingestion and inhalation (the two routes of absorption) include loss of appetite, anemia, malaise, insomnia, headache, irritability, muscle and joint pains, tremors, flaccid paralysis without anesthesia, hallucinations and distorted perceptions, muscle weakness, gastritis, and liver changes. Recent experimental evidence suggests that blood levels of lead below 10 μg/dl (micrograms per deciliter) can have the effect of diminishing the IQ scores of children.

- The OSHA PEL is listed as 0.05 mg/m3 and the OSHA PEL for tetraethyl lead and tetramethyl lead is listed as 0.075 mg/m3.
- The Cal/OSHA PEL for elemental lead is listed as 0.05 mg/m3 and the Cal/OSHA PEL for tetraethyl lead and tetramethyl lead is listed as 0.075 mg/m3.
- The TLV for elemental lead is listed as 0.05 mg/m3, the TLV for tetraethyl lead is 0.1 mg/m3 and the TLV for tetramethyl lead is 0.15 mg/m3.

Note: Published exposure limits designate a skin notation indicating that dermal contact (to organic forms) can contribute to the overall exposure.

WARNING: This chemical is known to the State of California to cause cancer.

WARNING: This chemical is known to the State of California to cause birth defects or other reproductive harm.

CADMIUM

Cadmium dust is an odorless gray powder. Short-term exposure to cadmium dust can cause irritation of the nose and throat, cough, chest pain, sweating, chills, shortness of breath, and weakness. Inhalation of cadmium compounds has been shown to cause lung cancer in humans. Fatal concentrations may be breathed without sufficient discomfort to warn a worker to leave the area. Ingestion of cadmium dust may cause nausea, vomiting, diarrhea, and abdominal cramps.

- The OSHA PEL is listed as 0.005 mg/m3.
- The Cal/OSHA PEL is listed as 0.005 mg/m3.
- The TLV is listed as 0.01 mg/m3 for dust (total) and 0.002 mg/m3 for the respirable dust fraction.

WARNING: This chemical is known to the State of California to cause cancer.

WARNING: This chemical is known to the State of California to cause birth defects or other reproductive harm.

COPPER

In its elemental form, copper is a common metal with a distinct reddish color. Human systemic effects by ingestion include nausea and vomiting. In animals, inhalation of copper dust has caused hemolysis of the red blood cells, deposition of hemofuscin in the liver and pancreas, and injury to the lung cells. Short-term exposure to copper dust can cause a feeling of illness similar to the common cold with sensations of chills and stuffiness of the head. Small copper particles may enter the eye and cause irritation, discoloration, and damage.

- The OSHA PEL is listed as 0.1 mg/m3 for copper as a fume, and 1.0 mg/m3 for dust.
- The Cal/OSHA PEL is listed as 0.1 mg/m3 for copper as a fume, and 1.0 mg/m3 for dust.
- The TLV is listed as 0.2 mg/m3 for copper as a fume, and 1.0 mg/m3 for dust (a value of 0.1 mg/m3 for elemental metal/and copper oxides, and 0.05 mg/m3 for soluble compounds is proposed).

NICKEL

Nickel is a silvery gray, metallic, odorless metal. It is a confirmed carcinogen with experimental carcinogenic, neoplastigenic, tumorigenic, and teratogenic data. Nickel is a poison by ingestion, subcutaneous, and intravenous routes. Hypersensitivity to nickel is common and can cause allergic contact dermatitis, pulmonary asthma, and conjunctivitis. Exposure to nickel can cause pneumonitis. Nickel and its compounds have also been reported to cause cancer of the lungs and sinuses. Nickel itself is not very toxic if swallowed.

- The OSHA PEL is listed as 1.0 mg/m3 for elemental, insoluble and soluble compounds, as Ni.
- The Cal/OSHA PEL is listed as 1.0 mg/m3 for metal and insoluble compounds (as Ni), and 0.1 mg/m3 for soluble compounds.
- The TLV is listed as 1.5 mg/m3 for elemental compounds, 0.2 mg/m3 for insoluble compounds, and 0.1 mg/m3 for soluble inorganiccompounds and nickel subsulfide, as Ni.

WARNING: This chemical is known to the State of California to cause cancer.

POLYNUCLEAR AROMATIC HYDROCARBONS (PAHS)

PAHs constitute a class of materials of which benzo[a]pyrene (BaP) is one of the most common and also the most hazardous. In general, PAHs can be formed in any hydrocarbon combustion process. The less efficient the combustion process, the higher the PAH emission factor is likely to be. The major sources are stationary sources, such as heat and power generation, refuse burning, industrial activity, such as coke ovens, and coal refuse heaps. PAHs may also be released from oil spills. Because of the large number of sources, people are exposed to very low levels of PAHs every day.

Certain PAHs, such as the more common BaP, have been demonstrated to be carcinogenic at relatively high exposure levels in laboratory animals. BaP is a yellowish crystalline solid that consists of five benzene rings joined together. It is highly soluble in fat tissue and has been shown to produce tumors in the stomachs of laboratory mice. In addition, skin cancers have been induced in a variety of animals at very low levels and unspecified lengths of application.

It is important to recognize the PAHs' ability to adhere to soil and other particulates. Therefore, good particulate emission controls and the use of air purifying respirators with particulate filters are required for protection against airborne PAH hazards.

- The OSHA PEL is listed as 0.2 mg/m3 (as coal tar pitch volatiles).
- The Cal/OSHA PEL is listed as 0.2 mg/m3 (as coal tar pitch volatiles).
- The TLV is listed as 0.2 mg/m3 (coal tar pitch volatiles, as benzene soluble aerosol).

POLYCHLORINATED BIPHENYLS (PCBs)

PCBs are a series of technical mixtures consisting of many isomers and compounds that vary from mobile oil liquids to white crystalline solids and hard non-crystalline resins. Technical products vary in composition, in the degree of chlorination, and possibly according to batch. Generally, they are moderately toxic by ingestion, and some are poisons by other routes. Most are suspect human carcinogens and experimental tumorigens, and exhibit experimental reproductive effects. They have two distinct actions on the body: a skin effect (chloracne) and a toxic action on the liver. The higher the chlorine content, the more toxic the PCBs tend to be.

- The OSHA PEL is listed as 0.5 mg/m3 for 54% chlorine content (as a PCB) and 1.0 mg/m3 for 42% chlorine content (as a PCB).
- The Cal/OSHA PEL is listed as 0.5 mg/m3 for 54% chlorine content (as a PCB) and 1.0 mg/m3 for 42% chlorine content (as a PCB).
- The TLV is listed as 0.5 mg/m3 for 54% chlorine content (as a PCB) and 1.0 mg/m3 for 42% chlorine content (as a PCB).

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

WARNING: This chemical is known to the State of California to cause cancer.

WARNING: This chemical is known to the State of California to cause birth defects or other reproductive harm.

DIOXINS

"Dioxin" is a general term that describes a group of hundreds of chemicals that are highly persistent in the environment. The most toxic compound is 2,3,7,8-tetrachlorodibenzo-p-dioxin or TCDD. The toxicity of other dioxins and chemicals like PCBs that act like dioxins are measured in relation to TCDD. Dioxins are formed as unintentional by-products of many industrial processes involving chlorine such as waste incineration, chemical and pesticide manufacturing, and pulp and paper bleaching.

Dioxins are formed by burning chlorine-based chemical compounds with hydrocarbons. The major source of dioxins in the environment (95%) comes from incinerators burning chlorinated wastes. Dioxins are confirmed human carcinogens and can also cause severe reproductive and developmental problems (at levels 100 times lower than those associated with their cancer-causing effects). Dioxins can also cause immune system damage and interfere with regulatory hormones.

WARNING: These chemicals are known to the State of California to cause cancer.

GASOLINE

Gasoline is produced from the light distillates during petroleum fractionation. Its major components include paraffins, olefins, naphthenes, aromatics, and recently ethanol. Gasoline also contains various functional additives as required for different uses, such as antiknock fluids, antioxidants, metal deactivators, corrosion inhibitors, anti-icing agents, preignition preventers, upper-cylinder lubricants, dyes, and decolorizers. Lead additives in particular were widely used in gasoline until the introduction of vehicle catalytic converters.

Mild cases of gasoline ingestion can cause inebriation, vomiting, vertigo, drowsiness, confusion, and fever. Aspiration into the lungs and secondary pneumonia may occur unless prevented. Gasoline can cause hyperemia of the conjunctiva and other eye disturbances. Gasoline is a skin irritant and a possible allergen. Repeated or chronic dermal contact can result in drying of the skin, lesions, and other dermatologic conditions.

- No OSHA PEL is listed for gasoline.
- The Cal/OSHA PEL is listed as 300 ppm.
- The TLV is listed as 300 ppm.

WARNING: The exhaust from this chemical is known to the State of California to cause cancer.

DIESEL FUEL

Diesel fuel is a gas oil fraction available in various grades as required by different engines. Composition of diesel varies in ratios of predominantly aliphatic, olefinic, cycloparaffinic, aromatic hydrocarbons, and additives.

It is a severe skin irritant and ingestion of diesel can lead to systemic effects such as gastrointestinal irritation, vomiting, diarrhea, and, in severe cases, drowsiness and central nervous system depression, progressing to coma and death. Absorption of diesel fuel can cause hemorrhaging and pulmonary edema, progressing to pneumonitis and renal involvement. It is combustible when exposed to heat or flame, and can react with strong oxidizing materials.

- No OSHA PEL or Cal/OSHA PEL is listed for diesel.
- The TLV is listed as 100 mg/m3 as total hydrocarbons (vapor and aerosol).

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

WARNING: The exhaust from this chemical is known to the State of California to cause cancer.

MOTOR OIL

Motor oil is a dark viscous liquid. It is composed of aliphatic, olefinic, naphthenic (cycloparaffinic), and aromatic hydrocarbons, as well as additives depending on specific uses. Motor oil has a burning lubricating oil odor. Short-term exposure via dermal contact with motor oil can cause irritation to the skin and dermatitis. Inhalation of motor oil can cause aspiration. Target organs are the upper respiratory system and the skin.

- No OSHA PEL, Cal/OSHA PEL, or ACGIH TLV is listed for motor oil.

BENZENE

Benzene is a clear, volatile liquid. It is colorless, highly flammable, and toxic, with a characteristic odor. It is a severe eye and moderate skin irritant. Human effects by inhalation and ingestion include euphoria, changes in sleep and motor activity, nausea and vomiting, other blood effects, dermatitis, and fever. In industry, inhalation is the primary route of chronic benzene poisoning. If the liquid is aspirated into the lung it may cause pulmonary edema. Poisoning by skin contact has also been reported. Exposure to high concentrations (3,000 ppm) may result in acute poisoning, which is characterized by the narcotic action of benzene on the central nervous system. Chronic poisoning occurs most commonly through inhalation and dermal absorption. Benzene is a known human carcinogen that can cause leukemia.

- The OSHA PEL is listed as 1 ppm.
- The Cal/OSHA PEL is listed as 1 ppm.
- The TLV is listed as 0.5 ppm.

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

WARNING: This chemical is known to the State of California to cause cancer.

WARNING: This chemical is known to the State of California to cause birth defects or other reproductive harm.

TOLUENE

Toluene is a colorless liquid with a benzol-like odor. Human systemic effects of exposure to toluene include central nervous system changes, hallucinations or distorted perceptions, motor activity changes, psychophysiological changes, and bone marrow changes. It is a severe eye irritant and an experimental teratogen. Inhalation of high vapor concentrations may cause impairment of coordination and reaction time, headaches, nausea, eye irritation, loss of appetite, a bad taste in the mouth, and lassitude.

- The OSHA PEL is listed as 200 ppm.
- The Cal/OSHA PEL is listed as 50 ppm.
- The TLV is listed as 50 ppm (a value of 20 ppm is proposed).

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

WARNING: This chemical is known to the State of California to cause birth defects or other reproductive harm.

ETHYLBENZENE

Ethylbenzene is a clear, colorless liquid. It is mildly toxic by inhalation and skin contact. Inhalation can cause eye, sleep, and pulmonary changes. It is an eye and skin irritant at levels as low as 0.1% (1,000 ppm) of the vapor in air. At higher concentrations, it is extremely irritating at first, then can cause dizziness, irritation of the nose and throat, and a sense of constriction in the chest. Exposure to high concentrations of ethylbenzene vapor may result in irritation of the skin and mucous membranes, dizziness, irritation of the nose and throat, and a sense of constriction of the chest.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 100 ppm.
- The TLV is listed as 100 ppm.

XYLENE

Xylene is a clear, colorless liquid. It exhibits the general chlorinated hydrocarbon central nervous system effects, olfactory (smell) changes, eye irritation and pulmonary changes. It is a severe skin irritant. There are three isomers: ortho, meta, and para. Exposure to high concentrations of xylene vapor may result in eye and skin irritation. Eye irritation may occur at concentrations of about 200 ppm.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 100 ppm.
- The TLV is listed as 100 ppm.

NAPHTHALENE

Naphthalene is a colorless to brown solid with an odor of mothballs. Poisoning may occur by inhalation, ingestion, or skin absorption. Naphthalene can cause nausea, headache, fever, anemia, liver damage, vomiting, convulsions, and coma. It is an experimental teratogen and a questionable carcinogen.

Naphthalene is flammable when exposed to heat or flame and reacts with oxidizing materials. It is explosive in the form of vapor or dust when exposed to heat or flame. When heated to decomposition, it emits acrid smoke and irritating fumes.

- The OSHA PEL is listed as 10 ppm.
- The Cal/OSHA PEL is listed as 10 ppm.
- The TLV is listed as 10 ppm.

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

3.2 Hazard Communication

In accordance with the Hazard Communication standard, material safety data sheets (MSDSs) will be maintained on site for chemical products used by BC personnel at the Site (i.e., spray paint, PVC cement, etc.). Subcontractors will be responsible for maintaining MSDSs for chemical products they bring on Site. In addition, containers will be clearly labeled in English to indicate their contents and appropriate hazard warnings. Please note that labeling containers includes, but is not limited to, any waste, used PPE, and/or decontamination materials collected.

3.3 Physical Hazards

The following physical hazards, as marked below, have been identified and may be encountered during scheduled field activities.

☒ Slips, Trips and Falls
☒ Heavy Equipment
☒ Excavations
☒ Noise
☐ Overhead Utilities
☐ Electrical Equipment

☒ Housekeeping
☐ Materials and Equipment Handling - Lifting
☐ Drilling
☒ Underground Utilities
☐ Equipment Refueling
☐ Lockout/Tagout

☐ Confined Spaces
☐ Sharp Objects/Cutting
☐ Elevated Platforms
☐ Traffic
☐ Arc Flash Protection
☐ Building Collapse
☐ Fire
☐ Cutting Acetate Sleeves
☐ Ladder Use
☒ Driving
☐ Boating Safety
☒ Personal Safety – Urban Setting

Actions to be taken to protect against the hazards identified are provided in the sections below.

3.3.1 Slip, Trips and Falls

Slipping hazards may exist due to uneven terrain, wet or slick surfaces, leaks or spills. Tripping hazards may be present from elevation changes, debris, poor housekeeping or tools and equipment. Some specific hazards may include: climbing/descending ladders, scaffolding, berms or curbing. Collectively, these types of injuries account for nearly 50 percent of all occupational injuries and accepted disabling claims. Prevention requires attention and alertness on the part of each worker, following and enforcing proper procedures, including good housekeeping practices, and wearing appropriate protective equipment.

3.3.2 Housekeeping

Personnel shall maintain a clean and orderly work environment. Make sure that all materials stored in tiers are stacked, racked, blocked, interlocked, or secured to prevent sliding, falling, collapse, or overturning. Keep aisles and passageways clear and in good repair to provide for free and safe movement of employees and material-handling equipment. Do not allow materials to accumulate to a degree that it creates a safety or fire hazard.

During construction activities, scrap and form lumber with protruding nails and other items shall be kept clear from work areas, passageways, and stairs. Combustible scrap and debris shall be removed at regular intervals. Safe means must be provided to facilitate removal of debris.

Containers must be provided for collecting and separating waste, used rags and other debris. Containers used for garbage and other oily flammable or hazardous waste such as caustics, acids, harmless dusts, etc., must be separated and equipped with covers. Garbage and other waste shall be disposed of at frequent and regular intervals.

3.3.3 Heavy Equipment

Equipment, including earth-moving equipment, drill rigs, or other heavy machinery, will be operated in compliance with the manufacturer's instructions, specifications, and limitations, as well as any applicable regulations. The operator is responsible for inspecting the equipment prior to use each work shift to verify that it is functioning properly and safely.

The following precautions should be observed whenever heavy equipment is in use.

- PPE, including steel-toed boots, safety glasses, high visibility vests, and hard hats must be worn.

- Personnel must be aware of the location and operation of heavy equipment and take precautions to avoid getting in the way of its operation. Workers must never assume that the equipment operator sees them; eye contact and hand signals should be used to inform the operator of the worker's intent.
- Personnel should not walk directly in back of, or to the side of, heavy equipment without the operator's knowledge. Workers should avoid entering the swing radius of equipment and be aware of potential pinch points.
- Nonessential personnel will be kept out of the work area.

3.3.4 Excavations

A competent person who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them, will be present during excavation activities.

The atmosphere will be tested in excavations, before employees are permitted to enter and begin work, greater than 4 feet in depth or where oxygen deficiency or toxic or flammable gases are likely to be present. The atmosphere shall be ventilated and re-tested until flammable gas concentrations less than 5 percent of the lower explosive limit (LEL) and site-specific action levels are obtained. Worker entry will not be allowed if the oxygen concentration is less than 20 percent. In addition, a safe means of access and egress (i.e., a ladder, stairs or ramp) must be provided so that no more than 25 feet of lateral travel is required by employees.

Workers will not enter unstable excavations or excavations greater than 5 feet in depth without appropriate protective systems such as benching, sloping, or shoring. If shoring or shielding systems are not used, side slopes will not be steeper than 1½:1 without written confirmation from the competent person that slope is safe for the soil conditions. Excavations will be constructed in accordance with the OSHA Excavation Safety Standard (29CFR1926 Subpart P).

The competent person will inspect excavations daily. If there is evidence that a cave-in or slide is possible, work will cease until the necessary safeguards have been taken. Excavated material will be placed far enough from the edge of the excavation (a minimum of 2 feet) so that it does not fall back into the opening or affect the integrity of the sidewall. At the end of each day's activities, open excavations will be clearly marked and secured to prevent nearby workers or unauthorized personnel from entering them. Remote sampling techniques will be the preferred method of sample collection in excavations.

3.3.5 Noise

Noise may result primarily from the operation of heavy equipment, process machinery or other mechanical equipment. Hearing protection with the appropriate noise reduction rating (NRR) shall be worn in areas with high noise levels. A good rule of thumb to determine if hearing protection is needed is the inability to have a conversation at arms length without raising voice levels. If loud noise is present or normal conversation becomes difficult, hearing protection in the form of ear plugs, or equivalent, will be required.

3.3.6 Underground Utilities

Reasonable efforts will be made to identify the location(s) of underground utilities (e.g., pipes, electrical conductors, fuel lines, and water and sewer lines) before intrusive soil work is performed. The state underground utility notification authority (e.g., USA, Dig Alert, Blue Stake, etc.) will be contacted prior to the start of intrusive field activities in accordance with local notification requirements. In areas not evaluated or serviced by the underground utility notification authority, and a reasonable potential for underground utilities exists, one or more of the following techniques will be employed to determine the location of subsurface structures.

- Contracting the services of a qualified private utility locator.
- Having a survey of the subject area conducted by staff trained in the use of subsurface utility locating equipment.
- Subsurface testing (i.e., hand digging or potholing) to the expected depth of probable utilities (not less than 5 feet).

If utilities cannot be located or if unlocated utilities are suspected to be present, subsurface activities (i.e., borings, excavation) should not be conducted before the location(s) or absence of underground utilities is confirmed.

Typical subsurface location marks are as follows:

- Red – electrical,
- Yellow – gas/oil/steam,
- Blue – water,
- Green – sanitary/storm drains/culverts,
- Orange – communications, and
- White – proposed excavation or boring.

Intrusive work should be limited to the area 3.3 feet (1 meter) on either side of the location marks. In some special cases such as fiber optics and high-pressure pipelines this area should be expanded to 16.5 feet (5 meters) on either side of the utility.

3.3.7 Driving

A lot of driving is required to get to, from, and between project Sites. Safe vehicle maintenance and operation must be a priority. It requires knowledge of directions to (and conditions of) the Site in advance, careful exiting and merging into traffic, anticipating the unexpected, remaining alert to one’s physical and mental condition, resisting distractions such as cell phone use, other car activities and contacting assistance when needed. Report all vehicle accidents/incidents to BC’s Risk Manager.

3.3.8 Personal Safety - Urban Setting

Working in a distressed neighborhood may present hazards associated with street violence or other crime. In these situations, mental preparation before going to the Site and awareness while on Site are of key importance. If in doubt, always ask Site or client personnel about the safety of a neighborhood. Forethought should be given to arranging to work during daylight hours if possible. Take advantage of any Site security measures (monitoring cameras, security guards) and investigate such measures prior to the field work. Once in the field, work in parties of two or more and stay within view of the general public. Keep a charged cell phone nearby or on your person at all times. Become familiar with your location so you can effectively communicate it over the phone.

In addition to these basic principals, the following is a list of common personal safety rules that apply not only to work at the Site, but to general safety practices while in the field and also between work shifts.

- If at all possible, work/travel in groups. Do not venture out alone.
- Be alert. Notice who passes you and who's behind you. Maintain distance between yourself and strangers. Know where you are, and note potential exit paths.
- If work has paused do not appear slack or distracted. Do not sit in a vehicle with the doors unlocked.
- Walk in well-lighted areas. Don't walk close to bushes, alleys, and so on. In dark or deserted neighborhoods, walk down the middle of the street (be alert to vehicle traffic).
- If a car pulls up slowly, or the occupants of the vehicle bother you, cross the street and walk or run in the other direction. If you are pursued, dial 911.
- If you feel someone is following you, turn around and check. Proceed to the nearest lighted house or place of business.
- Don't overburden yourself with bags or packages, which might impede running or taking care of yourself.
- Be aware of loose clothing, packs/purses and hair. These give an assailant an easier method of grabbing and controlling you. Wear unrestrictive clothing for ease of movement (but not overly loose).
- Carry a non-weapon personal safety device (such as a whistle, panic button, or key light) - anything that could visually or audibly draw attention to your location.
- What you carry in your hand(s) is important. Valuables make you a potential target. Items such as a hand auger or tool may help you be perceived as a less-than-inviting victim.
- Carry as little cash as possible.
- Hold your purse tightly, close to your body. Keep your wallet in a front or in a buttoned, hip pocket. When at a fixed location, lock your valuable items away and out of site (i.e., in a trunk).
- Be careful when people stop you for directions or information. Always reply from a distance; never get too close to a stranger' car.
- If you feel that you are in danger, don't be afraid to scream and run.
    - Toss wallet/keys away from direction of escape.
    - Don't attach car keys to house keys.
    - Leave large valuables (purse, laptop) locked and hidden in the vehicle.

3.4 Natural Phenomena

Natural phenomena such as weather-related emergencies and acts of nature can affect employees' safety. Natural phenomena can occur with little or no warning. If an emergency situation arises as a result of natural phenomena, adhere to the contingency procedures outlined in Section 10. The following natural phenomena have been identified and may be encountered during scheduled field activities.

☒ Sunburn
☒ Cold Stress
☐ Hurricanes
☒ Earthquakes
☒ Heat Stress
☐ Lightening/Electrical Storms
☐ Tornados and Strong/Straight Line Winds

3.4.1 Sunburn

Working outdoors with the skin unprotected for extended periods of time can cause sunburn to the skin. Excessive exposure to sunlight is associated with the development of skin cancer. Field staff should take precautions to prevent sunburn by using sunscreen lotion and/or wearing hats and long-sleeved garments.

3.4.2 Heat Stress

Adverse climate conditions, primarily heat, are important considerations in planning and conducting site operations. Heat-related illnesses range from heat fatigue to heat stroke, with heat stroke being the most serious condition. The effects of ambient temperature can cause physical discomfort, loss of efficiency, and personal injury, and can increase the probability of accidents. In particular, protective clothing that decreases the body's ventilation can be an important factor leading to heat-related illnesses.

To reduce the possibility of heat-related illness, workers should drink plenty of fluids and establish a work schedule that will provide sufficient rest periods for cooling down. Personnel shall maintain an adequate supply of non-caffeinated drinking fluids on site for personal hydration. Workers should be aware of signs and symptoms of heat-related illnesses, as well as first aid for these conditions. These are summarized in the table below.

Condition	Signs	Symptoms	Response
Heat Rash or Prickly Heat	Red rash on skin.	Intense itching and inflammation.	Increase fluid intake and observe affected worker.
Heat Cramps	Heavy sweating, lack of muscle coordination.	Muscle spasms, and pain in hands, feet, or abdomen.	Increase fluid uptake and rest periods. Closely observe affected worker for more serious symptoms.

Condition	Signs	Symptoms	Response
Heat Exhaustion	Heavy sweating; pale, cool, moist skin; lack of coordination; fainting.	Weakness, headache, dizziness, nausea.	Remove worker to a cool, shady area. Administer fluids and allow worker to rest until fully recovered. Increase rest periods and closely observe worker for additional signs of heat exhaustion. If symptoms of heat exhaustion recur, treat as above and release worker from the day's activities after he/she has fully recovered.
Heat Stroke	Red, hot, dry skin; disorientation; unconsciousness	Lack of or reduced perspiration; nausea; dizziness and confusion; strong, rapid pulse.	Immediately contact emergency medical services by dialing emergency medical services. Remove the victim to a cool, shady location and observe for signs of shock. Attempt to comfort and cool the victim by administering small amounts of cool water (if conscious), loosening clothing, and placing cool compresses at locations where major arteries occur close to the body's surface (neck, underarms, and groin areas). Carefully follow instructions given by emergency medical services until help arrives.

3.4.3 Cold Stress

Workers performing activities during winter and spring months may encounter extremely cold temperatures, as well as conditions of snow and ice, making activities in the field difficult. Adequate cold weather gear, especially head and foot wear, is required under these conditions. Workers should be aware of signs and symptoms of hypothermia and frostbite, as well as first aid for these conditions. These are summarized in the table below.

Condition	Signs	Symptoms	Response
Hypothermia	Confusion, slurred speech, slow movement.	Sleepiness, confusion, warm feeling.	Remove subject to a non-exposed, warm area, such as truck cab; give warm fluids; warm body core; remove outer and wet clothing and wrap torso in blankets with hot water bottle or other heat source. Get medical attention immediately.
Frostbite	Reddish area on skin, frozen skin.	Numbness or lack of feeling on exposed skin.	Place affected extremity in warm, not hot, water, or wrap in warm towels. Get medical attention.
Trench Foot	Swelling and/or blisters of the feet	Tingling/itching sensation; burning; pain in the feet	Remove wet/constrictive clothing and shoes. Gently dry and warm feet with slight elevation. Seek medical attention.

3.4.4 Earthquakes

Earthquakes strike suddenly, violently, and without warning. If your project is located near a fault line, earthquakes are an unpredictable possibility. For long term projects with temporary or permanent office area, keep an emergency preparedness kit consisting of, but not limited to:

- Current project/office contacts list - how to reach folks in an emergency,
- Blankets,
- Flashlights,
- Radio (operated by batteries),
- Batteries for flashlight and radio (note: batteries should be replaced as needed to assure freshness),

- Water (unless there is a water bubbler that can be used with no electricity), and
- Snack crackers, dried fruit, etc. - a source of food that won't go bad.

This kit is meant to serve as overnight survival in the event that it becomes unsafe to leave the project site. The kit's contents should be suited to meet the size and needs of your project.

If you feel the earth shaking, consider the following tips:

- Drop down; take cover under a desk or table and hold on.
- Stay indoors until the shaking stops and you are sure it is safe to exit.
- Stay away from bookcases, shelves, or anything that could fall on you.
- Stay away from windows.
- If inside a building, expect fire alarms and sprinklers to go off during the quake.
- If you are outdoors, find a clear spot away from buildings, trees, and power lines. Drop to the ground and cover your head.

If you are in a car, slow down and drive to a clear place, preferably away from power lines. Stay in the car until the shaking stops.

3.5 Biological Hazards

The following biological hazards have been identified and may be encountered during scheduled field activities.

☐ Bloodborne Pathogens/Sanitary Waste
☐ Rodents and Mammals
☐ Reptiles/Snakes
☐ Venomous Insects
☐ Mosquitoes
☐ Fire Ants
☐ Spiders/Scorpions
☐ Ticks
☐ Poisonous Plants

If any biological hazards are identified at the Site, workers in the area will immediately notify the SSO and nearby personnel.

4. PERSONAL PROTECTIVE EQUIPMENT

The purpose of PPE is to protect employees from hazards and potential hazards they are likely to encounter during site activities. The amount and type of PPE used will be based on the nature of the hazard encountered of anticipated. Respiratory protection will be utilized when an airborne hazard has been identified using real-time air monitoring devices, or as a precautionary measure in areas designated by the RSUM or SSO.

Dermal protection, primarily in the form of chemical-resistant gloves and coveralls, will be worn whenever contact with chemically affected materials (e.g., soil, groundwater, sludge) is anticipated, without regard to the level of respiratory protection required.

On the basis of the hazards identified for this project, the following levels of personal protective equipment (PPE) will be required and used. Changes to the specified levels of PPE will not be made without the approval of the SSO after consultation with the RSUM.

4.1 Conditions Requiring Level D Protection

In general, site activities will commence in Level D PPE unless otherwise specified, or if the SSO determines on site that a higher level of PPE is required. Air monitoring of employee breathing zones will be routinely conducted using real-time air monitoring devices to determine if upgrading to Level C PPE is necessary. Level D PPE will be permitted as long as air monitoring data indicate that airborne concentrations of chemicals of concern are maintained below the site-specific action levels defined in Section 5.2. Level A or B PPE is not anticipated and is therefore not addressed in this plan. If Level A or B PPE is necessary, this HASP will be revised to reflect changes as appropriate.

It is important to note that dermal protection is required whenever contact with chemically-affected materials is anticipated. The following equipment is specified as the minimum PPE required to conduct activities at the Site:

- Work shirt and long pants,
- ANSI- or ASTM-approved steel-toed boots or safety shoes,
- ANSI-approved safety glasses, and
- ANSI-approved hard hat.

Other personal protection readily available for use, if necessary, includes the following items.

- Outer nitrile gloves (11 mil or thicker) and inner nitrile surgical gloves when direct contact with chemically affected soils or groundwater is anticipated (nitrile surgical gloves may be used for collecting or classifying samples as long as they are removed and disposed of immediately after each sampling event).
- Chemical-resistant clothing (e.g., Tyvek or polycoated Tyvek coveralls) when contact with chemically affected soils or groundwater is anticipated.

- Safety shoes/boots with protective overboots or knee-high PVC polyblend boots when direct contact with chemically affected soils is anticipated.
- Hearing protection.
- Sturdy work gloves.
- High-visibility traffic safety vest.

Work will cease and PPE upgraded if action levels specified in Section 5.2 are exceeded. The RSUM will be notified whenever PPE is upgraded or downgraded.

4.2 Conditions Requiring Level C Protection

If air monitoring indicates that the site-specific action levels defined in Section 5.2 are exceeded, workers in the affected area(s) will upgrade PPE to Level C. In addition to the protective equipment specified for Level D, Level C also includes the following items.

- NIOSH-approved half- or full-face air-purifying respirator (APR) equipped with appropriate cartridges (reference Section 5.2). Note: safety glasses are not required when wearing a full-face APR.
- Outer nitrile gloves (11 mil or thicker) and inner nitrile surgical gloves when direct contact with chemically affected soils or groundwater is anticipated (nitrile surgical gloves may be used for collecting or classifying samples as long as they are removed and disposed of immediately after each sampling event).
- Chemical-resistant clothing (e.g., Tyvek or polycoated Tyvek coveralls) when contact with chemically affected soils or groundwater is anticipated.
- Safety shoes/boots with protective overboots or knee-high PVC polyblend boots when direct contact with chemically affected soils is anticipated.
- Hearing protection.
- Sturdy work gloves.

Respirators will be stored in clean containers (i.e., self-sealing bag) when not in use. Respirator cartridges will be replaced in accordance with the following change-out schedule.

Type of Cartridge	Cartridge Change-out Schedule
Particulate (i.e., HEPA)	At least weekly or sooner the employee detects an increase in breathing resistance. This will occur as the filter becomes loaded with particulate matter.
Sorbent (i.e., organic vapor)	At the end of each day's use or sooner if the employee detects an abnormal odor or other indicator.

Personnel who wear air-purifying respirators must be trained in their use and must have successfully passed either a qualitative or quantitative respirator fit test, and medical evaluation within the last 12 months in accordance with and 29 CFR 1910.134.

4.3 Stop Work Conditions

If air monitoring indicates that the site-specific action levels defined in Section 5.2 are exceeded, activities will cease, and personnel must evacuate the designated Exclusion Zone. The PM and RSUM will be contacted immediately.

Work will also cease if unanticipated conditions or materials are encountered or if an imminent danger is identified. The SSO will immediately contact the RSUM for consultation.

5. AIR MONITORING PLAN

Real-time air monitoring devices will be used to analyze airborne contaminant concentrations approximately every 15 minutes in the workers' breathing zones while workers are in the designated Exclusion Zone, or when task or exposure conditions change (whichever frequency is less). If elevated concentrations are indicated, the monitoring frequency will be increased, as appropriate.

Background concentrations will be determined at the beginning of each work shift by collecting several instrument readings upwind of the scheduled activities. Alternatively, background levels can be determined by collecting readings from a nearby (upwind) area that can reasonably be considered unaffected by Site activities.

Real-time measurements will be made as near as feasible to the breathing zone of the worker with the greatest exposure potential in each active work area. If authorized by the RSUM, real time measurements may cease being taken when enough historical data is generated to warrant its cessation. Air monitoring will be reinstated if potential exposure conditions change.

The equipment will be calibrated daily, and the results will be recorded on BC's Air Monitoring Form. The results of air monitoring will also be recorded on the Air Monitoring Form and will be retained in the project files following completion of field activities. A copy of the Air Monitoring Form is located in Appendix A.

5.1 Monitoring Instruments

On-site worker exposure to airborne contaminants will be monitored during intrusive site activities. A calibrated photoionization detector (PID) with a lamp strength of 10.6 eV or flame ionization detector (FID) will be used to monitor changes in personnel exposure to volatile organic compounds (VOCs). The SSO, or designee, will perform routine monitoring during site operations to evaluate concentrations of VOCs in employee breathing zones. If VOCs are detected above predetermined action levels specified in Section 5.2, the procedures found in Section 4 of this HASP will be followed.

5.2 Site Specific Action Levels

The following action levels were developed for exposure monitoring with real-time air monitoring instruments. Air monitoring data will determine the required respiratory protection levels at the Site during scheduled intrusive activities. The action levels are based on sustained readings indicated by the instrument(s). Air monitoring will be performed and recorded at up to 15-minute intervals.

If elevated concentrations are indicated, the monitoring frequency will be increased, as appropriate. If during this time, sustained measurements are observed, the following actions will be instituted, and the PM and RSUM will be notified. For purposes of this HASP, sustained readings are defined as the average airborne concentration maintained for a period of one (1) minute above established background levels.

Activity	Action Level	Level of Respiratory Protection
Soil Remediation	< 5 ppm above background	Level D: No respiratory protection required.
Soil Remediation	5 to 25 ppm	Level C: Half- or full-face air-purifying respirator fitted with organic vapor filter cartridges.
Soil Remediation	> 25 ppm	Cease operations and evacuate work area. Contact RSUM and PM immediately.

6. SITE CONTROL MEASURES

The SSO will conduct a safety inspection of the work site before each day's activities begin to verify compliance with the requirements of the HASP. Results of the first day's inspection will be documented on the Site Safety Checklist. A copy of the checklist is included in Appendix B. Thereafter, the SSO should document unsafe conditions or acts, along with corrective action, in the project field log book.

Procedures must be followed to maintain site control so that persons who may be unaware of site conditions are not exposed to hazards. The work area will be barricaded by tape, warning signs, or other appropriate means. Site equipment or machinery will be secured and stored safely.

Access to the specified work area will be limited to authorized personnel. Only BC employees and designated BC subcontracted personnel, as well as designated employees of the client, will be admitted to the work site. Personnel entering the work area are required to sign the signature page of this HASP, indicating they have read and accepted the health and safety practices outlined in this plan.

In some instances it may be necessary to define established work zones: an Exclusion Zone, a Contamination Reduction Zone, and a Support Zone. Work zones may be established based on the extent of anticipated contamination, projected work activities, and the presence or absence of non-project personnel. The physical dimensions and applicability of work zones will be determined for each area based on the nature of job activity and hazards present. Within these zones, prescribed operations will commence using appropriate PPE. Movement between zones will be controlled at checkpoints.

Considerable judgment is needed to maintain a safe working area for each zone, balanced against practical work considerations. Physical and topographical barriers may constrain ideal locations. Field measurements combined with climatic conditions may, in part, determine the control zone distances. Even when work is performed in an area that does not require the use of chemical-resistant clothing, work zone procedures may still be necessary to limit the movement of personnel and retain adequate site control.

Personnel entering the designated Exclusion Zone should exit at the same location. There must be an alternate exit established for emergency situations. In all instances, worker safety will take precedence over decontamination procedures. If decontamination of personnel is necessary, exiting the Site will include the decontamination procedures described in the following section.

7. DECONTAMINATION PROCEDURES

Decontamination will take place in the decontamination area identified on-Site. Workers, PPE, sampling equipment, and heavy equipment leaving the exclusion area will be inspected to determine the level of decontamination necessary to prevent the spread of potentially hazardous materials. Unnecessary equipment and support vehicles are to be left outside the designated Exclusion Zone so that decontamination will not be necessary.

Despite protective procedures, personnel may come in contact with potentially hazardous compounds while performing work tasks. If so, decontamination needs to take place using an Alconox or TSP wash, followed by a rinse with clean water. Standard decontamination procedures for levels C and D are as follows.

- equipment drop,
- boot cover and outer glove wash and rinse,
- boot cover and outer glove removal,
- suit removal,
- safety boot wash and rinse,
- inner glove wash and rinse,
- respirator removal,
- inner glove removal, and
- field wash of hands and face.

Site workers should employ only applicable steps in accordance with level of PPE worn and extent of contamination present. The SSO shall maintain adequate quantities of clean water to be used for personal decontamination (i.e., field wash of hands and face) whenever a suitable washing facility is not located in the immediate vicinity of the work area.

Disposable items will be disposed of in an appropriate container. Wash and rinse water generated from decontamination activities will be handled and disposed of properly. Non-disposable items (i.e., respirators) may need to be cleaned or sanitized before reuse. Each site worker is responsible for the maintenance, decontamination, and sanitizing of their own PPE.

Used equipment may be decontaminated as follows.

- Remove adhered materials (i.e., dirt or mud) to increase the effectiveness of the decontamination process.
- An Alconox or TSP and water solution may be used to wash the equipment.
- The equipment will then be rinsed with clean water until it is determined clean.

Each person must follow these procedures to reduce the potential for transferring chemically affected materials off site.

8. TRAINING REQUIREMENTS

BC Site personnel, including subcontractors and visitors conducting work in controlled areas of the Site, must have completed the appropriate training as required by 29 CFR 1910.120. In addition, the SSO will have completed the 8-hour Site Supervisor course, have current training in first aid and CPR, and any additional training appropriate to the level of site hazards. Further site-specific training will be conducted by the SSO prior to the initiation of project activities. This training will include, but will not necessarily be limited to, emergency procedures, site control, personnel responsibilities, and the provisions of this HASP. Each employee will document that they have been briefed on the hazards identified at the site and that they have read and understand the requirements of this HASP by signing the H&S Plan Acknowledgement Form attached as Appendix C.

A daily morning briefing to cover safety procedures and contingency plans in the event of an emergency is to be included with a discussion of the day’s activities. These daily meetings will be recorded on the Daily Tailgate Safety Meeting Form. A copy of the Daily Tailgate Safety Meeting Form is included in Appendix D.

9. MEDICAL SURVEILLANCE REQUIREMENTS

BC Site personnel, including subcontractors and site visitors, who will or may work in an area designated as an exclusion zone must have fulfilled the appropriate medical monitoring requirements in accordance with 29 CFR 1910.120(f). Each individual entering an exclusion zone must have successfully completed an annual surveillance examination and/or an initial baseline examination within the last 12 months.

Medical surveillance is conducted as a routine program for BC field staff in accordance with the requirements of 29 CFR 1910.120(f). There will not be any special medical tests or examinations required for staff involved in this project.

A Hepatitis B vaccination will be offered to BC personnel before the person participates in a task where direct exposure to potentially infectious materials is a possibility (i.e., first aid or CPR). For personnel who have potential exposure to sanitary wastes, a current tetanus/diphtheria inoculation or booster is recommended.

10. CONTINGENCY PROCEDURES

Minimum emergency equipment maintained on site will include a fully charged ABC dry chemical fire extinguisher, an adequately stocked first aid kit, and an emergency eyewash station (when corrosive chemicals are present). In addition, employees will consider maintaining the personal emergency supply items listed in Section 3: Natural Phenomena, as appropriate.

In the event of an emergency, site personnel will signal distress with three blasts of a horn (a vehicle horn will be sufficient), or other predetermined signal. Communication signals, such as hand signals, must be established where communication equipment is not feasible or in areas of loud noise.

It is the SSO's duty to evaluate the seriousness of the situation and to notify appropriate authorities. The first part of this plan contains emergency telephone numbers as well as directions to the hospital. Nearby telephone access must be identified and available to communicate with local authorities. If a nearby telephone is not available, a cellular telephone will be maintained on site during work activities. The operation of the cellular phone will be verified to ensure that a signal can be achieved at the work location.

The SSO, or designee, should contact local emergency services in the event of an emergency. After emergency services are notified, the PM and RSUM will be notified of the situation as soon as possible. If personal injury, property damage or equipment damage occurs, the PM and BC Risk Manager will be contacted as soon as practicable. An Accident/Incident Investigation Report will be completed within 24 hours by the SSO, or other designated person. A copy of the Accident/Incident Investigation Report is included in Appendix E.

MSHA Immediate Notification Rule:

At projects conducted at mining facilities, incident reporting requirements differ from OSHA standards. Site-specific MSHA reporting requirements must be addressed in conjunction with the RSUM and PM.

In order to comply with the MSHA Immediate Notification rule (50.10), Brown and Caldwell has developed the 'MSHA Immediately Reportable Accident/Injury Notification Procedure'. Note that incidents meeting the definition of "immediately reportable" must be reported to MSHA within 15 minutes of occurrence.

http://search.bc.com/health_safety/documents/BC_MSHANotificationProcedure.doc

This new procedure can be accessed by clicking the link above and includes a decision flowchart and accompanying instructions to help guide field personnel in the event of a reportable accident/injury at a mining site.

10.1 Injury or Illness

If an exposure or injury occurs, work will be temporarily halted until an assessment can be made to determine it is safe to continue work. The SSO, in consultation with the RSUM, will make the decision regarding the safety of continuing work. The SSO will conduct an investigation to determine the cause of the incident and steps to be taken to prevent recurrence.

In the event of an injury, the extent and nature of the victim's injuries will be assessed and first aid/CPR will be rendered as appropriate. If necessary, emergency services will be contacted or the individual may be transported to the nearby medical center. The mode of transportation and the eventual destination will be based on the nature and extent of the injury. A hospital route map is presented at the front of this HASP.

In the event of a life-threatening emergency, the injured person will be given immediate first aid and emergency medical services will be contacted by dialing the number listed in the Critical Project Information section at the beginning of this plan. The individual rendering first aid will follow directions given by emergency medical personnel via telephone.

10.2 Vehicle Collision or Property Damage

If a vehicle collision or property damage event occurs, the SSO, or designee, will contact the BC Risk Manager for appropriate action.

10.3 Fire

In the event of fire, the alarm will be sounded and Site personnel will evacuate to a safe location (preferably upwind). The SSO, or designee, should contact the local fire department immediately by dialing 911. When the fire department arrives, the SSO, or designated representative, will advise the commanding officer of the location and nature of the fire nature, and identification of hazardous materials on site. Only trained, experienced fire fighters should attempt to extinguish substantial fires at the Site. Site personnel should not attempt to fight fires, unless properly trained and equipped to do so. Site personnel should not attempt to fight a fire if it poses a risk to their personal safety.

Note that smoking is not permitted in controlled areas (i.e., exclusion or contamination reduction zones), near flammable or combustible materials, or in areas designated by the facility as non-smoking areas.

10.4 Underground Utilities

In the event that an underground conduit is damaged during subsurface work, mechanized equipment will immediately be shut off and personnel will evacuate the area until the nature of the piping can be determined. Depending on the nature of the broken conduit (e.g., natural gas, water, or electricity), the appropriate local utility will be contacted.

10.5 Site Evacuation

The SSO will designate evacuation routes and refuge areas to be used in the event of a Site emergency. Site personnel will stay upwind from vapors or smoke and upgradient from spills. If workers are in an Exclusion or Contamination Reduction Zone at the start of an emergency, they should exit through the established decontamination corridors, if possible. If evacuation cannot be done through an established decontamination area, site personnel will go to the nearest safe location and remove chemically-affected clothing there or, if possible, leave it near the Exclusion Zone. Personnel will assemble at the predetermined refuge following evacuation and decontamination. The SSO, or designated representative, will count and identify site personnel to verify that all have been evacuated safely.

10.6 Spill of Hazardous Materials

If a hazardous material spill occurs, site personnel should locate the source of the spill and determine the hazard to the health and safety of site workers and the public. Attempts to stop or reduce the flow should only be performed if it can be done without risk to personnel.

Isolate the spill area and do not allow entry by unauthorized personnel. De-energize sources of ignition within 100 feet of the spill, including vehicle engines. Should a spill be of the nature or extent that it cannot be safely contained, or poses an imminent threat to human health or the environment, an emergency cleanup contractor will be called out as soon as possible. Spill containment measures listed below are examples of responses to spills.

- Right or rotate containers to stop the flow of liquids. This step may be accomplished as soon as the spill or leak occurs, providing it is safe to do so.
- Sorbent pads, booms, or adjacent soil may be used to dike or berm materials, subject to flow, and to solidify liquids.
- Sorbent pads, soil, or booms, if used, must be placed in appropriate containers after use, pending disposal.
- Contaminated tools and equipment shall be collected for subsequent cleaning or disposal.

11. DOCUMENTATION

The implementation of the HASP must be documented on the appropriate forms (see appendices) to verify employee participation and protection. In addition, the regulatory requirements must be met for recordkeeping on training, medical surveillance, injuries and illnesses, exposure monitoring, health risk information, and respirator fit-tests. Documentation of each BC employee's health and safety records is maintained by the Health and Safety Data Manager in Walnut Creek, California.

Health and safety documentation and forms completed, as specified by this plan, are to be retained in the project file.

Other relevant project-specific health and safety documents, such as MSDSs or client-specified procedures, will be attached to this HASP in Appendix F.

APPENDIX A

Air Monitoring Form

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Air Monitoring Form

Page ____ of ____

Instructions: Complete this form immediately prior to project start.

Name of Project/Site:			Project No:
Project/Site Location:			
Employee Performing Air Monitoring: (Print and Sign):			Date:

Photo Ionization/Flame Ionization Detectors (PIDs/FIDs)

☐ PID ☐ FID	Manufacturer:	Model:	Serial #:
Initial Calibration Reading:		End-of-Use Calibration Reading:	
Calibration Standard/Concentration:			

Mini-RAM Dust Monitor

Manufacturer:	Model:	Serial #:
Zeroed in Z-Bag? ☐ Yes ☐ No		

Monitoring Data

Time	Location and Activity	PID/FID (ppm)	Mini-RAM (mg/m^3)	Time	Location and Activity	PID/FID (ppm)	Mini-RAM (mg/m^3)

Place a copy in the project file

APPENDIX B

Site Safety Checklist

BROWN AND CALDWELL

Site Safety Checklist

Page ____ of ____

Instructions: Complete this form immediately prior to project start.

Name of Project/Site:

Project No:

Project/Site Location:

Employee Completing Checklist:
(Print and Sign):

Date:

Yes No N/A
☐ ☐ ☐ Written Health and Safety (H&S) Plan is on site?
☐ ☐ ☐ Addenda to the H&S Plan are documented on site?
☐ ☐ ☐ H&S Plan information matches conditions/activities at the site?
☐ ☐ ☐ H&S Plan read/signed by all site personnel, including visitors?
☐ ☐ ☐ Daily tailgate H&S meetings have been held/documented?
☐ ☐ ☐ Site personnel have required training and medical?
☐ ☐ ☐ Air monitoring is performed/documented per the H&S Plan?
☐ ☐ ☐ Air monitoring equipment has been calibrated daily?
☐ ☐ ☐ Site zones are set up and observed where appropriate?
☐ ☐ ☐ Access to the work area limited to authorized personnel?
☐ ☐ ☐ Decontamination procedures followed/match the H&S Plan?
☐ ☐ ☐ Decontamination stations (incl. hand/face wash) are set up and used?
☐ ☐ ☐ PPE used matches H&S Plan requirements?
☐ ☐ ☐ Hearing protection used where appropriate?

Yes No N/A
☐ ☐ ☐ Respirators are available, properly cleaned, and stored?
☐ ☐ ☐ Overhead utilities do not present a hazard to equipt./personnel?
☐ ☐ ☐ Traffic control measures have been implemented?
☐ ☐ ☐ Trenches and excavations are safe for entry?
☐ ☐ ☐ Soil Spoils are at least 2 feet from the edge of the excavation?
☐ ☐ ☐ Emergency/FA equipt. is on site as described in the H&S Plan?
☐ ☐ ☐ Drinking water is readily available?
☐ ☐ ☐ Phone is readily available for emergency use?
☐ ☐ ☐ Utility locator has cleared subject locations?
☐ ☐ ☐ Proper drum and material handling techniques are used?
☐ ☐ ☐ Waste containers/drums are labeled appropriately?
☐ ☐ ☐ Ext. cords are grounded/protected from water/vehicle traffic?
☐ ☐ ☐ Tools and equipment are in good working order?
☐ ☐ ☐ GFCIs used for portable electrical tools and equipment?

Notes

(All “no” answers must be addressed and corrected immediately. Note additional health and safety observations here):

APPENDIX C

H&S Plan Acknowledgement Form

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H&S Plan Acknowledgement Form

Page ____ of ____

Instructions: Complete this form immediately prior to project start or as new personnel join the project.

Name of Project/Site:

Project No:

Project/Site Location:

Employee Performing Briefing:
(Print and Sign):

Date:

Employee Acknowledgement:

The following signatures indicate that these personnel have read and/or been briefed on this Health and Safety (H&S) Plan and understand the potential hazards/controls for the work to be performed.

Important Notice to Subcontractor(s):

Subcontractors are responsible for developing, maintaining, and implementing their own health and safety programs, policies, procedures and equipment as necessary to protect their workers, and others, from their activities. Subcontractors shall operate equipment in accordance with their standard operating procedures as well as manufacturer's specifications. Any project monitoring activities conducted by BC at the Site shall not in any way relieve subcontractors of their critical obligation to monitor their operations and employees for the determination of exposure to hazards that may be present at the Site and to provide required guidance and protection. If requested, subcontractors will provide BC with a copy of their own H&S Plan for this project or other health and safety program documents for review.

BC's Health and Safety Plan has been prepared specifically for this project and is intended to address health and safety issues solely with respect to the activities of BC's own employees at the site. A copy of BC's H&S Plan may be provided to subcontractors in an effort to help them identify expected conditions at the site and general site hazards. The subcontractor shall remain responsible for identifying and evaluating hazards at the site as they pertain to their activities and for taking appropriate precautions. For example, BC's H&S Plan does not address specific hazards associated with tasks and equipment that are particular to the subcontractor's scope of work and site activities. (e.g., operation of a drill rig, excavator, crane or other equipment). Subcontractors are not to rely on BC's H&S Plan to identify all hazards that may be present at the Site. Subcontractor personnel are expected to comply fully with subcontractor's Health and Safety Plan and to observe the minimum safety guidelines applicable to their activities which may be identified in the BC H&S Plan. Failure to do so may result in the removal of the subcontractor or any of the subcontractor's workers from the job site.

Print	Sign	Date	Print	Sign	Date

Distribution. Original – Project File

APPENDIX D

Daily Tailgate Meeting Form

BROWN AND CALDWELL

Daily Tailgate Meeting Form

Page ____ of ____

Name of Project/Site:	Project No:
Project/Site Location:	
Employee Completing Form: (Print and Sign):	Date:

Employee Acknowledgement:

The following signatures indicate that these personnel have read and/or been briefed on this Health and Safety (H&S) Plan and understand the potential hazards/controls for the work to be performed.

Important Notice to Subcontractor(s):

Subcontractors are responsible for developing, maintaining, and implementing their own health and safety programs, policies, procedures and equipment as necessary to protect their workers, and others, from their activities. Subcontractors shall operate equipment in accordance with their standard operating procedures as well as manufacturer's specifications. Any project monitoring activities conducted by BC at the Site shall not in any way relieve subcontractors of their critical obligation to monitor their operations and employees for the determination of exposure to hazards that may be present at the Site and to provide required guidance and protection. If requested, subcontractors will provide BC with a copy of their own H&S Plan for this project or other health and safety program documents for review.

BC's Health and Safety Plan has been prepared specifically for this project and is intended to address health and safety issues solely with respect to the activities of BC's own employees at the site. A copy of BC's H&S Plan may be provided to subcontractors in an effort to help them identify expected conditions at the site and general site hazards. The subcontractor shall remain responsible for identifying and evaluating hazards at the site as they pertain to their activities and for taking appropriate precautions. For example, BC's H&S Plan does not address specific hazards associated with tasks and equipment that are particular to the subcontractor's scope of work and site activities. (e.g., operation of a drill rig, excavator, crane or other equipment). Subcontractors are not to rely on BC's H&S Plan to identify all hazards that may be present at the Site. Subcontractor personnel are expected to comply fully with subcontractor's Health and Safety Plan and to observe the minimum safety guidelines applicable to their activities which may be identified in the BC H&S Plan. Failure to do so may result in the removal of the subcontractor or any of the subcontractor's workers from the job site.

Print	Sign	Date	Print	Sign	Date

Plan of the Day

(Describe the activities that are planned to be performed today)

Potential Hazards and Topics Discussed

(Describe the potential hazards and controls that may be associated with planned activities)

☐ Electrical ☐ Chemical ☐ Biological ☐ Physical ☐ Other (specify):

APPENDIX E

Incident Investigation Report

BROWN AND CALDWELL

Incident Investigation Report

Instructions:

If an accident or incident occurs, complete all applicable information in this form, make a copy for your records, and immediately forward the original to the office Health and Safety Coordinator (HSC). If fields are not applicable, indicate with “N/A”. Use separate sheet(s) if necessary and attach sketches, photographs, or other information that may be helpful in understanding how the accident/incident occurred.

HSC – Review and enter report into the BC Online Safety Observation and Incident Reporting System within 3 workdays of receipt. File original in appropriate office health and safety file.

NOTE:

This report is important – please take the time necessary to properly complete it. Incomplete reports will be forwarded to appropriate management for review and action.

General Information

Date of Accident/Incident	Time of Accident/Incident:	Date Accident/Incident Reported:	To Whom:
Exact Location of Accident/Incident (Street, City, State):			BC Office:
Name Project:			Project Number:
Employee Completing the Investigation (Print and Sign):			Date:

Injured/Ill Employee/Property Damage Information

Employee Name:	Employee No.	Department:	Phone Number:
Job Title:		Manager’s Name and Phone Number:	
Nature of Injury/Illness (laceration, contusion, strain, etc.):		Body Part Affected (arm, leg, head, hand, etc.):	
Describe Property Damage and Estimate Loss :			

Description of Accident/Incident

Describe the accident sequentially, beginning with the initiating event, and followed by secondary and tertiary events. End with the nature and extent of injury/damage. Name any object or substance and tell how they were included. Examples: 1) Employee was pulling utility cart that was loaded with wastepaper from office area to hallway. Wheel of utility cart caught against door casing. Bags of heavy wastepaper that were in cart fell to end of cart. Cart tipped over onto foot of employee. Right foot was crushed between utility cart and door casing, resulting in severe contusion to right foot of employee. 2) Employee was driving rental car from office to project site. Car struck icy section of road. Employee lost control of vehicle, which skidded across road into concrete abutment on side of road. Accident resulted in damage to right fender, tire, headlight, and grill.

BROWN AND CALDWELL

Incident Investigation Report

Analysis of Accident Causes

Immediate Causes - Substandard Actions

What substandard actions caused or could have caused the accident/incident? State the actions on the part of the employee or others that contributed to the occurrence of the accident/incident. Examples: 1) Employee overloaded the utility cart with wastepaper. 2) Employee exceeded safe speed on icy road, and was inattentive to hazard.

Codes (check all that apply)

☐ 1. Operating equipment without authority
☐ 2. Failure to warn
☐ 3. Failure to secure
☐ 4. Operating at improper speed
☐ 5. Making safety devices inoperable
☐ 6. Removing safety devices
☐ 7. Using defective equipment
☐ 8. Using equipment improperly
☐ 9. Failure to use PPE properly
☐ 10. Improper loading
☐ 11. Improper placement
☐ 12. Improper lifting
☐ 13. Improper position for task
☐ 14. Servicing equipment in operation
☐ 15. Horseplay
☐ 16. Alcohol or drug influence
☐ 17. Other (specify)

Immediate Causes - Substandard Conditions

What substandard conditions caused or could have caused the accident/incident? State the conditions that existed at the time of the accident (the specific control factors that were or may have been the direct or immediate cause or causes of the accident). Examples: 1) Wheel of utility cart was worn and would not roll properly; utility cart was overloaded with wastepaper. 2) Road was covered with icy spots; weather was foggy.

Codes (check all that apply)

☐ 1. Inadequate guards or barriers
☐ 2. Inadequate or improper PPE
☐ 3. Defective tools, equipment, or materials
☐ 4. Congestion or restricted action
☐ 5. Inadequate earning system
☐ 6. Fire and explosion hazards
☐ 7. Poor housekeeping
☐ 8. Noise exposures
☐ 9. Radiation exposures
☐ 10. High or low temperature exposures
☐ 11. Inadequate or excess illumination
☐ 12. Inadequate ventilation
☐ 13. Hazardous environ. conditions (vapors, dusts, etc.)
☐ 14. Other (specify)

Basic Causes - Personal and Job Factors

What personal and/or job factors caused or could have caused the accident/incident? State the influencing factors or underlying causes, either conditions or actions or both, that contributed to the accident/incident. Examples: 1) Employee had not been instructed in overloading hazards. 2) Employee had not been trained in driving under winter conditions; company has no driver training program.

Codes (check all that apply)

Personal Factors
☐ 1. Inadequate capability ☐ 2. Lack of knowledge ☐ 3. Lack of skill ☐ 4. Improper motivation
☐ 5. Other (specify):____

Job Factors
☐ 1. Inadequate leadership/supervision ☐ 2. Inadequate engineering ☐ 3. Inadequate purchasing ☐ 4. Inadequate maintenance ☐ 5. Inadequate tools/equipment
☐ 6. Inadequate work standards/procedures ☐ 7. Inadequate Wear and tear ☐ 8. Abuse or misuse
☐ 9. Other (specify):

Remedial Actions

Describe the actions taken or planned to prevent recurrence of accident/incident - provide the implementation date and person responsible for any planned corrective action.. Examples: 1) Wheels of utility cart were replaced with larger size wheels; all carts were inspected for safe operation; employees were instructed in overloading hazards. 2) All project personnel were instructed at the safety training meeting on driving under hazardous conditions; driver training program will be implemented.

Codes (check all that apply)

Job Factors
☐ 1. Reinstruction of personnel involved ☐ 2. Reprimand of personnel involved ☐ 3. Temporary/permanent reassignment of personnel ☐ 4. Action to improve clean-up
☐ 5. Equipment repair or replacement ☐ 6. Improve design ☐ 7. Improve construction ☐ 8. Improve PPE ☐ 9. Install of safety guard or device ☐ 10. Work method change
☐ 11. Order use of safer materials ☐ 12. Regional Safety Unit Manager Review
☐ 13. Other (specify):

APPENDIX F

Miscellaneous Health and Safety Information

APPENDIX J – QUALITY ASSURANCE PROJECT PLAN

PARCEL 4 AND 5 IA

QUALITY ASSURANCE
PROJECT PLAN

Prepared for
The City of Olympia and the LOTT Alliance
Olympia, WA
6/23/2010

THE CITY OF OLYMPIA / THE LOTT ALLIANCE
PARCEL 4 AND 5 INTERIM ACTION
QUALITY ASSURANCE PROJECT PLAN

Prepared for
The City of Olympia and the LOTT Alliance
Olympia, WA
6/23/2010

Brown and Caldwell
724 Columbia Street NW, Suite 420
Olympia, WA 98501

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LIST OF ACRONYMS

BC	Brown and Caldwell
˚C	degrees Celsius
CCL	contaminant candidate list
COPC	constituent of potential concern
CRM	certified reference materials
DI	Deionized water
DO	dissolved oxygen
DOC	dissolved organic carbon
DRL	detection limits for purposes of reporting (Title 22)
DQO	data quality objective
EC	electrical conductivity
Ecology	Washington State Department of Ecology
EDD	electronic database deliverable
EDMS	environmental database management system
EPA	United States Environmental Protection Agency
GC/MS	gas chromatography/mass spectrometry
HPLC	high performance liquid chromatography
ICP/MS	inductively coupled plasma mass spectrometry
IS	internal standard
LCM	laboratory control material
LCS	laboratory control spike
LCSD	laboratory control spike duplicate
MCL	maximum contaminant levels
MDL	method detection limit
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
mg/L	milligrams per liter
MP	Monitoring Plan
MPN	most probable number
MS	matrix spike
MSD	matrix spike duplicate
N	nitrogen
NIST	National Institute of Standards and Technology
P	phosphorus
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
SM	Standard Methods for the Examination of Water and Wastewaterr
SOP	standard operating procedure
SWAMP	Surface Water Ambient Monitoring Program
TOC	total organic cargon
TRL	target reporting limit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WQ	water quality

1. PROJECT MANAGEMENT

1.1 Monitoring Program Task Organization

Organization of the Project team for the Parcel 4 and 5 Interim Action and associated tasks are described in the following sections.

1.1.1 Involved Parties and Roles.

This Quality Assurance Project Plan (QAPP) has been prepared for the Parcel 4 and 5 Interim Action. Within this QAPP are descriptions of methods that will be used to assure and control the quality of monitoring data collected for Parcel 4 and 5 Interim Action. Specific details regarding the sampling and analyses for specific Sites are not included in the QAPP, but are discussed separately in the Site specific Sampling and Analysis Plan (SAP). Together, these two documents serve to completely describe the quality assurance / quality control (QA/QC) program that will be implemented as part of the Interim Action.

Table 1-1 Staff

Name	Affiliation	Title	Contact Information
Steve Teel	Washington State Department of Ecology	Site Manager	ph:(360) 407-6247 stee461@ecy.wa.gov
Rick Dougherty	City of Olympia	Project Manager	ph:(360) 753-8485 rdougher@ci.olympia.wa.us
Eric Hielema	LOTT Alliance	Project Manager	ph:(360) 528-5705 erichielema@lottonline.org
TBD	Brown and Caldwell	Project Manager	ph:(360) 943-7525
TBD	Brown and Caldwell	QA Officer	ph:(360) 943-7525
TBD	Brown and Caldwell	Data Management Coordinator	TBD
TBD	Contact Analytical Lab (TBD)	Laboratory Director	TBD
Kate Green	Brown and Caldwell	Sampling Support	ph:(360) 943-7525 kgreen@brwncald.com
John Turk	Brown and Caldwell	Technical Advisor	ph:(360) 943-7525 jturk@brwncald.com

Notes:
QA = Quality Assurance
BC = Brown and Caldwell

1.1.2 Quality Assurance Officer Role

The QA Officer is responsible for monitoring and verifying implementation of the quality assurance and quality control (QA/QC) procedures found in this QAPP and its referenced Standard Operating Procedures (SOPs). The QA Officer is independent of the personnel that will generate data for this project. Key personnel assigned to the project will have reviewed the QAPP and SAP, and will be instructed by the QA Officer regarding the requirements of the QA/QC program. The QA Officer will work with the Client Project Manager and Department of Ecology to ensure that QAPP objectives are being met and the team will continually assess the effectiveness of the QA/QC program and recommend modifications, as needed.

1.1.3 Persons Responsible for QAPP Update and Maintenance

If necessary, the QA Officer, with concurrence from the Client Project Manager, may revise and update the QAPP after presenting the evidence for such changes and obtaining the approval from Department of Ecology. Revisions that occur after the original QAPP is approved will be indicated on the QAPP title page and will be distributed to all parties listed in Table 1-1.

1.2 Problem Definition

Samples will be collected to confirm the extent of contaminated areas and to classify stockpiled soils as suitable for general reuse, suitable for reuse in capped areas, or to designate soil from disposal. Sample results for soils designated for disposal will be communicated to the disposal facility.

1.3 Regulatory Agencies and Applicable Regulatory Limits

The project is under the oversight of the Washington State Department of Ecology. Cleanup Levels and Remediation Levels for the project are established under the Model Toxics Cleanup Act (MTCA) and defined in the Interim Action Work Plan.

1.4 Project Description

The project was designed to remove contaminated soil from the site and to classify soils remaining on the site as suitable for general reuse or suitable for reuse in capped areas. A detailed description of the constituents to be monitored and the information used to develop the list of constituents is discussed in the Interim Action Work Plan and the SAP.

1.5 Project Schedule

The anticipated schedule for tasks associated with Parcel 4 and 5 Interim Action is shown in Table 1-2 below. Specific project schedules will be described in the SAPs.

Table 1-2. Program Timeline

Task	Anticipated Date of Initiation	Anticipated Date of Completion	Deliverable
Draft IA Work Plan, SAP, and QAPP		6/9/2010	Draft SAP and QAPP
Final IA Work Plan, SAP and QAPP	7/6/2010	8/6/2010	Final SAP and QAPP
Iterim IA Soil Sampling Report	TBD	TBD	Summary report, chain-of-custody forms, lab reports
Interim IA Soil Sampling Report	TBD	TBD	Summary report, chain-of-custody forms, lab reports
IA Report	TBD	TBD, within 60 days of completion of field work	Chapter in the report

1.6 Sampling Constraints

Sampling constraints typically encountered during sampling include safety of sampling personnel and cost considerations.

Sampling results must be complete before major earth-moving activities (stockpile disposal, excavation backfill, etc.). Timing constraints or missed events are therefore not anticipated.

1.7 Data Quality Objectives

DQOs have been selected for this project based on the expected data usage and are designed to ensure that accurate, precise, representative, and complete data are collected throughout the monitoring program. The DQOs are summarized in Table 1-3. Descriptions of how the DQOs will be assessed are provided in Section 1.7.

Table 1-3. Parcel 4 and 5 IA Quality Control Limits

Constituents	Proposed Methods	Reporting Limits	Accuracy Limits	Precision Limits (RPD)
Soil COPCs				
Arsenic	EPA 6020A	0.2 mg/Kg	± 30%	30%
Cadmium	EPA 6020A	0.2 mg/Kg	± 30%	30%
Lead	EPA 6020A	1 mg/Kg	± 30%	30%
Copper	EPA 6020A	0.2 mg/Kg	± 30%	30%
Nickel	EPA 6020A	0.5 mg/Kg	± 30%	30%
cPAHs	EPA 8270C / EPA 8270C-SIM	0.01 mg/Kg	± 30%	30%
Dioxins / Furans	EPA 1613 / EPA 8290	3 pg/g	± 30%	30%
TPH-D	NWTPH-Dx	25 mg/Kg	± 30%	30%
TPH-HO	NWTPH-Dx	25 mg/Kg	± 30%	30%
TPH-G	NWTPH-Gx	10 mg/Kg	± 30%	30%
Benzene	EPA 8260B	0.01 mg/Kg	± 30%	30%
Toluene	EPA 8260B	0.01 mg/Kg	± 30%	30%
Ethylbenzene	EPA 8260B	0.01 mg/Kg	± 30%	30%
Total Xylenes	EPA 8260B	0.03 mg/Kg	± 30%	30%
Total Naphthalenes	EPA 8270C / EPA 8270C-SIM	0.3 mg/Kg	± 30%	30%

1.7.1 Accuracy

Accuracy describes how close an analytical measurement is to its true value. Accuracy is typically measured by analyzing a sample of known concentration (prepared using analytical-grade standards) and comparing the analytical result with the known concentration. Accuracy objectives for all constituents are summarized in Table 1-3.

1.7.2 Precision

Precision describes how well repeated measurements agree. Precision is typically evaluated by comparing analytical results from duplicate (also called replicate) samples and calculating the relative percent difference (RPD), where RPD is defined as:

$$RPD = \left(\frac{\left| C_1 - C_2 \right|}{\left(\frac{C_1 + C_2}{2} \right)} \right) \times 100$$, where C_1 and C_2 are the analytical results for both duplicates

Precision will be measured using both field and laboratory duplicates in addition to duplicate laboratory control spikes.

1.7.3 Representativeness

The representativeness of the data is mainly dependent on the sampling locations (spatial), sampling frequency (temporal), sample collection procedures, and analytical constituents and methods. The sampling approach (described in detail within the individual Site SAPs) has been developed to ensure that all data collected during this project are representative to the extent possible.

1.7.4 Completeness

Completeness, which is expressed as a percentage, is calculated by subtracting the number of rejected and unreported results from the total planned results and dividing by the total number of planned results. Estimated results do not count against completeness because they are considered usable as long as any limitations are identified. Results rejected because of out-of-control analytical conditions, severe matrix effects, broken or spilled samples, or samples that could not be analyzed for any other reason are subtracted from the total planned number of results to calculate completeness. Though regulations currently do not require a specific percentage of data completeness, it is expected that the measurement techniques selected for use in this project are capable of generating data that is of 90 percent completeness for field and laboratory analyses.

1.7.5 Comparability

Comparability evaluates whether the reported data are comparable with similar data reported by other organizations. The use of approved analytical methods and certified laboratories will provide some level of comparability. Evaluation of performance evaluation samples is another measure of comparability. Certified laboratories are required to analyze performance evaluation samples on a regular basis to evaluate the comparability of their reported results.

1.8 Quality Control Limits

The quality control (QC) limits for precision and accuracy are provided in Table 1-3. These limits will be used to qualify data and alert the data users of any identified bias or uncertainty in results. Laboratories will follow method criteria and the laboratory's QA/QC manual and procedures for corrective action during sample analysis. Laboratories shall report detection limits based on current statistical detection limit studies and reporting limits based on the low standards in their calibration curves. Laboratory reporting limits should not exceed the maximum allowable reporting limits provided in Table 1-3. Proposed analytical methods shall be used unless written approval for alternative methods is given.

1.9 Training and Certification

Field personnel that participate in sampling will have reviewed the QAPP and SAP for the specific Site project, and will be instructed by the QA Officer. Training will occur prior to the beginning of the program and semi-annually thereafter through QC sessions, where QC procedures will be reviewed. Field personnel will have been trained prior to the first sampling event in sample collection procedures (including QA/QC, grab sampling techniques, completing laboratory chain-of-custody forms, and proper handling of water samples), and field analysis (including instrument calibration, data recording procedures, and interpretation of collected data).

All laboratories utilized to perform analytical services will be certified by NELAC. Laboratory personnel will be certified and trained as required by the laboratory's quality assurance manuals. The laboratory director of the primary analytical lab will be provided a copy of this QAPP.

Documentation of training for field staff will be maintained by Brown and Caldwell. Documentation will include a record of the training topic, training date, name and title of instructor, whether the class was an initial training or a refresher course, and whether the course was completed satisfactorily.

1.10 Documents and Records

1.10.1 Project Documents, Records, and Electronic Files

The documents and records that will be generated during this project include the following:

Quality Assurance Project Plan: The QAPP (this document) contains details on the QA and QC procedures that will be implemented throughout the project.

Sampling and Analysis Plans: The SAPs contain information regarding sampling locations, frequencies, and sample collection methods.

Field Records. The Brown and Caldwell Project Manager or other designee will maintain all field records, including field data sheets documenting results of field analyses and QC samples, a logbook documenting equipment maintenance and calibration, and sample collection and handling documentation (copies of chain-of-custody forms, shipping receipts, etc.).

Laboratory Records. Analytical labs will maintain sample receipt and storage documentation, instrument calibration logs, raw data and QC sample records.

Data validation records. Field data sheets, field QC results, chain-of-custody forms, and lab reports from each sampling event will be reviewed by the QA Officer and a data validation record will be generated which summarizes the quality of the collected data.

Project database: The Brown and Caldwell Olympia, WA office will be used to store all laboratory and field data gathered during this project. The database will be continually updated and managed as described in Section 2.9. At the completion of the project, data may be electronically submitted to the City of Olympia and the LOTT Alliance upon request.

1.10.2 Retention of Project Documentation

The original data sheets, equipment maintenance/calibration logs, chain-of-custody forms, lab reports, field records, training documents and data validation records will be stored by Brown and Caldwell until the end of the project. All records will be maintained by Brown and Caldwell and analytical labs for five years after project completion.

1.10.3 Distribution of QAPP Revisions

Revisions that occur after the original QAPP is approved will be indicated on the QAPP title page and will be distributed by the QA Officer to all parties listed in Table 1-1.

2. DATA GENERATION AND ACQUISITION

2.1 Sampling Process Design

The individual Site SAPs will provide a detailed description of the sampling approach and rationale that was used to select sampling locations, sampling frequencies, and constituents that will be analyzed.

2.2 Sampling Methods

Proper sample collection procedures are essential to ensure that representative and reliable data are being collected. Sample collection will be performed according to the SOP for Sample Collection, Documentation, and Delivery, included as Appendix I to the IA Work Plan. In general, the QA procedures that will be followed during sample collection include the following:

- Soil grab samples will be collected by hand or from the excavator bucket.
- Sample collection will be performed in such a manner as to minimize disturbance of surrounding soils.
- Soil grab samples will be transferred to sample jars carefully to minimize exposure to external influences such as wind, dust, or rain.
- Sample jars will be labeled (e.g., date, time, location, method) immediately after collection.
- Sampling date and time and sampler’s initials will be added to the chain of custody form immediately after sampling.
- If problems occur during sampling, the QA Officer will be notified. The source of the problem will be identified and the appropriate corrective action taken. These incidents will be documented in the project folder and filed with the appropriate data package. If the problem compromised the quality of collected data, the data will be flagged within the database.

2.3 Sample Handling and Custody

Once sample containers have been filled they will be labeled, placed in re-sealable plastic bags (e.g. *Ziploc* ®), and stored in a cooler on ice to maintain a temperature of approximately 4º C. Identification information for each sample will be recorded in the field logbook when the sample is collected. A chain-of-custody form will be completed at the time of sample collection and prior to sample shipment or release. The samples will be transported or shipped to the analytical lab in insulated containers within the appropriate holding time and will be accompanied by a chain-of-custody form that identifies the sample bottles, date and time of sample collection, and analyses requested. If shipment is needed, the samples will be packaged and shipped in accordance with U.S. Department of Transportation standards. The original chain-of-custody will be given to the lab with the samples and Brown and Caldwell will retain a copy for their records. Once received by the laboratory, a sample receipt and storage record will be generated. The recommended sample container type and volume, initial preservative and holding time for analytes that may be tested is shown in Table 2-1. The turn around time for the analytical laboratory will typically be within ten days from the sampling date. After analyses, all samples will be disposed of in accordance with federal, state, and local requirements.

Table 2-1. Sample Handling and Custody

Group	Parameter	Container[a]	Initial Preservative[a]	Max Allowable Holding Time	
				Extraction[b]	Analysis[c]
Metals	Arsenic	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Lead	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Cadmium	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Copper	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
	Nickel	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	6 months
Semi-Volatiles	cPAHs	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	14 days	40 days
	Total Naphthalenes	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	14 days	40 days
Dioxins / Furans	Dioxins / Furans	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	28 days	40 days
TPH	TPH-G	EnCore Sampler	Ice to 4° C, preserve w/ methanol w/ in 48 hours	---	14 days
	TPH-D	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	28 days
	TPH-HO	4-oz glass jar w/ Teflon lined lid	Ice to 4° C	---	28 days
Volatiles	Benzene	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days
	Toluene	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days
	Ethylbenzene	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days

Table 2-1. Sample Handling and Custody

Group	Parameter	Container[a]	Initial Preservative[a]	Max Allowable Holding Time	
				Extraction[b]	Analysis[c]
	Total Xylenes	EnCore Sampler x 3, o-ring cap	Ice to 4° C, preserve w/ methanol or sodium bisulfate w/ in 48 hours	---	14 days

[a] Sample containers, volumes, and preservatives will be reevaluated once contract laboratories are chosen and may be changed based on
recommendations from the lab(s).

[b] Starting from the date of collection

[c] Starting from the date of extraction; if no extraction, starting from the date of collection

2.4 Analytical Methods

Field measurements will be conducted by Brown and Caldwell staff using portable meters and field test kits that employ EPA-approved methods. Field measurements will be taken using the procedures recommended by the manufacturer of the meter or test kit and procedures discussed in the SOP for Field Data Collection, where applicable. Results of all field measurements will be recorded in field logbooks and on field data sheets.

Laboratory analyses will be conducted by NELAC-certified analytical laboratories using methods approved by the EPA and Washington State. Proposed analytical methods are provided in Table 1-3. Alternative methods may be requested by the laboratories performing analyses. These alternative methods may be used only upon written approval from the QA Officer. Major laboratory equipment or instruments that will be utilized include a gas chromatography/mass spectrometer (GC/MS), inductively coupled plasma mass spectrometer (ICP-MS), high performance liquid chromatography (HPLC), automated colorimeter, ion chromatograph, and a carbon detector. If any instrument failures occur, the laboratory will take immediate corrective action and notify the QA Officer if the quality of sample results was compromised.

2.5 Quality Control

QC samples will be collected and analyzed to ensure the accuracy and precision of both field and laboratory data. The following sections summarize the QC samples that will be collected for field and laboratory analysis.

2.5.1 Quality Control for Field Measurements

QC for field measurements will be assessed using the following methods:

- All field instruments will be inspected, maintained, and calibrated prior to each sampling event.
- Calibration-checks will be performed to verify accuracy within 24 hours before and 24 hours after each sampling day by analyzing a calibration standard.

- Triplicate measurements will be conducted on one sample per sampling event to evaluate precision.

Results of the QC tests will be recorded on a field data sheet.

In addition, QC sessions (a.k.a. inter-calibration exercises) will be held twice a year to verify the proper working order of equipment, refresh personnel in monitoring techniques and determine whether the data DQOs are being met. QC sessions will consist of a meeting with the QA Officer (or other qualified designee) and sampling personnel to review appropriate sample collection and field analysis SOPs, equipment maintenance/calibrations manuals, and the QAPP and SAP and discuss any questions or problems that may be occurring.

2.5.2 Quality Control for Laboratory Analyses

QC for laboratory analyses will be assessed using the results of both field-collected QC samples and laboratory-prepared QC samples, each of which is discussed below.

2.5.2.1 Field-collected QC samples

Field-collected QC samples will primarily consist of field duplicates and equipment blanks, which are described below.

Field Duplicates. Field duplicates will be collected at the same time and in the same manner as the primary soil samples and will be used to assess the precision of all steps after sample acquisition. Field duplicates will be collected and analyzed at a rate of at least five percent (5%).

Trip Blanks. Trip blanks will be used to determine whether sample cross-contamination has occurred during sample transportation, delivery, and storage when collecting samples that contain volatile organic compounds. Trip blanks consist of pre-filled bottles of laboratory certified water that are transported along with the collected samples in each cooler containing samples for volatiles analysis.

Equipment Blanks. Equipment blanks will be collected in the field once per sampling day to assess contamination from reusable sampling equipment and other external influences. A sample bottle will be filled with certified clean water from the laboratory, and passed through the pre-cleaned (triple-rinsed with distilled water) sample collection equipment, mimicking actual sampling, and captured again for laboratory analysis. If equipment blanks consistently indicate that contamination is not a concern for particular constituents and equipment cleaning procedures are adequate, the frequency of collection for these analytes may be reduced.

Other field-collected QC samples may be utilized as-needed throughout the program if analytical results indicate presence of QC error, such as unexplained contamination of equipment blanks, high RPDs between field duplicates, or low precision of analytical results. These additional QC samples that may be used include the following:

Field Split. Field splits may be used occasionally to assess the precision of the selected laboratory's analytical procedures and/or methods. A field split consists of a sample that is collected and split into two different samples, one of which is shipped to the normal lab for analysis, while the other is shipped to a different lab for similar analysis using either the same or different methods, depending on what information is desired If split samples are analyzed using the same method, then results from both labs can be compared to assess the precision of the method, whereas if they are analyzed using different methods, results can be compared to assess the accuracy of the methods.

Ambient Blank. Ambient blanks may be used to assess the potential sample contamination that could occur during field sampling and sample processing. Ambient blanks consist of a pre-filled bottle deionized (DI) or distilled water that is taken to the field, opened and exposed to the atmosphere and environment, preserved (if appropriate), and analyzed the same as the corresponding samples.

2.5.2.2 Laboratory-prepared QC Samples

Several additional samples will be prepared and analyzed in the laboratories to evaluate precision, accuracy, and the potential for laboratory contamination. Each laboratory will set its own warning limit criteria for QC samples based on the method requirements and the laboratories QA Manual. The QA Manuals for selected laboratories will be included in the project file once lab(s) are selected, and will be reviewed by the project QA Officer for compliance with the project requirements. Descriptions of some of the laboratory-prepared QC samples that will be analyzed are included below. At a minimum, the frequency for analysis of matrix spikes (MS), duplicates, and blanks will meet method requirements.

Method Blanks. Method blanks (also called extraction blanks, procedural blanks, or preparation blanks) are used to assess laboratory contamination during all stages of sample preparation and analysis. Method blanks are prepared by the laboratory from reagent grade water and are processed through the entire analytical procedure in a manner identical to that of the samples. At a minimum, the laboratory should report method blanks at a frequency of one method blank for each batch of up to 20 samples. If the laboratory method blank indicates presence of contamination, all impacted samples in the analytical batch should be flagged. Subtracting method blank results from sample results is not permitted.

Matrix Spike (MS). MS and will be used to evaluate the effect of the sample matrix on the recovery of the compound(s) of interest. To prepare a MS, a field sample is first homogenized and then split into two subsamples. One of the subsamples is fortified with the MS solution and one subsample is analyzed to provide a background concentration for each analyte of interest. Recovery is the accuracy of an analytical test measured against a known analyte addition to a sample, and is calculated as follows:

$$Recovery = \left(\frac{C_{matrix+spike} - C_{matrix}}{C_{spike(Exptected)}}\right)*100 \qquad \textit{Where } \mathrm{C} \textit{ is the measured concentration}$$

Recovery data for the fortified compound ultimately will provide a basis for determining the accuracy of the measurement and the prevalence of matrix effects in the samples analyzed during the project. Analysis of MS duplicates (MSD) is also useful for assessing laboratory precision.

Laboratory Control Spike (LCS). Laboratory control spikes are prepared by adding a known amount of target analyte(s) to reagent-grade water. When compared to the method blank, LCSs can be used to evaluate the accuracy (recovery) of the target analytes excluding any matrix effects.

Replicate Samples. Replicate (also called duplicates) samples are prepared by splitting a sample into two or more aliquots after delivery to the lab, but prior to sample preparation. Analysis of replicates is used to assess precision of an analytical method. Replicates that are typically utilized include:

- Laboratory replicates: These are replicates of the raw material that is extracted and analyzed in the same manner as the original sample to measure laboratory precision.
- MSD: These are used to assess both laboratory precision and accuracy within the sample matrix.
- Laboratory Control Spike Duplicate (LCSD): These are useful for assessing the accuracy and precision of the method, excluding matrix effects.

Internal Standards. Internal standards (IS) are used for organic analyses by GC/MS, some GC analyses, and some metals analyses using ICP/MS. An IS is an analyte included in each standard and added to each sample or extracted just before analysis. ISs should mimic the analytes of interest but not interfere with the analysis. ISs are used to monitor retention time, calculate relative response, and quantify the analytes of interest in each sample or extract.

Surrogates. Surrogates are compounds chosen to simulate the analytes of interest in organic analyses. Surrogates are used to estimate analyte losses during the extraction and cleanup process and must be added to each sample, including QA/QC samples, before extraction. The surrogate recovery data will be carefully monitored; each laboratory must report the percent recovery of the surrogate(s) along with the target analyte data for each sample. If possible, isotopically-labeled analogs of the analytes will be used as surrogates.

2.5.3 Additional Laboratory Quality Control Requirements

All laboratories providing analytical support for this project will have the appropriate facilities to store, prepare, and process samples and appropriate instrumentation and staff to provide data of the required quality within the time period dictated by the project. Laboratories shall be able to provide information documenting their ability to conduct the analyses with the required level of data quality. Such information may include results from inter-laboratory performance evaluation studies, control charts, and summary data from internal QA/QC checks, and results from analyses of Certified Reference Materials (CRM).

2.5.4 Assessing Data Quality Objectives using QC Samples

The QC samples described above will be used to evaluate the DQOs specified in Section 1.6. The following sections describe how the DQOs may be evaluated.

2.5.4.1 Accuracy

The accuracy of field chemical measurements will be checked daily by using standard solutions purchased from chemical or scientific supply companies. Accuracy measurements will be recorded on a field data sheet.

Accuracy of laboratory measurements will be determined by recoveries of spiked samples (matrix and LCS and/or through analysis of CRM, continuing calibration checks, or analysis of other similar standard solutions, the results of which will be summarized as part of each data package.

2.5.4.2 Precision

Precision will be evaluated in the field by conducting triplicate field measurements of all instrument parameters at least once during each sampling event. Precision measurements will be recorded on a field data sheet. If the measurements do not fall within the precision ranges described in Tables 3-1, the instrument will be recalibrated in the field if possible. After the sampling event, the instrument will again be recalibrated, tested, and examined to determine whether replacement is necessary.

Precision of laboratory measurements will be evaluated by comparing results from various duplicate samples listed below, where available:

- Field sample and field duplicate
- Field sample and laboratory replicate
- LCS and LCSD
- MS and MSD

2.5.4.3 Representativeness

Representativeness will be reviewed throughout the program by the Project Manager and QA Officer. If the team determines that representativeness should and can be improved, additional samples, or constituents may be considered, or sampling and analytical methods may be altered.

2.5.4.4 Completeness

Percent completeness will be checked by comparing the number of collected samples with the number of samples from which useable data were generated, as described in Section 1.6.4.

2.5.4.5 Comparability

Comparability will be addressed by the use of approved drinking water methods and certified laboratories. If the comparability of laboratory results is questioned, split samples and/or performance evaluation samples may be analyzed.

2.6 Instrument and Equipment Testing, Inspection, and Maintenance

2.6.1 Field Equipment

Inspection and preventive maintenance will be performed for all field equipment in accordance with the manufacturer's specifications prior to each sampling event. This includes battery checks, routine replacement of membranes, and cleaning of conductivity electrodes, among other tasks. Equipment will be re-inspected between each sampling site and after each sampling event. If problems occur and/or repair is needed during the sampling event, the field data sheet will be used to document the corrective action taken. If significant damage or equipment malfunctions are noted, the instrument(s) will be sent to the manufacturer for immediate repair. A maintenance/calibration log will be kept by the Monitoring Coordinator or other designee, which details the dates of instrument and sampling gear inspection, calibrations performed in the lab or field, battery replacement, dates reagents and standards are replaced, and any problems noted with instruments, samplers, or reagents. The logbook will also be used to document corrective action that was taken if equipment deficiencies were noted during an inspection. A small inventory of critical spare parts for field equipment will be kept at the Brown and Caldwell main office and also brought in the field if needed; however, perishable supplies or expensive parts may not be kept on hand, and will need to be ordered when needed. All spare parts and supplies will be obtained through the equipment manufacturer or other reputable sources.

2.6.2 Laboratory Equipment

All laboratories providing support for this project will maintain analytical equipment in accordance with relevant SOPs, which include those specified by the manufacturer and those specified by the method. The laboratories will maintain a log book documenting equipment inspections, and preventive and corrective maintenance.

2.7 Instrument/Equipment Calibration and Frequency

2.7.1 Field Instruments

Field instruments will be calibrated according to the schedule presented in Table 2-2. Standards will be purchased from a chemical supply company or prepared by (or with the assistance of) a professional laboratory. Calibration records will be kept in the maintenance/calibration log at the Brown and Caldwell main office where it can be easily accessed before and after equipment use. Calibrations that are performed by personnel in the field may also be recorded on the field data sheets to indicate which samples were analyzed pre- and post-calibration for the specific sampling event. If calibration is not successful or other issues pertaining to calibration arise, the equipment manufacturer will be contacted to determine the appropriate corrective action; the problem and corrective action will be documented in the maintenance/calibration logbook.

Table 2-2. Field Instrument Calibration and Frequency

Instrument	Parameter	Calibration Frequency	Standard or Calibration Instrument Used
PID	Gas concentration	Every sampling day	100 ppm isobutylene calibration gas

2.7.2 Laboratory Instruments

The contract laboratory maintains calibration practices and calibration-checks as part of the method SOPs. The QA Officer will review these practices and confirm that they are in compliance with project requirements.

2.8 Inspection/Acceptance of Supplies and Consumables

The Project Manager will ensure that the inspection/testing specifications and acceptance criteria are met. Upon receipt supplies will be inspected by the Project Manger or other designee for broken, leaking, or missing parts glasswear, seals, labels, preseravatives, or other supplies. Sealed supplies, such as EnCore samplers, will be visually inspected to ensure seals are intact.

2.9 Non-Direct Measurements (Existing Data)

A review of existing data for each individual Site will be included as part of the Site specific SAPs.

2.10 Data Management

The Data Management Coordinator will be primarily responsible for maintaining a project database.

2.10.1 Field Data

Field data will be documented in logbooks or on field data sheets. One sheet will be used at each monitoring site, and field staff will complete all necessary sections of the data sheet during the sampling event. Field data will be collected and entered into the project database.

2.10.2 Analytical Data

Analytical laboratories will provide reports in both hard copy and electronic formats. Requirements for electronic database deliverables (EDD) will be provided to selected analytical laboratories.

2.10.3 Database Maintenance

The Data Management Coordinator will be responsible for overseeing management of the project database. Additional responsibilities of the Data Management Coordinator include QA of data collected prior to input to the project database.

2.10.4 Data Submittal

Lab reports summarizing analytical results and QC results will be provided to the Brown and Caldwell Data Management Coordinator as a hard copy and electronically in the agreed upon format. The information contained within and the format of the hard-copy data report package will be determined during the initial negotiations with the lab and will include at a minimum the sample ID, sampling date/time, test method, extraction date/time, analysis date/time, analytical results, QA sample results, instrument and equipment calibration summary information, and a description of any corrective action taken to resolve data quality issues.

In accordance with WAC 173-340-840(5) and Ecology Toxics Cleanup Program Policy 840 (Data Submittal Requirements), data generated shall be submitted to Ecology in both a written and electronic format. All data collected for the Interim Action will be entered into Ecology's Environmental Information Management (EIM) database.

3. ASSESSMENT AND OVERSIGHT

3.1 Assessments and Response Actions

Periodic assessments will be conducted to ensure that data collection is conducted according to requirements presented in this QAPP. The QA Officer, whose responsibilities are described in Section 1.1, will have the primary responsibility for assessing compliance with the QAPP and SAP requirements pertaining to sample collection and handling procedures, field analytical procedures, and laboratory analytical procedures (DQOs), as detailed in the SAP. In addition, the QA Officer is also responsible for assessing compliance with Standard Operations Procedures outlined in IA Work Plan Appendix I. The QA Officer will review field sampling and analysis procedures at the beginning of the project. Laboratory analyses will be continually assessed through evaluating results of QC samples and compliance with DQOs.

If an audit discovers any discrepancy, the QA Officer will discuss the observed discrepancy with the appropriate person responsible for the activity to determine whether the information collected can still be considered accurate, what the cause(s) were leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered. The QA Officer will then follow up to ensure that corrective actions have been implemented.

The QA Officer has the power to halt all sampling and analytical work by both sampling personnel and contract laboratories if the discrepancies noted are considered detrimental to data quality.

3.2 Deliverables and Reporting

Interim and final reports will be issued by Brown and Caldwell to the City of Olympia, the LOTT Alliance, and the Department of Ecology according to Table 3-1.

Table 3-1. QA Management Reports

Type of Report	Frequency	Projected Delivery Dates(s)	Report Recipients
Draft QAPP and SAP	One time	June 2010	City, LOTT, Ecology
Final QAPP and SAP	One time	August 2010	City, LOTT, Ecology
Interim Soil Sampling Report, Parcel 5	One time	TBD	City, LOTT, Ecology
Interim Soil Sampling Report, Parcel 4	One Time	TBD	City, LOTT, Ecology
Interim Action Report	One time	TBD	City, LOTT, Ecology

4. DATA VALIDATION AND USABILITY

4.1 Data Review, Verification, and Validation Requirements

Data verification and validation are integral steps in the transition between data collection (via sampling and analysis) and data use and interpretation. The EPA has developed a comprehensive guidance document entitled Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8) (USEPA 2002). The purpose of this guidance is to explain how to implement data verification and data validation, to offer practical advice, and to provide references.

Although data verification and data validation are commonly used terms, they are defined and applied differently in various organizations and quality systems. For the purposes of this project, the terms will be generally defined as follows:

- **Data Verification** is confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. This is done to determine if everything that was agreed upon was actually done.
- **Data Validation** is confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set. In other words, what is the quality of this specific data set?

Data generated by project activities will be reviewed against the DQOs cited in Section 1.6 and flagged if the objectives are unmet. Data will also be assessed to determine whether the QC practices were in place during data collection. If data were collected without the stated QC practices in place, the data will be set aside until the impact of the QC failure on data quality can be determined. If the impact of the QC failure on data quality is minimal, the data will be flagged and included within the database. Data that does not meet the DQOs listed in Section 1.6 will be evaluated to determine the cause of the problem, and whether corrective actions can be implemented so that DQOs are met in the future.

4.2 Verification and Validation Methods

Laboratory data will be validated in accordance with the EPA's National Functional Guidelines for Organic and Inorganic Data Review (EPA 1999, 2004). These documents will serve as the equivalent of an SOP for data review and validation.

Data verification/validation will be performed by the QA Officer and designated reviewers/validators. Data reviewers will be responsible for reviewing field data sheets, chain-of-custody forms, and analytical lab reports from each sampling event to determine whether collected data meets the contractual requirements. The data validators will add to the data review, by also checking field equipment calibration records, QC results, assessing whether DQOs have been achieved, and flagging data that did not meet specific requirements. Data qualifiers will be added to the database to alert data users of data limitations and uncertainties. A Data Quality Assessment will be completed to summarize the results of the review and validation.

If corrective action is necessary based on the data verification/validation process, the QA Officer will be responsible for communicating the nonconformance and the corresponding corrective actions to the laboratory, the Project Manager, or other designee. A Data Quality Assessment section summarizing all qualified results and including any corrective actions will be reported in the final report.

4.3 Reconciliation with User Requirements

To fulfill the identified data needs, it is important that the data collected during this project meet the data quality objectives. If data do not meet the project's specifications, the results will be flagged in the database to alert the data user of the data limitations and the following actions will be taken. First, the QA Officer and Project Manager or other designee will review the errors and determine if the problem is equipment failure, calibration/maintenance techniques, or monitoring/sampling techniques. They will suggest corrective action. If the problem cannot be corrected by training, revision of techniques, or replacement of supplies/equipment, then the technical advisor will review the DQOs and determine if the DQOs are feasible. If the specific DQOs are not achievable, they will determine whether the specific DQO can be relaxed, or if the parameter should be eliminated from the monitoring program. Any revisions to DQOs will be reviewed by the project team prior to approval and QAPP revision.

At the completion of the sampling program, Brown and Caldwell will continue to maintain the database.

5. LIMITATIONS

Report Limitations

This document was prepared solely for the City of Olympia and the LOTT Alliance in accordance with professional standards at the time the services were performed and in accordance with the contract between Brown and Caldwell and the City of Olympia dated September 4, 2009, and the contract between Brown and Caldwell and the LOTT Alliance dated June 18, 2008. This document is governed by the specific scope of work authorized by the City of Olympia and the LOTT Alliance; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by the the City of Olympia, the LOTT Alliance and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

REFERENCES

REFERENCES

EPA 1999. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA 540/R-99/008. United States Environmental Protection Agency Office of Emergency and Remedial Response. October.

EPA 2000. U.S. Environmental Protection Agency.

EPA 2002. United States Environmental Protection Agency. 2002. *Guidance on Environmental Data Verification and Data Validation* (EPA QA/G-8), November.

EPA 2004. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* EPA 540-R-04-004. Office of Superfund Remediation and Technology Innovation (OSRTI), United States Environmental Protection Agency. October.

SM 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998. American Public Health Association, American Water Works Association, and Water Environment Federation.

APPENDIX K – STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE
<u>PREPARING FOR FIELD ACTIVITIES</u>

Proper planning of field activities and communication must occur to ensure that the required resources are available to implement the scope of work and accomplish the project's objectives. This Standard Operating Procedure (SOP) describes the requirements and procedures that must be followed by the Project Manager (PM) and assigned field staff to properly prepare for field activities. The PM is ultimately responsible for the proper planning, implementation and successful completion of the project.

PLANNING

The planning process for the implementation of field activities begins at the proposal stage and continues through the completion of the project. The PM must ensure that the following tasks are completed **prior** to the conduct of field activities:

- Sufficient number of personnel and labor hours are allocated in the budget and schedule to allow for proper mobilization, implementation of field work and demobilization from the Site.

- Prior to the conduct of field activities, a signed contract and/or work order is received from the Client. Similarly, a signed Subcontractor Task Order is received from each subcontractor. At a minimum, must have a cost Quote from subcontractor prior to start of field activities.

- A detailed Work Plan is prepared and submitted for review to the Client, Regulatory Agency and the project team personnel. If required, ensure approval from the Client and/or regulatory agency is received prior to the conduct of field activities.

- A site-specific Safety and Health Plan (SS&HP) is prepared and approved by BC's local or regional Health and Safety Officer. The SS&HP should also be submitted to the Client, regulatory agency and especially to each project team member, including subcontractors.

- All required permits and/or notifications are obtained. Examples of permits/notifications that may be required include:

    - Notice of Intent (NOI) to drill/abandon wells and/or borings
    - NOI to discharge under NPDES/AZPDES
    - Dust Control permit
    - NESHAP abatement and/or demolition notification
    - USTs, septics, dry wells registration/removal permits
    - Traffic Control Plans
    - 404 Corp of Engineers permit
    - SWPPP and/or SPCC

- Obtain Site Access from Client, property owner and/or tenant. If required, any site access agreement should be reviewed by BC's Legal Department. If vacant property, obtain any appropriate keys and or combinations to open gates/doors to the property.

- Ensure the locations of all underground utilities are clearly marked. By State Law, must notify Blue Stake a minimum of 48 hours prior to performing any excavation activity. The PM must understand that:

    - Blue Stake requires the borings and/or excavation limits be clearly marked with white paint.
    - Blue Stake only marks underground utilities within public right-of ways, not within private properties.
    - If the work is being performed within public right-of-way, must field-verify that all parties (water, sewer, gas, electric, telecommunication, etc.) have marked their lines. If not, ask Blue Stake for an emergency recall.

- Use a private utility locator to mark underground utilities within the project area rather than simply "clear" proposed boring locations.

COMMUNICATION

During the planning phase of field activities, communication and coordination between the PM and the Client, regulators, field staff and subcontractors was established. However, as the start date of field activities nears, the communication between the PM, field staff and subcontractors must be increased and maintained through implementation of the field tasks.

SUBCONTRACTORS

The PM is responsible for ensuring that, at a minimum, the following information is communicated with the different subcontractors at least two days prior to the start of field activities:

- Site location, start date and time of field activities, and BC field personnel contact information.

- Reiterate the required scope of work and the type of equipment needed:

    - For drillers, ensure the right type of rig (auger, air, sonic, mud, direct-push) and sampling device is scheduled. Specify requirements for concrete coring, need to hand-auger, sampling frequency, decontamination of sampling and drilling equipment, well construction design, well completion, IDW management and boring backfill material.

  - For laboratories, specify the analytical methods and method detection limits required. Confirm the type and number of containers required for each sample, each analytical method's holding time, and the timing of samples delivery or courier services.

  - For excavation contractors, ensure the correct type of equipment (backhoe, excavator, loader, water truck, etc.) is mobilized to complete the required scope of work. Confirm soil handling (stockpile over plastic sheeting, direct loading into roll-off bins or end-dump trucks), dust control, air monitoring and SWPPP requirements.

CLIENT

The PM must ensure that the Client, property owner and/or tenant are notified of the following information at least two days prior to the scheduled start of field activities:

- The proposed start date and time of field activities, the planned scope of work, and the anticipated duration of field activities.

- Proposed locations to store materials and/or equipment, soil stockpiles, and IDW drums or bins.

- Anticipated impacts to the Site, including:

  - Noise
  - Odors
  - Dust
  - Vibrations
  - Traffic control and restricted areas

- Availability of water and electricity.

FIELD STAFF

The most important required communication during the preparation of field activities is between the PM and the field personnel assigned to implement the field tasks. Although the Wok Plan may fully describe the field and analytical procedures to be implemented during the project, the information is typically divided into several different sections of the document and may not be always easily retrieved. Also, there may be a significant time period between the publishing of the work plan and the start of field activities. Therefore, to ensure that field personnel thoroughly understand the field procedures and analytical requirements to be implemented, the PM **must** use a Field Task Assignment Form (attached) in addition to verbal communication.

The purpose of the form is to concisely summarize in one page the field and analytical procedures required to successfully implement the field tasks. The form should be completed by the PM and discussed with field personnel a minimum of two days prior to the start of the field activities. The form may be modified or customized as needed, but it must at a minimum include the following information:

- Summary of the Scope of Work (i.e “drill four borings to a depth of 20 feet and collect soil samples at 5-foot depth intervals starting at the surface”) and the Intent of the field task (i.e. “to define the lateral and vertical extent of fuel contamination”). Providing the Intent of the field task allows the field personnel to determine and communicate to the PM if following completion of the proposed scope of work the task objectives have been accomplished.

- Site and Project Contacts. At a minimum, the cell/telephone numbers of the following personnel should be provided:

    - PM
    - Client, Owner and/or Tenant
    - Subcontractors (drillers, labs, excavation, etc.)
    - Blue Stake and Ticket Number

- List of Equipment needed and operational/monitoring requirements.

- Summary of field sampling plan, including:

    - Sampling frequency or interval
    - Number and location of duplicate samples
    - Number of field blank samples
    - Number and frequency of equipment blanks
    - Sample IDs and labeling convention

- Summary of analytical plan, describing the analyses and method to be performed on each sample.

MOBILIZATION

The last step in the preparation of field activities consists of the mobilization to the Site of all the required resources to perform the field tasks. The assigned field personnel or Field Task Leader is responsible to ensure the proper mobilization of the following:

- Vehicles and Lodging. The proper size and type of vehicle required to reach the site and transport all the required equipment shall be procured by reserving company-owned vehicles or rental vehicles. If overnight stay is required, arrange convenient lodging. Rentals and lodging should be pre-approved by the PM.

- Monitoring/Sampling Equipment. Field personnel should procure the proper type of monitoring/sampling equipment, and should ensure that:

    - Proper number and type of calibration gases/fluids accompanies the equipment.
    - Each piece of equipment is checked for proper function/operation prior to mobilizing to the Site.

  - Spare batteries are available.
  - All electrical equipment is charged the night prior to the start of field activities.

- Documents and Forms. Field staff should bring to the Site relevant project documents and monitoring forms, such as:

  - Task Assignment Form
  - Work Plan
  - SS&HP
  - Site Access Agreements and/or Permits
  - Copies of Subcontractors’ Task Orders
  - Boring and Well Construction Logs
  - Well Development Logs
  - Instrument Calibration Forms

The attached Field Equipment Checklist can be used by field personnel and/or PM to verify that all required equipment has been mobilized. Both attached forms may be modified to address project requirements.

FIELD TASK ASSIGNMENT FORM

DATE: ______________________ **PROJECT No.:** **PAGE** __ **OF** __

SITE: **BUDGETED HOURS:**

SCOPE OF WORK AND INTENT

PROJECT CONTACTS

BC PM ______________________

Driller ______________________

Other

Site Owner/Operator ______________________

Laboratory ______________________

Other

EQUIPMENT NEEDED

PID ☐
OVA ☐
GEM ☐
4-GAS ☐
______ ☐
☐

Sample Jars ☐
Metal Sleeve & Caps ☐
Encore/Methanol Kit ☐
Teflon Sheets ☐
______________ ☐
☐

Sounder ☐
Hydac ☐
Bailers ☐
Pump ☐
______ ☐
☐

Other __________ ☐
Other __________ ☐
Other __________ ☐
Other __________ ☐
______________ ☐
☐

SAMPLING PLAN

Sampling Interval: ______________________

Duplicate Samples (Number and Location): ______________________
____

Field Blanks: ______________________

Equipment Blanks: ______________________

Sample ID/Labeling Convention: ______________________

ANALYTICAL PLAN

TPH ☐
BTEX ☐
MTBE ☐
VOCs ☐
______ ☐
______ ☐
☐

SVOCs ☐
PAHs ☐
PCBs ☐
Pesticides ☐
__________ ☐
__________ ☐
☐

Total Metals 13 PP + Ba ☐
Total Metals RCRA 8 ☐
SPLP Metals 13 PP + Ba ☐
TCLP Metals RCRA 8 ☐
______________ ☐
______________ ☐
☐

General Chem. ☐
__________ ☐
__________ ☐
__________ ☐
__________ ☐
__________ ☐
☐

ATTACHMENTS

Site Location Map: ☐
Site/Facility Map: ☐
Sampling Locations Map: ☐

H&SP ☐
Work Plan ☐
__________ ☐

__________ ☐
__________ ☐
__________ ☐

Assigned By: ______________________ Received By: ______________________

FIELD EQUIPMENT CHECKLIST

Equipment Name		“✓” after loading
General		
	Camera	
	Mobile phone	
	GPS	
	Calculator	
	Stakes	
	Batteries	
Project Information		
	Field Forms and Logs	
	Project Notebook	
	Permits	
	Access Agreements	
	Site keys (gates, wells, vaults)	
	Workplan	
	SSHP	
Instruments		
	pH/Temp/EC	
	DO	
	Turbidity Meter	
	PID (w/ calibration gas)	
	FID (w/ calibration gas)	
	Multi-gases / LEL	
	Mini RAM Dust Monitor	
Decontamination Equipment		
	3 Buckets	
	DI water	
	Alconox or Liquinox	
	Scrub brushes	
	Paper Towels	
Health and Safety Equipment		
	Draeger pump and tubes	
	Respirator	
	Combination Cartridges	
	Tyvek suits	
	Gloves	
	Steel toe boots	
	Hard hat	
	Reflector vest	
	Safety glasses	
	Ear plugs	
	Sun screen lotion	

Equipment Name		“✓” after loading
Soil Sampling Supplies		
	Glass Jars	
	Brass Sleeves	
	Stainless steel sleeves	
	Sleeve caps	
	Teflon Sheeting	
	Aluminum foil	
	Encore samplers	
	Encore T-bar handle	
	Hand auger	
	Hand auger extensions	
	Drive slide hammer	
	Shovel/spade	
	Compositing bowl/bucket/bags	
	Stainless Steel trowel	
	Disposable trowels/scoops	
	Zip-lock bags	
Water Sampling Supplies		
	Water level sounder	
	Interface oil/water probe	
	Disposable bailers	
	Twine	
	Bladder pump w/ controller	
	Peristaltic pump and tubing	
	Submersible pump and tubing	
	Electrical generator	
	Air compressor	
Air Sampling Supplies		
	Air sampling pump	
	New air sampling tubing	
	Tedlar bags	
	Summa canisters	
General Sampling Supplies		
	Chain of custody forms	
	Sample labels	
	Sample containers	
	Coolers	
	Ice	
	Shipping labels	
	Custody seals	
	Packing tape	
	Sharpies	

Brown and Caldwell
Standard Operating Procedure

Field Activity Readiness Review

Revision 1.1
Revision Date: July 25, 2001

Prepared/Revised by:	**Wendy Linck** Name	**October 9, 2001** Date
Senior QA Review:	Jay Lucas Name	10/26/01 Date
Regional Quality Officer:	 Name	October 26, 2001 Date

FIELD ACTIVITY READINESS REVIEW

TABLE OF CONTENTS

1.0 OBJECTIVES

The objective of this Standard Operating Procedure (SOP) is to assure that field activity objectives are well established and that personnel, equipment, and required permits are in place to achieve field task objectives. The purpose of the Readiness Review is to increase the probability of field success and reduce risks in terms of personnel safety, cost, and litigation.

2.0 SCOPE AND APPLICABILITY

This SOP describes the requirements and performance of Readiness Reviews to determine readiness prior to initiation of field activities. It also describes the scheduling and conducting of a Readiness Review meeting.

The readiness review process should be carried out prior to carrying out field portions of <u>any</u> project. However, intensity and documentation required can vary significantly depending upon tasks involved, and risks involved with the project. Therefore, this SOP describes three tiers of readiness reviews that can be conducted, Levels I, II, or III.

Example definitions of the three levels are as follows:

Level I – Would consist of low cost, low risk and low liability, routine field work that is repetitively applied by project personnel very familiar with conducting such work.

Level II – Would consist of medium cost projects, where a relatively significant mobilization may occur, but risk and liabilities are relatively low to moderate.

Level III – Would consist of a high cost, medium to high risk or liability projects, where major mobilization occurs (e.g., establishment of a field office), and field personnel may be unfamiliar with many project nuances.

The readiness review consists of four general parts: determination of a need for a readiness review, pre-mobilization checks, -follow up actions and mobilization, and post-mobilization check (Level III only).

It is important to note that not all projects will neatly fit into a category. The process described herein can be mixed and matched as project needs complete full blown Level III review is unnecessary for a project, the level III pre-mobilization checklist is appropriate. The SOPs scope is to provide guidance for pre-field checking procedures and provide example tools for conducting such reviews. The following sections provide more detail regarding the Readiness Review, and Attachments A through G include example forms for this process.

3.0 RESPONSIBILITY

The Project Manager (PM) shall ensure that the Readiness Review procedures outlined in this SOP are used on all projects as defined by the PM and PIC, and that such reviews will conform with this SOP. The PM, or Project Quality Manager, if applicable, is responsible for conducting the Readiness Review, along with other team members and confirming that any outstanding items are completed. Attendance by all field personnel, especially the field supervisor is highly recommended. The field supervisor or lead field geologist is responsible for implementing any items found outstanding and ensuring that concerns identified in the Readiness Review are watched during field activities. Field personnel are responsible for following and adhering to the Readiness Review.

4.0 DEFINITIONS

Readiness Review - A review of information regarding a planned field activity to determine the readiness for initiation of that activity.

Readiness Review Meeting - A meeting scheduled and conducted by the Project Manager (PM) or designate to discuss planned activities and identify potential action items during the meeting.

5.0 PROCEDURES

This section describes the Readiness Review process.

5.1 Determination of Need for a Readiness Review

The process starts with an initial meeting between the project manager, quality manager, and PIC to determine whether a readiness review is required. Attachment A includes the Readiness Review evaluation form that can be used to document this meeting. If a readiness review is required, then the PM, QM, and PIC determine the level of review necessary. Determination of project needs with respect to readiness reviews also can be reviewed by the PM, QM, and PIC during project initiation, in which case the PM or QM can conduct the readiness review determination without specifically having the PIC involved in this decision. Figure 1 depicts the sequence for completing the Readiness Review process.

5.2 Readiness Review Participation

Once the need for a Readiness Review is determined, a Readiness Review meeting is scheduled and conducted by the Project Manager (PM), Quality Manager (QM), or designee. Participants may include the Principal in Charge (PIC), Project Manager (PM), a quality control representative, the site safety officer (SSO), field team personnel, and other representatives as determined by the PM or QM.

The PM or QM will notify the attendees of the time and location of the Readiness Review meeting and will request their (or their designee's) participation. The QM will assure that the review participants include an individual knowledgeable about regulatory requirements relevant to the field activity being reviewed. The QM or designee will distribute the checklists for the Readiness Review prior to the meeting. Readiness Review meetings may be conducted with the client in attendance. The client can often supply specific answers regarding some items identified during the meeting.

A Readiness Review meeting should be conducted prior to initial field mobilization, when the scope of the activity was not addressed at the initial Readiness Review, or when 3 months or more have elapsed between the initial Readiness Review and the new activity.

5.3 Readiness Review Documentation

The forms identified in Table 1 are used to conduct the Readiness Review.

Table 1
Documentation Responsibilities

Documentation	Responsibility	Attachment
Readiness Review Evaluation	Prepared by PM or designee, approved by PM, QM and PIC	A
Pre-Mobilization Readiness Review Checklist, Action Items Checklist	Participants and PM complete; PM approves	B, C, D, F
Field Activity Readiness Review Results	Approved by the PM and QM, along with SSO, and task manager.	E
Pre-Mobilization Readiness Review Checklist (Level III only)	QM completes and approves.	G

Note: <u>Attachments A and B, C, D, or F</u> must be completed before field activities are initiated.

5.4 Readiness Review Meeting

- Scheduling the Review - A time/place and participants for the Readiness Review should be established at least one week prior to initiation of fieldwork. Action items identified must be completed prior to the initiation of work. The PM or designee responsible for the fieldwork schedules the Readiness Review and notifies the participants outlined in 4.1.
- Beginning the Review Meeting
  - The QM opens a Readiness Review meeting by explaining its purpose, describing the review procedure, and presenting a general overview of the project objectives.
  - The QM/designee briefly describes the scope of work involved in the field activity, including identification of equipment and potential contamination exposure involved.
- The Review Procedure - The presentation systematically identifies those steps taken to plan and prepare for the fieldwork, and is organized in a manner that enables the Readiness Review participants to easily complete the checklist(s) provided in Attachment B, C, D, or F, depending upon tier of review.

If any action items are identified as the presentation progresses, the PM/designee will record them on Attachment E.

Attachment G is a Postmobilization Checklist, and is intended to be used once field activities have been initiated, not as a part of the actual Readiness Review meeting (for Level III tier projects only).

5.5 Readiness Review Judgment

The judgment of the members of the Readiness Review toward initiation of the activity takes one of the following forms:

- Approve,
- Conditional Approval pending resolution of action item(s), or
- Disapprove.

Each member individually recommends one of the above alternatives. Considering these recommendations, the Readiness Review team makes a determination.

Actions Required - Table 2 identifies the actions that should be taken based on the results of the Readiness Review.

If the field activity is not classified as major, Attachment A must be completed. The field activity will not begin until the Field Activity Readiness Review Results form (Attachment E) is signed as approved by the PM.

If a Readiness Review is not required, the mobilization checklists (Attachments B, C, D, or F) can be used as a tool during preparation for field activity.

5.6 Documentation

Completed documentation (including meeting minutes prepared by the PM/designee) will be filed. Documents will be filed by project number as outlined in the Project Management Plan.

Table 2
Readiness Review Actions

If the Readiness Review Team:	Then:
Approves the preparation for the field activity	No further action is required.
Identifies action items of sufficient concern to warrant the classification of "Approval Pending Resolution of Action Items"	The action items must be addressed. The QM/designee must present evidence of completed action items. Note: The action items will be noted either as "must be completed prior to initiation of fieldwork" or tied to a specific date or event.
Judges the preparation as inadequate and disapproves the initiation of fieldwork	The QM will work with the project team to correct the deficiencies and present evidence of completeness to the PM. Another Readiness Review is scheduled, if required by the PM.

5.7 Checklists

The checklists have been grouped into two main categories: Premobilization Readiness Review Checklist (Attachment B, C, D, or F depending upon tier), and Post-mobilization Checklist (Attachment G, Level III only).

For Level I, the checklists included are simple field checklists, primarily meant to gauge the field crew's readiness to collect samples.

For Level II, the above field checklists will be valuable tools, but this checklist includes a more comprehensive review of overall project and field considerations in a series of questions designed to make sure the project team has thought through aspects necessary to successfully implement a field program of moderate size.

Level III includes the checklists from Level I in response to one question. The Pre-mobilization checklists included in Attachment F give two examples of more intensive checks that can be performed for major field efforts. The follow summarizes these checklists:

The Level III checklists are organized into categories. Each category comprises (as appropriate) the following subgroups:

1. Overview, Planning, and Personnel;
2. Health and Safety;
3. Site Arrangement;
4. Documentation Prepared;
5. IDW; and
6. Contracts/Subcontracts.

The Post-mobilization checklist is a guide to the requirements; it is not an all-inclusive list of requirements. The Post-mobilization checklist is to be completed during the site mobilization on a Level III project. The completed checklist is signed, dated, and forwarded to the project file. Completion of the Post-mobilization checklist is the responsibility of the QM. This checklist can be completed for tiers lower than Level III, but is not required.

6.0 ATTACHMENTS

Attachment A: Evaluation of Need for a Readiness Review (All Levels)
Attachment B: Pre-mobilization Field Supplies Checklist (Level I)
Attachment C: Pre-mobilization Readiness Review Checklist (Level II)
Attachment D: Readiness Review Action Items List
Attachment E: Field Activity Readiness Review Results
Attachment F: Pre-mobilization Readiness Review Checklist (Level III)
Attachment G: Post-mobilization Checklist

ATTACHMENT A

EVALUATION OF NEED FOR A READINESS REVIEW

EVALUATION OF NEED FOR A READINESS REVIEW

Summary of Planned Activity Project Number # _________

Site ______________________________

Activity __________________________

Brief Description of Planned Activities:

Criteria for Major Field Activity

Indicate whether the activity meets any of the following criteria for a major field activity.

1. Is the fieldwork at a specific site?

   Yes ___ No ___

2. Is the field activity new or has it been significantly modified from the last field activity?

   Yes ___ No ___

3. Is the activity being restarted after an unplanned or extended 3-month shutdown?

   Yes ___ No ___

4. Has the activity been planned in a new or significantly different mode?

   Yes ___ No ___

5. Has program management designated the activity for review?

   Yes ___ No ___

Planned Work Needs Evaluation

The following chart evaluates the risk posed by the planned work. It is completed by the TM.

Area	Criteria	Risk (Significant, Minor, None, Unknown)
Health and Safety	What is the risk of a credible threat to the health and safety of the workers or general public?	
	Have utilities in the area been located and marked as required?	
Environment	What is the risk of a credible threat of release of contamination to the environment?	
	What is the risk that if a release occurred the cost to remediate the resulting contamination would be more than $50,000?	
Public Sensitivity	What is the risk that the field activity will attract strong public interest?	
	Has the community relations plan (CRP) coordinator been contacted, if applicable, to inquire if there are any problems?	
	What is the risk that an organized local intervenor group will actively oppose the planned field activity?	
Impact to Site Operations	What is the potential that field operations will disrupt or interfere with site operations?	
General	What is the potential for encountering potentially hazardous conditions/ unexploded ordnance?	

Indicate the approximate cost of the field activity (circle one):

< $100,000

$100,000 - $500,000

> $500,000

Indicate the Level of Readiness Review Required (circle one):

Level I:	(First stage, minimal checks of field readiness)
Level II:	(Second stage, moderate check of readiness)
Level III:	(Third stage, significant check of readiness, significant project risk)

<u>Quality Manager Recommendations</u>

Note:

Generally, fieldwork that involves drilling or other intrusive activities will be classified as major. Additionally, field activities which have <u>significant or minor</u> risks in any of the criteria shall be considered major.

Based on the above evaluation a Readiness Review **is** _____, **is not** ____ recommended.

______________________________	__________
QM	Date
______________________________	__________
PM	Date
______________________________	__________
PIC	Date

ATTACHMENT B

PRE-MOBILIZATION FIELD CHECKLIST (LEVEL I)

FIELD BAG CHECKLIST

- ☐ Calculator
- ☐ Hand lens
- ☐ Watch with step watch or second hand
- ☐ Ballpoint pens
- ☐ Sharpie (not for use on analytical samples)
- ☐ Field-fact cheat sheet (i.e. casing diameters, annular volumes, equivalency data)
- ☐ Engineer scale
- ☐ Safety vest
- ☐ 25-foot measuring tape (preferably decimal)
- ☐ Munsell color chart or condensed chart
- ☐ Grain size chart
- ☐ Unified soil classification chart
- ☐ Hard hat (preferably ratch-it type adjuster)
- ☐ Rain gear
- ☐ 1 Tyvek® outfit
- ☐ Respirator
- ☐ Ear plugs
- ☐ Drum labels
- ☐ Toilet paper
- ☐ Safety glasses
- ☐ Steel-toed boots
- ☐ Dry socks
- ☐ Disposable camera
- ☐ Ziplock® bags
- ☐ Paper towels
- ☐ Suntan lotion
- ☐ Water proof note book
- ☐ Gloves
- ☐ Flagging
- ☐ Wipes
- ☐ Drinking water
- ☐ Garbage bags
- ☐ Hand/Decon Soap

This checklist is a minimum list of items suggested to be in your field bag. Many of us in the field have additional containers with job specific items. We did not list all the possible items that you may carry with in the field. Please keep in mind this list is a start. Please update and add to, as needed.

FIELD EQUIPMENT CHECKLIST

Client: ____________________ Project #: ______________________

Field Personnel: ____________________ Date: ______________________

Location: ____________________

Equipment name	"✓" after verification			Equipment name	"✓" after verification		
	Yes	No	NA		Yes	No	NA
General				**General Sampling Items**			
Camera				Chain of Custodies			
Mobile phone				Sample labels			
GPS				Sample containers			
Picture scale				Ice			
Stakes				Coolers			
Project Info				Gloves, nitrile			
Project notebook				**Soil**			
Project Contact Sheet				*Sampling Supplies*			
Permits				Brass sleeves			
Right of Entry(s)				Stainless steel sleeves			
Site keys (wells, gate)				Sleeve caps			
Workplan				Teflon® Sheeting			
SSHP/Field work safety plan				Aluminum foil			
				Encore® samplers (5g or 25 g)			
Instruments				Encore® T-bar			
pH/temp combination				*Other*			
EC				Hand auger			
DO				Hand auger extensions			
PID (w/calibration gas)				Drive Slide hammer			
FID (w/calibration gas)				Drive sampler tubes			
LEL (w/calibration gas)				Shovel/spade			
				Trowel			
Shipping Supplies				Bowl for compositing			
Shipping labels				**Water**			
Custody seals				*Water supplies*			
Packing tape (only for cooler)				Bailer, disposable			
Location of drop-off center				Twine			
Latest drop-off time				Filters for dissolved analyses			
Bubble wrap				*Bailers*			
				Bailer, disposable			
Decontamination Equipment				Bailer, Teflon® or stainless steel			
3 Buckets				*Pumps and compressors*			
DI water				Centrifugal pump			
Alcolnox® or Liquinox®				Peristaltic			
Scrub brushes				Peristaltic tubing			
Paper towels				Submersible pump			
				Submersible pump tubing			
Health and Safety Equipment				*Water level probes*			
Draeger® pump				Interface oil/water probe			
Draeger® tubes				Solonist® water level			
Respirator (half or full face)				**Air**			
Combination cartridges				*Air supplies*			
Work gloves				Tedlar® bag			
Suits, Tyvek®				Summa canister			
Respirator dust filters				Air sampling pump			
Respirator wipes				Air sampling tubing			

These supplies do not include the items that should be in your field bag

ATTACHMENT C

PRE-MOBILIZATION READINESS REVIEW CHECKLIST (LEVEL II)

READINESS REVIEW CHECKLIST (Level II)

Project Name:____________________________________ Project No:______________

Date of Readiness Review Meeting: ____________ Date of Fieldwork: _________

Activity Covered:

Location:

Work Plan/Site Safety and Health Plan Title:

1. Does Brown and Caldwell have Notice to Proceed on this task from client?

Yes NA Will Be When:_______

2. Have appropriate client personnel been notified of the Schedule of Activities?

Yes NA Will Be When:___________________

3. Is the Work Plan approved and final?

Yes NA Will Be When:___________________

4. Does the property require Rights of Entry and have they been signed?

Yes NA Will Be When:___________________

5. Has the property owner been notified in writing of scope and schedule of activities?

Yes NA Will Be When:_____________

6. Are Subcontractor(s) under Contract?

List Subcontractors

____

____

____

____

____

____

Are task orders signed for these subcontractor(s)?

Yes NA Will Be When:_____________

Is the analytical laboratory ready to receive samples?

READINESS REVIEW CHECKLIST (Level II)

Yes NA Will Be When:____________

Are all appropriate sample containers on-site?

Yes NA Will Be When:____________

7. Is the courier set-up to pick up samples (if applicable)?

Yes NA Will Be When:____________

8. Field Supplies

Have field supplies (e.g., coolers, vermiculite, shipping labels, bubble wrap) been procured?

Yes NA Will Be When:____________

Have decon chemicals been obtained with MSDS sheets ready for mobilization?

Yes NA Will Be When:____________

Are sample labels prepared?

Yes NA Will Be When:____________

9. Documentation

Are field notebooks prepared?

Yes NA Will Be When:____________

Are sample documentation forms (e.g., COCs) prepared?

Yes NA Will Be When:____________

Is database ready to receive sample information?

Yes NA Will Be When:____________

10. Personnel

Do appropriate Brown and Caldwell personnel have copies of QAPP, SSHP, Work Plan or FSP?

Yes NA Will Be When:____________

Have the QAPP and appropriate SOPs been reviewed?

Yes NA Will Be When:____________

Has the Work Plan or FSP been reviewed?

Yes NA Will Be When:____________

READINESS REVIEW CHECKLIST (Level II)

Are all Brown and Caldwell personnel current on H&S training?

Yes NA Will Be When:____________

Are all subcontractor personnel current on H&S training (if applicable)?

Yes NA Will Be When:____________

Have subcontractors been briefed on QAPP requirements?

Yes NA Will Be When:____________

Is medical surveillance documentation for Brown and Caldwell personnel and subcontractors on file in field office or available?

Yes NA Will Be When:____________

Who is the competent person in charge ___________________________

Have certifications for training been checked for all field personnel involved with field effort and tasks they will be performing?

Yes NA Will Be When:____________

11. List the tenants that will be impacted from the field work.

Contact Name: ____

Business Name:____

Location: ____

Has the above tenant been notified when and where work will be conducted?

Yes NA Will Be When:____________

19. Have the sample locations been marked?

Yes NA Will Be When:____________

20. Has USA been contacted with regard to underground utilities?

Yes NA Will Be When:____________

Date: ____

Ticket number(s): ____

Date Expires: ____

21. Has site walk for public utilities been scheduled?

Yes NA Will Be When:____________

READINESS REVIEW CHECKLIST (Level II)

22. Have utilities been marked by all providers?

Yes NA Will Be When:____________

If not, who? ____

23. List all required field equipment. Is equipment procured and in working condition (use checklists as appropriate)?

Calibration gas within date? PID calibrated?

Calibration log on-site?

pH/EC/temperature meter(s)

pH calibration fluids in date? EC calibration fluids in date?

Meter(s) calibrated? Calibration log on-site?

Other equipment (list)

Equipment: ____

Equipment: ____

Equipment: ____

Equipment: ____

24. List any specialty equipment necessary for this project. Is equipment on-site and in working condition?

Equipment: ____

Yes NA Will Be When:____________

25. Is PPE procured and inspected?

Yes NA Will Be When:____________

___________________________________ __________

Task Manager Date

___________________________________ __________

Quality Manager Date

ATTACHMENT D

READINESS REVIEW ACTION ITEMS LIST

READINESS REVIEW ACTION ITEMS LIST

Project Number. ________

Item No.	**Action Item**	**Due Date**
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		

Actions completed

______________________________ __________
TM Date

______________________________ __________
PM Date

ATTACHMENT E

FIELD ACTIVITY

READINESS REVIEW RESULTS

PROJECT NUMBER :__________

FIELD ACTIVITY
READINESS REVIEW RESULTS

The results of the READINESS REVIEW for the initiation of the following activity at the ____________ site are listed below. Signature of the TM indicates that all READINESS REVIEW members have signed off previously.

Major activity:____

____

1. <u>READINESS REVIEW DECISION</u>

		A	CA	D
____________________ Task Manager	________ Date			
		RECOMMENDED		
		A	CA	D
____________________ Project Manager	________ Date			
____________________ Field Service Manager/Designee or Operations	________ Date			
____________________ Quality Manager	________ Date			
____________________ Health and Safety Manager	________ Date			
____________________	________ Date			

A - Approve

CA - Conditional Approval Pending Resolution of Action Items

D - Disapprove

ATTACHMENT F

PRE-MOBILIZATION READINESS REVIEW CHECKLIST (LEVEL III)

READINESS REVIEW CHECKLIST

PREMOBILIZATION

OVERVIEW, PLANNING, & PERSONNEL **SECTION I**

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Have the appropriate technical and regulatory experts been selected by PM based on work scope?			
2. Has the work scope been clearly defined for the site by the PM?			
3. Have data quality objectives been developed (as appropriate) using the U.S. EPA seven-step Data Quality Objectives (DQOs) process?			
4. Are objectives of work clearly understood by the team?			
5. Have appropriate personnel completed their training (e.g., QA orientation, Standard Operating Procedures [SOPs], technical specifications)?			
6. Are copies of training and certification records for all field personnel available at the READINESS REVIEW?			
7. Are cost estimates for work realistic and is the budget available for work?			
8. Have client comments been reviewed and the recommendations incorporated into work activities?			
9. Are appropriate site audits planned?			
10. Has a quality control representative been named and briefed by PM regarding responsibilities?			

	SAT	UNSAT	COMMENTS/ACTION ITEMS
11. Have appropriate permits been obtained and regulatory compliance issues been addressed?			
12. Is field office space being provided and will it be inspected for safety?			
13. Has a schedule been prepared, submitted, and approved by the client and regulatory agencies as appropriate?			
14. Has the Work Plan been approved by the client (as appropriate)?			
15. Have all supplies been procured based on a checklist (Exhibit A)?			
16. Are all outside vendors/suppliers and manufacturers identified and ready for use should field problems with instruments or equipment occur?			
17. Have supply storage facilities been procured, if applicable?			

HEALTH & SAFETY

SECTION II

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Have provisions been made for fire extinguishers, first aid kits, mobile phones or radios, eye wash station, and other safety equipment at the site?			
2. Has the Site Safety Officer (SSO) reviewed the HASP and made arrangements for the required H&S instrumentation?			
3. Have arrangements for emergency response contractors, local emergency services (police, fire, medical) been addressed?			
4. Has a contingency plan been prepared for emergencies?			
5. Has the contingency plan been submitted to local emergency responders (as appropriate)?			
6. Has an emergency coordinator been named, if required?			
7. Have emergency procedures been discussed and understood by the field team?			
8. Has Site Health and Safety Officer staffing been arranged and approved by the Health and Safety Manager?			
9. Does each subcontractor have an approved H&S Plan?			
10. Has each subcontractor designated or identified personnel responsible for H&S?			

	SAT	UNSAT	COMMENTS/ACTION ITEMS
11. Does each subcontractor have personnel that meet the appropriate health and safety training for their respective tasks?			
12. Has the SSO reviewed with each subcontractor, the specific documentation required for work, including equipment certifications, material safety data sheets (MSDS), and the Subcontractor's H&S Plan?			
13. Do program personnel meet training requirements (including site-specific orientation, quality orientation, and training to appropriate H&S SOPs)?			
14. Is the H&S Plan complete and has it been approved by the client (as appropriate)?			
15. Have personnel that will be operating motor vehicles in the field, submitted a copy of their current driver's license to the Safety & Health Officer, if required?			
16. Have subcontractors submitted a copy of their lock-out tag-out procedure (if applicable)?			

SITE ARRANGEMENT

SECTION III

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Has site access been arranged for personnel and equipment, including subcontractors?			
2. Have appropriate arrangements been made with a local hospital, as required in the SSHP?			
3. Have all required utility surveys been completed or have they been scheduled?			
4. Have appropriate federal, state, and local officials been notified for site entry?			
5. Have community relations activities been planned and has coordination been completed with the client and with local authorities/site owners, as required?			
6. Is there an internal communication system provided, if necessary/planned?			
7. Is there a means of contacting outside help?			
8. Have appropriate signs been procured? This would include OSHA Safety and Health Protection Poster, various types of caution signs (e.g., hearing protection required, eye protection required, authorized personnel only).			

DOCUMENTATION PREPARED

SECTION IV

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Has the Data Quality Objectives plan been approved for the samples being taken, if required?			
2. Has documentation (work plan, work-controlling documents, etc.) been completed and will copies be available for use on-site?			
3. Are appropriate calculations complete?			
4. Has the calculation been filed?			
5. Has the Data Management Plan been reviewed and approved by PIC and the client, if necessary?			
6. Has the Quality Assurance Project Plan (QAPP) been reviewed and approved by the client, if required?			

IDW

SECTION V

	SAT	UNSAT	ACTION ITEM
1. Are waste-storage areas properly defined and is posting material available?			
2. Are proper waste container labels available?			
3. Are security measures available to prevent unauthorized entry into storage areas after mobilization?			
4. Will hazardous waste be stored in tanks?			
5. Is this hazardous waste addressed adequately in the IDW Plan?			
6. If hazardous waste is anticipated, are storage requirements (including 90-day limits) understood?			
7. Have provisions been made to remove waste within 90 days of generation?			
8. Is an IDW awareness sign available for IDW storage area?			
9. Has the IDW Plan been reviewed and approved by the client?			

CONTRACTS/SUBCONTRACTS

SECTION VI

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Have target analyte detection limit requirements			

	SAT	UNSAT	COMMENTS/ACTION ITEMS
been determined, relative to appropriate regulatory action levels?			
2. Has the laboratory coordinator verified that the selected laboratory can meet required detection limits?			
3. Do the Task Orders (TOs) include in the scope of work to be performed, detection reporting limits, QC levels, turnaround times, and special analysis (e.g., hexavalent chromium)?			
4. Has the TOs been approved? Please have a copy of the TOs available at the READINESS REVIEW.			
5. Have equipment/materials/supply requirements been defined and arrangements made?			
6. Have vehicles for field transportation, equipment, and storage requirements been defined and arrangements?			
7. Have emergency repair capabilities been identified and arranged prior to going out to the field (e.g., phone, gas, water, power, and sewer)?			
8. Have arrangements been made for chemical samples to be transported and processed by analytical laboratories?			
9. Are personnel trained and aware of subcontractor change clauses?			
10. Has the PM been made aware of all field service DOs and the schedule requirements?			

Project Name: ____

Date of Readiness Review Meeting: __________________ Date of Fieldwork: _________

Activity:

Location:

Work Plan/Site Safety and Health Plan Title:

1. Does Brown and Caldwell have Notice to Proceed on this task from client?

Yes NA Will Be When:_________________________

2. Have appropriate client personnel been notified of the Schedule of Activities?

Yes NA Will Be When:_________________________

3. Is the Work Plan approved and final?

Yes NA Will Be When:_________________________

4. List the appropriate parcels requiring Rights of Entry and have they been signed?

    Parcel Number: ________________ Location: ____________________________

    Yes NA Will Be When:__________________

    Parcel Number: ________________ Location: ____________________________

    Yes NA Will Be When:__________________

    Parcel Number: ________________ Location: ____________________________

    Yes NA Will Be When:__________________

    Parcel Number: ________________ Location: ____________________________

    Yes NA Will Be When:__________________

    Are Rights of Entry on file in field office?

    Yes NA Will Be When:__________________

Readiness Review Checklist (Level III alternate)
for Site Name: ____

5. Has the property owner been notified in writing of scope and schedule of activities?

Yes NA Will Be When:__________________

6. Subcontractor(s)

A. Is _________________________ under contract?

Yes NA Will Be When:__________________

Is task order signed for this subcontractor?

Yes NA Will Be When:__________________

B. Is ________________________ under contract?

Yes NA Will Be When:__________________

Is task order signed for this subcontractor?

Yes NA Will Be When:__________________

C. Is ________________________ under contract?

Yes NA Will Be When:__________________

Is task order signed for this subcontractor?

Yes NA Will Be When:__________________

7. Laboratory (stationary)

Is ___________________________ under contract?

Yes NA Will Be When:__________________

Is the analytical laboratory ready to receive samples?

Yes NA Will Be When:__________________

Are all appropriate sample containers on-site?

Yes NA Will Be When:__________________

8. Laboratory (mobile) *Not Applicable*

Readiness Review Checklist (Level III alternate)
for Site Name: ______________________________________

9. Laboratory (QA)

Has QA lab been selected? Name:_______________________

Yes NA Will Be When:_________________

Is the QA laboratory ready to receive samples?

Yes NA Will Be When:_________________

10. Laboratory (specialized samples)

Is __________________________under contract?

Yes NA Will Be When:_________________

Is the analytical laboratory ready to receive samples?

Yes NA Will Be When:_________________

Are all appropriate sample containers on-site?

Yes NA Will Be When:_________________

11. Trip blanks on site from________________________ (analytical laboratory name)?

Yes NA Will Be When:_________________

12. Is the courier set-up to pick up samples (if applicable)?

Yes NA Will Be When:_________________

13. Field Office

Is field office equipment (e.g., refrigerator, phone) working properly?

Yes NA Will Be When:_________________

Are field supplies (e.g., coolers, vermiculite, shipping labels, bubble wrap) on-site?

Yes NA Will Be When:_________________

Are decon chemicals on-site with MSDS sheets on file in field office?

Yes NA Will Be When:_________________

Are sample labels prepared?

Yes NA Will Be When:_________________

Readiness Review Checklist (Level III alternate)
for Site Name: ____

14. Documentation

Are field notebooks prepared?

Yes NA Will Be When:__________________

Are sample documentation forms prepared and on-site?

Yes NA Will Be When:__________________

Is database ready to receive sample information?

Yes NA Will Be When:__________________

15. Personnel

Do appropriate Brown and Caldwell personnel have copies of QAPP, General SSHP, work Plan or FSP and site specific SSHP?

Yes NA Will Be When:__________________

Have the QAPP and appropriate SOPs been reviewed?

Yes NA Will Be When:__________________

Has the Work Plan or FSP been reviewed?

Yes NA Will Be When:__________________

Are all Brown and Caldwell personnel current on H&S training?

Yes NA Will Be When:__________________

Are all subcontractor personnel current on H&S training (if applicable)?

Yes NA Will Be When:__________________

Have subcontractors been briefed on QAPP requirements?

Yes NA Will Be When:__________________

Is medical surveillance documentation for Brown and Caldwell personnel and subcontractors on file in field office?

Yes NA Will Be When:__________________

Who is the competent person in charge ____

Readiness Review Checklist (Level III alternate)
for Site Name: ____

16. List the tenants that will be impacted from the field work.

Contact Name: ____

Business Name:____

Location: ____

Has the above tenant been notified when and where work will be conducted?

Yes NA Will Be When:____________________

List any special ROE requirements.

____

Contact Name: ____

Business Name:____

Location: ____

Has the above tenant been notified when and where work will be conducted?

Yes NA Will Be When:____________________

List any special ROE requirements.

____

Contact Name: ____

Business Name:_____NA____

Location:____

Has the above tenant been notified when and where work will be conducted?

Yes NA Will Be When:____________________

List any special ROE requirements.

____

Contact Name: ____

Business Name:____

Location:____

Readiness Review Checklist (Level III alternate)
for Site Name: ____________________________________

Has the above tenant been notified when and where work will be conducted?

Yes NA Will Be When:__________________

List any special ROE requirements.

____

17a. Does this site require UXO construction support (UXO potential moderate to high per EP 75-1-2)?

17b. Does this site require UXO safety support (UXO potential is low per EP 75-1-2)?

17c. Does the site require UXO clearance?

18. Have invasive locations been cleared for underground utilities?

Yes NA Will Be When:__________________

21. Has FA/BC marked the sample locations?

Yes NA Will Be When:__________________

22. Has USA been contacted with regard to underground utilities?

Yes NA Will Be When:__________________

Date: ____

Ticket number(s): ____

Date Expires: ____

21. Has site walk for public utilities been scheduled?

Yes NA Will Be When:__________________

Conducted?

Yes NA Will Be When:__________________

22. Have utilities been marked by all providers?

Yes NA Will Be When:__________________

If not, who? ____

Readiness Review Checklist (Level III alternate)
for Site Name: ______________________________________

23. List all required field equipment. Is equipment on site and in working condition?

Hand auger Drive sampler

PID

Calibration gas within date? PID calibrated?

Calibration log on-site?

pH/EC/temperature meter(s)

pH calibration fluids in date? EC calibration fluids in date?

Meter(s) calibrated? Calibration log on-site?

Other equipment (list)

Equipment: ____

Equipment: ____

Equipment: ____

Equipment: ____

Equipment: ____

Equipment: ____

Equipment: ____

24. List any specialty equipment necessary for this project. Is equipment on-site and in working condition?

Equipment: ____

Yes NA Will Be When:__________________

Equipment: ____

Yes NA Will Be When:__________________

25. Is PPE on-site and inspected?

Yes NA Will Be When:__________________

Readiness Review Checklist (Level III alternate)
for Site Name: ____

26. Has project readiness meeting been held?

Yes NA Will Be When:____________________

Attendees:

Printed Name	Signature	Date

ATTACHMENT G

POST-MOBILIZATION CHECKLIST

POSTMOBILIZATION CHECKLIST

HEALTH & SAFETY

SECTION II

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Are emergency planning requirements met?			
2. Are manifest records complete and correct?			
3. Have lost or missing shipments been traced?			
4. Are appropriate fire extinguishers provided at the site?			
5. Has a list of all required spill control, decontamination, safety, fire protection, and communication equipment specified for facility been made available?			
6. Does required equipment (e.g., fire extinguishers) have established test schedules, and are tests documented?			
7. Has field office space been installed and inspected for safety and the inspection report filed?			
8. Is the contingency plan maintained and kept up to date?			
9. Have appropriate arrangements been made with a local hospital?			
10. Is the site-specific Health and Safety Plan current; has the SSO (or representative) identified and			

	SAT	UNSAT	COMMENTS/ACTION ITEMS
received training, and have all premobilization requirements been met?			
11. Do program personnel meet training requirements (including site-specific orientation, quality orientation, and training to appropriate H&S SOPs)?			
12. Has compliance with medical surveillance program been achieved?			
13. Were special bioassays for program personnel scheduled and completed prior to start of work?			
14. Were special bioassays for subcontractors scheduled and completed prior to start of work?			
15. Is monitoring equipment available and operational?			
16. ARE PPE, site control, and decontamination equipment available and operational?			
17. Are appropriate calibration gases available?			
18. Are decontamination testing methods in place?			
19. Have emergency phone numbers been verified, made part of the site-specific training, and have they been tested, and are they posted?			
20. Are emergency supplies readily available?			
21. Does subcontractor(s) have all applicable health and safety records on-site (e.g., medical fitness			

	SAT	UNSAT	COMMENTS/ACTION ITEMS
records, training classes, Hazard Communication Program)?			
22. Are the Hazardous Communication training records and MSDS filed on-site?			

SITE ARRANGEMENT

SECTION III

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Was work scope reviewed with subcontractors at kick-off meeting?			
2. Has the subcontractor been made familiar with site contacts?			
3. Does the subcontractor have required materials, equipment, and personnel to perform assigned tasks?			
4. Did you check to see if the subcontractor has their Health and Safety Plan on-site?			

SITE INSTRUMENTS AND SUPPLIES

SECTION IV

	SAT	UNSAT	COMMENTS/ACTION ITEMS
1. Have all required supplies been secured and stored on site?			
2. Have all instruments been checked to make sure they can be calibrated and are operational?			
3. Are manufacturers' or suppliers' phone numbers readily available if problems are encountered?			
4. Has an alternative nearby source of supplies been identified?			

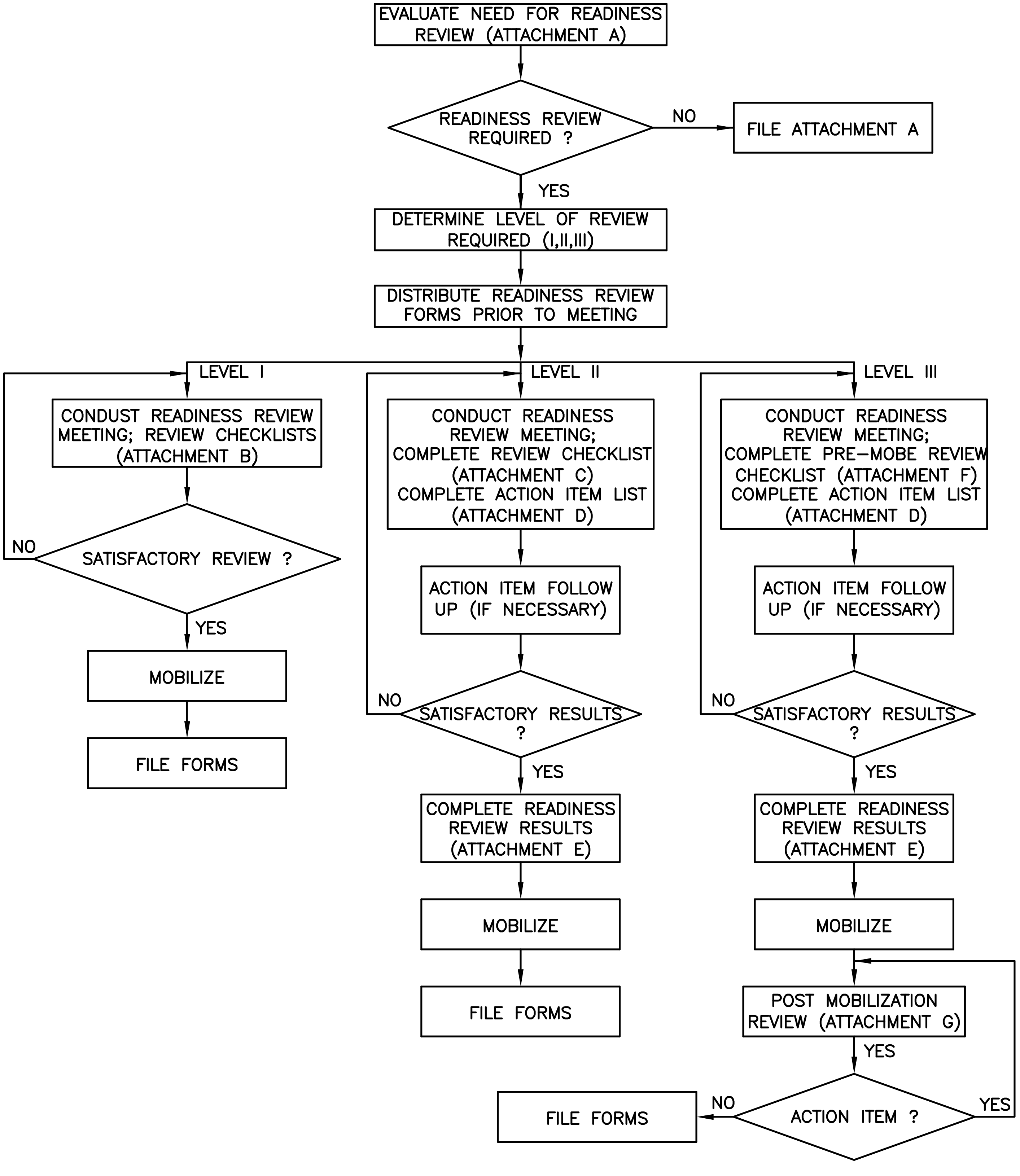
IDW

SECTION V

	SAT	UNSAT	ACTION ITEM
1. Has individual responsible for waste received training? Is it documented?			
2. Are records of storage time being maintained?			
3. Are warning signs posted at facility entrances and each side of storage areas?			
4. Is adequate aisle space maintained between containers in the storage area?			
5. Are storage areas posted with signs legible at 25 feet? Do these signs state, for example, “IDW Storage Area, Unauthorized Personnel Keep Out”?			
6. Are waste materials in storage, within the 90-day limit?			
7. Are containers maintained in good condition (no leaks; all contents of leaking containers are transferred to good containers)?			
8. Are containers compatible with waste?			
9. Are containers maintained closed except when adding waste?			
10. Are containers inspected weekly and are these inspections documented?			

	SAT	UNSAT	ACTION ITEM
11. Does each container have a label with a start date on it?			
12. Has the inspection schedule been developed and implemented?			
13. Are weekly IDW inventory forms filled out regularly and submitted to the PM and FSM?			

Task Manager ____________________ Date __________



DATE
JULY 2001

PROJECT NUMBER
00044

BROWN AND CALDWELL
SAN DIEGO, CALIFORNIA

FIELD READINESS REVIEW ACTIVITIES

PROJECT LOCATION
SAN DIEGO, CALIFORNIA

FIGURE
1

LAF 00044FRR.DWG

Brown and Caldwell
Standard Operating Procedure

Field Classification and Description of Soils and Rock

Revision 1.0
Revision Date: August 10, 2001

Prepared/Revised by: **Wendy Linck** — **August 10, 2001**
Name — Date

Senior QA Review: Jay Lucas — 10/26/01
Name — Date

Regional Quality Officer: — October 26, 2001
Name — Date

FIELD CLASSIFICATION AND DESCRIPTION OF SOILS AND ROCK

TABLE OF CONTENTS

1.0 OBJECTIVES

This objective of this Standard Operating Procedure (SOP) is to establish a consistent method for Brown and Caldwell staff to follow when completing the description of soil and rock samples obtained from field sampling efforts and entry into borehole logs. Consistency with description is important because during many projects multiple employees may be involved at different times. Hence, being able to compare between logs that were created by different geologists is essential for creating subsurface interpretations.

2.0 SCOPE AND APPLICABILITY

This procedure will be used during all field activities when bore hole subsurface drilling, surface soil or rock sampling, reconnaissance geological mapping is occurring. These activities should be documented as described herein, and following the SOP for Field Notes and Documentation.

3.0 RESPONSIBILITIES

The Project Manager (PM) shall ensure that the soil or rock classification and description procedures used in the field conform to the guidelines in this SOP. The PM shall ensure that all field personnel providing descriptions are properly trained to conduct this task and are providing descriptions under the oversight of a Senior Geologist registered in the state in which the logging is occurring. If the state does not have requirements for registration, then the Senior Geologist should meet the standards for a professional geologist under that states law or be registered in another state. The Field Supervisor is responsible for reviewing lithologic logs for accuracy and completeness prior to releasing them to the project manager for review. The Field Geologist is responsible for following the soil classification and description procedures in this SOP, and for accurately and completely representing the lithology encountered in the field

4.0 DEFINITIONS

ASTM. American Society for Testing Materials.

Feldpathoids. Alkali (potassium) or basic (plagioclase) feldspar.

IUSG. International Union of Geological Sciences

USCS. Unified Soil Classification System.

5.0 MATERIALS REQUIRED

The materials required for completing the procedures outlined in this SOP, at a minimum, include the following:

- Hand lens
- Field notebook and borehole log forms
- Protractor
- Pencils
- Pocket knife
- Dilute hydrochloric acid in small dispenser
- Field charts of grain size examples (e.g., American Geological Institute [AGI] data sheets)
- Squirt bottle with water
- Compass with altimeter

6.0 METHODS

The following sections provide guidance for how proper field visual descriptions of soils and rock samples should be conducted. These methods may not be applicable to every soil or rock sample found, but should provide enough guidance to allow accurate and defensible descriptions by a variety of field geologists.

6.1 DESCRIPTION OF SOILS

The following section provides a description of the procedures that should be used when describing soils.

6.1.1 General Considerations

The most popular soil classification method that is based on grain size and other properties, is the Unified Soil Classification System (USCS). This system was initially developed by A. Casagrande in 1948 and was then called the Airfield Classification System. It was adopted with minor modifications by the U.S. Bureau of Reclamation and the U.S. Corps of Engineers in 1952. In 1969, the American Society for Testing and Materials (ASTM) adopted the system. This system is designated currently by ASTM as D-2488-90 and will be used as a guideline for classifying and describing lithology. It requires certain information (e.g. liquid limit, plastic limit moisture content and plasticity index) about the soil which can only be obtained in a laboratory.

The USCS is based on grain size and response to physical manipulation at various water contents. This system is often used for classifying soils encountered in boreholes, test pits, and surface sampling. The following properties form the basis of USCS soil classification:

- Percentage of gravel, sand, and fines;
- Shape of the grain size distribution curve; and
- Plasticity and compressibility characteristics.

Four soil fractions are recognized. They are cobbles, gravel, sand, and fines (silt or clay). The soils are divided as coarse grained soils, fine grained soils, and highly organic soils. The coarse grained soils contain 50 percent of grains coarser than a number 200 sieve (approximately 0.08 mm). Fine grained soils contain more than 50 percent of material smaller than the number 200 sieve. Organic soils contain particles of leaves, roots, peat, etc.

6.1.2 Soil Description Procedures

The following will be used as a guideline for logging lithology from subsurface activities (i.e. borehole drilling, trenching, etc.).

The USCS recognizes 15 soil groups and uses names and letter symbols to distinguish between these groups. The coarse grained soils are subdivided into gravels (G) and sands (S). Both the gravel and sand groups are divided into four secondary groups. Fine grained soils are subdivided into silts (M) and clays (C).

Soils are also classified according to their plasticity and grading. Plastic soils are able to change shape under the influence of applied stress and to retain the shape once the stress is removed. Soils are referred to either low (L) or high (H) plasticity. The grading of a soil sample refers to the particle size distribution of the sample. A well graded (W) sand or gravel has a wide range of particle sizes and substantial amounts of particles sized between the coarsest and finest grains. A poorly graded (P) sand or gravel consists predominately of one size or has a wide range of sizes with some intermediate sizes missing.

Soils which have characteristics of two groups are given boundary classifications using the names that most nearly describe the soil. The two groups are separated by a slash. The same is true when a soil could be well or poorly graded. Again the two groups are separated by a slash.

Soil description should be concise and stress major constituents and characteristics for fine-grained, organic, or coarse-grained soils. Tables 1 and 2 are checklists for descriptions of fine-grained, organic soils, and coarse-grained soils, respectively. Field descriptions should include as a minimum:

Soil name. The basic name of the predominant constituent and a single-word modifier indicating the major subordinate constituent;

Particle Size Distribution. An estimate of the percentage and grain-size range of each of the soil's subordinate constituents with emphasis on clay-particle constituents. This description may also include a description of angularity. This parameter is critical for assessing hydrogeology of the site and should be carefully and fully documented;

Gradation or Plasticity. For granular soil (sands or gravels) that should be described as well-graded, poorly graded, uniform, or gap-graded, depending on the gradation of the minus 3-inch fraction. Cohesive soil (silts or clays) should be described as non-plastic, low plastic, medium plastic, or highly plastic. The table below summarizes how to grade plasticity based on simple field tests.

Criteria for Describing Plasticity

Descriptive item	Criteria
Nonplastic	A 1/8 inch (3 mm) thread cannot be rolled at any moisture content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.

High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times close to the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Dry Strength. Dry strength describes the crushing characteristics of a dry soil crumb about ¼ inch (5 mm) in diameter. If a crumb of dry soil is not available, after removing particles larger than No. 40 sieve size, mold at least three balls of soil about ¼ inch (5 mm) in diameter to the consistency of putty, adding water if necessary. Allow the balls to dry completely by oven, sun, or air drying, and then test their strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity. The table below includes criteria for determining dry strength descriptions in the field.

Criteria for Describing Dry Strength

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

Dilatancy. Dilatancy describes the soils reaction to shaking. After removing particles larger than No. 40 sieve size, prepare a ball of moist soil about ½ inch (15 mm) in diameter. Add enough water, if necessary, to make the soil soft but not sticky.

Place the ball in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the ball which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the ball stiffens, and finally cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil. The table below outlines the criteria for determining dilatancy in the field.

Criteria for Describing Dilatancy

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

<u>Toughness.</u> Toughness is the consistency of the soil near the plastic limit. After removing particles larger than the No. 40 sieve size, mold a ball of soil about ½ inch (15 mm) in diameter to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. The specimen is then rolled out by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. The thread is folded and rerolled repeatedly. During this manipulation, the moisture content is gradually reduced and the specimen stiffens, finally loses it

plasticity, and crumbles when the plastic limit is reached. The table below outlines criteria for determining toughness in the field.

Criteria for Describing Toughness

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

Moisture Content. The amount of soil moisture described as dry, moist, or wet/saturated;

Criteria for Describing Moisture

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

Color. The basic color of the soil. (Refer to Munsell soil color charts.);

Odor. Odor is described from a warm, moist sample. The odor should only be described if it is organic or unusual. An organic odor will have distinctive decaying vegetation smell. Unusual odors, petroleum product, chemical, and the like should be described.

Soil Texture and Structure. Description of particle size distribution, arrangement of particles into aggregates, and their structure. This description includes joints, fissures, slicked sides, bedding, veins, root holes, debris, organic content, and residual or relict structure, as well as other characteristics that may influence the movement or retention of water or contaminants;

Structure (for description of soils only)

Descriptive item	**Criteria**
Stratified	Alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
Laminated	Alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small lenses of sand scattered through a mass of clay; note thickness.
Homogeneous	Same color and appearance throughout.

Relative Density or Consistency. An estimate of density of a fine-grained soil or consistency of a cohesive soil, usually based on standard penetration tests;

Criteria for Describing Consistency

Descriptive item	Criteria
Very soft	Thumb penetrates soil more than 1 inch
Soft	Thumb penetrates about 1 inch
Firm	Thumb indentation up to ¼ inch
Hard	No indentation with thumb, readily indented with thumbnail
Very Hard	Not indented with thumbnail

Cementation. An estimate of cementation of a coarse-grained soil.

Criteria for Describing Cementation

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

Relative Permeability. An estimate of the permeability based on visual examination of materials (e.g., high permeability for course sand and gravel verses low permeability for silty clay). The estimate should address presence and condition of fractures (open, iron-stand, calcite-filled, open but claylined, etc.), as well as fracture density and orientation;

Local Geologic Name. Any specific local name or generic name (i.e., alluvium, loess); and

Group Symbol. USCS of symbols.

The soil logs should also include a complete description of any tests run in the borehole; placement and construction details of piezometers, wells, and other monitoring equipment; abandonment records; geophysical logging techniques used; and notes on readings obtained by air monitoring instruments.

6.2 DESCRIPTION OF ROCK

The following section provides a description of the procedures that should be used when describing rock samples.

6.2.1 General Considerations

Rock identification is based on minerals and textures. Drilling in rock will be slow and core recovery may consist of pulverized chips. The proper drilling technique is necessary for adequate recovery and accurate rock identification.

6.2.2 Rock Description Procedures

Rocks can be categorized into three types: sedimentary, igneous, and metamorphic. Descriptions for these three types of rocks are different. The following procedures are organized following the three categories.

Sedimentary Rock Classification. Sedimentary rocks result from two processes (and combinations thereof):

- Consolidation of loose sediments that have accumulated in layers, forming clastic rocks.
- Precipitation from solution to form a chemical rock. Included in this category are rocks directly or indirectly formed by biological processes.

The following text summarizes how to characterize these two types of sedimentary rock.

Clastic Rocks. Clastic rocks have been classified different ways. They may be classified according to the size of particles, sorting, and distribution of particles, or chemical content of silica, feldspar, and calcite.

Grain Size. In the most commonly used classification system, the size of the particles determines the general rock name. For example, sand-sized particles for sandstones; pebbles form conglomerates, and so on. The rack names are shown in the table below along with their component particle sizes. The divisions in the classification are based upon the Modified Wentworth scale used to measure grain size.

Grain Size Scale (Modified Wentworth Scale)

Diameter (in)	Particle	Sediment	Rock
< 0.0002	Clay	Mud	Claystone, mudstone, shale
0.0002 to 0.002	Silt		Siltstone
0.002 to 0.08	Sand	Sand	Sandstone
0.08 to 2.5	Pebble	Gravel	Conglomerate (rounded) Breccia (angular)
2.5 to 11.8	Cobble		
> 11.8	Boulder		

Conglomerates and breccias have adjectives such as *clast-supported and matrix supported*. *Clast-supported* means that he clasts are sorted well enough so that the large clasts touch, and *matrix-supported* is not.

A well-sorted sandstone is called an arenite. A poorly sorted sandstone with a matrix of silt and clay is called a wacke. A sandstone with more than 25% feldspar is an arkose. And, if lithic fragments or iron and magnesium minerals and feldspar are present along with quartz sand and silt, the rock is called a graywacke.

Sorting. Sedimentary rock names are further characterized by the sorting the particles have undergone. The distribution of grain sizes reflects the type of transport a sediment has experienced and the depositional environment. A well-sorted (or poorly graded) sediment has two or three sizes present. A poorly sorted (or well-graded) sediment has a wide range of grain sizes present.

Cementation. Cementing substances have usually been referred to by adjectives such as calcareous, dolomitic, and siliceous; however, these terms might also imply accessory detrital materials, so that the unambiguous terms calcite-cemented, dolomite-cemented, and quartz-cemented are recommended.

Chemical Rocks. Chemical rocks have been classified according to chemical composition, depositional texture, and depositional environment.

Common chemical rocks are limestone, dolomite, evaporites (gypsum, anhydrite, halite, etc.) phosphate rocks (apatite), manganese nodules, ironstones (limonite, siderite, and chlorite silicates), coal, pyrite, chert, and diatomite, and some cherts have a biogenic component to their formation.

Igneous Rock Classification. Classification of igneous rocks is based upon the mineral content of the rock. Minerals upon which the classification is based are feldspar, quartz (or feldspathoids), and mafic minerals such as biotite, hornblende, pyroxene, and olivine. Of these minerals, identifying feldspar is the key to classification.

The International Union of Geological Sciences (IUGS), Sub commission on the Systematics of Igneous Rocks attempted to create a universal classification of igneous rocks. The committee's recommendations for plutonic and volcanic rocks are shown in the following two tables, respectively. A rock is classified by determining it composition relative to the percentage of alkali feldspar, plagioclase, and quartz (or feldspathoid).

Modal Classification of Plutonic Igneous Rocks

Modal Values	**Classification**
Q > 60	Not igneous
Q = 20-60, P <10	Alkali feldspar granite
Q = 20-60, P = 10-65	Granite
Q = 20-60, P = 65-90	Granodiorite
Q = 20-60, P >90	Tonalite
Q = 5-20, P <10	Alkali feldspar quartz syenite
Q = 5-20, P = 10-35	Quartz syenite
Q = 5-20, P = 35-65	Quartz monzonite
Q = 5-20, P = 65-90	Quartz monzodiorite (An < 50), Quartz monzogabbro (An > 50), Quartz anorthosite (M < 10)
Q = 5-20, P >90	Quartz diorite (An < 50), Quartz gabbro (An > 50), Quartz anorthosite (M < 10)
Q = 0-5, P <10	Alkali feldspar syentie
Q = 0-5, P = 10-35	Syenite
Q = 0-5, P = 35-65	Monzonite
Q = 0-5, P = 65-90	Monzodiorite (An < 50), Monzogabbro (An > 50), Anorthosite (M < 10)
Q = 0-5, P >90	Diorite (An < 50), Gabbro (An > 50), Anorthosite (M < 10)
F = 0-10, P <10	Foid-bearing alkali feldspar quartz syenite
F = 0-10, P = 10-35	Foid-bearing syenite
F = 0-10, P = 35-65	Foid-bearing monzonite
F = 0-10, P = 65-90	Foid-bearing monzodiorite (An < 50), Foid-bearing monzogabbro (An > 50)
F = 0-10, P >90	Foid-bearing diorite (An < 50), Foid-bearing gabbro (An > 50)
F = 10-60, P <10	Foid syenite
F = 10-60, P = 10-50	Foid monzosyenite
F = 10-60, P = 50-90	Foid monzodiorite (An < 50) Foid monzogabbro (An > 50)
F = 10-60, P >90	Foid diorite (An < 50), Foid gabbro (An > 50)
F > 60	Foidolites

Q = quartz/(quartz = alkali feldspar = plagioclase)
F = feldspathoids/(feldspathoids = alkali feldspar)
P = feldspathoids/(feldspathoids = plagioclase feldspar)
M = color index
An = % anorthite inplagioclase

Modal Classification of Volcanic Igneous Rocks

Modal Values	Classification
Q > 60	Not igneous
Q = 20-60, P <10	Alkali feldspar rhyolite
Q = 20-60, P = 10-65	Rhyolite
Q = 20-60, P = 65-90	Dacite
Q = 20-60, P >90	Dacite
Q = 5-20, P <10	Alkali feldspar quartz trachyte
Q = 5-20, P = 10-35	Quartz trachyte
Q = 5-20, P = 35-65	Quartz latite
Q = 5-20, P = 65-90	In all six fields, the names andesite and basalt are applied; basalt is used if SiO_2 < 52wt % after H_2O and CO_2 are deleted and the analysis recalculated to sum 100%
Q = 5-20, P >90	
Q = 0-5, P = 65-90	
Q = 0-5, P >90	
F = 0-10, P = 65-90	
F = 0-10, P >90	
Q = 0-5, P <10	Alkali feldspar trachyte
Q = 0-5, P = 10-35	Trachyte
Q = 0-5, P = 35-65	Latite
F = 0-10, P <10	Foid-bearing alkali feldspar quartz trachyte
F = 0-10, P = 10-35	Foid-bearing trachyte
F = 0-10, P = 35-65	Foid-bearing latite
F = 10-60, P <10	Phonolite
F = 10-60, P = 10-50	Tephritic phonolite
F = 10-60, P = 50-90	Phonolitic tephrite
F = 10-60, P > 90	Tephrite (olivine < 10%) Basanite (olivine > 10%)
F > 60	Foidite

Q = quartz
P = feldspathoids/(feldspathoids = plagioclase feldspar)
F = feldspathoids/(feldspathoids = alkali feldspar)

Metamorphic Rock Classification. In this binomial system for naming metamorphic rocks, the main rock name is based on the texture of the rock, and the principal or more significant minerals are added as modifying nouns, as in biotite-quartz schist or andalusite-cordierite hornfels. The names are meant to be applied on a descriptive basis; a schistose rock, for example, should not be called a hornfels just because it is found in a contact aureole.

Textures.

- Schistose – grains platy or elongate and oriented parallel or subparallel. *Foliated* (lepidoblasitc) of fabric is planar, *lineated* (nematoblastic) if linear.
- Granobalstic – grains approximately equidimensional; platy and linear grains oriented randomly or so subordinate that foliation is not developed.
- Hornfelsic – grains irregular and interincluded but generally microscopic; recognized in field by unusual toughness, ring to hammer blow, and hackly fracture at all angles. Under hand lens, freshly broken surfaces show a sugary coating that will not rub off (formed by rending of interlocking grains).
- Semischistose (gneissic) – platy or linear grains subparallel but so subordinate or so unevenly distributed that rock has only a crude folliation; especially common in metamorphosed granular rocks, such as sandstones and igneous rocks.
- Cataclastic – clastic textures resulting from breaking and grinding with little if any recrystallization; characterized by angular, lensoid, or rounded fragments (porphyroclasts) in a fine-grained and commonly streaked or layered

- Groundmass. *Mortar structure* applies to nonorientated arrangements, and *phacoidal*, *flaser*, and *augen structure* apply to lenticular arrangements.

Rock Names.

Schistose Rocks.

- Schist – grains can be seen without using a microscope.
- Phyllite – all (or almost all) grains of groundmass are microscopic, but cleavage have sheen caused by reflections from platy or linear minerals; commonly corrugated.
- Slate – grains are microscopic; very cleavable; surface dull; tougher than shale and cleavage commonly oblique to bedding.
- Phyllonite – appearance like phyllite but formed by cataclasis (see mylonite) and recrystallization commonly of coarser-grained rocks, as indicated by relict rock slices, slip folds, and prophyroclasts.

Granoblastic Rocks.

- Granulite or Granofels – granoblastic rocks, irrespective of mineral composition; because granulite can connote special compositions and conditions or origin, granofels may be preferred.
- Quartzite, marble, and amphibolite – compositional names that generally connote granoblastic texture; exceptions should be modified for clarity, as schistose quartzite or plagioclase hornblende schist.
- Tactite (skarn) – heterogeneous calc-sillicate granulites and related metasomatic rocks of typically uneven grain.

Hornfelsic Rocks. All called hornfels, or, if relict features are clear, hornfelsic may be used with the original rock name (as hornfelsic andesite)

Semi-schistose (Gneissic) Rocks.

- Semi-schist – fine-grained (typically less than 1.4 mm) so that individual platy or lineate grains are indistinct; relict features often common.
- Gneiss – generally coarser than ½ mm with small aggregates of platy or lineate grains forming separate lenses, bladed, or streaks in otherwise granoblastic rock. Platy or lineate structures may be distributed evenly through the rock or may be concentrated locally so that some layers or lenses are granoblastic or schistose (banded gneiss).

Cataclastic Rocks. Where original nature of rock is still apparent, rock name can be modified by suitable adjectives (as cataclastic granite, flaser gabbro, phacoidal rhyollite).

- Mylonite – crushing so thorough that rock is largely aphanitic and commonly dark-colored; may be layered and crudely folliated but not schistose like phyllonite; porphyroclasts commonly rounded or lenticular.
- Ultrmylonite, pseudotachyylyte – aphanitic to nearly vitreous-appearing dark rock commonly injected as dikes into adjoining rocks.

Relict and Special Textures and Structures. If textures of low-grade metamorphic rocks are dominantly relict, original rock names may be modified (as massive metabasalt, semischistose met-andesite). If hydrothermal alteration has produces prominent new minerals, names such as chloritized diorite and sercitized granite can be used.

- Strongly metasomatized rocks with coarse or unusual textures may require special names such as gneissen, quartz-schorl rock, and corundum-mica rock.
- Magmatite – a composite rock composed of igneous or igneous-appearing and/or metamorphic materials that are generally distinguishable megascopically.

7.0 REFERENCES

American Society for Testing and Materials (ASTM), 1990, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), ASTM Standard D-2488-90.

Dunn, I.S., Anderson, L.R. and Kiefer, F.W., 1980, Fundamentals for Geotechnical Analysis, John-Wiley, New York.

Compton, Robert R., 1985, Geology In The Field, John Wiley & Sons, New York.

Osiecki, P. and Dirth, L., 1996, RG Exam Study Guide.

International Union of Geological Sciences (IUGS) Sub commission on the Systematics of Igneous Rocks, 1973, "Plutonic rocks, classification and nomenclature," *Geotimes*, 18, no. 10, pg. 26-30.

U.S. Bureau of Reclamation, Geotechnical Branch, 1986, Visual Classification of Soils, Unified Soil Classification System, Denver, Colorado.

8.0 ATTACHMENTS

Attachment A - Checklist for the Description of Fine-Grained Soils
Attachment B - Checklist for the Description of Coarse-Grained Soils

ATTACHMENTS

Attachment A

Checklist for Description of Fine-grained and Organic Soils

Items of descriptive data	Typical information desired for silt and clay
Group name	SILT, LEAN CLAY, ETC., include cobbles and boulders in typical name when applicable.
Size distribution	Approximate percent of fines, sand, and gravel of fraction less than 3 inch in size; must add to 100 percent
Plasticity of fines	Nonplastic; low; medium; high
Dry strength	None; low; medium; high; very high
Dilatancy	None; slow; rapid
Toughness near plastic limit	Low; medium; high
Moisture condition	Dry; moist; wet
Color	Munsell color chart; if possible, note mottling or banding
Odor	Only mention of organic or related to contaminants
Structure	Stratified; laminated; fissured; slickensided; blocky; lensed; homogeneous
Consistency	Very soft; soft; firm; hard; very hard
Relative Permeability	Low; medium; high; fractures, open, iron-stand, calcite-filled, open but claylined
Local Geologic Name	If applicable
Group symbol	CL, CH, ML, MH, OL/OH, or appropriate borderline symbol when applicable; should be compatible with typical name used above

Attachment B

Checklist for Description of Coarse-grained Soils

Items of descriptive data	Typical information desired for sand and gravel
Group name	WELL-GRADED GRAVEL WITH SAND, ETC., will include cobbles and boulders in typical name when applicable.
Gradation	Describe range of particle sizes, such as fine to medium sand or fine to coarse gravel, or the predominant size or sizes as coarse, medium. Fine sand or coarse or fine gravel.
Size distribution	Approximate percent of gravel, sand, and fines in the fraction finer than 3 inch; must add to 100 percent.
Plasticity of fines	Nonplastic; low; medium; high
Particle shape	Flat, elongated, or flat and elongated (if applicable)
Particle angularity	Angular; subangular; subrounded; rounded
Moisture condition	Dry; moist; wet
Color	Munsell color chart
Odor	Only mention of organic or related to contaminants
Structure	Stratified; lensed; homogeneous
Cementation	Weak; moderate; strong
Relative Permeability	Low; medium; high; fractures, open, iron-stained, calcite-filled, open but claylined
Local Geologic Name	If applicable
Group symbol	GP, GW, SP, SW, GM, GC, SM, SC, or the appropriate symbol when applicable; should be compatible with typical name used above
Mineralogy	Rock hardness for gravel and coarse sand. Note presence of mica flakes, shaly particles, or organic matter.

Brown and Caldwell
Standard Operating Procedure

Field Measurements of Organic Vapors

Revision 1.1
Revision Date: October 26, 2001

Prepared/Revised by:	Wendy Linck Name	October 26, 2001 Date
Senior QA Review:	Jay Lucas Name	10/26/01 Date
Regional Quality Officer:	Van Winkle Name	October 26, 2001 Date

Brown and Caldwell
Standard Operating Procedure

Field Measurement of Organic Vapors
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FIELD NOTES AND FIELD DOCUMENTATION

TABLE OF CONTENTS

1.0 OBJECTIVES

This standard operating procedure (SOP) describes the procedures and guidance to conduct soil gas field surveys or headspace measurements of organic vapors in environmental samples. In order to keep this document relatively brief, specific procedures regarding calibration and use of particular instruments are not described except in general terms. The reader should **always** review and understand the manufacturer instructions for each instrument used.

2.0 APPLICABILITY

This procedure will be used during those field activities that require monitoring of organic vapors. These activities may include, but are not limited to, all types of media sampling (soil vapor, soil, groundwater, etc), utility clearance, well installation, sample point locating and surveys, site reconnaissance, free product removal, remediation, and waste handling.

This field procedure is used in determining the concentrations of various volatile organic compounds (VOCs) in soil gas samples. It is applicable to all project team personnel and subcontractors who collect samples for organic vapor measurements.

The rapid detection of VOCs at hazardous waste sites during sampling, cleanup and remedial investigation activities allows onsite analytical screening of air, water, sediment, and soils. These measurements can be used to evaluate risk/exposure while performing site activities and as a basis for setting health and safety levels of protection.

Field measurements of volatile organic vapors will be achieved using one or more of the following instruments:

- Photoionization Detector (PID)

- Flame Ionization Detector (FID)
- Combustible Gas Indicator (CGI)
- Oxygen Meter (LEL/O_2)
- Direct Reading Colorimetric Indicator Tubes
- Field Gas Chromatograph (GC) with applicable detector (not addressed in this SOP - usually a Subcontractor is hired to conduct these sensitive measurements).

3.0 RESPONSIBILITY

The Project Manager (PM) is responsible for supervising the development of the necessary project planning documents. The PM assigns trained, qualified personnel to conduct organic vapor measurements as described in the procedure, and ensures that all field personnel are thoroughly proficient in the use, maintenance, and calibration of all field equipment to be used. The PM also ensures that the necessary equipment and supplies are obtained for the measurement of organic vapors.

The Field Supervisor is responsible for the supervision of daily operations as related to organic vapor measurements. This individual will oversee the collection and documentation of all field data generated. The Field Supervisor will ensure that the equipment used by the operator is calibrated at the appropriate frequency, and maintained and operated correctly at all times.

The Quality Assurance/Quality Control (QA/QC) Officer will review all QA plans and documents to ensure that all organic vapor measurements are precise, accurate, representative, complete, and comparable. The QA/QC officer may schedule and facilitate field audits and QA/QC reviews.

The field sampling personnel will be responsible for the understanding and implementing this SOP during all field activities, as well as, obtaining the appropriate field logbooks, field records, instruments, materials and calibration standards necessary to complete the field task.

4.0 DEFINITIONS

Volatile Organic Compounds (VOCs). These chemicals are a group of organic compounds that have a tendency to evaporate when exposed to air.

Photoionization Detector (PID). This instrument detects total concentrations of many organic and some inorganic gases and vapors. Molecules are ionized using ultraviolet radiation. A current is produced in proportion to the number of ions present.

Headspace gases. These gases are the accumulated gaseous components found above solid or liquid layers in closed vessels.

Flame Ionization Detector (FID). This instrument detects total concentrations of many organic gases and vapors. Gases and vapors are ionized in a flame. A current is produced in proportion to the number of carbon atoms present.

Initial Calibration. A process whereby analysis of analytical standards for a series of different specified concentrations is used to define the linearity and dynamic range of the response of an instrument to the target compounds.

Continuing Calibration Verification. A process where an analytical standard is run periodically to verify the instrument calibration.

Combustible Gas Indicator (CGI) measures the concentration of a combustible gas or vapor. A filament, usually made of platinum, is heated by burning the combustible gas or vapor and the increase in heat is measured.

Ionization Potential. (IP) is the potential difference through which a bound electron must be raised to free it from the atom or molecule to which it is attached. In particular, the ionization potential is the difference between the initial state, in which the electron is bound, and the final state, in which the electron is at rest, at infinity.

5.0 REQUIRED MATERIALS

The materials required for this SOP include the following:

- Bound field logbooks,
- Black waterproof and/or indelible ink pens,
- The organic vapor measurement instruments required for meeting particular project objectives,
- Results from previous organic vapor measurements at a site, if available and applicable,
- Instrument Calibration records, and
- Health and safety monitoring records and sign-off sheets.

6.0 METHODS

This SOP includes methods for using different groups or types of instruments. As mentioned before five different vapor monitors will be discussed:

- Photoionization Detector (PID)
- Flame Ionization Detector (FID)
- Combustible Gas Indicator (CGI)
- Lower Explosive Limit/Oxygen Meter (LEL/O_2)
- Direct Reading Colorimetric Indicator Tubes

A field Gas Chromatograph (GC), while applicable for monitoring organic vapors, is typically not handled by Brown and Caldwell staff during normal site evaluations. Instead Subcontractors operate these instruments, following SOPs developed for a particular instrument type. The instruments listed above provide several advantages to field investigations of organic vapors including:

- The analysis of organic vapors by FID or PID, in conjunction with a gas chromatograph (GC) for an onsite, real-time assessment of potentially contaminated soil, water and air, has become an increasingly useful tool in measuring depth and lateral extent of contamination.

- Organic vapor measurement is both cost and time effective.

- Calibration and maintenance shall be as specified in Health and Safety Plan or, if unlisted, according to manufacturer specifications. At a minimum, calibrations shall be performed or checked daily, prior to start of field activities when using PID instruments.

- Operation of PID instruments should also be tested using the calibration span gas whenever field readings are suspect.

The following subsections provide information regarding the use of the five different types of organic vapor monitors (OVMs) and their applications.

6.1 Photoionization Detectors (PID)

There are numerous portable *organic vapor meters* available which utilize the principle of photoionization. These instruments are portable, and contain a non-specific vapor/gas detector that employs the principle of photoionization to detect a wide variety of organic and inorganic chemical compounds.

These instruments can be used in many applications including screening soil samples, screening ambient air conditions, monitoring breathing zones, and checking the presence of organic vapors at the well heads. The standard equipment required for field measurement of volatile organic vapors using the PIDs are an eV (electron volt) lamp assembly, span gas air calibration standard (e.g., 100 ppmv isobutylene); and an AC-battery recharging unit.

Selection of Lamp. The meters may be fitted with different lamps of varying electron volt ratings. Typical electron volt ratings include 9.5, 10.2, and 11.7 eV. The lamp rating must be higher than the ionization potential of the chemical(s) being monitored. Attachment A includes common ionization potentials for common chemicals found in environmental investigations. The operator is responsible for ensuring that the lamp which best matches those compounds that are expected is used.

Commercially prepared standard span gases are available from companies who rent these meters. The choice of standards is dependent on the monitoring requirements for the actual chemical compounds at each facility. Typically, zero air and 100 ppm isobutylene is sufficient for most applications.

Startup and Calibration. Instrument calibration or calibration check is required at the beginning of each workday. Calibration can also be tested any time a reading needs verification by connecting the instrument to the span gas sample and observing results. Prior to instrument calibration, a tedlar bag should be filled with the calibration span gas. The sampling bag should also be outfitted with a three- to four-inch piece of tubing to direct the gas into the instrument. Specific calibration procedures should always follow the manufacturer's instructions.

Typically calibration for most PIDs follows a sequence where the instrument is turned on and allowed to warm up for some specified time (usually a few minutes), and then a sequence of parameters are set through buttons or dials to get the instrument into a calibration mode. The tedlar bag with calibration gas is then attached via tubing to the instrument intake or inlet probe, followed by a reading of the instrument output and calibration verification. Once through this process the instrument is ready to use for field measurements. Instrument calibration should be checked at regular intervals as outlined in project–specific planning documents. Should unusual measurements be noted, the instrument also should be recalibrated.

The following calibration and operation information must be logged in the field notebook for quality assurance documentation:

- Instrument model and serial number;
- Date;
- Calibration gas concentration;
- Initial span setting and actual reading; and
- Comments (i.e., adjustments, cleaning requirements).

Some projects may require this information to be logged on a calibration log form instead of recording the information in the field notebook (or both places).

Other Considerations. All instruments should be plugged into their respective charging units at the end of each day to ensure ample power supply for the next days use. If any instrument will not be used for an extended period of time, it should be placed back into its shipping/storage case. To maintain a fully charged battery, turn off the instrument when not in use. Additional uses and time saving tips can be found in the users guide that accompanies each instrument.

6.2 Flame Ionization Detection (FID)

This class of instruments uses ionization as the detection method, much the same as the PID, except that the ionization is caused by a hydrogen flame, rather than by a UV light. This flame has sufficient energy to ionize any organic species with an IP of 15.4 or less. The ions are then passed between two charged plates. The conductivity charge is measured and converted to ppm measurements.

FIDs typically are portable units that consist of two major parts: a main body that contains, support electronics, FID, hydrogen gas cylinder, and an optional GC column, and a hand-held meter/sampling probe assembly.

The pressure of hydrogen gas in the FID unit must be sufficient for unit operation. A field sample contained in a tedlar bag or ambient air can be routed through the OVA into the detector, allowing all organic species to be ionized and detected simultaneously. Based on the sensitivity of the instrument to various compounds, an overall organic vapor concentration is displayed on the display panel.

Startup and Calibration. The operator may refill the FID with hydrogen gas if access to a hydrogen gas tank is provided. Once the unit is assembled and switched on, the internal hydrogen gas cylinder should be opened and pressure monitored until the valve indicates sufficient hydrogen line pressure has been obtained. Once this pressure has been obtained, the flame igniter button must be pushed for several seconds to ignite the FID. On most units a low audible sound is evident once ignition occurs. If this sound is not heard it indicates that either the flame did not light or background noises were greater than the ignition “click” sound.

The FID must be tested prior to field use by switching the concentration interval on the unit to the lowest setting (0-10 ppm), and placing a source of organic vapors (such as a marker pen or fuel tank vapor) up to the FID inlet wand to see if it provides a reading. If no reading is evident, the flame must be re-lit using the igniter button followed by the test procedure described.

Typically the manufacturer performs calibration of these instruments, with field personnel verifying that calibration is still maintained through gas standards. Certified gas/vapor standards may be obtained through certified or approved vendors as necessary for identification or quantification of specific VOCs.

Other Considerations. A highly concentrated sample introduced to the FID often causes a flameout in which another "click" sound may be heard and readings will decrease to zero. In this instance, the FID will need re-ignition.

Instrument attachments (needle valves) are available to read high concentration vapors. The proper readout range must be selected during instrument use. The OVA responds differently to different compounds. The following table presents relative responses as a percentage of the methane standard. The instrument operator should adjust the readings accordingly if the compound being measured is known.

Relative Response of the Century OVM to Different Compounds

COMPOUND	RELATIVE RESPONSE (%)
Methane	100
Ethane	90
Propane	64
n-Butane	61
n-Pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Acetone	100
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
Methanol	15
Ethanol	25
Isopropyl alcohol	65
Carbon tetrachloride	10
Chloroform	70
Trichloroethene	72
Vinyl chloride	35

A more complete listing of relative responses for different chemicals can be found in Attachment B.

All instruments should be plugged into their respective charging units at the end of each day to ensure ample power supply for the next day's use. If any instrument will not be used for an extended period of time, it should be placed back into its shipping/storage case. To maintain a fully charged battery, turn off the instrument when not in use. Additional uses and time saving tips can be found in the users guide that accompanies each instrument.

6.3 Combustible gas indicators (CGI)

This class of instruments is used to determine the potential for combustion or explosion of unknown atmospheres. These instruments, in combination with oxygen detectors and instruments as outlined in project planning documents, should be the first monitors used when entering a hazardous area. In this sense they provide a general indication of the degree of immediate hazard to personnel and can be used to assist the safety officer in making decisions on levels of protection required at the site. However, they provide little or no information about the presence of compounds, hazardous or toxic, at trace level concentrations.

A CGI consists of three primary components: the sensor (hotwire, catalytic, solid state, etc.), signal processor, and readout display. A sample is introduced to the sensor either by diffusion into a passive sensor or by pumping.

The sensor produces a signal, which is processed and displayed as the ratio of the combustible gas present to the total required to reach the lower explosive limit (LEL).

The LEL (also LFL, lower flammability limit) is defined as the lowest concentration of gas or vapor in air, which can be ignited by an ignition source and cause an explosion or flame propagation. Conversely, the upper explosive limit (UEL) (also

UFL, upper flammability limit) is the concentration of gas in air above which there is insufficient oxygen available to support combustion, and an explosion is unlikely. A flame, however, may burn at the gas-air interface, or should additional air enter the mixture, a very explosive atmosphere may develop.

In general, the instruments respond in the following manner:

- When the meter indicates 0.5 LEL (50 percent), this means that 50 percent of the concentration of combustible gas needed to reach an unstable combustible situation is present. If the LEL of the gas is 5 percent in air, then the instrument indicates a 2.5 percent mixture is present.

- If the meter needle stays above 1.0 LEL (100 percent) it means that the concentration of combustible gas is greater than the LEL and less than the UEL and, therefore, immediately combustible and explosive; and

- When the meter needle rises above the 1.0 LEL (100 percent) mark and then returns to zero, this indicates the ambient atmosphere has a combustible gas concentration greater than the UEL.

Of the many instruments commercially available for detecting combustible or explosive gas, some are not certified safe for operation in the atmospheres they can detect. It is important to use only those monitors that are certified safe for use in atmospheres greater than 25 percent of the LEL.

Some combustible gas monitors provide readouts in units of percent LEL, some in percent combustible gases by volume, and some have scales for both. Many situations may occur where types of combustible gases to be encountered are unknown. In such instances the more explosive the calibration gas (the lower the LEL) the more sensitive the indication of explosivity, and thus the greater margin of safety. The operator should be familiar with the LEL concentrations for specific gases to effectively use instruments that provide data in percent combustible (by volume) only.

Startup and Calibration. Start up of these monitors is typically a simple push button exercise. The meter should be allowed to warm up, typically for a couple minutes, prior to calibration verification. Although monitors can be purchased that are factory calibrated using gases such as butane, pentane, natural gas, or petroleum vapors, methane calibration is the most common. The LEL of methane is 5 percent by volume in air, therefore, an air mixture containing 5 percent methane will be read as 100 percent LEL and will be explosive if a source of ignition is present. When combustible gases other than methane are sampled, the relative response of the detector for these other gases must be considered.

After the instrument is turned on, verify that the sample pump is operable (if so equipped). After warm up, place the intake assembly in a combustible gas-free ambient air, zero the meter by rotating the zero control until the meter reads 0 percent LEL. These units are typically calibrated against a known concentration of a calibration gas by rotating the calibration control (span or gain) until the meter reads the same concentration as the known standard. For those instruments with internal or nonadjustable span, a calibration curve should be prepared, using concentrations in the concentration range expected.

Re-calibration to other gases may be possible; see manufacturer's recommendations. The relative sensitivity of the detector and the differences in LEL for different gases will produce varying meter responses equal to concentrations of different gases. Actual correlation equations that will convert the percent LEL (based on methane) read by the unit to a percent LEL for another combustible gas can usually be found in the operating manual.

Other Considerations. Many units also have alarm systems which can be adjusted for various LELs and several are available that incorporate oxygen analyzers.

Maintenance and operating procedures include making certain that the instrument is clean and serviceable, especially at sample lines and detector surfaces. Following are the general operating procedures:

- Check battery charge level. Charge the battery as described in operating manual. Some units have charge level meters, while others have only low charge alarms;
- If necessary, adjust alarm setting to appropriate combustibility setting; and
- Position intake assembly or cell in close proximity to area in question to get an accurate reading. If alarm occurs, or if readings reach the action levels designated in the safety plan, evacuate and assess the situation. If the instrument malfunctions, personnel should also evacuate the area.
- Slow sweeping motions of intake or cell assembly will help assure that problem atmospheres are not bypassed. Cover an area from floor (ground) to ceiling, or above breathing zone.
- Operation of unit in temperatures outside of the recommended operating range may compromise the accuracy of readings or damage the instrument.
- Platinum filament detectors may be poisoned (reduced in sensitivity) by gases such as leaded gasoline vapors (tetraethyl lead), sulphur compounds (mercaptan and hydrogen sulfide) and silicon compounds.
- Many combustible gas detectors are not designed for use in oxygen-enriched or depleted atmospheres. If this condition is encountered or suspected, personnel should evacuate the area. Specially designed units are available for operation in such atmospheres.
- An oxygen detector should always be used in conjunction with explosimeters.
- Accurate data depends on regular calibration and battery charging (refer to the operating manual).

- Effective utilization of the unit requires an operator with full understanding of operating principles and procedures for the specific instrument in use.

6.4 Oxygen Meters

This class of instruments uses an electrochemical sensor to determine the oxygen concentration in air. The sensor consists of two electrodes, a sensing and a counting electrode; a housing containing a basic electrolytic solution; and a semipermeable Teflon® membrane.

Oxygen molecules (O_2) diffuse through the membrane into the solution. Reactions between the oxygen and the electrodes produce a small electric current, which is directly proportional to the sensor's oxygen content. The current passes through the electronic circuit. The resulting signal is shown as a needle deflection on a meter, which is usually calibrated to read 0-10 percent, 0-25 percent, or 0-100 percent oxygen.

The oxygen content in a confined space is of prime concern to anyone about to enter that space. Removal of oxygen by combustion, reduction reactions, or displacement by gases or vapors is a hazard that response personnel cannot detect. Consequently, remote measurements must be made before anyone enters any confined space.

The operation of oxygen meters depends on the absolute atmospheric pressure. The concentration of natural oxygen (to differentiate it from manufactured or generated oxygen) is a function of the atmospheric pressure at a given altitude.

At sea level, where the weight of the atmosphere above is the greatest, more O_2 molecules are compressed into a given volume than at higher elevations. As elevation increases, this compression decreases, resulting in fewer O_2 molecules being "squeezed" into a given volume. Consequently, an O_2 indicator calibrated at sea level and operated at an altitude of several thousand feet will falsely indicate an oxygen-deficient atmosphere (less than 19.5 percent).

High concentrations of carbon dioxide (CO_2) shorten the useful life of the oxygen detector cell. Therefore, the unit can be used in atmospheres greater than .05 percent CO_2 only with frequent replacing or rejuvenating of the oxygen detector cell.

Although several instruments can measure an oxygen-enriched atmosphere (O_2 greater than 21 percent), no testing or other work should ever be performed under such conditions because a spark, arc, or flame could lead to fire or explosion. Oxygen measurements are most informative when paired with combustible gas measurements. Together, they provide response personnel with quick and reliable data on the hazards they may encounter.

Typically, these units are not calibrated. However, users need to verify that the instrument is reading correctly by placing the intake into fresh air and reading the value. Normal atmospheric readings should be about 21 percent oxygen.

6.5 Direct-reading colorimetric indicator tubes

In evaluating hazardous waste sites, the need often arises to quickly measure a specific vapor or gas. Direct-reading colorimetric indicator tubes (e.g., Draeger tubes) can successfully fill that need. The interaction of two or more substances may result in chemical changes. This change may be as subtle as two clear liquids producing a third clear liquid, or as obvious as a colorless vapor and colored solid producing a differently colored substance. Indicator tubes use this latter phenomenon to estimate the concentration of gas or vapor in air. Colorimetric indicator tubes consist of an impregnated glass tube with an indicating chemical. There is no calibration associated with these tubes. Users should be careful, however, that the tubes are still within the expiration period.

To make measurements with these indicators, the tube is connected to a piston cylinder- or bellows-type pump. The following procedures are then followed to obtain a reading.

- A known volume of contaminated air is pulled at the predetermined rate through the tube. The contaminant reacts with the indicator chemical in the tube, producing a stain whose length is proportional to the contaminant's concentration.
- A preconditioning filter may precede the substrate to remove contaminants (other than the one in question) that may interfere with the measurement. Filters are also used to react with the contaminant to change it into a compound that reacts with the indicating chemical, and to completely change a non-indicating contaminant into an indicating one.
- Several indicating chemicals may be able to measure the concentration of a particular gas or vapor, each operating on a different chemical principle and each affected in varying degrees by temperature, air volume pulled through the tube, and interfering gases or vapors. A "true" concentration versus the "measured" concentration may vary considerably among and between manufacturers. To limit these sources of error, control the numerous types and manufacturers of tubes, and provide a degree of confidence to users, the National Institute of Occupational Safety and Health (NIOSH) tests and certifies indicator tubes. Certified tubes have an accuracy of ± 35% at 1/2 the threshold limit value (TLV) of the chemical and ± 25% at the TLV.

To improve performance on all tubes, they should be refrigerated prior to use to maintain shelf life of approximately 2 years.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

Measurements associated with many monitoring devices for organic vapors, even though they yield a numerical value, really result in qualitative results. Hence, quality assurance/quality control measures are typically calibration and calibration checks. Field duplicates can easily be collected and incorporated into a field QA/QC program. More complete QA/QC steps may be incorporated into a project should more rigorous, quantitative data be an objective. Such QA/QC should be developed and presented in project specific planning documents.

8.0 REFERENCES

Volatile Organics in Soil Gas - Absorbent Tube Method, FASP Method Number F080.008, U.S. Environmental Protection Agency (EPA), July 1990.

RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. Environmental Protection Agency (EPA), Office of Waste Programs Enforcement, and Office of Solid Waste and Emergency Response, September 1986.

Technical Guidance for Corrective Measures - Subsurface Gas, U.S. Department of Commerce, National Technical Information Service (NTIS), March 1985.

Field Screening Methods Catalog, User's Guide, United States Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC 20460, September 1988.

9.0 ATTACHMENTS

Attachment A – List of Common Ionization Potentials for Different Chemicals.

Attachment B – List of Relative Responses for Different Chemicals.

ATTACHMENT A

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps 9.5 eV	10.2 eV	11.7 eV
Acetaldehyde	Ethyl Aldehyde	Ethanal	10.21	0.20		2.80
Acetaldehyde oxime					2.30	
Acetamide			9.77			
Acetic acid	Ethanoic acid		10.35		0.50	3.28
Acetic anhydride					0.90	
Acetone	2-propanone		9.69		4.20	3.80
Acetonitrile	Methyl cyanide		12.22			0.08
Acetophenone			9.27			
Acetyl bromide			10.55			
Acetic chloride			11.02			
Acetylene	Ethyne		11.41		0.00	
Acetylene dichloride			9.80			
Acetylene tetrabromide			N/A			
Acridene			7.78			
Acrolein	2-propenal	Acrylaldehyde	10.10		3.10	2.70
Acrylic acid			10.09			
Acrylonitrile	Vinyl cyanide	Propene nitrile	10.90			3.85
Allene			9.83			
Allyl alcohol			9.67		2.50	4.70
Allyamine			9.6*			
Allyl chloride	3-chloropropene		10.20		1.30	11.90
Aminoethanol			9.87			
2-amino-pyridine			8.34			
Ammonia			10.15		0.60	3.00
n-amyl acetate			N/A			
sec-amyl acetate			N/A			
Aniline	Phenylamine	Aminobenzene	7.70	3.90		
Anisole			8.20			
Arsine			10.60		2.18	
Benzaldehyde	Benzoic aldehyde		9.53		6.70	8.60
Benzene			9.25	10.00	10.00	10.00
Benzenethiol			8.33			
Benzonitrile			9.70			
Benzotrifluoride			9.68			
Benzyl chloride	Alpha-chlorotoluene		10.16		6.70	11.70
Biphenyl			8.27			
Bromobenzene	Phenyl bromide		8.98		15.60	17.80
1-bromobutane			10.13			
2-bromobutane			9.95			
1-bromobutane			9.54			
1-bromobutanone			9.54			
1-bromo-2-chloroethane			10.63			
Bromochloromethane			10.77			
Bromodichloromethane			10.88			
1-bromo-2-chloropropane			N/A			
Bromoethane			10.24			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
Bromothene			9.80			
Bromoform			10.51			
1-bromo-3-hexanone			9.26			
Bromomethane			10.53			
Bromomethyl ethyl ether			10.08			
1-bromo-2-methylpropane			10.09			
2-bromo-2-methylpropane			9.98			
1-bromopentane			10.10			
1-bromopropane			10.18			
2-bromopropane			10.08			
1-bromopropene			9.30			
2-bromopropene			10.06			
3-bromopropene			9.70			
2-bromothiophene			8.63			
o-bromotoluene			8.78			
m-bromotoluene			8.81			
p-bromotoluene			8.67			
1, 2-butadiene			9.57		6.99	
1, 3-butadiene	Vinylethylene		9.57		6.99	7.60
2, 3-butadione			9.23			
Butanal	n-butanal		9.83			
2-butanal			9.73			
Butane	n-butane		10.63			7.13
1-butanethiol			9.14			
2-butanone			9.53			
iso-butanol			10.47			
sec-butanol			10.23			
tert-butanol			10.25			
2-butanol			10.10			
1-butene			9.58			
cis-2-butene			9.13			
trans-2-butene			9.13			
3-butene nitrile			10.90			
Butoxyethanol					2.80	
n-butyl acetate			10.01			
sec-butyl acetate			9.91			
t-butyl acetate			9.90			
n-butyl alcohol			10.04			
n-butylamine			8.71			
iso-butylamine			8.70			
sec-butylamine			8.70			
tert-butylamine			8.64			
n-butylbenzene			8.69			
iso-butylbenzene			8.68			
tert-butylbenzene			8.68			
Butyl cellosolve			8.68			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
iso-butyl ethanoate			9.95			
iso-butyl mercaptan			9.12			
n-butyl mercaptan			9.15			
tert-butyl mercaptan			9.03			
iso-butyl methanoate			10.46			
p-tert-butyltoluene			8.35			
isobutylene			9.44		5.50	7.40
1-butyne	iso-butyne		10.18			
2-butyne			9.85			
n-butyl acetate			10.01			
n-butyraldehyde			9.86			
Caprolactam			9.86			
Carbon dioxide			13.79			
Carbon disulfide	Carbon bisulfide		10.07	3.37	4.90	27.70
Carbon tetrachloride	Perchloromethane	tetrachloromethane	11.47			4.22
Carbon monoxide			14.01			
Cellosolve acetate			N/A			
Chloroacetaldehyde			10.16			
o-chloroiodobenzene			8.35			
Chlorobenzene	Phenyl chloride		9.07		13.00	14.40
1-chloro-2-bromoethane			10.63			
Chlorobromomethane			10.77			
1-chlorobutane			10.67			
2-chlorobutane			10.65			
1-chlorobutanone			9.54			
1-chloro-2, 3 epoxypropane			10.60			
Chloroethane	Ethyl chloride		10.97			
Chloroethanol					0.20	6.70
Chloroethene			10.00			
2-chloroethoxyethene			10.61			
1-chloro-2-fluorobenzene			9.15			
1-chloro-3-fluorobenzene			9.21			
cis-1-chloro-2-fluoroethene			9.87			
trans-1-chloro-2-fluoroethene			9.87			
Chloroform	Trichloromethane		11.42			3.15
o-chloroiodobenzene			8.35			
1-chloro-2-methylbenzene			8.72			
1-chloro-4-methylbenzene			8.78			
Chloromethylethyl ether			10.08			
Chloromethylmethyl ether			10.25			
1-chloro-2-methylpropane			10.66			
2-chloro-2-methylpropane			10.61			
1-chloropropane			10.82			
2-chloropropane			10.78			
3-chloropropene			10.04			
p-chlorostyrene			N/A			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
2-chlorothiphene			8.68			
o-chlorotoluene	2-chloro-1-methylbenzene		8.83		10.60	13.60
m-chlorotoluene			8.86			
p-chlorotoluene	4-chloro-1-methylbenzene		8.69		10.80	15.00
Chlorotrifluoroethane			10.40			
Citral					0.50	
m-cresol			8.48			
o-cresol			8.48			
p-cresol			8.48			
Crotonaldehyde	2-butenal	Betamethylacrolein	9.73		3.10	6.40
Crotonaldehyde			9.73			
Cumene	I-propyl-benzene		8.75	3.79		
Cyanoethane			10.91			
Cyanogen bromide			11.95			
Cyanogen chloride			12.49			
3-cyanopropene			10.39			
Cyclobutane			10.50			
Cyclohexane	Hexamethylene		9.88		3.40	
Cyclohexanol			10.00			
Cyclohexanone	Ketohexamethylene		9.14		8.20	7.30
Cyclohexene	1, 2, 3, 4-tetrahydrobenzene		8.95		3.40	
Cyclo-octateraene			7.99			
Cyclopentadiene			8.58			
Cyclopentane	Pentamethylene		10.52		0.90	13.20
Cyclopentanone			9.26			
Cyclopentene			9.01			
Cyclopropane			10.06			
Cyclopropene			9.95			
Decalin					10.41	
Decane	n-decane	Decyl hydride	10.19		3.30	
2-decanone			9.40			
Diacetone alcohol			N/A			
Diborane			11.9*			1.54
1, 3-dibromobutane			N/A			
1, 4-dibromobutane			10.25*			
Dibromochloromethane			10.59			
Dibromochloropropane					0.70	
Dibromoethane	Ethylene dibromide		10.19		2.30	21.80
1, 1-dibromoethane			10.19			
1, 3-dibromopropane			10.07			
Dibutyl amine			7.69		9.90	
o-dichlorobenzene			9.07		11.90	15.50
m-dichlorobenzene			9.12		11.90	15.50
p-dichlorobenzene			8.94		11.90	15.50
1, 3-dichlorobutane			N/A			
1, 4-dichlorobutane			N/A			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
2, 2-dichlorobutane			N/A			
2, 3-dichlorobutane			N/A			
cis-1, 4-dichloro-2-butene			N/A			
1, 1-dichlroethane			11.06			8.40
1, 1-dichlroethane						
1, 2-dichlroethane	Ethylene dichloride		11.04			10.57
cis-dichloroethane			9.65			
trans-dichloroethane			9.65			
Dichloroethyl ether			N/A			
1, 1-dichloroethylene	Vinylidene chloride	1, 1, dichloroethene	9.60		6.40	
Dichlorofluoromethane			11.75			
Dichloromethane	Methylene dichloride		11.35			8.70
1, 2-dichloropropane	Propylene dichloride		10.87		0.20	12.10
1, 3-dichloropropane	Propylene dichloride		10.85		0.20	12.10
1, 1-dichloropropanone			9.71			
2, 3-dichloropropene			9.82		4.00	
Dicyclopentadiene			7.74			
Diethoxymethane			9.70			
Diethyl			8.01			
Diethylamine			8.01	10.08	4.80	
Diethylamino ethanol			8.58			
Diethyl ether			9.53			
N, N-diethyl formamide			8.89			
Diethyl ketone			9.32			
Diethyl sulfide			8.43		10.00	
o-difluorobenzene	1, 2-difluorobenzene		9.31			
p-difluorobenzene	1, 4-difluorobenzene		9.15			
Difluorodibromomethane			11.10			
Difluoromethylbenzene			9.45			
Diiodomethane			9.34			
Diisopropylamine			7.73			
Diisobutyl ketone			9.04			
Diisopropylamine			7.73			
1,1-dimethoxymethane			9.65			
Dimethoxymethane			10.00			
Dimethylamine			8.24		4.90	
Dimethylaniline			7.13			
2, 3-dimethylbutadiene			8.72			
2, 2-dimethylbutane			10.05			
2, 2-dimethyl butane-3, 1			9.18			
2, 3-dimethylbutane			10.01			
3, 3-dimethyl butanone			9.17			
2, 3-dimethyl-2-butene			8.30			
Dimethyl ether			10.00			
3, 5-dimethyl-4-heptanone			9.04			
2, 2-dimethyl-3-pentanone			8.98			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
2, 2-dimethyl propane			10.35			
Dimethyl disulfide			8.46		16.00	20.00
N, N Dimethyl formamide			9.12			
3, 5-dimethyl-4-heptanone			9.04			
1, 1-dimethylhydrazine			8.88			
2, 2-dimethyl-3-pentanone			8.98			
2, 2-dimethylpropane			10.35			
Dimethyl sulfide			8.69			
p-dioxane			9.13			
Di-n-propyl disulfide			8.27			
Di-n-propylamine			7.84			
Di-i-propyl ether			9.20			
Di-n-propyl ether			9.27			
Di-n-propyl sulfide			8.30			
Epichlorohydrin	Cyclopropylene oxide		10.60		0.70	10.30
Ethane	n-ethane	Methylmethane	11.65			0.69
Ethanal			11.65			
Ethanol	Ethyl alcohol		10.21		2.46	2.40
Ethanethiol			9.29			
Ethanethiol	Ethyl mercaptan		9.29			
Ethylene	Ethene		10.52		0.89	
Ethylene glycol					4.00	
Ethoxyethanol					2.50	
Ethyl acetate			10.11			
Ethyl acrylate			N/A			
Ethyl amine			8.86			
Ethyl amyl ketone			9.10			
Ethylbenzene			8.76			
Ethyl bromide			10.29			
Ethyl butyl ketone			9.02			
Ethyl chloride (Chloroethane)			10.97			
Ethyl chloroacetate			10.20			
Ethyl ethanoate			10.10			
Ethyl ether			9.41			
Ethyl disulfide			8.27			
Ethyl disulfane			9.40			
Ethyl formate			10.61			4.40
Ethyl iodine			9.33			
Ethyl mercaptan			9.29			
Ethyl methanoate			10.61			
Ethyl isothiocyanate			9.14			
Ethyl methyl sulfide			8.55			
Ethyl nitrate			11.22			
Ethyl propanoate			10.00			
Ethyl trichloroacetate			10.44			
Ethylene	Ethene		10.52		0.60	

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
Ethylene chloride						9.20
Ethylene chlorohydrin			10.90			
Ethylene dibromide	Dibromomethane	EDB	10.37		1.86	21.80
Ethylene dichloride	1, 2-dichloroethane		11.00			10.50
Ethylene dichlorohydrin			10.90			
Ethylene oxide	EtO		10.57		0.30	13.20
Ethylbenzene			8.87			
Ethyne			11.41			
Fluorobenzene			9.20			
Fluoroethane			12.00			
Fluoroethene			10.37			
Mono-fluoromethanal			11.40			
Fluorobromomethane			11.77			
o-fluorotoluene			8.91			
m-fluorotoluene			8.91			
p-fluorotoluene			9.79			
Formaldehyde			10.87			1.07
Formic acid			10.37			
Formamide			10.25			
Freon 11 (CFCl3)			11.77			
Freon 12 (CF2Cl2)			12.31			
Freon 13 (CF3Cl)			12.91			
Freon 13 B-I			12.08			
Freon 14 (neat)			16.25			
Freon 21			12.00			
Freon 22 (CHClF2)			12.45			
Freon 113 (CF3CCl3)			11.78			
Freon 114			12.00			
2-Furaldehyde			9.21			
Furan			8.89			
Furfural			9.21			
Furfuryl Alcohol			N/A			
Genetron 101			11.98			
Heptane	n-heptane		10.07	0.20	2.20	15.90
2-heptanone			9.33			
4-heptanone			9.12			
Hexane	n-hexane		10.18		1.24	8.43
Hexafluoroacetone			11.81			
Hexafluorobenzene			9.39			
Hexafluoropropene			10.30			
Hexamethylbenzene			7.85			
2-hexanone			9.34			
1-hexene			9.46		0.20	
Hydrazine			9.00			
Hydrofluoric acid			9.88			
Hydrogen			15.43			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps 9.5 eV	10.2 eV	11.7 eV
Hydrogen cyanide			13.73			
Hydrogen selenide			9.88			
Hydrogen sulfide			10.46		1.20	10.10
Hydrogen telluride			9.14			
Iodine			9.28		32.18	
Iodobenzene			8.73			
1-iodobutane			9.71			
2-iodobutane			9.09			
Iodoethane	Ethyl iodide		9.33			
Iodomethane	Methyl iodide		9.45			
1-iodo-2-methylpropane			9.18			
1-iodopentane			9.19			
1-iodopropane			9.26			
2-iodopropane			9.17			
m-iodotoluene			8.61			
o-iodotoluene			8.62			
p-iodotoluene			8.50			
Isoamyl acetate			9.90			
Isobutylene	2-methylpropene		9.23		5.50	
Isopar					18.96	
Isopropanol	Isopropyl alcohol		10.16		0.88	3.60
Isopropyl acetate			9.99		1.00	
Isopropylamine			8.72			
Isopropylbenzene			8.75			
Isopropyl ether			9.20			
Isovalderhyde			9.71			
Ketene			9.61			
Mesitylene			8.40			
Mesityl oxide			9.08			
Methane	n-methane		12.48	0.00	0.00	0.00
Methanol	Methyl alcohol		10.85			2.34
Methyl acetate			10.27			5.10
Methyl acrylate			10.72			
Methyl amine			8.97			
2-methyl-1, 3-butadiene			8.85			
2-methylbutanal			9.71			
2-methylbutane			10.31			
2-methyl-1-butene			9.12			
3-methyl-1-butene			9.51			
3-methyl-2-butene			8.67			
Methyl n-butyl ketone			9.34			
Methyl bromide	Bromomethane		10.53		2.73	
Methyl butyrate			10.07			
Methyl cellosolve			N/A			
Methyl cellosolve acetate			N/A			
Methyl chloroacetate			10.35			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
Methyl chloride	Chloromethane		11.28			7.60
Methylchloroform			11.25			
Methylcyclohexane			9.85			
Methylcyclohexanol			9.80			
Methylcyclohexanone			9.05			
4-methylcyclohexene			8.91			
Methylcyclopropane			9.52			
Methyl dichloroacetate			10.44			
Methylene chloride	Dichloromethane		11.35		0.14	6.83
Methyl ethanoate			10.27			
Methyl ethyl ether			9.81			
Methyl ethyl ketone	MEK	2-butanone	9.53	2.90	5.59	5.30
Methyl ethyl sulfide			8.55			
Methyl formate						18.87
2-methyl furan			8.39			
Methyl iodide			9.54	36.48	26.76	
Methyl isobutyl ketone	Hexanone	Isopropylacetone	9.32		8.90	9.20
Methyl isobutyrate			9.98			
Methyl isocyanate			10.67		4.50	
1-methyl-4-isopropylbenzene			N/A			
Methyl isopropyl ketone			9.32			
Methyl mercaptan	Methanethiol		9.44		4.30	
Methyl methacrylate			9.74	0.50	3.00	
Methyl methanoate			10.82			
2-methylpentane			10.11			
3-methylpentane			10.08			
3-methylpentane			10.07			
2-methylpropanal			9.74			
2-methyl-2-propanol			9.70			
2-methylpropene			9.23			
Methyl n-propyl ketone			9.39			
Methyl styrene			8.35			
Methyl sulfide					7.00	
Methyl-tert-butylether			10.00			
Mineral spirits					4.00	
Monomethyl hydrazine			N/A			
Morpholine			8.88			
Naptha (85% aromatics)					5.00	
Napthalene			8.12		16.20	
Nitric oxide			9.25		0.60	
Nitrobenzene			9.82			
p-mitrochlorobenzene			9.96			
Nitroethane			9.92			
Nitrogen			15.60			
Nitrogen dioxide					0.02	
Nitrotoluene			10.88			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps 9.5 eV	10.2 eV	11.7 eV
Nitromethane			11.08			
Nonane	n-nonane		10.21			
5-nonanone			9.10			
Octane	n-octane		10.24		1.96	
3-octanone			9.19			
4-octanone			9.10			
1-octene			9.52			
Oxygen			12.08			
Pentane	n-pentane	Amyl hydride	10.34			10.08
Isopentane			10.32			
Pentachloroethane			11.28			
1, 3-pentadiene (cis)			8.65			
1, 3-pentadiene (trans)			8.56			
Pentafluorobenzene			9.84			
Pentamethylbenzene			7.92			
n-pentanal			9.82			
2, 4-pentanedione			8.87			
2-pentanone			9.39			
3-pentanone			9.32			
1-pentene			9.50			
Perchloroethylene			9.32			
Perfluoro-2-butene			11.25			
Perfluoro-1-heptene			10.48			
n-perfluoropropyl iodide			10.26			
(n-perfluoropropyl)-iodomethane			9.96			
(n-perfluoropropyl)-methyl ketone			10.58			
Phenol			8.50	7.70		
Phenyl ether			8.09			
Phenyl isocyanete			8.77			
Phosgene			11.77			
Phosphine			10.10		2.00	
Pinene, alpha			8.07		0.70	
Pinene, beta			8.07		0.50	
Propadiene			10.19			
n-propanal			9.95			
Propane	n-propane	Dimethylmethane	11.07			4.51
1-propanethiol			9.20			
Propanol	n-propanol alcohol	Propyl alcohol	10.51		0.80	
Propanone			11.07			
Propenal (Acrolein)			10.10			
Propene (propylene)			9.73		4.00	
Prop-1-ene-2-ol			8.20			
Prop-2-ene-1-ol			9.67			
Propionaldehyde			9.98			
Propionic acid			10.34			
Propionitrile			11.84			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
n-propyl acetate			10.04			
n-propyl amine			8.78			
n-propyl benzene			8.72			
propylene	Propene		9.73		4.00	
Propylene dichloride			N/A			
Propylene imine			8.76			
Propylene oxide			10.22		0.76	
n-propyl ether			9.27			
n-propyl formate			10.54			
Propyne			10.36			
Pyridine			9.32	2.20	6.10	
Styrene	Vinyl benzene	Phenyl ethylene	8.47	15.34	14.87	10.70
Tetrabromoethane			N/A			
1, 1, 1, 2-tetrachloroethane			N/A			
1, 1, 2, 2-tetrachloroethane			11.10			8.60
Tetrachloroethylene	Perchloroethylene	PERC	9.32		8.60	
Tetrachloromethane			11.47			
1, 1, 1, 2-tetrachloropropane			N/A			
1, 2, 2, 3-tetrachloropropane			N/A			
1, 2, 3, 4-tetrafluorobenzene			9.61			
1, 2, 3, 5-tetrafluorobenzene			9.55			
1, 2, 4, 5-tetrafluorobenzene			9.39			
Tetrafluoroethane			10.12			
Tetrahydrofuran	THF		9.45		6.00	6.30
Tertrahydropyran			9.26			
1, 2, 4, 5-tetramethylbenzene			8.03			
2, 2, 4, 4-tetramethyl-3-pentanone			8.65			
Thioethanol			9.29			
Thiomethanol			9.44			
Thiophene			8.86			
1-thiopropanol			9.20			
Toluene			8.82	10.20	9.28	11.40
o-toluidine			7.44			
Tribromoethene			9.27			
Tribromomethane			10.51			
1, 1, 1-trichlorobutanone			9.54			
1, 1, 1-trichloroethane	Methyl chloroform		11.25			10.70
1, 1, 2-trichloroethane			N/A			
Trichloroethylene	Trichloroethene	TCE	9.45		9.00	
Trichloromethyl ethyl ether			10.08			
Trichloromethane			11.42			
1, 1, 2-trichloropropane			N/A			
1, 2, 3-trichloropropane			N/A			
Triethylamine			7.50			
1, 2, 4-trifluorobenzene			9.37			
1, 3, 5-trifluorobenzene			9.30			

Photoionization Characteristics of Selected Compounds
Updated 6 March 1997, HNU Systems, Inc.

Compound Name	Alternate Name	Alternate Name	Ionization Potential eV	Molar Sensitivity Relative to Benzene (= 10.0) with Different Lamps		
				9.5 eV	10.2 eV	11.7 eV
1, 1, 2-trifluoroethane			10.14			0.24
Trifluoroethene			10.14			
1, 1, 1-trifluoro-2-iodoethane			10.00			
Trifluoroiodomethane			10.40			
Trifluoromethylbenzene			9.68			
Trifluoromethylcyclohexane			10.46			
1, 1, 1-trifluoropropene			10.90			
Trimethylamine			7.82			
1, 2, 3-trimethylbenzene			8.48			
1, 2, 4-trimethylbenzene			8.27			
1, 3, 5-trimethylbenzene			8.39			
2, 2, 4-trimethyl pentane			9.85			
2, 2, 4-trimethyl-3-pentanone			8.82			
n-valderaldehyde			9.82			
Vinyl acetate			9.19			
Vinyl benzene (styrene)			8.47		9.70	
Vinyl bromide			9.80			
Vinyl chloride	Chloroethylene	VCM	10.00		3.20	7.80
4-vinylcyclohexene			8.93			
Vinyl ethanoate			9.19			
Vinyl fluoride			10.37			
Vinylidene chloride					6.40	
Vinyl methyl ether			8.93			
o-vinyl toluene			8.20			
Water (H2O)			12.59			
o-xylene			8.56		10.44	
m-xylene			8.56		11.20	
p-xylene			8.45		11.40	
2,4-xylidine			7.65			

Notes:
1) The above molar sensitivities have been determined on a volume/volume basis, generally at a level of 100 ppm.
2) Molar sensitivities will vary from instrument to instrument and will be effected by field conditions such as humidity.
3) The highest level of accuracy for compounds will be achieved by utilizing standards prepared with the actual compounds to be measured.
4) Ionization potentials established by photoionization except those marked " * ", determined by electron impact

ATTACHMENT B

1/4/94

FOXBORO OVA CENTURY RESPONSE CHART RELATIVE TO METHANE CALIBRATION

COMPOUND	RELATIVE RESPONSE %	RESPONSE FACTOR
1 ACETALDEHYDE	23	4.35
2 ACETIC ACID (slow)	38	2.63
3 ACETIC ACID, glacial	11	9.09
4 ACETIC ANHYDRIDE	61	1.64
5 ACETONE	82	1.22
6 ACETONITRILE	70	1.43
7 ACETYLENE	225	0.44
8 ACROLEIN	27	3.70
9 ACRYLIC ACID (slow)	18	5.56
10 ACRYLONITRILE	98	1.02
11 ALLYL ALCOHOL	30	3.33
12 ALLYL CHLORIDE	50	2.00
13 AMMONIA	N/F	N/F
14 ANILINE (slow)	4	25.00
15 ANIS-p ALDEHYDE (slow)	N/F	N/F
16 ANIS-p ALDEHYDE (slow) in methanol equiv.	8	12.5
17 BENZENE	185	0.54
18 BENZOTRICHLORIDE @300ppm (a-trichlorotoluene)	40	2.50
19 BENZOYL CHLORIDE @800 ppm	47	2.13
20 BENZYL CHLORIDE	60	1.67
21 BIPHENYL	N/F	N/F
22 BROMOBUTANE,1- (MDL=0.8ppm)	63	1.59
23 BROMOETHANE (ethyl bromide)	75	1.33
24 BROMOPROPANE,1- (propyl bromide)	75	1.33
25 BUTADIENE,1,3-	33	3.03
26 BUTANE	63	1.59
27 BUTANE,2- (isobutane)	70	1.43
28 BUTANOL,n- (butanol)	41	2.44
29 BUTANOL,sec- (2-butanol)	60	1.67
30 BUTANOL,tert- @ 0-2500 ppm	76	1.32
31 BUTANOL,tert- (2-methyl-2-propanol) @8000 ppm	114	0.88
32 BUTENE	45	2.22
33 BUTOXY ETHANOL,2- (butyl cellosolve) slow	21	4.76
34 BUTYL ACETATE,n-	63	1.59
35 BUTYL ACRYLATE,2-	70	1.43
36 BUTYL ACRYLATE.n-	60	1.67
37 BUTYL FORMATE,2-	60	1.67
38 BUTYL FORMATE,n-	50	2.00
39 BUTYL METHACRYLATE,2-	80	1.25
40 BUTYL METHACRYLATE,n-	60	1.67
41 BUTYL METHYL ETHER,tert-	58	1.72
42 BUTYLENE OXIDE	55	1.82
43 BUTYLMERCAPTAN (slow)	12	8.33
44 BUTYLTIN TRICHLORIDE (@ 100 deg C)	2	50.00
45 CARBON DISULFIDE	N/F	N/F

N/F IS NOT FEASIBLE: F IS FEASIBLE BUT NO DATA: ALL AT 50-100 PPM UNLESS NOTED

1/4/94

FOXBORO OVA CENTURY RESPONSE CHART RELATIVE TO METHANE CALIBRATION

	COMPOUND	RELATIVE RESPONSE %	RESPONSE FACTOR
46	CARBON TETRACHLORIDE	8	12.50
47	CELLOSOLVE ACETATE (EGMEEA)	40	2.50
48	CFC-11 (Freon 11)	7	14.29
49	CFC-113 (Freon 113)	90	1.11
50	CFC-114 (Freon 114)	110	0.91
51	CFC-115 (Freon 115)	42	2.38
52	CFC-12 (Freon 12)	15	6.67
53	CFC-13 (Freon 13)	15	6.67
54	CHLOROBENZENE	179	0.56
55	CHLOROBENZOTRICHLORIDE,p- @40ppm	13	7.69
56	CHLOROBUTADIENE,2-	20	5.00
57	CHLOROBUTANE (butyl chloride)	58	1.72
58	CHLORODIFLUOROMETHANE (HCFC-22)	67	1.49
59	CHLOROETHYL METHYL ETHER,2-	34	2.94
60	CHLOROFORM	57	1.75
61	CHLOROPROPANE,1-	75	1.33
62	CHLOROPROPANE,2-	55	1.82
63	CHLOROPYIRIDINE,2-	48	2.08
64	CRESOL,o-	N/F	N/F
65	CUMENE (isopropyl benzene)	18	5.56
66	CYCLOHEXANE	85	1.18
67	CYCLOHEXANOL	45	2.22
68	CYCLOHEXANONE	43	2.33
69	CYMENE,p-	31	3.23
70	DECANE (slow)	53	1.89
71	DESFLURANE	176	0.57
72	DIACETONE ALCOHOL	56	1.79
73	DIAZENE-42 @12ppm (styrene dibromide)	12	8.33
74	DIAZENE-42 @250ppm (1,2-dibromethyl benzene)	7	14.29
75	DIBROMOMETHANE	20	5.00
76	DICHLOROBENZENE,1,3-	57	1.75
77	DICHLOROBENZENE,o-	119	0.84
78	DICHLOROBENZENE,p-	113	0.88
79	DICHLOROBUTANE,1,4-	34	2.94
80	DICHLOROBUTANE,2,3-	64	1.56
81	DICHLOROETHANE,1,1-	70	1.43
82	DICHLOROETHANE,1,2- (ethylene dichloride)	89	1.12
83	DICHLOROETHYL ETHER	9	11.11
84	DICHLOROETHYLENE,trans-1,2-	40	2.50
85	DICHLOROMETHANE (methylene chloride)	84	1.19
86	DICHLOROPHENOXY ACETIC ACID,2,4-	N/F	N/F
87	DICHLOROPROPANE,1,2-	90	1.11
88	DICHLOROPROPANE,1,3-	80	1.25
89	DICHLOROTOLUENE @800 ppm (benzal chloride)	55	1.82
90	DICYCLOPENTADIENE	48	2.08

N/F IS NOT FEASIBLE: F IS FEASIBLE BUT NO DATA: ALL AT 50-100 PPM UNLESS NOTED

1/4/94

FOXBORO OVA CENTURY RESPONSE CHART RELATIVE TO METHANE CALIBRATION

	COMPOUND	RELATIVE RESPONSE %	RESPONSE FACTOR
91	DIESEL FUEL	F	F
92	DIETHANOLAMINE	N/F	N/F
93	DIETHYL ETHER	47	2.13
94	DIETHYL KETONE	80	1.25
95	DIETHYLAMINE	75	1.33
96	DIETHYLANILINE,n,n-	N/F	N/F
97	DIETHYLBENZENE,o-	75	1.33
98	DIETHYLENE GLYCOL (very slow)	4	25.00
99	DIFLUOROMETHOXYTRIFLUOROETHANE	111	0.90
100	DIMETHOXY METHANE	23	4.35
101	DIMETHYL ANILINE	45	2.22
102	DIMETHYL ETHER	16	6.25
103	DIMETHYL FORMAMIDE	34	2.94
104	DIMETHYL HYDRAZINE (slow)	20	5.00
105	DIMETHYL SULFIDE	20	5.00
106	DIMETHYLANILINE,n,n- (xyenol)	N/F	N/F
107	DIMETHYLETHYLAMINE (slow)	44	2.27
108	DIMETHYLETHYLAMINE (slow)	44	2.27
109	DIMETHYLPHTHALATE	8	12.50
110	DIOCTYLPHTHALATE	N/F	N/F
111	DIOXANE	30	3.33
112	DIOXANE,1,4-	24	4.17
113	DIOXOLANE (ethyleneglycolmethylene ether)	23	4.35
114	DIPROPYLAMINE	110	0.91
115	DISECOCTYLPHTHALATE	N/F	N/F
116	DOWANOL (slow) dipropyleneglycolmethylether	25	4.00
117	DOWTHERM A (very slow, 2 min) @ 90 deg C	9	11.11
118	ENDRIN	N/F	N/F
119	EPICHLOROHYDRIN	51	1.96
120	EPOXYBUTANE	55	1.82
121	ETHANE	80	1.25
122	ETHANOL	20	5.00
123	ETHANOLAMINE	N/F	N/F
124	ETHOXYETHANOL,2- (slow)	22	4.55
125	ETHRANE enflurane	150	0.67
126	ETHYL ACETATE	65	1.54
127	ETHYL ACRYLATE	71	1.41
128	ETHYL BENZENE	111	0.90
129	ETHYL BROMIDE	75	1.33
130	ETHYL BUTYRATE	91	1.10
131	ETHYL CHLORIDE	58	1.72
132	ETHYL FORMATE	40	2.50
133	ETHYL HEXANOIC ACID	N/F	N/F
134	ETHYL HEXYL ALCOHOL,2-	17	5.88
135	ETHYL MERCAPTAN (ethanethiol)	28	3.57

N/F IS NOT FEASIBLE: F IS FEASIBLE BUT NO DATA: ALL AT 50-100 PPM UNLESS NOTED

1/4/94

FOXBORO OVA CENTURY RESPONSE CHART RELATIVE TO METHANE CALIBRATION

COMPOUND	RELATIVE RESPONSE %	RESPONSE FACTOR
136 ETHYL METHACRYLATE	70	1.43
137 ETHYL PROPIONATE	83	1.20
138 ETHYL SULFATE (diethylsulfate) (slow)	11	9.09
139 ETHYLENE (ethene)	48	2.08
140 ETHYLENE DIAMINE	N/F	N/F
141 ETHYLENE DIBROMIDE	56	1.79
142 ETHYLENE DICHLORIDE	89	1.12
143 ETHYLENE GLYCOL	N/F	N/F
144 ETHYLENE OXIDE	49	2.04
145 ETHYLHEXYL,2- ACRYLATE	17	5.88
146 ETHYLTOLUENE,3-	43	2.33
147 FORMALDEHYDE	N/F	N/F
148 FORMIC ACID	N/F	N/F
149 FUFFURYL ALCOHOL	4	25.00
150 FURFURAL (2-furaldehyde)	23	4.35
151 GUANFACINE ESTER (slow)	5	20.00
152 GUANFACINE ESTER (slow) in methanol equiv.	36	2.78
153 HALOTHANE	49	2.04
154 HCFC-123 (Freon 123)	86	1.16
155 HCFC-141B (Freon 141B)	125	0.80
156 HCFC-142B (Freon 142B)	192	0.52
157 HCFC-21 (Freon 21)	72	1.39
158 HCFC-22 (Freon 22)	67	1.49
159 HEPATNOL,2- (very slow)	24	4.17
160 HEPTANE	75	1.33
161 HEXACHLOROCYCLOPENTADIENE	N/F	N/F
162 HEXACHLORO-1,3-BUTADIENE	71	1.41
163 HEXADECANE	52	1.92
164 HEXAFLUOROPROPENE	81	1.23
165 HEXANE	75	1.33
166 HEXANOL	60	1.67
167 HEXENE (hexylene)	60	1.67
168 HFC-134A (1,1,1,2-tetrafluoroethane)	191	0.52
169 HFC-152A (1,1-difluoroethane)	163	0.61
170 HYDRAZINE	N/F	N/F
171 HYDROGEN PEROXIDE (50% wt vol)	N/F	N/F
172 HYDROGEN SULFIDE	N/F	N/F
173 ISOBUTANOL (2-methyl propanol)	63	1.59
174 ISOBUTENE (isobutylene)(2-methyl propene)	64	1.56
175 ISOFLURANE forane	93	1.08
176 ISOPAR E	97	1.03
177 ISOPAR E (@ 90 deg C)	122	0.82
178 ISOPAR E @ 500 ppm	87	1.15
179 ISOPAR K	45	2.22
180 ISOPAR K (@ 120 deg F)	55	1.82

N/F IS NOT FEASIBLE: F IS FEASIBLE BUT NO DATA: ALL AT 50-100 PPM UNLESS NOTED

1/4/94

FOXBORO OVA CENTURY RESPONSE CHART RELATIVE TO METHANE CALIBRATION

	COMPOUND	RELATIVE RESPONSE %	RESPONSE FACTOR
181	ISOPAR K (@ 175 deg F)	75	1.33
182	ISOPAR L (slow) (ppm/(mg/m3))	0.74	F
183	ISOPAR M	5	20.00
184	ISOPAR M (@ 90 deg C)	15	6.67
185	ISOPAR M @ 500 ppm	6	16.67
186	ISOPAR V	6	16.67
187	ISOPENTANE	80	1.25
188	ISOPHORONE (slow)	28	3.57
189	ISOPRENE	59	1.69
190	ISOPROPANOL (2-propanol)	54	1.85
191	ISOPROPOXY ETHANOL,2-	32	3.13
192	ISOPROPYL ACETATE	71	1.41
193	ISOPROPYL ETHER	75	1.33
194	ISOPROPYLAMINE (slow @ 15 sec survey)	5	20.00
195	ISOPROPYLAMINE (slow @ 30 sec survey)	9	11.11
196	KEROSENE 15 ppm / 641 mg/m3	0.024	F
197	LIMONENE (3M Scotchcast 4413, aged)	17	5.88
198	LIMONENE (Bioact EC-7R, fresh)	48	2.08
199	LIMONENE (slow)	31	3.23
200	LIMONENE (slow) in methanol equivalents	240	0.42
201	LINDRANE	N/F	N/F
202	MALEIC ANHYDRIDE	N/F	N/F
203	METHACRYLIC ACID	N/F	N/F
204	METHANE	100	1.00
205	METHANOL	10	10.00
206	METHOXYETHANOL,2-	14	7.14
207	METHOXY-2-PROPANOL,1-	24	4.17
208	METHYL ACETATE	46	2.17
209	METHYL ACRYLATE	40	2.50
210	METHYL BROMIDE	23	4.35
211	METHYL CELLOSOLVE @500 ppm PGME	5	20.00
212	METHYL CHLORIDE	56	1.79
213	METHYL CYCLOHEXANE	67	1.49
214	METHYL CYCLOPENTANE	80	1.25
215	METHYL ETHYL KETONE (2-butanone)	80	1.25
216	METHYL IODIDE (iodomethane)	11	9.09
217	METHYL ISO-BUTYL KETONE (isopropyl acetone)	82	1.22
218	METHYL ISO-PROPYL KETONE	90	1.11
219	METHYL METHACRYLATE	50	2.00
220	METHYL PROPYL KETONE (2-pentanone)	76	1.32
221	METHYL STYRENE,alpha- @ 15 sec survey	30	3.33
222	METHYL STYRENE,alpha- @ 30 sec survey	33	3.03
223	METHYL SULFATE (dimethyl sulfate) (slow)	4	25.00
224	METHYLAL (dimethoxy methane)	23	4.35
225	METHYLENE CHLORIDE	84	1.19

N/F IS NOT FEASIBLE: F IS FEASIBLE BUT NO DATA: ALL AT 50-100 PPM UNLESS NOTED

1/4/94

FOXBORO OVA CENTURY RESPONSE CHART RELATIVE TO METHANE CALIBRATION

	COMPOUND	RELATIVE RESPONSE %	RESPONSE FACTOR
226	METHYLHEPTANE,2-	84	1.19
227	METHYL-1,3-DIOXOLANE,2-	23	4.35
228	METHYL-2-BUTANONE,4-	90	1.11
229	METHYL-2-PENTANONE,4- (MIBK)	82	1.22
230	MINERAL SPIRITS (white) (ppm/(mg/m3))	0.14	F
231	MONOMETHANOLAMINE	N/F	N/F
232	MONOMETHYL HYDRAZINE (slow)	16	6.25
233	MORPHOLINE (slow)	7	14.29
234	MPA n-methyl-2-methanolpiperidine	N/F	N/F
235	MPC 2-(1-methylpiperidyl-2)-1-chloroethane	N/F	N/F
236	NAPHTHA (recovered) (ppm/mg/m3))	0.13	F
237	NAPTHALENE	48	2.08
238	NITROBENZENE	6	16.67
239	NITROGEN OXIDE	N/F	N/F
240	NITROMETHANE	34	2.94
241	NITROPROPANE,1-	60	1.67
242	NITROPROPANE,2-	70	1.43
243	NITROTOLUENE	N/F	N/F
244	NONANE	90	1.11
245	NONENE,1-	78	1.28
246	NORPAR 12	16	6.25
247	NORPAR 12 (@ 90 deg C)	31	3.23
248	OCTANE	80	1.25
249	OCTANOL,1-	14	7.14
250	OCTANONE,3- ethyl amyl ketone	18	5.56
251	PENTANE	65	1.54
252	PENTANOL	39	2.56
253	PESTICIDES (most)	N/F	N/F
254	PHENOL (slow)	54	1.85
255	PHTHALIC ANHYDRIDE	N/F	N/F
256	PIPERIDINE	70	1.43
257	PIVALOYL CHLORIDE	66	1.52
258	PROPANE	70	1.43
259	PROPANOIC ACID	32	3.13
260	PROPANOL,1-	35	2.86
261	PROPANOL,2- (isopropanol)	65	1.54
262	PROPYL ACETATE	60	1.67
263	PROPYL BROMIDE (bromopropane)	75	1.33
264	PROPYL ETHER,n	56	1.79
265	PROPYL FORMATE,n	58	1.72
266	PROPYLENE	42	2.38
267	PROPYLENE GLYCOL	N/F	N/F
268	PROPYLENE GLYCOL METHYL ETHER @500 ppm	5	20.00
269	PROPYLENE OXIDE	66	1.52
270	PYRIDINE	109	0.92

N/F IS NOT FEASIBLE: F IS FEASIBLE BUT NO DATA: ALL AT 50-100 PPM UNLESS NOTED

1/4/94

FOXBORO OVA CENTURY RESPONSE CHART RELATIVE TO METHANE CALIBRATION

	COMPOUND	RELATIVE RESPONSE %	RESPONSE FACTOR
271	PYRROLIDINE @500 ppm	12	8.33
272	SOL 71	44	2.27
273	STODDARD SOLVENT	~40	2.50
274	STODDARD SOLVENT (slow) (ppm/(mg/m3))	0.16	F
275	STYRENE	92	1.09
276	TETRACHLOROETHANE,1,1,1,2-	81	1.23
277	TETRACHLOROETHANE,1,1,2,2-	100	1.00
278	TETRACHLOROETHYLENE (perchloroethylene)	68	1.47
279	TETRAETHYL LEAD	16	6.25
280	TETRAHYDROFURAN	47	2.13
281	TOLUENE	126	0.79
282	TOLUENE DIISOCYANATE,2,4-	N/F	N/F
283	TOLUIDINE,o-	N/F	N/F
284	TRICHLOROBENZENE (slow)	70	1.43
285	TRICHLOROETHANE,1,1,1-	105	0.95
286	TRICHLOROETHANE,1,1,2-	95	1.05
287	TRICHLOROETHYLENE	54	1.85
288	TRICHLOROPHENOXY ACETIC ACID,2,4,5-	N/F	N/F
289	TRICHLOROPROPANE,1,2,3-	73	1.37
290	TRIETHANOLAMINE	N/F	N/F
291	TRIETHYLAMINE	59	1.69
292	TRIFLUOROETHANOL,2,2,2-	15	6.67
293	TRIFLUOROETHERS (CClF2OCCl2CF3)	16	6.25
294	TRIFLUOROETHERS (CClF2OCH2CF3)	42	2.38
295	TRIFLUOROETHERS (CClF2OCHClCF3)	28	3.57
296	TRIFLUOROETHERS (CHF2OCCl2CF3)	50	2.00
297	TRIFLUORO-2-CHLOROETHYL MONOCLME ETHER,	37	2.70
298	TRIFLUORO-2-CHLOROMETHYL ETHER,1,1,2-	96	1.04
299	TRIMETHYL BENZENE,1,2,3- (slow) (mesitylene)	64	1.56
300	TRIMETHYL BENZENE,1,2,4- (slow) pseudocumene	63	1.59
301	TRIMETHYL BENZENE,1,3,5- (slow)	70	1.43
302	TRIMETHYLACETYLCHLORIDE (pivaloyl chloride)	66	1.52
303	TRIMETHYLPENTANE,2,2,4- (isooctane)	91	1.10
304	TRIOXANE (metaformaldehyde) ((< 1))	N/F	N/F
305	TRIOXY PHOSPHATE (tri-(2-ethylhexylphosphate))	18	5.56
306	VINYL ACETATE	40	2.50
307	VINYL CHLORIDE (chloroethylene)	35	2.86
308	VINYL FLUORIDE	62	1.61
309	VINYLIDENE CHLORIDE	49	2.04
310	XYLENE,m-	111	0.90
311	XYLENE,o-	92	1.09
312	XYLENE,p-	116	0.86
313			

N/F IS NOT FEASIBLE: F IS FEASIBLE BUT NO DATA: ALL AT 50-100 PPM UNLESS NOTED

TABLE 3–1 RESPONSE FACTORS SUMMATION TABLE
EPA 500 PPM

MANUFACTURER	FOXBORO	FOXBORO	FOXBORO	FOXBORO
ANALYZER	OVA–108	OVA–128	OVA–128	MIRAN 1B2
SERIAL NUMBER	20868	41092	41102	322214
COMPOUND/CALCULATED RESPONSE FACTOR				
ACETALDEHYDE*	8.41	9.96	7.95	OK–B 400
ACETONITRILE*	1.2	1.24	1.27	OK–B 200
ACETOPHENONE**	2.71	2.62	2.43	RECAL–A
ACROLEIN*	6.25	6.69	5.64	RECAL–B
ACRYLIC ACID***	10.51	10.81	9.63	RECAL–B
ACRYLONITRILE	1.55	1.58	1.56	OK–B 100
ALLYLCHLORIDE	2.77	2.73	2.51	RECAL–B
ANILINE***	14.44	20.45	22.68	RECAL–A
BENZENE	0.56	0.54	0.5	OK–B 200
BENZYL CHLORIDE	1.43	1.42	1.21	OK–B 100
BROMOFORM*	5.9	6.71	5.68	RECAL–A
1,3–BUTADIENE	2.41	2.69	2.37	OK–A
2–BUTOXYETHANOL***	19.37	26.11	24.69	RECAL–B
CARBON DISULFIDE*	33.87	53.06	N/R	RECAL–A
CARBON TETRACHLORIDE*	12.07	15.99	13.72	OK–B 200
CARBONYL SULFIDE*	103.95	N/R	N/R	RECAL–B
CHLOROACETYL CHLORIDE	1.86	1.93	1.66	RECAL–B
CHLOROBENZENE	0.62	0.6	0.54	RECAL–A
CHLOROFORM	2.06	2.38	1.91	OK–A
CHLOROMETHYL–METHYL ETHER*	7.77	9.76	7.52	RECAL–B
50% CHLOROPRENE/XYLENE	1.46	1.47	1.27	
CUMENE**	2.05	1.82	1.55	RECAL–A
1,4–DICHLOROBENZENE		SOLID––NOT TESTED		
DICHLOROETHYL ETHER***	22.12	25.1	24.48	RECAL–A
1,3–DICHLOROPROPENE	2.03	2.08	1.93	RECAL–B
DIMETHYL FORMAMIDE*	6.42	6.38	7.2	RECAL–A
1,1–DIMETHYTHYDRAZINE	2.68	2.84	3	RECAL–B
1,4–DIOXANE	3.74	4.27	3.6	OK–A
EPICHLOROHYDRIN	2.3	2.41	2.07	RECAL–B
1,2–EPOXYBUTANE	2.67	2.54	2.16	RECAL–B
ETHYL ACRYLATE	2.49	2.64	2.18	RECAL–B
ETHYL CHLORIDE	1.68	1.84	1.65	OK–A
ETHYLBENZENE	0.77	0.76	0.66	RECAL–A
ETHYLENE DIBROMIDE	2.03	2.22	2.03	RECAL–A
ETHYLENE DICHLORIDE	1.37	1.59	1.41	RECAL–A
ETHYLENE GLYCOL***	24.81	39.39	N/R	RECAL–B
ETHYLENE OXIDE*	2.4	2.77	2.4	OK–B 100
ETHYLIDENE DICHLORIDE		NOT AVAILABLE IN		RECAL–B
2–ETHYOXYETHANOL*	3.55	4.09	3.5	RECAL–B
(37% FORMALDEHYDE/H2O) FORMALIN	18.83	31.39	27.66	RECAL–A
HEXACHLOROBUTADIENE***	16.28	22.99	18.06	RECAL–B
HEXANE	1.42	1.49	1.33	OK–A
IODOMETHANE*	8.06	8.76	7.35	RECAL–A
ISOOCTANE	1.05	1.05	0.89	RECAL–B
ISOPHORONE***	28.8	40.71	N/R	RECAL–B
MALEIC ANHYDRIDE		SOLID––NOT TESTED		
META–CRESOL***	75.6	115.2	N/R	RECAL–A

TABLE 3–1 RESPONSE FACTORS SUMMATION TABLE
EPA 500 PPM

MANUFACTURER	FOXBORO	FOXBORO	FOXBORO	FOXBORO
ANALYZER	OVA–108	OVA–128	OVA–128	MIRAN 1B2
SERIAL NUMBER	20868	41092	41102	322214
COMPOUND/CALCULATED RESPONSE FACTOR				
META–XYLENE	0.89	0.89	0.75	RECAL–A
METHANOL*	13.24	17.34	N/R	OK–A
METHYL BROMIDE	3.71	3.83	3.46	RECAL–A
METHYL CHLORIDE	1.97	2.38	1.97	OK–A
METHYL ETHYL KETONE	1.78	1.84	1.59	OK–A
METHYL HYDRAZINE**	5.47	5.5	5.74	RECAL–B
METHYL ISOBUTYL KETONE	1.65	1.69	1.4	RECAL–B
METHYL METHACRYLATE	2.02	2.16	1.81	OK–B 250
2–METHOXYETHANOL***	9.61	9.87	N/R	RECAL–A
METHYL TERT–BUTYL KETONE	1.23	1.25	1.03	RECAL–B
METHYLENE CHLORIDE	1.67	1.72	1.41	OK–A
NITROBENZENE***	16.41	16.52	N/R	RECAL–A
2–NITROPROPANE	1.86	1.91	1.6	RECAL–B
ORTHO–CRESOL		SOLID– –NOT TES		RECAL–B
ORTHO–XYLENE	0.95	0.95	0.8	RECAL–A
PARA–CRESOL	N/R	N/R	N/R	RECAL–B
PARA–XYLENE	0.89	0.88	0.74	RECAL–A
PHENOL (90% CARBOXYLIC ACID)	16.38	44.89	47.01	RECAL–B
PROPIONALDEHYDE	4.01	4.27	3.95	RECAL–B
PROPYLENE DICHLORIDE	1.49	1.48	1.26	RECAL–B
1,2–PROPYLENEIMINE	1.75	1.52	1.53	RECAL–B
PROPYLENE OXIDE	2.02	2.14	1.78	OK–B 200
SYTRENE	1.1	1.08	0.93	OK–B 200
SYTRENE OXIDE**	2.61	2.49	2.06	RECAL–B
1,1,2,2–TETRACHLOROETHANE	1.64	1.69	1.66	RECAL–A
TETRACHLOROETHYLENE	1.77	2.09	1.72	OK–A
TOLUENE	0.87	0.87	0.76	OK–A
1,1,1–TRICHLORETHANE	1.09	1.16	1.03	OK–A
1,2,4–TRICHLOROBENZENE	12.55	16.71	N/R	RECAL–B
1,1,2–TRICHLOROETHANE	1.19	1.27	1.11	RECAL–A
TRICHLOROETHYLENE	2.26	2.6	2.14	OK–A
TRIETHYLAMINE	0.47	0.49	0.48	RECAL–B
VINYL ACETATE	3.63	3.36	2.8	RECAL–A
VINYL BROMIDE	2.14	2.41	2.33	RECAL–B
VINYL CHLORIDE	2.03	2.11	2.11	RECAL–A
VINYLIDENE CHLORIDE	2.73	2.97	2.61	RECAL–A

N/R = NO RESPONSE OR O/L = OFF–LINE
* = LOW INSTRUMENT RESPONSE DETECTED/HIGH RESPONSE FACTOR CALCULATED.
** = UNSTABLE RESPONSE AND TAILING OF INSTRUMENT STRIP CHART RECORD OVER TIME NOTED
*** = VOLATILITY PROBLEM WITH COMPOUND

MIRAN 1B2

OK–A = COMPOUND LISTED IN MIRAN FIXED LIBRARY AT/ABOVE 500 PPM.
OK–B = COMPOUND LISTED IN MIRAN FIXED LIBRARY BELOW 500 PPM YET GAVE SATISFACTORY RESULTS WHEN TESTED AT 500 PPM; THE LIBRARY RANGE IS ALSO LISTED.
RECAL–A = COMPOUND LISTED IN MIRAN FIXED LIBRARY; MOST UNDER 100 PPM BUT GAVE UNSATISFACTORY WHEN TESTED AT 500 PPM; REQUIRED RECALIBRATION OF MIRAN 1B2 FOR 500 PPM RANGE.
RECAL–B = COMPOUND NOT LISTED IN MIRAN FIXED LIBRARY AND NEEDS COMPLETE USER LISTING, PEAK IDENTIFICATION, AND CALIBRATION OF ANALYZER FOR 500 PPM.

Brown and Caldwell
Standard Operating Procedure

Soil Sampling

Revision 1.1
Revision Date: October 9, 2001

Prepared/Revised by:	**Wendy Linck** Name	**October 9, 2001** Date
Senior QA Review:	Jay Lucas Name	10/26/01 Date
Regional Quality Officer:	David Van Winkle Name	October 26, 2001 Date

Brown and Caldwell
Standard Operating Procedure

Soil Sampling
Revision 1.1
Revision Date: October 9, 2001

SOIL SAMPLING

TABLE OF CONTENTS

1.0 PURPOSE

The objective of this standard operating procedure (SOP) is to provide standardized methods for the field collection of soil samples using manual or rig-assisted techniques.

2.0 SCOPE AND APPLICABILITY

This procedure specifies the methods to be followed by the field personnel for the collection of surface and subsurface soil samples. The collection techniques and equipment selected are dependent on the nature of subsurface soil conditions (i.e., degree of consolidation and moisture content), depth of the desired sample, type of sample required, type of soil being sampled, and analytical and/or geotechnical laboratory testing methods that will be requested for the sample.

Soil samples are used to determine the physical, hydrogeologic, and chemical properties of site soil. Analytical data aid in the characterization of the site, identification of hazardous substance source areas, and determination of the nature and extent of contamination. Typically a project Work Plan will be prepared that details sample locations, numbers, analytical methods, and specific field techniques that may be required. Different SOPs will be referenced in the Work Plan to provide detailed descriptions of how each procedure will be conducted. The project Work Plan may or may not include a field sampling plan (FSP) and Quality Assurance Project Plan (QAPP) based on client requirements. Proper sampling techniques, proper selection of sampling equipment, and proper decontamination procedures as outlined in the project Work Plan eliminates cross-contamination and introduction of contaminants from external sources.

Detailed records will be maintained during sampling activities, particularly with respect to location, depth, color, odor, lithology, hydrogeologic characteristics, and readings derived from field monitoring equipment. These records will be prepared following the Brown and Caldwell SOP for Field Documentation. All soils are classified in the field by a geologist, hydrogeologist, or soil scientist using the Unified Soil Classification System (USCS), and as described in SOP 3.0 Field

Classification and Description of Soils. Color of the samples is determined in the field using a Munsell Color Chart.

3.0 RESPONSIBILITIES

The Project Manager develops or directs the preparation of a Work Plan, which describes the sampling procedures to be used and ensures that the procedures achieve the objectives of the investigation.

The Field Supervisor ensures that soil samples are collected according to procedures outlined in the project Work Plan or provides rational and justifiable decisions in circumstances where deviations from the project Work plan are necessary due to field conditions or unforeseen problems. The field supervisor also ensures that samples are handled, labeled, and shipped according to procedures outlined in the project Work Plan.

Field personnel are responsible for implementing this SOP as stated, and following the Work Plan requirements for sampling, QA/QC sample collection and frequency, and following other Brown and Caldwell SOPs for field sample shipment and handling.

4.0 DEFINITIONS

Surface soil is generally considered to be the top 6 inches of a soil horizon profile (i.e., soil from 0-to-6-inches below ground surface [bgs]). Depending on the program or project, however, soil to 2 feet bgs may be considered surface soil. For the purposes of this procedure, surface soil represents the soil occurring from 0- to- 6-inches bgs.

Subsurface soil represents the soil occurring between surface soil and bedrock.

Composite soil samples are combinations of aliquots collected at various sample locations, or at various depths at a single location. Analysis of composite samples yields a value representing an average over the various sampled sites or depths from which individual samples were collected.

Discrete soil samples are discrete aliquots from distinct sampling intervals, of a specific size, that are representative of one specific sample location at a specific point in time.

Continuous samplers are devices that allow a soil specimen to enter a split barrel during drilling. Both plastic and steel liners can be used inside the sample tube to retain the sample. In some formations, the soil sample may be considered “undisturbed.”

Split-barrel samplers collect samples by driving a 1.5-inch nominal inner diameter (typical), split barrel into a soil formation with a 140-pound hammer dropped 30 inches. For environmental applications, 2-, 2.5- and 3-inch inner diameter split barrels are not uncommon. If a standard 1.5-inch split barrel is used, the number of blows to drive the last 1 foot of the sample are referred to as the standard penetration resistance or N-value. See ASTM D-1586 for the specification for this type of sampler. Another type of split barrel sampler is the core barrel. A core barrel is longer and usually wider in diameter than the typical split barrel samplers and used on hollow stem auger drill rigs. Core barrels are usually 5 feet long and approximately 4-inch outside diameter, which sit into the leading auger and collect soil while drilling. Core barrels are typically unlined.

Ring-lined samplers are split barrels lined with removable rings. The rings are thin-walled and arranged in 1-, 2- or 6-inch increments to section the recovered soil sample. This device is used to collect soil samples for environmental applications and to collect relatively undisturbed soils in stiff and hard cohesive soils where it is not possible to push a sampler. See ASTM D3550 for the specification for this type of additional sampler.

Thin-walled tubes are used to recover relatively undisturbed soil samples by pressing the tubes into soil either hydraulically, or with a Denison or Pitcher sampler.

5.0 REQUIRED MATERIALS

Equipment used during manual collection of surface or subsurface soil samples may include a wide variety of tools depending upon the type of sampling and methods being used. This equipment can include, but is not limited to the following:

- Hand lens
- Stainless steel spoons/trowels and stainless steel hand augers
- Stainless steel split-spoon, split-barrel or continuous sampler
- Brass or stainless steel sampling sleeves, if applicable
- Encore™ Sampler T-bar and samplers (5 gram or 25 gram size), if applicable
- Field Balance accurate to 0.01 gram and VOA vials, and preservatives for field preservation of VOC vials under EPA 5035, if applicable
- Stainless steel bowls and pans, if applicable
- Silicon Tape, strapping tape, duct tape
- Field notebook or logbook
- Ball point pen
-
- Paper towels or Kimwipes
- Aluminum foil
- Teflon sheets
- Appropriate decontamination equipment
- Appropriate health and safety equipment
- Appropriate sample containers and labels, sample coolers and ice
- Chain of Custody forms
- Munsell soil color charts and grain size charts

6.0 PROCEDURE

This section identifies important preparations that should be made before initiating a soil sampling event and describes the steps that should be followed during soil sample collection at environmental sites.

Surface soil samples are defined in this procedure as samples collected from 0 to 6 inches below ground surface (bgs) or the first 2 inches of soil below a surficial layer of vegetation. These samples can be obtained easily using manual methods (i.e., a spade, trowel and scoop, or hand-auger). Surface soil samples can also be obtained with the assistance of a drilling rig equipped with a split-barrel sampler. The split-barrel sampler may be either unlined or lined with brass or stainless steel thin-wall sleeves.

Subsurface soil samples to be collected from depths greater than 6 inches bgs can be obtained manually using a hand-auger, a drilling rig, or excavating device (e.g., backhoe). A split-barrel sampler can be employed to depths in excess of 100 feet bgs with the assistance of a drilling rig. An excavating device can provide bulk soil samples from the ground surface to the limits of the excavator (typically 15 to 25 feet bgs . For bulk soil sampling at greater depths in unsaturated soils, a bucket auger rig may be used.

Composite soil samples are combinations of aliquots collected at various sample locations, or at various depths at a single location. Analysis of composite samples yields a value representing an average over the various sampled sites or depths from which individual samples were collected. Composite soil sampling is typically used in sampling soil for the characterization of investigation derived waste for disposal purposes. Other uses of composite sampling is in characterization of large surface area where a material may have been distributed.

6.1. Preparation for Soil Sample Collection

Preparation for the field collection of surface and subsurface soil samples shall commence with an assessment of ground surface conditions (e.g., undeveloped, vegetated or not vegetated, paved or unpaved, type and thickness of any pavement present) and subsurface conditions (e.g., soil types present, degree of consolidation, moisture content, depth of groundwater). Information available to assess these conditions may include regional soil survey reports by the USDA Natural Resources Conservation Service and/or borehole or test-pit/trench logs maintained during previous geological, geotechnical, or environmental investigations.

If a point designated for soil sample collection is overlain by abundant vegetation, it may be necessary to clear the area before sampling to provide access. If the sampling point is overlaid with concrete pavement, it is necessary to arrange for a cement cutter/corer to remove the paving material prior to sampling (cement cutting services are available through construction support or drilling subcontractors).

Prior to field collection of soil samples, the Project Manager (PM), Task Manager (as appropriate), and field personnel shall also perform the following tasks.

- Conduct a general site reconnaissance in accordance with the site-specific safety and health plan.
- Mark or identify all sampling locations using stakes, markers, or flags. If required, a proposed sampling location may be adjusted based on access, property boundaries, surface obstructions, and subsurface utilities.
- Determine the extent of the monitoring and sampling effort, analytical methods to be requested for each sample, sample container types required, sampling methods to be used, and specific equipment and supplies necessary to conduct the monitoring and sampling.
- Prepare all field forms as appropriate (field logbooks, pre-prepared Chain of Custody records and labels, etc.)
- Determine required monitoring equipment (e.g., photoionization detector, vapor detection tubes) and personal protective equipment (PPE) required for the health and safety of personnel.
- Obtain the necessary sampling and monitoring equipment and ensure it is in working order.
- Prepare field sampling schedules, provide these schedules to the client (if required), subcontractors, and regulatory agencies (if required), and

coordinate field sampling activities with their designated representatives.

- Perform an underground utility clearance of all staked sampling locations prior to excavating or drilling.
- Conduct a readiness review to the tier necessary as defined by the PM following Brown and Caldwell's SOP for Readiness Reviews.

6.2. Manual Soil Sample Collection

The following sections describe the specific steps that the environmental engineer/geologist shall follow when collecting surface and subsurface soil samples.

6.2.1. Collection of Surface Soil Samples

Tools such as spades, shovels, trowels, scoops, or spoons can be used to collect most surface soil samples, however, the sampler should be certain the sampling tools are not made out of a material that may effect the sample results (e.g., galvanized metal should not be used to collect metals samples and plastic should not be used to collect semivolatile organic samples).

For densely packed soils, and to collect discrete surface soil samples, it may be necessary to use a hand auger (Section 6.2.2), or a drilling rig (Section 6.3). Also, if relatively undisturbed samples are required, a flat, pointed, mason trowel can be used to cut a block sample of the desired soil. The procedure is as follows:

1. Prior to beginning sampling, don clean disposable nitrile or latex surgical gloves and impervious outer gloves to prevent cross-contamination and to provide personal protection. New gloves should be donned for sample collection at each new location or whenever gloves are torn or otherwise compromised.
2. Carefully remove the top layer of vegetation, soil or debris to the desired sample depth with a decontaminated spade, shovel, or equivalent.

3. Using a decontaminated, stainless steel scoop, plastic spoon, or trowel, remove and discard a thin layer of soil from the area that came in contact with the spade. Also discard any pebbles, roots and other large objects that may be present in the sample material.

4. If a composite sample is required, place the sample into a stainless steel or other appropriate container and mix thoroughly to obtain a homogenous sample representative of the entire depth interval sampled. However, volatile organic samples are the exception; samples being analyzed for volatile organic compounds must be taken from discrete locations prior to mixing. This practice is necessary to prevent loss of volatile constituents and to preserve, to the extent practicable, the physical integrity of the volatile fraction. The process of homogenization is described below. After homogenization, place the sample into an appropriate container, as specified in the project Work Plan, and secure the cap tightly.

   – If the sample is to be analyzed for volatile organic compounds (VOCs), transfer a portion of the sample directly (i.e., without homogenization) into the appropriate sample container with a stainless steel spoon, plastic spoon, or equivalent, and secure the container cap tightly. The sample container should be sealed with Teflon sheeting and capped with rubber caps in order to prevent VOCs from escaping. Alternatively, sampling using EPA Method 5035 may be used (Section 6.4).

   – Place a sample from each sampling interval into the homogenization container and mix thoroughly. When compositing is complete, place the sample into the appropriate sample container(s) and secure the cap tightly.

   5.0 Homogenization of the sample for remaining parameters may be necessary to create a representative sample volume if sample heterogeneity is not being evaluated. Moisture content, sediments, and waste materials may inhibit the ability to achieve complete mixing prior to filling sample containers. Therefore, when homogenization is requested, it is extremely important that soil samples be mixed as thoroughly as possible to ensure that the sample is a representative as possible of the sample location. When homogenization is requested, the following procedure should be followed:

5.1 The soil is extruded from the sampling apparatus (i.e., drive sampler) or collected by a stainless steel trowel and emptied into the decontaminated stainless steel tray or bowl. Homogenization should be accomplished by then mixing with a decontaminated stainless steel or Teflon® instrument.

5.2 The method of choice for mixing is referred to as quartering and can be performed in a bowl or tray of an appropriate material (material depends on the parameters to be analyzed for). The soil in the sample pan is divided into quarters. Each quarter is mixed, then all quarters are mixed into the center of the pan. This procedure is followed several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material over.

5.3 The extent of mixing required will depend on the nature of the sample and should be done to achieve a consistent physical appearance prior to filling sample containers.

5.4 Once mixing is completed, the sample should be divided in half and containers should be filled by scooping sample material alternatively from each half.

5.5 Potential Problems

(1) The higher the moisture or clay content, the more difficult it is to homogenize the sample.

(2) A true homogenization of soil, sediment, or sludge samples is almost impossible to accomplish under field conditions.

6. If a composite sample is not required, then the soil can be transferred directly into the sample containers. Attach a sample label to the container using the sample numbering system described in the Project Work Plan and the sample identification numbers generated for the specific locations.

7. Describe the sample following procedures outlined in Brown and Caldwell's SOP for Borehole Logging.

8. Record required field logbook and sample custody information as specified in Brown and Caldwell's SOP for Field Documentation. Package the samples and prepare for transfer or shipment in accordance with Brown and Caldwell's SOP for Environmental Sample Handling.

9. Mark the sample location with a numbered stake or other type of marker. If possible, photograph the sample location.

10. Sketch the sample location in the field logbook. If the proposed sampling point was relocated due to conditions encountered in the field, indicate both the original and actual sample locations on the site map, and record the reason for its relocation in the logbook.

11. Decontaminate sampling equipment in accordance with Brown and Caldwell's SOP for Equipment Decontamination.

12. After a sampling round is complete, survey all sample locations to determine the ground surface elevation and horizontal coordinates.

6.2.2. Soil Sampling with a Hand Auger

The equipment used for this manual method of soil sampling consists of an auger, a series of extensions, and a T-handle. The auger is used to bore a shallow hole to the desired sampling depth. The auger is then withdrawn, and the sample is collected by inserting a manual drive sampler (split-barrel) with brass or stainless steel sampler sleeves, and driving ahead of the auger hole. The typical sampler is a single shoe that contains one 6-inch sleeve or two 3-inch sleeves. Several types of hand augers are available, including tube, continuous-flight (screw), and posthole augers.

- With continuous-flight augers, the sample can be collected directly from the flights. Continuous-flight augers are satisfactory for use when a composite of the complete soil column is desired. This is not appropriate for depth discrete sampling.
- Posthole augers have limited utility for sample collection because they are designed to cut through fibrous, rooted, and/or swampy soils.

The following procedure is provided for manual collection of soil samples with a tube auger, as shown in Attachment A.

1. Don clean disposable nitrile or latex surgical gloves to prevent cross-contamination and to provide personal protection. New gloves should be donned for sample collection at each new location or whenever gloves are torn or otherwise compromised.
2. Check and clear each subsurface soil sample location prior to intrusive activities using as-built drawings, geophysical surveys (e.g. ground penetrating radar), or have clearances performed by the local utility company.

3. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter). If a surface soil sample is to be collected, the environmental engineer/geologist shall follow the procedure for surface soils presented in Section 6.2.1. Before advancing the auger, it may be advisable to remove the first 3 to 6 inches of surface soil over a radius of approximately 6 inches around the borehole.

4. Attach the auger bit to a drill rod extension, and attach the T-handle to the drill rod.

5. Begin augering, periodically removing and depositing accumulated soils into an appropriate investigation-derived waste storage or transfer container. Temporary storage on plastic sheeting is appropriate, if identified in a project Work Plan or Waste Management Plan.

6. After reaching the desired depth, slowly and carefully remove the auger from the borehole.

7. Decontaminate the split-barrel sampler and sleeves (if required) in accordance with Brown and Caldwell's SOP for Equipment Decontamination. Place the decontaminated sampler sleeve(s) into the sampler barrel. The sampler barrels are generally 6 inches in length and can hold one 6-inch or two 3-inch sleeves. Assemble the sampler by aligning both sides of the barrel and then attaching the drive shoe and head to the barrel's bottom and top, respectively. Some drive samplers are a two-piece unit – the shoe, which contains the sleeve and the head. For these samplers, the head is aligned with the shoe and threaded onto the head. The impact driver is threaded onto the head. Extensions may be added between the impact driver and the sampler for depths greater than 2 feet.

8. If a lined soil sampler is to be used, decontaminate the sample sleeves according to Brown and Caldwell's SOP for Equipment

Decontamination. Store decontaminated sample sleeves in aluminum foil or on clean plastic sheeting as project requirements dictate prior to assembling the split-barrel sampler.

9. Carefully lower the drive assembly into the borehole, then drive it until the sleeve(s) are advanced into the undisturbed soil below the borehole.

10. Retrieve the sampler from the borehole and disassemble it. Remove the sample from the unlined sampler and transfer it to the appropriate container(s) or remove the sleeve from the sampler, and submit each sample sleeve as stipulated in the Project Work Plan.

11. For sample sleeves, seal the ends of each sample sleeve with Teflon™ sheeting and tightly fitting plastic end caps. The end caps shall then be held in place with silicone tape or other U.S. EPA-approved sealing tape. Electrical or duct tape **shall not** be used.

12. For sampling using EPA Method 5035, samples may be collected directly from the middle or bottom sleeve with the EnCore™ sampler, or aliquots placed into VOA vials and preserved as discussed in Section 6.4.

13. If another sample is to be collected at a greater depth in the same borehole, reattach the auger bit to the drill and assembly, and follow the steps above. Decontaminate the auger between samples.

14. Attach a sample label(s) to the container(s) using the sample numbering system described in the Project Work Plan and the sample identification numbers generated for the specific locations.

15. Abandon the borehole according to applicable state, county, and local regulations and Brown and Caldwell's SOP for Borehole Abandonment and Monitoring Well Destruction.

16. Follow Steps 7 through 12 of Section 6.2.1.

If vertical composite samples are desired, aliquots of soil should be collected at more than one sampling depth and placed in a single collection container prior to mixing. Mixing is then performed using the procedures outlined in the surface soil composition section (Section 6.2).

6.3. Subsurface Soil Sampling with a Drilling Rig

Most often, when subsurface soil sampling is required at depths exceeding 5 feet bgs, a drilling subcontractor is used to help obtain the samples. Several drilling methods may be employed to collect the samples. Regardless of the drilling method, a 2-inch or 2.5-inch internal diameter split-barrel sampler (Attachment B) is often used to collect samples at depth. The split barrel sampler is attached to the appropriate drive-weight assembly, is positioned at the desired sampling depth and driven by repeated blows of a 140-pound hammer with a free-fall of 30 inches in general accordance with ASTM D1586 or with a pneumatic air hammer. Generally, split-barrel samples are 18 inches in length, but longer samples are also available.

Soil samples to be submitted to an analytical laboratory for testing may be collected in an unlined split-barrel sampler and transferred to sample containers as appropriate for shipment to the laboratory. However, the preferable method is to collect soil samples using a split-barrel sampler lined with thin-wall brass or stainless steel sleeves. This method allows for the collection of samples for chemical and physical properties or geotechnical analysis. Soil samples to be analyzed for metals shall be collected in stainless steel sleeves. Six-inch, 3-inch, or combinations of both sizes of sleeves can be used to line the split-barrel sampler. The procedures are outlined in the following sections.

Some of the procedures included in the following subsections are performed by the drilling subcontractor. Any procedure that deals with the apparatus (e.g. drill rig, split barrel samplers, drill rods) and services (e.g. drilling the boring and collection of soil samples) provided by the drilling subcontractor is operated by that subcontractor, who is qualified to do so.

6.3.1. Split-barrel sampler

1. Don clean disposable surgical nitrile or latex gloves to prevent cross-contamination and to provide personal protection. New gloves should be donned for sample collection at each new location or whenever gloves are torn or otherwise compromised.

2. Clear the ground surface of any surface debris (e.g., twigs, rocks, litter) or pavement prior to initiating drilling and sampling operations.

3. Decontaminate the split-barrel sampler and sleeves in accordance with Brown and Caldwell's SOP for Equipment Decontamination.

4. Place the decontaminated sampler sleeve(s) into the sampler barrel. Assemble the sampler by aligning both sides of the barrel and then attaching the drive shoe and head to the barrel's bottom and top, respectively.

5. Attach the soil sampler to the drill rod assembly and advance it 18 inches bgs or the total length of the sampler.

6. Retrieve the sampler from the borehole and disassemble it. Remove the bottom 6 inches of the sample from the unlined sampler and transfer it to the appropriate containers. If sample sleeves are used and full recovery is achieved, typically, the middle sleeve shall constitute the soil sample for analytical analysis. The ends of the middle sleeve should be quickly noted for lithological descriptions, the sample prepared for shipment and the remaining soil from the remaining sleeves used to describe the soil for that drive interval. The sleeve used for analytical analysis is dependent on the purpose of the sampling. Consult the PM for direction. If the soil is the litholgically the same throughout the interval, the less disturbed sample should be used for analytical analysis. The number of sleeves to be sent depends upon project analytical requirements. The top

sleeve or top portion of the sampler is often material that has fallen back in the borehole and is not characteristic of the sample depth. If inadequate sample recovery is obtained, use material from the bottom sleeve first, followed by whatever material is in other sleeves, or attempt to recollect the sample. Sleeve samples shall also be packaged and handled in accordance with Brown and Caldwell's SOP for Environmental Sample Handling.

7. When collecting subsurface soil samples, advance the drill bit and rod assembly to the top of the next desired sampling interval. After removing any excess cuttings from the borehole and tripping the drill bit out of the borehole, attach the empty decontaminated soil sampler to the drill rod assembly and lower it into the borehole.

8. Mark the drill rods in successive 6-inch increments so that the advance of the soil sampler can be easily observed by the environmental engineer/geologist. Advance the split-barrel sampler the required distance (generally 18 inches) with blows from the hammer.

9. Count the number of blows applied for each 6-inch increment of sampler advance into subsurface soils and record this information on the borehole log in accordance with Brown and Caldwell's SOP for Field Documentation and Borehole Logging. Sampler refusal is generally indicated if more than 50 blows are required to advance the sampler 6 inches.

10. If an orientated geotechnical sample is required, mark each of the sample sleeves, if used, with a "T" and a "B," using a wax crayon or a pen with indelible ink, to indicate stratigraphic "top" and "bottom," respectively. Log the exposed soil at the ends of each sample sleeve other than the lowest in accordance with Brown and Caldwell's SOP for Borehole Logging.

11. Without disturbing the sample, seal the ends of each sample sleeve with Teflon sheeting and tightly fitting plastic end caps. The end caps may then be held in place with silicone tape.

12. If another soil sample is to be collected at a greater depth in the same borehole, drill to the desired depth, reattach the split-barrel sampler to the drill rod assembly, and follow Steps 5 through 8 above. Be sure to decontaminate the sampler between samples.

13. Label sample sleeves using the sample numbering system described in the Project Work Plan and the sample identification numbers generated for the specific locations. The sample identification number for split-barrel samples shall include the sample depth, accounting for the appropriate incremental depth based on the location of the sleeve within the split-barrel sampler. Record other required field logbook information as specified in Brown and Caldwell's SOP for Field Documentation.

14. Follow Steps 15 and 16 of Section 6.2.2.

6.3.2. Continuous sampler (Physical characterization only – not for analytical sampling)

1. Don clean, disposable nitrile or latex surgical gloves to prevent cross-contamination and provide personal protection. New gloves will be donned for sample collection at each location, or whenever gloves are torn or otherwise compromised.

2. Using the drilling equipment (e.g., hollow stem augers), advance the soil boring to the depth immediately above the sampling interval.

3. Attach the continuous sampler to the rods or cable and insert into the hollow-stem augers (or casing) and lower it to the bottom of the borehole.

4. Advance the sampler ahead of the augers into the undisturbed sampling interval.

5. Retrieve and split open the sampler.

6. Log the samples in accordance with Brown and Caldwell's SOP for Borehole Logging.

6.4. Field Sampling Using EPA 5035

Collection and storage of soils for VOC analysis using current US EPA methodology has changed since the promulgation of SW846 Method 5035. The EnCore™ Sampler is one of three collection options promulgated from the change in SW846 Method 5035. The other two collections are Acid Preservation and Methanol Preservation. The other two methods are employed only if field constraints are such that samples cannot be shipped and received by a laboratory within 24 to 36 hours of sampling. EPA Method 5035 calls for the preservation of samples if analysis cannot occur within 48 hours. To allow adequate time for the laboratory to preserve the samples if necessary, the laboratory should receive them within **24 to 36 hours of collection**. This section describes the proper procedures and methods to be employed in the collection and shipment of soil samples collected under EPA Method 5035.

Innovative Technologies (1-888-411-0757) is at this time the only supplier of the Encore™ sampler. Detailed information from Innovative Technologies about the Encore sampler™ is provided in Attachment C.

6.4.1. Collection of samples for Low Level Analyses (> 1 µg/Kg)

Each sample point requires two 5g samplers, one 25g sampler or one 5g sampler for screening and/or high level analysis, one dry weight cup, one T-handle and paper towels. The number of samplers required may be different from these typical numbers based on the QAPP requirements for the project. The Project chemist should be consulted in determining the number of Encore™ samplers required for the project. The procedure is as follows:

1. Remove sampler and cap from package and attach T-handle to sampler body. Make sure that the sampler is locked into place in the T-handle.

2. Quickly push sampler into a freshly exposed surface of soil until the sampler is full. The sampler is full when the o-ring is visible in the hole on the side of the T-handle.

3. Use paper towel to quickly wipe the sampler head so that the cap can be tightly attached.

4. Push cap on with a twisting motion to attach cap.

5. Place sampler into the package.

6. Fill out label and attach to the package, where specified for the label..

7. Repeat procedure for the other two samplers.

8. Collect dry weight sample – fill container. If other samples (non-Encore™) are collected for the same sampling interval, the dry weight sample may be designated and analyzed using the other sample.

9. Store samplers at 4 degrees Celsius.

10. Ship sample containers with plenty of ice to the laboratory. Samples must arrive at the laboratory **within 40 hours** of collection.

6.4.2. Acid Preservation Sampling for Low Level Analyses (≥ 1 µg/kg).

This procedure should be done in the field **only** if field constraints prevent shipment to the laboratory such that the laboratory cannot perform the analysis within 48 hours (or samples will not arrive within 24 to 36 hours of collection).

Each sample point requires the following equipment:

1. One 40ml VOA vial with acid preservative (for field testing of soil pH).

2. Two pre-weighted 40ml VOA vials with acid preservative and stir bar (for lab analysis).
3. Two pre-weighted 40 ml VOA vials with water and stir bar (in case samples effervesces).
4. One pre-weighted jar that contains methanol or a pre-weighted empty jar accompanied with a pre-weighted vial that contains methanol (for screening sample and/or high level analysis).
5. One dry weight cup.
6. One 2 oz jar with NaHSO4 acid preservative (in case additional acid is needed due to high soil pH).
7. One scoop capable to deliver about one gram of solid sodium bisulfate.
8. pH paper.
9. Weighing balance that weighs to 0.01 gram (filed balances may not reliably weigh to 0.01 gram).
10. Set of balance weights used in daily balance calibration.
11. Gloves for working with pre-weighted sample vials.

The field chemistry procedure for testing effervescing capacity of soils is as follows:

1. Place 5 grams of soil into vial that contains acid preservative and no stir bar.
2. Do not cap this vial as it may EXPLODE upon interaction with the soil.
3. Observe the sample for gas evolution (due to carbonates in the soil).

4. If vigorous or sustained gas evolution occurs, then acid preservation is not acceptable to preserve the sample. In this case, the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.

5. If a small amount or no gas evolution occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering testing detailed below. In this case, the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

The field chemistry procedure for testing buffering capacity of soils is as follows:

1. If acid preservation is acceptable for sampling soils than the sample vial that was used in the effervescing testing can be used here for testing the buffering capacity of the soil.

2. Cap the vial that contains 5 grams of soil, acid preservative and no stir bar from Step #1 in the effervescing testing.

3. Shake the vial gently to attempt to make a homogenous solution.

4. When done, open the vial and check the pH of the acid solution with the pH paper.

5. If the pH paper reads below 2 then the sampling can be conducted in the two pre-weighted 40 ml VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.

6. If the pH paper reads above 2, then additional acid needs to be added to the sample.

7. Use the jar with the solid sodium bisulfate acid and add another gram of acid to the sample.

8. Cap the vial and shake thoroughly again.

9. When done, open the vial and check the pH of the acid solution with a new piece of pH paper.

10. If the pH paper reads below 2 then the sampling can be conducted in the two pre-weighted 40 ml VOA vials with the acid preservative and stir bar and one extra gram of acid.

11. Make a note of the extra gram of acid needed so the same amount of extra acid can be added to the vials the lab will analyze.

12. If the pH paper reads above 2, then add another gram of acid and repeat this procedure one more time.

The procedure for collection of samples is as follows:

1. Wear gloves during all handling of pre-weighed vials.

2. Quickly collect a 5 gram sample using a cut off plastic syringe or other coring device designed to deliver 5 grams of soil from a freshly exposed surface of soil.

3. Carefully wipe exterior of sample collection device with clean paper towel.

4. Quickly transfer to the appropriate VOA vial, extruding with caution so that the solution does not splash out of the vial.

5. Add more acid if necessary (this is based on the buffering testing discussed on the previous section).

6. Use the paper towel and quickly remove any soil off of the vial threads.

7. Cap vial and weigh the jar to the nearest 0.01 gram.

8. Record exact weight on the sample label.

9. Repeat sampling procedure for the duplicate VOA vial.

10. Collect dry weight sample – fill container.

11. Store samples at 4 degrees Celsius.

12. Ship containers with plenty of ice and per DOT regulations to the laboratory.

6.4.3. Encore™ Sampler Collection For High Level Analyses (> 200 μg/Kg)

Each sample point requires the following equipment:

1. One 25g sampler or one 5g sampler. (The sampler size used will be dependent on who is doing the sampling and who is doing the laboratory analysis).

2. One dry weight cup.

3. One T-handle.

4. Paper towels.

The procedure for collecting soil samples is as follows:

1. Remove sampler and cap from package and attach T-handle to sampler body. Make sure that the sampler is locked into place in the T-handle.

2. Quickly push sampler into a freshly exposed surface of soil until the sampler is full. The sampler is full when the o-ring is visible in the hole on the side of the T-handle.

3. Use paper towel to quickly wipe the sampler head so that the cap can be tightly attached.

4. Push cap on with a twisting motion to attach cap.

5. Place sampler into the package.

6. Fill out label and attach to the package, where specified for the label.

7. Collect dry weight sample – fill container. If other samples (non-Encore™) are collected for the same sampling interval, the dry weight sample may be designated and analyzed using the other sample.

8. Store samplers at 4 degrees Celsius.

9. Ship sample containers with plenty of ice to the laboratory. Samples must arrive at the laboratory **within 40 hours** of collection.

6.4.4. Methanol Preservation Sampling for High Level Analyses (≥ 200 μg/kg).

This procedure should be done in the field **only** if field constraints prevent shipment to the laboratory such that the laboratory cannot perform the analysis within 48 hours (or samples will not arrive within 24 to 36 hours of collection).

Methanol preservation of each sample point requires the following equipment:

1. One pre-weighted jar that contains methanol or a pre-weighted empty jar accompanied with a pre-weighted vial that contains methanol.

2. One dry weight cup.

3. Weighing balance that weighs to 0.01 gram (filed balances may not reliably weigh to 0.01 gram).

4. Set of balance weights used in daily balance calibration.

5. Gloves for working with pre-weighted sample vials.

6. Paper towels.

The procedure for collection of soil samples is as follows:

1. Wear gloves during all handling of pre-weighed vials.

2. Weigh the vial with methanol preservative in it to 0.01 gram. If the weight of the vial with methanol varies by more than 0.01 gram from the original weight recorded on the vial - discard the vial. If the weight is within tolerance it can be used for soil preservation below.

3. Tare the empty jar or the jar that contains the methanol preservative.

4. Quickly collect a 25 gram or 5 gram sample using a cutoff plastic syringe or other coring device designed to deliver 25 gram or 5 gram of soil from a freshly exposed surface of soil. The 25 gram or 5 gram is dependent on who is doing the sampling and who is doing the laboratory analysis.

5. Carefully wipe the exterior of the collection device with clean papa towel.

6. Quickly transfer the soil to an empty soil jar that contains methanol. If extruding into a jar that contains methanol be careful not splash the methanol outside of the vial. Again, the type of jar received is dependent on who is doing the laboratory analysis.

7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided – using only one vial of methanol preservative per sample jar.

8. Use the paper towel and remove any soil off of the vial treads and cap the jar.

9. Weigh the jar with the soil in it to 0.10 gram and record the weight on the sample label.

10. Collect dry weight sample – fill container.

11. Store samples at 4 degrees Celsius.

12. Ship containers with plenty of ice and per DOT regulation to the laboratory.

6.5. Bulk Soil Sampling

Large volumes of soil are generally not required for environmental investigations. However, soil samples may be collected in bulk with a backhoe from test-pits or trenches to a maximum depth of approximately 15 to 25 feet . A bucket auger may be used to collect bulk soil samples to maximum depths of 250 feet if the soils are unsaturated.

If bulk sampling is required for a given project, the procedure for sample collection will be provided in the project Work Plan. In general, any bulk sampling conducted on a project will follow the procedures discussed under the sections above. Whether samples will be composited into stainless steel bowls, collected under EPA 5035, or into sample sleeves will be determined and described in the project Work Plan.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

In order to assess the accuracy and precision of the field methods and laboratory analytical procedures, quality assurance/quality control (QA/QC) surface and subsurface soil samples are collected during the sampling program according to the project Work Plan. QA/QC samples may be labeled with QA/QC identification numbers or fictitious identification numbers if blind submittal is desired, and are sent to the laboratory with the other samples for analyses. The frequency, types, and locations of QA/QC samples are specified in the project Work Plan. Examples of QA samples are equipment rinsate samples, duplicate samples, matrix spike/matrix spike duplicate samples, performance evaluation samples, and laboratory blind duplicate samples.

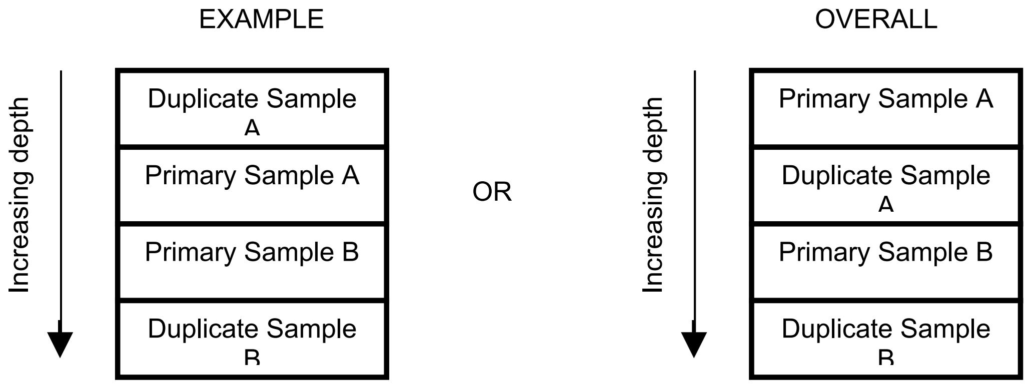
7.1. Equipment Rinsate Samples

An equipment rinsate sample is intended to check if decontamination procedures have been effective and to assess potential contamination resulting from containers, preservatives, sample handling and laboratory analysis. Procedures for collection are as follows:

1. Rinse the decontaminated sampling apparatus with deionized water. Allow the rinsate to drain from the sampling apparatus directly into the sample bottle.
2. Add any preservatives associated with the soil sample analytical methods to the rinsate sample.
3. Specify (on the COC) the same analytical methods for rinsate samples as is specified for the soil samples.
4. For validation reasons, assign the rinsate sample an identification number and label as rinsate samples, not as blanks.
5. Place the rinsate sample in a chilled cooler and ship it to the laboratory with the other samples.

7.2. Duplicate Samples

Duplicate samples are collected to assess the precision of field and laboratory components of field samples and matrix heterogeneity. Duplicate samples are similar to split samples and should be collected like split samples. Project specifications will determine if the duplicate samples are homogenized. If so, proceed with the instructions for homogenization in Section 6.2.1. Otherwise, the collection of duplicate samples will be collected in the next consecutive sample. For example, if a 18-inch long split barrel contains three 6-inch long full sleeves of soil. The middle sleeve is designated as the primary sample, then the next sleeve, either the top or bottom sleeve must be the duplicate sample. The collection of duplicate samples is more complex, when more sleeves are needed for analyses. For example, for the same split barrel and three full sleeves of soil, two sleeves are necessary for the primary analyses (i.e. A and B). In this scenario the duplicate is the next sleeve. The middle sleeve can be designated as Primary Sample A, the top sleeve as the duplicate for Primary Sample A and the third sleeve as Primary Sample B. The duplicate for Primary Sample B must be collected from the top sleeve in the next split barrel, which means the sampler must be driven again into the soil from the point where the last sampler stopped. The example and the overall relationship of collection of the primary and duplicate soil samples are illustrated below.



To maximize the information available in assessing total precision, collect duplicate samples from locations suspected of the highest contaminant concentration. Use field measurements (such as HNu data) or visual observations, past sampling results, and historical information to select appropriate locations for duplicate analyses.

The duplicate sample is handled and preserved in the same manner as the primary sample and assigned a sample number, stored in a chilled cooler, and shipped to the laboratory with the other samples. Whenever possible, the sample identification numbers for the characteristic sample and its duplicate are independent such that the receiving laboratory is not able to distinguish which samples are duplicates prior to analysis.

7.3. Matrix Spike/Matrix Spike Duplicate Samples

An extra volume of sample media may be collected during the sampling event for performance of matrix spike (MS)/matrix spike duplicate (MSD) analyses by the laboratory to assess laboratory accuracy, precision, and matrix interference. Following shipment of the samples to the laboratory, the laboratory prepares MS and MSD samples by homogenizing the soil matrix collected in the field and splitting the material into three separate sets of containers. Note that sample aliquots for volatile analysis are not homogenized. The laboratory spikes the split samples with appropriate analytes prior to performing the extraction in order to evaluate the total of the spiked compound and whatever quantity of the compound may be present in the sample. Results of the analyses are compared with the results of the primary sample and the known concentrations of the spike compounds. The percent recovery and relative percent difference are calculated and results are used to evaluate the precision and accuracy of the analytical method for various labeled "extra volume samples for MS/MSD." The sample volumes required for these analyses should be coordinated with the laboratory and are described in the project Work Plan.

7.4. Performance Evaluation Samples

Performance evaluation or pre-spiked soil samples may be used to assess laboratory extraction efficiency and accuracy in constituent identification and quantification. Because these samples are helpful in assessing the potential bias of analytical methods, they are also commonly used to evaluate the accuracy of non-standard methods or mobile laboratory procedures. These samples are generally prepared by an independent laboratory and shipped in pre-sealed containers to the field to be included with the samples sent to the laboratory performing the analysis of site soil samples. As for field blanks, these spiked samples are generally limited to organic constituents. The analytes of interest and corresponding analyte concentrations for the spike samples must be specified in the request to the independent laboratory providing the samples in accordance with the project Work Plan. These samples are assigned an identification number, stored in a chilled cooler, and shipped blind to the laboratory with the other samples.

7.5. Laboratory Blind Duplicate Samples

If appropriate, or required by program Quality Assurance, laboratory blind duplicate samples may also be used to assess laboratory accuracy in constituent identification and quantification. Laboratory blind duplicate samples consist of two or more representative sample volumes from one heterogeneous soil sample obtained from one sampling location. Equal volumes of representative aliquots from the mixture are submitted to two or more laboratories for analysis. The results of each laboratory are compared as a check on the laboratory accuracy. Because two samples are analyzed, environmental variability and precision (from one location to another) are included in this assessment.

The laboratory blind duplicate sample volume collected by the sampling team is preserved, packaged and submitted for analysis in the same manner as the other characteristic samples in accordance with the project Work Plan.

7.6. Other Sample Types

Ambient or background samples are used to assess the range of concentrations of potential contaminants and naturally occurring inorganic compounds in the vicinity of the site which are not the result of site activities. These samples are collected from areas not believed impacted by historical site operations (i.e., away from source areas and upwind).

The ambient or background samples are collected at the locations and depths specified in the project Work Plan. If the locations are not specified, a nearby park or other area void of industrial activity, for example, may be suitable for collection of ambient samples. The soil type should be as close as possible to the onsite characteristic samples. If appropriate, information can be obtained from various state and local agencies (e.g. USDA Natural Resources Conservation Service) that could aid in selection of ambient soil sampling locations. Ambient soil samples should be collected following the same procedure as that used for the onsite soil samples.

8.0 REFERENCES

U.S. Environmental Protection Agency, A Compendium of Superfund Field Operations Methods, EPA/540/P-87/001, December 1987.

U.S. Environmental Protection Agency, Compendium of ERT Soil Sampling and Surface Geophysics Procedures, EPA/540/
P-91/006, Interim Final, January 1991.

U.S. Environmental Protection Agency, Description and Sampling of Contaminated Soils - A Field Pocket Guide, EPA/625/P-12-91/902, November 1991.

American Society for Testing Materials, Annual Book of ASTM Standards, Section 4, Volume 4.08, Practice for Soil Investigation and Sampling by Auger Borings, ASTM D 1452-80 (1990), 1992.

American Society for Testing Materials, Annual Book of ASTM Standards, Section 4, Volume 4.08, Standard Method for Penetration Test and Split-Barrel Sampling of Soils, ASTM D 1586-84, 1992.

American Society for Testing Materials, Annual Book of ASTM Standards, Section 4, Volume 4.08, Standard Practice for Thin-walled Tube Sampling of Soils, ASTM D 1587-88, 1992.

American Society for Testing Materials, Annual Book of ASTM Standards, Section 4, Volume 4.08, Practice for Ring-Lined Barrel Sampling of Soils, ASTM D 3550-84 (1991), 1992.

American Society for Testing Materials, Annual Book of ASTM Standards, Section 4, Volume 4.08, Standard Practice for Preserving and Transporting Soil Samples, ASTM D 4220-89, 1992.

En Novative Technologies, Inc., SW846 Method 5035 Field Sampling Guide, February 1998.

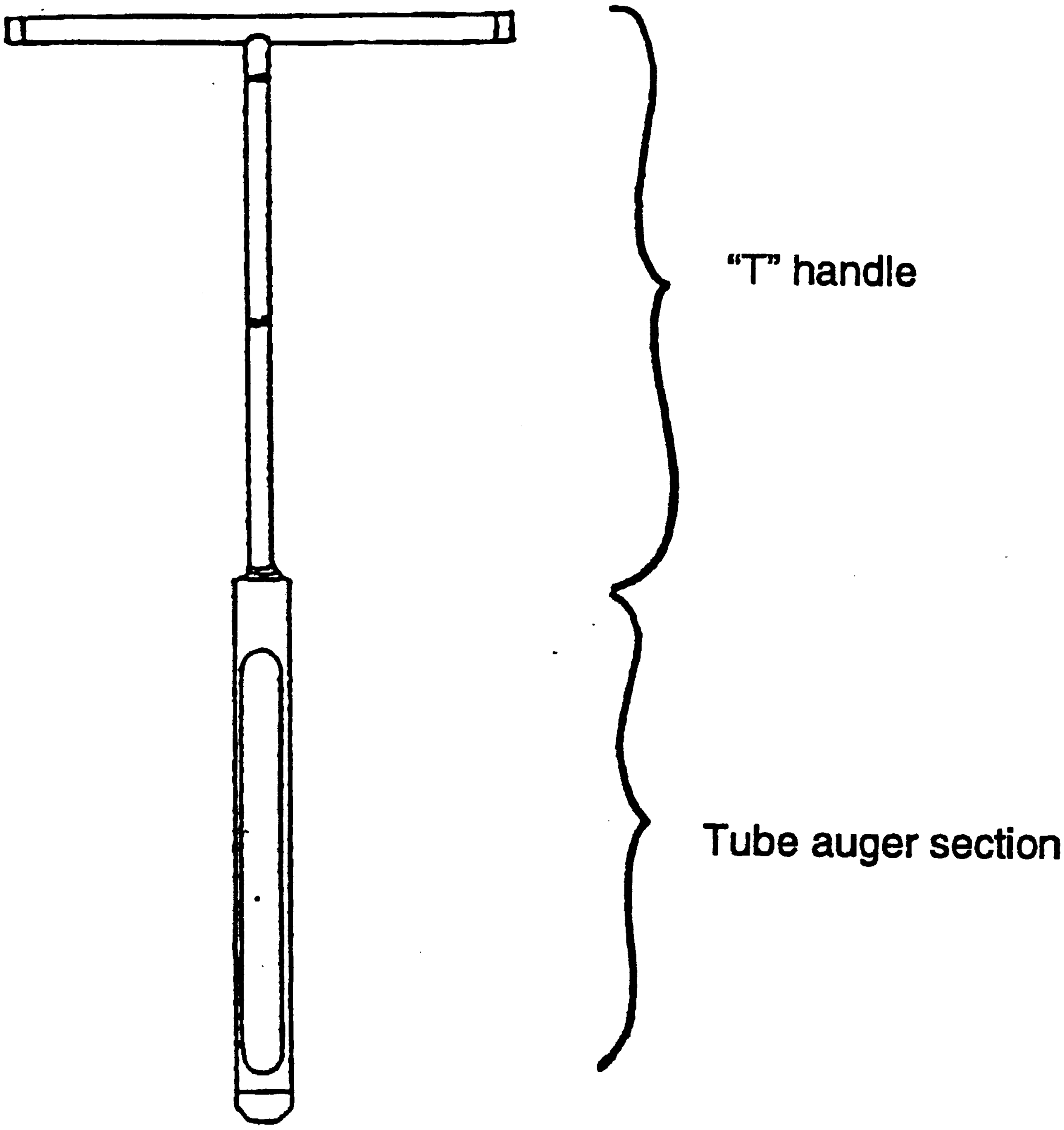
9.0 ATTACHMENTS

A	Tube Auger
B	Split-Barrel Sampler
C	En Core Sampler Information

ATTACHMENT A

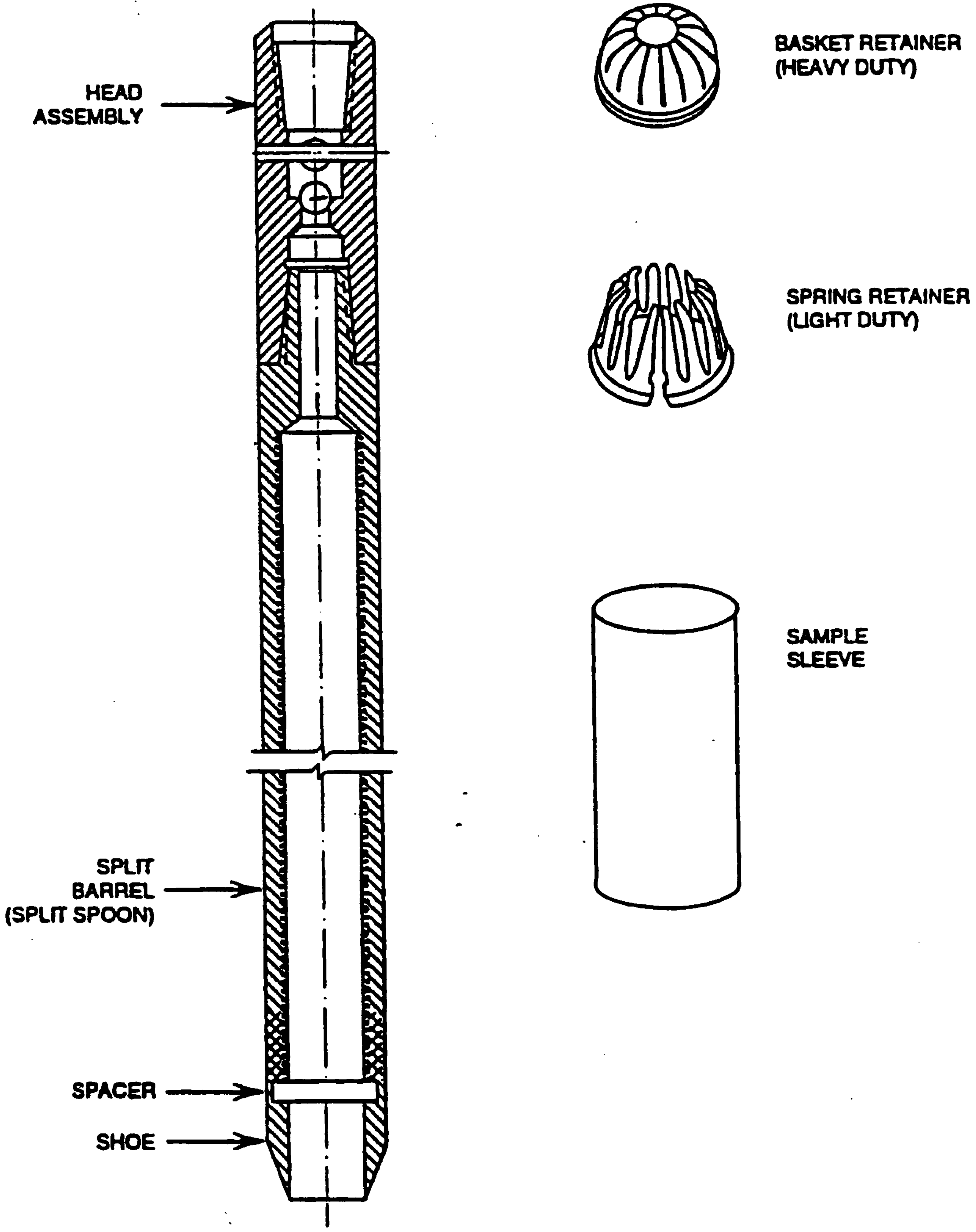
TUBE AUGER

TUBE AUGER



ATTACHMENT B

SPLIT-BARREL SAMPLER


HEAD ASSEMBLY
SPLIT BARREL (SPLIT SPOON)
SPACER
SHOE
BASKET RETAINER (HEAVY DUTY)
SPRING RETAINER (LIGHT DUTY)
SAMPLE SLEEVE

ATTACHMENT C

ENCORE™ SAMPLER INFORMATION

Disposable
En Core® Sampler

En Novative Technologies, Inc.
1241 Bellevue Street
Green Bay, WI 54302
Telephone: 920-465-3960 • Toll Free: 1-888-411-0757
Fax: 920-465-3963

SAMPLING PROCEDURES

USING THE
En Core® T-HANDLE

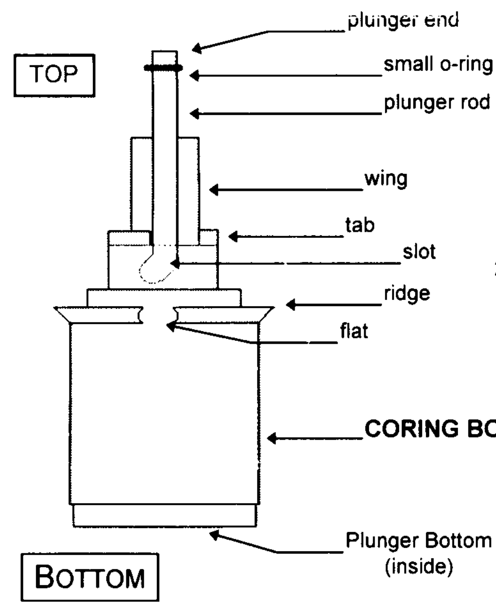
NOTE:

1. En Core Sampler is a SINGLE USE *device. It cannot be cleaned and/or reused.*

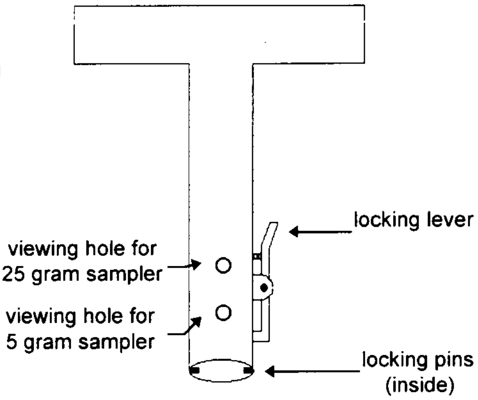
2. En Core Sampler is designed to store soil. Do not use En Core Sampler to store solvent or free product!

3. En Core Sampler must be used with En Core® T-Handle and/or En Core® Extrusion Tool exclusively. (These items are sold separately.)

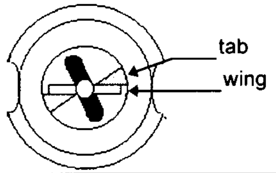
En Core Sampler



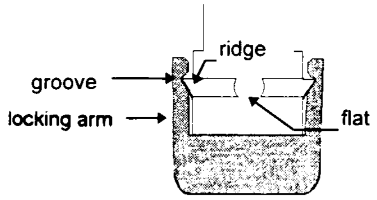
En Core T-Handle



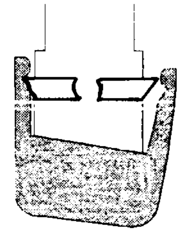
Locked Plunger



Sampler Correctly Capped
(Locking Arm Grooves Seated Over Coring Body Ridge)



Sampler Incorrectly Capped
(Cap Appears Crooked; Locking Arm Grooves Not Fully Seated Over Coring Body Ridge)



BEFORE TAKING SAMPLE:

1. Hold **coring body** and push **plunger rod** down until **small o-ring** rests against **tabs**. This will assure that plunger moves freely.
2. Depress **locking lever** on En Core T-Handle. Place coring body, **plunger end** first, into open end of T-Handle, *aligning the (2)* ***slots*** *on the coring body with the (2)* ***locking pins*** *in the T-Handle.* Twist coring body clockwise to lock pins in slots. Check to ensure Sampler is locked in place. Sampler is ready for use.

TAKING SAMPLE:

3. Turn T-Handle with T-up and coring body down. This positions plunger bottom flush with bottom of coring body (ensure that plunger bottom is in position). Using T-Handle, push Sampler into soil until coring body is completely full. When full, small o-ring will be centered in T-Handle **viewing hole**. Remove Sampler from soil. Wipe excess soil from coring body exterior.
4. Cap coring body while it is still on T-handle. *Push* **cap** over **flat** area of **ridge** *and twist* to lock **cap** in place. CAP MUST BE SEATED TO SEAL SAMPLER (see diagram).

PREPARING SAMPLER FOR SHIPMENT:

5. Remove the capped Sampler by depressing locking lever on T-Handle while twisting and pulling Sampler from T-Handle.
6. Lock plunger by rotating extended plunger rod fully counter-clockwise until **wings** rest firmly against tabs (see plunger diagram).
7. Attach completed circular label (from En Core Sampler bag) to cap on coring body.
8. Return full En Core Sampler to zipper bag. Seal bag and put on ice.

Disposable En Core® Sampler

EXTRUSION PROCEDURES

USING THE En Core® EXTRUSION TOOL

CAUTION! Always use the Extrusion Tool to extrude soil from the En Core Sampler. If the Extrusion Tool is not used, the Sampler may fragment, causing injury.

1. Use a pliers to break locking arms on cap of En Core Sampler. Do not remove cap at this time. **(CAUTION: Broken edges will be sharp.)**

2. To attach En Core Sampler to En Core Extrusion Tool: Depress locking lever on Extrusion Tool and place Sampler, plunger end first, into open end of Extrusion Tool, *aligning slots on coring body with pins in Extrusion Tool.* Turn coring body clockwise until it locks into place. Release locking lever.

3. Rotate and gently push Extrusion Tool plunger knob clockwise until plunger slides over wings of coring body. (When properly positioned plunger will not rotate further.)

4. Hold Extrusion Tool with capped Sampler pointed upward so soil does not fall out when cap is removed. To release soil core, remove cap from Sampler and push down on plunger knob of En Core Extrusion Tool. Remove and properly dispose of En Core Sampler.

Warranty and Disclaimers

IMPORTANT: FAILURE TO USE THE EN CORE™ SAMPLER IN COMPLIANCE WITH THE WRITTEN INSTRUCTIONS PROVIDED HEREIN VOIDS ALL EXPRESS AND IMPLIED WARRANTIES, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

PRINCIPLE OF USE. The En Core Sampler Cartridge System is a volumetric sampling system designed to collect, store and deliver a soil sample. The En Core Sampler comes in two sizes for sample volumes of approximately 25 or 5 grams. There are four components: the cartridge with a movable plunger; a cap with two locking arms; a T-handle (purchased separately); and an extrusion handle (purchased separately). NOTE: The En Core Sampler is designed to store soil. It is not designed to store solvent or free product.

The soil is stored in a sealed headspace-free state. The seals are achieved by three special Viton® * o-rings, two located on the plunger and one on the cap of the Sampler. **At no time and under no condition should these o-rings be removed or disturbed.**

QUALITY CONTROL. The cartridge is sealed in an airtight package to prevent contamination prior to use. Due to the stringent quality control requirements associated with the use of this system, the disposable cartridge is designed to be used only once.

WARRANTY. En Novative Technologies, Inc. ("En Novative Technologies") warrants that the En Core Sampler shall perform consistent with the research conducted under En Novative Technologies' approval, within thirty (30) days from the date of delivery, provided that the Customer gives En Novative Technologies prompt notice of any defect or failure to perform and satisfactory proof thereof. THIS WARRANTY DOES NOT APPLY TO THE FOLLOWING, AS SOLELY DETERMINED BY EN NOVATIVE TECHNOLOGIES: (a) Damage caused by accident, abuse, mishandling or dropping; (b)Samplers that have been opened, taken apart or mishandled; (c)Samplers not used in accordance with the directions; and (d)Damages exceeding the cost of the sampler. Seller warrants that all En Core Samplers shall be free from defects in title. THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES, WHETHER ORAL, WRITTEN, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY INFORMATION PROVIDED BY SALES REPRESENTATIVES OR IN MARKETING LITERATURE. IMPLIED WARRANTIES OF FITNESS AND MERCHANTABILITY SHALL NOT APPLY. En Novative Technologies' warranty obligations and Customer's remedies, except as to title, are solely and exclusively as stated herein.

LIMITATION OF LIABILITY. IN NO EVENT SHALL EN NOVATIVE TECHNOLOGIES BE LIABLE FOR ANTICIPATED PROFITS, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES, INCLUDING, BUT NOT LIMITED TO, DAMAGES FOR LOSS OF REVENUE, DOWN TIME, REMEDIATION ACTIVITIES, REMOBILIZATION OR RESAMPLING, COST OF CAPITAL, SERVICE INTERRUPTION OR FAILURE OF SUPPLY, LIABILITY OF CUSTOMER TO A THIRD PARTY, OR FOR LABOR, OVERHEAD, TRANSPORTATION, SUBSTITUTE SUPPLY SOURCES OR ANY OTHER EXPENSE, DAMAGE OR LOSS, INCLUDING PERSONAL INJURY OR PROPERTY DAMAGE. En Novative Technologies' liability on any claim of any kind shall be replacement of the En Core Sampler or refund of the purchase price. En Novative Technologies shall not be liable for penalties of any description whatsoever. In the event the En Core Sampler will be utilized by Customer on behalf of a third party, such third party shall not occupy the position of a third-party beneficiary of the obligation or warranty provided by En Novative Technologies, and no such third party shall have the right to enforce same. All claims must be brought within one (1) year of shipment, regardless of their nature.

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The En Core® Sampler is covered by One or More of the Following U.S. Patents: 5,343,771; 5,505,098; 5,517,868; 5,522,271. Other U.S. and Foreign Patents Pending.

* Viton® is a registered trademark of DuPont Dow Elastomers.

Brown and Caldwell
Standard Operating Procedure

Sample Preservation
Revision 1.0
Revision Date: May 11, 2001

Prepared/Revised by: **Wendy Linck** — May 11, 2001
Name — Date

Senior Quality Manager Review: Jay Lucas — 10/26/01
Name — Date

Regional Quality Officer : [illegible] Van Winkle — October 26, 2001
Name — Date

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SAMPLE PRESERVATION

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1.0 OBJECTIVES

The objective of this standard operating procedure (SOP) is to establish procedures that allow the chemical integrity of a sample is maintained from time of collection until chemical analysis.

2.0 APPLICABILITY

This SOP documents the procedures and chemicals to be used for the preservation of field samples. The environmental media addressed in this SOP include soil, sediment, solid waste, and aqueous samples. These procedures apply to all Project team personnel and subcontractors involved with the collection, shipping and chemical analysis of environmental samples.

3.0 RESPONSIBILITY

The Project Manager (PM), or designee, shall ensure that the sampling procedures used, including provisions for proper storage, preservation and shipping, are adequate to maintain sample integrity until custody is assumed by the laboratory. The PM shall develop or direct the preparation of a detailed sampling plan for sampling air, water, biota, sediment, soil, or waste, which shall describe the procedures used to preserve samples during the interval from sampling until receipt by the laboratory.

The Project Chemist (PC), or designee, shall ensure that the samples are collected in terms of the analytical methods and compliance with sampling protocols. For smaller projects, the PC and the Field Supervisor may be the same person. The field supervisor or PC also are responsible for maintaining adequate supplies of containers and preservatives. The PM will determine the roles and personnel for each project.

The Field Supervisor or his or her designate shall be responsible for ensuring the competence of field sampling personnel and their training. The field supervisor shall ensure that specified preservation and storage procedures are followed during sampling and during shipment to the laboratory.

The field sampling personnel will be responsible for the understanding and implementation of this SOP during all field activities. Field personnel are also responsible for checking the collected samples, and verifying that they are preserved with prescribed range.

4.0 REQUIRED MATERIALS

The materials required for this SOP include the following:

- Sample Containers,
- pH instrument or Litmus paper with appropriate pH range,
- Field notebook, and
- Sampling forms (e.g. Chain of Custody Records, sample labels).

5.0 DEFINITIONS

<u>Maximum Holding Time</u>. Maximum Holding Time is the maximum length of time that may elapse before sample preparation (extraction or digestion) or analysis is completed. It is calculated from the date and time of collection in the field. Holding

times are usually measured to the nearest day with the exception of those analyses that must be completed within 24 or 48 hours.

Preservation. Preservation refers to temperature control and/or pH adjustment procedures performed to prevent or slow the loss of target analytes through precipitation, volatilization, decomposition, or biodegradation.

Temperature. Temperature is defined as the temperature within the refrigerator, cooler or ice chest that holds the samples. Samples shall be held at 4 degrees Celsius (°C) (± 2° C represents the acceptable range).

6.0 METHODS

Proper communication between the project manager and the analytical laboratory is essential prior to sampling, preferably in writing. This necessary so that the proper type and number of containers and preservatives can be specified and so that all technical and regulatory requirements can be met regarding the analyses.

Field personnel should coordinate in writing with the laboratory at least two weeks before the sample container kits are to be shipped from the lab to identify the analytes to be requested. The information exchange between lab and field personnel include the project identification, sample kit shipment address, QA/QC regulatory requirements, required turnaround requirements, and the number and type of laboratory analyses.

Most chemical and biological reactions and many physical processes are slowed by lowering the temperature. Therefore, as a general rule, all samples need to be cooled at the time of collection and maintained slightly above freezing until preparation for final analysis. This restriction is not critical in the case of metals analysis since most metals exist in the form of involatile salts with the exception of liquid mercury and organometallic compounds such as tetraethyl lead, which still need to be kept cold. Hexavalent chromium is kept cold to slow its reduction to trivalent chromium.

Soil samples and other solid samples, including sediments, sludges, and solid waste, shall be preserved by cooling to 4°, ± 2° C. Soil and solid samples require no other preservatives. However, analysis must be performed within the method-specific holding time requirements.

Aqueous samples may be presumed to be homogenous and amenable to chemical preservation. In addition to keeping such samples cold, the following general approaches shall be employed depending on the analyte(s):

- Volatile acids (HCN, H_2S) are rendered involatile in the presence of strong base (NaOH, pH greater than [>] 12);
- Volatile bases (ammonia) are rendered involatile in the presence of strong acid (H_2SO_4, pH less than [<] 2);
- Biodegradation of organic compounds is retarded under strongly acidic conditions (HCl or H_2SO_4, $pH < 2$);
- Dehydrohalogenation (loss of HCl) of chlorinated solvents is counteracted in the presence of acid (HCl, $pH < 2$);
- Oxidation of target analytes by the chlorine found in drinking water is eliminated by destroying the chlorine with a reducing agent such as sodium thiosulfate; and
- Many soluble metal salts tend to adhere to the walls of the container or they form precipitates with time. This can be prevented by the addition of nitric acid to a pH of < 2, which maintains the metals as soluble nitrate salts.

Groundwater samples for dissolved metals analysis are filtered (usually with a 0.45 micron filter) before preservation with the appropriate preservative. The filtrate is added directly to the plastic container, which has been supplied with the proper amount of preservative.

With the exception of the stainless-steel sleeves used to capture soil boring samples, all sample containers will be supplied in advance by the subcontracting laboratories.

The required chemical preservatives for aqueous samples will normally be added to the appropriate containers by the subcontracting laboratories before delivery to the field. There are two reasons why already-preserved containers are preferred. First, the laboratory scheduled to perform the analysis maintains control over sample integrity and container cleanliness and, second, field crews are generally not equipped to “appropriately handle” hazardous chemicals like hydrochloric acid. However, it may become necessary to add additional preservation to achieve the proper pH.

For most constituents in groundwater, preservation can be checked by pouring a slight amount of water from the collection vessel over pH Litmus paper. For more volatile constituents (i.e. VOCs, dissolved gases), this procedure is not recommended. Instead an extra sample bottle that contains the same preservative should be filled and then tested. Field personnel shall ensure all field activities are documented completely at the end of each field day.

Sample preservatives should be identified on the chain of custody (COC).

Solid samples, whether in metal sleeves, wide-mouth glass jars, or other containers, will be labeled and secured appropriately, then placed immediately in an ice chest containing sufficient ice to maintain a temperature range of 4° ± 2° C through delivery to the laboratory.

Sufficient ice chests and quantities of ice to manage all samples collected during the day (or shift) shall be maintained at the sampling site.

Samples are maintained in ice or, if available, in refrigerators, within a range of 4° ± 2° C, from the time the sample control manager assumes custody until the samples are packed for shipment and relinquished to the shipper or other transport agent.

All samples are shipped in ice chests packed with sufficient ice to maintain a temperature range of 4° ± 2° C for at least 24 hours.

Temperature checks are placed in the cooler for the laboratory to check the temperature upon arrival at the lab. A temperature check is provided by the laboratory and shall be placed in the middle of the samples within the cooler. The temperature check should be labeled as such and added to the COC to record that it was placed into the cooler. If the laboratory did not provide a temperature check as requested or the sampling team runs out of checks, temperature checks can be made in the field. A temperature check is a 40-mililiter VOA, without preservative, filled with deionized water.

The receiving laboratory will measure the temperature within the ice chest immediately upon assuming custody of a shipment of samples. This temperature will be noted on the chain-of-custody form. Temperatures in excess of 6° C will be reported immediately to the project chemist. After consultation with the PM, the PC will communicate whether re-sampling is necessary.

With respect to procedures for maintaining a temperature range of 4° ± 2° C, aqueous samples will be treated as described above, for solid samples.

Table 1 is a listing of the common analyses with associated containers, preservatives, and holding times. The analyses and associated other data shown in Table 1 give a general background regard what is required. However, when particular analytical procedures are specified in planning documents, it is best to check directly with the cited method to make sure sample vessels and preservatives are correct.

7.0 REFERENCES

American Public Health Association, 1985. Standard Methods for the Examination of Water and Wastewater, 16th Edition.

40 CFR 136, Code of Federal Regulations, dated July 1, 1990.

State of California, 1989. Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure, Leaking Underground Fuel Tank Task Force.

United Stated Environmental Protection Agency (USEPA), 1991. Statement of Work for Organics Analysis, Document Number OLMO1.0, USEPA Contract Laboratory Program, June.

United States Environmental Protection Agency (USEPA), 1990a. Statement of Work for Inorganics Analysis, Document Number ILMO1.0, USEPA Contract Laboratory Program, March. November.

EPA (U.S. Environmental Protection Agency), 1990b. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Third Edition, Final Update I, USEPA Office of Solid Waste,

United States Environmental Protection Agency (USEPA), 1982. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-82-055, December

8.0 ATTACHMENTS

Table 1. Sample Containers, Preservation Methods, and Analytical Holding Times

Table 1
Sample Containers, Preservation Methods, and Analytical Holding Times (1 of 2)

					Maximum Holding Times	
Parameter	Matrix	Container	Lid	Preservation	Extraction[a]	Analysis[b]
Metals	Water	500 ml polyethylene	Cap with Teflon® seal	HNO3 to pH<2; Ice to 4°C	-	6 months (Hg: 28 days)
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	-	6 months (Hg: 28 days)
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	-	6 months (Hg: 28 days)
Volatiles	Water	40 ml glass vials X 3	Cap with Teflon® septum	HCI to pH<2; Ice to 4°C	-	14 days
	Soil	EnCore sampler X 3	o-ring cap	Ice to 4°C; 48 hours to preserve with methanol or sodium bisulfate	-	14 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	-	14 days
Purgeable Hydrocarbons	Water	1 liter glass amber jar	Cap with Teflon® septum	HCI to pH<2; Ice to 4°C	-	14 days
	Soil	EnCore sampler X 3	o-ring cap	Ice to 4°C	-	14 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	-	14 days
Extractable Hydrocarbons	Water	1 liter glass amber jar X 2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days
Total Recoverable Petroleum Hydrocarbons	Water	1 liter glass amber jar X 2	Teflon®-lined caps	H2SO4 to pH<2; Ice to 4°C	-	28 days
	Soils	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	-	28 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C		28 days
	Soil (volatiles)	Encore sampler	o-ring cap	Ice to 4°C; methanol within 48 hours	-	14 days
Phenols	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days
Organochloride Pesticides and PCBs	Water	1 liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days
Chlorinated Herbicides	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days
Semivolatiles	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days

Table 1
Sample Containers, Preservation Methods, and Analytical Holding Times (Page 2 of 2)

					Maximum Holding Times	
Parameter	Matrix	Container	Lid	Preservation	Extraction[a]	Analysis[b]
Dioxins and Furans	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	28 days	40 days[a]
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	28 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	28 days	40 days
Polynuclear Aromatic Hydrocarbons	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days
Nitroaromatics and Nitroamines	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days
Nitroglycerine	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	7 days	40 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	14 days	40 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	14 days	40 days
Anions (Cl, NO2-N, NO3-N, & SO4)	Water	250 ml polyethylene	Teflon®-lined caps	Ice to 4°C (Cl: none)	-	28 days (NO2:48 hrs)
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C (Cl: none)	c	28 days (NO2:48 hrs)
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C (Cl: none)	c	28 days (NO2:48 hrs)
Ignitability	Water	250 ml polyethylene	Teflon®-lined caps	none	none	none
	Soil	4 oz. glass jar	Teflon®-lined lids	none	none	none
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	none	none	none
Total Cyanide	Water	I liter polyethylene	Teflon®-lined caps	NaOH to pH>12; Ice to 4°C	c	14 days
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	c	14 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	c	14 days
Hexavalent Chromium	Water	I liter glass amber jar X2	Teflon®-lined caps	Ice to 4°C	c	24 hours
	Soil	4 oz. glass jar	Teflon®-lined lids	Ice to 4°C	30 days	4 days
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	Ice to 4°C	30 days	4 days
pH	Water	250 ml polyethylene	Teflon®-lined caps	none	-	immediate
	Soil	4 oz. glass jar	Teflon®-lined lids	none	c	immediate
	Soil	Stainless steel sleeve	Teflon®-lined plastic end-caps	none	c	immediate
Field Soil gas	Air or Soil gas	Tedlar bag	None	none	-	3 days
	Air or Soil gas	Summa Canister	None	none	-	14 days

Abbreviations:	a = Starting from the date of collection
ml = milliliter	b = Starting from the date of extraction; if no extraction is involved, starting from the date of collection
oz = ounce	c = Extraction may occur any time prior to analysis. Only the analysis holding time is monitored.

Brown and Caldwell
Standard Operating Procedure
Environmental Sample Handling

Revision 1.0
Revision Date: January 5, 2000

Prepared/Revised by:	**Diane Henry** Name	January 5, 2000 Date
Senior QA Review:	Name	10/26/01 Date
Regional Quality Officer:	Name	October 26, 2001 Date

Brown and Caldwell
Standard Operating Procedure

Environmental Sample Handling
Revision 1.0
Revision Date: January 5, 2000

ENVIRONMENTAL SAMPLE HANDLING

TABLE OF CONTENTS

1.0 OBJECTIVE

The objective of this procedure is to establish a uniform method for the handling of environmental samples. This includes the procurement of the appropriate sample containers and preservatives, chain of custody procedures and the use of appropriate sample shipment methods.

2.0 SCOPE AND APPLICABILITY

This procedure will be used during the collection of all types of environmental media that include, but are not limited to, groundwater, surface water and soil. Handling of air samples is not addressed in the current version of this procedure.

3.0 RESPONSIBILITIES

The Project Manager (PM), or designee, will have the responsibility to oversee and ensure that the handling of samples is in accordance with this SOP and any site-specific or project specific planning documents. The field sampling personnel will be responsible for the understanding and implementation of this SOP during all field activities, as well as, obtaining the appropriate field logbooks, forms, and records necessary to complete the field activities. Field personnel will ensure all field activities are documented completely at the end of each field day. Field personnel are responsible for assuring that the original documentation (or copies of the field log book, if needed for another project at the same site), are filed at the end of the field project, or during a long project (greater than a month) every couple of weeks.

4.0 DEFINITIONS

EnCore® Sampler – Sampler designed for collecting Volatile Organic Carbon (VOC) samples.

PPE – Personal Protective Equipment

5.0 REQUIRED MATERIALS

The materials required for this SOP include the following:

- Bound field log books
- Black waterproof and/or indelible ink pens
- Field forms
- Chain of Custody forms
- Sample Labels

6.0 METHOD

The following method outlines general considerations for sample handling in the field and maintaining sample custody after collection.

Environmental samples are collected in the field in order to evaluate whether conditions in soil gas, soil, surface water, or groundwater are hazardous. These samples therefore, should be handled with the utmost care to maintain integrity so that analytical data represents as closely as possible, field conditions. In addition, sample chain of custody is extremely important for establishing that sample integrity was maintained between field crew and laboratory.

Details regarding collection of samples are provided in other SOPs (e.g., soil sampling SOP). General considerations for handling during sampling are:

- Always wear proper PPE when handling samples.
- Sample receptacles or containers should be wrapped in a way that is protective of both surrounding containers and the container the sample is in.
- Always check and document procedures well in field logbooks or sampling forms. There is never “too much information”.

Samples must be stabilized for transport from the field to the laboratory through the use of the proper sample containers and preservation techniques. This is due to the potential changes in chemical quality that may occur after samples are collected. Sample containers and preservation are discussed in the Sample Preservation SOP.

Great care must be exercised in the sampling and handling of volatile compounds (e.g. VOCs or volatile gases) in order to minimize the introduction of sampling bias. This bias is caused largely through the loss of volatile constituents. Special handling procedures are described in respective sampling SOPs for the handling of aqueous and non-aqueous samples that should be followed in order to minimize the loss of volatile constituents.

Non-aqueous samples for VOC analysis should be placed in the appropriate container as quickly as possible following their collection. Consideration should be given to trimming soil samples that have been in contact with the air and the sampling device in order to minimize the loss of VOCs and inadvertent sample contamination, respectively. Some agencies require the use of USEPA Method 5035 (or similar) that utilizes containerization in a special sampler (EnCore® or equivalent), or field methanol preservation using specially prepared containers. Lastly, the sample container should be cooled immediately after it is filled.

6.1 Sample Labels

Sample labels are required on all sample containers for the primary purpose of sample identification. Specific field data need not be recorded on the labels. The sample labels should contain the following information:

- Sample or location identification number (i.e., well number, boring number/depth, or arbitrary sample number)
- Analysis to be performed

- Preservative (even if only keeping sample chilled)
- Project name and number
- Date and time of sample collection
- Details of samplers (initials, etc.)

It is recommended that the sample label be preprinted in the office on adhesive labels prior to initiation of the sampling program. Tape should NOT be used to cover any label or seal the ends of soil sleeves. Recent studies indicate that most commercially available tapes contain VOCs and that there is the potential for contamination from the tapes.

6.2 Chain-of-Custody

The goal of implementing chain-of-custody procedures is to ensure that the sample is traceable from the time that it is collected until it, or its derived data, are used. Samples would be considered to be "in custody" under the following conditions:

- It is in personal possession.
- It is in personal view after being in personal possession.
- It was in personal possession when it was properly secured.
- It is in a designated secure area.

6.2.1 Chain-of-Custody Forms

A chain-of-custody form may be initiated at the time that the sample containers are filled or, at a minimum, when the sample containers leave the site at which they are prepared, usually that of the analytical laboratory supplying the containers. Additionally, chain-of-custody forms may be specially prepared with some initial information for the project and specific analytical methods listed prior to field work to decrease the amount of information that has to be recorded in the field. However, in this event, actual sample collection information should be recorded only in the field after the sample has been collected.

It is important that the field personnel completely fill out the applicable sections of the form. Chain of custody forms should be numerically sequenced with a number clearly indicated on the form. The chain-of-custody forms should be placed in shipping containers, protected from moisture using plastic bags (e.g., Ziploc®), and should accompany the containers during shipment to the laboratory. Chain-of-custody forms included in any shipping container should only reflect those samples that are in that container. The field personnel collecting the samples will be responsible for the custody of the samples until transport to the laboratory. Sample transfer requires the individuals relinquishing and receiving the samples to sign, date and note the time of transfer on the chain-of-custody forms. The chain-of-custody is considered to be complete after it has been received and signed in by the analytical laboratory. A copy of the chain-of-custody record should be maintained by the field personnel along with the other field records.

Common carriers (i.e., Federal Express) are not expected to sign the chain-of-custody form. However, the bill of lading or airbill becomes part of the chain-of-custody record in the event that a common carrier is used to transport the samples. Airbill or bill of lading numbers should be recorded on the chain-of-custody forms.

6.2.2 Chain-of-Custody Seals

Chain-of-custody seals or evidence tape may be used on the sample containers in order to demonstrate that the sample containers have not been opened or otherwise tampered with. While not required on all projects, PMs should consider using custody seals to demonstrate sample integrity. Chain-of-custody seals or evidence tape, if used, should be affixed to each sample container as soon after sample collection as is possible. An additional use of chain of seals would be on the outside of the shipping container. For particularly sensitive projects subject to potential legal action, serial numbers that are printed on chain-of-custody seals should be recorded on the chain-of-custody record.

Some projects require custody seals on the outside of the cooler. Commonly, two seals are required. The seals do not necessarily need to be custody tape, but any type of tape that can be used to record the date and initials of the packager. The seals should be placed at two points along the front of the cooler at the point where the lid meets the body of the cooler.

6.3 Sample Shipment

Shipment of samples to an analytical laboratory is usually required upon completion of sample collection. Proper packaging is necessary in order to protect the sample containers, to maintain the samples at a temperature of 4°C, and to comply with all applicable transportation regulations.

In general, samples are shipped using packaging that is supplied by the analytical laboratory. The packaging normally includes a shippable insulated box such as an ice cooler and contains protective internal packaging materials such as foam sleeves or bubble wrap. Some laboratories use proprietary sample packaging with integral internal packaging. In either case, provisions need to be made for maintaining the temperature of the samples either with the use of ice packs or ice. Care should be taken to ensure that the sample bottles are adequately protected from breakage during shipments. Samples should be secured tightly with bubble wrap or other suitable packing media and covered with plastic bags. Ice should be added to the shipping container only after the samples have been secured with packing media. Ice should never be used to provide separation between sample bottles. Once packed, the cooler should be secured shut by wrapping duct or fiber reinforced tape completely around the cooler. If custody seals are placed on the outside of the cooler as described above in Section 5.2, then the wrapping tape should be wrapped around the cooler to cover each seal without obliterating serial numbers, signatures or other significant data.

Regulations must be observed regarding the shipment of Dangerous Goods. Sample containers and certain field equipment may be defined as Dangerous Goods such that special requirements must be followed for their shipment. Air shipment of Dangerous Goods is regulated by the International Air Transport Association (IATA) as described in "Dangerous Goods Regulations". Shipment by ground is regulated by the U.S. Department of Transportation (DOT). Furthermore, individual shippers (e.g., Federal Express) may have additional requirements for Dangerous Goods shipment. The shipment of Dangerous Goods must be consistent with the instruction and authorization of the analytical laboratory shipping and receiving coordinator and the Health and Safety director.

Environmental samples, including groundwater samples, are currently exempt from Hazardous Goods regulations. 40 CFR 261.40(d) states, "A sample of solid waste or a sample of water, soil, or air which is collected for the sole purpose of testing to determine its characteristics or composition is not subject to this Part or Parts 262 through 267 or Part 124 of this chapter or to the notification requirements of Section 3010 of RCRA." Therefore, no special regulations are required to be followed for the shipment of environmental samples from the field. However, sample containers should be properly packed such that inadvertent spillage does not occur during shipment (e.g., any discharge spouts should be tapped closed). Samples of NAPL do not fall under this exemption.

Specific regulations do exist, however, for the shipment of many reagents that are commonly used as preservatives and decontamination agents. Consequently, the shipment to the field site of "empty" sample containers containing small quantities of preservatives must be conducted in accordance with the regulations. The most significant limitations for the shipment of preservatives (IATA, 1992) involve those for nitric acid in which only small quantities (<0.5L) of low concentration (<20%) nitric acid can be shipped in any given shipment.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance for sample handling centers upon following procedures outlined above and double checks as samples are collected. Checks should be performed either by 1) the field personnel, or, preferably, 2) by a project chemist or other personnel that constantly check field chain of custody forms versus laboratory receipt acknowledgment forms, discuss condition of samples as received by laboratory personnel, and communicate constantly with the laboratory project manager to prevent quality assurance issues from starting or becoming significant problems should they occur.

8.0 REFERENCES

United States Environmental Protection Agency, 1984, Soil Sampling Quality Assurance Users Guide, EPA/600/4-84/043.

United States Environmental Protection Agency, 1986, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, OSWER-9950.1.

United States Environmental Protection Agency, 1987, A Compendium of Superfund Field Operations Methods, EPA/600/P-87/001.

United States Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance, EPA/600/R-92/001.

9.0 ATTACHMENTS

None.

Brown and Caldwell
Standard Operating Procedure
Field Notes and Documentation

Revision 1.0
Revision Date: May 11, 2001

Prepared/Revised by:	**Wendy Linck** Name	May 11, 2001 Date
Senior Quality Manager Reviewer:	Jay Lucas Name	10/26/01 Date
Regional Quality Manager Reviewer:	Van Winkle Name	October 26, 2001 Date

FIELD NOTES

TABLE OF CONTENTS

1.0 OBJECTIVES

The objective of this standard operating procedure (SOP) is to establish a consistent method and format for the use and control of documentation generated during daily field activities. Field notes and records are intended to provide sufficient information that can be used to recreate the field activities, as well as, the collection of environmental data. Information placed in these documents and/or records shall be factual, detailed and objective.

2.0 SCOPE AND APPLICABILITY

This procedure will be used during all field activities, regardless of the purpose by all project team personnel and subcontractors who conduct field investigations. These activities may include, but are not limited to, all types of media sampling (soil vapor, soil, groundwater, wastewater, etc), utility clearance, well installation, sample point locating and surveys, site reconnaissance, free product removal, remediation, and waste handling.

3.0 RESPONSIBILITY

The Project Manager (PM), or designee, will have the responsibility to oversee and ensure that field documentation is collected in accordance with this SOP and any site-specific or project specific planning documents. The field sampling personnel will be responsible for the understanding and implementation of this SOP during all field activities, as well as, obtaining the appropriate field logbooks, forms and records necessary to complete the field activities. Field personnel shall ensure all field activities are documented completely at the end of each field day. Field personnel are responsible for tracking the location of all field documentation, including field logbooks. Field personnel are responsible for assuring that the original documentation (or copies of the field log book, if needed for another project at the same site), are filed at the end of the field project or during a long project (greater than month) every couple of weeks.

4.0 REQUIRED MATERIALS

The materials required for this SOP include the following:

- Bound field logbooks, and
- Black waterproof and/or indelible ink pens
- Field Forms

5.0 METHODS

This SOP primarily includes the documentation procedures for the field logbooks. However, procedures discussed in this SOP are applicable to all other types of field documentation collected, and should be universal in application. Details of other field records and forms (e.g. boring logs, sample labels, chain of custody records, and waste containment labels are discussed in the specific SOP associated with that particular field activity (e.g. borehole drilling, sample handling, investigative derived waste), and not covered in detail in this SOP.

5.1 Field Logbooks

Field personnel will keep accurate written records of their daily activities in a bound logbook that will be sufficient to recreate the project field activities without reliance on memory. This information will be recorded in chronological order. All entries will be legible, written in black waterproof or indelible ink, and contain accurate and inclusive documentation of field activities, including field data observations, deviations from project plans, problems encountered, and actions taken to solve the problem. Each page of the field logbook will be consecutively numbered, signed and dated by the field author(s). Pages should not be removed for any reason.

There should be no blank lines on a page. A single blank line or a partial blank line (such as at the end of a paragraph) should be lined to the end of the page. If only part of a page is used, the remainder of the page should have an "X" drawn across it.

In addition to documenting field activities, field logbooks will include, but are not limited to, the following:

- Date and time of activities,
- Site location
- Purpose of site visit,
- Site and weather conditions,
- Personnel present, including sampling crew, facility/site personnel and representatives (including site arrival and departure times),
- Subcontractors present,
- Regulatory agencies and their representatives (including phone numbers, site arrival and departure times),
- Level of health and safety protection,
- Sampling methodology and information,
- Sample Locations (sketches are very helpful),
- Source of sample(s), sample identifications, sample container types and preservatives used, and lot numbers for bottles and preservatives (if applicable and if not recorded on other forms or in a sample control logbook),
- A chronological description of the field observations and events,
- Specific considerations associated with sample acquisition (e.g., field parameter measurements, field screening data, HASP monitoring data, etc.) (if not recorded on another form),

- Wastes generated, containment units (including volumes, matrix, etc), and storage location (if not recorded on another form),
- Field quality assurance/quality control samples collection, preparation, and origin (if not recorded on other forms or in a sample control logbook),
- The manufacturer, model and serial number of field instruments (e.g., OVM, water quality, etc.) shall be recorded, if not using a calibration form. Also, source lot # and expiration date of standard shall be recorded if calibrated in the field.
- Well construction materials, water source(s), and other materials used on-site (if not recorded on another form).
- Sample conditions that could potentially affect the sample results,
- If deviating from plan, clearly state the reason(s) for deviation,
- Persons contacted and topics discussed,
- Documentation of exclusion zone set-up and location,
- Documentation of decontamination procedures, and
- Daily Summary.

Field situations vary widely. No general rules can specify the extent of information that must be entered in a logbook. However, records should contain sufficient information so that someone can reconstruct the field activity without relying on the collector's memory. Language used shall be objective, factual, and free of personal opinions. Hypothesis for observed phenomena may be recorded, however, they must be clearly indicated as such and only relate to the subject observation.

Logbooks will be assigned to a specific sampling team. If it is necessary to transfer the log book to alternative team member during the course of field work, the person relinquishing the log book will sign and date the log book at the time of transfer.

Field logbooks should consist of a bound book, in which the insertion or removal of pages will be visibly noticeable after the logbook has been assembled. Logbooks can be prepared by gluing or laminating pages together either at the left side or top of the page. If inclement weather is expected, logbooks may have plastic laminated front and back covers to protect the interior pages, and should not be broken apart for coping. Loose-leaf binding, such as comb binding is not considered hard binding. To maintain the integrity of the logbook, pages should be consecutively numbered prior to use. Logbook pages can be of any format, and may include blank pages for recording or field forms that are used for specific tasks. As an alternative, commercially bound and consecutive page numbered field logbooks may also be used.

5.2 Photographs

Photographs provide the most accurate demonstration of the field worker's observations. They can be significant to the field team during future inspections, informal meetings, and hearings. Photographs should be taken with a camera-lens system having a perspective similar to that afforded by the naked eye. Telephoto or wide-angle shots cannot be used in enforcement proceedings. Some industrial clients do not permit photographs on their sites. In industrial settings, confirm with the project manager that photographs are allowed.

A photograph must be documented if it is to be a valid representation of an existing situation. Therefore, for each photograph taken, several items shall be recorded in the field logbooks:

- Date and time photograph taken;
- Name of photographer;
- Site name, location, and field task;
- Brief description of the subject and the direction taken; and
- Sequential number of the photograph and the roll number.

5.3 Additional Field Forms/Records

Additional field records may be required for each specific field event. The use of these records and examples are described in other SOPs specific for the activity (e.g. Borehole Logging SOP, Groundwater Sampling and Purging SOP, etc.). These other records may include:

- Borehole Logs during drilling
- Well Construction and Development records (groundwater, soil vapor, extraction, etc.),
- Groundwater Purge and Sample Collection Records,
- Soil Vapor Purge and Sample Collection Records,
- Water Level Monitoring and Product Removal Records,
- NAPL Removal Records,
- Investigation Derived Waste (IDW) Tracking Records,
- Instrument Calibration Records, and
- Health and Safety Monitoring Records and sign-off sheets.

Prior to field activities, the field sampling personnel will coordinate with the Project Manager, or designee, to determine which additional records will be required for the specific field task. These additional records will be maintained in a field file or a three-ring notebook throughout the duration of the field activities, or included in a specially prepared site-specific notebook. If the field notebook is being created, the forms may be part of the laminated book.

6.0 CORRECTIONS

If an error is made in the field, logbook corrections will be made by drawing a single line through the error, entering the correct information, and initialing and dating the change. Materials that obliterate the original information, such as correction fluids and/or mark-out tapes, are prohibited. All corrections will be initialed and dated. Some projects require that a brief reason for the change must also be added where the correction was made. Ask the Project Manager, if this requirement is necessary.

7.0 DOCUMENTATION REVIEWS

Periodically, the Project Manager, or designee, will review the field logbooks pertaining to the activities under their supervision. The elements of this review will include technical content, consistency, and compliance with the project plans and SOPs. Discrepancies and errors identified during the review should be resolved between reviewer and author of the field documentation. Corrections and/or additions of information shall be initialed and dated by the field author or reviewer.

8.0 FIELD RECORD BACKUP

Periodically, the Project Manager, or designee, will determine if and when field logbooks and records need to be photocopied. Photocopies will be maintained in the project files, and can be used as backup in the event that the original field logbook or records are lost or damaged.

9.0 DOCUMENTATION ARCHIVE

At the completion of the project, all original field logbooks and records will be store in the project files in accordance with Brown and Caldwell procedures. Typically project files lifetimes are controlled and spelled out in contractual agreements with clients. Typically, project files are archived after project finalization and kept indefinitely in archive.

10.0 REFERENCES

None cited.

11.0 ATTACHMENTS

None listed.

Brown and Caldwell
Standard Operating Procedure

Equipment Decontamination
Revision 1.1
Revision Date: October 9, 2001

Prepared/Revised by: **Wendy Linck** **October 9, 2001**
Name Date

Senior QA Review: Jay Lucas 10/26/01
Name Date

Regional Quality: Officer October 26, 2001
Name Date

EQUIPMENT DECONTAMINATION

TABLE OF CONTENTS

1.0 OBJECTIVES

The objective of this standard operating procedure (SOP) is to establish consistent methods to reduce or eliminate:

- Contamination and cross-contamination of environmental samples by sample equipment, other samples, or personnel.
- Health and environmental risk caused by the spread of contaminants.

2.0 APPLICABILITY

Decontamination should occur any time a sampling tool or instrument used in field investigations may contact sampled media, or personnel using the equipment. This procedure will be used in conjunction with use of reusable equipment during field activities associated with handling, sampling or measuring environmental media such as soil, groundwater, soil gas, or air. These procedures are to be implemented primarily on-site such as at the point of use or at a designated equipment decontamination station at the project site. Equipment decontamination should be completed before each use and prior to transporting off-site.

Examples of soil and groundwater sample collection equipment usually requiring decontamination includes pumps, bailers, oil/water interface tapes, tubing, hand augers, split spoon samplers, and other related equipment used for the collection of samples or the measurement of field parameters.

These procedures are general minimum standards. They may be modified or supplemented for a specific project by site-specific workplans or health and safety plans.

3.0 RESPONSIBILITY

The Project Manager, or designee, will have the responsibility to oversee and ensure that equipment decontamination procedures are implemented in accordance this SOP and any site-specific workplan, field sampling plan (FSP), quality assurance project plan (QAPP), and site safety plan (SSP). The field personnel will be responsible for the understanding and implementation of this SOP during all field activities, as well as, obtaining the appropriate field logbooks, forms and records necessary to complete the field activities.

4.0 DEFINITIONS

MSDS. Material Safety Data Sheets. These documents need to be kept on site, and discuss the physical and toxicological aspects for a particular substance used during decontamination.

Decontamination area. An area that is not expected to be contaminated and is upwind of the exclusion zone

Exclusion zone. The area in which contaminants are known or suspected to be present.

Measurement/monitoring equipment. Any equipment used to check or evaluate site conditions.

Potable. Drinkable.

Sampling equipment. Any equipment used during the process of sample collection.

SSHP. Site Safety and Health Plan. Plan written to coordinate and outline precautions that will be taken to initiate and monitor worker safety.

5.0 REQUIRED MATERIALS

The equipment and supplies required for this SOP include the following:

- Clean buckets or tubs to hold wash and rinse solutions of a size appropriate to the equipment to be decontaminated.
- Tap water.
- Deionized or distilled water (grade determined by project requirements. Many projects require "organic free" or ASTM Type II water).
- Long-handled brushes for scrubbing. Flat-bladed scrapers, garden type spray bottles (no oil lubricated parts).
- Non-phosphate detergent such as Alconox® or Liqui-Nox®.
- Plastic sheeting for the decontamination area.
- Department of Transportation certified drums to hold waste decontamination solutions and expendable supplies.
- Drum labels to properly identify the contents of the drum (more information about drum labels is included in the SOP for Investigation Derived Waste Handling Procedures)
- Plastic bags and/or aluminum foil to keep decontaminated equipment clean until the next use.
- Gloves, aprons, safety glasses, and any other PPE required in the SSHP.
- Towels and wipes.
- Dispensing bottles.
- Methanol (if required by the project work plan or quality assurance plan).
- Hexane (if required by the project work plan or quality assurance plan).
- Hot water high-pressure sprayer.
- Sump and collection system for waste derived liquids.

Some Work Plans or FSPs may include additional equipment rinses based on the contaminants being investigated. Examples of this are 0.1N nitric acid when cross-contamination from metals is a concern, and solvents such as methanol, isopropanol, or hexane, when cross-contamination from organics is a concern. If these are required, labeled inert dispensing bottles and Material Safety Data Sheets (MSDS) for these rinses will be necessary. Labels should be well marked. MSDS' should be filed on site and hazard communication needs to occur as outlined in the Site Safety Plan.

6.0 METHODS

Decontamination consists of physically removing contaminants from personnel or equipment. To prevent the transfer of harmful materials, procedures have been developed and are implemented before anyone enters a site and continue throughout site operations.

A decontamination plan should be based on the worst-case scenario (if information about the site is limited). The plan can be modified, if justified, by supplemental information. Initially, the decontamination plan assumes all protective clothing and equipment which leave the exclusion zone are contaminated. Based on this assumption, a system is established to wash and rinse all non-disposable equipment. Decontamination plans will be site-specific and presented in the SSHP for each site.

The decontamination area should be located, if possible, where decontamination fluids and soil wastes can be easily discarded or discharged after receipt of analytical results which determine if discharge parameters have been met. Decontamination wastewater should be managed in accordance with the Investigation Derived Waste Plan or as directed in the work plan or quality assurance plan. Wastewater will be collected and stored onsite until it can be properly disposed.

6.1 Decontamination Station Set-up

A decontamination pad should be established for cleaning of heavy equipment or large sampling tools. This pad can be a prefabricated area that already exists on site for washing large equipment, or can be constructed. If a prefabricated area exists, it needs have characteristics that allow for collecting fluids and solids that will fall off the large equipment. Decontamination pads can be constructed in a variety of ways, but things to consider during construction are the following:

- The pad will need to be constructed so it provides complete secondary containment. Hence all sides will require berms to prevent off pad migration of fluids. The berms need to be constructed by considering the balance between sump pump removal rates and the amount of fluid that will be generated.
- Fluids from decontamination processes cannot escape and be directly discharged vertically into the ground; hence if plastic sheeting is used it should be minimally double layered and thick (greater than 8 mil).
- The pad will have to drain in one general direction where a sump pump can collect fluids.
- The pad will need to be located near power and water, if possible. However, a generator can supply power and water can be trucked in.

For small equipment decontamination and PPE decontamination a smaller station is established, usually in the contaminant reduction zone, between the exclusion zone and buffer zone. For this station, clean buckets or tubs (5 gallon buckets are most common) should be used. There should be enough room within this area for storing used and unused drums. Buckets should be placed on plastic sheeting to prevent spillage to the ground, and to help keep the decontamination area and equipment as clean as possible. The buckets should be filled half to three-quarters full as follows:

Bucket 1	Tap water with non-phosphate detergent such as Liqui-Nox made up as directed by the manufacturer.
Bucket 2	Tap water or deionized water for rinsing
Bucket 3	Deionized or distilled water for the second rinsing

If additional rinses using wash or dispensing bottles are called for in the project-specific documents, an additional bucket to catch the discharge from the final rinse will be necessary.

A clean area, generally covered with plastic sheeting or large clean plastic bags, is also needed to set down decontaminated equipment prior to reuse or air drying and packaging for later use. A stainless steel rack (e.g., grill for barbecue) can often help drying activities.

After the decontamination area is set up, equipment decontamination is comprised of four general steps:

1) Removal of gross (visible) contamination
2) Removal of residual contamination
3) Prevention of recontamination, and
4) Disposal of wastes associated with the decontamination

6.2 Remove Gross Contamination

Gross contamination generally applies to soil sampling equipment, which may have significant residue clinging to the piece of equipment. This can be removed by dry brushing or scraping or by a high-pressure steam or water rinse often, in areas not grossly contaminated, steam washes may be all that is applied to larger equipment, such as drill casings. If utilizing high-pressure steam or water, the rinse water should be containerized as investigation derived waste. Since a significant amount of wastes may be generated, this operation is often best conducted on a decon pad, which has been designed as a secondary containment area to collect wastes.

6.3 Remove Residual Contamination

All sampling equipment used at the site must be cleaned prior to any sampling effort, after each sample is collected, and after the sampling effort is accomplished.

Removal of residual contamination consists of the following steps:

1) Place the item in the first bucket (detergent wash) and scrub the entire surface area of each piece of equipment to be decontaminated. Utilize scrub brushes to remove all visible contamination. Change the water periodically to minimize the amount of residue carried over into the second rinse.
2) Place the item in the second bucket (clear water rinse – tap or deionized water) and rinse. Change the water periodically to minimize the amount of residue carried over into the third rinse.
3) Place the item in the third bucket (deionized or distilled water) and repeat the rinsing procedure. Change water as necessary.
4) Unless the Work Plan or FSP directs additional rinses, place the item on a clean surface such as plastic sheeting to await reuse or packaging for storage (e.g., wrapping foil).

Additional rinses for field sampling equipment are sometimes called for in the Work Plan or FSP. These include a 0.1 N nitric acid rinse when cross contamination from metals is a concern, and a pesticide-grade solvent (e.g., methanol, isopropanal, or hexane) when organic contamination may be present. These rinses are applied with a wash bottle so that the stream of liquid has completely covered the area of surface of the equipment that may come in contact with the sample. The rinse should be conducted over a container to catch the runoff from the equipment. The nitric acid rinses, if required, should also be followed by a distilled water rinse, also applied with a wash bottle. Solvent rinses should be conducted from more polar (i.e., methanol) to less polar (i.e. hexane or methylene chloride), and allowed to air dry if at all possible. Application of the methanol and hexane rinses requires liberal amounts of hexane to remove the methanol. Under some circumstances (e.g., poor weather), complete air drying of equipment is impractical. In such a case, allowing the equipment to dry as long as practical followed by an organic free water rinse can be used. In some projects (few), equipment may need to be baked to complete the decontamination process. Typical items baked are stainless steel air sampling fittings, where typical decontamination practices are not sufficient to remove potential contamination. Other items that may be baked are soil sleeves. Items are baked at 160 degrees Celsius for a minimum of 8 hours. The requirement to bake items is a project specific requirement and should be specifically discussed in project specific planning documents.

6.4 Prevent Recontamination After Decontamination

After the decontamination process, equipment should be stored to preserve its clean state to the extent practical. The method will vary by the nature of the equipment. Protection measures include covering or wrapping in plastic or sealable plastic bags, or wrapping with oil-free aluminum foil.

6.5 Disposal of Contaminants and Spent Rinse Fluids

All washing and rinsing solutions are considered investigation derived waste and should be containerized. After use, gloves and other disposable PPE should also be containerized and handled as investigation derived waste. See SOP on Investigation Derived Waste Handling Procedures.

6.6 Record Keeping

The decontamination method should be documented within the field documentation designated for the project. Entries documenting the procedure used, fluids used, lot numbers for fluids, and any changes and approval for changes should be entered into a bound field notebook or on project-specific forms. Upon completion of the field activity, it is the responsibility of the field personnel to ensure the project/task manager receives copies of all of the field documentation.

7.0 REFERENCES

Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. October 1985.

United States Environmental Protection Agency (U.S. EPA), 1990. Procedures to Schedule and Complete Sampling Activities in Cooperation with EPA Region VII Environmental Services Division. February.

U.S. EPA Region VII, 1991. Environmental Services Division Operations and Quality Assurance Manual. February.

U.S. EPA, 1987. A Compendium of Superfund Field Operations Methods, Volumes I and II. EPA/540/P-87/001a&b.

U.S. EPA, 1992. Standard Operating Safety Guidelines; Publication 9285.1-03. June.

The Code of Federal Regulations, 1993. Title 29, 1910.120. July.

8.0 ATTACHMENTS

None.

APPENDIX L – REFERENCED ELECTRONIC COMMUNICATIONS

From:	Troy Bussey [busseyt@USPIONEER.COM]
Sent:	Friday, July 31, 2009 3:04 PM
To:	Johnson, Josh
Cc:	Joanne Snarski
Subject:	Phase 2 RI Data
Attachments:	RI Ph 2 DP soil data_DAL.pdf; RI Ph2 MW soil data_DAL.pdf; RI Ph 2 DP soil data_PACE.pdf; RI Ph 2 MW soil data_PACE.pdf; DAL report - June 2009 GWM_8.5x11.pdf; Pace report - June 2009 GWM.pdf

Josh -

Joanne asked me today to send the RI data you had requested previously. Attached to this email are the pdfs of the analytical reports for the Phase 2 RI soil samples.

<<RI Ph 2 DP soil data_DAL.pdf>> <<RI Ph2 MW soil data_DAL.pdf>> <<RI Ph 2 DP soil data_PACE.pdf>> <<RI Ph 2 MW soil data_PACE.pdf>>

Also, attached are the analytical reports for the 1st round of GW samples.

<<DAL report - June 2009 GWM_8.5x11.pdf>> <<Pace report - June 2009 GWM.pdf>>

I will send you shortly figures that display all Site RI soil data for the 13 COPCs in the IAWP. Please don't hesitate to contact me if you have questions.

Respectfully,
Troy

Troy Bussey Jr., P.E., L.G., L.HG.
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From:	Troy Bussey [busseyt@uspioneer.com]
Sent:	Monday, April 12, 2010 4:28 PM
To:	Joanne Snarski; Teel, Steve (ECY)
Cc:	Chris Waldron; Johnson, Josh; Rose, Scott (ECY)
Subject:	RE: East Bay - Preliminary March 2010 GWM Results
Attachments:	Tables of Detailed GWM Results_041210.xls

Joanne and Steve -

To assist us in our discussions about the soil-to-surface water empirical evaluation report, I am attaching updated constitutent result tables from the Feb 2010 report that incorporate data from the March 2010 GWM event.

<<Tables of Detailed GWM Results_041210.xls>>

Respectfully,
Troy

Troy Bussey Jr., P.E. (WA, CA), L.G. (WA), L.HG. (WA)
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mailto:busseyt@uspioneer.com

From: Troy Bussey
Sent: Tuesday, April 06, 2010 1:56 PM
To: 'Joanne Snarski'; 'Teel, Steve (ECY)'
Cc: Chris Waldron; Melody Feden; 'Johnson, Josh'; Rose, Scott (ECY)
Subject: East Bay - Preliminary March 2010 GWM Results

Joanne and Steve -

I just wanted to provide you with a summary of the results from the East Bay groundwater monitoring (GWM) event conducted from 3/15 - 3/17. Groundwater samples were collected from all 20 of the regularly sampled monitoring wells (MWs). All samples were analyzed by Anatek Labs for TPH-G, TPH-D, TPH-HO, PAHs, BTEX, and 5 metals (arsenic, chromium, copper, lead, and nickel) per Steve's 3/5 email. Attached are the the following data files for your reference:

- Analytical lab report from Anatek showing preliminary raw results
- Scanned copy of field notes

<< File: Lab Results_March 2010.pdf >> << File: Field Notes_March 2010 GWM.pdf >>

Here's the summary of the results from this GWM event from my perspective:

- No measurable LNAPL was observed in any of the MWs.
- TPH-G, BTEX, TPH-D, TPH-HO, and cPAHs were not detected in any MW, with a couple of minor exceptions in a couple of MWs. There were no exceedances of surface water screening levels in any MW for any of these constituents.
- Metals concentrations are similar to or less than previous GWM events. The only surface water screening level exceedances for total metals were arsenic in MW02R and MW04, chromium in MW14 (which had an elevated turbidity), and copper in MW04, MW14, MW16, MW18, MW24S, and MW25S. These same MWs had similar concentrations in past GWM events. There were no screening level exceedances for any of the dissolved metals analyses, with the exception of copper at 3.6 ug/L in MW14. Although the metals concentrations observed at the site are within the range of natural background concentrations, it appears that total metals concentrations are continuing to decrease over time. This decreasing metals concentration trend combined with the differences between total concentrations vs. dissolved concentrations in most MWs suggests to me that suspended solids in extremely small diameter MWs that cannot be fully developed are a primary cause of the total metals exceedances.
- The elevated total copper concentration in the equipment blank is not suprising since tap water was used for decon and filling the equipment blank.
- Reporting limits were acceptable.

Please note that this March 2010 GWM event was the last planned GWM event for the RI phase.

Respectfully,
Troy

Troy Bussey Jr., P.E. (WA, CA), L.G. (WA), L.HG. (WA)
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Johnson, Josh

From:	Troy Bussey [busseyt@uspioneer.com]
Sent:	Wednesday, May 26, 2010 1:45 PM
To:	Johnson, Josh
Subject:	RE: Depth to GW / GW elevations for March 2009
Attachments:	Tables 4 GW Elev_052610.xls

Here you go.

Respectfully,
Troy

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From: Johnson, Josh [mailto:jjohnson@brwncald.com]
Sent: Wednesday, May 26, 2010 1:11 PM
To: Troy Bussey
Subject: Depth to GW / GW elevations for March 2009

Troy,

I can’t find GW elevations for the March 2009 event. Can you please forward tabulated elevations / depth to GW or field notes?

Thanks,
Josh

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Table 4
Measured Depth to Groundwater and Calculated Groundwater Elevations

Monitoring Well	Surveyed Elevations (feet) (1)	Revised Surveyed Elevation (feet) (1,2)	Measured Depth to Groundwater (feet) (3)											Groundwater Elevation (feet NGVD29)										
			Date of Groundwater Measurements											Date of Groundwater Measurements										
			Jan-07	Jun-07 (4)	Jul-07	Aug-07	Jul-08 Low Tide	Jul-08 High Tide	Jun-09 (5)	Sep-09 (5)	Nov-09 (5)	Dec-09 (5)	Mar-10	Jan-07	Jun-07	Jul-07	Aug-07	Jul-08 Low Tide	Jul-08 High Tide	Jun-09	Sep-09	Nov-09	Dec-09	Mar-10
MW01	10.78	--	4.14	4.44	4.30	4.55	4.40	4.39	4.18	4.83	2.08	4.09	4.27	6.64	6.34	6.48	6.23	6.38	6.39	6.60	5.95	8.70	6.69	6.51
MW02	10.41	--	3.48	3.88	3.70	3.92	3.65	3.70	3.49	NM	NM	NM	NM	6.93	6.53	6.71	6.49	6.76	6.71	6.92	NM	NM	NM	NM
MW02R	10.15	--	NM	NM	NM	NM	NM	NM	NM	4.08	2.93	3.73	4.13	NM	NM	NM	NM	NM	NM	NM	6.07	7.22	6.42	6.02
MW03	11.05	--	4.28	4.82	4.64	4.92	4.79	5.78	4.58	5.11	3.13	4.07	4.82	6.77	6.23	6.41	6.13	6.26	5.27	6.47	5.94	7.92	6.98	6.23
MW04	11.70	--	5.33	6.37	5.40	6.46	5.69	5.65	5.49	6.29	4.32	5.42	6.14	6.37	5.33	6.30	5.24	6.01	6.05	6.21	5.41	7.38	6.28	5.56
MW05	11.69	--	4.19	4.22	4.19	4.25	4.19	4.21	NM	NM	NM	NM	NM	7.50	7.47	7.50	7.44	7.50	7.48	NM	NM	NM	NM	NM
MW06	10.26	--	0.82	0.37	0.50	0.84	1.14	1.05	NM	NM	NM	NM	NM	9.44	9.89	9.76	9.42	9.12	9.21	NM	NM	NM	NM	NM
MW07	10.99	11.01	4.70	4.81	4.57	5.12	5.03	5.00	5.15	5.16	4.05	7.00	5.12	6.29	6.18	6.42	5.87	5.96	5.99	5.84	5.85	6.96	4.01	5.89
MW08	11.32	--	NM	2.22	2.06	2.42	2.62	2.55	2.73	4.48	2.72	3.12	3.02	NM	9.10	9.26	8.90	8.70	8.77	8.59	6.84	8.60	8.20	8.30
MW09	10.78	--	2.61	2.51	2.05	2.66	2.65	2.60	2.73	NM	NM	NM	NM	8.17	8.27	8.73	8.12	8.13	8.18	8.05	NM	NM	NM	NM
MW10	11.39	--	2.61	3.57	3.55	3.80	3.55	3.48	NM	NM	3.70	NM	4.38	8.78	7.82	7.84	7.59	7.84	7.91	NM	NM	7.69	NM	7.01
MW11	11.07	--	NM	NM	NM	3.12	3.42	NM	3.42	3.17	2.40	2.60	3.34	NM	NM	NM	7.95	7.65	NM	7.65	7.90	8.67	8.47	7.73
MW12	10.37	11.74	NM	NM	NM	7.48	9.40	7.11	9.73	8.84	8.92	7.04	9.72	NM	NM	NM	2.89	0.97	3.26	0.64	2.90	2.82	4.70	2.02
MW13	9.91	--	NM	NM	NM	4.18	4.26	4.23	4.22	4.11	3.29	NM	4.10	NM	NM	NM	5.73	5.65	5.68	5.69	5.80	6.62	NM	5.81
MW14	10.74	--	NM	NM	NM	1.41	1.59	1.48	2.00	2.21	2.64	1.53	1.64	NM	NM	NM	9.33	9.15	9.26	8.74	8.53	8.10	9.21	9.10
MW15	9.86	--	NM	NM	NM	4.04	4.09	4.09	3.82	3.87	2.09	2.56	3.08	NM	NM	NM	5.82	5.77	5.77	6.04	5.99	7.77	7.30	6.78
MW16	11.40	--	NM	NM	NM	6.35	5.32	5.41	5.21	5.51	4.36	4.50	5.60	NM	NM	NM	5.05	6.08	5.99	6.19	5.89	7.04	6.90	5.80
MW17	10.28	--	NM	NM	NM	3.56	2.85	2.93	NM	NM	NM	NM	NM	NM	NM	NM	6.72	7.43	7.35	NM	NM	NM	NM	NM
MW18	12.21	--	NM	NM	NM	8.63	11.40 (6)	6.56	8.88	10.71	7.45	5.50	Dry	NM	NM	NM	3.58	0.81	5.65	3.33	1.50	4.76	6.71	NM
MW19	9.38	--	NM	NM	NM	3.47	3.78	3.68	NM	NM	NM	NM	NM	NM	NM	NM	5.91	5.60	5.70	NM	NM	NM	NM	NM
MW20	10.06	--	NM	NM	NM	5.65	5.70	5.70	5.12	5.05	3.92	4.73	4.70	NM	NM	NM	4.41	4.36	4.36	4.94	5.01	6.14	5.33	5.36
MW21S	9.81	--	NM	NM	NM	NM	NM	NM	4.20	4.31	NM	NM	4.21	NM	NM	NM	NM	NM	NM	5.61	5.50	NM	NM	5.60
MW22S	10.48	--	NM	NM	NM	NM	NM	NM	0.77	0.70	0.02	0.00	0.50	NM	NM	NM	NM	NM	NM	9.71	9.78	10.46	10.48	9.98
MW23S	10.72	--	NM	NM	NM	NM	NM	NM	4.11	4.62	3.28	4.05	4.59	NM	NM	NM	NM	NM	NM	6.61	6.10	7.44	6.67	6.13
MW24S	11.49	--	NM	NM	NM	NM	NM	NM	3.70	4.49	3.71	3.65	3.87	NM	NM	NM	NM	NM	NM	7.79	7.00	7.78	7.84	7.62
MW25S	10.95	--	NM	NM	NM	NM	NM	NM	0.81	0.89	0.80	1.00 (7)	0.67	NM	NM	NM	NM	NM	NM	10.14	10.06	10.15	9.95	10.28

Notes:

MW = Monitoring well

NGVD29 = National Geodetic Vertical Datum of 1929

NM = Not measured

(1) Surveyed by licensed surveyor from Skillings Connolly, with vertical datum of NGVD29.

(2) Surface seals for MW07 and MW12 were revised between the June 2009 and September 2009 events. The revised elevations in this column were used for calculating elevations in the September 2009 and subsequent events.

(3) From top of PVC casing

(4) Depth to groundwater calculated from well elevations and map of groundwater elevations included in GeoEngineers report (GeoEngineers 2007c).

(5) Groundwater measurements were not collected synoptically during this event since the Remedial Investigation Work Plan (GeoEngineers and PIONEER 2008) did not specify collection of synoptic measurements, and previous tidal studies concluded there was minimal tidal influence at the site.

(6) Depth estimated by Greylock Consulting based on wetness at bottom of MW.

(7) Assumed depth to groundwater since depth was reported as "< 1" in field notes.