REMEDIAL ACTION PLAN AND ENGINEERING DESIGN REPORT

FORMER CREAM WINE PROPERTY

Prepared for
PORT OF SUNNYSIDE
SUNNYSIDE, WASHINGTON
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Project No. 0346.04.06

Prepared by
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MAUL
FOSTER
ALONGI

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The material and data in this report were prepared under the supervision and direction of the undersigned.

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ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
CUL	cleanup level
Ecology	Washington State Department of Ecology
FP-XRF	field-portable X-ray fluorescence
HASP	health and safety plan
IHS	indicator hazardous substance
ISCR	in situ chemical reduction
LCA	lead characteristic area
MFA	Maul Foster & Alongi, Inc.
mg/L	milligrams per liter
MTBE	methyl tert butyl ether
MTCA	Model Toxics Control Act
PCE	tetrachloroethene
Plan	remedial action plan and engineering design report
Port	Port of Sunnyside, Washington
Property	former Cream Wine property, 111 East Lincoln Avenue, Sunnyside, Washington
SAP	sampling and analysis plan
SES	Sound Environmental Strategies Corporation
TCLP	toxicity characteristic leaching procedure
Time Oil	TOC Holdings Company
UST	underground storage tank
VVM	Valley View Market
WHC	Washington Hills Cellar

1 INTRODUCTION

On behalf of the Port of Sunnyside (the Port), Maul Foster & Alongi, Inc. (MFA) has prepared this remedial action plan and engineering design report (Plan) for the soil removal and groundwater treatment actions at the former Cream Wine property located at 111 East Lincoln Avenue in Sunnyside, Washington (the Property) (see Figure 1). The Property is currently vacant but was used historically as a winery and originally as a milk plant. Historical operations on the Property, including truck washing and repair and chemical storage, have resulted in the release of hazardous substances to soil on the Property. Hazardous substances present in groundwater beneath the Property have been attributed to upgradient off-property historical releases. The Property is listed with the Washington State Department of Ecology (Ecology) as Facility Site No. 46552166 and Cleanup Site No. 4863. Cleanup of the site is being conducted under a Prospective Purchaser Consent Decree between the Port and Ecology No. 12-2-04273-9 enacted on December 14, 2012. This Plan has been developed to ensure that remedial action work is conducted consistent with Ecology requirements.

For efficiency, the two elements (i.e., the remedial action plan and the engineering design report) of this Plan have been combined to address the requirements of both documents, thereby removing redundancies where the requirements are the same. This Plan defines the approach for implementation of the preferred alternative described in the Cleanup Action Plan (Ecology, 2012) and includes the following Ecology-required elements, consistent with the requirements of Washington Administrative Code 173-340-400 and 173-303-410:

- A brief site operational history and site characterization (Section 2), including attached maps and figures identifying existing site conditions, as well as locations of the proposed cleanup actions.
- Contaminant and contaminated media characteristics as well as sampling specifications (Section 3).
- The proposed remedial action, including a soil excavation plan; sampling specifications; backfill, compaction, and final grading; and groundwater treatment and monitoring (Section 4).
- Institutional controls required for the Property (Section 5).
- Appendices, including construction plans detailing the work to be performed; a health and safety plan (HASP); and a sampling and analysis plan (SAP) that incorporates quality assurance project plan elements.

2 SITE DESCRIPTION AND OVERVIEW

2.1 Location and Background

The Property is located in Yakima County, Washington, at 111 East Lincoln Avenue in Sunnyside, and is zoned heavy industrial. The Property comprises approximately 4.58 acres and is located in section 36, township 10 north, and range 22 east of the Willamette Meridian, on tax lot 221036-22006 (see Figure 1).

The Property is bordered by Lincoln Avenue and residential areas to the north; industrial development to the south; First Street, a residential area, and Valley View Market (VVM) to the west; and a commercial development to the east (Ken's Auto Wash & Quick Lube). The VVM property located at 107 West Lincoln Avenue, Sunnyside, Washington, once operated a retail gasoline service station and a dry cleaner or laundry and is currently undergoing cleanup for petroleum hydrocarbon contamination resulting from an underground storage tank (UST) release (Facility Site No. 24231643 and Cleanup Site No. 5744). Features associated with the VVM property remediation exist on the Property, including monitoring and recovery wells and a remediation building housing components of the now inactive groundwater remediation system.

The Property is currently vacant and has three main buildings (see Figure 2):

- **Main Building:** The main building on the Property was formerly used for the milk plant and winery operations and covers approximately 36,309 square feet. It is composed of many rooms, including processing rooms, storage room, cold rooms, boiler room, office rooms, rest rooms, a warehouse area, and a product testing laboratory. The building structure consists of various materials, including wood, metal, brick, and concrete block. There are two production wells (Well No. 1 and Washington Hills Cellar's [WHC]) inside the building.
- **Former Chemical Storage Building:** An approximately 200-square-foot building located south of the main building was formerly used for chemical storage. It has a concrete floor and is constructed of concrete blocks.
- **Remediation Building:** The remediation building is located west of the main building and covers approximately 200 square feet.

A truck repair building was formerly located on the southwest corner of the Property. The building has been removed, but the concrete foundation remains.

The Property is generally flat and mostly paved, with localized unpaved areas to the north of the main building and on the eastern end of the Property. Unpaved areas are generally covered with landscaped grass and a few trees. The Port installed a stormwater infiltration swale on the southeast portion of the Property in 2011.

2.2 Overview of Historical Operations and Impacts

The Property was originally developed for use as an evaporated milk plant by the Morning Milk Company, which operated on the Property from approximately 1942 to 1946. Carnation acquired the Property and operated from approximately 1946 to 1986. The Port bought the Property in 1986 and leased the facility to a winery in 1988, then sold it to the Seitz family in 1990. In 1992 the Property was bought by WHC and used as a winery. Federal Agricultural Mortgage Corporation foreclosed on the Property in 2007 because WHC was unable to make loan payments. Cream Wine leased the Property for operation of a winery in 2007 and vacated it in 2010. The Property has remained vacant and unused since 2010. The Port acquired the Property in December 2012 after executing a Prospective Purchaser Consent Decree.

Site investigations have been conducted on the Property since 2006 to assess groundwater impacts resulting from the UST release from the VVM property. In 1996, TOC Holdings Company ("Time Oil") discovered petroleum hydrocarbon contamination on the VVM property during installation of cathodic protection on the UST system. Time Oil initiated a remedial investigation on the VVM site and discovered that the release had resulted in migration of petroleum hydrocarbons in groundwater onto the Property (Sound Environmental Strategies Corporation [SES], 2009). Time Oil installed a dual-phase extraction groundwater remediation system in May 2000 on the VVM site and the Property. The remediation system operated between August 2000 and August 2006. Following operation of the remediation system, petroleum hydrocarbon concentrations observed in groundwater were below Ecology's Model Toxics Control Act (MTCA) Method A cleanup levels (CULs); however, methyl tert butyl ether (MTBE) and benzene concentrations above CULs remained (SES, 2010). In 2010, Time Oil completed in situ groundwater treatment to address the MTBE and benzene contamination (SES, 2010).

Groundwater monitoring was conducted on the VVM site on a quarterly to semiannual basis between March 1997 and December 2008. Quarterly groundwater monitoring was conducted for a subset of the monitoring wells from 2010 to 2012 to monitor concentrations of MTBE and benzene following in situ treatment. The most recent round of groundwater monitoring showed groundwater cleanup levels are being met; therefore, Time Oil plans to request a No Further Action determination from Ecology for the VVM site (SoundEarth Strategies, Inc. [formerly Sound Environmental Strategies Corporation], 2013).

Investigations for the VVM project also detected tetrachloroethene (PCE) in groundwater on the Property. The source for the PCE contamination was not conclusively identified in previous investigations. MFA conducted additional investigations in 2012 and 2013 to further characterize PCE impacts on the Property, including characterizing the surface of the lower groundwater confining unit and evaluating groundwater flow paths; to identify potential sources of PCE; and to evaluate impacts associated with potential environmental conditions identified during the 2011 Phase I Environmental Site Assessment. The following features were identified as potential environmental conditions:

- The former dry cleaner at the VVM property and the former truck shop on the Property as potential sources of PCE in groundwater

- Potential soil and/or groundwater contamination associated with drains in the former chemical storage building and truck washing area, from a pipe draining into the stormwater swale, and from a former wastewater line that may have discharged to an open drainage ditch along the south property boundary
- Potential soil and/or groundwater contamination associated with a former coal pit and bunker fuel UST

The results of the 2012 and 2013 investigations are presented in the 2012 focused site assessment report (MFA, 2012) and the pre-remedial action sampling results letter (MFA, 2013) and are summarized in Section 3.2.

3 SITE CONDITIONS

3.1 Geology and Hydrogeology

The Property is located on late Pliocene lacustrine deposits composed of interbedded silt and fine-grain sands deposited by the Missoula Floods (Maxim Technologies, Inc., 1999). The lacustrine deposits may be up to 90 feet thick; they overlie coarse-grained fluvial deposits from former channels of the Columbia River. These fluvial deposits compose the Snipes Mountain Conglomerate and may range in thickness from 90 to 450 feet (Maxim Technologies, Inc., 1999). Unconsolidated deposits in the area may be up to 2,000 feet thick and are underlain by the Wanapum Basalt, which is part of the Columbia River Basalt Group (SES, 2009). In the Sunnyside area, unconsolidated deposits are typically up to 400 feet thick (SES, 2009). Multiple aquifers are present in both the unconsolidated deposits and the basalts (SES, 2009).

A cross-sectional interpretation of the property geology, based on soil boring observations (see Appendix A), was completed along the transect shown in Figure 3. The cross section is provided as Figure 4. Soil boring observations indicate that most of the Property is underlain by 10 to 15 feet of silt overlying an approximately 20- to 35-foot-thick deposit of interbedded silty sand and sandy silt, which most likely represent the lacustrine deposits discussed above. A dense silt and clay unit underlies the silty sand and sandy silt, generally at a depth of 40 feet below ground surface (bgs).

The silty sand and sandy silt deposits make up an unconsolidated, shallow aquifer that has been observed to be hydraulically disconnected from deeper groundwater present beneath the Property (Kennedy/Jenks Consultants, 2008). Groundwater was typically encountered between 11.5 and 22 feet bgs, and the average groundwater flow direction historically observed at the Property is toward the southeast (MFA, 2013; SoundEarth Strategies, Inc., 2011). The underlying silt and clay unit was characterized as unsaturated and likely acts as a fully confining unit, based on the observed absence of moisture and the hydraulic discontinuity between the shallow and deep groundwater units identified by previous investigations (Kennedy/Jenks Consultants, 2008).

3.2 Environmental Conditions

A focused site assessment was performed to assess the nature and extent of contamination in soil and groundwater on the Property (MFA, 2012). An additional pre-remedial action sampling event, focused on evaluating conditions for in situ groundwater treatment and delineating a lead CUL exceedance in shallow soil, was conducted in May 2013 (MFA, 2013). Boring logs and analytical results from the focused site assessment and pre-remedial action sampling are provided as Appendices A and B, respectively. Figure 5 shows groundwater monitoring PCE results.

The potential environmental conditions identified in the Phase I Environmental Site Assessment (as mentioned in Section 2.2 of this report) were investigated during the focused site assessment. The only indicator hazardous substance (IHS) identified in soil is lead, which is limited to one exceedance of the MTCA Method A CUL in shallow soil in the vicinity of the former chemical storage building (GP08 at 1.0 foot bgs). The lead contamination is vertically bounded at 5 feet bgs. Additional sampling was conducted on May 29, 2013, to further characterize the lateral extent of lead contamination. Lead-impacted soil was not observed to extend beyond the footprint of the storage building to the north and south and is believed to be limited in extent to the east and west, based on the presence of structures in the vicinity of the observed exceedance.

The only IHS identified in groundwater is PCE. A fate and transport analysis conducted as part of the focused site assessment indicates a single-event, single-source release of PCE, most likely originating from the former dry cleaner at the upgradient VVM property. Historical and recent data indicate that there is a strong declining trend in PCE concentrations, and PCE has not been detected in groundwater downgradient of the Property. Whereas additional sampling would be required to confirm the PCE source, additional data from the PCE source area are not expected to change the current interpretation of PCE decay and the downgradient plume extent and therefore are not necessary in order to move forward with the site cleanup.

PCE exceedances were observed along the western edge and in the southeast corner of the Property (see Figure 5). With one exception (MW08, which was last sampled in 2008), PCE CUL exceedances were not observed outside the property boundaries. PCE concentrations generally increase with increasing depth, with the highest concentrations observed at the top of the lower confining unit (see Figure 4). However, PCE is believed to be confined to the upper aquifer and not migrating to the deeper groundwater unit, as there appears to be no groundwater flow between the units (see Section 3.1).

During the focused site assessment, MTBE was detected in groundwater at a concentration above the MTCA Method A CUL, but was not identified as an IHS. MTBE is a known groundwater contaminant associated with the UST release at the VVM property and is being actively remediated by Time Oil. In addition, MTBE was detected only in approximately 6 percent of the groundwater samples collected on the Property during the focused site assessment investigation. Therefore, given the low frequency of detection, the fact that it originates from an off-property source (there are no known or suspected sources of MTBE on the Property), and the fact that remediation activities associated with the VVM site are addressing MTBE, MTBE is not considered an IHS for the Property.

Soil vapor samples were not collected as part of the focused site assessment or pre-remedial action sampling. PCE was detected in groundwater at concentrations exceeding the Ecology vapor-intrusion-to-indoor-air Method B groundwater screening level of 1 microgram per liter (Ecology, 2009). However, concentrations of PCE in indoor or outdoor air likely are below risk levels, considering the relatively thick unsaturated zone and the relatively low concentrations of PCE observed in groundwater. In addition, because vapors disperse rapidly in outdoor air, and PCE concentrations above the indoor air screening level are generally present in deep groundwater, they do not pose a vapor intrusion risk. PCE has not been detected in groundwater beneath any existing buildings, and development plans currently do not include constructing buildings over areas within the footprint of the PCE groundwater plume. However, potential risks associated with groundwater vapor conditions will be considered if future site development plans change.

4 REMEDIAL ACTION ENGINEERING DESIGN

4.1 Mobilization and Site Preparation

Excavation extents will be located and painted by the contractor and will be verified by the engineer. The final extent of the excavation will be confirmed by a combination of field-portable X-ray fluorescence (FP-XRF) screening for lead levels and the predesignated boundary. Before excavation, the locations of subsurface utilities within 50 feet of the excavation areas will be identified by "One Call" public notification and a private utility locating company.

Exclusion zones using temporary fencing and warning tape, as well as any additional appropriate site controls necessary, will be established in accordance with the site-specific HASP (Appendix C). The site will be secured and locked when the engineer or contractor is not present.

Equipment will be mobilized to the site and is expected to include, but not be limited to, the following:

- Trackhoe excavator, or equivalent
- Dump truck
- Water truck
- Support vehicles and equipment for groundwater treatment

4.2 Soil Excavation and Management

The soil remedial action includes the excavation of soils with lead concentrations exceeding the MTCA Method A CUL (see the attached table). The anticipated extent of excavation is defined on Figure 6.

Oversight and monitoring for consistency with this Plan will be performed under the direction of an engineer registered in the state of Washington. Field screening will be performed during excavation activities and sampling conducted upon reaching apparent contaminant boundaries. Field screening and sampling techniques for lead may include, but are not limited to:

- FP-XRF instrument
- Analytical—optional

4.2.1 Excavation

Excavation activities will initially be limited to the areal extent defined on Figure 6. The estimated excavation depth of 3 feet below ground surface (bgs) was established based on the detection of lead exceeding the associated CUL in a sample collected from 1.5 feet bgs and a non-detect for lead in a sample collected at 5 feet bgs. The excavation boundaries were developed as part of the pre-remedial action sampling event (MFA, 2013) and are expected to result in removal of all on-site soils exceeding CULs. The estimated removal volume is 11 cubic yards.

Upon removal of all soil as described above, sampling will be completed as outlined in Section 4.2.4 and in the SAP. Before backfilling begins, the results of the initial excavation sampling will be analyzed to determine appropriate additional management (i.e., additional removal, further evaluation of risk, and/or management through institutional controls).

4.2.2 Waste Designation

The area in Figure 6 represents the extent of soil where lead concentrations are assumed to exceed not just CULs, but also the 100 parts per million[1] disposal limit (i.e., the "lead characteristic area" [LCA]). These data indicate that soil within the excavation limit may be defined as a characteristic waste because of elevated lead concentrations, in which case it would require either treatment before disposal or direct disposal as hazardous waste. Soil from within the LCA boundary will be excavated and stockpiled for toxicity characteristic leaching procedure (TCLP) analysis to determine disposal requirements (see SAP Section 3.3 in Appendix D). The stockpiled soil will then be loaded into a dump truck for disposal at the appropriate facility.

Once excavation has reached the LCA boundary, lead measurements will be collected from the walls and floor of the excavation, using FP-XRF to determine if elevated lead concentrations extend beyond the estimated LCA boundary (see Appendix D, the SAP). Should lead concentrations in excess of the associated CUL be detected, the site engineer will have the option to either excavate further until an acceptable level of lead is detected by FP-XRF, or obtain a sample to determine if lead in soil is below the site CUL.

4.2.3 Dust Controls

The excavation process will disturb soil and has the potential to generate dust. Appropriate dust-control methods will be employed during excavation as necessary to prevent the generation of

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[1] The TCLP limit for lead is 5 milligrams per liter (mg/L). By applying the "20 times rule" to the leachable limit, the converted TCLP limit can be compared to a total concentration in soil. In this case 5 mg/L x 20 = 100 parts per million.

airborne contaminants. These control methods will include soil wetting and misting, at a minimum. The excavation area may be wetted before excavation should the work be completed during excessively dry weather by spraying the area immediately around the excavation so that visible dust emissions are controlled.

The contractor will locate a nearby water source (e.g., fire hydrant) to fill a water tank/truck and keep water readily available during the construction activities. Soil will be kept wet during handling until the soil is placed in haul trucks and covered, pending transport to an off-site permitted landfill. Dry excavation, dry shoveling, or dry sweeping of soil will not be allowed.

4.2.4 Excavation Limits Sampling and Analysis

Soil samples collected from the excavation walls and floor will be obtained to assist in determining the necessity for further removal or, upon analysis of the sample results, of any further appropriate actions. The excavation boundary delineated in Figure 6 will serve as the maximum horizontal extent of the excavation (except to the extent to which further excavation is warranted; see Section 4.2.1). The maximum excavation depth will be bounded by the depth of CUL exceedances. Soil samples collected from the floor and walls of the excavation will be analyzed in accordance with the SAP (see Appendix D).

A minimum of one sample will be collected from the floor of the excavation for analysis. Discrete soil samples will be collected along the walls of the excavation at 20 foot increments, or a minimum of one sample on each sidewall. The wall samples from the excavation area will be collected approximately halfway between the floor of the excavation and the original ground surface. Soil sampling and analysis are described further in the SAP (Appendix D).

In the event that over-excavation is conducted as discussed in Section 4.2.1, the sampling procedures described above will be followed for the expanded excavation limits.

4.3 Backfill, Compaction, and Final Grade

Following confirmation of attainment of cleanup goals, authorization to proceed with backfill will be provided by the on-site engineer. The excavation will be backfilled using clean soil from a local source. Before imported soil is accepted and placed, verification will be provided that the soil does not contain contaminant concentrations that exceed CULs established for this site. A fill source statement will be required from the landowner for each proposed off-site soil borrow source, stating the location and the current and previous land uses, and that, to the best of the landowner's knowledge, there has never been contamination of the borrow source site with hazardous or toxic materials.

Clean soil backfill will be placed in the excavated areas and compacted in accordance with the project plans (Appendix E). The final grade will be placed to match the existing grade, and will be leveled, sloped, and protected with gravel to guard against runoff.

4.4 Groundwater Treatment and Monitoring

In situ groundwater treatment will be conducted to treat remaining PCE CUL exceedances in groundwater. Although PCE concentrations continue to decline (MFA, 2013), treatment is recommended in order to achieve compliance with groundwater CULs within a shorter timeframe and to provide additional assurance that PCE concentrations will not exceed the associated CUL beyond the downgradient property boundary.

Natural attenuation parameters (e.g., anions, dissolved metals, TOC, ferrous iron) were analyzed in groundwater to define the preferred treatment approach for the in situ pilot study and to determine injection quantities (MFA, 2013). Whereas concentrations of competing electron acceptors (e.g., nitrate and sulfate) were relatively high, these concentrations are not insurmountable with an in situ chemical reduction (ISCR) approach. In addition, ISCR will be more cost effective than a chemical oxidation approach given the low PCE concentrations and given that a large quantity of added oxidant likely would be consumed overcoming the soil oxidant demand as opposed to degrading the PCE. Based on these findings, MFA recommends ISCR as an initial approach for the pilot study.

An ISCR pilot study will be conducted in order to evaluate the effectiveness of the treatment on a smaller scale before expanding to a full-scale treatment, if needed. Performance monitoring will be implemented following the pilot study in order to evaluate the treatment effectiveness and to determine if additional treatment may be required. Work will be conducted in accordance with the site-specific HASP (Appendix C) and the SAP (Appendix D).

Existing on-site groundwater wells will be used for the treatment and monitoring. A subset of the existing monitoring well network will be used as pilot injection points. Monitoring wells exhibiting recent PCE CUL exceedances (MW08, MW11, MW17, and MW18), as well as downgradient monitoring well MW19, will be used for the pilot study injection (see Figure 5). All monitoring wells used for injection will be registered with Ecology's Underground Injection Control program, and the local water and stormwater utility operators will be notified before injection. Monitoring wells MW13, MW17, MW19, and MW20 will be included in the post-injection performance monitoring network. MW13 will be used as a background monitoring point, MW17 will be used to monitor conditions in the center of the plume, and MW19 and MW20 will be used to evaluate downgradient conditions and determine CUL compliance at the property boundary.

The product EHC®-L will be used for the pilot study injections. EHC®-L is a liquid, controlled-release ISCR reagent consisting of food-grade carbon, nutrients, and iron. A description of the product and site-specific chemical demand calculations are included in Appendix F; a material safety data sheet is included as an attachment to the HASP (Appendix C). EHC®-L is effective at reducing chlorinated solvent concentrations by promoting anaerobic bioremediation processes and abiotic dechlorination reactions. The reagent is designed to be diluted on site with cold water and injected via existing wells.

In order to estimate the volume of product needed, a treatment zone volume was estimated based on the approximate dimensions of the observed PCE plume. Based on observed PCE CUL exceedances (see Figure 5), the horizontal plume dimensions were conservatively estimated as 200 feet long (parallel to groundwater flow) and 100 feet wide (perpendicular to groundwater flow). The treatment zone thickness was assumed to be 20 feet, based on a typical saturated zone thickness (see Figure 4). Using the estimated treatment zone volume; default assumptions for typical soil, aquifer, and groundwater flow parameters; and the maximum PCE concentration and geochemical data collected during the May 2013 sampling event, a recommended application amount of EHC®-L was calculated (see chemical demand calculations provided in Appendix F).[2]

The pilot study treatment will be conducted according to the following steps (see the SAP in Appendix D for detailed procedures):

1. Prior to injection activities, water levels and water quality parameters (pH, dissolved oxygen, and oxidation reduction potential) will be measured in the following nearby wells: RW02 to RW05, RW08, RW09, MW15, and MW20. The wells will be opened and allowed to equilibrate with atmospheric pressure for 15 minutes before water levels are measured. Water quality parameters will be monitored according to low-flow groundwater sampling purging procedures.

2. The EHC®-L will be delivered as two components (one liquid and one dry powder) and mixed in the field. The dry powder will be added to the liquid component and the resulting mixture (the batch of injectate) will be diluted with water during injection. Each batch of injectate will consist of 50 gallons of liquid emulsion, one 24-pound bag of dry powder, and 100 gallons of water; a total of 41 batches are recommended for treatment.[3] Eight batches of injectate will be injected into each of the following wells, working in order from downgradient toward upgradient locations as listed: MW19, MW17, MW11, MW18, and MW08. The product mixing and injecting will be conducted by a licensed drilling contractor.

3. During injection, water levels will be measured at the nearby monitoring wells listed in Step 1 to monitor changes in groundwater levels and to evaluate the radius of influence. Water levels may be measured in additional wells if the radius of influence is observed to extend beyond those wells listed.

4. Following injection, water levels and water quality parameters will be remeasured in the nearby wells listed in Step 1. Before any equipment leaves the site, it will be cleaned and decontaminated following the procedures defined in the SAP (Appendix D).

The ISCR treatment is scheduled to be completed during the summer of 2013. Performance monitoring will be conducted approximately four to six weeks following injection activities. The performance monitoring results will be reviewed to evaluate the effectiveness of the pilot study treatment. Following receipt of the performance monitoring results, a report will be prepared summarizing the injection activities and results, treatment effectiveness, and recommendations for additional work, if deemed necessary.

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[2] Note that the calculated application amount in Appendix F assumes a 5 times safety factor. For the pilot study, a 3 times safety factor will be applied, but may be lowered further in order to reduce costs.

[3] Injection quantities assume a 3 times safety factor. If the safety factor is lowered to reduce costs, the injection quantities will be adjusted accordingly.

5 INSTITUTIONAL CONTROLS

As stated in the CAP, no institutional controls are planned for the Property at this time since the remedial actions are intended to achieve CULs in soil and groundwater.

LIMITATIONS

The services undertaken in completing this report were performed consistent with generally accepted professional consulting principles and practices. No other warranty, express or implied, is made. These services were performed consistent with our agreement with our client. This report is solely for the use and information of our client unless otherwise noted. Any reliance on this report by a third party is at such party's sole risk.

Opinions and recommendations contained in this report apply to conditions existing when services were performed and are intended only for the client, purposes, locations, time frames, and project parameters indicated. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this report.

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TABLE

Table
Cleanup Levels
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Medium	Analyte	Cleanup Level	Cleanup Level Source
Soil	Lead	250 mg/kg	MTCA Method A, Unrestricted Land Use
Groundwater	Tetrachloroethene	5 µg/L	MTCA Method A, Table Value

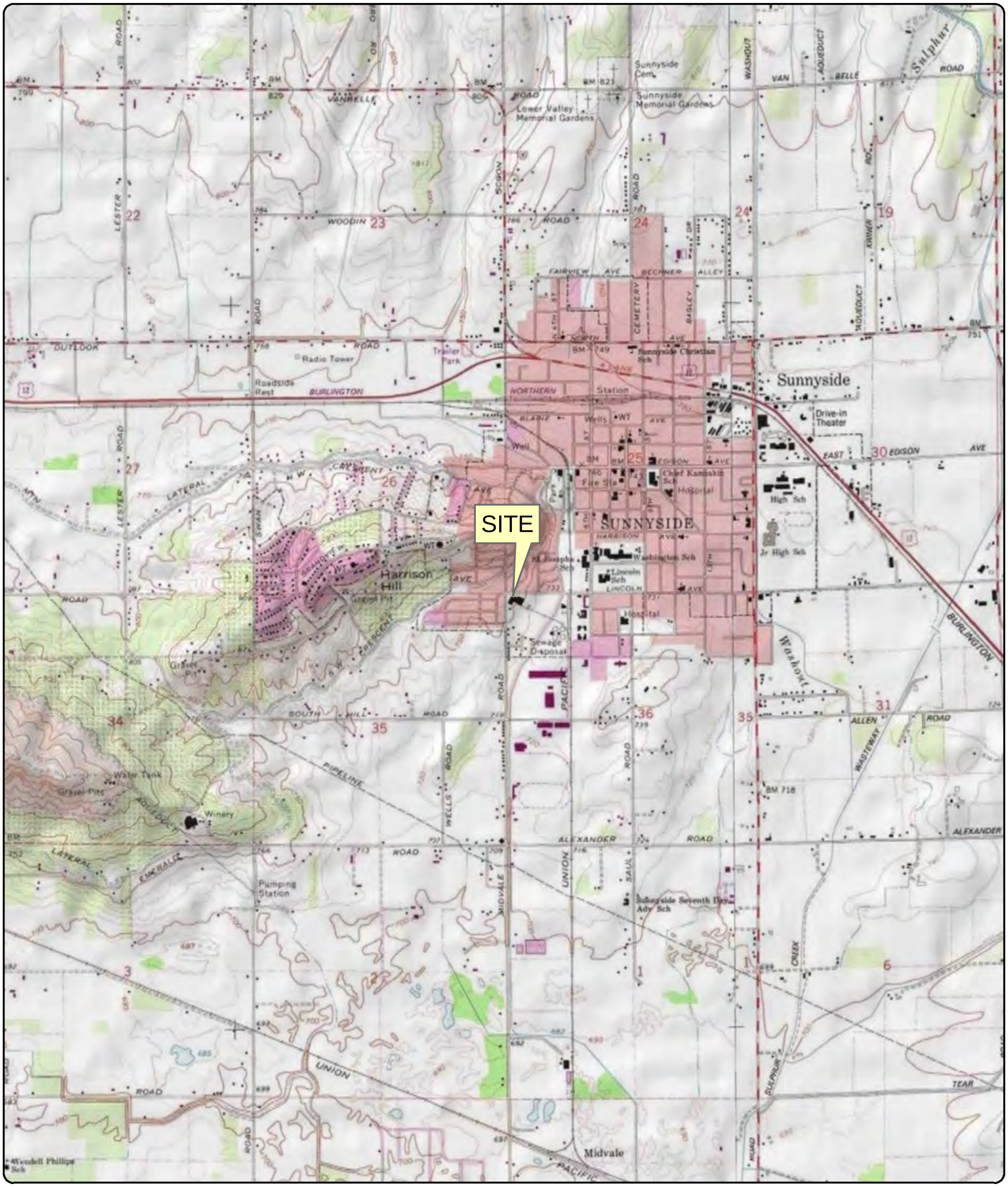
NOTES:

mg/kg = milligrams per kilogram (parts per million).

MTCA = Model Toxics Control Act.

µg/L = micrograms per liter (parts per billion).

FIGURES



Site Address: 111 E Lincoln Ave, Sunnyside, Washington
Source: US Geological Survey (1990) 7.5-minute
topographic quadrangle: Sunnyside
Section 36, Township 10 North, Range 22 East

Figure 1
Site Location

Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

0 1,500 3,000
Feet

MAUL FOSTER ALONGI
p. 971 544 2139 | www.maulfoster.com

Path: X:\0346.04\Projects\Fig1_Site Location.mxd
Print Date: 9/17/2012
Approved By: J. Pounds
Produced By: J. Schane
Project: 0346.04.02

Path: X:\0346.04\Projects\Fig2 Site Features.mxd

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Produced By: J. Schane

Project: 0346.04.02

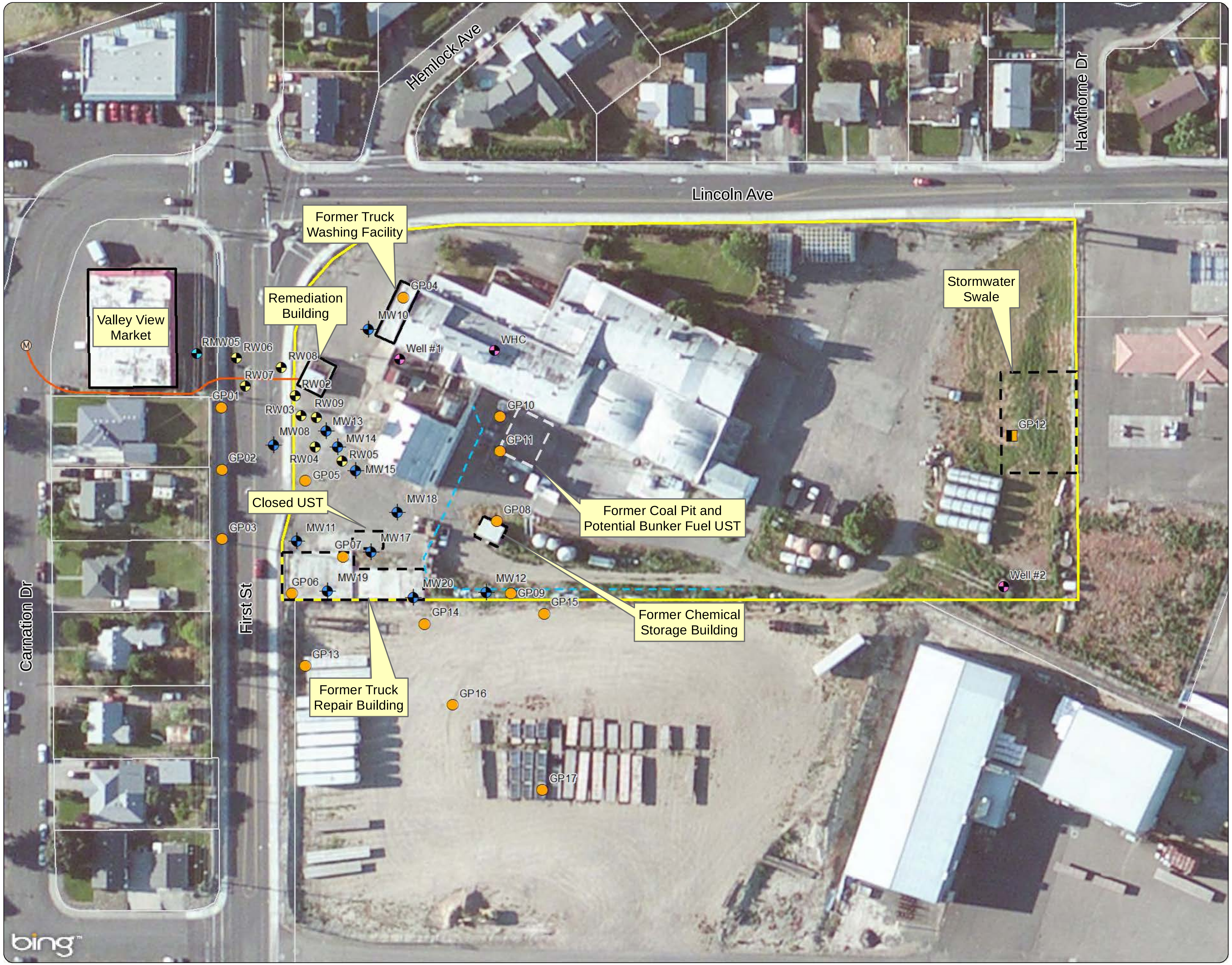

Figure 2
Site Features

Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Legend

- ● Boring Location
- ⊕ Monitoring Well
- ◑ Monitoring/Recovery Well
- ◑ Production Well
- ◑ Recovery Well
- ◧ Soil Sample Location
- Ⓜ Existing Manhole Sanitary Sewer
- --- Former Wastewater Line/ Former Open Ditch
- ~ Discharge Line from Remediation Building
- ☐ Site Boundary (Approximate)
- ☐ Tax Lots (Approximate)

Note: Sample locations were surveyed by Gray's Survey and Engineering on June 18 and 19, 2012.

0 40 80
Feet

Source: Aerial photograph obtained from ESRI, Inc. ArcGIS Online/Bing Maps

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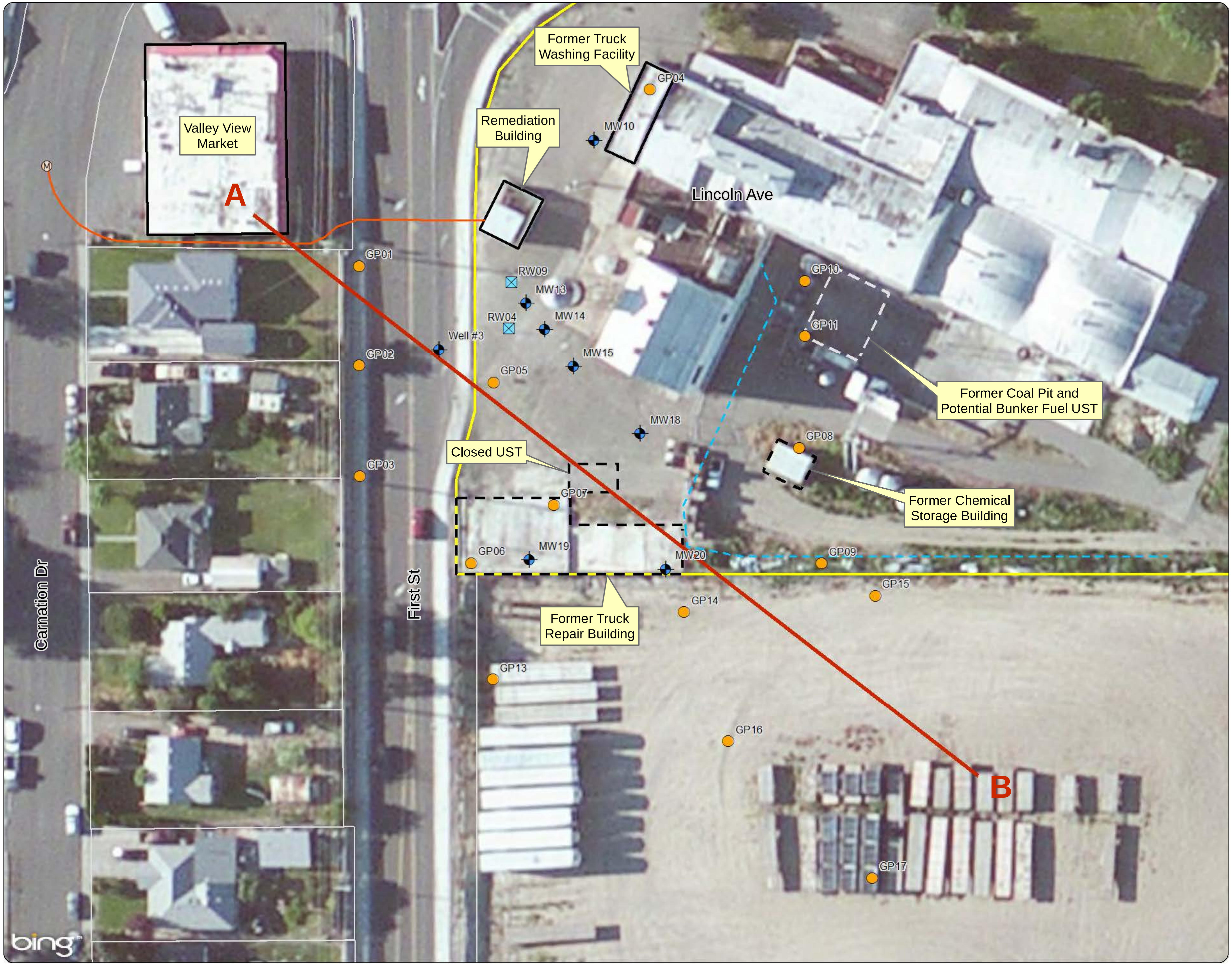

Figure 3
Cross Section Transect

Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Legend

- Cross Section A-B
- ● Boring Location
- ☒ Vault Location
- ⊕ Monitoring Well Location
- Ⓜ Existing Manhole Sanitary Sewer
- Discharge Line from Remediation Building
- Former Wastewater Line/ Former Open Ditch
- Site Boundary (Approximate)
- Tax Lots (Approximate)

Note: Sample locations were surveyed by Gray's Survey and Engineering on June 18 and 19, 2012.

0 25 50
Feet

Source: Aerial photograph obtained from ESRI, Inc. ArcGIS Online/Bing Maps

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Path: X:\0346.04\Projects\Supplemental Investigation\Fig3 Cross Section Transect.mxd

Print Date: 10/29/2012
Approved By: H. Hirsch
Produced By: J. Schane
Project: 0346.04.02

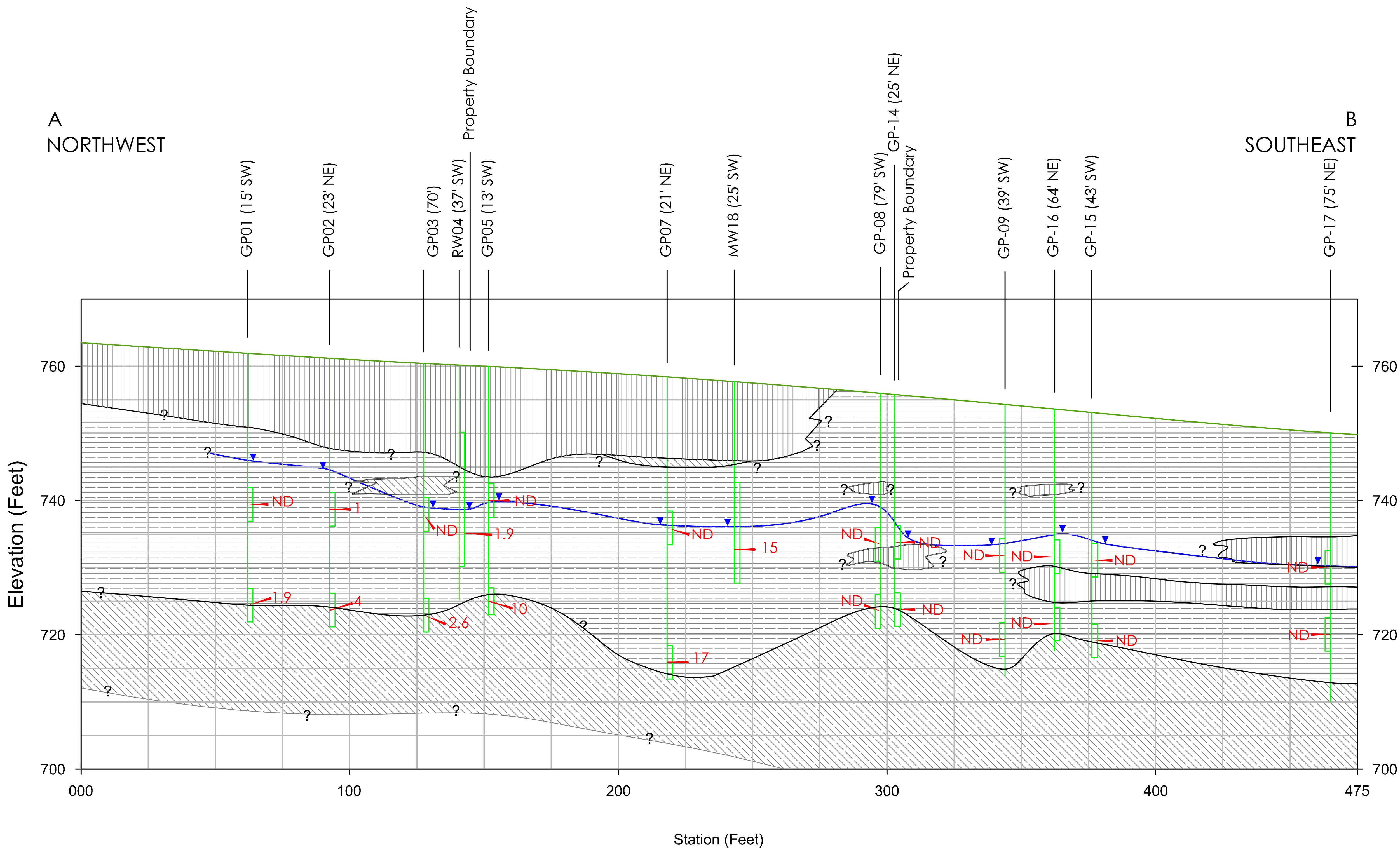
Filepath: F:\00_MFA Civil 3D\00_PROJECTS\0346.04 Port of Sunnyside\03_Carnation Dairy Supplemental Investigation\Xsect Layout-2012.08.01.dwg

Printed by: Jamie Fisher

Date: 9/19/2012 10:43:24 AM

Figure 4
Cross Section A-B

Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington



PROFILE VIEW OF SECTION A-B
HORIZONTAL SCALE: 1" = 40'   VERTICAL SCALE: 1" = 16'
VERTICAL EXAGGERATION: 2.5

LEGEND:

GP01 (15' S) Sample Location Projected in Feet Northeast (NE) or Southwest (SW) to the Transect

Blank Casing

Screened Interval

Sample Taken

15 Tetrachloroethene Concentrations in Micrograms per Liter (μg/L)

Ground Surface (Feet)

▼ Water Level Elevation (feet)

? Inferred Geologic Contact

▥ ML: silt

☰ SP, SM, and MLS: interbedded silty sands and sandy silts

▨ ML-OL: dense silts and clays

0 40' 80'
SCALE IN FEET
VERTICAL EXAGGERATION 2.5X

NOTES:
1. Surface elevation digitized from U.S.G.S. National Elevation Dataset.
2. Groundwater elevations are approximate based on observations during drilling.
3. ND = Non-detect.

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Path: X:\0346.04\06\02 Groundwater Remedy Pilot Study\Projects\Remedial Action Plan\Fig5_Groundwater PCE Results.mxd

Print Date: 6/28/2013 Approved By: J. Pounds Produced By: J. Schane Project: 0346.04.02

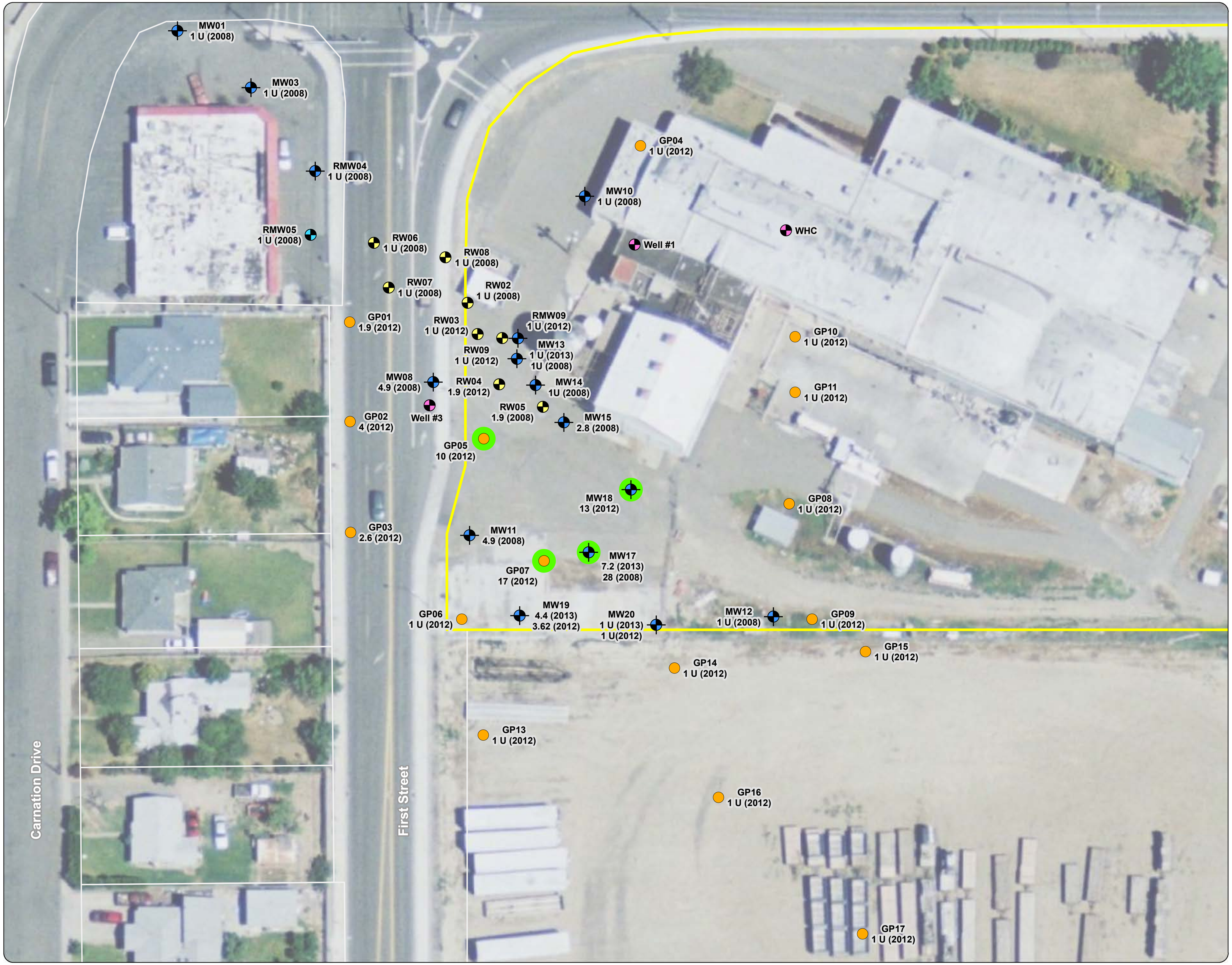

Figure 5
Groundwater PCE Results

Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Legend

●	Boring
⊕	Monitoring Well
◐	Recovery Well
◐	Monitoring/Recovery Well
◐	Production Well
●	Exceedance (PCE >5 µg/L)
GP15	Sample ID
1 U (2012)	PCE Concentration in µg/L & (Sample Year)
☐	Site Boundary (Approximate)
☐	Tax Lots (Approximate)

Notes:
1. Sample locations were surveyed by Gray's Survey and Engineering on June 18 and 19, 2012. The locations of other site features are approximate.
2. 2013 samples were collected May 29, 2013.
3. Historical data were obtained from Kennedy/ Jenks, 2009 and SoundEarth Strategies, 2011 and 2012.
3. CUL = cleanup level
4. Model Toxics Control Act Method A CUL for PCE = 5 µg/L.
5. µg/L = micrograms per liter.
6. PCE = tetrachloroethene.
7. U = Analyte was not detected at or above method reporting limit.

0 25 50
Feet

Source: Aerial photograph (June 2011) obtained from Esri ArcGIS Online

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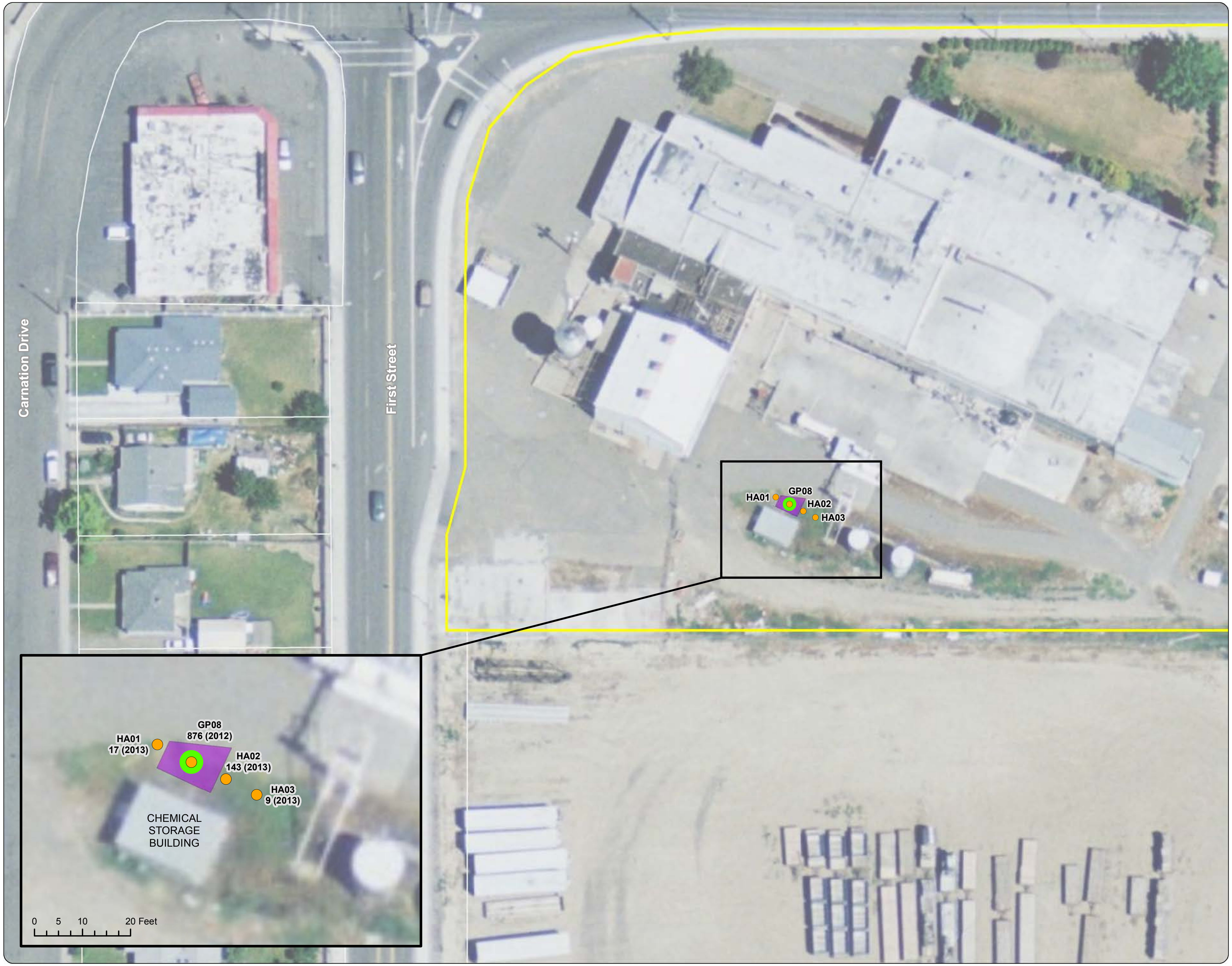

Figure 6
Preliminary Excavation Area

Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Legend

●	Sample Location
●	Exceedance (Lead >250 mg/kg)
HA01 **179 (2013)**	Sample ID Lead Concentration in mg/kg & (Sample Year)
■	Preliminary Excavation Area
☐	Site Boundary (Approximate)
☐	Tax Lots (Approximate)

Notes:
1. 2013 samples were collected May 29, 2013. Sample locations are approximate.
2. 2012 sample was collected on January 24, 2012. Sample location surveyed by Gray's Survey and Engineering on June 18-19, 2012.
3. CUL = cleanup level
4. Model Toxics Control Act Method A CUL for lead = 250 mg/kg.
5. mg/kg = milligrams per kilogram.
6. Extent of preliminary excavation are is approximate.

0 25 50
Feet

Source: Aerial photograph (June 2011) obtained from Esri ArcGIS Online

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Project: 0346.04.02 Produced By: J. Schane Approved By: J. Pounds Print Date: 7/2/2013 Path: X:\0346.04\06\02 Groundwater Remedy Pilot Study\Projects\Remedial Action Plan\Fig6_Preliminary Excavation Area.mxd

APPENDIX A

BORING AND MONITORING WELL LOGS

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP01**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/26/2012 to 1/26/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**40.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
									0.0 to 0.4 feet: CONCRETE.
1				**GRAB**		**GP01-S-1.0**			0.4 to 1.5 feet: SILTY SAND WITH GRAVEL (SM); dark brown; 40% fines, non-plastic; 50% sand; 10% gravel, sub-angular; dry.
2									1.5 to 11.0 feet: SILT (ML); dark brown; 100% fines, dense, non-plastic; dry.
3									
4									
5				**GRAB**		**GP01-S-5.0** **PID = 3.6 ppm**			
6									
7									
8									
9									
10				**GRAB**		**GP01-S-10.0** **PID = 8.6 ppm**			
11									11.0 to 11.4 feet: SAND (SP); light brown; 100% sand, loose, non-plastic; dry.
12									11.4 to 11.8 feet: SANDY SILT (MLS); dark brown; 90% fines, dense, non-plastic; 10% sand; dry.
									11.8 to 12.2 feet: SAND (SP); light brown; 100% sand, loose; non-plastic; dry.
13									12.2 to 15.5 feet: SANDY SILT (MLS); dark brown; 90% fines, soft, non-plastic; 10% sand; damp.
14									
15				**GRAB**		**GP01-S-15.0** **PID = 1.7 ppm**			
16									15.5 to 16.0 feet: SILTY SAND (SM); dark brown; 10% fines; 90% sand, loose, non-plastic; wet.
	∇								16.0 to 16.5 feet: SANDY SILT (MLS); dark brown; 90% fines, soft, low plasticity; 10% sand; wet.
17									16.5 to 18.0 feet: SILTY SAND (SM); dark brown; 20% fines, soft, non-plastic; 80% sand; wet.
18									18.0 to 20.0 feet: SANDY SILT (MLS); dark brown; 90% fines, dense, non-plastic; 10% sand; moist.
19									
20									

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP01**	**2 of 2**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
									20.0 to 22.0 feet: SANDY SILT (MLS); dark brown; 80% fines, dense, non-plastic; 20% sand; wet.
21									
22									
									22.0 to 23.5 feet: SANDY SILT (MLS); dark brown; 50% fines, soft; 50% sand; wet.
23				**GW**		**GP01-W-22.5**			
									23.5 to 24.4 feet: SANDY SILT (MLS); dark brown; 90% fines, soft, low plasticity; 10% sand; wet.
24									
									24.4 to 25.0 feet: SANDY SILT (MLS); dark brown; 60% fines, dense, non-plastic; 40% sand; dry.
25									
						PID = 3.2 ppm			25.0 to 29.5 feet: SANDY SILT (MLS); dark brown; 60% fines, soft, low plasticity; 40% sand; wet.
26									
27									
28									
29									
									29.5 to 31.0 feet: SANDY SILT (MLS); dark brown; 80% fines, dense, non-plastic; 20% sand; wet.
30									
31									
									31.0 to 32.5 feet: SANDY SILT (MLS); dark brown; 90% fines, soft; 10% sand; wet.
32									
									32.5 to 33.0 feet: SANDY SILTY CLAY (OL); dark brown; 90% fines, dense, low plasticity; 10% sand; moist.
33									
									33.0 to 36.0 feet: SANDY SILT; dark brown; 90% fines, dense, non-plastic; 10% sand.
34									
35									
36									
									36.0 to 37.5 feet: SANDY SILT (MLS); dark brown; 80% fines, soft, low plasticity; 20% sand; wet.
37									
38				**GW**		**GP01-W-37.5**			37.5 to 40.0 feet: SANDY CLAYEY SILT (OL); dark brown; 90% fines, very dense, low plasticity; 10% sand; dry.
39									
40									

NOTES:

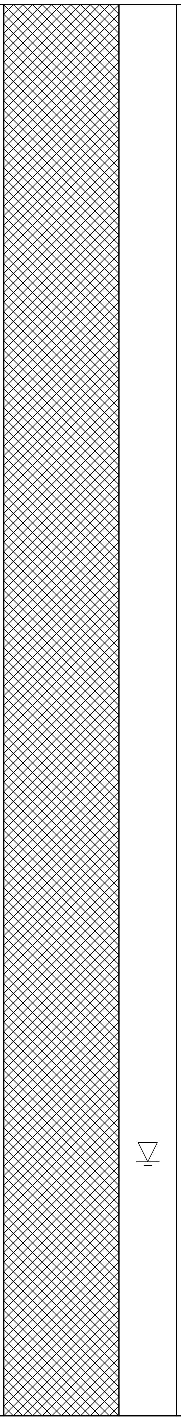
▽ **Water level depth at time of drilling.**

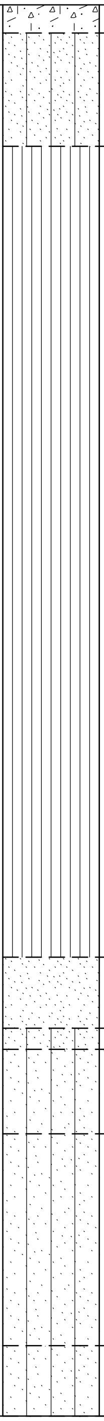
Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP02**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/26/2012 to 1/26/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**40.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**





Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0									0.0 to 0.4 feet: CONCRETE.
0.4									0.4 to 2.0 feet: SILTY SAND WITH GRAVEL (SM); gray brown; 40% fines, non-plastic; 50% sand; 10% gravel, sub-angular; dry.
1.5				**GRAB**		**GP02-S-5.0** **PID = 1.6 ppm**			
2									2.0 to 13.5 feet: SANDY SILT (MLS); dark brown; 90% fines, dense, non-plastic; 10% sand; dry.
5.5				**GRAB**		**GP02-S-5.0** **PID = 0.5 ppm**			
10.5				**GRAB**		**GP02-S-10.0** **PID = 0.7 ppm**			
13.5									13.5 to 14.5 feet: SANDY SILT (MLS); dark brown; 90% fines, dense, non-plastic; 10% sand; moist.
14.5									14.5 to 14.8 feet: SILTY SAND (SM); dark brown; 40% fines, dense, non-plastic; 60% sand; dry.
14.8									14.8 to 16.0 feet: SANDY SILT (MLS); dark brown; 80% fines, dense, non-plastic; 20% sand; dry.
15.5				**GRAB**		**GP02-S-15.0** **PID = 1.2 ppm**			
16									16.0 to 19.0 feet: SANDY SILT (MLS); dark brown; 80% fines, soft, low plasticity; 20% sand; wet.
16.5	∇								
19									19.0 to 20.0 feet: SANDY SILT (MLS); dark brown; 60% fines, dense, non plastic; 40% sand; moist.
20									

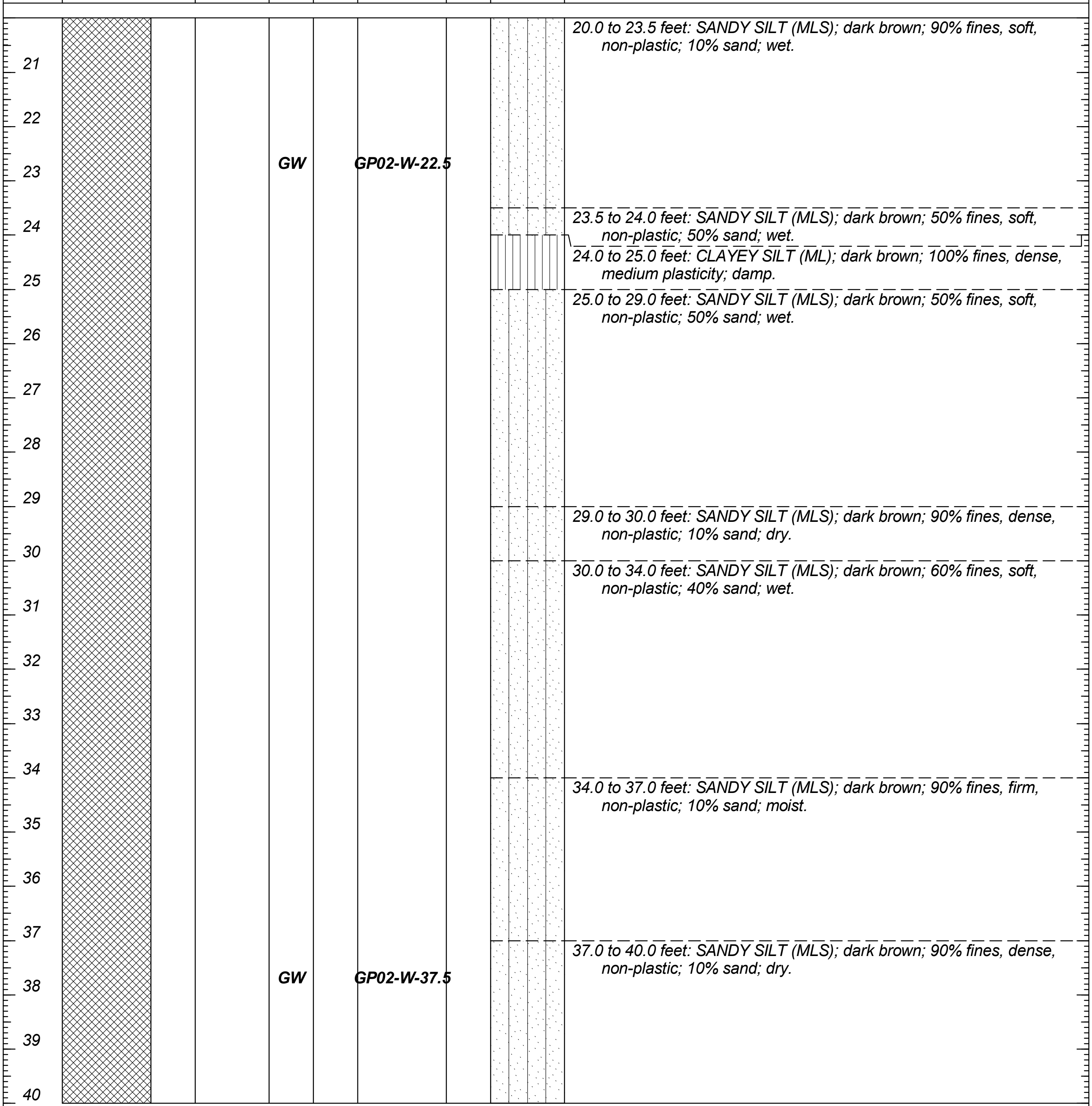
NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP02**	**2 of 2**



Depth (feet, BGS)	Collection Method	Number	Name (Type)	Soil Description
20.0–23.5	**GW**		**GP02-W-22.5**	20.0 to 23.5 feet: SANDY SILT (MLS); dark brown; 90% fines, soft, non-plastic; 10% sand; wet.
23.5–24.0				23.5 to 24.0 feet: SANDY SILT (MLS); dark brown; 50% fines, soft, non-plastic; 50% sand; wet.
24.0–25.0				24.0 to 25.0 feet: CLAYEY SILT (ML); dark brown; 100% fines, dense, medium plasticity; damp.
25.0–29.0				25.0 to 29.0 feet: SANDY SILT (MLS); dark brown; 50% fines, soft, non-plastic; 50% sand; wet.
29.0–30.0				29.0 to 30.0 feet: SANDY SILT (MLS); dark brown; 90% fines, dense, non-plastic; 10% sand; dry.
30.0–34.0				30.0 to 34.0 feet: SANDY SILT (MLS); dark brown; 60% fines, soft, non-plastic; 40% sand; wet.
34.0–37.0				34.0 to 37.0 feet: SANDY SILT (MLS); dark brown; 90% fines, firm, non-plastic; 10% sand; moist.
37.0–40.0	**GW**		**GP02-W-37.5**	37.0 to 40.0 feet: SANDY SILT (MLS); dark brown; 90% fines, dense, non-plastic; 10% sand; dry.

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	GP03	1 of 2

Project Name	Former Cream Wine Property	TOC Elevation (feet)	
Project Location	111 East Lincoln Ave, Sunnyside, Washington	Surface Elevation (feet)	
Start/End Date	1/26/2012 to 1/26/2012	Northing	
Driller/Equipment	Tyler Day, Cascade Drilling L.P./6600 Geoprobe	Easting	
Geologist/Engineer	J. Pounds	Hole Depth	40.0-feet
Sample Method		Outer Hole Diam	2.25-inch

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
									0.0 to 0.3 feet: CONCRETE. 0.3 to 1.0 feet: SILTY SAND WITH GRAVEL (SM); gray brown; 40% fines, non-plastic; 50% sand; 10% gravel, sub-angular; dry.
1				GRAB		GP03-S-1.0 PID = 0.6 ppm			1.0 to 13.0 feet: SANDY SILT (MLS); dark brown; 90% fines, dense, non-plastic; 10% sand; dry.
2									
3									
4									
5				GRAB		GP03-S-5.0 PID = 0.5 ppm			
6									
7									
8									
9									
10				GRAB		GP03-S-10.0 PID = 0.6 ppm			
11									
12									
13									13.0 to 13.3 feet: SILTY SAND (SM); light brown; 10% fines, non-plastic; soft; 90% sand; dry. 13.3 to 14.0 feet: SANDY SILT (MLS); dark brown; 90% fines, firm, non-plastic; 10% sand; dry.
14									14.0 to 16.5 feet: SILTY SAND (SM); dark brown; 50% fines, non-plastic, firm; 50% sand; dry.
15				GRAB		GP03-S-15.0 PID = 0.9 ppm			
16									
17									16.5 to 16.8 feet: SILTY SAND (SM); light brown; 10% fines, soft, non-plastic; 90% sand; dry. 16.8 to 19.5 feet: CLAYEY SILT (OL); dark brown; 100% fines, very dense, medium plasticity; dry.
18									
19									
20									19.5 to 20.0 feet: SANDY SILT (MLS); dark brown; 60% fines, dense,

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP03***	*Sheet* ***2 of 2***

Depth (feet, BGS)	*Well Details*	*Sample Data*						*Lithologic Column*	*Soil Description*
		Interval	*Percent Recovery*	*Collection Method*	*Number*	*Name (Type)*	*Blows/6"*		
									non-plastic, 40% sand; dry.
21									*20.0 to 21.5 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, non-plastic; 20% sand; damp.*
22	∇								*21.5 to 24.0 feet: SANDY SILT (MLS); dark brown; 60% fines, low plasticity, firm; 40% sand; wet.*
23				***GW***		***GP03-W-22.5***			
24									*24.0 to 26.0 feet: SILTY SAND (SM); dark brown; 40% fines, soft, low plasticity; 60% sand; wet.*
25						***PID = 0.9 ppm***			
26									*26.0 to 28.5 feet: SANDY SILT (MLS); dark brown; 90% fines, soft, low plasticity; 10% sand; wet.*
27									
28									
29									*28.5 to 31.5 feet: SILTY SAND (SM); dark brown; 40% fines, soft, non-plastic; 60% sand; wet.*
30									
31									
32									*31.5 to 33.5 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, medium plasticity; 20% sand; damp.*
33									
34									*33.5 to 34.0 feet: SILTY SAND (SM); dark brown; 40% fines, soft, non-plastic; 60% sand; wet.* *34.0 to 35.0 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, low plasticity; 20% sand; damp.*
35									*35.0 to 37.0 feet: SANDY SILT (MLS); dark brown; 50% fines, soft, non-plastic; 50% sand; wet.*
36									
37									*37.0 to 38.5 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, low plasticity; 20% sand; wet.*
38				***GW***		***GP03-W-37.5***			
39									*38.5 to 40.0 feet: SANDY SILT (MLS); dark brown; 90% fines, very firm, non-plastic; 10% sand; damp.*
40									

NOTES:

∇ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.	Project Number	Well Number	Sheet
	0346.04.02	**GP04**	**1 of 2**

Geologic Borehole Log/Well Construction

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/25/2012 to 1/25/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**40.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0.0									0.0 to 0.4 feet: CONCRETE.
0.4									0.4 to 12.0 feet: SANDY SILT (MLS); dark brown; 90% fines, non-plastic; 10% sand; dry.
1.0				**GRAB**		**GP04-S-1.0** **PID = 3.4 ppm**			
5.0				**GRAB**		**GP04-S-5.0** **PID = 5.2 ppm**			
10.0				**GRAB**		**GP04-S-10.0** **PID = 3.2 ppm**			
12.0									12.0 to 13.0 feet: SANDY SILT (MLS); dark brown; 80% fines, non-plastic; 20% sand; dry.
13.0									13.0 to 14.5 feet: CLAYEY SILT (CL-ML); dark brown; 100% fines, medium plasticity, soft; moist.
14.5									14.5 to 16.0 feet: SANDY SILT (MLS); dark brown; 80% fines, non-plastic, firm; 20% sand; dry.
15.0				**GRAB**		**GP04-S-15.0**			
16.0	▽								16.0 to 18.0 feet: SANDY SILT (MLS); dark brown; 50% fines, non plastic, soft; 50% sand; wet.
18.0									18.0 to 21.0 feet: SANDY SILT (MLS); dark brown; 80% fines, non plastic, firm; 20% sand; moist.
20									

NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP04**	**2 of 2**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21									21.0 to 22.0 feet: SILTY SAND (SM); dark brown; 40% fines, non-plastic, soft; 60% sand; wet.
22									22.0 to 25.0 feet: SANDY SILT (MLS); dark brown; 50% fines, non-plastic, firm; 50% sand; wet.
23				**GW**		**GP04-W-22.5**			
24									
25									25.0 to 29.0 feet: SANDY SILT (MLS); dark brown; 70% fines, non-plastic, soft; 30% sand; wet.
26									
27									
28									
29									29.0 to 30.0 feet: SANDY SILT (MLS); dark brown; 70% fines, non-plastic, firm; 30% sand; moist.
30									30.0 to 31.0 feet: SANDY SILT (MLS); dark brown; 70% fines, non-plastic, soft; 30% sand; wet.
31									31.0 to 34.0 feet: SANDY SILT (MLS); dark brown; 90% fines, non-plastic, firm; 10% sand; moist.
32									
33									
34									34.0 to 35.0 feet: SANDY SILT (MLS); dark brown; 70% fines, low plasticity, soft; 30% sand; wet.
35									35.0 to 37.0 feet: SANDY SILT (MLS); dark brown; 70% fines, low plasticity, very stiff; 30% sand; wet.
36									
37									37.0 to 40.0 feet: SANDY SILT (MLS); dark brown; 90% fines, low plasticity, hard; 10% sand; wet.
38				**GW**		**GP04-W-37.5**			
39									
40									

NOTES:

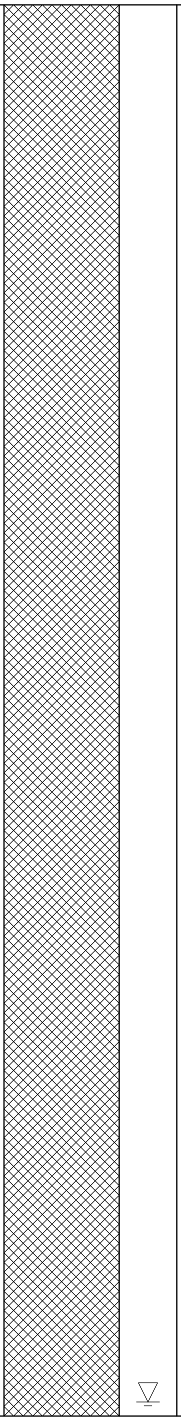
▽ **Water level depth at time of drilling.**

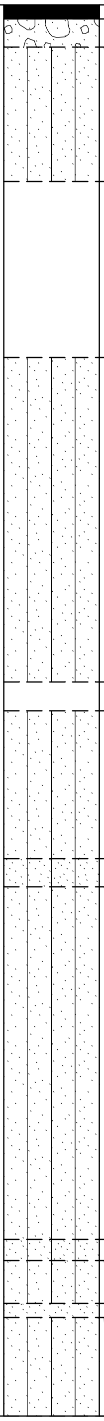
Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP05**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/24/2012 to 1/24/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**37.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**





Depth (feet, BGS)	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"
1			**GRAB**		**GP05-S-1.0** **PID = 0.4 ppm**	
5			**GRAB**		**GP05-S-5.0** **PID = 1.2 ppm**	
10			**GRAB**		**GP05-S-10.0** **PID = 0.9 ppm**	
15			**GRAB**		**GP05-S-15.0** **PID = 0.6 ppm**	

Soil Description

0.0 to 0.2 feet: ASPHALT.

0.2 to 0.6 feet: SILTY SANDY GRAVEL (GPS); greyish brown; 20% fines; 30% sand, fine to medium; 50% gravel, sub-angular; dry.

0.6 to 2.5 feet: SANDY SILT (MLS); brown; 60% fines, soft, non-plastic; 40% sand, fine; dry.

2.5 to 5.0 feet: NO RECOVERY.

5.0 to 9.6 feet: SANDY SILT (MLS); brown; 80% fine, non-plastic, stiff; 20% sand, fine; dry.

9.6 to 10.0 feet: NO RECOVERY.

10.0 to 12.1 feet: SANDY SILT (MLS); brown; 80% fine, non-plastic, stiff; 20% sand, fine; dry.

12.1 to 12.5 feet: SILTY SAND (SM); brown; 20% fine, soft; 80% sand, fine to medium; dry.

12.5 to 17.5 feet: SANDY SILT (MLS); brown; 90% fine, stiff, non-plastic; 10% sand, fine; dry.

17.5 to 17.8 feet: SILTY SAND (SM); brown; 40% fine, soft; 60% sand, fine; damp.

17.8 to 18.4 feet: SANDY SILT (MLS); brown; damp.

18.4 to 18.6 feet: SAND (SP); black and multi-colored; 100% sand, medium to coarse; wet.

18.6 to 20.0 feet: SANDY SILT (MLS); dark brown; 80% fine, stiff, low plasticity; 20% sand, fine; damp.

NOTES:

▽ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP05**	**2 of 2**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
				GW		**GP05-W-20.0**			20.0 to 25.0 feet: SANDY SILT (MLS); dark brown; 80% fines, stiff, low plasticity; 20% sand, fine; wet.
21									
22									
23									
24									
25									25.0 to 34.0 feet: SANDY SILT (MLS); dark brown; 60% fines, non-plastic, soft; 40% sand; wet.
26									
27									
28									
29									
30									
31									
32									
33									
34									34.0 to 37.0 feet: SILT (ML); dark brown; 100% fines, stiff; damp.
35				**GW**		**GP05-W-35.0**			
36									
37									

NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP06**	**1 of 3**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/24/2012 to 1/24/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**45.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column
1				**GRAB**		**GP06-S-1.0** **PID = 0.8 ppm**		
5				**GRAB**		**GP06-S-5.0** **PID = 1.4 ppm**		
10				**GRAB**		**GP06-S-10.0** **PID = 0.4 ppm**		
15				**GRAB**		**GP06-S-15.0** **PID = 0.3 ppm**		

Soil Description

0.0 to 0.3 feet: CONCRETE.

0.3 to 0.6 feet: SANDY SILTY GRAVEL (GM); gray; 40% fines; 10% sand; 50% gravel, sub-angular; dry.

0.6 to 3.0 feet: SANDY SILT (MLS); brown; non-plastic; stiff; dry.

3.0 to 11.1 feet: SILT (ML); dark brown; 100% fines; non-plastic; stiff; dry.

11.1 to 11.5 feet: SAND (SP); brown; 20% fines; 80% sand, fine to medium; dry.

11.5 to 12.5 feet: SANDY SILT (MLS); brown; 80% fines; stiff, non-plastic; 20% sand, fine; dry.

12.5 to 12.8 feet: SAND (SP); brown; 20% fines; 80% sand, fine to medium; dry.

12.8 to 14.8 feet: SANDY SILT (MLS); brown; 80% fines; stiff, non-plastic; 20% sand, fine; dry.

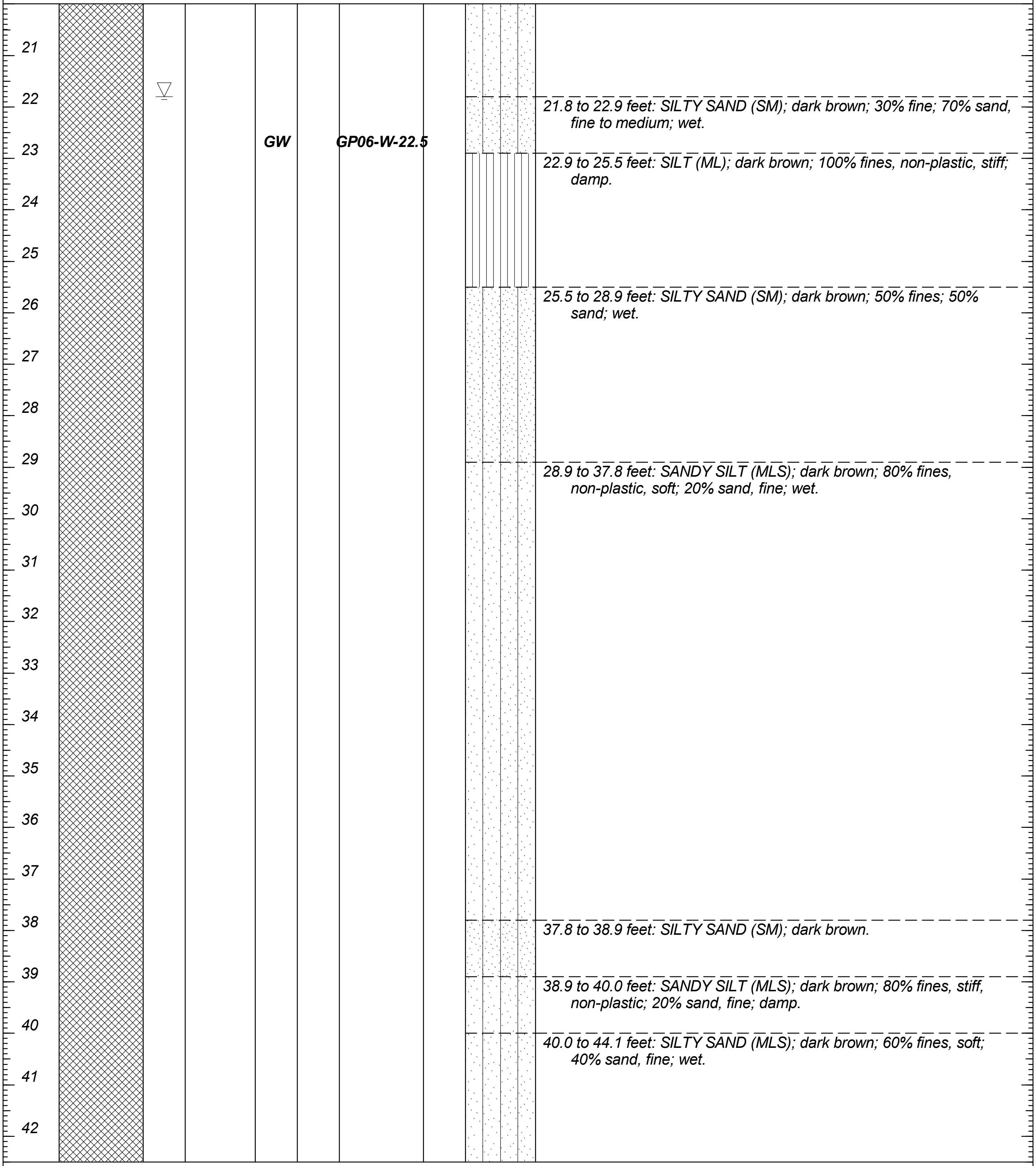
14.8 to 15.0 feet: NO RECOVERY.

15.0 to 21.8 feet: SANDY SILT (MLS); dark brown; 90% fines, non-plastic, stiff; 10% sand, fine; damp.

NOTES:

▽ **Water level depth at time of drilling.**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description



21.8 to 22.9 feet: SILTY SAND (SM); dark brown; 30% fine; 70% sand, fine to medium; wet.

22.9 to 25.5 feet: SILT (ML); dark brown; 100% fines, non-plastic, stiff; damp.

25.5 to 28.9 feet: SILTY SAND (SM); dark brown; 50% fines; 50% sand; wet.

28.9 to 37.8 feet: SANDY SILT (MLS); dark brown; 80% fines, non-plastic, soft; 20% sand, fine; wet.

37.8 to 38.9 feet: SILTY SAND (SM); dark brown.

38.9 to 40.0 feet: SANDY SILT (MLS); dark brown; 80% fines, stiff, non-plastic; 20% sand, fine; damp.

40.0 to 44.1 feet: SILTY SAND (MLS); dark brown; 60% fines, soft; 40% sand, fine; wet.

NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP06**	**3 of 3**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Sample Data: Percent Recovery	Sample Data: Collection Method	Sample Data: Number	Sample Data: Name (Type)	Sample Data: Blows/6"	Lithologic Column	Soil Description
43	▨			**GW**		**GP06-W-42.5**			
44	▨								44.1 to 45.0 feet: CLAY/SILT (OL); dark brown; 100% fines, medium plasticity; damp.
45	▨								

NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP07***	*Sheet* ***1 of 3***

Project Name	***Former Cream Wine Property***	*TOC Elevation (feet)*	
Project Location	***111 East Lincoln Ave, Sunnyside, Washington***	*Surface Elevation (feet)*	
Start/End Date	***1/23/2012 to 1/23/2012***	*Northing*	
Driller/Equipment	***Tyler Day, Cascade Drilling L.P./6600 Geoprobe***	*Easting*	
Geologist/Engineer	***J. Pounds***	*Hole Depth*	***45.0-feet***
Sample Method		*Outer Hole Diam*	***2.25-inch***

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column
1				**GRAB**		**GP07-S-1.0** **PID = 0.6 ppm**		
5				**GRAB**		**GP07-S-5.0** **PID = 0.7 ppm**		
10				**GRAB**		**GP07-S-10.0** **PID = 1.1 ppm**		
15				**GRAB**		**GP07-S-15.0** **PID = 0.8 ppm**		

Soil Description

0.0 to 0.4 feet: CONCRETE; grey.

0.4 to 0.9 feet: SILTY SANDY GRAVEL (GPS); dark gray; 20% fines; 30% sand; 50% gravel, fine to coarse, angular; dry.

0.9 to 3.2 feet: SANDY SILT (MLS); dark brown; soft, non-plastic; dry.

3.2 to 10.7 feet: SILT (ML); dark brown; 100% fines, non-plastic, soft; dry.

10.7 to 11.2 feet: SANDY SILT (MLS); brown; 70% fines, non-plastic; 30% sand, fine, soft; dry.

11.2 to 11.9 feet: SANDY SILT (MLS); brown; 90% fines, stiff, non-plastic; 10% sand, dry.

11.9 to 12.1 feet: SILTY SAND (SP); 10% fines; 90% sand; dry.

12.1 to 14.2 feet: CLAY (CL); brown; 100% fines, stiff, medium toughness; medium plasticity.

14.2 to 14.4 feet: SAND (SP); 100% sand.

14.4 to 15.0 feet: SILT (ML); brown, stiff; dry.

15.0 to 16.9 feet: SANDY SILT (MLS); brown; 70% fines, stiff; 30% sand, fine.

16.9 to 21.2 feet: SANDY SILT (MLS); brown; 90% fines, stiff; 10% sand; damp.

NOTES:

▽ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0346.04.02**	Well Number **GP07**	Sheet **2 of 3**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21	∇								
22									21.2 to 33.7 feet: SANDY SILT (MLS); brown; 60% fines; 40% sand, fine; wet.
23				**GW**		**GP07-W-22.5**			
24									
25									
26									
27									
28									
29									
30									
31									
32									
33									
34									33.7 to 37.8 feet: SILTY SAND (SP); brown; 40% fines, soft; 60% sand, fine to medium; wet.
35									
36									
37									
38									37.8 to 40.8 feet: SANDY SILT (MLS); brown; 70% fine, soft, low plasticity; 30% sand, wet.
39									
40									
41									40.8 to 41.9 feet: SAND (SP); gray; 100% sand, fine to medium; wet.
42									41.9 to 44.0 feet: SANDY SILT (MLS); brown; 70% fines, stiff; 30% sand, fine.

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number **0346.04.02**	Well Number **GP07**	Sheet **3 of 3**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Sample Data: Percent Recovery	Sample Data: Collection Method	Sample Data: Number	Sample Data: Name (Type)	Sample Data: Blows/6"	Lithologic Column	Soil Description
43	▨			**GW**		**GP07-W-42.5**			
44	▨								44.0 to 45.0 feet: SILT/CLAY (OL); brown; 90% fines, very stiff, medium plasticity; damp.
45									

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number **0346.04.02**	Well Number **GP08**	Sheet **1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/24/2012 to 1/24/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**35.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0									0.0 to 0.4 feet: SILTY SAND (SM); dark brown; 50% fines, loose; 50% sand, organics; dry.
0.4									0.4 to 2.2 feet: SILTY SAND (SM); dark brown; 40% fines; 60% sand, fine to medium; dry.
1				**GRAB**		**GP08-S-1.0** **PID = 1.2 ppm**			
2.2									2.2 to 2.4 feet: BRICK; red.
2.4									2.4 to 5.0 feet: NO RECOVERY.
5				**GRAB**		**GP08-S-5.0** **PID = 0.7 ppm**			5.0 to 13.1 feet: SANDY SILT (MLS); dark brown; 80% fines, non-plastic, soft; 20% sand, fine to medium; dry.
10				**GRAB**		**GP08-S-10.0** **PID = 0.4 ppm**			
13.1									13.1 to 15.0 feet: SILT (ML); dark brown; 100% fines, stiff.
15				**GRAB**		**GP08-S-15.0** **PID = 0.3 ppm**			15.0 to 23.0 feet: SANDY SILT (MLS); dark brown; 80% fines; 20% sand, fine to medium; wet.
16	▽								
20									

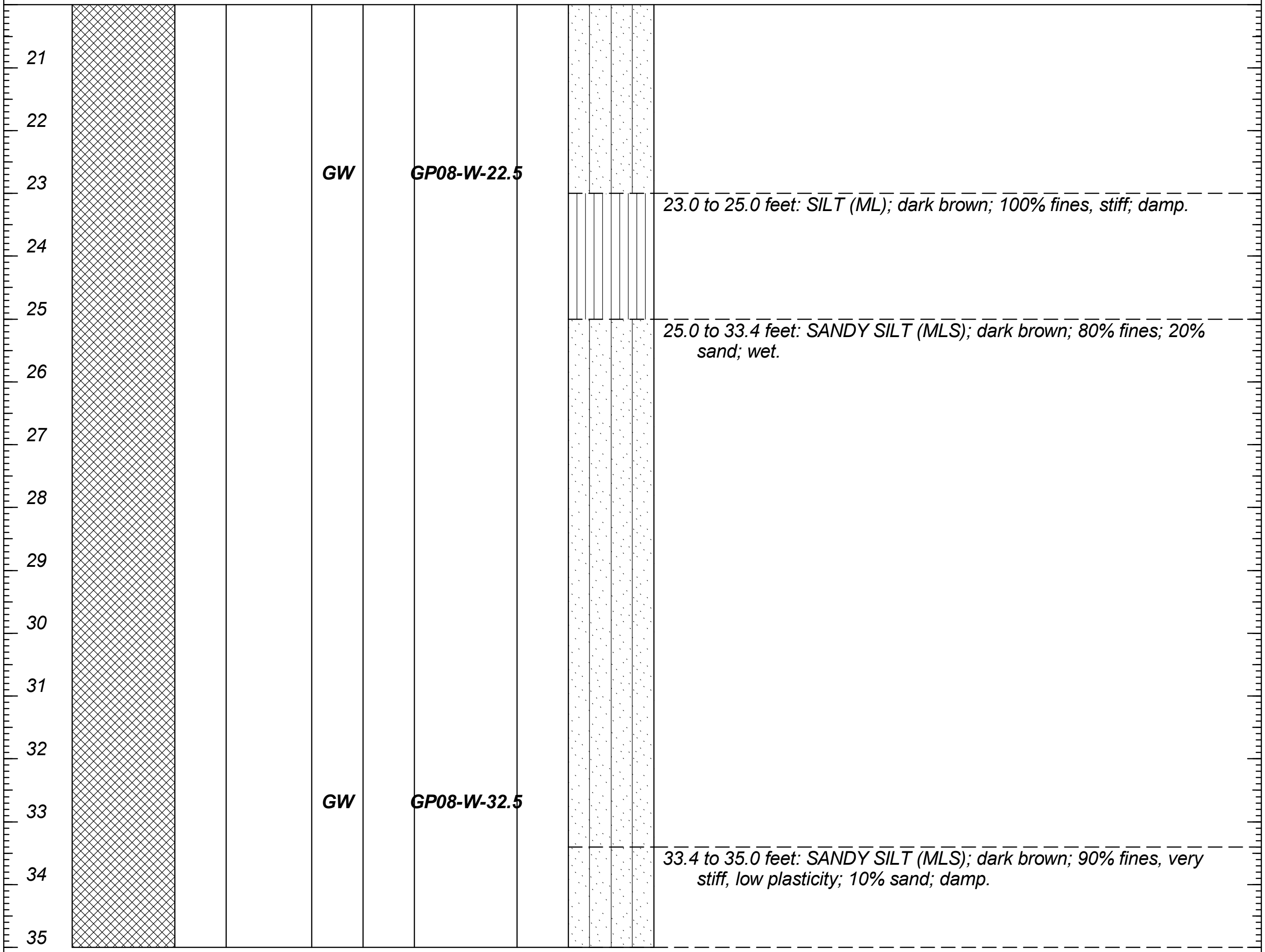
NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP08**	**2 of 2**



Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21									
22									
23				**GW**		**GP08-W-22.5**			23.0 to 25.0 feet: SILT (ML); dark brown; 100% fines, stiff; damp.
24									
25									25.0 to 33.4 feet: SANDY SILT (MLS); dark brown; 80% fines; 20% sand; wet.
26									
27									
28									
29									
30									
31									
32									
33				**GW**		**GP08-W-32.5**			33.4 to 35.0 feet: SANDY SILT (MLS); dark brown; 90% fines, very stiff, low plasticity; 10% sand; damp.
34									
35									

NOTES:

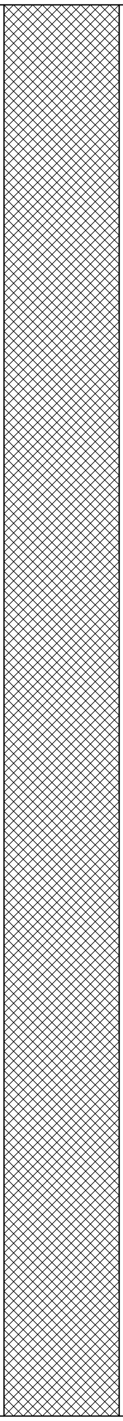
∇ **Water level depth at time of drilling.**

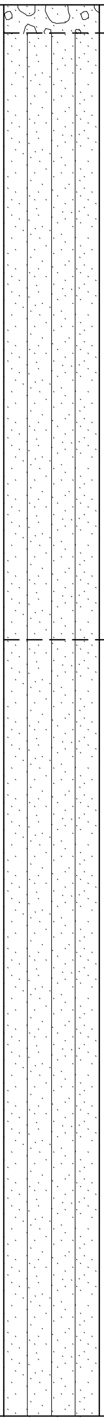
Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP09**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/25/2012 to 1/25/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**40.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**





Depth (feet, BGS)	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
0							0.0 to 0.4 feet: SILTY SANDY GRAVEL (GPS); dark brown; 20% fines, 30% sand, 50% gravel; dry.
0.4							0.4 to 9.0 feet: SANDY SILT (MLS); light brown; 80% fines, non-plastic, soft; 20% sand, fine; dry.
1			**GRAB**		**GP09-S-1.0** **PID = 0.5 ppm**		
5			**GRAB**		**GP09-S-5.0** **PID = 0.6 ppm**		
9							9.0 to 21.0 feet: SANDY SILT (MLS); dark brown; 80% fines, stiff, non-plastic; 20% sand, fine; dry.
10			**GRAB**		**GP09-S-10.0** **PID = 0.2 ppm**		
15			**GRAB**		**GP09-S-15.0** **PID = 0.2 ppm**		
20							

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP09***	*Sheet* ***2 of 2***

Depth (feet, BGS)	*Well Details*	*Sample Data* *Interval*	*Percent Recovery*	*Collection Method*	*Number*	*Name (Type)*	*Blows/6"*	*Lithologic Column*	*Soil Description*
21	▽								*21.0 to 25.0 feet: SANDY SILT (MLS); dark brown; 50% fines, low plasticity, soft; 50% sand, fine; wet.*
22									
23				***GW***		***GP09-W-22.5***			
24									
25									*25.0 to 29.0 feet: SANDY SILT (MLS); dark brown; 50% fines, low plasticity, soft; 50% sand, fine; wet.*
26									
27									
28									
29									*29.0 to 33.0 feet: SANDY SILT (MLS); dark brown; 50% fines, non-plastic; 50% sand; damp.*
30									
31									
32									
33				***GW***		***GP09-W-32.5***			*33.0 to 35.0 feet: SANDY SILT (MLS); dark brown; 50% fines, stiff, low plasticity; 50% sand; damp.*
34									
35									*35.0 to 39.5 feet: SANDY SILT (MLS); dark brown; 90% fines, low plasticity, soft; 10% sand; wet.*
36									
37									
38									
39									
40									*39.5 to 40.0 feet: SANDY CLAYEY SILT (CL-ML); dark brown; 90% fines, low plasticity, stiff; 10% sand; damp.*

NOTES:

▽ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP10**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/27/2012 to 1/27/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**40.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

Depth (feet, BGS)	Well Details	Sample Data						Lithologic Column	Soil Description
		Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"		
									0.0 to 0.3 feet: CONCRETE.
1									0.3 to 0.6 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, non-plastic; 20% sand; dry.
				GRAB		**GP10-S-1.0** **PID = 0.5 ppm**			0.6 to 0.7 feet: GRAVELLY SANDY SILT (MLS); red; 60% fines, firm; 20% sand; 20% gravel; dry.
2									0.7 to 1.5 feet: SANDY SILT (MLS); dark brown; 60% fines, firm, non-plastic; 40% sand; dry.
3									1.5 to 2.5 feet: SILTY SAND (SM); dark brown; 60% fines, firm, non-plastic; 40% sand; dry.
									2.5 to 5.0: NO RECOVERY.
4									
5				**GRAB**		**GP10-S-5.0** **PID = 0.4 ppm**			5.0 to 11.0 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, non-plastic; 20% sand; dry.
6									
7									
8									
9									
10				**GRAB**		**GP10-S-10.0** **PID = 0.3 ppm**			
11	▽								11.0 to 11.3 feet: SILTY SAND (SM); light brown; 20% fines, firm, non-plastic; 80% sand; moist.
12									11.3 to 11.8 feet: SANDY SILT (MLS); dark brown; 80% fines, soft, low plasticity; 20% sand; wet.
13									11.8 to 14.8 feet: SANDY SILT (MLS); dark brown; 50% fines, soft, low plasticity; 50% sand; wet.
14									
15				**GRAB**		**GP10-S-15.0** **PID = 1.2 ppm**			14.8 to 17.0 feet: SANDY SILT; dark brown; 70% fines, soft, non-plastic; 30% sand; wet.
16									
17									17.0 to 22.5 feet: SANDY SILT (MLS); dark brown; 70% fines, firm, non-plastic; 30% sand; wet.
18									
19									
20									

NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP10***	*Sheet* ***2 of 2***

Depth (feet, BGS)	Well Details	Sample Data: Interval	Sample Data: Percent Recovery	Sample Data: Collection Method	Sample Data: Number	Sample Data: Name (Type)	Sample Data: Blows/6"	Lithologic Column	Soil Description
21									
22									
23				**GW**		**GP10-W-22.5**			22.5 to 24.8 feet: SANDY SILT (MLS); dark brown; 70% fines, firm, non-plastic; 30% sand; dry.
24									
25						**PID = 0.4 ppm**			24.8 to 39.0 feet: SANDY SILT (MLS); dark brown; 70% fines, firm, non-plastic; 30% sand; wet.
26									
27									
28									
29									
30									
31									
32									
33									
34									
35									
36									
37									
38				**GW**		**GP10-W-37.5**			
39									39.0 to 40.0 feet: CLAYEY SILT (CL-ML); dark brown; 100% fines, very firm, medium plasticity; moist.
40									

NOTES:

▽ ***Water level depth at time of drilling.***

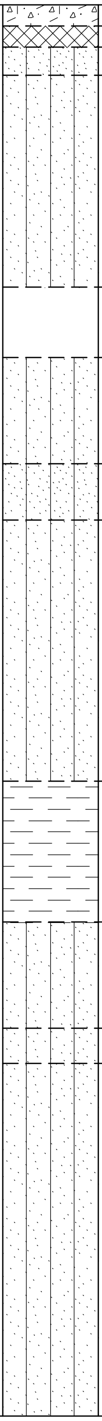
Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP11**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**1/27/2012 to 1/27/2012**	Northing	
Driller/Equipment	**Tyler Day, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**40.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0–1				**GRAB**		**GP11-S-1.0** **PID = 1.0 ppm**			0.0 to 0.3 feet: CONCRETE. 0.3 to 0.6 feet: SANDY GRAVELLY SILT (FILL); dark brown; dry. 0.6 to 1.0 feet: SILTY SAND (SM); light brown; 10% fines; 90% sand, fine; dry. 1.0 to 4.0 feet: SANDY SILT (MLS); dark brown; 90% fines, firm, non-plastic; 10% sand; dry.
4									4.0 to 5.0 feet: NO RECOVERY.
5				**GRAB**		**GP11-S-5.0** **PID = 1.8 ppm**			5.0 to 6.5 feet: SANDY SILT (MLS); dark brown; 90% fines, firm, non-plastic; 10% sand; dry.
6.5									6.5 to 7.3 feet: SILTY SAND (SM); light brown; 30% fines, firm, non-plastic; 70% sand; dry.
7.3									7.3 to 11.0 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, non-plastic; 20% sand; dry.
10				**GRAB**		**GP11-S-10.0** **PID = 1.6 ppm**			
11	▽								11.0 to 13.0 feet: CLAYEY SILT (OL); dark brown; 100% fines, firm, medium plasticity; wet.
13									13.0 to 14.5 feet: SANDY SILT (MLS); dark brown; 90% fines, firm, non-plastic; 10% sand; moist.
14.5									14.5 to 15.0 feet: SANDY SILT (MLS); dark brown; 50% fines, firm, non-plastic; 50% sand; dry.
15				**GRAB**		**GP11-S-15.0** **PID = 1.1 ppm**			15.0 to 20.5 feet: SANDY SILT (MLS); dark brown; 70% fines, soft, non-plastic; 30% sand; wet.



NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP11***	*Sheet* ***2 of 2***

Depth (feet, BGS)	*Well Details*	*Interval*	*Percent Recovery*	*Collection Method*	*Number*	*Name (Type)*	*Blows/6"*	*Lithologic Column*	*Soil Description*
21									*20.5 to 21.8 feet: CLAYEY SILT (OL); dark brown; 100% fines, soft, medium plasticity; wet.*
22									*21.8 to 24.0 feet: SILTY SAND (SM); dark brown; 20% fines, soft, non-plastic; 80% sand; wet.*
23				***GW***		***GP11-W-22.5***			
24									*24.0 to 25.0 feet: SANDY SILT (MLS); dark brown; 80% fines, firm, non-plastic; 20% sand; wet.*
25						***PID = 2.4 ppm***			*25.0 to 26.5 feet: SANDY CLAYEY SILT (CLS); dark brown; 80% fines, soft, medium plasticity; 20% sand; wet.*
26									
27									*26.5 to 32.0 feet: SANDY SILT (MLS); dark brown; 80% fines, non-plastic, firm; 20% sand; moist.*
28									
29									
30									
31									
32									*32.0 to 32.5 feet: SANDY SILT (MLS); dark brown; 80% fines, soft, non-plastic; 20% sand; wet.*
33									*32.5 to 35.5 feet: SANDY SILT (MLS); dark brown; 50% fines, firm, non-plastic; 50% sand; moist.*
34									
35									
36									*35.5 to 40.0 feet: SANDY CLAYEY SILT (CLS); dark brown; 80% fines, firm, medium plasticity; 20% sand; moist.*
37									
38				***GW***		***GP11-W-37.5***			
39									
40									

NOTES:

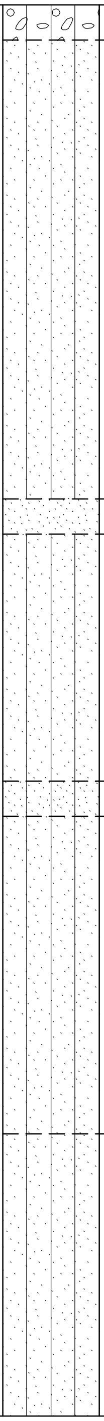
▽ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP13**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**6/18/2012 to 6/18/2012**	Northing	
Driller/Equipment	**Marc Chalona, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**29.8-feet**
Sample Method		Outer Hole Diam	**2.25-inch**



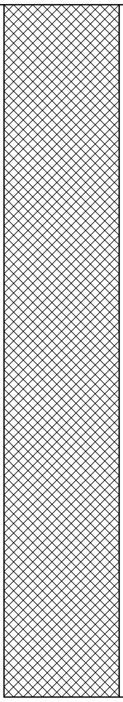
Depth (feet, BGS)	Well Details	Sample Data Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
									0.0 to 0.5 feet: SANDY SILTY GRAVEL (GM); light brown; 30% fines; 20% sand, fine to medium; 50% gravel, rounded; dry.
1									0.5 to 7.0 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
2									
3									
4									
5									
6									
7									7.0 to 7.5 feet: SAND (SP): dark brown; 100% sand, fine to medium; dry.
8									7.5 to 11.0 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
9									
10									
11									11.0 to 11.5 feet: SILTY SAND (SM); dark brown; 10% fine, 90% sand, fine; dry.
12				**GRAB**		**GP13-S-12.0**			11.5 to 16.0 feet: SANDY SILT (MLS); dark brown; 90% fine, non-plastic, medium stiff; 10% sand, medium; dry.
13									
14									
15									
16	∇								16.0 to 21.2 feet: SANDY SILT (MLS); dark brown; 90% fine, non-plastic, medium stiff; 10% sand, medium; wet.
17									
18									
19									
20									

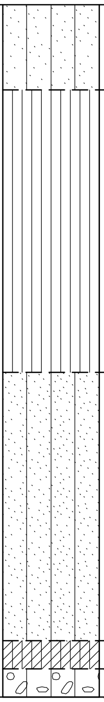
NOTES:

∇ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP13***	*Sheet* ***2 of 2***

Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
21				**GW**		**GP13-W-21.0**			*21.2 to 25.2 feet: SILT (ML); dark brown; 100% fines, stiff; damp.*
22									
23									
24									
25									*25.2 to 29.0 feet: SILTY SAND (SM); dark brown; 30% fines; 70% sand, fine to medium; wet.*
26									
27									
28									
29				**GW**		**GP13-W-29.0**			*29.0 to 29.4 feet: SILTY CLAY (CL-ML); dark brown; 100% fines, stiff; damp.* *29.4 to 29.8 feet: SILTY GRAVEL (GM); dark brown; 40% fines; 60% gravel, 3/4 to 1 inch gravel, rounded, packed; damp.*





NOTES:

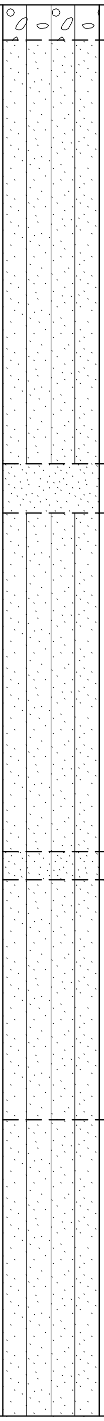
∇ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP14**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**6/18/2012 to 6/18/2012**	Northing	
Driller/Equipment	**Marc Chalona, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**34.5-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

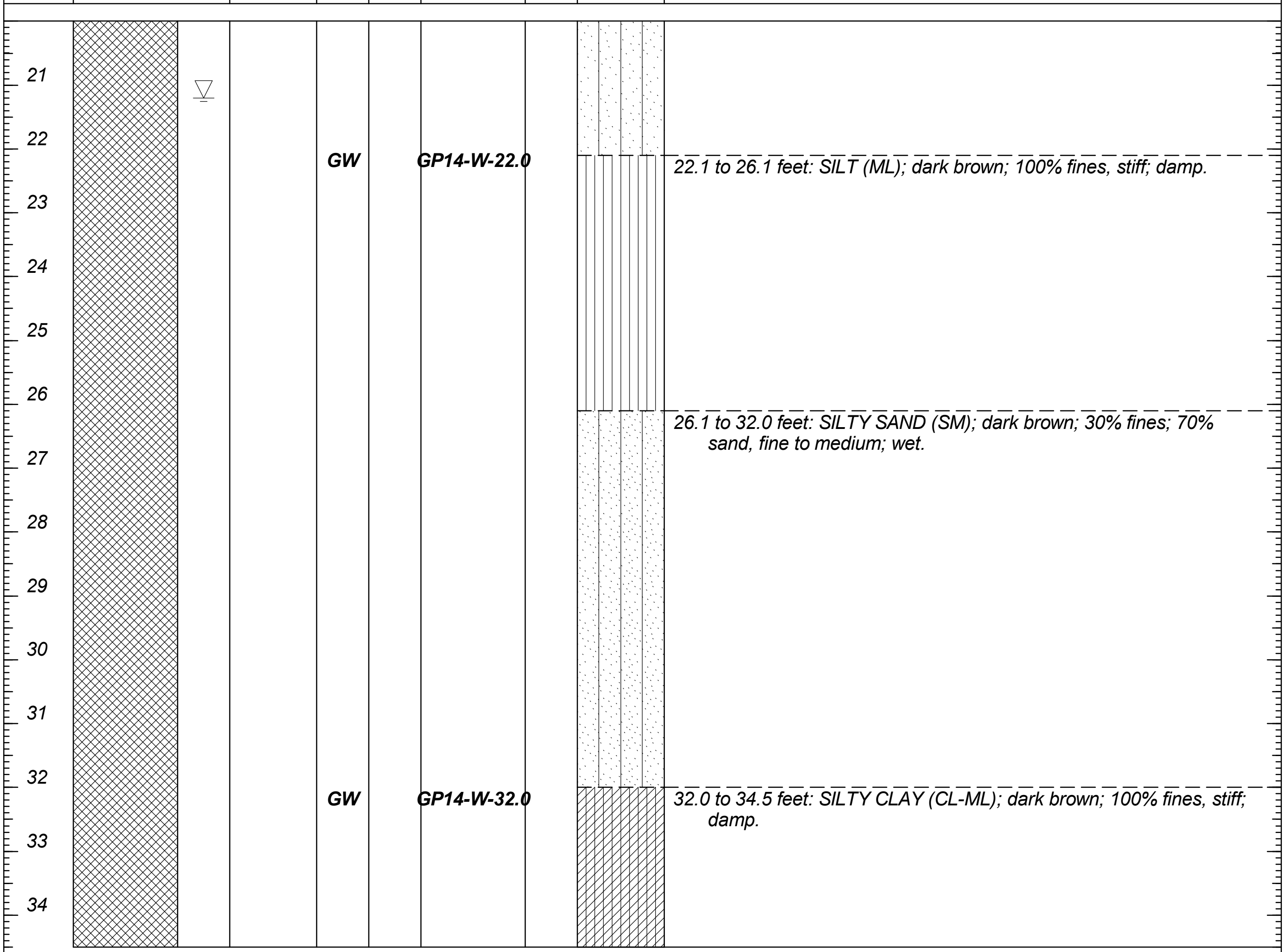


Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
0.0–0.5								0.0 to 0.5 feet: SANDY SILTY GRAVEL (GM); light brown; 30% fines, 20% sand, fine to medium; 50% gravel, rounded; dry.
0.5–6.5								0.5 to 6.5 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
6.5–7.2								6.5 to 7.2 feet: SAND (SP): dark brown; 100% sand, fine to medium; dry.
7.2–12.0								7.2 to 12.0 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
12.0–12.4				**GRAB**		**GP14-S-12.0**		12.0 to 12.4 feet: SILTY SAND (SM); dark brown; 10% fine, 90% sand, fine; dry.
12.4–15.8								12.4 to 15.8 feet: SANDY SILT (MLS); dark brown; 90% fine, non-plastic, medium stiff; 10% sand, medium; dry.
15.8–20								15.8 to 22.1 feet: SANDY SILT (MLS); dark brown; 90% fine, non-plastic, medium stiff; 10% sand, medium; wet.

NOTES:

▽ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number	*Well Number*	*Sheet*
	0346.04.02	***GP14***	***2 of 2***



Depth (feet, BGS)	*Well Details*	*Interval*	*Percent Recovery*	*Collection Method*	*Number*	*Name (Type)*	*Blows/6"*	*Soil Description*
22.1				***GW***		***GP14-W-22.0***		*22.1 to 26.1 feet: SILT (ML); dark brown; 100% fines, stiff; damp.*
26.1								*26.1 to 32.0 feet: SILTY SAND (SM); dark brown; 30% fines; 70% sand, fine to medium; wet.*
32.0				***GW***		***GP14-W-32.0***		*32.0 to 34.5 feet: SILTY CLAY (CL-ML); dark brown; 100% fines, stiff; damp.*

NOTES:

∇ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP15**	**1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**6/19/2012 to 6/19/2012**	Northing	
Driller/Equipment	**Marc Chalona, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**36.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Sample Data: Percent Recovery	Sample Data: Collection Method	Sample Data: Number	Sample Data: Name (Type)	Sample Data: Blows/6"	Lithologic Column	Soil Description
0.0–0.5									0.0 to 0.5 feet: SANDY SILTY GRAVEL (GM); light brown; 30% fines, 20% sand, fine to medium; 50% gravel, rounded; dry.
0.5–6.7									0.5 to 6.7 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
6.7–7.2									6.7 to 7.2 feet: SAND (SP): dark brown; 100% sand, fine to medium; dry.
7.2–11.2									7.2 to 11.2 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
11.2–12.0									11.2 to 12.0 feet: SILTY SAND (SM); dark brown; 10% fine; 90% sand, fine; dry.
12.0–17.0									12.0 to 17.0 feet: SANDY SILT (MLS); dark brown; 90% fine, non-plastic, medium stiff; 10% sand, medium; dry.
14				GRAB		GP15-S-14.0			
17.0–20									17.0 to 24.0 feet: SANDY SILT (MLS); dark brown; 90% fine, non-plastic, medium stiff; 10% sand, medium; wet.
20	∇								

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP15***	*Sheet* ***2 of 2***

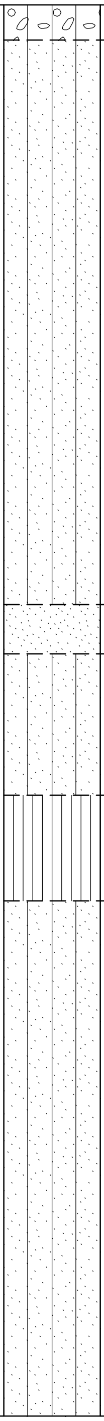
Depth (feet, BGS)	*Well Details*	*Interval*	*Percent Recovery*	*Collection Method*	*Number*	*Name (Type)*	*Blows/6"*	*Lithologic Column*	*Soil Description*
21									
22				***GW***		***GP15-W-22.0***			
23									
24									*24.0 to 28.0 feet: SILT (ML); dark brown; 100% fines, stiff; damp.*
25									
26									
27									
28									*28.0 to 34.2 feet: SILTY SAND (SM); dark brown; 30% fines; 70% sand, fine to medium; wet.*
29									
30									
31									
32									
33									
34				***GW***		***GP15-W-34.0***			*34.2 to 36.0 feet: SILTY CLAY (CL-ML); dark brown; 100% fines, stiff; damp.*
35									
36									

NOTES:

∇ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.	Geologic Borehole Log/Well Construction		
	Project Number **0346.04.02**	Well Number **GP16**	Sheet **1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**6/19/2012 to 6/19/2012**	Northing	
Driller/Equipment	**Marc Chalona, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**35.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**



Depth (feet, BGS)	Well Details	Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Soil Description
0.0–0.5								0.0 to 0.5 feet: SANDY SILTY GRAVEL (GM); light brown; 30% fines, 20% sand, fine to medium; 50% gravel, rounded; dry.
0.5–8.5								0.5 to 8.5 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
8.5–9.2								8.5 to 9.2 feet: SAND (SP); gray; 100% sand; wet.
9.2–11.2								9.2 to 11.2 feet: SANDY SILT (MLS); dark brown; 50% fines, low plasticity; 50% sand, fine; dry.
11.2–12.7								11.2 to 12.7 feet: SILT (ML); dark brown; 100% fines; stiff.
12.7–23.0								12.7 to 23.0 feet: SANDY SILT (MLS); dark brown; 80% fines, soft, medium plasticity; 20% sand, fine; damp
15				**GRAB**		**GP16-S-15.0**		
18.4	∇							

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number ***0346.04.02***	*Well Number* ***GP16***	*Sheet* ***2 of 2***

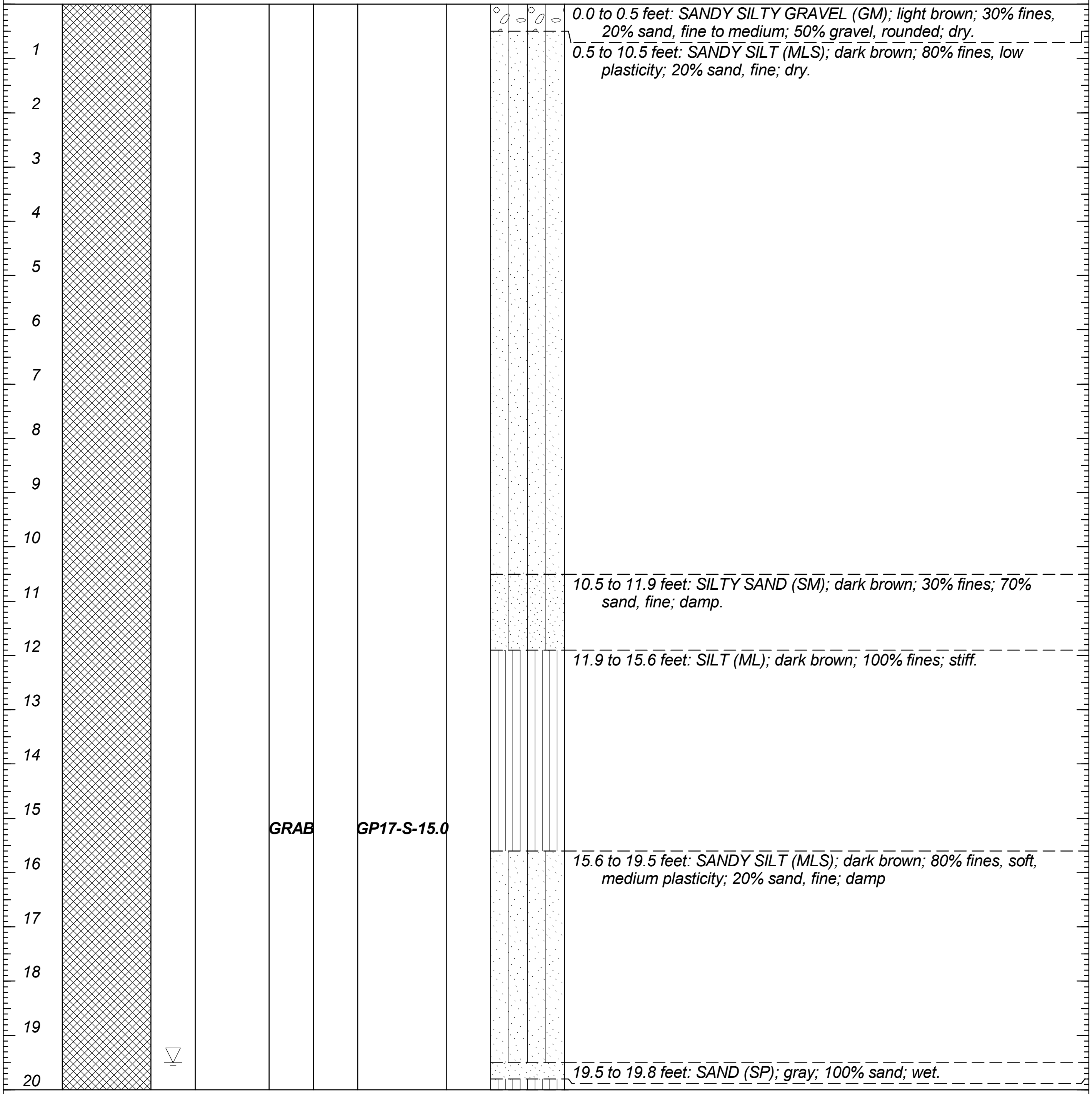
Depth (feet, BGS)	Well Details	Sample Data						Lithologic Column	Soil Description
		Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"		
21									
22				**GW**		**GP16-W-22.0**			
23									23.0 to 29.0 feet: SILT; dark brown; 100% fines; low plasticity; stiff; dry.
24									
25									
26									
27									
28									
29									29.0 to 33.2 feet: SANDY SILT (MLS); dark brown; 50% fines, soft; 50% sand, fine; wet.
30									
31									
32				**GW**		**GP16-W-32.0**			
33									33.2 to 35.0 feet: SILT; dark brown; 100% fines, stiff, dry.
34									
35									

NOTES:

▽ ***Water level depth at time of drilling.***

Maul Foster & Alongi, Inc.	**Geologic Borehole Log/Well Construction**		
	Project Number **0346.04.02**	Well Number **GP17**	Sheet **1 of 2**

Project Name	**Former Cream Wine Property**	TOC Elevation (feet)	
Project Location	**111 East Lincoln Ave, Sunnyside, Washington**	Surface Elevation (feet)	
Start/End Date	**6/19/2012 to 6/19/2012**	Northing	
Driller/Equipment	**Marc Chalona, Cascade Drilling L.P./6600 Geoprobe**	Easting	
Geologist/Engineer	**J. Pounds**	Hole Depth	**40.0-feet**
Sample Method		Outer Hole Diam	**2.25-inch**



Depth (feet, BGS)	Well Details	Sample Data: Interval	Percent Recovery	Collection Method	Number	Name (Type)	Blows/6"	Lithologic Column	Soil Description
0.0–0.5									0.0 to 0.5 feet: SANDY SILTY GRAVEL (GM); light brown; 30% fines, 20% sand, fine to medium; 50% gravel, rounded; dry.
0.5–10.5									0.5 to 10.5 feet: SANDY SILT (MLS); dark brown; 80% fines, low plasticity; 20% sand, fine; dry.
10.5–11.9									10.5 to 11.9 feet: SILTY SAND (SM); dark brown; 30% fines; 70% sand, fine; damp.
11.9–15.6									11.9 to 15.6 feet: SILT (ML); dark brown; 100% fines; stiff.
15				**GRAB**		**GP17-S-15.0**			
15.6–19.5	∇								15.6 to 19.5 feet: SANDY SILT (MLS); dark brown; 80% fines, soft, medium plasticity; 20% sand, fine; damp
19.5–19.8									19.5 to 19.8 feet: SAND (SP); gray; 100% sand; wet.

NOTES:

∇ **Water level depth at time of drilling.**

Maul Foster & Alongi, Inc.

Geologic Borehole Log/Well Construction

Project Number	Well Number	Sheet
0346.04.02	**GP17**	**2 of 2**

Depth (feet, BGS)	Well Details	Sample Data: Interval	Sample Data: Percent Recovery	Sample Data: Collection Method	Sample Data: Number	Sample Data: Name (Type)	Sample Data: Blows/6"	Lithologic Column	Soil Description
				GW		**GP17-W-20.0**			19.8 to 20.0 feet: SILT; dark brown; 100% fines; low plasticity; stiff.
21									20.0 to 22.8 feet; SILTY SAND (SM); dark brown; 40% fines, soft; 60% sand, fine to medium; wet.
22									
23									22.8 to 26.2 feet: SILT; dark brown; 100% fines, stiff, non plastic; moist.
24									
25									
26									
27									26.2 to 30.0 feet: SILTY SAND (SM); dark brown; 40% fines; 60% sand, fine; wet.
28									
29									
30				**GW**		**GP17-W-30.0**			30.0 to 37.2 feet: SILTY SAND; dark brown; 50% fines; 50% sand, fine; soft; wet.
31									
32									
33									
34									
35									
36									
37									
38									37.2 to 40.0 feet; SILTY CLAY (OH); dark brown; 100% fines; hard; stiff; damp.
39									
40									

NOTES:

▽ **Water level depth at time of drilling.**

ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

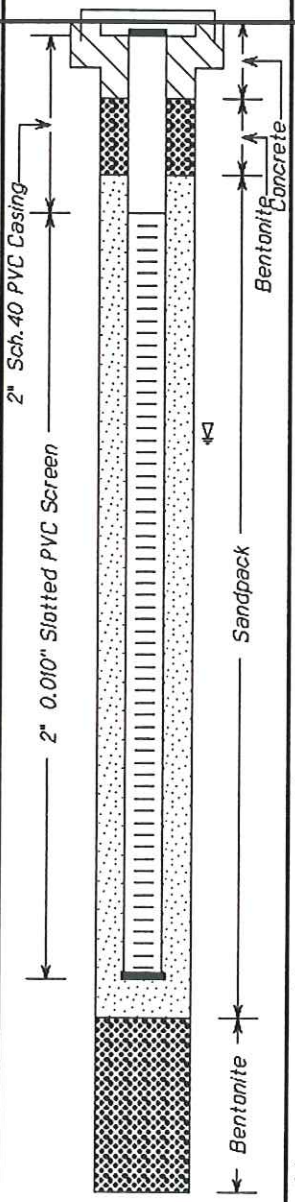
LOG OF BORING MW-1

Page 1 of 1

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01* DATE DRILLED: *03/11/97*
CLIENT: *Time Oil Co., Facility No. 01-068*
LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*
DRILLING METHOD: *Hollow-stem auger (4"); split spoon*
DRILLING COMPANY: *Cascade Drilling* CASING ELEVATION: *760.28*
LOGGED BY: *Craig Ware* APPROVED BY: *Al Sevilla*

WELL DIAGRAM



BLOWS/6 IN.	PID VALUES	DEPTH feet	SAMPLES	SOIL CLASS	GEOLOGIC DESCRIPTION
				ML	4" Asphaltic concrete
					Hand auger to 4 feet.
		5			sandy SILT: light-brown to brown, slightly moist, fine-grained sand.
					No sampling to 14 feet.
		10			
8,21,24	0.2	15	■		Same: olive-brown, moist, hard.
17,18,22	0.3		■		Same.
18,21,21	0.1		■	SM	silty SAND: wet, dense; fine to medium-grained.
17,18,20	0		■	ML	sandy SILT: olive, wet, very stiff.
28,30,30	0.2	20	■		
30,30,30	0.3		■	SM	SAND: olive, medium-grained with some coarse lenses; dense.
28,30,35	0.5		■	ML	sandy SILT: green-brown, wet, very stiff.
30,30,34	0.5	25	■	SM	SAND: green-brown to brown, wet, dense; very fine-grained.
30,30,33	0.3		■		Same.
29,30,33	0.3		■	ML	SILT: hard; trace very fine-grained sand.
30,29,30	0.4	30	■		Same: green-brown to brown, wet, increasing fine-grained sand.
					Boring terminated at 30.5 feet.

ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

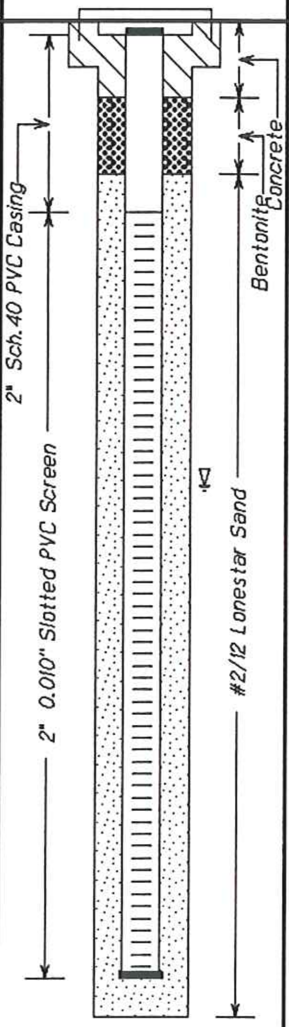
LOG OF BORING MW-2

Page 1 of 1

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01*	DATE DRILLED: *03/11/97*
CLIENT: *Time Oil Co., Facility No. 01-068*	
LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*	
DRILLING METHOD: *Hollow-stem auger (4"); split spoon*	
DRILLING COMPANY: *Cascade Drilling*	CASING ELEVATION: *759.43*
LOGGED BY: *Craig Ware*	*APPROVED BY: Al Sevilla*

WELL DIAGRAM



BLOWS/6 IN.	PID VALUES	DEPTH feet	SAMPLES	SOIL CLASS	GEOLOGIC DESCRIPTION
				ML	4" Asphaltic concrete
					Hand auger to 4 feet.
17,20,23	0.8	5	■		sandy SILT: light-brown, moist, very stiff; very fine-grained sand.
24,26,30	0.6	10	■		Same: increasing moisture content.
22,28,30	0.3	15	■		Same: wet.
28,30,30	2.7	20	■		Same: medium-grained sand layers interspersed.
27,30,30	0.5	25	■		Same:
					Boring terminated at 26 feet.
		30			

ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

LOG OF BORING MW-3

Page 1 of 1

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01* DATE DRILLED: *03/11/97*

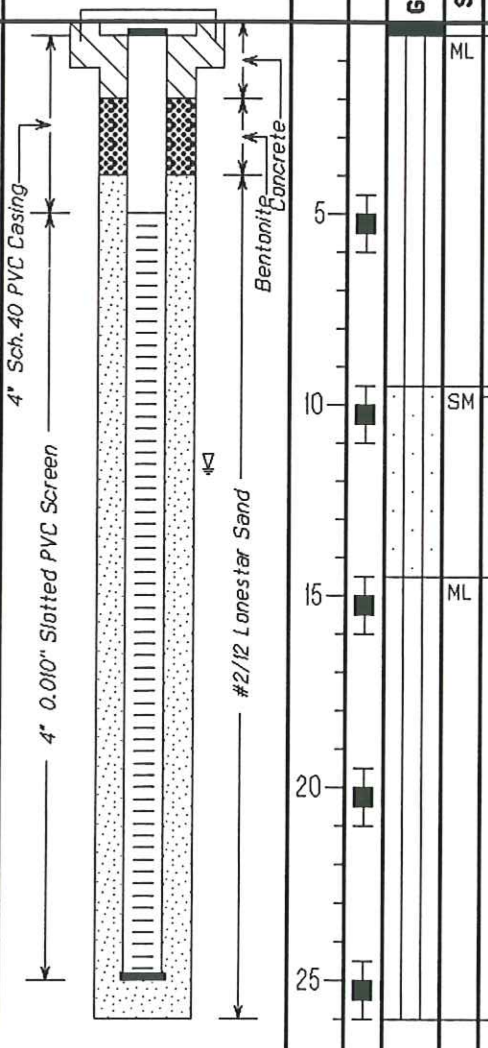
CLIENT: *Time Oil Co., Facility No. 01-068*

LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*

DRILLING METHOD: *Hollow-stem auger (6"); split spoon*

DRILLING COMPANY: *Cascade Drilling* CASING ELEVATION: *758.11*

LOGGED BY: *Craig Ware* *APPROVED BY: Al Sevilla*



BLOWS/6 IN.	PID VALUES	DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
			ML	4" Asphaltic concrete
				Hand auger to 4 feet.
18,20,20	74	5		sandy SILT: light-brown, moist, very stiff; very fine-grained sand.
20,24,26	119	10	SM	silty SAND: olive-brown to brown, very moist, dense; fine- to medium- grained.
29,30,30	130	15	ML	sandy SILT: wet, very stiff; fine-grained sand.
28,29,30	132	20		Same:
28,30,31	2.9	25		Same:
				Boring terminated at 26 feet.

ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

LOG OF BORING MW-4

Page 1 of 1

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01* DATE DRILLED: *03/11/97*

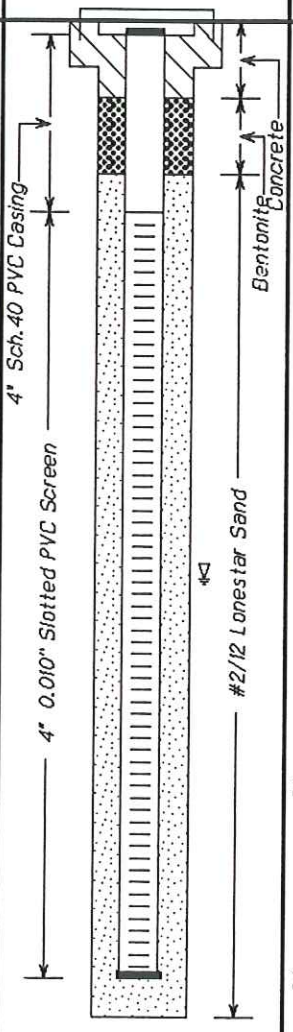
CLIENT: *Time Oil Co., Facility No. 01-068*

LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*

DRILLING METHOD: *Hollow-stem auger (6"); split spoon*

DRILLING COMPANY: *Cascade Drilling* CASING ELEVATION: *756.89*

LOGGED BY: *Craig Ware* *APPROVED BY: Al Sevilla*



BLOWS/6 IN.	PID VALUES	DEPTH feet	SAMPLES	SOIL CLASS	GEOLOGIC DESCRIPTION
		0		ML	4" Asphaltic concrete Hand auger to 4 feet. No sampling to 10 feet.
N/A	N/A	5			sandy SILT: light-brown to brown, dry.
20,22,26	0.3	10	■	SM	silty SAND: green-brown, moist; dense; fine-grained with medium- grained sand layers interspersed.
27,30,30	326	15	■		SAND: olive-brown, wet, dense; irridescent sheen; fine- to medium- grained.
22,28,30	386	20	■	ML	sandy SILT: olive-brown, wet, very stiff; very fine-grained sand.
24,26,28	13.0	25	■		Same:
					Boring terminated at 26 feet.
		30			

ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

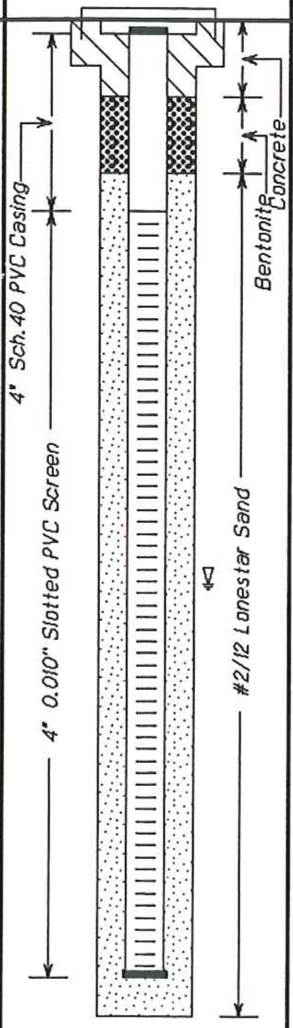
LOG OF BORING MW-5

Page 1 of 1

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01* DATE DRILLED: *03/11/97*
CLIENT: *Time Oil Co., Facility No. 01-068*
LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*
DRILLING METHOD: *Hollow-stem auger (6"); split spoon*
DRILLING COMPANY: *Cascade Drilling* CASING ELEVATION: *755.81*
LOGGED BY: *Craig Ware* APPROVED BY: *Al Sevilla*

WELL DIAGRAM



BLOWS/6 IN.	PID VALUES	DEPTH feet	SAMPLES	SOIL CLASS	GEOLOGIC DESCRIPTION
				ML	4" Asphaltic concrete
					Hand auger to 4 feet. No sampling to 10 feet.
N/A	N/A	5			sandy SILT: brown, dry.
18,20,23	0.3	10	■		Same: olive-brown, very moist, very stiff; very fine-grained sand.
16,20,23	782	15	■		Same: wet.
23,28,29	305	20	■		Same:
18,23,27	4.6	25	■		Same:
					Boring terminated at 26 feet.
		30			

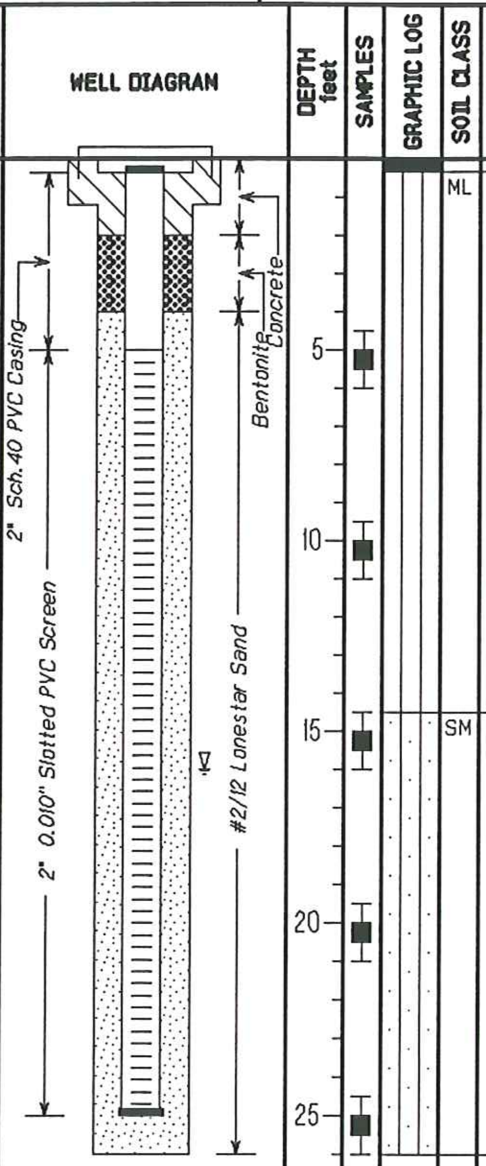
ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

LOG OF BORING MW-6

Page 1 of 1

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01* DATE DRILLED: *03/12/97*
CLIENT: *Time Oil Co., Facility No. 01-088*
LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*
DRILLING METHOD: *Hollow-stem auger (4"); split spoon*
DRILLING COMPANY: *Cascade Drilling* CASING ELEVATION: *753.81*
LOGGED BY: *Craig Ware* *APPROVED BY: Al Sevilla*



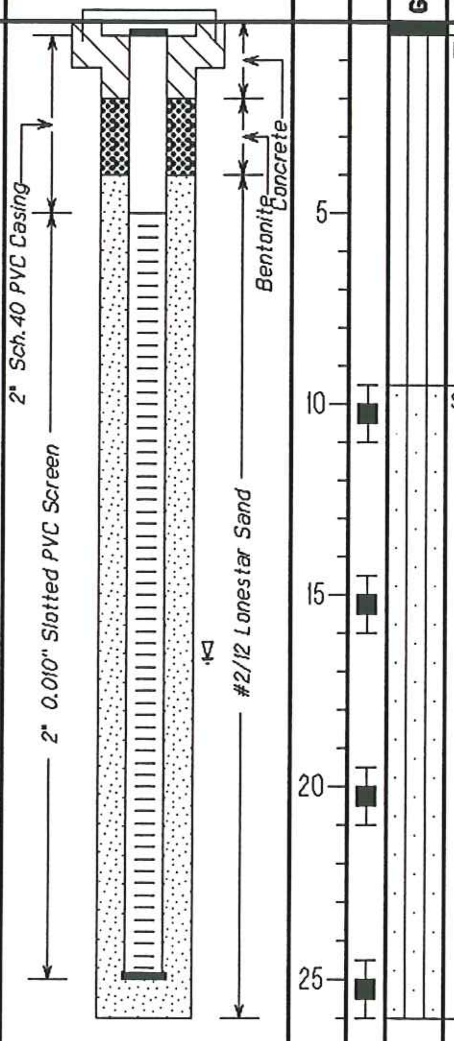
BLOWS/6 IN.	PID VALUES	SOIL CLASS	GEOLOGIC DESCRIPTION
			4" Asphaltic concrete
		ML	Hand auger to 4 feet.
			silty SAND: light-brown, dry to slightly moist, fine-grained.
18,20,23	0.1		sandy SILT: medium-brown, dry, very stiff; fine-grained sand.
18,30,30	0.3		Same: olive-brown with orange-molting, slightly moist.
28,29,30	91	SM	SAND: olive-brown, very moist to wet, dense; very fine-grained.
30,30,30	690		Same: wet, trace of silt.
29,29,30	9.7		Same:
			Boring terminated at 26 feet.

ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

LOG OF BORING MW-7

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01* DATE DRILLED: *03/12/97*
CLIENT: *Time Oil Co., Facility No. 01-068*
LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*
DRILLING METHOD: *Hollow-stem auger (4"); split spoon*
DRILLING COMPANY: *Cascade Drilling* CASING ELEVATION: *755.44*
LOGGED BY: *Craig Ware* APPROVED BY: *Al Sevilla*



BLOWS/6 IN.	PID VALUES	DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
		0	ML	4" Asphaltic concrete Hand auger to 4 feet. No sampling to 10 feet.
N/A	N/A	5		sandy SILT: light-brown, dry, very fine-grained sand.
28,28,30	0.2	10	SM	SAND: olive-brown, slightly moist, dense; very fine-grained.
28,30,30	0.1	15		Same: olive-brown, moist to very moist, increasing silt.
26,28,30	0.6	20		Same: very moist to wet.
30,30,30	0.4	25		Same: wet, decreasing silt fraction.
				Boring terminated at 26 feet.
		30		

ALISTO ENGINEERING GROUP
SEATTLE, WASHINGTON

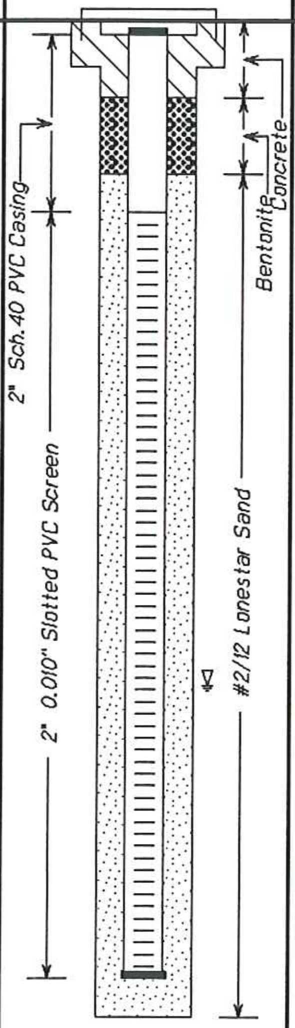
LOG OF BORING MW-8

Page 1 of 1

SEE SITE PLAN

ALISTO PROJECT NO: *20-025-01* DATE DRILLED: *03/12/97*
CLIENT: *Time Oil Co., Facility No. 01-088*
LOCATION: *107 West Lincoln Avenue, Sunnyside, Washington*
DRILLING METHOD: *Hollow-stem auger (4"); split spoon*
DRILLING COMPANY: *Cascade Drilling* CASING ELEVATION: *751.46*
LOGGED BY: *Craig Ware* *APPROVED BY: Al Sevilla*

WELL DIAGRAM



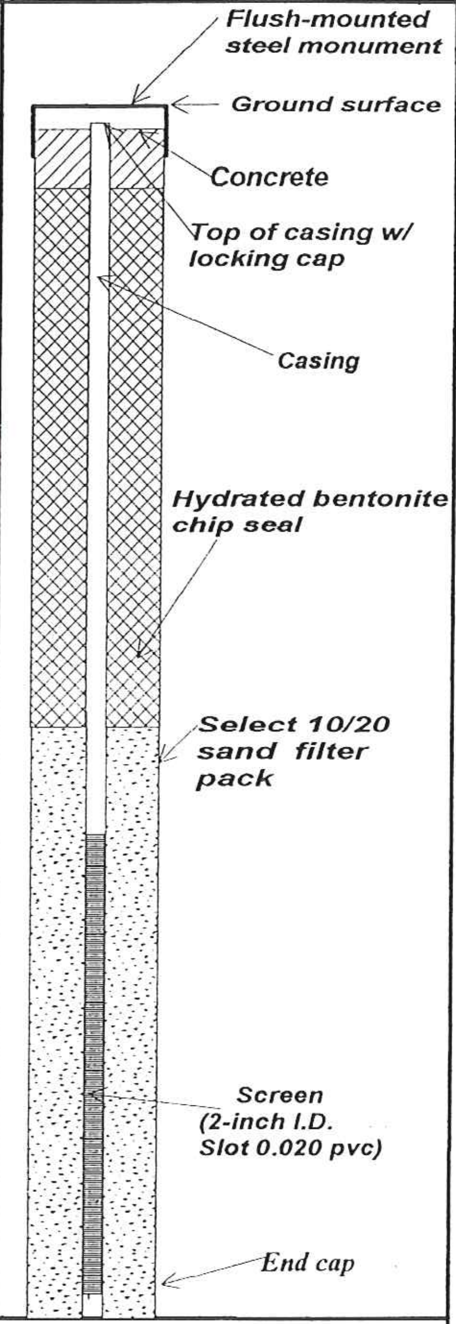
BLOWS/6 IN.	PID VALUES	DEPTH feet	SAMPLES	SOIL CLASS	GEOLOGIC DESCRIPTION
				ML	4" Asphaltic concrete
					Hand auger to 4 feet. No sampling to 10 feet.
N/A	N/A	5			sandy SILT: brown, dry to slightly moist.
28,28,30	0	10	■		Same: slightly moist, very stiff; very fine-grained sand.
28,28,30	0.2	15	■	SM	SAND: olive-brown, wet, dense; fine- to medium-grained with a trace of silt.
30,30,30	1.1	20	■		silty SAND: olive-brown, wet, dense; fine- to medium-grained.
29,29,30	0.2	25	■		SAND: wet, dense; fine- to coarse-grained with a trace of silt.
					Boring terminated at 28 feet.
		30			

PROJECT *SUNNYSIDE TIME OIL* W.O. *99-04808* WELL NO. *MW-13*

Elevation reference:
Ground surface elevation: 750.69 **Casing elevation:** 750.25

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER	TESTING
0	*0-4" Asphalt*						
5	*Very stiff, moist, brown, fine, sandy SILT*		S-1	18	21.8		
10	*Hard, moist, brown, fine sandy SILT with fine to medium sand interbed (1/2" to 1" thick) @ 10.5 and 11.0' depth*		S-2	35	21.3		
15	*Very stiff, wet grading to saturated, brown, fine sandy SILT becomes saturated at 15.6' depth*		S-3	22	460.0	▼ ATD	
	Very stiff, wet, brown, fine sandy SILT to SILT with some fine sand, saturated, medium to find sand layer at 18.0 -18.5' depth		S-4	26	2617		
20	*Very stiff, saturated, brown, fine sandy SILT and medium to fine SAND, trace silt from 19.5-20.0' depth*		S-5	34	2677		
	Dense, saturated, brown, silty, medium to fine SAND		S-6	31	48		
	Dense, saturated, brown, silty, medium to fine SAND		S-7	31	65		
25	*Boring terminated at approximately 25.0 feet*						
30							

AS-BUILT DESIGN



LEGEND

MAXIM TECHNOLOGIES, INC.
N. 10220 Nevada, Suite 290
Spokane, Washington 99218

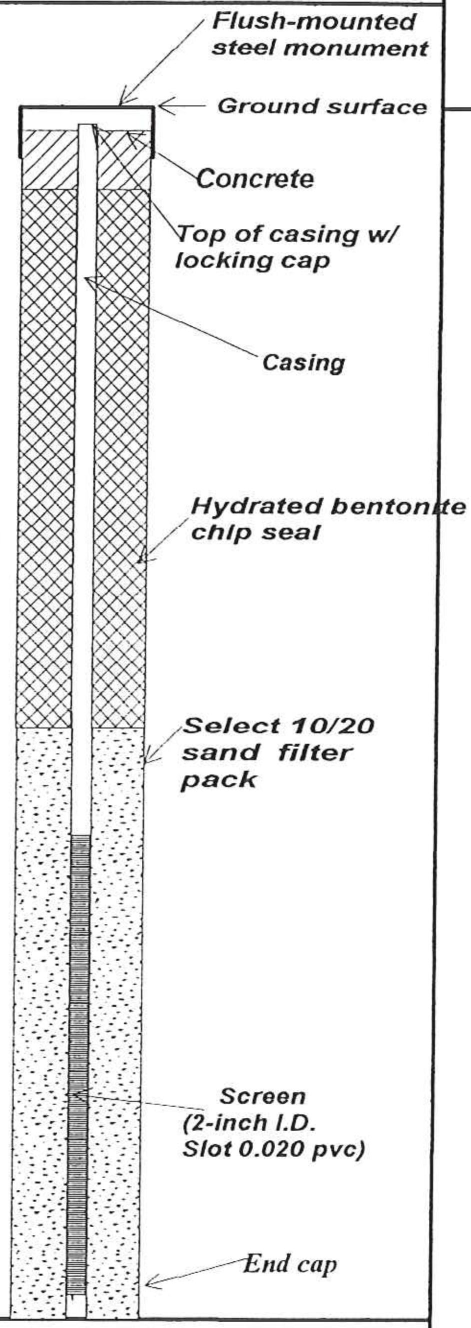
Drilling started: *13 April 1999* **Drilling completed:** *13 April 1999* **Logged by:** *EJP*

PROJECT *SUNNYSIDE TIME OIL* W.O. *99-04808* WELL NO. *MW-14*

Elevation reference:
Ground surface elevation: 750.25 **Casing elevation: 749.88**

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0	*0-4" Asphalt*					
5	*Stiff, moist, brown, fine, sandy SILT with medium to fine SAND interbeds (0.5" to 1" thick at 5.5 and 6' depth)*		S-1	13	23.2	
10	*Very stiff, moist, brown, fine sandy SILT with one medium to fine SAND interbed (1" thick) at 11' depth*		S-2	26	24.9	
15	*Very stiff, wet grading to saturated, brown, fine sandy SILT*		S-3	26	25.1	▼ ATD
20	*Medium dense, saturated, brown, medium to fine SAND grading to a silty, fine SAND to 21' depth. Very stiff, saturated, brown, SILT with some fine SAND from 21' to 21.5' depth.*		S-4	27	398	
	Boring terminated at approximately 25.0 feet					
25	*Medium dense, saturated, brown, silty, fine SAND*		S-5	26	32.4	
30						

AS-BUILT DESIGN



TESTING

LEGEND

MAXIM TECHNOLOGIES, INC.
N. 10220 Nevada, Suite 290
Spokane, Washington 99218

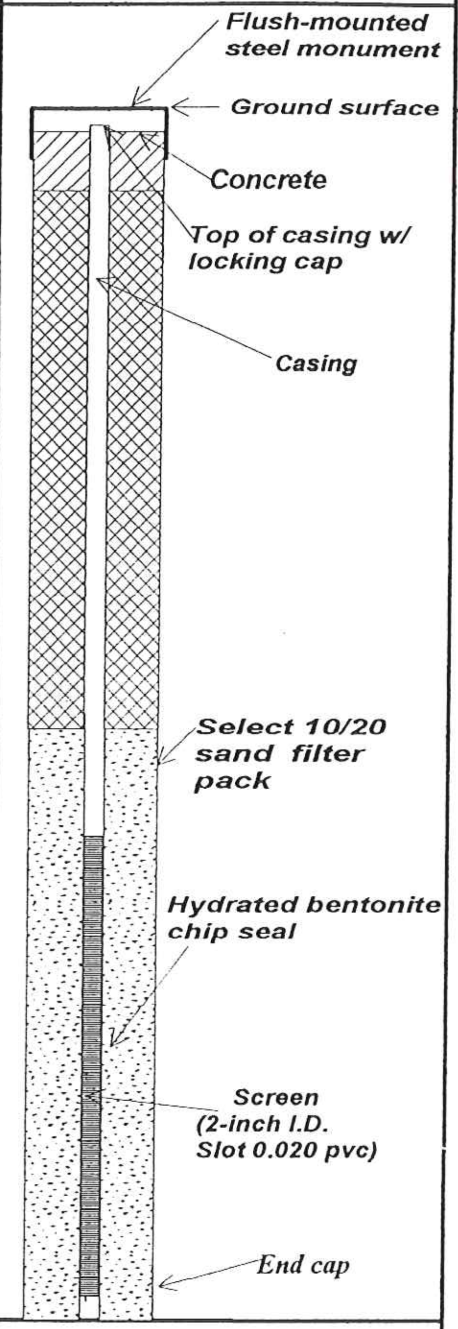
Drilling started: *13 April 1999* **Drilling completed:** *13 April 1999* **Logged by:** *EJP*

PROJECT *SUNNYSIDE TIME OIL* W.O. *99-04808* WELL NO. *MW-15*

Elevation reference:
Ground surface elevation: **Casing elevation:**

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0	*0-4" Asphalt*					
5	*Medium stiff, moist, brown, fine, sandy SILT*		S-1	7	27.6	
10	*Very stiff, moist, brown, fine sandy SILT with medium to fine SAND interbed at 10.5 to 11' depth*		S-2	22	30.5	
15	*Very stiff, moist grading to saturated, brown, fine sandy SILT and one medium to fine SAND with some silt interbed 1.5" to 2" thick at 16.6' depth*		S-3	31	29.7	ATD
	Medium dense, saturated, brown, silty, fine SAND grading to a medium to fine SAND with some silt to 18.2' depth over a very stiff, saturated, brown SILT with some fine sand		S-4	37	28.8	
20	*Medium dense, saturated, brown, medium to fine SAND with some silt to 20' depth over silty fine SAND to 21' depth*		S-5	29	31.6	
	Medium dense, saturated, brown, medium to fine SAND with some silt		S-6	39	35.9	
	Medium dense, saturated, brown, medium to fine SAND with some silt		S-7	30		
25	*Boring terminated at approximately 25.0 feet*					
30						

AS-BUILT DESIGN



TESTING

LEGEND

MAXIM TECHNOLOGIES, INC.
N. 10220 Nevada, Suite 290
Spokane, Washington 99218

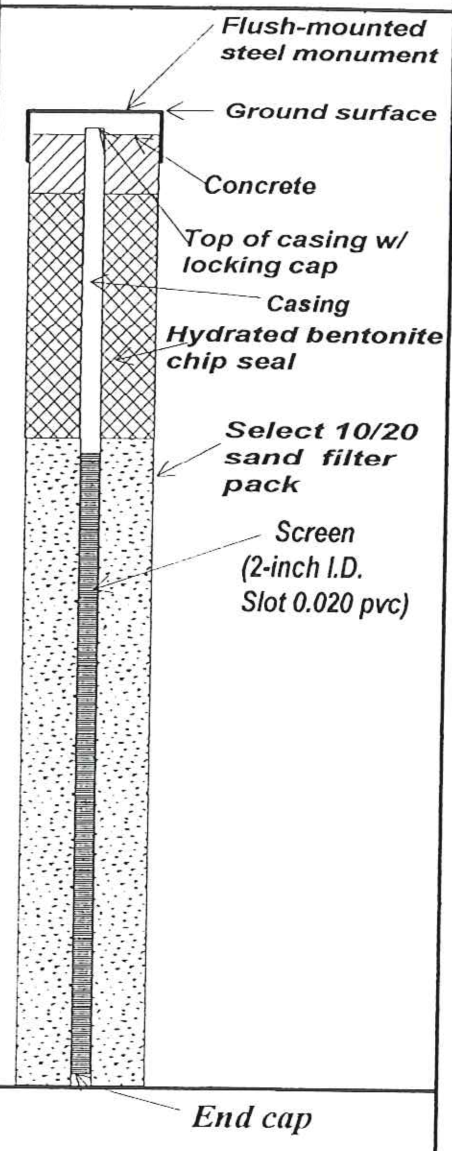
Drilling started: *13 April 1999* **Drilling completed:** *13 April 1999* **Logged by:** *EJP*

PROJECT *SUNNYSIDE TIME OIL* W.O. *99-04808* WELL NO. *MW-16*

Elevation reference:
Ground surface elevation: 757.79 **Casing elevation: 757.48**

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0	*0-4" Asphalt*					
5	*Loose, moist to damp, brown, silty, fine SAND one thick white/gray ash layer at 6' depth*		S-1	9	22.6	
10	*Very stiff, moist grafding to wet, brown, fine sandy SILT with one fine SAND interbed @ 10.5' depth*		S-2	26	22.5	
15						▽ ATD
20	*Boring terminated at approximately 20 feet*					
25						
30						

AS-BUILT DESIGN



TESTING

LEGEND

MAXIM
TECHNOLOGIES, INC.
N. 10220 Nevada, Suite 290
Spokane, Washington 99218

Drilling started: *14 April 1999* **Drilling completed:** *14 April 1999* **Logged by:** *EJP*

PROJECT *Sunnyside* W.O. *19046* WELL NO. *MW-17*

Elevation reference:
Ground surface elevation: Casing elevation:

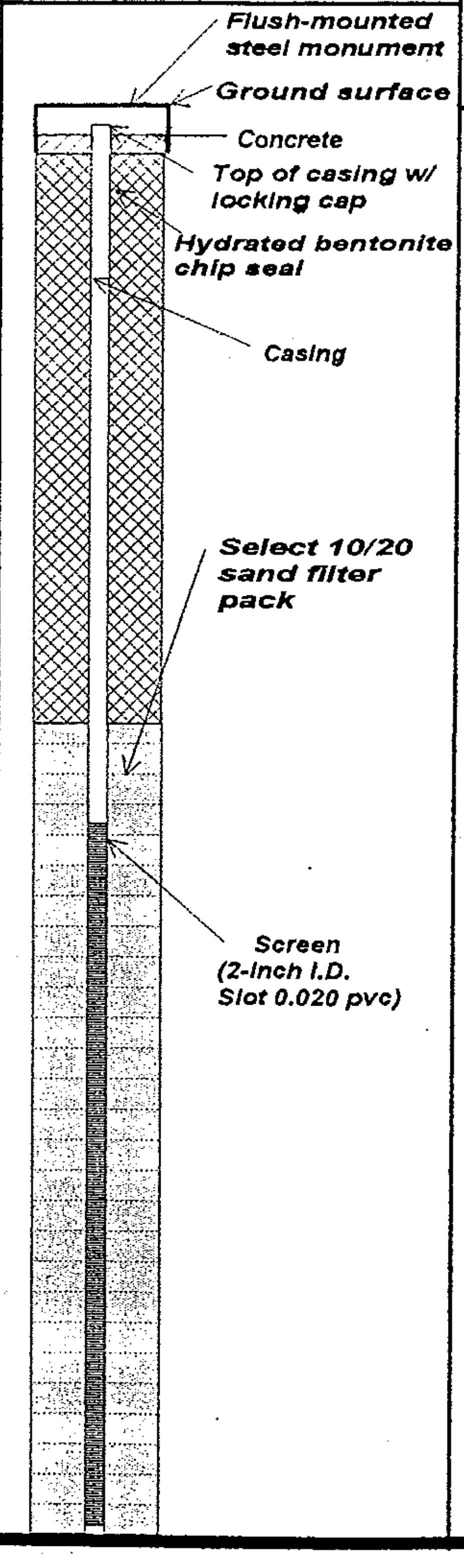
DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
	Stiff, wet, gray SILT with fine sand					
	3" layer of fine SAND with silt		S-1	8/27 30/34	5.3	
	Stiff, saturated, gray, SILT with fine					ATD
20						
25						
30						

Well terminated at approxiamtely 30 feet

LEGEND

AS-BUILT DESIGN

TESTING



BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

Drilling started: *1 May 2000* **Drilling completed:** *1 May 2000* **Logged by:** *ME*

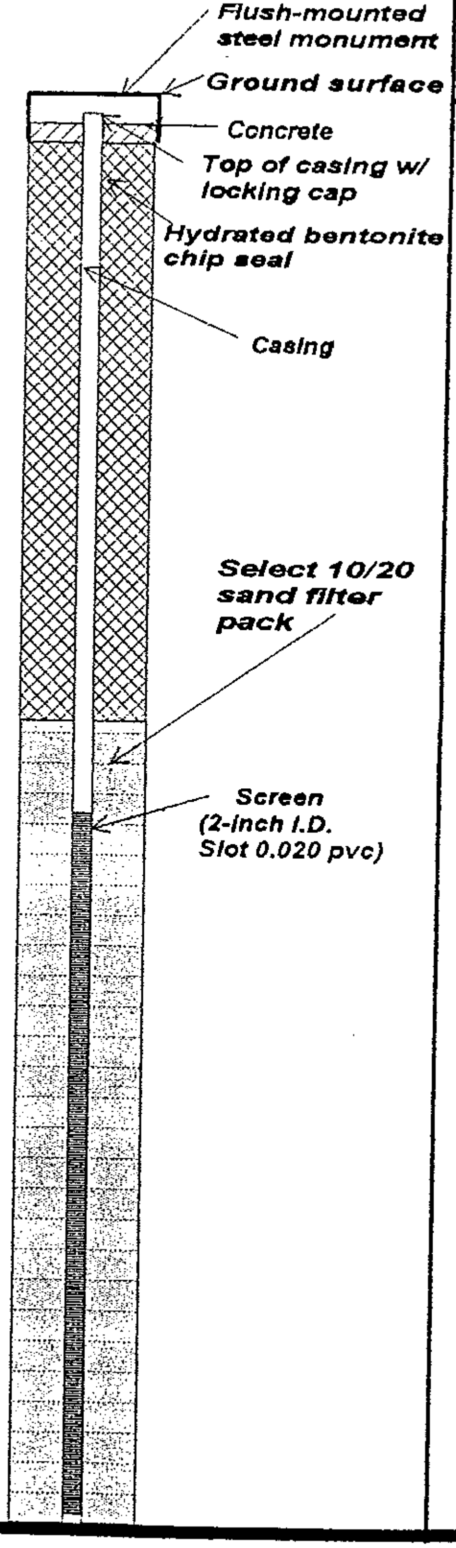
PROJECT *Sunnyside* W.O. *19046* WELL NO. *MW-18*

Elevation reference:
Ground surface elevation:
Casing elevation:

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
	Stiff, set, gray, SILT with fine grained sand		S-1	10/18 30/30	0.8	
						ATD
20						
25						
30						

Well terminated at approxiamtely 30 feet

AS-BUILT DESIGN



TESTING

LEGEND

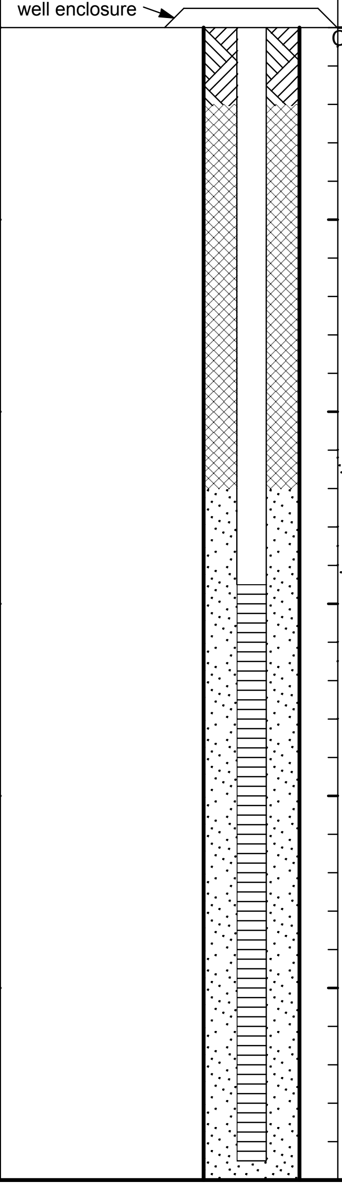
BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

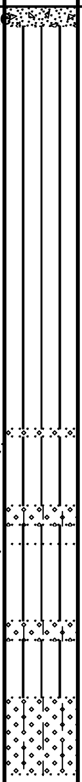
Drilling started: *1 May 2000* Drilling completed: *1 May 2000* Logged by: ME

Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION **Former Apex Winery**		Well Name **MW-19**	
DRILLING COMPANY **Cascade Drilling, Inc.**	DRILLER **Mark Chalona**	Project Name **Former Apex Winery**	
DRILLING METHOD(S) **DP and Hollow Stem Auger**	DRILL BIT(S) SIZE **8-inch**	Project Number **0792027.40**	
ISOLATION CASING **n/a**	FROM **n/a** TO **n/a** FT.	ELEVATION AND DATUM	TOTAL DEPTH **30.0 ft. bgs**
BLANK CASING **2-Inch Sch 40 PVC**	FROM **0** TO **14.5** FT.	DATE STARTED **8/11/09**	DATE COMPLETED **8/11/09**
SLOTTED CASING **2-inch Sch 40 PVC with 0.010 slots**	FROM **14.5** TO **29.5** FT.	STATIC WATER ELEVATION **n/a**	
SIZE AND TYPE OF FILTER PACK **10-20 Sand**	FROM **12** TO **30** FT.	LOGGED BY **SM**	
SEAL **3/8" bent. chips, hydrated**	FROM **2** TO **12** FT.	SAMPLING METHODS **Microcore**	WELL COMPLETION ☒ SURFACE HOUSING ☐ STAND PIPE **n/a** FT.
GROUT **Concrete**	FROM **0** TO **2** FT.		





SAMPLES Type & No.	SAMPLES Recovery (Feet)	SAMPLES Penetr. Resist. Blows/6"	Drill Depth (Feet)	USCS Log	Lithology	Color	SAMPLE DESCRIPTION and DRILLING REMARKS
				Concrete			**(Concrete)** CONCRETE
	4/5			ML			**(ML)** SILT, GRAY BROWN, DRY TO SLIGHTLY MOIST, STIFF WHERE SLIGHTLY MOIST, MINOR VERY FINE SAND. NO ODOR OR DISCOLORATION.
			5				
	5/5						
			10				
				SP			**(SP)** VERY FINE SAND, GRAY BROWN, SLIGHTLY MOIST.
	5/5			ML			**(ML)** SILT, SAME AS 6' - 11', SLIGHTLY MOIST, VERY STIFF, NO ODOR OR DISCOLORATION.
				SM			**(SM)** SILTY VERY FINE SAND, SLIGHTLY MOIST, 60% SAND 40% SILT.
				ML			**(ML)** SILT, SAME AS 6' - 11', MOIST TO VERY MOIST.
			15	ML			**(ML)** VERY FINE SANDY SILT, GRAY BROWN, SLIGHTLY MOIST, VERY STIFF, 60% SILT, 40% SAND.
				SM			**(SM)** SILTY VERY FINE SAND, SAME AS 13' - 13.5'
	5/5			ML			**(ML)** VERY FINE SANDY SILT, SAME AS 14' - 16'. VERY MOIST, STIFF.
				SM			**(SM)** SILTY VERY FINE SAND, SAME AS 16' - 16.5', SLIGHTLY MOIST, NO ODOR OR DISCOLORATION.
			20				20-30 NOT LOGGED.
			25				
			30				

BORING & WELL CONSTRUCTION APEX_WINERY.GPJ KENNEDY JENKS.GDT 9/25/09

F-40.1
(6-87) (3-88) (8-90)

SHEET 1 OF 1

Boring & Well Construction Log

Kennedy/Jenks Consultants

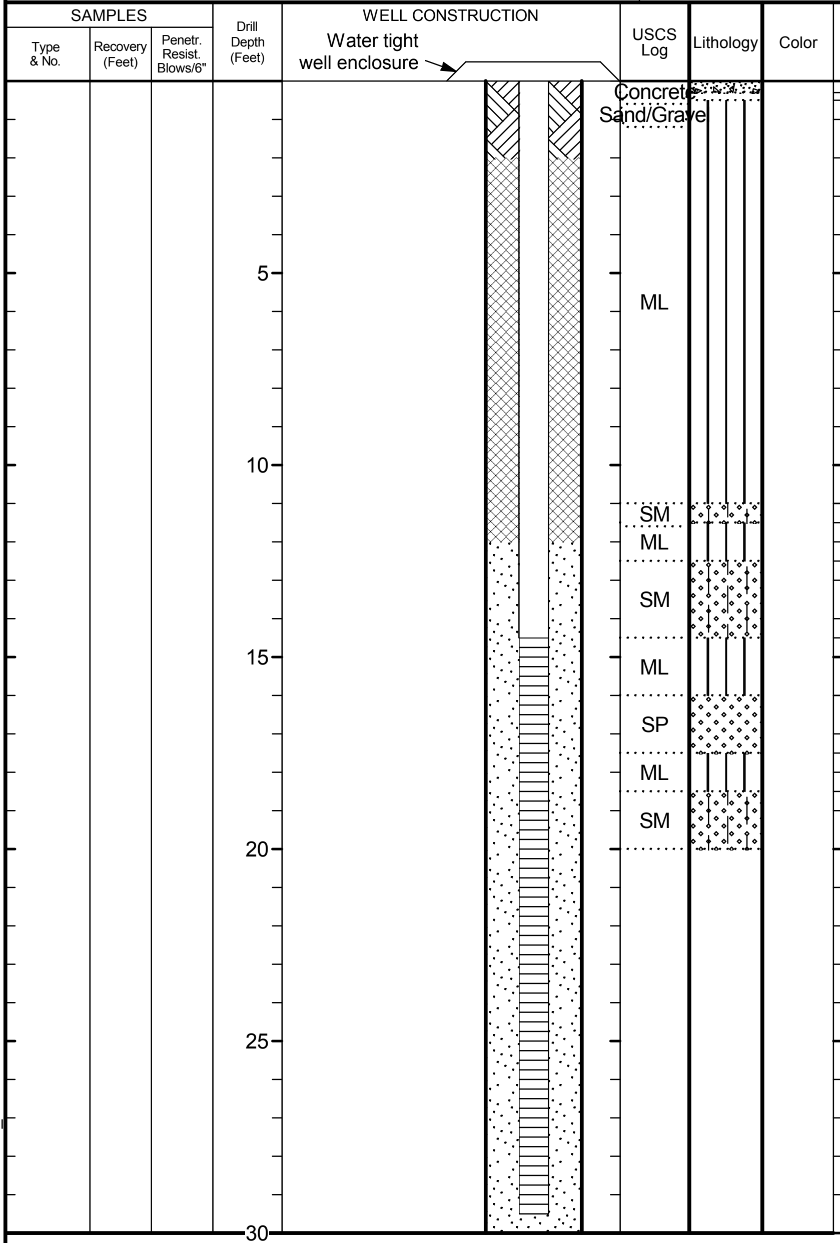
BORING LOCATION **Former Apex Winery**				
DRILLING COMPANY **Cascade Drilling, Inc.**	DRILLER **Mark Chalona**			
DRILLING METHOD(S) **DP and Hollow Stem Auger**	DRILL BIT(S) SIZE **8-inch**			
ISOLATION CASING **n/a**	FROM **n/a**	TO **n/a**	FT.	
BLANK CASING **2-Inch Sch 40 PVC**	FROM **0**	TO **14.5**	FT.	
SLOTTED CASING **2-inch Sch 40 PVC with 0.010 slots**	FROM **14.5**	TO **29.5**	FT.	
SIZE AND TYPE OF FILTER PACK **10-20 Sand**	FROM **12**	TO **30**	FT.	
SEAL **3/8" bent. chips, hydrated**	FROM **0.3**	TO **12**	FT.	
GROUT **Concrete**	FROM **0**	TO **0.3**	FT.	

Well Name **MW-20**

Project Name **Former Apex Winery**

Project Number **0792027.40**

ELEVATION AND DATUM	TOTAL DEPTH **30.0 ft. bgs**
DATE STARTED **8/13/09**	DATE COMPLETED **8/13/09**
STATIC WATER ELEVATION **n/a**	
LOGGED BY **SM**	
SAMPLING METHODS **Microcore**	WELL COMPLETION ☒ SURFACE HOUSING ☐ STAND PIPE **n/a** FT.



SAMPLE DESCRIPTION and DRILLING REMARKS

(Concrete) CONCRETE

(Sand/Gravel) SAND/GRAVEL BASE

(ML) SILT, GRAY BROWN, DRY TO SLIGHTLY MOIST, MINOR VERY FINE SAND AT 6' - 6.2' AND 8' - 8.4', NO ODOR OR DISCOLORATION.

(SM) SILTY VERY FINE SAND, GRAY BROWN, SLIGHTLY MOIST, 60% SAND, NO ODOR OR DISCOLORATION.

(ML) SILT, SAME AS 0.5' - 11'. MOIST.

(SM) SILTY VERY FINE SAND, SAME AS 11' - 11.5'.

(ML) SILT, SAME AS 11.5' - 12.5'.

(SP) SAND, BROWN, SLIGHTLY MOIST, FINE TO MEDIUM SAND WITH MINOR SILT, NO ODOR OR DISCOLORATION.

(ML) SANDY SILT, BROWN, MOIST, 60% SILT 40% VERY FINE SAND.

(SM) SILTY VERY FINE SAND, SAME AS 12.5' - 14.5', BECOMES VERY MOIST AT 18.8', NO ODOR OR DISCOLORATION.

20-30 NOT LOGGED.

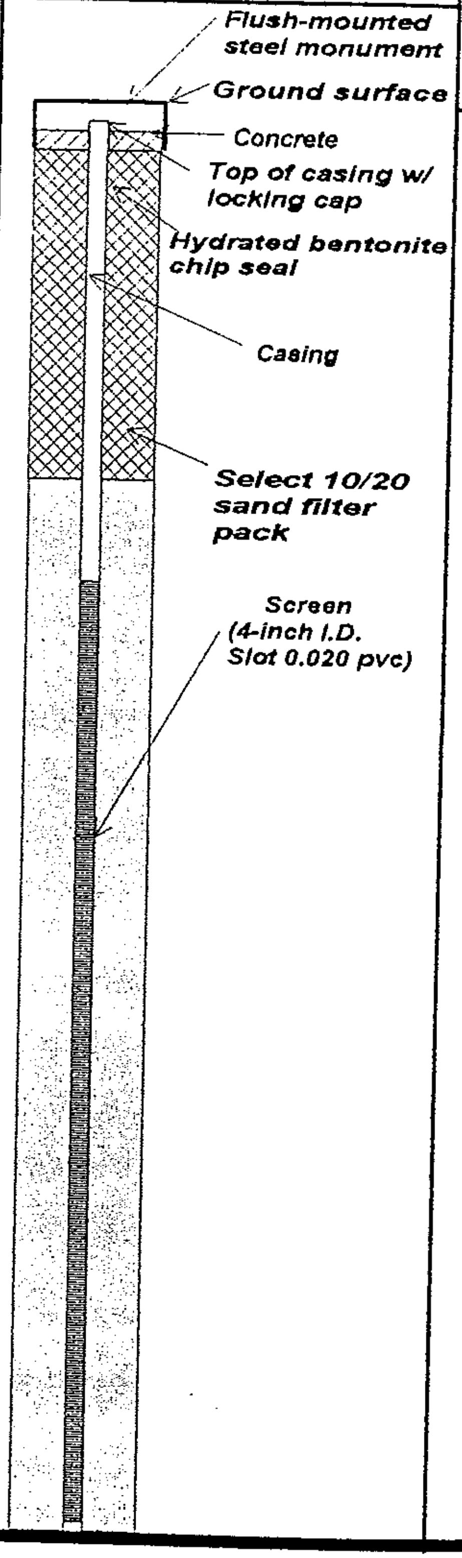
BORING & WELL CONSTRUCTION APEX_WINERY.GPJ KENNEDY JENKS.GDT 9/25/09

PROJECT *Sunnyside* W.O. *19046* WELL NO. *RW-1*

Elevation reference:
Ground surface elevation:
Casing elevation:

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						▽ ATD
	Stiff, wet, brown/gray, CLAY with silt *Wet, brown/gray SAND with little silt*	☐	S-1	8/12 20/30	1218	
20						
25						
30						

AS-BUILT DESIGN



TESTING

Well terminated at approxiamtely 35 feet

LEGEND

BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

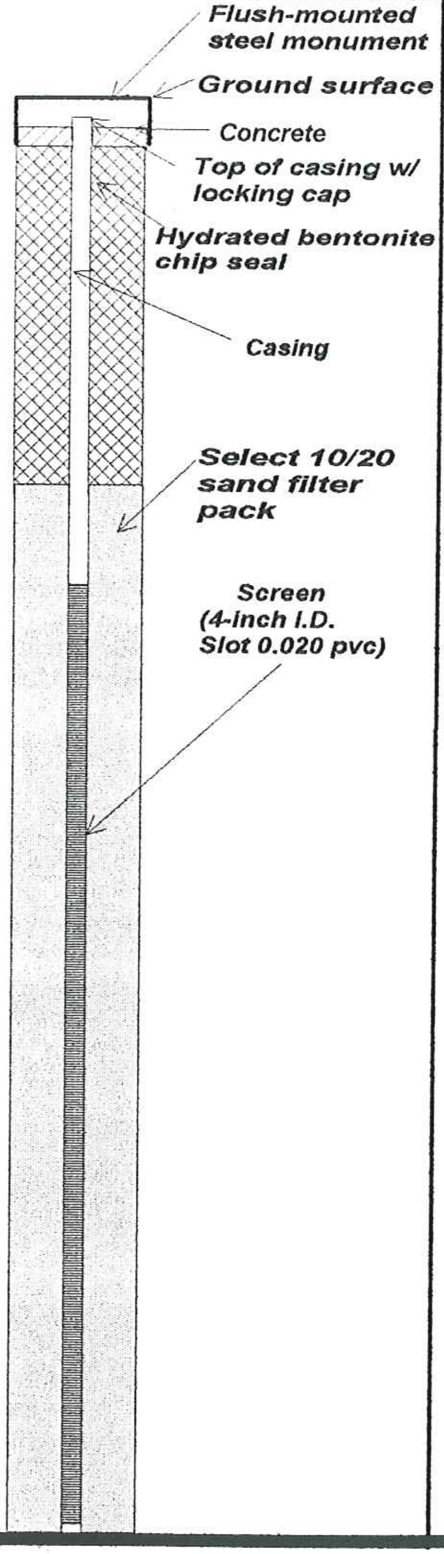
Drilling started: *2 May 2000*
Drilling completed: *2 May 2000*
Logged by: *ME*

PROJECT *Sunnyside* **W.O.** *19046* **WELL NO.** *RW-2*

Elevation reference:
Ground surface elevation: **Casing elevation:**

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
						▽ ATD
	Medium stiff, saturated, gray, SILT with fine sand		S-1	8/18 18/28	1930	
20	*Mdium stiff, saturated, gray,fine SAND with silt*					
25						
30						

AS-BUILT DESIGN



TESTING

Well terminated at approxiamtely 35 feet

LEGEND

BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

Drilling started: *2 May 2000* **Drilling completed:** *2 May 2000* **Logged by:** *ME*

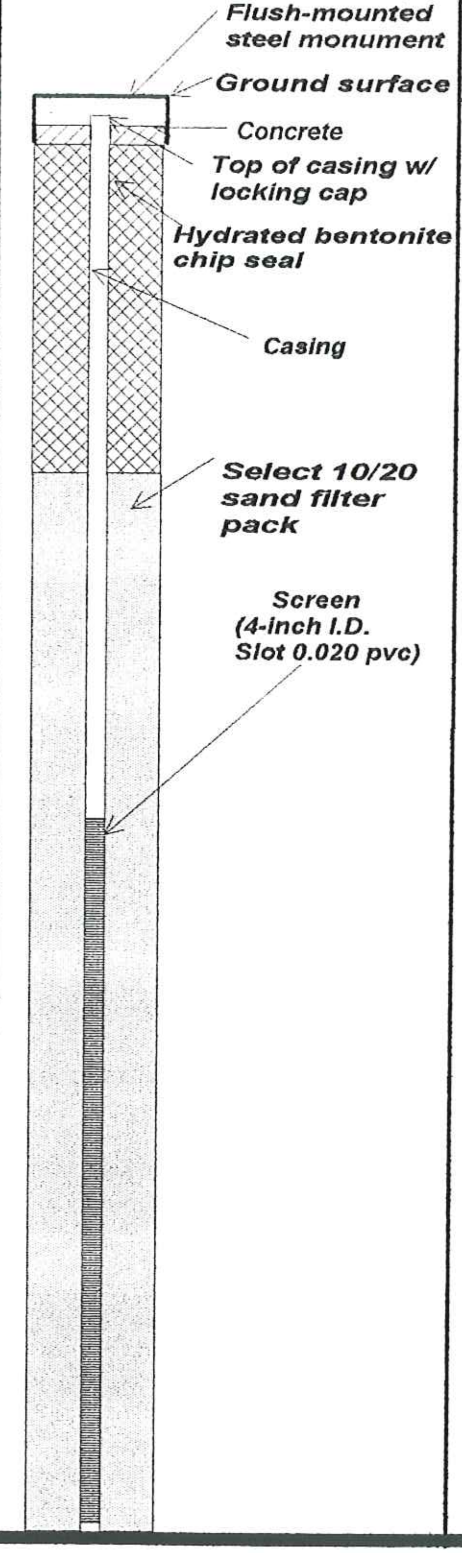
PROJECT *Sunnyside* W.O. *19046* WELL NO. *RW-3*

Elevation reference:
Ground surface elevation: Casing elevation:

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
	Stiff, wet, gray SILT with fine grained sand layers of wet, gray, fine grained SAND with little silt	☐	S-1	6/14 25/35	2938	▼ ATD
20						
25						
30						

AS-BUILT DESIGN

TESTING



Well terminated at approxiamtely 30 feet

LEGEND

BROWN AND CALDWELL
Environmental Consulting

10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

Drilling started: *1 May 2000* **Drilling completed:** *1 May 2000* **Logged by:** *ME*

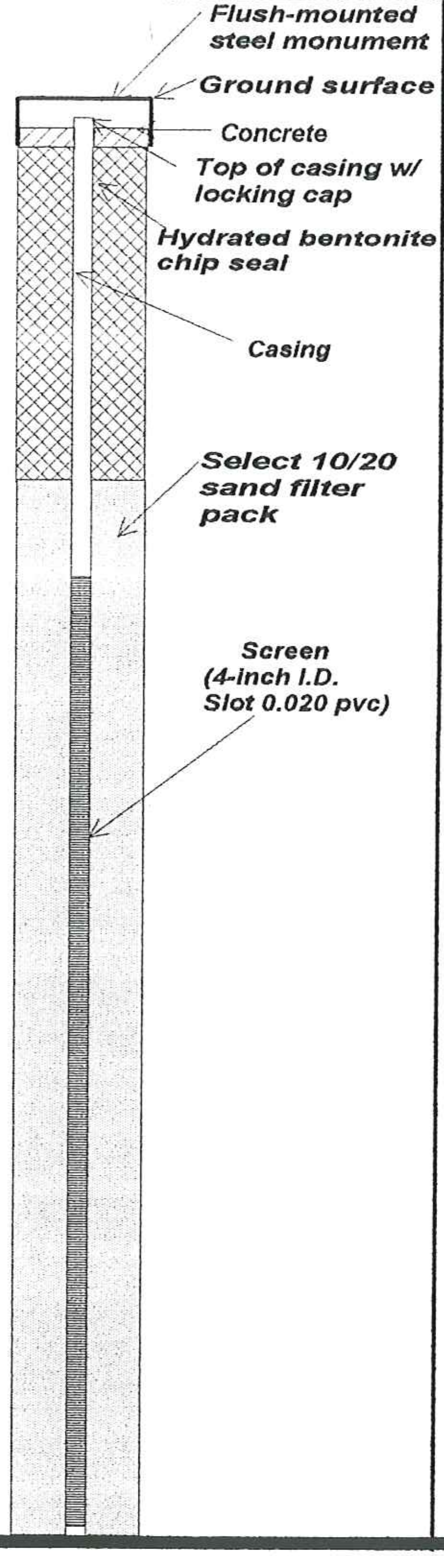
PROJECT *Sunnyside* **W.O.** *19046* **WELL NO.** *RW-4*

Elevation reference:
Ground surface elevation:
Casing elevation:

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
	Stiff, wet, gray SILT with moderate fine grained SAND		S-1	8/16 18/24	548	▼ AID
20						
25						
30						

Well terminated at approxiamtely 35 feet

AS-BUILT DESIGN



TESTING

LEGEND

BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

Drilling started: *1 May 2000* **Drilling completed:** *1 May 2000* **Logged by:** *ME*

PROJECT *Sunnyside*

W.O. *19046*

WELL NO. *RW-5*

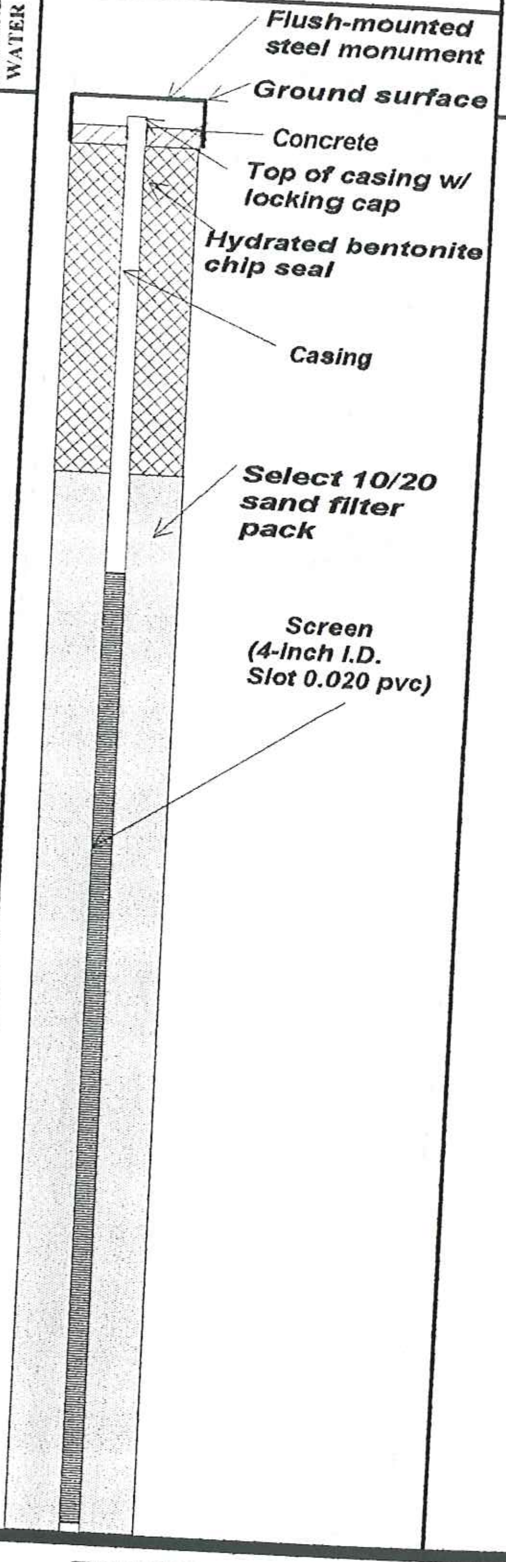
Elevation reference:

Ground surface elevation:

Casing elevation:

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
	Stiff, wet, gray SILT with fine grained SAND		S-1	10/16 28/32	3.4	▽ ATD
20						
25						
30						

AS-BUILT DESIGN



TESTING

Well terminated at approxiamtely 35 feet

LEGEND

BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

Drilling started: *1 May 2000*

Drilling completed: *1 May 2000*

Logged by: *ME*

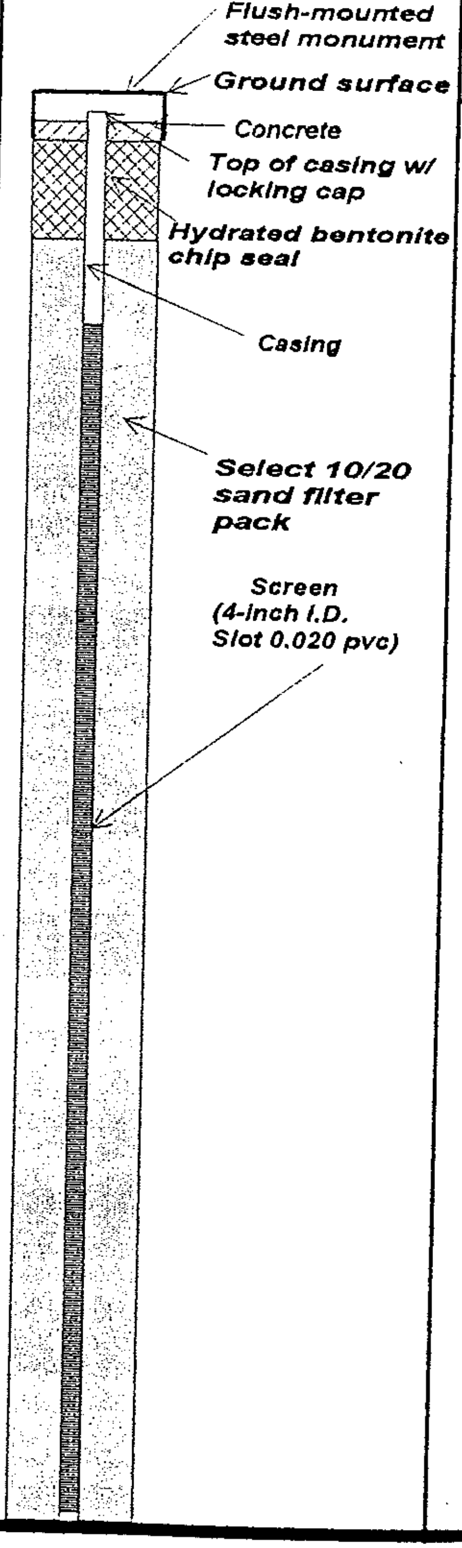
PROJECT *Sunnyside* W.O. *19046* WELL NO. *RW-6*

Elevation reference:
Ground surface elevation: Casing elevation:

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
	Medium stiff, wet, brown/gray SILT with fine grained SAND	☐	S-1	8/20 22/25	876	
	Saturated, brown/gray, fine SAND with silt					▽ ATD
20						
25						
30						

Well terminated at approxiamtely 35 feet

AS-BUILT DESIGN



TESTING

LEGEND

BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

Drilling started: *2 May 2000* Drilling completed: *2 May 2000* Logged by: *ME*

PROJECT *Sunnyside* **W.O.** *19046* **WELL NO.** *RW-7*

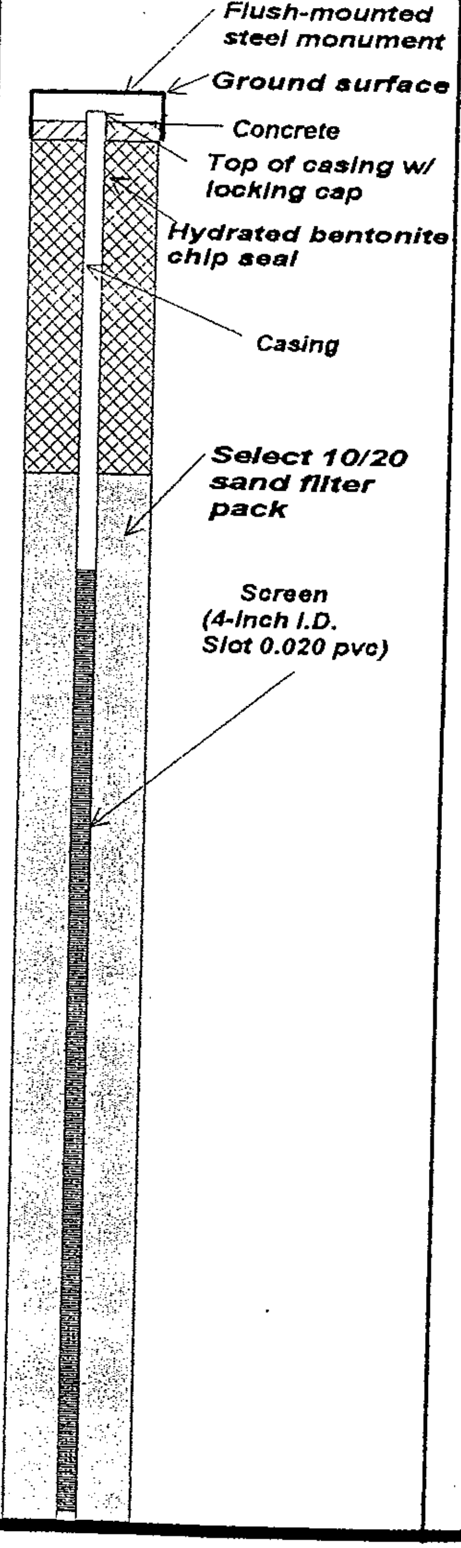
Elevation reference:

Ground surface elevation:

Casing elevation:

DEPTH (feet)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	BLOW COUNTS	OVM READING (ppm)	GROUND WATER
0						
5						
10						
15						
	Stiff, wet, brown/gray SILT with fine grained SAND	☐	S-1	9/12 18/32		ATD
20						
25						
30						

AS-BUILT DESIGN



TESTING

Well terminated at approxiamtely 35 feet

LEGEND

BROWN AND CALDWELL
Environmental Consulting
10015 North Division Street, Suite 100
Spokane, WA 99218
Tel: 509-777-1126/Fax: 509-777-1133

Drilling started: *2 May 2000* **Drilling completed:** *2 May 2000* **Logged by:** *ME*

APPENDIX B

ANALYTICAL TABLES

Table B-1
Soil Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP01	GP01	GP02	GP03	GP04	GP04	GP05	GP06	GP07	GP08	GP08
Sample Date:		01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/25/2012	01/25/2012	01/24/2012	01/24/2012	01/23/2012	01/24/2012	01/24/2012
Depth (feet bgs)		5	15	15	15	5	15	15	15	15	1	5
VOCs (µg/kg)												
1,1,1,2-Tetrachloroethane	38000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,1,1-Trichloroethane	160000000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,1,2,2-Tetrachloroethane	5000	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,1,2-Trichloroethane	18000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,1-Dichloroethane	16000000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,1-Dichloroethene	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,1-Dichloropropene	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2,3-Trichlorobenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2,3-Trichloropropane	33	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2,4-Trichlorobenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2,4-Trimethylbenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2-Dibromo-3-chloropropane	13000	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2-Dibromoethane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2-Dichlorobenzene	7200000	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2-Dichloroethane	11000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,2-Dichloropropane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,3,5-Trimethylbenzene	800000	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,3-Dichlorobenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,3-Dichloropropane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
1,4-Dichlorobenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
2,2-Dichloropropane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
2-Butanone	NV	27 U	56.2 U	62.5 U	56.1 U	57.7 U	60.1 U	53.4 U	61 U	51.5 U	53.4 U	NV
2-Chlorotoluene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
2-Hexanone	NV	13.5 U	28.1 U	31.3 U	28.1 U	28.9 U	30 U	26.7 U	30.5 U	25.7 U	26.7 U	NV
4-Chlorotoluene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
4-Isopropyltoluene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
4-Methyl-2-pentanone	NV	27 U	56.2 U	62.5 U	56.1 U	57.7 U	60.1 U	53.4 U	61 U	51.5 U	53.4 U	NV
Acetone	72000000	67.4 U	141 U	156 U	140 U	144 U	150 U	133 U	153 U	129 U	133 U	NV
Benzene	18000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Bromobenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Bromodichloromethane	16000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Bromoform	130000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Bromomethane	110000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Carbon disulfide	8000000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Carbon tetrachloride	14000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Chlorobenzene	1600000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV

Table B-1
Soil Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP01	GP01	GP02	GP03	GP04	GP04	GP05	GP06	GP07	GP08	GP08
Sample Date:		01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/25/2012	01/25/2012	01/24/2012	01/24/2012	01/23/2012	01/24/2012	01/24/2012
Depth (feet bgs)		5	15	15	15	5	15	15	15	15	1	5
Chlorobromomethane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Chloroethane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Chloroform	800000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Chloromethane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
cis-1,2-Dichloroethene	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
cis-1,3-Dichloropropene	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Dibromochloromethane	12000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Dibromomethane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Dichlorodifluoromethane	16000000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Ethylbenzene	8000000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Hexachlorobutadiene	13000	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Isopropylbenzene	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
m,p-Xylene	16000000	13.5 U	28.1 U	31.3 U	28.1 U	28.9 U	30 U	26.7 U	30.5 U	25.7 U	26.7 U	NV
Methyl tert-butyl ether	100*	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Methylene chloride	130000	33.7 U	70.3 U	78.2 U	70.1 U	72.2 U	75.1 U	66.7 U	76.3 U	64.3 U	66.7 U	NV
Naphthalene	1600000	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
n-Butylbenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
n-Propylbenzene	8000000	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
o-Xylene	16000000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
sec-Butylbenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Styrene	16000000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
tert-Butylbenzene	NV	6.74 U	14.1 U	15.6 U	15.7 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Tetrachloroethene	50*	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Toluene	6400000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
trans-1,2-dichloroethene	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
trans-1,3-Dichloropropene	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Trichloroethene	30*	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Trichlorofluoromethane	NV	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Vinyl chloride	240000	6.74 U	14.1 U	15.6 U	14 U	14.4 U	15 U	13.3 U	15.3 U	12.9 U	13.3 U	NV
Metals (mg/kg)												
Lead	250*	NV	7.13	2.45 U	6.55	NV	5.18	6.63	9.14	6.95	**876**	8.01
Hydrocarbons (mg/kg)												
Gasoline	100*	NV	3.61 U	4.34 U	3.75 U	NV	3.68 U	3.25 U	3.83 U	5.44 U	49	4.07 UJ
Diesel	2000*	NV	19.7 U	19.1 U	19.5 U	NV	20.1 U	18.5 U	19.7 U	18.1 U	155	19.6 UJ
Lube Oil	2000*	NV	65.8 U	63.7 U	65 U	NV	66.9 U	61.7 U	65.7 U	60.3 U	399	65.4 UJ
Total Heavy Oils	2000*	NV	42.8 U	41.4 U	42.3 U	NV	43.5 U	40.1 U	42.7 U	39.2 U	554	42.5 UJ

Table B-1
Soil Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP08	GP09	GP10	GP11	GP11-DUP	GP12	GP13	GP14	GP15	GP16	GP17
Sample Date:		01/24/2012	01/25/2012	01/27/2012	01/27/2012	01/27/2012	01/27/2012	06/19/2012	06/19/2012	06/19/2012	06/18/2012	06/18/2012
Depth (feet bgs)		15	15	15	15	15	1	12	12	14	15	15
VOCs (µg/kg)												
1,1,1,2-Tetrachloroethane	38000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,1,1-Trichloroethane	160000000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,1,2,2-Tetrachloroethane	5000	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,1,2-Trichloroethane	18000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,1-Dichloroethane	16000000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,1-Dichloroethene	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,1-Dichloropropene	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2,3-Trichlorobenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2,3-Trichloropropane	33	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2,4-Trichlorobenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2,4-Trimethylbenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2-Dibromo-3-chloropropane	13000	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2-Dibromoethane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2-Dichlorobenzene	7200000	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2-Dichloroethane	11000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,2-Dichloropropane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,3,5-Trimethylbenzene	800000	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,3-Dichlorobenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,3-Dichloropropane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
1,4-Dichlorobenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
2,2-Dichloropropane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
2-Butanone	NV	68.3 U	48.8 U	66.3 U	63.4 U	69.2 U	49.7 U	49.8 U	45.4 U	41.4 U	39.1 U	47.6 U
2-Chlorotoluene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
2-Hexanone	NV	34.2 U	24.4 U	33.1 U	31.7 U	34.6 U	24.9 U	24.9 U	22.7 U	20.7 U	19.6 U	23.8 U
4-Chlorotoluene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
4-Isopropyltoluene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
4-Methyl-2-pentanone	NV	68.3 U	48.8 U	66.3 U	63.4 U	69.2 U	49.7 U	49.8 U	45.4 U	41.4 U	39.1 U	47.6 U
Acetone	72000000	171 U	122 U	166 U	159 U	173 U	199	124 U	113 U	103 U	97.8 U	119 U
Benzene	18000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Bromobenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Bromodichloromethane	16000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Bromoform	130000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Bromomethane	110000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Carbon disulfide	8000000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Carbon tetrachloride	14000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Chlorobenzene	1600000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U

Table B-1
Soil Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP08	GP09	GP10	GP11	GP11-DUP	GP12	GP13	GP14	GP15	GP16	GP17
Sample Date:		01/24/2012	01/25/2012	01/27/2012	01/27/2012	01/27/2012	01/27/2012	06/19/2012	06/19/2012	06/19/2012	06/18/2012	06/18/2012
Depth (feet bgs)		15	15	15	15	15	1	12	12	14	15	15
Chlorobromomethane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Chloroethane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Chloroform	800000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Chloromethane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
cis-1,2-Dichloroethene	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
cis-1,3-Dichloropropene	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Dibromochloromethane	12000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Dibromomethane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Dichlorodifluoromethane	16000000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Ethylbenzene	8000000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Hexachlorobutadiene	13000	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Isopropylbenzene	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
m,p-Xylene	16000000	34.2 U	24.4 U	33.1 U	31.7 U	34.6 U	24.9 U	24.9 U	22.7 U	20.7 U	19.6 U	23.8 U
Methyl tert-butyl ether	100*	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Methylene chloride	130000	85.4 U	61 U	82.8 U	79.3 U	86.5 U	62.1 U	62.2 U	56.7 U	51.7 U	48.9 U	59.5 U
Naphthalene	1600000	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
n-Butylbenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
n-Propylbenzene	8000000	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
o-Xylene	16000000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
sec-Butylbenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Styrene	16000000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
tert-Butylbenzene	NV	17.1 U	12.2 U	15.5 U	12.7 U	658 U	11.9 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Tetrachloroethene	50*	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Toluene	6400000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
trans-1,2-dichloroethene	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
trans-1,3-Dichloropropene	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Trichloroethene	30*	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Trichlorofluoromethane	NV	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Vinyl chloride	240000	17.1 U	12.2 U	16.6 U	15.9 U	17.3 U	12.4 U	12.4 U	11.3 U	10.3 U	9.78 U	11.9 U
Metals (mg/kg)												
Lead	250*	7.15	5.93	5.24	2.93	4.38	6.18	NV	NV	NV	NV	NV
Hydrocarbons (mg/kg)												
Gasoline	100*	3.99 U	3.24 U	3.38 U	6 U	3.49 U	3.17 U	NV	NV	NV	NV	NV
Diesel	2000*	19.1 U	18.4 U	19.5 U	19 U	19.7 U	18.2 U	NV	NV	NV	NV	NV
Lube Oil	2000*	63.7 U	61.4 U	64.9 U	63.4 U	65.8 U	60.5 U	NV	NV	NV	NV	NV
Total Heavy Oils	2000*	41.4 U	39.9 U	42.2 U	41.2 U	42.8 U	39.4 U	NV	NV	NV	NV	NV

Table B-1
Soil Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

NOTES:

Exceedances in **bold**.

bgs = below ground surface.

J = Result is an estimated quantity. Associated numerical value is approximate concentration of analyte in sample.

mg/kg = milligrams per kilogram (parts per million).

MTCA = Model Toxics Control Act. MTCA cleanup levels are from Method B unless otherwise noted.

µg/kg = micrograms per kilogram (parts per billion).

NV = no value.

U = Analyte not detected at or above method detection limit.

VOC = volatile organic compound.

*MTCA Method A unrestricted land use cleanup level.

Table B-2
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP01	GP01	GP02	GP02	GP03	GP03	GP04	GP04	GP05	GP05	GP06	GP06	GP07
	Sample Date:	01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/25/2012	01/25/2012	01/24/2012	01/24/2012	01/24/2012	01/24/2012	01/23/2012
	Depth (feet bgs)	22.5	37.5	22.5	37.5	22.5	37.5	22.5	37.5	20	35	22.5	42.5	22.5
VOCs (µg/L)														
1,1,1,2-Tetrachloroethane	1.7	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	16000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	0.22	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	0.77	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloropropene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	0.0015	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2,4-Trichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-Trimethylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	0.055	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dibromoethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	720	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	0.48	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3,5-Trimethylbenzene	80	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Hexanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Isopropyltoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acetone	7200	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Benzene	0.8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	0.71	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	5.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	11	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon disulfide	800	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	0.63	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	160	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobromomethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Table B-2
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP01	GP01	GP02	GP02	GP03	GP03	GP04	GP04	GP05	GP05	GP06	GP06	GP07
	Sample Date:	01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/26/2012	01/25/2012	01/25/2012	01/24/2012	01/24/2012	01/24/2012	01/24/2012	01/23/2012
	Depth (feet bgs)	22.5	37.5	22.5	37.5	22.5	37.5	22.5	37.5	20	35	22.5	42.5	22.5
Chloroethane	NV	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	80	1 U	1.7	1.5	2.1	1 U	1 U	1 U	1 U	1 U	1.2	1 U	1 U	1 U
Chloromethane	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
cis-1,2-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	NV	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	800	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Freon 113	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Isopropylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m,p-Xylene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methyl tert-butyl ether	20	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	5.8	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	160	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
n-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
n-Propylbenzene	800	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
sec-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Styrene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
tert-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5*	1 U	1.9	1	4	1 U	2.6	1 U	1 U	1 U	**10**	1 U	1 U	1 U
Toluene	1000*	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	NV	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5*	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Acetate	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl chloride	24	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Hydrocarbons (mg/L)														
Gasoline	1*	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Diesel	0.5*	0.101	0.0783 U	0.0769 U	0.0762 U	0.0771 U	0.0998	0.1	0.0763 U	0.118	0.0769 U	0.166	0.0773 U	0.0766 U
Lube Oil	0.5*	0.381	0.196 U	0.192 U	0.19 U	0.193 U	0.382	0.192 U	0.191 U	0.195 U	0.192 U	0.191 U	0.193 U	0.192 U
CSIA of Tetrachloroethene (PCE)														
δ^{37}Cl ‰ (SMOC)	NV	NV	1.5	1.6	1	NV	1.1	NV	NV	NV	1.3	NV	NV	NV
δ^{13}C ‰ (PDB)	NV	NV	-27.7	-27.9	-28.1	NV	-27.9	NV	NV	NV	-27.6	NV	NV	NV

Table B-2
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP07	GP08	GP08	GP09	GP09	GP10	GP10	GP11	GP11	GP13	GP13	GP14	GP14
	Sample Date:	01/23/2012	01/25/2012	01/25/2012	01/25/2012	01/25/2012	01/27/2012	01/27/2012	01/27/2012	01/27/2012	06/19/2012	06/19/2012	06/19/2012	06/19/2012
	Depth (feet bgs)	42.5	22.5	32.5	22.5	35	22.5	37.5	22.5	37.5	21	29	22	32
VOCs (µg/L)														
1,1,1,2-Tetrachloroethane	1.7	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	16000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	0.22	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	0.77	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloropropene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	0.0015	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2,4-Trichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-Trimethylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	0.055	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dibromoethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	720	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	0.48	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3,5-Trimethylbenzene	80	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Hexanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Isopropyltoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acetone	7200	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Benzene	0.8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	0.71	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	5.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	11	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon disulfide	800	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	0.63	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	160	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobromomethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Table B-2
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP07	GP08	GP08	GP09	GP09	GP10	GP10	GP11	GP11	GP13	GP13	GP14	GP14
Sample Date:		01/23/2012	01/25/2012	01/25/2012	01/25/2012	01/25/2012	01/27/2012	01/27/2012	01/27/2012	01/27/2012	06/19/2012	06/19/2012	06/19/2012	06/19/2012
Depth (feet bgs)		42.5	22.5	32.5	22.5	35	22.5	37.5	22.5	37.5	21	29	22	32
Chloroethane	NV	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	80	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
cis-1,2-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	NV	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	800	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Freon 113	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Isopropylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m,p-Xylene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methyl tert-butyl ether	20	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	5.8	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	160	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
n-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
n-Propylbenzene	800	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
sec-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Styrene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
tert-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5*	**17**	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1000*	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	NV	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5*	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Acetate	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl chloride	24	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Hydrocarbons (mg/L)														
Gasoline	1*	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NV	NV	NV	NV
Diesel	0.5*	0.0771 U	0.207	0.0773 U	0.0798 U	0.0806 U	0.0768 U	0.0763 U	0.266	0.114	NV	NV	NV	NV
Lube Oil	0.5*	0.193 U	0.479	0.193 U	0.199 U	0.202 U	0.192 U	0.191 U	1.33	0.318	NV	NV	NV	NV
CSIA of Tetrachloroethene (PCE)														
δ^{37}Cl ‰ (SMOC)	NV	1.1	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV
δ^{13}C ‰ (PDB)	NV	-27.9	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV	NV

Table B-2
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP14-W-DUP	GP15	GP15	GP16	GP16	GP17	GP17	MW18	RW04	RMW09-DUP	RMW09
	Sample Date:	06/19/2012	06/19/2012	06/19/2012	06/19/2012	06/18/2012	06/19/2012	06/18/2012	01/23/2012	01/25/2012	01/26/2012	01/26/2012
	Depth (feet bgs)	32	22	34	22	32	20	30	25	25	25	25
VOCs (µg/L)												
1,1,1,2-Tetrachloroethane	1.7	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	16000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	0.22	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	0.77	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloropropene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	0.0015	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2,4-Trichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-Trimethylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	0.055	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
1,2-Dibromoethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	720	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	0.48	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3,5-Trimethylbenzene	80	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
2-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Hexanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
4-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Isopropyltoluene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Acetone	7200	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U	20 U
Benzene	0.8	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Bromobenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	0.71	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	5.5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	11	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon disulfide	800	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Carbon tetrachloride	0.63	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Chlorobenzene	160	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobromomethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

Table B-2
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	MTCA Cleanup Level	GP14-W-DUP	GP15	GP15	GP16	GP16	GP17	GP17	MW18	RW04	RMW09-DUP	RMW09
Sample Date:		06/19/2012	06/19/2012	06/19/2012	06/19/2012	06/18/2012	06/19/2012	06/18/2012	01/23/2012	01/25/2012	01/26/2012	01/26/2012
Depth (feet bgs)		32	22	34	22	32	20	30	25	25	25	25
Chloroethane	NV	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Chloroform	80	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
cis-1,2-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	NV	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Dibromochloromethane	0.52	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dichlorodifluoromethane	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	800	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Freon 113	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Isopropylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m,p-Xylene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methyl tert-butyl ether	20	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	15	**250**	**250**
Methylene chloride	5.8	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	160	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
n-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
n-Propylbenzene	800	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
sec-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Styrene	1600	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
tert-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5*	1 U	1 U	1 U	1 U	1 U	1 U	1 U	**15**	1.9	1 U	1 U
Toluene	1000*	1 U	1 U	1 U	1 U	1 U	6.2	1 U	1 U	1 U	1 U	1 U
trans-1,2-dichloroethene	NV	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	NV	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5*	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl Acetate	NV	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Vinyl chloride	24	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Hydrocarbons (mg/L)												
Gasoline	1*	NV	NV	NV	NV	NV	NV	NV	0.1 U	0.1 U	0.1 U	0.1 U
Diesel	0.5*	NV	NV	NV	NV	NV	NV	NV	0.191	0.0764 U	0.244	0.241
Lube Oil	0.5*	NV	NV	NV	NV	NV	NV	NV	0.984	0.191 U	0.191 U	0.292
CSIA of Tetrachloroethene (PCE)												
δ^{37}Cl ‰ (SMOC)	NV	NV	NV	NV	NV	NV	NV	NV	1	1.5	NV	NV
δ^{13}C ‰ (PDB)	NV	NV	NV	NV	NV	NV	NV	NV	-28.4	-27.9	NV	NV

Table B-2
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

NOTES:

Exceedances in **bold**.

$\delta^{13}C$ (PDB) = ratio of carbon-13 to carbon-12 stable isotopes relative to the Pee Dee Belemnite standard.

$\delta^{37}Cl$ (SMOC) = ratio of chlorine-37 to chlorine-35 stable isotopes relative to the Standard Mean Ocean Chloride.

‰ = per mil.

bgs = below ground surface.

CSIA = compound-specific isotope analyses.

mg/L = milligrams per liter (parts per million).

MTCA = Model Toxics Control Act. MTCA cleanup levels are from Method B unless otherwise noted.

µg/L = micrograms per liter (parts per billion).

NV = no value.

U = Analyte not detected at or above method detection limit.

VOC = volatile organic compound.

*MTCA Method A groundwater cleanup level.

Table B-3
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Location:		MW13	MW17	MW17-DUP	MW19	MW20
Collection Date:		05/29/2013	05/29/2013	05/29/2013	05/29/2013	05/29/2013
Screened Interval Depth (ft bgs):		15 to 25	15 to 30	15 to 30	14.5 to 29.5	14.5 to 29.5
	MTCA Method A CUL					
Anions (mg/L)						
Chloride	NV	**376**	**24.2**	**24.3**	**42.7**	**45.7**
Nitrate*	10	**105**	**6.1**	**6.1**	**10.4**	**16.3**
Sulfate	NV	**237**	**44.5**	**44.1**	**73.6**	**95.8**
Dissolved Metals (mg/L)						
Calcium	NV	**342**	**88.6**	**88.9**	**125**	**207**
Iron	NV	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Magnesium	NV	**104**	**22.8**	**22.8**	**34.8**	**57**
Manganese	NV	**0.476**	**0.001**	**0.002**	**0.001**	**0.004**
Total Organic Carbon (mg/L)						
Total Organic Carbon	NV	**7.84**	1.5 U	1.5 U	**1.78**	**5.21**
VOCs (µg/L)						
1,1,1,2-Tetrachloroethane	NV	1 U	1 U	1 U	1 U	1 U
1,1,1-Trichloroethane	200	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	NV	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	NV	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	NV	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U
1,1-Dichloropropene	NV	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichlorobenzene	NV	5 U	5 U	5 U	5 U	5 U
1,2,3-Trichloropropane	NV	2 U	2 U	2 U	2 U	2 U
1,2,4-Trichlorobenzene	NV	5 U	5 U	5 U	5 U	5 U
1,2,4-Trimethylbenzene	NV	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	NV	5 U	5 U	5 U	5 U	5 U

Table B-3
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

	Location:	MW13	MW17	MW17-DUP	MW19	MW20
	Collection Date:	05/29/2013	05/29/2013	05/29/2013	05/29/2013	05/29/2013
	Screened Interval Depth (ft bgs):	15 to 25	15 to 30	15 to 30	14.5 to 29.5	14.5 to 29.5
	MTCA Method A CUL					
1,2-Dibromoethane	0.01	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	5	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U
1,3,5-Trimethylbenzene	NV	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U
1,3-Dichloropropane	NV	5 U	5 U	5 U	5 U	5 U
1,4-Dichlorobenzene	NV	1 U	1 U	1 U	1 U	1 U
2,2-Dichloropropane	NV	1 U	1 U	1 U	1 U	1 U
2-Butanone	NV	5 U	5 U	5 U	5 U	5 U
2-Chloroethylvinyl ether	NV	5 U	5 U	5 U	5 U	5 U
2-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U
2-Hexanone	NV	5 U	5 U	5 U	5 U	5 U
4-Chlorotoluene	NV	1 U	1 U	1 U	1 U	1 U
4-Isopropyltoluene	NV	1 U	1 U	1 U	1 U	1 U
4-Methyl-2-pentanone	NV	5 U	5 U	5 U	5 U	5 U
Acetone	NV	10 U	10 U	10 U	10 U	10 U
Acrolein	NV	10 U	10 U	10 U	10 U	10 U
Acrylonitrile	NV	5 U	5 U	5 U	5 U	5 U
Benzene	5	1 U	1 U	1 U	1 U	1 U
Bromobenzene	NV	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	NV	1 U	1 U	1 U	1 U	1 U
Bromoethane	NV	2 U	2 U	2 U	2 U	2 U
Bromoform	NV	1 U	1 U	1 U	1 U	1 U

Table B-3
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

	Location:	MW13	MW17	MW17-DUP	MW19	MW20
	Collection Date:	05/29/2013	05/29/2013	05/29/2013	05/29/2013	05/29/2013
	Screened Interval Depth (ft bgs):	15 to 25	15 to 30	15 to 30	14.5 to 29.5	14.5 to 29.5
	MTCA Method A CUL					
Bromomethane	NV	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	NV	1 U	1 U	1 U	1 U	1 U
Carbon tetrachloride	NV	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	NV	1 U	1 U	1 U	1 U	1 U
Chlorobromomethane	NV	1 U	1 U	1 U	1 U	1 U
Chloroethane	NV	1 U	1 U	1 U	1 U	1 U
Chloroform	NV	1 U	1 U	1 U	1 U	1 U
Chloromethane	NV	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	NV	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	NV	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	NV	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NV	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	700	1 U	1 U	1 U	1 U	1 U
Freon 113	NV	2 U	2 U	2 U	2 U	2 U
Hexachlorobutadiene	NV	5 U	5 U	5 U	5 U	5 U
Isopropylbenzene	NV	1 U	1 U	1 U	1 U	1 U
m,p-Xylene	1000	2 U	2 U	2 U	2 U	2 U
Methyl iodide	NV	1 U	1 U	1 U	1 U	1 U
Methyl tert-butyl ether	20	**5.1**	1 U	1 U	1 U	1 U
Methylene chloride	5	2 U	2 U	2 U	2 U	2 U
Naphthalene	160	5 U	5 U	5 U	5 U	5 U
n-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U
n-Propylbenzene	NV	1 U	1 U	1 U	1 U	1 U
o-Xylene	NV	1 U	1 U	1 U	1 U	1 U

Table B-3
Groundwater Analytical Results
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

	Location:	MW13	MW17	MW17-DUP	MW19	MW20
	Collection Date:	05/29/2013	05/29/2013	05/29/2013	05/29/2013	05/29/2013
	Screened Interval Depth (ft bgs):	15 to 25	15 to 30	15 to 30	14.5 to 29.5	14.5 to 29.5
	MTCA Method A CUL					
sec-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U
Styrene	NV	1 U	1 U	1 U	1 U	1 U
tert-Butylbenzene	NV	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	1 U	**6.8**	**7.2**	**4.4**	1 U
Toluene	1000	1 U	1 U	1 U	1 U	1 U
trans-1,2-dichloroethene	NV	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	NV	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	NV	5 U	5 U	5 U	5 U	5 U
Trichloroethene	5	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	NV	1 U	1 U	1 U	1 U	1 U
Vinyl Acetate	NV	5 U	5 U	5 U	5 U	5 U
Vinyl chloride	0.2	1 U	1 U	1 U	1 U	1 U

NOTES:

Exceedances highlighted.

Detection in **bold.**

CUL = cleanup level.

ft bgs = feet below ground surface.

mg/L = milligrams per liter (parts per million).

MTCA = Model Toxics and Control Act.

µg/L = micrograms per liter (parts per billion).

NV = no value.

U = Analyte was not detected at or above method reporting limit.

VOC = Volatile Organic Compound.

*Nitrate is not an indicator hazardous substance for the Property, is not associated with historical activities on the Property, and was analyzed in order to characterize geochemical conditions.

Table B-4
Soil Analytical Results (mg/kg)
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

	Location:	HA01	HA02	HA03
	Collection Date:	05/29/2013	05/29/2013	05/29/2013
	Depth (ft bgs):	1.5	1.5	1.5
	MTCA Method A Unrestricted Land Use CUL			
Total Metals				
Lead	250	**17**	**143**	**9**

NOTES:

Detection in **bold.**

CUL = cleanup level.

ft bgs = feet below ground surface.

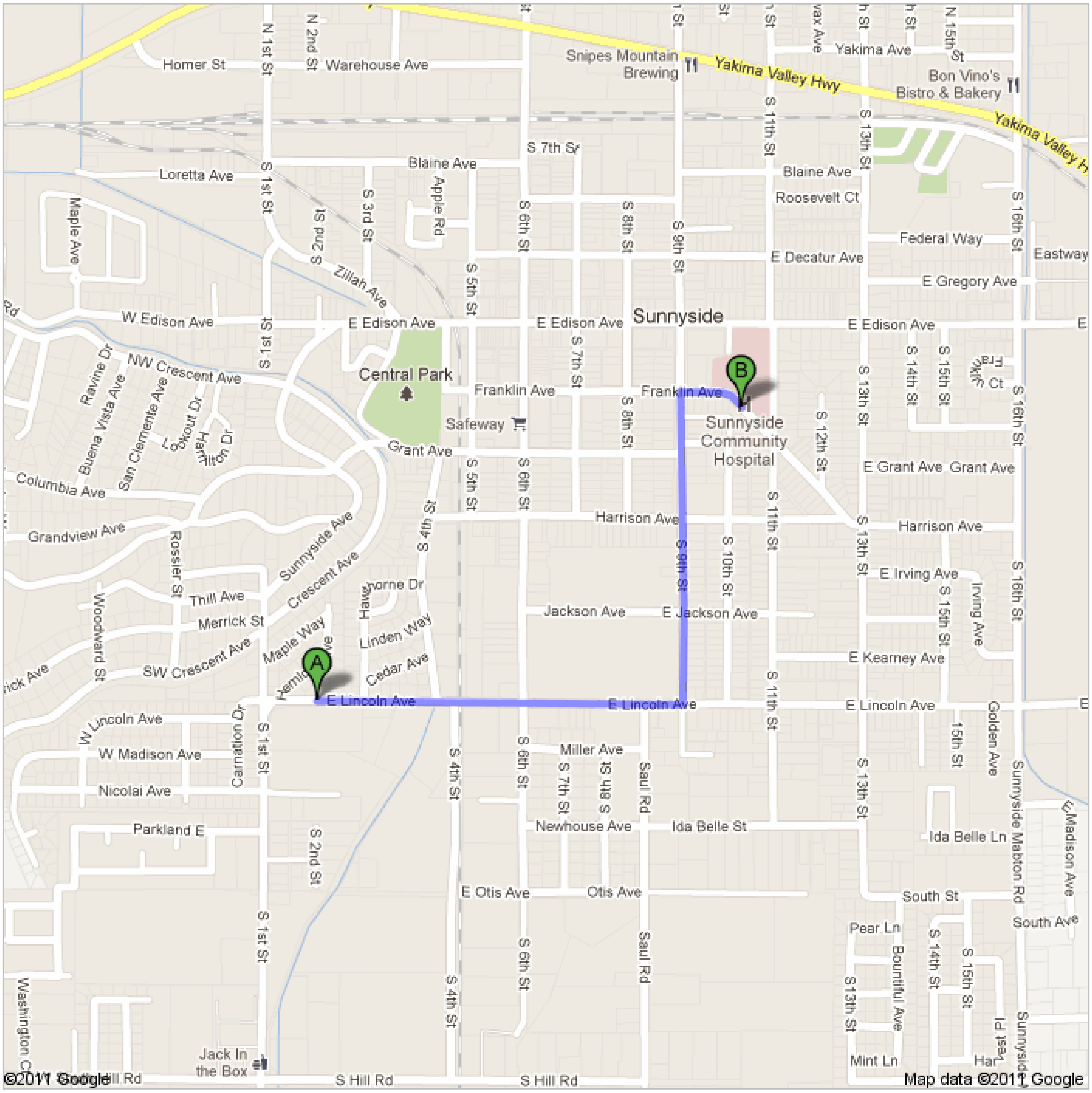
mg/kg = milligrams per kilogram (parts per million).

MTCA = Model Toxics Control Act.

APPENDIX C

HEALTH AND SAFETY PLAN

Directions to 1016 Tacoma Ave, Sunnyside, WA 98944
1.0 mi – about **3 mins**



A 111 E Lincoln Ave, Sunnyside, WA 98944

1.	Head **east** on **E Lincoln Ave** toward **Hawthorn Dr/Hawthorne Dr** About 1 min	go 0.5 mi total 0.5 mi
2.	Turn left onto **S 9th St** About 2 mins	go 0.4 mi total 0.9 mi
3.	Turn right onto **Franklin Ave**	go 295 ft total 1.0 mi
4.	Continue onto **Tacoma Ave** Destination will be on the left	go 177 ft total 1.0 mi

B 1016 Tacoma Ave, Sunnyside, WA 98944

HEALTH AND SAFETY PLAN

FORMER CREAM WINE PROPERTY
111 EAST LINCOLN AVENUE
SUNNYSIDE, WASHINGTON

Prepared for

PORT OF SUNNYSIDE

SUNNYSIDE, WASHINGTON

August 13, 2013

Project No. 0346.04.06

Prepared by

Maul Foster & Alongi, Inc.

1329 N State Street, Suite 301, Bellingham WA 98225

MAUL
FOSTER
ALONGI

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HEALTH AND SAFETY PLAN

FORMER CREAM WINE PROPERTY
111 EAST LINCOLN AVENUE
SUNNYSIDE, WASHINGTON

The material and data in this health and safety plan were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.

Heather Hirsch, LHG
Project Hydrogeologist

Justin Clary, PE
Principal Engineer

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CONTENTS

1 NEAREST HOSPITAL/EMERGENCY MEDICAL CENTER

1.1 Nearest Hospital

Sunnyside Community Hospital
1016 Tacoma Avenue
Sunnyside, WA 98944

Phone: 509-837-1500

Distance: 1.0 mile

Travel Time: 3 minutes

1.2 Emergency Route to Hospital

See first page of document.

1.2.1 Driving Directions

1. Head east on E Lincoln Avenue toward Hawthorne Drive.
2. Turn left onto S 9th Street.
3. Turn right onto Franklin Avenue.
4. Continue onto Tacoma Avenue; hospital will be on the left.

1.3 Emergency Phone Numbers

Ambulance, Police, Fire	**Dial 911**
Michael Stringer Project Manager	Phone: (206) 858-7617 Cell: (206) 498-9147
Jim Darling Project Director	Phone: (360) 594-6252 Cell: (360) 739-1595
Andrew Vidourek Health and Safety Coordinator	Phone: (360) 433-0248 Cell: (541) 760-9692

2 PROJECT INFORMATION

Date: July 8, 2013

Project: 0346.04.06

Site: Former Cream Wine property (the "Site")

Location: Sunnyside, Washington

Project Manager: Michael Stringer

Prepared By: Heather Hirsch

3 KEY PROJECT PERSONNEL

3.1 Site Work Team

Name	Responsibility
Jim Darling	Project Director
Michael Stringer	Project Manager
Heather Hirsch	Field Personnel
Connor Lamb	Field Personnel
Andrew Vidourek	Health and Safety Coordinator

3.2 Entry Briefing Date

First day of on-site work.

3.3 Special Conditions (e.g., work schedule or limitations)

Any work performed at night must be include lights mounted on stands (or equivalent) and use of the "buddy system."

Maul Foster & Alongi, Inc. (MFA) personnel are not allowed to perform site activities alone after dark.

3.4 Required Training

MFA employees as well as contractor employees assigned to perform field activities covered by this health and safety plan (HASP) must be currently approved for hazardous-waste fieldwork, including:

- Current medical clearance to conduct hazardous-waste fieldwork and to wear a respirator;
- Successful completion of a respirator fit test within the last 12 months for the make and model of the respirator assigned to that individual; and
- Completion of training as required by Title 29 Code of Federal Regulations (CFR) 1910.120(e), including:
    - Forty hours of hazardous-waste worker basic instruction within the last 12 months, or
    - Eight hours of hazardous-waste worker refresher training within the last 12 months, subsequent to completion of 40 hours of basic hazardous-waste worker training.

3.5 Special Training

Copies of all required training certificates, current medical surveillance certificates, and respirator fit test records must be compiled before site entry. This information must also be provided to MFA by all subcontractors for their on-site personnel.

4 PROJECT DESCRIPTION

MFA has prepared this HASP for the former Cream Wine property (the Site). The physical address of the Site is 111 East Lincoln Avenue, Sunnyside, Washington. The Site is located in section 36, township 10 north, range 22 east of the Willamette Meridian. MFA will be conducting remedial actions, including oversight of soil excavation and in situ groundwater treatment, at the Site. This HASP has been prepared to instruct MFA personnel working on site. Any contractors or subcontractors involved in the scope of work for this HASP are responsible for developing their own HASPs to ensure that proper health and safety procedures are followed by their personnel.

The purpose of this HASP is to provide information to minimize the potential for adverse exposures or injuries while performing work on the Site. A combination of personal protective equipment (PPE), engineering controls, and safe work practices will be used to minimize the risk of physical injuries and chemical exposures. All personnel are advised that this field project may result in exposure to chemical and physical hazards, and that this plan must be followed to minimize and/or eliminate these risks.

The procedures and requirements contained in this plan are intended for MFA personnel performing field activities. All MFA field personnel are responsible for understanding and adhering to this HASP, and should also be alert to any unsafe conditions or practices that may affect their safety. Each day before beginning fieldwork, a site safety officer (SSO) who is familiar with health and safety procedures and the Site will be designated by the on-site MFA personnel. All subcontractors have the primary responsibility for the safety of their own personnel on the Site. Any safety deficiencies should be immediately communicated to the SSO and to the health and safety coordinator (HSC). If personnel safety is threatened, the SSO, project manager, or MFA HSC must be contacted immediately.

All personnel who will be working on site are required to read and understand this HASP. All personnel entering the work area must sign the Personnel Acknowledgment Sheet (Section 12), certifying that they have read and understand this HASP and agree to abide by it.

4.1 Scope of Work

The MFA scope of work for this project includes the following activities:

- Soil excavation oversight and field screening
- Profiling of stockpiles and/or waste drums for disposal purposes
- Oversight of backfilling, including compacting and grading
- Oversight of monitoring well decommissioning

- Oversight of in situ groundwater treatment
- Soil and groundwater sampling
- Water level monitoring

NOTE: This HASP must be reevaluated and updated annually or when site conditions or scope of work changes.

5 FACILITY DESCRIPTION AND BACKGROUND

5.1 Type of Facility

The Site was originally developed for use as an evaporated milk plant and was later used as a winery. The Site has remained vacant and unused since 2010. The Site is zoned as "heavy industrial" and is bordered by residential, industrial, and commercial zones.

5.2 Building/Structures

The facility has three main buildings: the winery, former chemical storage building, and groundwater remediation building.

5.3 Access

The Site is accessible from S 1st Street.

5.4 Topography

The Site is mostly flat, with a slight, gentle dipping to the southeast.

5.5 General Geologic/Hydrologic Setting

Previous investigations indicate that most of the Site is underlain by 10 to 15 feet of silt overlying an approximately 20- to 35-foot-thick deposit of interbedded silty sand and sandy silt, which most likely represent the lacustrine deposits from the Missoula Floods. A dense silt and clay unit underlies the silty sand and sandy silt, generally at a depth of 40 feet below ground surface.

The silty sand and sandy silt deposits make up an unconsolidated, shallow aquifer that has been observed to be hydraulically disconnected from deeper groundwater present beneath the Site. Groundwater was typically encountered between 11.5 and 22 feet below ground surface, and the average groundwater flow direction historically observed at the Site is toward the southeast. The underlying silt and clay unit was characterized as unsaturated and likely acts as a fully confining unit, based on the observed absence of moisture and the hydraulic discontinuity between the shallow and deep groundwater units identified by previous investigations.

5.6 Site Status

Inactive.

5.7 Site History

The Site was originally developed for use as an evaporated milk plant, which operated from approximately 1942 to 1986. The Site was used as a winery and was punctuated by periods of inactivity, starting in 1988, until it was vacated in 2010. The Site has remained vacant and unused since 2010.

TOC Holdings Company ("Time Oil") has conducted groundwater remediation at the Property for petroleum hydrocarbon, benzene, and methyl tert-butyl ether (MTBE) contamination, which originated from an underground storage tank release at the upgradient Valley View Market (VVM) property. Petroleum hydrocarbon contamination was addressed through dual-phase groundwater extraction. The remaining benzene and MTBE were addressed by in situ groundwater treatment. Quarterly groundwater monitoring has been conducted since 2010 to monitor concentrations of MTBE and benzene following treatment. The most recent round of groundwater monitoring showed groundwater cleanup levels are being met; therefore, Time Oil plans to request a No Further Action determination from Ecology for the VVM site.

Tetrachloroethene (PCE) contamination has also been detected in groundwater at the Site; this likely originated from a former dry cleaner at the VVM property. PCE was confirmed not to be migrating across the downgradient, southern site boundary above the Model Toxics Control Act (MTCA) Method A cleanup level. One lead exceedance of the MTCA Method A cleanup level was observed in shallow soil adjacent to the former chemical storage building. No other environmental conditions were identified.

5.8 Special Conditions/Comments

Vehicular traffic poses a potential safety hazard. If the work area is located in a travel corridor, use triangle reflectors, traffic cones, and/or traffic barriers immediately upon beginning work at a sampling location. See Appendix A for procedures for conducting work near vehicular traffic.

6 WASTE TYPE(S)/CHARACTERISTICS

6.1 Hazardous Substances

Are hazardous substances known to have been stored/spilled on site?

__X__ YES ______ NO

6.2 Special Considerations/Comments

Before any site work, a copy of this HASP must be read and the Acknowledgment page (Section 12) signed. Before any underground exploration begins, make sure the following calls are made: One Call Utility Check, (800) 424-5555; on site—contact a private utility-locating company.

7 HAZARD EVALUATION

The following subsections describe the potential physical and chemical hazards associated with implementing this project. The control measures that field personnel must use to eliminate or minimize these hazards, such as air monitoring, PPE, and decontamination procedures, are detailed in subsequent sections of this plan.

7.1 Physical Hazards

Potential physical hazards in site operations include:

- Vehicular traffic
- Equipment and machinery
- Fire/explosion
- Falling objects/loads
- Uneven walking surfaces
- Noise

7.2 Electrical/Mechanical/Vapor Systems

MFA employees will not be working on electrical or mechanical systems. The contractor will be responsible for administering lockout/tagout procedures, as applicable.

7.3 Activity/Traffic/Pedestrian Control

Immediately upon moving to a new location, restrict access to the work area with vehicles, traffic cones or barriers, and barrier tape. Be alert for inattentive drivers at or near the job site. Wear high-visibility orange or yellow safety vests when near traffic areas. Keep all nonessential personnel out of the sampling areas.

7.4 Fires and Explosions

In the case of an emergency, fire safety is the responsibility of all persons on site. The following general precautions address site-wide operations:

- A currently certified Type ABC fire extinguisher will be kept in the MFA field vehicle.

- MFA personnel are not allowed to smoke on site.
- Leaks and spills of flammable or combustible fluids must be cleaned up immediately.

See the air monitoring section for potential explosive-atmosphere precautions.

7.5 Uneven Walking Surfaces

Care should be used when walking in or out of large areas of excavations. A combination of steep grades and loose material can make walking or standing on these surfaces difficult and potentially hazardous.

7.6 Noise

In addition to interference with oral communication, job performance, and safety, the effects of noise on humans include physiological effects, particularly temporary and permanent hearing loss. The factors that affect the degree and extent of hearing loss are intensity or loudness of the noise, type of noise, period of exposure, and distance from the noise source. When working in close proximity to operating equipment or other loud noise sources, all MFA personnel will be required to use hearing protection.

7.7 MFA Vehicle Use

When operating vehicles on the Site, employees will adhere to the requirements in the MFA standard operating procedure (SOP) for vehicle safety operations (Appendix B). Any traffic incidents must be reported as indicated in the MFA incident report SOP (Appendix C).

7.8 Excavations

When working near excavations, MFA employees will adhere to the requirements in the MFA SOP for trenching construction and other excavations (Appendix D).

7.9 Chemical Hazard Evaluation

A liquid in situ chemical reducing reagent will be injected into on-site monitoring wells by a licensed contractor in order to treat the PCE contamination in groundwater. A material safety data sheet for the reagent is provided in Appendix E. In addition, the following potentially hazardous chemicals are known or suspected to be present in environmental media on the Site:

POTENTIALLY HAZARDOUS CHEMICALS

Chemical of Concern	OSHA PEL	OSHA STEL	OSHA IDLH	Odor Threshold	LEL (%)	IP(eV)	Other Hazard
Gasoline	NA	NA	NA	0.06–0.08 ppm	1.4	NA	C, E, F, P
Diesel (Naphthalene)	10 ppm	15 ppm	250 ppm	14.68-12.0 ppm	0.9	8.12	E, F, P
Benzene	1 ppm	5 ppm	500 ppm; C; P	12 ppm	1.2	9.24	F, C, P, R
Toluene	100 ppm	150 ppm	500 ppm	0.17–2.9 ppm	1.1	8.82	E, F, P, R
Ethylbenzene	100 ppm	125 ppm	800 ppm	NA	0.8	8.76	F, P
Xylenes	100 ppm	150 ppm	900 ppm	0.62–5.4 ppm	0.9	8.44–8.56	F, P
Lead (leaded gasoline)	0.050 mg/m^3 (8-hr TWA)	0.050 mg/m^3	100 mg/m^3	NA	NA	NA	P, SC
Tetra-chloroethene (PCE)	100 ppm	NA	150 ppm	NA	NA	9.32	SC

NOTES:

C — carcinogen.
E — explosivity.
F — flammable.
IDLH — immediately dangerous to life and health.
IP (eV) — ionization potential.
LEL — lower explosive limit.
mg/m^3 — milligrams per cubic meter.
NA — not available.
OSHA — Occupational Safety and Health Administration.
P — poison.
PEL — permissible exposure level.
ppm — parts per million.
R — reactive.
SC — suspected carcinogen.
STEL — short-term exposure level.
TWA — time-weighted average.

8 SAFETY EQUIPMENT AND PROCEDURES

8.1 Safety Equipment

The following safety equipment will be used as needed on the Site:

- Photoionization detector (PID), flame ionization detector (FID), and/or Dräger tubes (if necessary; see Section 9.1, Toxicity Action Levels).
- Combustible gas indicator (CGI) capable of measuring oxygen, methane, and hydrogen sulfide (if necessary, based on presence of organic or flammable vapors; see Sections 9.1 and 9.2, Toxicity Action Levels and Explosion Hazard Action Levels, respectively).
- Dust meter capable of measuring to a minimum level of micrograms per cubic meter.
- Respirator—Half-face respirator with high-efficiency purified air (HEPA) and organic vapor (OV) cartridges. The selection, use, and maintenance of respiratory protective equipment shall meet the requirements of established MFA procedures, recognized consensus standards (i.e., American Industrial Hygiene Association [AIHA], American National Standards Institute [ANSI], and National Institute for Occupational Safety and Health [NIOSH]), and shall comply with the requirements set forth in 29 CFR 1910.134.
- Protective clothing—Tyvek® or equivalent.
- Chemical protective gloves—nitrile.
- Decontamination equipment—soap and water.
- Steel-toed boots.
- Hearing protection.
- Safety glasses—safety glasses with side shields are required at all times during active site work. Use splash shields if performing activities where the potential exists for liquids to contact face or eyes.
- Hard hat.
- Caution tape, traffic cones, or barriers.

- High-visibility vest or clothing for working in or adjacent to any roadway.
- First-aid kit—located in the MFA field vehicle.
- Fire extinguisher—located in the MFA field vehicle.
- Drinking water and Gatorade or equivalent.

Each level of protection will incorporate the following equipment:

Level D:	Workers performing general site activities where skin contact with contaminated materials is not likely will wear steel-toed leather or chemical-resistant work boots, work clothes or coveralls, hard hat, safety glasses, nitrile gloves, and hearing protection, as needed.
Modified D:	Same as Level D (when performing activities in which inhalation of dust or volatile organic compounds is not of concern), plus chemical-resistant, steel-toed boots and Tyvek coveralls (if contaminated soil is encountered); and coated Tyvek or rain gear (if liquid contaminants are encountered).
Level C:	Same as Modified Level D, plus half- or full-face air-purifying respirator with combination OV/HEPA filters (when performing activities in which inhalation of dust or volatile organic compounds is of concern).

Note: project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the SSO or the HSC.

8.2 Air Monitoring Equipment

An OV analyzer (PID or FID) may be needed on the Site, as well as Dräger tubes (if necessary; see Section 9.1, Toxicity Action Levels) and a CGI (if necessary, based on presence of organic or flammable vapors; see Sections 9.1 and 9.2, Toxicity Action Levels and Explosion Hazard Action Levels, respectively).

8.3 Communications

A mobile phone will be available to MFA personnel. Field personnel are not permitted to carry mobile phones or pagers into a potentially flammable environment, as such instruments are not intrinsically safe.

8.4 Decontamination Procedures

Decontamination procedures are outlined below.

8.4.1 Partial Decontamination Procedure

Partial decontamination procedures will be followed when exiting the exclusion zone and will apply to items used in the exclusion zone.

- Wash and rinse boots and outer gloves in buckets in the contamination-reduction zone.
- Inspect Tyvek suit for stains, rips, or tears. If suit is contaminated or damaged, full decontamination will be performed as described in Section 8.4.2.
- Remove outer gloves. Inspect and discard in a container labeled for disposable clothing if gloves are ripped or damaged.
- Remove respirator, if worn, and clean with premoistened alcohol wipes. Deposit used cartridges in a plastic bag at the frequency directed by the SSO.
- Wash hands and face with soap and water.

8.4.2 Full Decontamination Procedures

Full decontamination procedures will be followed at the end of each work shift and will apply to items used.

- Wash and rinse boots and outer gloves in buckets in the contamination-reduction zone.
- Remove outer gloves and Tyvek suit and deposit in a container labeled for disposable clothing.
- Remove respirator and place used cartridges in a plastic bag at the frequency directed by the SSO.
- If end of day, wash and rinse respirator in a special "respirators only" decontamination bucket.
- Remove inner gloves and deposit in a container labeled for disposable clothing.
- Remove work boots without touching exposed surfaces, and put on street shoes. Place work boots in a plastic bag for later reuse.
- Wash hands and face with soap and water.

- Shower as soon after the work shift as practicable.

8.5 Emergency Equipment

A fire extinguisher will be kept in the MFA field vehicle. The extinguisher will be Type ABC, approved by the National Fire Prevention Association. The extinguisher will be inspected monthly and serviced yearly. A first-aid kit will be available in the MFA field vehicle.

9 AIR MONITORING

Personnel exposure monitoring should be performed as specified in this section to protect field personnel from hazardous concentrations of vapors. Monitoring must be performed by individuals familiar with the calibration, use, and care of the required instruments.

During site activities, air monitoring shall be conducted as appropriate in the worker's breathing zone, which is the area within a 1-foot radius of the worker's head. The frequency of air monitoring in the breathing zone shall be increased to at least every half hour if petroleum vapors are indicated by PID readings above ambient or olfactory observations. Respirators must be worn when meter readings in the breathing zone (sustained for two minutes) equal or exceed the action levels described below for upgrading to Level C PPE. See Appendix F for the air monitoring record.

9.1 Toxicity Action Levels

The toxicity action levels given below are set to comply with OSHA Permissible Exposure Levels and American Conference of Governmental Industrial Hygienists Threshold Limit Values, and with NIOSH recommendations for the chemicals that may be encountered on the Site. These action levels are also adjusted for the relative response of common PID or FID instruments to motor-fuel vapors.

The alarm on this instrument should be set to sound at the action level. If the instrument must be unattended, the detector inlet should be located as close to the worker's breathing zone as practicable.

Workers must be evacuated from the area when vapor concentrations exceeding respiratory equipment protection factors are encountered.

During site activities that generate airborne dust, MFA employees will remain upwind and outside of residual dust plumes. Dust monitoring will be undertaken at the discretion of the SSO. Engineering controls will be required of the contractor if the action level shown on the table below is exceeded. MFA workers must be evacuated until dust levels fall below the action level.

Air Monitoring Procedures and Toxicity Action Levels

Instrument	Action Level	Initial Action	Followup Action
FID or PID[a]	Detection of **1 ppm** (above ambient) or greater in breathing zone **sustained for two minutes**	Dräger tube test for **benzene**. If **1 ppm benzene** detected with Dräger tube, upgrade to level C.	Ventilate area, always work upwind.
Dräger tube test (benzene)	Over **1 ppm benzene sustained** in breathing zone	After upgrade to Level C, continue to monitor breathing zone with Dräger tube. If **10 ppm or greater benzene**, leave exclusion zone. Return only if levels decrease to below 10 ppm.	Ventilate area, always work upwind.
FID or PID[a]	Detection of 10 ppm (above ambient) in breathing zone **and determined not to be benzene**	Upgrade to Level C and continue to monitor breathing zone with Dräger tube. **If 50 ppm, leave exclusion zone**. Return only if levels decrease to below 50 ppm.	Ventilate area, always work upwind.
CGI[b]	At or above 10 percent of lower explosive limit	Cease activities. Turn off all potential sources of ignition. Evacuate.	Determine source of flammable vapors.
Dust meter	5 mg/m^3	Dust suppression, e.g., misting.	Adjust operations.

[a] Some PIDs do not work in high (>90%) humidity or rainy weather. Under these atmospheric conditions, only PIDs certified for use in high humidity will be used.

[b] See Section 9.2 for complete explosion hazard action levels.

Respirator/Respirator Cartridge Information

Respirator Manufacturer	**North (or equivalent)**
Respirator Cartridge Selected for Use	HEPA/OV
Respirator Cartridge Change Schedule	**Determine using contaminant types and levels, per North Web site http://www.northsafety.com**

Note: Project personnel are not permitted to deviate from the specified levels of protection without the prior approval of the SSO or MFA HSC.

9.2 Explosion Hazard Action Levels

A CGI should be used when working in a potentially explosive atmosphere, based on the presence of flammable vapors. The explosivity action levels in the table above (≥ 10% LEL) are set to minimize risk due to flammable or explosive atmospheres.

Measurements should be taken at all locations where flammable vapors may cause an explosive condition. American Petroleum Institute procedures shall be followed for measurements in tanks or piping.

The CGI alarm must be set to sound at the action level and calibrated to a methane standard. When measurements with a CGI indicate the presence of combustible gas levels equal to or exceeding the explosivity action level in the work area, the following action must be taken:

1. Extinguish all possible ignition sources in the work area and shut down all powered equipment.
2. Move personnel at least 100 feet away from the work area.
3. Contact the MFA HSC.
4. At the instruction of the MFA HSC and after waiting 15 minutes for OVs to dissipate, the SSO may use the CGI to, cautiously and with prudence, approach the worksite to determine the extent and concentration of organic emissions. The SSO shall not enter (or allow any personnel to enter) any area where CGI readings exceed the explosivity action level, nor shall the SSO make any approach if there is a possibility of fire or explosion.
5. Personnel may reenter the work area only by clearance from the SSO after the cause of the emission has been determined and the source abated.

9.3 Instrument Calibrations

All instruments shall be calibrated both immediately before the day's fieldwork begins and after work ceases for the day. Calibration and monitoring records shall be kept in the project file and provided to the HSC. Records shall include:

- Worker's name
- Date
- Time
- Location
- Temperature and humidity
- Calibration gas identity and concentration
- Exposure data (time, location, and concentration)

10 HEALTH AND SAFETY EQUIPMENT CHECKLIST

REQUIRED SAFETY EQUIPMENT:

Equipment	Requirements
Hard Hat	Required on all job sites.
Steel-Toed Boots	Required on all job sites.
Safety Glasses w/Side Shields	Required on all job sites.
Hearing Protection	Use when appropriate.
PID or FID	PID calibrated to 100 ppm isobutylene.
CGI	To be used when working in a potentially explosive atmosphere, based on the presence of high concentrations of vapors. Methane standard to be used for calibration.
Respirator	Half-face respirator with cartridges appropriate for contaminants of concern.
Protective Clothing	Tyvek suit when appropriate.
Chemical Protective Gloves	Scorpio or Solvex gloves.
Decontamination Equipment	Bring soap and water to wash hands and face if no facilities are available.
Caution Tape, Traffic Cones, or Barriers	Use when working near traffic.
Emergency Eyewash	Located in the MFA field vehicle.
First-Aid Kit	Located in the MFA field vehicle.
Fire Extinguisher	Located in the MFA field vehicle.
Drinking Water	Located in the MFA field vehicle.

11 GENERAL SAFE WORK PRACTICES

Field operations for this project shall be conducted in accordance with the minimum safety practices described below, which are required for MFA employees.

11.1 Safety Practices for Field Personnel

1. Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of materials is prohibited in any area where the possibility of contamination exists.
2. Field personnel must thoroughly wash hands when leaving a contaminated or suspected contaminated area before eating, drinking, or any other activities.
3. Contaminated protective equipment shall not be removed from the work area until it has been properly decontaminated or containerized on site.
4. Avoid activities that may cause dust. Removal of materials from protective clothing or equipment by blowing, shaking, or any means that may disperse materials into the air is prohibited.
5. Field personnel must use the buddy system when wearing any respiratory protective devices. Communications between members must be maintained at all times. Emergency communications shall be prearranged in case unexpected situations arise. Visual contact must be maintained between pairs on site, and team members should stay close enough to assist one another in the event of an emergency.
6. Personnel should be cautioned to inform one another of subjective symptoms of chemical exposure such as headache, dizziness, nausea, and irritation of the respiratory tract.
7. No excessive facial hair that interferes with the seal of the respirator to the face will be allowed on personnel required to wear respiratory protective equipment.
8. The selection, use, and maintenance of respiratory protective equipment shall meet the requirements of established MFA procedures and recognized consensus standards (AIHA, ANSI, NIOSH), and shall comply with the requirements set forth in 29 CFR 1910.134.
9. At sites with known or suspected contamination, appropriate work areas for field personnel support, contaminant reduction, and exclusion will be designated and maintained.
10. MFA field personnel are to be briefed thoroughly on the anticipated hazards, equipment requirements, safety practices, emergency

procedures, and communications methods, both initially and in daily briefings.

11. All MFA field vehicles shall contain a first-aid kit and a multipurpose, portable fire extinguisher.
12. All field personnel will, whenever practicable, remain upwind of drilling rigs, open excavations, boreholes, etc.
13. Subsurface work shall not be performed at any location until the area has been confirmed by a utility-locator firm to be free of underground utilities or other obstructions.
14. Field personnel are specifically prohibited from entering excavations, trenches, or other confined spaces deeper than 4 feet. Unattended boreholes must be properly covered or otherwise protected.

12 ACKNOWLEDGMENT

MFA cannot guarantee the health or safety of any person entering this Site. Because of the potentially hazardous nature of visits to active sites, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at this Site. The health and safety guidelines in this plan were prepared specifically for this Site and should not be used on any other site without prior evaluation by trained health and safety personnel.

All MFA personnel are to read, understand, and agree to comply with the specific practices and guidelines as described in this HASP (including attachments for specific activities) regarding field safety and health hazards.

This HASP has been developed for the exclusive use of MFA personnel. MFA makes this plan available for review by contracted or subcontracted personnel for information only. This plan does not cover the activities performed by employees of any other employer on the Site. All contract or subcontracted personnel are responsible for generating and using their own plan, which must have requirements at least as stringent as those listed in this HASP.

I have read and I understand this HASP and all attachments, and agree to comply with the requirements described herein:

Name	Title	Date

APPENDIX A

WORKING NEAR TRAFFIC STANDARD OPERATING PROCEDURE

PROCEDURE FOR WORKING NEAR VEHICULAR TRAFFIC

PURPOSE

Project activities may be conducted in areas of frequent vehicle traffic. This document identifies procedures and practices for Maul Foster & Alongi, Inc. (MFA) personnel, equipment, and vehicles that will provide protection and safety for personnel operating in or near moving vehicle traffic. It also identifies several individual practices to keep workers safe while exposed to the hazardous environment created by moving traffic.

High-visibility markers, sampling equipment, and vehicles at any street, road, highway or expressway shall be positioned in a manner that best protects the workers. Such positioning shall afford protection to MFA personnel and the motoring public from the hazards of working in or near moving traffic.

RISKS

All site workers shall understand and appreciate the high risk that personnel are exposed to when operating in or near moving vehicular traffic. To the extent practicable, site workers should always operate within a protected environment when near any vehicle-related roadway.

Always consider moving vehicles as a threat to your safety. At every vehicle-related work scene, personnel are exposed to passing motorists of varying driving abilities. Approaching vehicles may be driven at speeds from a creeping pace to well beyond the posted speed limit. Some of these vehicle operators may be vision-impaired, under the influence of alcohol and/or drugs, or have a medical condition that affects their judgment or abilities. **In order to protect yourself and other workers, you should attempt to recognize these potentially dangerous conditions as they occur.**

SAFETY BENCHMARKS

All personnel are at great risk of injury while operating in or near moving traffic. There are several procedures that should be followed to protect all work personnel (both MFA and subcontractors) at the work site, including:

1. Never trust approaching traffic to keep its current path; anticipate potential threats from erratic drivers.

2. Avoid turning your back to approaching traffic.
3. Establish an initial “block” with your vehicle, if possible.
4. Always wear Class II or III high-visibility reflective vests during daylight operations.
5. Wear all protective clothing plus the highway safety vest at all times.
6. Turn off all sources of vision impairment to approaching motorists at nighttime, including vehicle headlights and spotlights that may face the roadway.
7. Use cones and barriers to initially redirect the flow of moving traffic and to provide a “buffer zone” for site workers.
8. Establish advance warning and adequate transition-area traffic-control measures in the nearest lane at an adequate distance from the work area to reduce travel speeds of approaching motorists.
9. Use traffic cones and/or cones illuminated by flares where appropriate for sustained highway-work-area traffic control and direction.

DEMARKING AREA

The work area will be clearly delineated and lit, if necessary, and access by unauthorized personnel or vehicles will be limited by traffic cones, caution tape, and/or barricades. All personnel on site will wear high-visibility and reflective orange safety vests. Immediately upon moving to a new sample location, restrict motorists’ access to the work area with vehicles, traffic cones or barriers, and barrier tape. **Be alert for inattentive drivers at the job site. Keep all nonessential personnel out of the work area.**

Sampling areas along streets will be demarked using traffic cones and/or fluorescent candlesticks. Drilling areas will also have signage. Signage, cones, and/or candlesticks will be placed starting at least 75 feet from the drilling/sampling location or as required by work permits. Cones will be placed in such a fashion as to make a “safe zone” around the work location.

MOVEMENT WITHIN WORK AREA

Personnel arriving in vehicles should exit and enter from the protected “shadow” side, away from moving traffic. Always look before opening doors and stepping out of vehicles into any moving-traffic areas. When walking around equipment or vehicles, be alert to your proximity to moving traffic. Stop at the corner of the vehicle, check for traffic, and then proceed along the vehicle, remaining as close to the vehicle as possible. To the extent practicable, maintain a “reduced profile” when moving through any area where a minimum buffer-zone condition exists.

SAFETY GARMENTS

Wear high-visibility orange safety vests or jackets at all times. The MFA health and safety coordinator can provide the safety garments discussed in this section.

Workers who are exposed to a wide range of weather conditions and who work near traffic that exceeds 50 miles per hour (mph) must wear Class 3 designated garments. Road-construction crews, utility workers, railway personnel, and emergency-response teams are among those included in the Class 3 designation.

Workers who require high visibility in inclement weather and who work near traffic that exceeds 25 mph should wear Class 2 designated garments. Parking and toll-gate workers, airport ground personnel, and some construction workers are included in the Class 2 designation.

Those who work in areas where the background is not complex, away from vehicle traffic that does not exceed 25 mph, should (at a minimum) wear Class 1 designated garments. People who work in warehouses with equipment traffic, sidewalk-maintenance crews, and parking personnel are included in the Class 1 designation.

When deemed necessary because of extremely hazardous traffic conditions (working near interstates, high-speed “blind area” roadways, etc.), workers must be outfitted with garments that include a combination of fluorescent and retro-reflective materials. Fluorescence is particularly important in low-light instances, such as dawn and dusk, because it makes colors more visible against the sky. Retro-reflective materials are those that reflect light rays back in the direction from which they came.

Workers should wear enough reflective material to be visible. Reflective areas should wrap around the body and be worn on appendages—arms, legs and head—so that a person is distinguishable from a barrel or other piece of equipment. Reflective materials on the wrists and ankles draw attention to movement and let drivers know at a distance that the form is a human being. The chosen apparel should also be of a different color scheme from that of equipment used at the worksite.

APPENDIX B

VEHICLE SAFETY STANDARD OPERATING PROCEDURE

VEHICLE SAFETY

This operating procedure applies to Maul Foster & Alongi, Inc. (MFA)-owned vehicles, vehicles leased or rented for MFA business, and personal vehicles when used on MFA business. In order to drive a vehicle on behalf of the company, you must have a valid driver's license as well as a driving record that is satisfactory to MFA and its insurance carriers.

Additional policies relating to vehicle use are provided in Part 2, Section 3 of the MFA Policies and Procedures Manual.

COMPANY-OWNED AND COMPANY-RENTED VEHICLES

Company vehicles are to be driven by authorized employees only, except in case of testing by a mechanic. An employee must be familiarized with the vehicle before it is driven. To avoid accidents because an accessory cannot be located during operation (e.g., windshield wipers), it is recommended that the driver locate the horn, windshield-wiper switch, lights, defroster, gauges, hood and gas fill door releases, and seat and mirror adjustments before the vehicle is started. Once the vehicle is started, fluid levels, wiper blades, and lights should be checked. The spare tire should be located, along with instructions and tools for changing a flat tire.

HAZARDOUS SUBSTANCES

Hazardous substances or potentially hazardous substances may not be transported in privately-owned vehicles. Hazardous substances include, but are not limited to, environmental-media samples, air-monitoring meters (photoionization detectors, four-gas meters) and associated calibration gases, investigation-derived waste, decontamination chemicals, fuel, and fuel products.

DRIVER SAFETY GUIDELINES

The use of a vehicle for company business while under the influence of intoxicants or other drugs that could impair driving ability is forbidden and is sufficient cause for disciplinary action, up to and including termination of employment.

Cell-phone use while driving is a major cause of accidents. Drivers should complete calls while the vehicle is parked. While driving, attention to the road and safety must always take precedence over conducting business over the phone.

No driver shall operate a vehicle on company business when his/her ability to do so safely has been impaired by illness, fatigue, injury, or prescription medication.

All drivers and passengers operating or riding in a company vehicle must wear seat belts, even if air bags are available.

No unauthorized personnel are allowed to ride in company vehicles.

Headlights shall be used starting two hours before sunset until two hours after sunrise, during inclement weather, and at any time when the area 500 feet ahead of the vehicle cannot be clearly seen.

Allot enough time for travel to avoid the need to hurry.

Be well rested and alert.

Notify someone of your destination and anticipated time of arrival.

DEFENSIVE-DRIVING GUIDELINES

Drivers are required to maintain a safe following distance at all times. Drivers should keep at least a two-second interval between their vehicle and the vehicle immediately ahead. During slippery road conditions, the following distance should be increased.

Drivers must yield the right of way at all traffic control signals and signs requiring them to do so. Drivers should also be prepared to yield for safety’s sake at any time. Pedestrians and bicycles in the roadway always have the right of way.

Drivers must honor posted speed limits. In adverse driving conditions, reduce speed to a safe operating speed that is consistent with the conditions of the road, weather, lighting, and volume of traffic.

Radar detectors are strictly prohibited in company vehicles. Drivers are to drive at the speed of traffic but are never to exceed the posted speed limit.

Turn signals must be used before every turn or lane change.

When passing or changing lanes, view the entire vehicle in your rearview mirror before pulling into that lane.

Be alert to other vehicles, pedestrians, and bicyclists when approaching intersections. Never speed through an intersection on a caution light. When the traffic light turns green, look both ways for oncoming traffic before proceeding.

When waiting to make left turns, keep your wheels facing straight ahead. If rear-ended, you will not be pushed into the path of oncoming traffic.

When stopping behind another vehicle, leave enough space so you can see the rear wheels of the car in front. This allows room to go around the vehicle, if necessary, and may prevent you from being pushed into the car in front of you if you are rear-ended.

Avoid backing where possible, but when necessary, keep the distance traveled to a minimum and be particularly careful. Check behind your vehicle before backing. Back the vehicle toward the driver's side. Do not back around a corner or into an area of no visibility.

ACCIDENT PROCEDURES

All accidents, in either company vehicles, rented vehicles, or personal vehicles (while on company business), must follow these accident procedures.

In an attempt to minimize the results of an accident, the driver involved in the accident must prevent further damages or injuries and obtain all pertinent information and report it accurately. Call for medical aid, if necessary.

Record names and addresses of driver, witnesses, and occupants of the other vehicles and any medical personnel who may arrive at the scene. Complete the form located in the Vehicle Accident Packet. An employee who is involved in an accident when on MFA business must report it by completing an MFA Accident/Loss Report and submit it to the health and safety coordinator as soon as possible. An Accident/Loss Report form is attached.

Pertinent information to obtain includes: driver's license number of other drivers; insurance company names and policy numbers of other vehicles; make, model, year, and license plate number of other vehicles; date and time of accident; and overall road and weather conditions. Provide the other party with your name, address, driver's license number, and insurance information. Do not discuss the accident with anyone at the scene except the police. Do not accept any responsibility for the accident. Do not argue with anyone.

All accidents, regardless of severity, must be reported to the police and also to the Managing Director or your Group Manager. Accidents are to be reported immediately (from the scene, during the same day, or as soon as practicable if immediate or same-day reporting is not possible). If the driver cannot get to a phone, he/she should write a note giving the location to a reliable-appearing motorist and ask him or her to notify the police. MFA may conduct a review of each accident to determine its cause and how it could have been prevented.

Accidents involving personal injury to an MFA employee must be reported to the Managing Director or your Group Manager so that a workers' compensation claim can be promptly filed and MFA's short-term-disability carrier can be notified, if applicable. Failing to stop after an accident and/or failure to report an accident may result in disciplinary action, up to and including termination of employment.

TRAFFIC VIOLATIONS

Driving motor vehicles is a serious responsibility and must be done safely and in accordance with all traffic laws. Vehicle accidents are costly to our company, but more importantly, they may result in injury to you or others. It is the driver's responsibility to operate the vehicle in a safe manner and to drive defensively to prevent injuries and property damage. MFA endorses all applicable state motor-vehicle regulations relating to driver responsibility and expects each driver to drive in a safe and courteous manner pursuant to the preceding safety rules. The attitude you take when behind the wheel is the single most important factor in driving safely. Traffic and/or parking citations will not be reimbursed by MFA.

ATTACHMENT

ACCIDENT/LOSS REPORT

******THIS REPORT MUST BE COMPLETED IN FULL AND SUBMITTED TO THE MFA MANAGING DIRECTOR******

Date of Accident:________________________________

Company:_____________________________

Time Occurred:_________________________________

Project Number:______________________________

Where Occurred:_______________________________

Name and Location of Project:___________________

PART I—PROPERTY DAMAGE/LOSS

Equipment Involved:____

Names of Persons Involved:____

Describe Incident/Damage:____

____

Estimated Cost of Damage:____

***Copy of Police Report, if filed, must also be submitted.**

DRAW A DIAGRAM OF INCIDENT ON THE BACK OF THIS REPORT

PART II—PERSONAL INJURY *(fill out only if personal injury occurred)*

Name of employee injured:________________________

Age:_____

Address:____

Occupation:__________________________________

What was employee doing when injured:____

Exact location where injury occurred (station number or prominent landmark):_______________________

____

Was place of accident or exposure on job site?:____

Describe injury:____

____

How did injury occur?:____

____

Did employee see a doctor or go to the hospital?________ If yes, give name, address, and phone number of Doctor and/or hospital:____

____

Employee Name (print):_______________________________________

Employee Signature: ____

Date of this report: ____

APPENDIX C

MFA INCIDENT REPORT

ACCIDENT/LOSS REPORT

******THIS REPORT MUST BE COMPLETED IN FULL AND SUBMITTED TO THE MFA MANAGING DIRECTOR******

Date of Accident:_______________________________ Company:____________________________

Time Occurred:_________________________________ Project Number:______________________________

Where Occurred:_______________________________ Name and Location of Project:___________________

PART I—PROPERTY DAMAGE/LOSS

Equipment Involved:____

Names of Persons Involved:____

Describe Incident/Damage:____

____

Estimated Cost of Damage:____

***Copy of Police Report, if filed, must also be submitted.**

DRAW A DIAGRAM OF INCIDENT ON THE BACK OF THIS REPORT

PART II—PERSONAL INJURY *(fill out only if personal injury occurred)*

Name of employee injured:________________________ Age:_____

Address:____ Occupation:____________________________________

What was employee doing when injured:____

Exact location where injury occurred (station number or prominent landmark):________________________________

____

Was place of accident or exposure on job site?:____

Describe injury:____

____

How did injury occur?:____

____

Did employee see a doctor or go to the hospital?________ If yes, give name, address, and phone number of Doctor and/or hospital:____

____

Employee Name (print):______________________________

Employee Signature: ________________________________

Date of this report: __________________________________

APPENDIX D

TRENCH CONSTRUCTION AND OTHER EXCAVATION SOP

TRENCH CONSTRUCTION AND OTHER EXCAVATING OPERATIONS

PURPOSE

This document contains an overview of the safety requirements for excavating and trenching operations. The requirements are consistent with standards established by the Occupational Safety and Health Administration (OSHA) and are described in Title 29 Code of Federal Regulations (CFR). The OSHA standard should be consulted by the excavation contractor before designing a shoring system, with questions regarding sloping options, or before working as a "competent person" on an excavation site. The term "competent person" is used in many OSHA standards and documents. As a general rule, the term is not specifically defined. In a broad sense, an OSHA competent person is an individual who, by way of training and/or experience, is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, is designated by the employer, and has authority to take appropriate actions.

RESPONSIBILITY

The responsibility and authority for excavating and trenching safety must be well defined before project startup. In general, the contractor will assume responsibility for excavation safety, and Maul Foster & Alongi, Inc. (MFA) will maintain safety responsibility and authority only for MFA. MFA employees will not serve in the OSHA-defined role of competent person unless this is specifically defined in the project scope of work and approved by the project manager (PM) and health and safety coordinator. The PM shall ensure that the MFA field staff members clearly understand the limitation of their excavation-safety responsibilities and authorities.

APPLICABILITY

This procedure is applicable to all MFA projects in which trenching or other excavating operations, exclusive of borings, are entered by personnel employed by firms under a subcontract to MFA. The best approach for avoiding the detailed trenching requirements is to conduct sampling and other procedures without entry into excavations. Use of a backhoe to bring up samples, use of long-handled sampling devices, and similar techniques are recommended. During observation of excavation work, MFA should stay a safe distance from and upwind of the work area, if possible**.**

REQUIREMENTS

Preliminary Requirements

Certain government agencies require a permit to conduct excavation operations. Before digging, determine or have the client or excavation contractor determine if underground installations such as sewer, water, fuel, or electrical lines are to be encountered, and if so, determine the exact locations of the lines. Information can be obtained by contacting Underground Service Alert (consult local telephone directory for toll-free number), local utility companies, and the owner of the property on which excavating operations are planned. Also, trees, boulders, and other surface encumbrances that pose a potential hazard to employees must be removed or made safe before the operation begins.

Placement of Excavated Materials

Excavated materials must be placed at least 2 feet back from the edge of the excavation, and precautions must be taken to prevent the materials from falling into the excavation.

Working in Excavations

Shoring and Sloping

Except for solid rock, trenches in which personnel are required to work must be shored or sloped if the depth of the excavation is 5 feet or more. When a shoring system is used, it shall consist of hydraulic shores or the equivalent, with sheathing or sheet piling as needed. Trench boxes are also permitted. OSHA uses a soil-classification system to determine the allowable slopes for trenches. The shoring system must be properly designed and installed to sustain all existing and expected loads. For details on shoring and sloping requirements, consult Title 29 CFR.

Access

When work is to be performed in any excavation, safe access to the excavation must be provided by means of ladders, stairs, or soil ramps. Trenches 4 or more feet deep must have ladders spaced no less than 25 feet apart, and the ladders must extend at least 3 feet above grade.

Hazardous Atmospheres

At sites where oxygen deficiency or hazardous concentrations of flammable or toxic vapors or gases may be encountered in excavations, the atmospheres in the excavations must be tested by a qualified person before work in an excavation begins and at appropriate intervals afterward. Trenches may be classified as confined spaces and require an entry permit, as covered in the operating procedure (OP) for confined-space entry. Please note that any employee of MFA is prohibited from entering into a confined space.

Inspection of Excavation

Excavations must be observed daily by a competent person. If evidence for potential cave-ins or slides is apparent, all work in the excavation must be suspended until necessary steps have been taken to safeguard employees.

Operation of Vehicles near Excavations

When vehicles or heavy equipment must operate near an excavation, the sides of the excavation must be shored or braced as necessary to withstand forces exerted by the superimposed load and the earth pressure. Stop logs or other types of secure barriers must be installed at the edges of the excavations.

Barricades and Fences

Excavated areas must be completely guarded on all sides with barricades or fences, as appropriate. If barricades are used, they must be spaced no more than 20 feet apart and shall not be less than 35 inches high when erected. A yellow or yellow-and-black tape, at least 0.75-inch wide, shall be stretched between the barricades.

Backfilling

Excavated areas should be backfilled in accordance with a work plan as soon as practical after work is completed, and all associated equipment should be removed from the area.

EXCAVATIONS NEXT TO EXISTING STRUCTURES

A professional engineer will review all plans for excavations next to existing structures to avoid undermining the structures and possible collapse.

APPENDIX E

MSDS

Material Safety Data Sheet

EHC® Liquid - liquid component

MSDS #: EHCL-C
Revision Date: 2013-04-11
Version 1.02

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

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	**EHC® Liquid - liquid component**
Recommended use	Bioremediation product for the remediation of contaminated soil and groundwater
Uses advised against	Not for use in potable drinking water

Manufacturer	**Emergency telephone number**
FMC CORPORATION Environmental Solutions 1735 Market Street Philadelphia, PA 19103 Phone: +1 215/ 299-6000 (General Information) E-Mail: msdsinfo@fmc.com	For leak, fire, spill or accident emergencies, call: +1 703-527-3887 (CHEMTREC) 1 303 / 595 9048 (Medical - U.S. - Call Collect)

2. Hazards identification

Emergency Overview

CONTAINMENT HAZARD:
Any vessel that contains wet EHC-L must be vented due to potential pressure build up from fermentation gases

Potential health effects

Acute Toxicity	No significant health effects anticipated
Eyes	May cause slight irritation.
Skin	May cause irritation.
Inhalation	No information available.
Ingestion	No information available.

3. Composition/information on ingredients

Ingredients

Chemical Name	CAS-No	Weight %
Water	7732-18-5	60-80
Lecithin	8002-43-5	20-30
Sorbitan monooleate, ethoxylated	9005-65-6	2-4
Sodium Benzoate	532-32-1	2-4

4. First aid measures

Eye contact	In case of contact, immediately flush eyes with plenty of water. Get medical attention if irritation develops and persists.
Skin contact	Wash skin with soap and water. Get medical attention if irritation develops and persists.
Inhalation	Move to fresh air in case of accidental inhalation of vapors. Consult a physician if necessary.
Ingestion	Drink 1 or 2 glasses of water. Get medical attention if symptoms occur.
Notes to physician	Treat symptomatically.

5. Fire-fighting measures

Flammable properties	Combustible material: may burn but does not ignite readily.
Flash Point	> 200 °F
Suitable extinguishing media	Carbon dioxide (CO_2). Dry chemical. Dry powder.

Explosion Data

Sensitivity to Mechanical Impact	Not sensitive.
Sensitivity to Static Discharge	Not sensitive.
Protective equipment and precautions for firefighters	As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA	**Health Hazard** 1	**Flammability** 1	**Stability** 0	**Special Hazards** -

6. Accidental release measures

Personal precautions	For personal protection see section 8.
Methods for containment	Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal.
Methods for cleaning up	After cleaning, flush away traces with water.

7. Handling and storage

Handling	Handle in accordance with good industrial hygiene and safety practice.
Storage	Any vessel that contains wet EHC-L must be vented due to potential pressure build up from fermentation gases. Keep away from open flames, hot surfaces and sources of ignition.

8. Exposure controls/personal protection

Exposure guidelines	This product does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

Occupational exposure controls

Engineering measures	None under normal use conditions.
General Information	If the product is used in mixtures, it is recommended that you contact the appropriate protective equipment suppliers These recommendations apply to the product as supplied
Respiratory protection	Use only with adequate ventilation.
Eye/face protection	Safety glasses with side-shields
Skin and body protection	Wear suitable protective clothing.
Hand protection	Protective gloves
Hygiene measures	Handle in accordance with good industrial hygiene and safety practice Wash hands before breaks and immediately after handling the product.

9. Physical and chemical properties

9.1 Information on basic physical and chemical properties

Appearance	Light amber emulsion
Physical state	Liquid
Odor	odorless
pH	6.5 - 6.9
Melting Point/Range	No information available.
Freezing point	No information available.
Boiling Point/Range	No information available.
Flash Point	> 200 °F
Evaporation rate	not applicable
Flammable properties	Combustible material: may burn but does not ignite readily
Vapor pressure	No information available.
Vapor density	No information available.
Specific Gravity	1 - 1.1
Relative density	
Bulk density	not applicable
Water solubility	Dispersible in water
Percent volatile	No information available.
Partition coefficient:	not applicable
Viscosity	No information available.

9.2 Other information

Decomposition Temperature	No information available.

10. Stability and reactivity

Stability	Stable.
Conditions to avoid	Temperatures above 71°C
Materials to avoid	Water, Alkalis
Hazardous decomposition products	None under normal use.
Hazardous polymerization	Hazardous polymerization does not occur.

11. Toxicological information

Acute effects

Remarks	The product has not been tested. Ingredients in this product have been designated as GRAS (Generally Recognized as Safe) by govenment agencies.
Eye irritation	No information available.
Skin irritation	No information available.
LD50 Oral	There are no data available for this product
LD50 Dermal	There are no data available for this product
LC50 Inhalation:	No information available.
Sensitization	Not expected to be sensitizing based on the components.

Chronic Toxicity

Carcinogenicity	Contains no ingredient listed as a carcinogen

12. Ecological information

Ecotoxicity

Contains no substances known to be hazardous to the environment or that are not degradable in waste water treatment plants

Persistence and degradability	Expected to biodegrade, based on component information
Bioaccumulation	Bioaccumulation is unlikely.
Mobility	No information available.

Chemical Name	log Pow
Sodium Benzoate	-2.13

Other adverse effects	None known

13. Disposal considerations

Waste disposal methods	This material, as supplied, is not a hazardous waste according to Federal regulations (40 CFR 261). This material could become a hazardous waste if it is mixed with or otherwise comes in contact with a hazardous waste, if chemical additions are made to this material, or if the material is processed or otherwise altered. Consult 40 CFR 261 to determine whether the altered material is a hazardous waste. Consult the appropriate state, regional, or local regulations for additional requirements.
Contaminated packaging	Dispose of in accordance with local regulations.

14. Transport information

DOT	not regulated
TDG	not regulated
ICAO/IATA	not regulated
IMDG/IMO	not regulated

15. Regulatory information

International Inventories

TSCA Inventory (United States of America)	Complies
DSL (Canada)	Complies
NDSL (Canada)	Complies
EINECS/ELINCS (Europe)	Complies
ENCS (Japan)	Complies
IECSC (China)	Complies
KECL (Korea)	Complies
PICCS (Philippines)	Complies
AICS (Australia)	Complies
NZIoC (New Zealand)	Complies

U.S. Federal Regulations

SARA 313

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

SARA 311/312 Hazard Categories

Acute Health Hazard	no
Chronic Health Hazard	no
Fire Hazard	no
Sudden Release of Pressure Hazard	no
Reactive Hazard	no

CERCLA

This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material.

International Regulations

Mexico - Grade	Minimum risk, Grade 0

Canada
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.
WHMIS Hazard Class
Non-controlled

16. Other information

HMIS	Health Hazard 1	Flammability 1	Stability 0	Special precautions -

NFPA/HMIS Ratings Legend
Severe = 4; Serious = 3; Moderate = 2; Slight = 1; Minimal = 0

Revision Date:	2013-04-11
Reason for revision:	Qualify trade name.

Disclaimer
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Prepared By

FMC Corporation
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End of Material Safety Data Sheet

APPENDIX F

AIR MONITORING RECORD

Maul Foster & Alongi, Inc.
AIR MONITORING RECORD

Project Title ____ Project No. ____________________________

Site-Specific Name/Location ____________________________________ Date ________________ Day ______________

Weather: Temp _____________________________ Wind Direction/Speed __________/____________ Humidity ________

	Instrument	S/N	Calibration date	Calibration gas/method	Calibration by
Organic vapors					
Particulates					
O_2					
Radiation					
Combustible gas					

Time	Location/Description	Organic vapor ppm	Particulates mg/m^3	O_2 %	H_2S ppm	CG % LEL

Notes:____

____

Data collected by____
Print Name Signature

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APPENDIX D

SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN

FORMER CREAM WINE PROPERTY

Prepared for
PORT OF SUNNYSIDE
SUNNYSIDE, WASHINGTON
August 13, 2013
Project No. 0346.04.06

Prepared by
Maul Foster & Alongi, Inc.
1329 N State Street, Suite 301, Bellingham WA 98225

MAUL
FOSTER
ALONGI

SAMPLING AND ANALYSIS PLAN

FORMER CREAM WINE PROPERTY

The material and data in this plan were prepared under the supervision and direction of the undersigned.

MAUL FOSTER & ALONGI, INC.

Heather Hirsch, LHG
Project Hydrogeologist

James Peale, RG, LHG
Principal Hydrogeologist

CONTENTS

TABLES

FOLLOWING PLAN:

ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chain of custody
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
FP-XRF	field-portable X-ray fluorescence
FSDS	field sampling data sheet
LCS	laboratory control sample
MFA	Maul Foster & Alongi, Inc.
mg/kg	milligrams per kilogram
MS/MSD	matrix spike and matrix spike duplicate
Port	Port of Sunnyside
Property	111 East Lincoln Avenue, Sunnyside, Washington
QA	quality assurance
QC	quality control
RA	remedial action
RAP	Remedial Action Plan
RCRA	Resource Conservation and Recovery Act
SAP	sampling and analysis plan
TCLP	toxicity characteristic leaching procedure
USEPA	U.S. Environmental Protection Agency
VOA	volatile organic analysis
VOC	volatile organic compound
WAC	Washington Administrative Code

1 INTRODUCTION

Maul Foster & Alongi, Inc. (MFA) has prepared this sampling and analysis plan (SAP), including quality assurance project plan elements, consistent with the requirements of the Washington Administrative Code (WAC) 173-340-820 for the Port of Sunnyside (the Port), to guide field activities to be performed during the remedial action (RA) at 111 East Lincoln Avenue in Sunnyside, Washington (the Property). The Property is currently vacant but was used historically as a winery and originally as a milk plant. An RA is planned for the Property to address hazardous substances in soil and groundwater.

The Port received an Integrated Planning Grant and a Remedial Action Grant from the Washington State Department of Ecology (Ecology) to support the environmental characterization, planning, and cleanup of the Property and its redevelopment into a revitalized asset for the community. The work described in this SAP is being conducted in support of the property cleanup. This SAP describes procedures for collection, preservation, and analysis of samples of environmental media, and will be used during the RA and subsequent monitoring activities. The goals of the sampling are (1) to obtain reliable data about conditions at the site that will aid in the groundwater treatment, soil removal, and waste characterization during cleanup and (2) to document post-remedy site conditions. This SAP is to be used in conjunction with the Remedial Action Plan and Engineering Design Report (RAP).

This SAP has been prepared consistent with the requirements of Ecology's Guidance on Sampling and Data Analysis Methods (Ecology, 1995), Guidance for Preparing Quality Assurance Project Plans for Environmental Studies (Ecology, 2004), and the Model Toxics Control Act (WAC Chapter 173-340).

1.1 Investigation Objectives

The primary objective of this SAP is to establish procedures for the collection of data of sufficient quality for their intended use. This SAP describes methods that will be used during the RA. Activities to be performed include:

- Groundwater monitoring and treatment
- Soil excavation and disposal

The RA currently does not include installation of additional monitoring wells; however, well installation procedures are included in this SAP in the event that future data collected indicate a need for additional groundwater monitoring or treatment points. Groundwater decommissioning procedures are also included in the event that existing monitoring wells are no longer needed.

During the RA, soil samples will be collected from excavated material for waste characterization and from soil remaining on site to confirm that concentrations are below cleanup levels or to inform future institutional control requirements, if needed. No institutional controls are currently planned for the Property.

Groundwater monitoring will be performed after groundwater treatment in order to evaluate the effectiveness of the selected treatment. Periodic groundwater monitoring will be performed following completion of treatment to evaluate treatment effectiveness and monitor compliance with cleanup standards.

This SAP is meant to ensure that reliable data about physical, environmental, and chemical conditions at the Property are obtained in support of the RA. It provides a consistent set of procedures that will be used throughout the work identified in the RAP. If a phase of work or an unforeseen change in methodology requires modification to the SAP, an addendum may be prepared that describes the specific revision(s), or the revisions will be documented in the completion report. Procedures are provided that will be used to direct the investigation process so that the following conditions are met:

- Data collected are of high quality, representative, and verifiable.
- Use of resources is cost effective.
- Data can be obtained within a useful time frame, given the time constraints of the RA.

This SAP describes methods that will be used for sampling environmental media, decontaminating equipment, and characterizing waste for disposal. It also includes procedures for collecting, analyzing, evaluating, and reporting the data. This SAP includes all currently foreseen analytical methods that may be applied to environmental samples. The document includes quality assurance (QA) procedures for field activities, sampling QA and quality control (QC) procedures, and data validation.

2 ACCESS AND SITE PREPARATION

2.1 Access

MFA personnel will be on the Property during all phases of the RA. Access to the Property will be in conjunction with monitoring, remediation, and construction activities and is allowed at all reasonable times for the purpose of conducting or overseeing work. Construction activity resulting in loud noises will generally be confined to the hours between 7 a.m. and 7 p.m.

2.2 Site Preparation and Coordination

Before the RA, field oversight, and sampling programs begin at the site, public and private utility-locating services and other information sources will be used to check for underground utilities or pipelines near each excavation location. MFA will also work with the Port to identify locations of possible on-site utilities, piping, and other subsurface obstructions. Ecology will be notified a minimum of 48 hours before site activities begin.

3 SAMPLE PROGRAM DESIGN

The following sampling is anticipated during and after the RA:

1. Soil samples will be collected during excavation to screen excavation extents before confirmation sampling (on-site, field-portable X-ray fluorescence [FP-XRF] analyses; see Section 3.1).

2. Soil samples will be collected from the bottom and side walls of the excavation area. The results of the initial excavation sampling will be compiled and reviewed with Ecology to determine appropriate additional management prior to backfill. These could include removal, further evaluation of risk, and/or management through institutional controls.

3. Soil samples will be collected from the excavated soil and analyzed for lead, using the toxicity characteristic leaching procedure (TCLP) in order to characterize the soil for disposal, and specifically to confirm that soil may be disposed of at a Resource Conservation and Recovery Act (RCRA) Subtitle D landfill.

4. Groundwater samples will be collected from existing on-site monitoring wells after *in situ* treatment to evaluate the effectiveness of the remedial action and to monitor compliance with cleanup levels.

The methods for collecting, handling, and analyzing each type of sample are described below. For each of the four sampling efforts, the following procedures will be carried out, as applicable:

- Samplers will wear clean, disposable gloves while collecting samples. Gloves will be changed between sampling locations.
- Field activities, conditions, and sample descriptions will be recorded in a field notebook. Any deviations from the sampling protocol will be noted on field records and will be brought to the attention of the project manager. Observations of discoloration and odors will be recorded as well.
- Collected samples will be placed in the containers specified in Table D-1. Samples intended for laboratory analysis will be labeled, stored in iced shipping containers with chain-of-custody (COC) documentation, and transported to the contract laboratory.

The RA currently does not include installation of additional monitoring wells or decommissioning of exiting monitoring wells; however, well installation and decommissioning procedures are included in this SAP in the event that future data collected indicate a need for additional groundwater monitoring or treatment points, or if existing monitoring points are no longer needed.

3.1 Field-Portable X-ray Fluorescence Analysis Sampling

An area of soil known to contain concentrations of lead that are likely to exceed both the site CUL and the characteristic levels for disposal (i.e., exceed 100 milligrams per kilogram [mg/kg] and thus are expected to exceed the 5-milligrams-per-liter RCRA TCLP leachate criteria[1]) has been delineated (see the RAP). This area of soil will be excavated and disposed of off site.

During excavation activities, material will be tested on site for lead in order to screen excavation extents before collecting confirmation samples. An FP-XRF instrument with a suitable detection limit will be used on site to efficiently characterize lead concentrations. FP-XRF instruments are capable of producing near real-time results (i.e., results are available within a couple of hours of sample collection) that are comparable with Contract Laboratory Program (CLP) method results (U.S. Environmental Protection Agency [USEPA], 2004b). The USEPA Environmental Technology Verification program found that FP-XRF and CLP method lead concentrations in soil had correlations ranging from 0.85 to 0.97 (USEPA, 2004a). In order to produce quantitative results, using ex-situ FP-XRF, that are comparable to CLP methods, proper sample preparation is imperative (USEPA, 2004a). The appropriate sample preparation method and instrument calibration procedures, consistent with USEPA Method 6200 (included as Appendix A), are described below.

As noted above, FP-XRF results have been demonstrated to be consistent with definitive laboratory results. However, because there is a range in correlations, a conservative threshold value was developed for decision making during RA activities. This threshold value was developed to avoid inadvertently leaving soil above the CUL behind. The threshold value was developed as follows: the site CUL is 250 mg/kg; the lower end of correlation between the FP-XRF and definitive laboratory data identified by the USEPA is 0.85; this lower-end correlation is applied to the CUL of 250 mg/kg to provide an additional safety factor and derive a threshold value of 200 mg/kg lead.

All soil encountered beyond the preestablished excavation extent with FP-XRF lead results at or above 200 mg/kg will be excavated and stockpiled for further testing as described below (Section 3.3, Stockpile Sampling).

Prior to sample analysis, the FP-XRF instrument will be calibrated in accordance with USEPA Method 6200 (see Appendix A) and the manufacturer's instructions. Instrument calibration procedures are outlined in section 4.1 of this report.

The following sample preparation procedure will be followed in order to achieve quality, ex situ FP-XRF data consistent with USEPA Method 6200. Following the procedure will generate FP-XRF results that are comparable to definitive laboratory method results.

- Collect samples from a 4-inch-by-4-inch square to a depth of 1 inch. The exact dimensions of the sampling area and the depth can be adjusted in order to achieve a homogeneous sample. Homogenize the soil volume in a decontaminated stainless steel bowl and dry at a temperature no higher than 150 degrees Celsius.

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[1] The results of the total metals analysis may be divided by 20 to convert the total results into the maximum leachable concentration (USEPA, 2012).

- Grind the dried sample, using a decontaminated mortar and pestle (glass, agate, or aluminum oxide), and sieve through a 60-mesh (nylon or stainless steel) sieve.
- Fill a 31.0-millimeter polyethylene cup one-half to three-quarters full with the sieved, dried sample and cover the cup with 2.5 micron Mylar film. Prepare a duplicate aliquot for every ten samples.
- Save the remaining dried, sieved sample volume for laboratory analysis if needed.
- Conduct FP-XRF sample analysis according to USEPA Method 6200 (Appendix A).

3.2 Excavation Limits Soil Sampling

As reflected in the RAP, the RA includes soil excavation to a specified areal extent and vertical depth. Soil samples will be collected when the preestablished excavation boundaries have been reached, or any additional excavation informed by the engineer has been concluded, using an excavator or hand-held equipment. The excavation bottom and side walls will be sampled as representative of the extent of excavation at the approximate locations identified in the RAP. These soil sample results will be used to inform the required institutional controls.

Soil samples and associated QC samples will be analyzed for lead by USEPA Method 6010C (USEPA, 1986).

3.3 Stockpile Sampling

Potentially lead-characteristic soil will be stockpiled and sampled as follows before transportation to the landfill to determine if it is RCRA-regulated waste (i.e., to determine whether it passes the TCLP-lead criterion):

- A five-point composite sample will be obtained from the soil stockpile. Five subsamples of approximately equal volume will be collected and composited. The uppermost layer of soil will be removed before each subsample is obtained.
- A standard stainless steel spoon or hand auger will be used to obtain the samples from various depths within the stockpile. The stockpile will be divided into five quadrants, with one subsample obtained from a random location within each quadrant from random depth intervals.
- The subsamples will be composited in a stainless steel bowl with a stainless steel spoon; a portion of the sample will be place into the sample container. The stainless steel bowl and spoon and the auger will be decontaminated between sampling events. Rocks and debris will not be placed in the sample container.
- Samples will be labeled, stored in iced shipping containers with COC documentation, and transported to the contract laboratory.
- Soil samples and associated QC samples will be analyzed for TCLP-lead.

3.4 Groundwater Sampling

Groundwater samples will be collected from monitoring wells in accordance with standard low-flow sampling techniques. Groundwater samples will be collected from the middle of the screened interval or, if the water level is below the top of the screen, from the middle of the water column. New disposable tubing will be used at each monitoring location.

Before groundwater sample collection begins, the water level will be measured and the well will then be purged. Each well will be purged prior to sampling, using a peristaltic pump with new disposable tubing at a flow rate of 0.1 to 0.5 liters per minute. A minimum of three well volumes will be purged before sample collection or until selected water quality parameters (i.e., temperature, electrical conductance, pH, turbidity, and dissolved oxygen) have stabilized. During purging, the flow rates, water levels, and water quality parameters will be recorded on a field sampling data sheet (FSDS) (see Appendix B). Groundwater will be pumped directly into laboratory-supplied containers specific to the analysis required.

Groundwater samples and associated QC samples will be collected following treatment and will be analyzed for volatile organic compounds (VOCs) by USEPA Method 8260C (USEPA, 1986) to determine the effectiveness of groundwater treatment and to evaluate compliance with cleanup levels. Groundwater samples will also be analyzed for other analytes or analyte groups (e.g., anions, conventionals, dissolved metals) as needed to aid in the evaluation of treatment effectiveness and/or to provide additional information for supplementing or modifying the selected treatment. Specific analytes and methods could include, but are not limited to:

- Total organic carbon by USEPA Method 415.1
- Nitrate as nitrogen (nitrate), chloride, and sulfate by USEPA Method 300.0
- Dissolved calcium, magnesium, manganese, and iron by USEPA Method 200.7

3.5 Nomenclature

Soil samples will be labeled with a prefix to describe the type of sampling and provide a location identification number, an “S” to indicate a soil sample matrix, and sample depth. For example, a soil sample collected with a hand auger at location 12 and at 2 feet below ground surface will have the sample number HA12-S-2.0. The depth interval will be specified as the middle of the sampling interval. Samples will be documented on an FSDS (see Appendix B).

Duplicate soil samples will replace the location number with “DUP” and the sample will have the same sample time as the primary sample. A duplicate sample of the abovementioned sample would appear as HA12DUP-S-2.0.

Groundwater samples collected from monitoring wells will be labeled with an “MW” prefix followed by the location identification number. For example, a groundwater sample collected from MW01 will have the sample number MW01.

Duplicate groundwater samples will replace the location number with "DUP" and the sample will have the same sample time as the primary sample. A duplicate sample of the abovementioned sample would appear as MW01DUP.

Groundwater samples will be documented on an FSDS (see Appendix B). Documentation will include the screened interval, equipment used, water quality parameters (see Section 3.4), and the amount of water purged before sampling.

3.6 Monitoring Well Installation

The RA currently does not include installation of additional monitoring wells; however, well installation procedures are included in this SAP in the event that future data collected indicate a need for additional groundwater monitoring or treatment points. Monitoring wells will be constructed according to the Washington State well construction standards (Chapter 173-160 WAC) and as described below.

- Monitoring wells will be constructed with 2-inch polyvinyl chloride schedule-40 riser pipe and 10-foot-long screened sections. The well screens will consist of 0.010-inch machine slots. The monitoring wells will be constructed with prepacked well screen with 10 x 20 washed silica sand to ensure that a good filter pack surrounds the well.
- Additional filter pack will be placed around the prepacked screen. The additional filter pack will consist of graded 10 x 20 washed silica sand and will extend a maximum of 1 foot below the bottom of the screen and 3 feet above the top of the screen. A weighted line will be used to monitor the level of the filter pack during installation. The filter pack will be surged in approximately 6-foot lifts during installation.
- Bentonite grout or chips (0.75-inch minus) will be used to seal the annulus above the filter pack. Potable water from a municipal supply will be used. A weighted line will be used to measure the top of the bentonite chips as they are poured into place.
- Each wellhead will be completed with a flush-mount monument approximately 1 to 2 inches above the ground surface.
- At least 24 hours after completion of the wells, wells will be developed by surging, bailing, and pumping to remove sediment that may have accumulated during installation and to improve the hydraulic connection with the water bearing zone(s). A minimum of ten well-bore volumes of water will be removed during development.
- Specific conductance, pH, temperature, and turbidity will be measured as deemed appropriate during well development. The wells will be developed until the sediment content is 10 nephelometric turbidity units or less, or until there is no noticeable decrease in turbidity; and specific conductance stabilizes to within 10 percent of the previous reading, pH is within 0.1 standard unit of the previous reading, and temperature is within 0.1 degree Celsius of the previous reading.

3.7 Monitoring Well Decommissioning

The RA currently does not include decommissioning of existing monitoring wells; however, well decommissioning procedures are included in this SAP in the event that future data collected indicate that existing groundwater monitoring points are no longer needed.

If decommissioning of existing monitoring wells is deemed necessary, activities will be performed consistent with Washington State well decommissioning standards (Chapter 173-160 WAC). The well casing will be pulled and the borehole backfilled with bentonite grout. If the casing cannot be pulled, it be perforated at a frequency of four equidistant cuts (at least 0.5 inch long) per row, and one row per foot, from the bottom of the hole to 5 feet below ground surface. The grout will be placed (under hydrostatic pressure) using a tremie pipe with a side discharge, starting from the bottom of the hole. The hole will be capped with cement. The decommissioning procedures and the volume required to fill the borehole, including the actual amount of grout added, will be recorded in the field notes.

3.8 Groundwater Level Measurements

Water level measurements from monitoring wells will include measuring the depth to water and the total well depth to the nearest 0.01 foot, using an electronic water level meter. The depths within wells will be measured from the top of casing (typically the inner casing) at the surveyed elevation point. This reference point will be marked so that readings are consistently taken from the same reference point. Water levels will be measured and recorded on an appropriate field form at each well location prior to purging or sample collection activities. The field form will include fields for date and time of the measurement, depth to water (in feet), and the meter used. In addition, the well condition (including the condition of the lock, monument integrity, and legibility of well labels) will be recorded for each location. Gauging equipment will be decontaminated between wells in accordance with the procedures outlined in Section 3.10.

3.9 Management of Miscellaneous Waste

Soil samples will be collected during the RA as described above. The FP-XRF samples will remain on site and will be managed accordingly (i.e., direct off-site disposal for samples exceeding the cleanup level, or on site if below). Equipment decontamination fluids will be mixed with the corresponding waste stream. Care will be taken to avoid creating pockets or areas of saturated soil.

Materials generated during groundwater sampling and/or monitoring well decommissioning will be managed separately from the excavated soil. These may include unsaturated and saturated soil cuttings, purged groundwater, decontamination fluids, and sampling debris. These materials will be segregated into solids, liquids, and sampling debris (e.g., personal protective equipment, disposable pump discharge tubing, and disposable bailers). They will be stored in a designated area on the Property, in 55-gallon drums approved by the Washington State Department of Transportation.

Drums (tops and sides) will be labeled with their contents, the volume of material, the date of collection, and the origin of the material. The waste drums will be sealed, secured, and transferred to the designated area on the Property at the end of each workday. The waste will be stored in the designated holding area until it has been characterized. Hazardous-waste and/or risk labels will be placed on the drums after characterization, if necessary.

Analytical data from the soil sampling and groundwater sampling activities previously described, as well as data from previously completed site characterization efforts, will be used to characterize the soil cuttings, drilling fluids, purge water, and decontamination fluids generated during monitoring well sampling and decommissioning. After the work is complete and analytical results are received, the wastes will be characterized and disposed of appropriately as part of the RA.

3.10 Equipment Decontamination

The objective of decontamination is to reduce the likelihood of sample cross-contamination. Disposable equipment will be used to collect samples whenever possible. When nondedicated sampling equipment is used, the equipment will be decontaminated in accordance with the following procedures.

Sampling equipment and reusable materials that contact the soil or water will be decontaminated on site and between sampling locations. Decontamination will consist of the following:

- Tap-water rinse (may consist of an equivalent high-pressure, hot-water rinse)
- Nonphosphate detergent wash, consisting of a dilute mixture of Liqui-Nox and tap water (visible soil to be removed by scrubbing)
- Ten percent nitric acid rinse
- Distilled-water rinse
- Methanol solution rinse (1:1 solution with distilled water)
- Final distilled-water rinse

The thoroughness of equipment decontamination will be verified by collection and analysis of equipment rinsate samples. Liquid generated by decontamination will be properly handled, according to procedures specified in Section 3.9.

3.11 Field Quality Assurance and Quality Control Samples

QC samples will be collected to ensure that field samples and quantitative field measurements are representative of the media collected. Field QA/QC samples and collection frequency are as follows:

- **Equipment Rinsate Blanks—**To ensure that decontamination procedures are sufficient, an equipment rinsate blank will be collected when nondedicated equipment is used. At least one equipment rinsate blank will be collected each day or for every 20 samples collected, whichever is greater. Equipment rinsate blanks will be collected by passing laboratory-provided deionized/distilled water through or over sampling equipment.

- **Trip Blanks—**A trip blank monitors the potential of sample-to-sample cross-contamination during sample collection and transport. A trip blank consists of reagent-grade water in a new sample container, which is prepared at the same time as the sample containers. The trip blank will accompany the samples throughout collection, shipment, and storage. One trip blank will be included with each cooler in which samples for VOC analyses are stored.
- **Field Duplicates—**Field duplicates are collected to measure sampling and laboratory precision. For soil samples, when sufficient sample volume is available, an individual sample will be split into two separate sample containers and labeled as two different samples. Care will be taken when collecting duplicate soil samples to ensure that the same ratio of fine to coarse material is included in each sample. One duplicate sample will be collected for every 20 samples of each matrix type or one per day, whichever is greater.

In addition to field QA/QC samples, extra volume will be collected for laboratory matrix spike/matrix spike duplicate (MS/MSD) samples at a rate of one per 20 samples per matrix.

3.12 Work Documentation

Field notes will be maintained during sampling. As a minimum, the following information will be included in the field notes:

- Sampler's name
- Weather conditions
- Sample name
- Sample location
- Sampling method, depth, date, and time
- Problems encountered with equipment or methods
- Physical description of soil samples
- FP-XRF sample results (as applicable)
- Other field observations

3.13 Sample Containers, Preservation, and Handling

Sample container, preservation, and handling requirements for each analysis are summarized in Table D-1. Water samples for VOC analysis will be collected in hydrochloric-acid-preserved, 40-milliliter, glass volatile organic analysis (VOA) vials. The VOA vials will be collected with no headspace and free of bubbles. Each vial will be checked for bubbles. If air bubbles exist, the vial will be topped-off again and then recapped. Soil samples will be collected in glass jars. The samples will be stored in iced coolers at 4° ± 2 Celsius. Care will be taken to ensure that sample coolers are packed with sufficient quantities of ice, and not over-packed with samples, in order to maintain preservation temperatures. Additional coolers will be requested from the laboratory, as necessary, to avoid over-packing. Sample containers will be supplied by the laboratory.

3.14 Sample Custody, Packaging, and Shipping

Sample custody will be tracked from point of origin through final analysis and disposal, using a COC form, which will be filled out with the appropriate sample and analytical information as soon as possible after samples are collected. For purposes of this work, custody will be defined as follows:

- In plain view of MFA field representatives
- Inside a cooler that is in plain view of MFA field representatives
- Inside any locked space such as a cooler, locker, car, or truck to which the MFA field representatives have the only available key(s)

After sample containers have been filled, they will be packed on ice in coolers and then transported in iced shipping containers to the analytical laboratory. A custody seal will also be affixed to the cooler if the cooler is to be shipped or will otherwise leave the custody of the MFA field representative prior to receipt of the samples at the laboratory. Analytical laboratories that may be used include Specialty Analytical at 11711 SE Capps Road, Clackamas, OR 97015; and Analytical Resources, Inc. at 4611 South 134th Place, # 100, Tukwila, Washington.

COC procedures will begin in the field and will track delivery of the samples to the laboratories. Specific procedures for sample shipping are as follows:

- Samples will be packaged and shipped in accordance with U.S. Department of Transportation regulations as specified in 49 Code of Federal Regulations (CFR) 173.6 and 49 CFR 173.24.
- Individual sample containers will be packed to prevent breakage.
- The coolers will be clearly labeled with sufficient information (name of project, time and date container was sealed, person sealing the cooler, and laboratory's name and address) to enable positive identification.
- A sealed envelope containing COC forms will be enclosed in a plastic bag inside the cooler.
- Signed and dated COC seals will be placed on all coolers before shipping.

Upon transfer of samples to the laboratory, the COC form will be signed by the persons transferring custody of the coolers. Upon receipt of samples at the laboratory, the shipping container seal will be broken and the condition of the samples will be recorded by the receiver.

4 FIELD MEASUREMENTS, ANALYTICAL PROCEDURES, AND QUALITY CONTROL

Measurements will be collected in the field, using screening tools, and soil and groundwater samples will be collected and submitted for laboratory analyses. Field and laboratory methods are described below.

4.1 Field Instrumentation

Field instruments will be used during the investigations. The following field equipment will require calibration before use and periodically during sampling activities:

- pH meter
- Conductivity meter
- Dissolved oxygen
- FP-XRF
- Oxygen/reduction potential meter
- Turbidity meter
- Thermometer
- Photoionization detector
- Electronic water-level probe

Field instrument calibration and preventive maintenance will follow the manufacturers' guidelines, and any deviation from the established guidelines will be documented. Additionally, the FP-XRF instrument will be calibrated in accordance with USEPA Method 6200 (Appendix A). Generally, field instruments will be calibrated daily before work begins. Field personnel may decide to calibrate more than once a day if inconsistent or unusual readings are received, or if conditions warrant more frequent calibration. Calibration activities will be recorded in instrument-specific logbooks or field notebooks.

4.1.1 Field Calibration

Calibration procedures, calibration frequency, and standards for measurement will be conducted according to manufacturers' guidelines. To ensure that field instruments are properly calibrated and remain operable, the following procedures will be used, at a minimum:

- Operation, maintenance, and calibration will be performed in accordance with the instrument manufacturers' specifications.

- All standards used to calibrate field instruments will meet the minimum requirements for source and purity recommended in the equipment operation manual. Standards will be used before any expiration dates that may be printed on the bottle.
- Acceptable criteria for calibration will be based on the limits set in the operations manual.
- All users of the equipment will be trained in the proper calibration and operation of the instrument.
- Operation and maintenance manuals for each field instrument will be brought to the site.
- Field instruments will be inspected before they are taken to the site.
- Field instruments will be calibrated at the start and end of each work period. Meters will be recalibrated, as necessary, during the work period.

Calibration procedures (including time, standards used, and calibration results) will be recorded in a field notebook. Although not reviewed during routine QA/QC checks, the data will be available if problems are encountered.

4.1.2 Preventive Maintenance

Preventive maintenance of field instruments and equipment will follow the operations manuals. A schedule of preventive-maintenance activities will be followed to minimize downtime and ensure the accuracy of measurement systems. Maintenance will be documented in the field notebook.

4.2 Laboratory Test Methods and Reporting Limits

Soil samples will be analyzed for lead and TCLP-lead. Groundwater samples will be analyzed for VOCs. Analytical procedures are described below. Test methods and reporting limits are summarized in Table D-2. Reporting limits are compared with cleanup levels to ensure that the analytical method is appropriate for the data use. Reporting limits shown in Table D-2 are achievable in clean matrices; reporting limits in environmental samples may be affected by soil moisture or matrix interference. The laboratory will use appropriate measures, such as cleanup procedures, to attain reporting limits below cleanup levels.

4.3 Laboratory Instrumentation

Specific laboratory instrument calibration procedures, frequency of calibration, and preparation of calibration standards will be according to the method requirements developed by the USEPA, following procedures presented in SW-846 (USEPA, 1986) and Analytical Methods for Petroleum Hydrocarbons (Ecology, 1997).

4.3.1 Preventive Maintenance

Preventive maintenance of laboratory equipment will be the responsibility of the laboratory personnel and analysts. This maintenance includes routine care and cleaning of instruments, and inspection and monitoring of carrier gases, solvents, and glassware used in analyses. The preventive-maintenance approach for specific equipment will follow the manufacturers' specifications and good laboratory practices.

Precision and accuracy data will be examined for trends and excursions beyond control limits to determine evidence of instrument malfunction. Maintenance will be performed when an instrument begins to change, as indicated by the degradation of peak resolution, shift in calibration curves, decrease in sensitivity, or failure to meet any of the QC criteria.

4.3.2 Laboratory QA/QC Checks

QC samples and procedures verify that the instrument is calibrated properly and remains in calibration throughout the analytical sequence, and that the sample preparation procedures have been effective and have not introduced contaminants into the samples. Additional QC samples are used to identify and quantify positive or negative interference caused by the sample matrix. The following laboratory QC procedures are required for most analytical procedures:

- **Calibration Verification—**Initial calibration of instruments will be performed at the start of the project or sample run, as required, and when any ongoing calibration does not meet control criteria. The number of points used in the initial calibration is defined in the analytical method. Continuing calibration will be performed as specified in the analytical method to track instrument performance. If a continuing calibration does not meet control limits, analysis of project samples will be suspended until the source of the control failure is either eliminated or reduced to within control specifications. Any project samples analyzed while the instrument was outside of control limits will be reanalyzed.

- **Method Blanks—**Method blanks are used to assess possible laboratory contamination of samples associated with all stages of preparation and analysis of samples and extracts. The laboratory will not apply blank corrections to the original data. A minimum of one method blank will be analyzed for every sample extraction group, or one for every 20 samples, whichever is more frequent.

- **MS/MSD Samples—**MS samples are analyzed to assess the matrix effects on the accuracy of analytical measurements. A minimum of one MS will be analyzed for each sample delivery group, or one for every 20 samples, whichever is more frequent. Because the spike is a duplicate sample, it measures the quality of laboratory preparatory techniques and the heterogeneity of the sample.

- **Surrogate Spike Compounds—**Surrogate spikes are used to evaluate the recovery of an analyte from individual samples. All project samples to be analyzed for organic compounds will be spiked with appropriate surrogate compounds as defined in the analysis method. Recoveries determined using these surrogate compounds will be reported by the laboratory; however, the laboratory will not correct sample results using these recoveries.

- **Laboratory Control Samples (LCSs)—**Analyses of LCSs will be performed by the laboratory at a frequency that satisfies the analytical methods requirements.

4.4 Data Reduction, Validation, and Reporting

The analytical laboratory will submit analytical data packages that include laboratory QA/QC results to permit independent and conclusive determination of data quality. Data quality will be determined by MFA, using the data evaluation procedures described in this section. The results of the MFA evaluation will be used to determine if the project data quality objectives are met.

4.4.1 Field Data Reduction

Daily internal QC checks will be performed for field activities. Checks will consist of reviewing field notes and field activity memoranda to confirm that the specified measurements, calibrations, and procedures are being used. The need for corrective action will be assessed on an ongoing basis, in consultation with the project manager.

4.4.2 Laboratory Evaluation

Initial data reduction, evaluation, and reporting at the analytical laboratory will be carried out as described in USEPA SW-846 manuals for organic analyses (USEPA, 1986), as appropriate. Additional laboratory data qualifiers may be defined and reported to further explain the laboratory's QC concerns about a particular sample result. All additional data qualifiers will be defined in the laboratory's case narrative reports associated with each case.

4.4.3 Data Deliverables

Laboratory data deliverables are listed below. Electronic deliverables will contain the same data that are presented in the hard-copy report:

- Transmittal cover letter
- Case narrative
- Analytical results
- COC
- Surrogate recoveries
- Method blank results
- MS/MSD results
- Laboratory duplicate results

4.4.4 Data QA/QC Review

MFA will evaluate the laboratory data for precision, completeness, accuracy, and compliance with the analytical method. MFA will review data and assign data qualifiers to sample results, following applicable sections of the USEPA procedures for inorganics and organics data review (USEPA, 1986, 2004b, 2008).

Data qualifiers, as defined by the USEPA, are used to classify sample data according to their conformance to QC requirements. The most common qualifiers are listed below:

- J—Estimate, qualitatively correct but quantitatively suspect.
- R—Reject, data not suitable for any purpose.
- U—Not detected at a specified reporting limit.

Poor surrogate recovery, blank contamination, or calibration problems, among other things, can cause the sample data to be qualified. Whenever sample data are qualified, the reasons for the qualification will be stated in the data evaluation report.

QC criteria not defined in the guidelines for evaluating analytical data are adopted, where appropriate, from the analytical method.

The following information will be reviewed during data evaluation, as applicable:

- Sampling locations and blind sample numbers
- Sampling dates
- Requested analysis
- COC documentation
- Sample preservation
- Holding times
- Method blanks
- Surrogate recoveries
- MS/MSD results
- Laboratory duplicates (if analyzed)
- Field duplicates
- Field blanks
- LCSs
- Method reporting limits above requested levels
- Any additional comments or difficulties reported by the laboratory
- Overall assessment

The results of the data evaluation review will be summarized for each data package. Data qualifiers will be assigned to sample results on the basis of USEPA guidelines, as applicable.

4.4.5 Data Management and Reduction

MFA uses EQuIS environmental data management software to manage all laboratory data. The laboratory will provide the analytical results in electronic EQuIS-deliverable format. Following data evaluation, data qualifiers and analytical results will be entered into the EQuIS database. Any data representing concentrations in the unexcavated subsurface will be entered into Ecology's Environmental Information Management (EIM) database in addition to MFA's EQuIS database. Data collected from excavated materials will not be entered into EIM.

Data may be reduced to summarize particular data sets and to aid interpretation of the results. Statistical analyses may also be applied to results. Data reduction QC checks will be performed on all hand-entered data, any calculations, and any data graphically displayed. Data may be further reduced and managed using one or more of the following computer software applications:

- Microsoft Excel (spreadsheet)
- EQuIS (database)
- Ecology's EIM (database)
- AutoCad and/or Arc GIS (graphics)
- USEPA ProUCL (statistical software)

5 REPORTING

After data collection, validation, evaluation, and reduction have been completed, the data will be incorporated into reports. Copies of the reports will be kept in MFA's main project files, submitted to the Port for review, and then submitted to Ecology.

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TABLES

Table D-1
Sample Handling Summary
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	Method	Suggested Volume	Container	Number of Containers	Preservative	Storage Temperature	Holding Time from Collection
Soil							
Lead	USEPA 6010	4 ounces	Glass Jar	1	none	4 degrees C	6 months
TCLP Lead	USEPA 6010	8 ounces	Glass Jar	1	none	none	6 months
Groundwater							
VOCs	USEPA 8260	40 milliliter	VOA vial	3	HCL pH < 2	4 degrees C	14 Days

NOTES:

C = Celsius.

HCL = hydrochloric acid.

TCLP = toxicity characteristic leaching procedure.

USEPA = U.S. Environmental Protection Agency.

VOA = volatile organic analysis.

VOC = volatile organic compound.

Table D-2
Analytical Methods
Former Cream Wine Property
Port of Sunnyside
Sunnyside, Washington

Analyte	Method	Method Reporting Limit	Cleanup Level
Soil (mg/kg)			
Lead	USEPA 6010	2	250
Groundwater (µg/L)			
Tetrachloroethene (PCE)	USEPA 8260	1	5

NOTES:

mg/kg = milligrams per kilogram (parts per million).

µg/L = micrograms per liter (parts per billion).

USEPA = U.S. Environmental Protection Agency.

APPENDIX A

USEPA METHOD 6200

METHOD 6200

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

1.0 SCOPE AND APPLICATION

1.1 This method is applicable to the in situ and intrusive analysis of the 26 analytes listed below for soil and sediment samples. Some common elements are not listed in this method because they are considered "light" elements that cannot be detected by field portable x-ray fluorescence (FPXRF). These light elements are: lithium, beryllium, sodium, magnesium, aluminum, silicon, and phosphorus. Most of the analytes listed below are of environmental concern, while a few others have interference effects or change the elemental composition of the matrix, affecting quantitation of the analytes of interest. Generally elements of atomic number 16 or greater can be detected and quantitated by FPXRF. The following RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Antimony (Sb)	7440-36-0
Arsenic (As)	7440-38-0
Barium (Ba)	7440-39-3
Cadmium (Cd)	7440-43-9
Chromium (Cr)	7440-47-3
Cobalt (Co)	7440-48-4
Copper (Cu)	7440-50-8
Lead (Pb)	7439-92-1
Mercury (Hg)	7439-97-6
Nickel (Ni)	7440-02-0
Selenium (Se)	7782-49-2
Silver (Ag)	7440-22-4
Thallium (Tl)	7440-28-0
Tin (Sn)	7440-31-5

Analytes	CAS Registry No.
Vanadium (V)	7440-62-2
Zinc (Zn)	7440-66-6

In addition, the following non-RCRA analytes have been determined by this method:

Analytes	CAS Registry No.
Calcium (Ca)	7440-70-2
Iron (Fe)	7439-89-6
Manganese (Mn)	7439-96-5
Molybdenum (Mo)	7439-93-7
Potassium (K)	7440-09-7
Rubidium (Rb)	7440-17-7
Strontium (Sr)	7440-24-6
Thorium (Th)	7440-29-1
Titanium (Ti)	7440-32-6
Zirconium (Zr)	7440-67-7

1.2 This method is a screening method to be used with confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnance atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)). This method’s main strength is that it is a rapid field screening procedure. The method's lower limits of detection are typically above the toxicity characteristic regulatory level for most RCRA analytes. However, when the obtainable values for precision, accuracy, and laboratory-established sensitivity of this method meet project-specific data quality objectives (DQOs), FPXRF is a fast, powerful, cost effective technology for site characterization.

1.3 The method sensitivity or lower limit of detection depends on several factors, including the analyte of interest, the type of detector used, the type of excitation source, the strength of the excitation source, count times used to irradiate the sample, physical matrix effects, chemical matrix effects, and interelement spectral interferences. Example lower limits of detection for analytes of interest in environmental applications are shown in Table 1. These limits apply to a clean spiked matrix of quartz sand (silicon dioxide) free of interelement spectral interferences using long (100 -600 second) count times. These sensitivity values are given for guidance only and may not always be achievable, since they will vary depending on the sample matrix, which instrument is used, and operating conditions. A discussion of performance-based sensitivity is presented in Sec. 9.6.

1.4 Analysts should consult the disclaimer statement at the front of the manual and the information in Chapter Two for guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and on the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly specified in a regulation, the use of SW-846 methods is *not* mandatory in response to Federal testing requirements. The information contained in this method is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.5 Use of this method is restricted to use by, or under supervision of, personnel appropriately experienced and trained in the use and operation of an XRF instrument. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

2.1 The FPXRF technologies described in this method use either sealed radioisotope sources or x-ray tubes to irradiate samples with x-rays. When a sample is irradiated with x-rays, the source x-rays may undergo either scattering or absorption by sample atoms. This latter process is known as the photoelectric effect. When an atom absorbs the source x-rays, the incident radiation dislodges electrons from the innermost shells of the atom, creating vacancies. The electron vacancies are filled by electrons cascading in from outer electron shells. Electrons in outer shells have higher energy states than inner shell electrons, and the outer shell electrons give off energy as they cascade down into the inner shell vacancies. This rearrangement of electrons results in emission of x-rays characteristic of the given atom. The emission of x-rays, in this manner, is termed x-ray fluorescence.

Three electron shells are generally involved in emission of x-rays during FPXRF analysis of environmental samples. The three electron shells include the K, L, and M shells. A typical emission pattern, also called an emission spectrum, for a given metal has multiple intensity peaks generated from the emission of K, L, or M shell electrons. The most commonly measured x-ray emissions are from the K and L shells; only metals with an atomic number greater than 57 have measurable M shell emissions.

Each characteristic x-ray line is defined with the letter K, L, or M, which signifies which shell had the original vacancy and by a subscript alpha (α), beta (β), or gamma (γ) etc., which indicates the higher shell from which electrons fell to fill the vacancy and produce the x-ray. For example, a K_α line is produced by a vacancy in the K shell filled by an L shell electron, whereas a K_β line is produced by a vacancy in the K shell filled by an M shell electron. The K_α transition is on average 6 to 7 times more probable than the K_β transition; therefore, the K_α line is approximately 7 times more intense than the K_β line for a given element, making the K_α line the choice for quantitation purposes.

The K lines for a given element are the most energetic lines and are the preferred lines for analysis. For a given atom, the x-rays emitted from L transitions are always less energetic than those emitted from K transitions. Unlike the K lines, the main L emission lines (L_α and L_β) for an element are of nearly equal intensity. The choice of one or the other depends on what interfering element lines might be present. The L emission lines are useful for analyses involving elements of atomic number (Z) 58 (cerium) through 92 (uranium).

An x-ray source can excite characteristic x-rays from an element only if the source energy is greater than the absorption edge energy for the particular line group of the element, that is, the K absorption edge, L absorption edge, or M absorption edge energy. The absorption edge energy is somewhat greater than the corresponding line energy. Actually, the K absorption edge energy is approximately the sum of the K, L, and M line energies of the particular element, and the L absorption edge energy is approximately the sum of the L and M line energies. FPXRF is more sensitive to an element with an absorption edge energy close to but less than the excitation energy of the source. For example, when using a cadmium-109 source, which has an excitation energy of 22.1 kiloelectron volts (keV), FPXRF would exhibit better sensitivity for zirconium which has a K line energy of 15.77 keV than to chromium, which has a K line energy of 5.41 keV.

2.2 Under this method, inorganic analytes of interest are identified and quantitated using a field portable energy-dispersive x-ray fluorescence spectrometer. Radiation from one or more radioisotope sources or an electrically excited x-ray tube is used to generate characteristic x-ray emissions from elements in a sample. Up to three sources may be used to irradiate a sample. Each source emits a specific set of primary x-rays that excite a corresponding range of elements in a sample. When more than one source can excite the element of interest, the source is selected according to its excitation efficiency for the element of interest.

For measurement, the sample is positioned in front of the probe window. This can be done in two manners using FPXRF instruments, specifically, in situ or intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. The sample cup is then placed on top of the window inside a protective cover for analysis.

Sample analysis is then initiated by exposing the sample to primary radiation from the source. Fluorescent and backscattered x-rays from the sample enter through the detector window and are converted into electric pulses in the detector. The detector in FPXRF instruments is usually either a solid-state detector or a gas-filled proportional counter. Within the detector, energies of the characteristic x-rays are converted into a train of electric pulses, the amplitudes of which are linearly proportional to the energy of the x-rays. An electronic multichannel analyzer (MCA) measures the pulse amplitudes, which is the basis of qualitative x-ray analysis. The number of counts at a given energy per unit of time is representative of the element concentration in a sample and is the basis for quantitative analysis. Most FPXRF instruments are menu-driven from software built into the units or from personal computers (PC).

The measurement time of each source is user-selectable. Shorter source measurement times (30 seconds) are generally used for initial screening and hot spot delineation, and longer measurement times (up to 300 seconds) are typically used to meet higher precision and accuracy requirements.

FPXRF instruments can be calibrated using the following methods: internally using fundamental parameters determined by the manufacturer, empirically based on site-specific calibration standards (SSCS), or based on Compton peak ratios. The Compton peak is produced by backscattering of the source radiation. Some FPXRF instruments can be calibrated using multiple methods.

3.0 DEFINITIONS

3.1 FPXRF -- Field portable x-ray fluorescence.

3.2 MCA -- Multichannel analyzer for measuring pulse amplitude.

3.3 SSCS -- Site-specific calibration standards.

3.4 FP -- Fundamental parameter.

3.5 ROI -- Region of interest.

3.6 SRM -- Standard reference material; a standard containing certified amounts of metals in soil or sediment.

3.7 eV -- Electron volt; a unit of energy equivalent to the amount of energy gained by an electron passing through a potential difference of one volt.

3.8 Refer to Chapter One, Chapter Three, and the manufacturer's instructions for other definitions that may be relevant to this procedure.

4.0 INTERFERENCES

4.1 The total method error for FPXRF analysis is defined as the square root of the sum of squares of both instrument precision and user- or application-related error. Generally, instrument precision is the least significant source of error in FPXRF analysis. User- or application-related error is generally more significant and varies with each site and method used. Some sources of interference can be minimized or controlled by the instrument operator, but others cannot. Common sources of user- or application-related error are discussed below.

4.2 Physical matrix effects result from variations in the physical character of the sample. These variations may include such parameters as particle size, uniformity, homogeneity, and surface condition. For example, if any analyte exists in the form of very fine particles in a coarser-grained matrix, the analyte’s concentration measured by the FPXRF will vary depending on how fine particles are distributed within the coarser-grained matrix. If the fine particles "settle" to the bottom of the sample cup (i.e., against the cup window), the analyte concentration measurement will be higher than if the fine particles are not mixed in well and stay on top of the coarser-grained particles in the sample cup. One way to reduce such error is to grind and sieve all soil samples to a uniform particle size thus reducing sample-to-sample particle size variability. Homogeneity is always a concern when dealing with soil samples. Every effort should be made to thoroughly mix and homogenize soil samples before analysis. Field studies have shown heterogeneity of the sample generally has the largest impact on comparability with confirmatory samples.

4.3 Moisture content may affect the accuracy of analysis of soil and sediment sample analyses. When the moisture content is between 5 and 20 percent, the overall error from moisture may be minimal. However, moisture content may be a major source of error when analyzing samples of surface soil or sediment that are saturated with water. This error can be minimized by drying the samples in a convection or toaster oven. Microwave drying is not recommended because field studies have shown that microwave drying can increase variability between FPXRF data and confirmatory analysis and because metal fragments in the sample can cause arcing to occur in a microwave.

4.4 Inconsistent positioning of samples in front of the probe window is a potential source of error because the x-ray signal decreases as the distance from the radioactive source increases. This error is minimized by maintaining the same distance between the window and each sample. For the best results, the window of the probe should be in direct contact with the sample, which means that the sample should be flat and smooth to provide a good contact surface.

4.5 Chemical matrix effects result from differences in the concentrations of interfering elements. These effects occur as either spectral interferences (peak overlaps) or as x-ray absorption and enhancement phenomena. Both effects are common in soils contaminated with heavy metals. As examples of absorption and enhancement effects; iron (Fe) tends to absorb copper (Cu) x-rays, reducing the intensity of the Cu measured by the detector, while chromium (Cr) will be enhanced at the expense of Fe because the absorption edge of Cr is slightly lower in energy than the fluorescent peak of iron. The effects can be corrected mathematically through the use of fundamental parameter (FP) coefficients. The effects also can be compensated for using SSCS, which contain all the elements present on site that can interfere with one another.

4.6 When present in a sample, certain x-ray lines from different elements can be very close in energy and, therefore, can cause interference by producing a severely overlapped spectrum. The degree to which a detector can resolve the two different peaks depends on the energy resolution of the detector. If the energy difference between the two peaks in electron volts is less than the resolution of the detector in electron volts, then the detector will not be able to fully resolve the peaks.

The most common spectrum overlaps involve the K_β line of element Z-1 with the K_α line of element Z. This is called the K_α/K_β interference. Because the $K_\alpha:K_\beta$ intensity ratio for a given element usually is about 7:1, the interfering element, Z-1, must be present at large concentrations to cause a problem. Two examples of this type of spectral interference involve the presence of large concentrations of vanadium (V) when attempting to measure Cr or the presence of large concentrations of Fe when attempting to measure cobalt (Co). The V K_α and K_β energies are 4.95 and 5.43 keV, respectively, and the Cr K_α energy is 5.41 keV. The Fe K_α and K_β energies are 6.40 and 7.06 keV, respectively, and the Co K_α energy is 6.92 keV. The difference between the V K_β and Cr K_α energies is 20 eV, and the difference between the Fe K_β and the Co K_α energies is 140 eV. The resolution of the highest-resolution detectors in FPXRF instruments is 170 eV. Therefore, large amounts of V and Fe will interfere with quantitation of Cr or Co, respectively. The presence of Fe is a frequent problem because it is often found in soils at tens of thousands of parts per million (ppm).

4.7 Other interferences can arise from K/L, K/M, and L/M line overlaps, although these overlaps are less common. Examples of such overlap involve arsenic (As) K_α/lead (Pb) L_α and sulfur (S) K_α/Pb M_α. In the As/Pb case, Pb can be measured from the Pb L_β line, and As can be measured from either the As K_α or the As K_β line; in this way the interference can be corrected. If the As K_β line is used, sensitivity will be decreased by a factor of two to five times because it is a less intense line than the As K_α line. If the As K_α line is used in the presence of Pb, mathematical corrections within the instrument software can be used to subtract out the Pb interference. However, because of the limits of mathematical corrections, As concentrations cannot be efficiently calculated for samples with Pb:As ratios of 10:1 or more. This high ratio of Pb to As may result in reporting of a "nondetect" or a "less than" value (e.g., <300 ppm) for As, regardless of the actual concentration present.

No instrument can fully compensate for this interference. It is important for an operator to understand this limitation of FPXRF instruments and consult with the manufacturer of the FPXRF instrument to evaluate options to minimize this limitation. The operator's decision will be based on action levels for metals in soil established for the site, matrix effects, capabilities of the instrument, data quality objectives, and the ratio of lead to arsenic known to be present at the site. If a site is encountered that contains lead at concentrations greater than ten times the concentration of arsenic it is advisable that all critical soil samples be sent off site for confirmatory analysis using other techniques (e.g., flame atomic absorption spectrometry (FLAA), graphite furnance atomic absorption spectrometry (GFAA), inductively coupled plasma-atomic emission spectrometry, (ICP-AES), or inductively coupled plasma-mass spectrometry, (ICP-MS)).

4.8 If SSCS are used to calibrate an FPXRF instrument, the samples collected must be representative of the site under investigation. Representative soil sampling ensures that a sample or group of samples accurately reflects the concentrations of the contaminants of concern at a given time and location. Analytical results for representative samples reflect variations in the presence and concentration ranges of contaminants throughout a site. Variables affecting sample representativeness include differences in soil type, contaminant concentration variability, sample collection and preparation variability, and analytical variability, all of which should be minimized as much as possible.

4.9 Soil physical and chemical effects may be corrected using SSCS that have been analyzed by inductively coupled plasma (ICP) or atomic absorption (AA) methods. However, a major source of error can be introduced if these samples are not representative of the site or if the analytical error is large. Another concern is the type of digestion procedure used to prepare the soil samples for the reference analysis. Analytical results for the confirmatory method will vary depending on whether a partial digestion procedure, such as Method 3050, or a total digestion procedure, such as Method 3052, is used. It is known that depending on the nature of the soil or sediment, Method 3050 will achieve differing extraction efficiencies for different analytes of interest. The confirmatory method should meet the project-specific data quality objectives (DQOs).

XRF measures the total concentration of an element; therefore, to achieve the greatest comparability of this method with the reference method (reduced bias), a total digestion procedure should be used for sample preparation. However, in the study used to generate the performance data for this method (see Table 8), the confirmatory method used was Method 3050, and the FPXRF data compared very well with regression correlation coefficients (r often exceeding 0.95, except for barium and chromium). The critical factor is that the digestion procedure and analytical reference method used should meet the DQOs of the project and match the method used for confirmation analysis.

4.10 Ambient temperature changes can affect the gain of the amplifiers producing instrument drift. Gain or drift is primarily a function of the electronics (amplifier or preamplifier) and not the detector as most instrument detectors are cooled to a constant temperature. Most FPXRF instruments have a built-in automatic gain control. If the automatic gain control is allowed to make periodic adjustments, the instrument will compensate for the influence of temperature changes on its energy scale. If the FPXRF instrument has an automatic gain control function, the operator will not have to adjust the instrument's gain unless an error message appears. If an error message appears, the operator should follow the manufacturer's procedures for troubleshooting the problem. Often, this involves performing a new energy calibration. The performance of an energy calibration check to assess drift is a quality control measure discussed in Sec. 9.2.

If the operator is instructed by the manufacturer to manually conduct a gain check because of increasing or decreasing ambient temperature, it is standard to perform a gain check after every 10 to 20 sample measurements or once an hour whichever is more frequent. It is also suggested that a gain check be performed if the temperature fluctuates more than 10° F. The operator should follow the manufacturer's recommendations for gain check frequency.

5.0 SAFETY

5.1 This method does not address all safety issues associated with its use. The user is responsible for maintaining a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals listed in this method. A reference file of material safety data sheets (MSDSs) should be available to all personnel involved in these analyses.

NOTE: No MSDS applies directly to the radiation-producing instrument because that is covered under the Nuclear Regulatory Commission (NRC) or applicable state regulations.

5.2 Proper training for the safe operation of the instrument and radiation training should be completed by the analyst prior to analysis. Radiation safety for each specific instrument can be found in the operator's manual. Protective shielding should never be removed by the analyst or any personnel other than the manufacturer. The analyst should be aware of the local state and national regulations that pertain to the use of radiation-producing equipment and radioactive materials with which compliance is required. There should be a person appointed within the organization that is solely responsible for properly instructing all personnel, maintaining inspection records, and monitoring x-ray equipment at regular intervals.

Licenses for radioactive materials are of two types, specifically: (1) a general license which is usually initiated by the manufacturer for receiving, acquiring, owning, possessing, using, and transferring radioactive material incorporated in a device or equipment, and (2) a specific license which is issued to named persons for the operation of radioactive instruments as required by local, state, or federal agencies. A copy of the radioactive material license (for specific licenses only) and leak tests should be present with the instrument at all times and available to local and national authorities upon request.

X-ray tubes do not require radioactive material licenses or leak tests, but do require approvals and licenses which vary from state to state. In addition, fail-safe x-ray warning lights should be illuminated whenever an x-ray tube is energized. Provisions listed above concerning radiation safety regulations, shielding, training, and responsible personnel apply to x-ray tubes just as to radioactive sources. In addition, a log of the times and operating conditions should be kept whenever an x-ray tube is energized. An additional hazard present with x-ray tubes is the danger of electric shock from the high voltage supply, however, if the tube is properly positioned within the instrument, this is only a negligible risk. Any instrument (x-ray tube or radioisotope based) is capable of delivering an electric shock from the basic circuitry when the system is inappropriately opened.

5.3 Radiation monitoring equipment should be used with the handling and operation of the instrument. The operator and the surrounding environment should be monitored continually for analyst exposure to radiation. Thermal luminescent detectors (TLD) in the form of badges and rings are used to monitor operator radiation exposure. The TLDs or badges should be worn in the area of maximum exposure. The maximum permissible whole-body dose from occupational exposure is 5 Roentgen Equivalent Man (REM) per year. Possible exposure pathways for radiation to enter the body are ingestion, inhaling, and absorption. The best precaution to prevent radiation exposure is distance and shielding.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for use. The products and instrument settings cited in SW-846 methods represent those products and settings used during method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

6.1 FPXRF spectrometer -- An FPXRF spectrometer consists of four major components: (1) a source that provides x-rays; (2) a sample presentation device; (3) a detector that converts x-ray-generated photons emitted from the sample into measurable electronic signals; and (4) a data processing unit that contains an emission or fluorescence energy analyzer, such as an MCA, that processes the signals into an x-ray energy spectrum from which elemental concentrations in the sample may be calculated, and a data display and storage system. These components and additional, optional items, are discussed below.

6.1.1 Excitation sources -- FPXRF instruments use either a sealed radioisotope source or an x-ray tube to provide the excitation source. Many FPXRF instruments use sealed radioisotope sources to produce x-rays in order to irradiate samples. The FPXRF instrument may contain between one and three radioisotope sources. Common radioisotope sources used for analysis for metals in soils are iron Fe-55 (^{55}Fe), cadmium Cd-109 (^{109}Cd), americium Am-241 (^{241}Am), and curium Cm-244 (^{244}Cm). These sources may be contained in a probe along with a window and the detector; the probe may be connected to a data reduction and handling system by means of a flexible cable. Alternatively, the sources, window, and detector may be included in the same unit as the data reduction and handling system.

The relative strength of the radioisotope sources is measured in units of millicuries (mCi). All other components of the FPXRF system being equal, the stronger the source, the greater the sensitivity and precision of a given instrument. Radioisotope sources undergo constant decay. In fact, it is this decay process that emits the primary x-rays used to excite samples for FPXRF analysis. The decay of radioisotopes is measured in "half-lives." The half-life of a radioisotope is defined as the length of time required to reduce the radioisotopes strength or activity by half. Developers of FPXRF technologies recommend source replacement at regular intervals based on the source's half-life. This is due to the ever increasing time required for the analysis rather than a decrease in instrument performance. The characteristic x-rays emitted from each of the different sources have energies capable of exciting a certain range of analytes in a sample. Table 2 summarizes the characteristics of four common radioisotope sources.

X-ray tubes have higher radiation output, no intrinsic lifetime limit, produce constant output over their lifetime, and do not have the disposal problems of radioactive sources but are just now appearing in FPXRF instruments. An electrically-excited x-ray tube operates by bombarding an anode with electrons accelerated by a high voltage. The electrons gain an energy in electron volts equal to the accelerating voltage and can excite atomic transitions in the anode, which then produces characteristic x-rays. These characteristic x-rays are emitted through a window which contains the vacuum necessary for the electron acceleration. An important difference between x-ray tubes and radioactive sources is that the electrons which bombard the anode also produce a continuum of x-rays across a broad range of energies in addition to the characteristic x-rays. This continuum is weak compared to the characteristic x-rays but can provide substantial excitation since it covers a broad energy range. It has the undesired property of producing background in the spectrum near the analyte x-ray lines when it is scattered by the sample. For this reason a filter is often used between the x-ray tube and the sample to suppress the continuum radiation while passing the characteristic x-rays from the anode. This filter is sometimes incorporated into the window of the x-ray tube. The choice of accelerating voltage is governed both by the anode material, since the electrons must have sufficient energy to excite the anode, which requires a voltage greater than the absorption edge of the anode material and by the instrument's ability to cool the x-ray tube. The anode is most efficiently excited by voltages 2 to 2.5 times the edge energy (most x-rays per unit power to the tube), although voltages as low as 1.5 times the absorption edge energy will work. The characteristic x-rays emitted by the anode are capable of exciting a range of elements in the sample just as with a radioactive source. Table 3 gives the recommended operating voltages and the sample elements excited for some common anodes.

6.1.2 Sample presentation device -- FPXRF instruments can be operated in two modes: in situ and intrusive. If operated in the in situ mode, the probe window is placed in direct contact with the soil surface to be analyzed. When an FPXRF instrument is operated in the intrusive mode, a soil or sediment sample must be collected, prepared, and placed in a sample cup. For FPXRF instruments operated in the intrusive mode, the probe may be rotated so that the window faces either upward or downward. A protective sample cover is placed over the window, and the sample cup is placed on top of the window inside the protective sample cover for analysis.

6.1.3 Detectors -- The detectors in the FPXRF instruments can be either solid-state detectors or gas-filled, proportional counter detectors. Common solid-state detectors include mercuric iodide (HgI_2), silicon pin diode and lithium-drifted silicon Si(Li). The HgI_2 detector is operated at a moderately subambient temperature controlled by a low power thermoelectric cooler. The silicon pin diode detector also is cooled via the thermoelectric Peltier effect. The Si(Li) detector must be cooled to at least -90 °C either with liquid nitrogen or by thermoelectric cooling via the Peltier effect. Instruments with a Si(Li) detector have an internal liquid nitrogen dewar with a capacity of 0.5 to 1.0 L. Proportional counter detectors are rugged and lightweight, which are important features of a field portable detector. However, the resolution of a proportional counter detector is not as good as that of a solid-state detector. The energy resolution of a detector for characteristic x-rays is usually expressed in terms of full width at half-maximum (FWHM) height of the manganese K_α peak at 5.89 keV. The typical resolutions of the above mentioned detectors are as follows: HgI_2-270 eV; silicon pin diode-250 eV; Si(Li)–170 eV; and gas-filled, proportional counter-750 eV.

During operation of a solid-state detector, an x-ray photon strikes a biased, solid-state crystal and loses energy in the crystal by producing electron-hole pairs. The electric charge produced is collected and provides a current pulse that is directly proportional to the energy of the x-ray photon absorbed by the crystal of the detector. A gas-filled, proportional counter detector is an ionization chamber filled with a mixture of noble and other gases. An x-ray photon entering the chamber ionizes the gas atoms. The electric charge produced is collected and provides an electric signal that is directly proportional to the energy of the x-ray photon absorbed by the gas in the detector.

6.1.4 Data processing units -- The key component in the data processing unit of an FPXRF instrument is the MCA. The MCA receives pulses from the detector and sorts them by their amplitudes (energy level). The MCA counts pulses per second to determine the height of the peak in a spectrum, which is indicative of the target analyte's concentration. The spectrum of element peaks are built on the MCA. The MCAs in FPXRF instruments have from 256 to 2,048 channels. The concentrations of target analytes are usually shown in ppm on a liquid crystal display (LCD) in the instrument. FPXRF instruments can store both spectra and from 3,000 to 5,000 sets of numerical analytical results. Most FPXRF instruments are menu-driven from software built into the units or from PCs. Once the data–storage memory of an FPXRF unit is full or at any other time, data can be downloaded by means of an RS-232 port and cable to a PC.

6.2 Spare battery and battery charger.

6.3 Polyethylene sample cups -- 31 to 40 mm in diameter with collar, or equivalent (appropriate for FPXRF instrument).

6.4 X-ray window film -- Mylar^{TM}, Kapton^{TM}, Spectrolene^{TM}, polypropylene, or equivalent; 2.5 to 6.0 µm thick.

6.5 Mortar and pestle -- Glass, agate, or aluminum oxide; for grinding soil and sediment samples.

6.6 Containers -- Glass or plastic to store samples.

6.7 Sieves -- 60-mesh (0.25 mm), stainless-steel, Nylon, or equivalent for preparing soil and sediment samples.

6.8 Trowels -- For smoothing soil surfaces and collecting soil samples.

6.9 Plastic bags -- Used for collection and homogenization of soil samples.

6.10 Drying oven -- Standard convection or toaster oven, for soil and sediment samples that require drying.

7.0 REAGENTS AND STANDARDS

7.1 Reagent grade chemicals must be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Pure element standards -- Each pure, single-element standard is intended to produce strong characteristic x-ray peaks of the element of interest only. Other elements present must not contribute to the fluorescence spectrum. A set of pure element standards for commonly sought analytes is supplied by the instrument manufacturer, if designated for the instrument; not all instruments require the pure element standards. The standards are used to set the region of interest (ROI) for each element. They also can be used as energy calibration and resolution check samples.

7.3 Site-specific calibration standards -- Instruments that employ fundamental parameters (FP) or similar mathematical models in minimizing matrix effects may not require SSCS. If the FP calibration model is to be optimized or if empirical calibration is necessary, then SSCSs must be collected, prepared, and analyzed.

7.3.1 The SSCS must be representative of the matrix to be analyzed by FPXRF. These samples must be well homogenized. A minimum of 10 samples spanning the concentration ranges of the analytes of interest and of the interfering elements must be obtained from the site. A sample size of 4 to 8 ounces is recommended, and standard glass sampling jars should be used.

7.3.2 Each sample should be oven-dried for 2 to 4 hr at a temperature of less than 150 °C. If mercury is to be analyzed, a separate sample portion should be dried at ambient temperature as heating may volatilize the mercury. When the sample is dry, all large, organic debris and nonrepresentative material, such as twigs, leaves, roots, insects, asphalt, and rock should be removed. The sample should be homogenized (see Sec. 7.3.3) and then a representative portion ground with a mortar and pestle or other mechanical means, prior to passing through a 60-mesh sieve. Only the coarse rock fraction should remain on the screen.

7.3.3 The sample should be homogenized by using a riffle splitter or by placing 150 to 200 g of the dried, sieved sample on a piece of kraft or butcher paper about 1.5 by 1.5 feet in size. Each corner of the paper should be lifted alternately, rolling the soil over on itself and toward the opposite corner. The soil should be rolled on itself 20 times. Approximately 5 g of the sample should then be removed and placed in a sample cup for FPXRF analysis. The rest of the prepared sample should be sent off site for ICP or AA analysis. The method use for confirmatory analysis should meet the data quality objectives of the project.

7.4 Blank samples -- The blank samples should be from a "clean" quartz or silicon dioxide matrix that is free of any analytes at concentrations above the established lower limit of detection. These samples are used to monitor for cross-contamination and laboratory-induced contaminants or interferences.

7.5 Standard reference materials -- Standard reference materials (SRMs) are standards containing certified amounts of metals in soil or sediment. These standards are used for accuracy and performance checks of FPXRF analyses. SRMs can be obtained from the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), the Canadian National Research Council, and the national bureau of standards in foreign nations. Pertinent NIST SRMs for FPXRF analysis include 2704, Buffalo River Sediment; 2709, San Joaquin Soil; and 2710 and 2711, Montana Soil. These SRMs contain soil or sediment from actual sites that has been analyzed using independent inorganic analytical methods by many different laboratories. When these SRMs are unavailable, alternate standards may be used (e.g., NIST 2702).

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

Sample handling and preservation procedures used in FPXRF analyses should follow the guidelines in Chapter Three, "Inorganic Analytes."

9.0 QUALITY CONTROL

9.1 Follow the manufacturer’s instructions for the quality control procedures specific to use of the testing product. Refer to Chapter One for additional guidance on quality assurance (QA) and quality control (QC) protocols. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a Quality Assurance Project Plan (QAPP) or a Sampling and Analysis Plan (SAP), which translates project objectives and specifications into directions for those that will implement the project and assess the results.

9.2 Energy calibration check -- To determine whether an FPXRF instrument is operating within resolution and stability tolerances, an energy calibration check should be run. The energy calibration check determines whether the characteristic x-ray lines are shifting, which would indicate drift within the instrument. As discussed in Sec. 4.10, this check also serves as a gain check in the event that ambient temperatures are fluctuating greatly (more than 10 °F).

9.2.1 The energy calibration check should be run at a frequency consistent with manufacturer’s recommendations. Generally, this would be at the beginning of each working day, after the batteries are changed or the instrument is shut off, at the end of each working day, and at any other time when the instrument operator believes that drift is occurring during analysis. A pure element such as iron, manganese, copper, or lead is often used for the energy calibration check. A manufacturer-recommended count time per source should be used for the check.

9.2.2 The instrument manufacturer’s manual specifies the channel or kiloelectron volt level at which a pure element peak should appear and the expected intensity of the peak. The intensity and channel number of the pure element as measured using the source should be checked and compared to the manufacturer's recommendation. If the energy calibration check does not meet the manufacturer's criteria, then the pure element sample should be repositioned and reanalyzed. If the criteria are still not met, then an energy calibration should be performed as described in the manufacturer's manual. With some FPXRF instruments, once a spectrum is acquired from the energy calibration check, the peak can be optimized and realigned to the manufacturer's specifications using their software.

9.3 Blank samples -- Two types of blank samples should be analyzed for FPXRF analysis, specifically, instrument blanks and method blanks.

9.3.1 An instrument blank is used to verify that no contamination exists in the spectrometer or on the probe window. The instrument blank can be silicon dioxide, a polytetraflurorethylene (PTFE) block, a quartz block, "clean" sand, or lithium carbonate. This instrument blank should be analyzed on each working day before and after analyses are conducted and once per every twenty samples. An instrument blank should also be analyzed whenever contamination is suspected by the analyst. The frequency of analysis will vary with the data quality objectives of the project. A manufacturer-recommended count time per source should be used for the blank analysis. No element concentrations above the established lower limit of detection should be found in the instrument blank. If concentrations exceed these limits, then the probe window and the check sample should be checked for contamination. If contamination is not a problem, then the instrument must be "zeroed" by following the manufacturer's instructions.

9.3.2 A method blank is used to monitor for laboratory-induced contaminants or interferences. The method blank can be "clean" silica sand or lithium carbonate that undergoes the same preparation procedure as the samples. A method blank must be analyzed at least daily. The frequency of analysis will depend on the data quality objectives of the project. If the method blank does not contain the target analyte at a level that interferes with the project-specific data quality objectives then the method blank would be considered acceptable. In the absence of project-specific data quality objectives, if the blank is less than the lowest level of detection or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the method blank would be considered acceptable. If the method blank cannot be considered acceptable, the cause of the problem must be identified, and all samples analyzed with the method blank must be reanalyzed.

9.4 Calibration verification checks -- A calibration verification check sample is used to check the accuracy of the instrument and to assess the stability and consistency of the analysis for the analytes of interest. A check sample should be analyzed at the beginning of each working day, during active sample analyses, and at the end of each working day. The frequency of calibration checks during active analysis will depend on the data quality objectives of the project. The check sample should be a well characterized soil sample from the site that is representative of site samples in terms of particle size and degree of homogeneity and that contains contaminants at concentrations near the action levels. If a site-specific sample is not available, then an NIST or other SRM that contains the analytes of interest can be used to verify the accuracy of the instrument. The measured value for each target analyte should be within ±20 percent (%D) of the true value for the calibration verification check to be acceptable. If a measured value falls outside this range, then the check sample should be reanalyzed. If the value continues to fall outside the acceptance range, the instrument should be recalibrated, and the batch of samples analyzed before the unacceptable calibration verification check must be reanalyzed.

9.5 Precision measurements -- The precision of the method is monitored by analyzing a sample with low, moderate, or high concentrations of target analytes. The frequency of precision measurements will depend on the data quality objectives for the data. A minimum of one precision sample should be run per day. Each precision sample should be analyzed 7 times in replicate. It is recommended that precision measurements be obtained for samples with varying concentration ranges to assess the effect of concentration on method precision. Determining method precision for analytes at concentrations near the site action levels can be extremely important if the FPXRF results are to be used in an enforcement action; therefore, selection of at least one sample with target analyte concentrations at or near the site action levels or levels of concern is recommended. A precision sample is analyzed by the instrument for the same field analysis time as used for other project samples. The relative standard deviation (RSD) of the sample mean is used to assess method precision. For FPXRF data to be considered adequately precise, the RSD should not be greater than 20 percent with the exception of chromium. RSD values for chromium should not be greater than 30 percent. If both in situ and intrusive analytical techniques are used during the course of one day, it is recommended that separate precision calculations be performed for each analysis type.

The equation for calculating RSD is as follows:

$$\text{RSD} = (\text{SD}/\text{Mean Concentration}) \times 100$$

where:

RSD = Relative standard deviation for the precision measurement for the analyte
SD = Standard deviation of the concentration for the analyte
Mean concentration = Mean concentration for the analyte

The precision or reproducibility of a measurement will improve with increasing count time, however, increasing the count time by a factor of 4 will provide only 2 times better precision, so there is a point of diminishing return. Increasing the count time also improves the sensitivity, but decreases sample throughput.

9.6 The lower limits of detection should be established from actual measured performance based on spike recoveries in the matrix of concern or from acceptable method performance on a certified reference material of the appropriate matrix and within the appropriate calibration range for the application. This is considered the best estimate of the true method sensitivity as opposed to a statistical determination based on the standard deviation of replicate analyses of a low-concentration sample. While the statistical approach demonstrates the potential data variability for a given sample matrix at one point in time, it does not represent what can be detected or most importantly the lowest concentration that can be calibrated. For this reason the sensitivity should be established as the lowest point of detection based on acceptable target analyte recovery in the desired sample matrix.

9.7 Confirmatory samples -- The comparability of the FPXRF analysis is determined by submitting FPXRF-analyzed samples for analysis at a laboratory. The method of confirmatory analysis must meet the project and XRF measurement data quality objectives. The confirmatory samples must be splits of the well homogenized sample material. In some cases the prepared sample cups can be submitted. A minimum of 1 sample for each 20 FPXRF-analyzed samples should be submitted for confirmatory analysis. This frequency will depend on project-specific data quality objectives. The confirmatory analyses can also be used to verify the quality of the FPXRF data. The confirmatory samples should be selected from the lower, middle, and upper range of concentrations measured by the FPXRF. They should also include samples with analyte concentrations at or near the site action levels. The results of the confirmatory analysis and FPXRF analyses should be evaluated with a least squares linear regression analysis. If the measured concentrations span more than one order of magnitude, the data should be log-transformed to standardize variance which is proportional to the magnitude of measurement. The correlation coefficient (r) for the results should be 0.7 or greater for the FPXRF data to be considered screening level data. If the r is 0.9 or greater and inferential statistics indicate the FPXRF data and the confirmatory data are statistically equivalent at a 99 percent confidence level, the data could potentially meet definitive level data criteria.

10.0 CALIBRATION AND STANDARDIZATION

10.1 Instrument calibration -- Instrument calibration procedures vary among FPXRF instruments. Users of this method should follow the calibration procedures outlined in the operator's manual for each specific FPXRF instrument. Generally, however, three types of calibration procedures exist for FPXRF instruments, namely: FP calibration, empirical calibration, and the Compton peak ratio or normalization method. These three types of calibration are discussed below.

10.2 Fundamental parameters calibration -- FP calibration procedures are extremely variable. An FP calibration provides the analyst with a "standardless" calibration. The advantages of FP calibrations over empirical calibrations include the following:

- No previously collected site-specific samples are necessary, although site-specific samples with confirmed and validated analytical results for all elements present could be used.

- Cost is reduced because fewer confirmatory laboratory results or calibration standards are necessary.

However, the analyst should be aware of the limitations imposed on FP calibration by particle size and matrix effects. These limitations can be minimized by adhering to the preparation procedure described in Sec. 7.3. The two FP calibration processes discussed below are based on an effective energy FP routine and a back scatter with FP (BFP) routine. Each FPXRF FP calibration process is based on a different iterative algorithmic method. The calibration procedure for each routine is explained in detail in the manufacturer's user manual for each FPXRF instrument; in addition, training courses are offered for each instrument.

10.2.1 Effective energy FP calibration -- The effective energy FP calibration is performed by the manufacturer before an instrument is sent to the analyst. Although SSCS can be used, the calibration relies on pure element standards or SRMs such as those obtained from NIST for the FP calibration. The effective energy routine relies on the spectrometer response to pure elements and FP iterative algorithms to compensate for various matrix effects.

Alpha coefficients are calculated using a variation of the Sherman equation, which calculates theoretical intensities from the measurement of pure element samples. These coefficients indicate the quantitative effect of each matrix element on an analyte's measured x-ray intensity. Next, the Lachance Traill algorithm is solved as a set of simultaneous equations based on the theoretical intensities. The alpha coefficients are then downloaded into the specific instrument.

The working effective energy FP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of sampling. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. A manufacturer-recommended count time per source should be used for the calibration check. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A percent difference (%D) is then calculated for each target analyte. The %D should be within ±20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line or the y-intercept value for the analyte. The SRM or SSCS is reanalyzed until the %D falls within ±20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

The equation to calibrate %D is as follows:

$$\%D = ((C_s - C_k) / C_k) \times 100$$

where:

%D = Percent difference
C_k = Certified concentration of standard sample
C_s = Measured concentration of standard sample

10.2.2 BFP calibration -- BFP calibration relies on the ability of the liquid nitrogen-cooled, Si(Li) solid-state detector to separate the coherent (Compton) and incoherent (Rayleigh) backscatter peaks of primary radiation. These peak intensities are known to be a function of sample composition, and the ratio of the Compton to Rayleigh peak is a function of the mass absorption of the sample. The calibration procedure is explained in detail in the instrument manufacturer's manual. Following is a general description of the BFP calibration procedure.

The concentrations of all detected and quantified elements are entered into the computer software system. Certified element results for an NIST SRM or confirmed and validated results for an SSCS can be used. In addition, the concentrations of oxygen and silicon must be entered; these two concentrations are not found in standard metals analyses. The manufacturer provides silicon and oxygen concentrations for typical soil types. Pure element standards are then analyzed using a manufacturer-recommended count time per source. The results are used to calculate correction factors in order to adjust for spectrum overlap of elements.

The working BFP calibration curve must be verified before sample analysis begins on each working day, after every 20 samples are analyzed, and at the end of the analysis. This verification is performed by analyzing either an NIST SRM or an SSCS that is representative of the site-specific samples. This SRM or SSCS serves as a calibration check. The standard sample is analyzed using a manufacturer-recommended count time per source to check the calibration curve. The analyst must then adjust the y-intercept and slope of the calibration curve to best fit the known concentrations of target analytes in the SRM or SSCS.

A %D is then calculated for each target analyte. The %D should fall within ±20 percent of the certified value for each analyte. If the %D falls outside this acceptance range, then the calibration curve should be adjusted by varying the slope of the line the y-intercept value for the analyte. The standard sample is reanalyzed until the %D falls within ±20 percent. The group of 20 samples analyzed before an out-of-control calibration check should be reanalyzed.

10.3 Empirical calibration -- An empirical calibration can be performed with SSCS, site-typical standards, or standards prepared from metal oxides. A discussion of SSCS is included in Sec. 7.3; if no previously characterized samples exist for a specific site, site-typical standards can be used. Site-typical standards may be selected from commercially available characterized soils or from SSCS prepared for another site. The site-typical standards should closely approximate the site's soil matrix with respect to particle size distribution, mineralogy, and contaminant analytes. If neither SSCS nor site-typical standards are available, it is possible to make gravimetric standards by adding metal oxides to a "clean" sand or silicon dioxide matrix that simulates soil. Metal oxides can be purchased from various chemical vendors. If standards are made on site, a balance capable of weighing items to at least two decimal places is necessary. Concentrated ICP or AA standard solutions can also be used to make standards. These solutions are available in concentrations of 10,000 parts per million, thus only small volumes have to be added to the soil.

An empirical calibration using SSCS involves analysis of SSCS by the FPXRF instrument and by a conventional analytical method such as ICP or AA. A total acid digestion procedure should be used by the laboratory for sample preparation. Generally, a minimum of 10 and a maximum of 30 well characterized SSCS, site-typical standards, or prepared metal oxide standards are necessary to perform an adequate empirical calibration. The exact number of standards depends on the number of analytes of interest and interfering elements. Theoretically, an empirical calibration with SSCS should provide the most accurate data for a site because the calibration compensates for site-specific matrix effects.

The first step in an empirical calibration is to analyze the pure element standards for the elements of interest. This enables the instrument to set channel limits for each element for spectral deconvolution. Next the SSCS, site-typical standards, or prepared metal oxide standards are analyzed using a count time of 200 seconds per source or a count time recommended by the manufacturer. This will produce a spectrum and net intensity of each analyte in each standard. The analyte concentrations for each standard are then entered into the instrument software; these concentrations are those obtained from the laboratory, the certified results, or the gravimetrically determined concentrations of the prepared standards. This gives the instrument analyte values to regress against corresponding intensities during the modeling stage. The regression equation correlates the concentrations of an analyte with its net intensity.

The calibration equation is developed using a least squares fit regression analysis. After the regression terms to be used in the equation are defined, a mathematical equation can be developed to calculate the analyte concentration in an unknown sample. In some FPXRF instruments, the software of the instrument calculates the regression equation. The software uses calculated intercept and slope values to form a multiterm equation. In conjunction with the software in the instrument, the operator can adjust the multiterm equation to minimize interelement interferences and optimize the intensity calibration curve.

It is possible to define up to six linear or nonlinear terms in the regression equation. Terms can be added and deleted to optimize the equation. The goal is to produce an equation with the smallest regression error and the highest correlation coefficient. These values are automatically computed by the software as the regression terms are added, deleted, or modified. It is also possible to delete data points from the regression line if these points are significant outliers or if they are heavily weighing the data. Once the regression equation has been selected for an analyte, the equation can be entered into the software for quantitation of analytes in subsequent samples. For an empirical calibration to be acceptable, the regression equation for a specific analyte should have a correlation coefficient of 0.98 or greater or meet the DQOs of the project.

In an empirical calibration, one must apply the DQOs of the project and ascertain critical or action levels for the analytes of interest. It is within these concentration ranges or around these action levels that the FPXRF instrument should be calibrated most accurately. It may not be possible to develop a good regression equation over several orders of analyte concentration.

10.4 Compton normalization method -- The Compton normalization method is based on analysis of a single, certified standard and normalization for the Compton peak. The Compton peak is produced from incoherent backscattering of x-ray radiation from the excitation source and is present in the spectrum of every sample. The Compton peak intensity changes with differing matrices. Generally, matrices dominated by lighter elements produce a larger Compton peak, and those dominated by heavier elements produce a smaller Compton peak. Normalizing to the Compton peak can reduce problems with varying matrix effects among samples. Compton normalization is similar to the use of internal standards in organics analysis. The Compton normalization method may not be effective when analyte concentrations exceed a few percent.

The certified standard used for this type of calibration could be an NIST SRM such as 2710 or 2711. The SRM must be a matrix similar to the samples and must contain the analytes of interests at concentrations near those expected in the samples. First, a response factor has to be determined for each analyte. This factor is calculated by dividing the net peak intensity by the analyte concentration. The net peak intensity is gross intensity corrected for baseline reading. Concentrations of analytes in samples are then determined by multiplying the baseline corrected analyte signal intensity by the normalization factor and by the response factor. The normalization factor is the quotient of the baseline corrected Compton K_α peak intensity of the SRM divided by that of the samples. Depending on the FPXRF instrument used, these calculations may be done manually or by the instrument software.

11.0 PROCEDURE

11.1 Operation of the various FPXRF instruments will vary according to the manufacturers' protocols. Before operating any FPXRF instrument, one should consult the manufacturer's manual. Most manufacturers recommend that their instruments be allowed to warm up for 15 to 30 minutes before analysis of samples. This will help alleviate drift or energy calibration problems later during analysis.

11.2 Each FPXRF instrument should be operated according to the manufacturer's recommendations. There are two modes in which FPXRF instruments can be operated: in situ and intrusive. The in situ mode involves analysis of an undisturbed soil sediment or sample. Intrusive analysis involves collection and preparation of a soil or sediment sample before analysis. Some FPXRF instruments can operate in both modes of analysis, while others are designed to operate in only one mode. The two modes of analysis are discussed below.

11.3 For in situ analysis, remove any large or nonrepresentative debris from the soil surface before analysis. This debris includes rocks, pebbles, leaves, vegetation, roots, and concrete. Also, the soil surface must be as smooth as possible so that the probe window will have good contact with the surface. This may require some leveling of the surface with a stainless-steel trowel. During the study conducted to provide example performance data for this method, this modest amount of sample preparation was found to take less than 5 min per sample location. The last requirement is that the soil or sediment not be saturated with water. Manufacturers state that their FPXRF instruments will perform adequately for soils with moisture contents of 5 to 20 percent but will not perform well for saturated soils, especially if ponded water exists on the surface. Another recommended technique for in situ analysis is to tamp the soil to increase soil density and compactness for better repeatability and representativeness. This condition is especially important for heavy element analysis, such as barium. Source count times for in situ analysis usually range from 30 to 120 seconds, but source count times will vary among instruments and depending on the desired method sensitivity. Due to the heterogeneous nature of the soil sample, in situ analysis can provide only “screening” type data.

11.4 For intrusive analysis of surface or sediment, it is recommended that a sample be collected from a 4- by 4-inch square that is 1 inch deep. This will produce a soil sample of approximately 375 g or 250 cm^3, which is enough soil to fill an 8-ounce jar. However, the exact dimensions and sample depth should take into consideration the heterogeneous deposition of contaminants and will ultimately depend on the desired project-specific data quality objectives. The sample should be homogenized, dried, and ground before analysis. The sample can be homogenized before or after drying. The homogenization technique to be used after drying is discussed in Sec. 4.2. If the sample is homogenized before drying, it should be thoroughly mixed in a beaker or similar container, or if the sample is moist and has a high clay content, it can be kneaded in a plastic bag. One way to monitor homogenization when the sample is kneaded in a plastic bag is to add sodium fluorescein dye to the sample. After the moist sample has been homogenized, it is examined under an ultraviolet light to assess the distribution of sodium fluorescein throughout the sample. If the fluorescent dye is evenly distributed in the sample, homogenization is considered complete; if the dye is not evenly distributed, mixing should continue until the sample has been thoroughly homogenized. During the study conducted to provide data for this method, the time necessary for homogenization procedure using the fluorescein dye ranged from 3 to 5 min per sample. As demonstrated in Secs. 13.5 and 13.7, homogenization has the greatest impact on the reduction of sampling variability. It produces little or no contamination. Often, the direct analysis through the plastic bag is possible without the more labor intensive steps of drying, grinding, and sieving given in Secs. 11.5 and 11.6. Of course, to achieve the best data quality possible all four steps should be followed.

11.5 Once the soil or sediment sample has been homogenized, it should be dried. This can be accomplished with a toaster oven or convection oven. A small aliquot of the sample (20 to 50 g) is placed in a suitable container for drying. The sample should be dried for 2 to 4 hr in the convection or toaster oven at a temperature not greater than 150 °C. Samples may also be air dried under ambient temperature conditions using a 10- to 20-g portion. Regardless of what drying mechanism is used, the drying process is considered complete when a constant sample weight can be obtained. Care should be taken to avoid sample cross-contamination and these measures can be evaluated by including an appropriate method blank sample along with any sample preparation process.

CAUTION: Microwave drying is not a recommended procedure. Field studies have shown that microwave drying can increase variability between the FPXRF data and confirmatory analysis. High levels of metals in a sample can cause arcing in the microwave oven, and sometimes slag forms in the sample. Microwave oven drying can also melt plastic containers used to hold the sample.

11.6 The homogenized dried sample material should be ground with a mortar and pestle and passed through a 60-mesh sieve to achieve a uniform particle size. Sample grinding should continue until at least 90 percent of the original sample passes through the sieve. The grinding step normally takes an average of 10 min per sample. An aliquot of the sieved sample should then be placed in a 31.0-mm polyethylene sample cup (or equivalent) for analysis. The sample cup should be one-half to three-quarters full at a minimum. The sample cup should be covered with a 2.5 µm Mylar (or equivalent) film for analysis. The rest of the soil sample should be placed in a jar, labeled, and archived for possible confirmation analysis. All equipment including the mortar, pestle, and sieves must be thoroughly cleaned so that any cross-contamination is below the established lower limit of detection of the procedure or DQOs of the analysis. If all recommended sample preparation steps are followed, there is a high probability the desired laboratory data quality may be obtained.

12.0 DATA ANALYSIS AND CALCULATIONS

Most FPXRF instruments have software capable of storing all analytical results and spectra. The results are displayed in ppm and can be downloaded to a personal computer, which can be used to provide a hard copy printout. Individual measurements that are smaller than three times their associated SD should not be used for quantitation. See the manufacturer’s instructions regarding data analysis and calculations.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance criteria for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method. These performance data are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

13.2 The sections to follow discuss three performance evaluation factors; namely, precision, accuracy, and comparability. The example data presented in Tables 4 through 8 were generated from results obtained from six FPXRF instruments (see Sec. 13.3). The soil samples analyzed by the six FPXRF instruments were collected from two sites in the United States. The soil samples contained several of the target analytes at concentrations ranging from "nondetect" to tens of thousands of mg/kg. These data are provided for guidance purposes only.

13.3 The six FPXRF instruments included the TN 9000 and TN Lead Analyzer manufactured by TN Spectrace; the X-MET 920 with a SiLi detector and X-MET 920 with a gas-filled proportional detector manufactured by Metorex, Inc.; the XL Spectrum Analyzer manufactured by Niton; and the MAP Spectrum Analyzer manufactured by Scitec. The TN 9000 and TN Lead Analyzer both have a HgI_2 detector. The TN 9000 utilized an Fe-55, Cd-109, and Am-241 source. The TN Lead Analyzer had only a Cd-109 source. The X-Met 920 with the SiLi detector had a Cd-109 and Am-241 source. The X-MET 920 with the gas-filled proportional detector had only a Cd-109 source. The XL Spectrum Analyzer utilized a silicon pin-diode detector and a Cd-109 source. The MAP Spectrum Analyzer utilized a solid-state silicon detector and a Cd-109 source.

13.4 All example data presented in Tables 4 through 8 were generated using the following calibrations and source count times. The TN 9000 and TN Lead Analyzer were calibrated using fundamental parameters using NIST SRM 2710 as a calibration check sample. The TN 9000 was operated using 100, 60, and 60 second count times for the Cd-109, Fe-55, and Am-241 sources, respectively. The TN Lead analyzer was operated using a 60 second count time for the Cd-109 source. The X-MET 920 with the Si(Li) detector was calibrated using fundamental parameters and one well characterized site-specific soil standard as a calibration check. It used 140 and 100 second count times for the Cd-109 and Am-241 sources, respectively. The X-MET 920 with the gas-filled proportional detector was calibrated empirically using between 10 and 20 well characterized site-specific soil standards. It used 120 second times for the Cd-109 source. The XL Spectrum Analyzer utilized NIST SRM 2710 for calibration and the Compton peak normalization procedure for quantitation based on 60 second count times for the Cd-109 source. The MAP Spectrum Analyzer was internally calibrated by the manufacturer. The calibration was checked using a well-characterized site-specific soil standard. It used 240 second times for the Cd-109 source.

13.5 Precision measurements -- The example precision data are presented in Table 4. These data are provided for guidance purposes only. Each of the six FPXRF instruments performed 10 replicate measurements on 12 soil samples that had analyte concentrations ranging from "nondetects" to thousands of mg/kg. Each of the 12 soil samples underwent 4 different preparation techniques from in situ (no preparation) to dried and ground in a sample cup. Therefore, there were 48 precision data points for five of the instruments and 24 precision points for the MAP Spectrum Analyzer. The replicate measurements were taken using the source count times discussed at the beginning of this section.

For each detectable analyte in each precision sample a mean concentration, standard deviation, and RSD was calculated for each analyte. The data presented in Table 4 is an average RSD for the precision samples that had analyte concentrations at 5 to 10 times the lower limit of detection for that analyte for each instrument. Some analytes such as mercury, selenium, silver, and thorium were not detected in any of the precision samples so these analytes are not listed in Table 4. Some analytes such as cadmium, nickel, and tin were only detected at concentrations near the lower limit of detection so that an RSD value calculated at 5 to 10 times this limit was not possible.

One FPXRF instrument collected replicate measurements on an additional nine soil samples to provide a better assessment of the effect of sample preparation on precision. Table 5 shows these results. These data are provided for guidance purposes only. The additional nine soil samples were comprised of three from each texture and had analyte concentrations ranging from near the lower limit of detection for the FPXRF analyzer to thousands of mg/kg. The FPXRF analyzer only collected replicate measurements from three of the preparation methods; no measurements were collected from the in situ homogenized samples. The FPXRF analyzer conducted five replicate measurements of the in situ field samples by taking measurements at five different points within the 4-inch by 4-inch sample square. Ten replicate measurements were collected for both the intrusive undried and unground and intrusive dried and ground samples contained in cups. The cups were shaken between each replicate measurement.

Table 5 shows that the precision dramatically improved from the in situ to the intrusive measurements. In general there was a slight improvement in precision when the sample was dried and ground. Two factors caused the precision for the in situ measurements to be poorer. The major factor is soil heterogeneity. By moving the probe within the 4-inch by 4-inch square, measurements of different soil samples were actually taking place within the square. Table 5 illustrates the dominant effect of soil heterogeneity. It overwhelmed instrument precision when the FPXRF analyzer was used in this mode. The second factor that caused the RSD values to be higher for the in situ measurements is the fact that only five instead of ten replicates were taken. A lesser number of measurements caused the standard deviation to be larger which in turn elevated the RSD values.

13.6 Accuracy measurements -- Five of the FPXRF instruments (not including the MAP Spectrum Analyzer) analyzed 18 SRMs using the source count times and calibration methods given at the beginning of this section. The 18 SRMs included 9 soil SRMs, 4 stream or river sediment SRMs, 2 sludge SRMs, and 3 ash SRMs. Each of the SRMs contained known concentrations of certain target analytes. A percent recovery was calculated for each analyte in each SRM for each FPXRF instrument. Table 6 presents a summary of this data. With the exception of cadmium, chromium, and nickel, the values presented in Table 6 were generated from the 13 soil and sediment SRMs only. The 2 sludge and 3 ash SRMs were included for cadmium, chromium, and nickel because of the low or nondetectable concentrations of these three analytes in the soil and sediment SRMs.

Only 12 analytes are presented in Table 6. These are the analytes that are of environmental concern and provided a significant number of detections in the SRMs for an accuracy assessment. No data is presented for the X-MET 920 with the gas-filled proportional detector. This FPXRF instrument was calibrated empirically using site-specific soil samples. The percent recovery values from this instrument were very sporadic and the data did not lend itself to presentation in Table 6.

Table 7 provides a more detailed summary of accuracy data for one particular FPXRF instrument (TN 9000) for the 9 soil SRMs and 4 sediment SRMs. These data are provided for guidance purposes only. Table 7 shows the certified value, measured value, and percent recovery for five analytes. These analytes were chosen because they are of environmental concern and were most prevalently certified for in the SRM and detected by the FPXRF instrument. The first nine SRMs are soil and the last 4 SRMs are sediment. Percent recoveries for the four NIST SRMs were often between 90 and 110 percent for all analytes.

13.7 Comparability -- Comparability refers to the confidence with which one data set can be compared to another. In this case, FPXRF data generated from a large study of six FPXRF instruments was compared to SW-846 Methods 3050 and 6010 which are the standard soil extraction for metals and analysis by inductively coupled plasma. An evaluation of comparability was conducted by using linear regression analysis. Three factors were determined using the linear regression. These factors were the y-intercept, the slope of the line, and the coefficient of determination (r^2).

As part of the comparability assessment, the effects of soil type and preparation methods were studied. Three soil types (textures) and four preparation methods were examined during the study. The preparation methods evaluated the cumulative effect of particle size, moisture, and homogenization on comparability. Due to the large volume of data produced during this study, linear regression data for six analytes from only one FPXRF instrument is presented in Table 8. Similar trends in the data were seen for all instruments. These data are provided for guidance purposes only.

Table 8 shows the regression parameters for the whole data set, broken out by soil type, and by preparation method. These data are provided for guidance purposes only. The soil types are as follows: soil 1--sand; soil 2--loam; and soil 3--silty clay. The preparation methods are as follows: preparation 1--in situ in the field; preparation 2--intrusive, sample collected and homogenized; preparation 3--intrusive, with sample in a sample cup but sample still wet and not ground; and preparation 4–intrusive, with sample dried, ground, passed through a 40-mesh sieve, and placed in sample cup.

For arsenic, copper, lead, and zinc, the comparability to the confirmatory laboratory was excellent with r^2 values ranging from 0.80 to 0.99 for all six FPXRF instruments. The slopes of the regression lines for arsenic, copper, lead, and zinc, were generally between 0.90 and 1.00 indicating the data would need to be corrected very little or not at all to match the confirmatory laboratory data. The r^2 values and slopes of the regression lines for barium and chromium were not as good as for the other for analytes, indicating the data would have to be corrected to match the confirmatory laboratory.

Table 8 demonstrates that there was little effect of soil type on the regression parameters for any of the six analytes. The only exceptions were for barium in soil 1 and copper in soil 3. In both of these cases, however, it is actually a concentration effect and not a soil effect causing the poorer comparability. All barium and copper concentrations in soil 1 and 3, respectively, were less than 350 mg/kg.

Table 8 shows there was a preparation effect on the regression parameters for all six analytes. With the exception of chromium, the regression parameters were primarily improved going from preparation 1 to preparation 2. In this step, the sample was removed from the soil surface, all large debris was removed, and the sample was thoroughly homogenized. The additional two preparation methods did little to improve the regression parameters. This data indicates that homogenization is the most critical factor when comparing the results. It is essential that the sample sent to the confirmatory laboratory match the FPXRF sample as closely as possible.

Sec. 11.0 of this method discusses the time necessary for each of the sample preparation techniques. Based on the data quality objectives for the project, an analyst must decide if it is worth the extra time necessary to dry and grind the sample for small improvements in comparability. Homogenization requires 3 to 5 min. Drying the sample requires one to two hours. Grinding and sieving requires another 10 to 15 min per sample. Lastly, when grinding and sieving is conducted, time has to be allotted to decontaminate the mortars, pestles, and sieves. Drying and grinding the samples and decontamination procedures will often dictate that an extra person be on site so that the analyst can keep up with the sample collection crew. The cost of requiring an extra person on site to prepare samples must be balanced with the gain in data quality and sample throughput.

13.8 The following documents may provide additional guidance and insight on this method and technique:

13.8.1 A. D. Hewitt, "Screening for Metals by X-ray Fluorescence Spectrometry/Response Factor/Compton K_α Peak Normalization Analysis," American Environmental Laboratory, pp 24-32, 1994.

13.8.2 S. Piorek and J. R. Pasmore, "Standardless, In Situ Analysis of Metallic Contaminants in the Natural Environment With a PC-Based, High Resolution Portable X-Ray Analyzer," Third International Symposium on Field Screening Methods for Hazardous Waste and Toxic Chemicals, Las Vegas, Nevada, February 24-26, 1993, Vol 2, pp 1135-1151, 1993.

13.8.3 S. Shefsky, "Sample Handling Strategies for Accurate Lead-in-soil Measurements in the Field and Laboratory," *International Symposium of Field Screening Methods for Hazardous Waste and Toxic Chemicals*, Las Vegas, NV, January 29-31, 1997.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operation. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste Reduction* available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th St., N.W. Washington, D.C. 20036, http://www.acs.org.

15.0 WASTE MANAGEMENT

The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available from the American Chemical Society at the address listed in Sec. 14.2.

16.0 REFERENCES

1. Metorex, X-MET 920 User's Manual.

2. Spectrace Instruments, "Energy Dispersive X-ray Fluorescence Spectrometry: An Introduction," 1994.

3. TN Spectrace, Spectrace 9000 Field Portable/Benchtop XRF Training and Applications Manual.

4. Unpublished SITE data, received from PRC Environment Management, Inc.

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables referenced by this method. A flow diagram of the procedure follows the tables.

TABLE 1

EXAMPLE INTERFERENCE FREE LOWER LIMITS OF DETECTION

Analyte	Chemical Abstract Series Number	Lower Limit of Detection in Quartz Sand (milligrams per kilogram)
Antimony (Sb)	7440-36-0	40
Arsenic (As)	7440-38-0	40
Barium (Ba)	7440-39-3	20
Cadmium (Cd)	7440-43-9	100
Calcium (Ca)	7440-70-2	70
Chromium (Cr)	7440-47-3	150
Cobalt (Co)	7440-48-4	60
Copper (Cu)	7440-50-8	50
Iron (Fe)	7439-89-6	60
Lead (Pb)	7439-92-1	20
Manganese (Mn)	7439-96-5	70
Mercury (Hg)	7439-97-6	30
Molybdenum (Mo)	7439-93-7	10
Nickel (Ni)	7440-02-0	50
Potassium (K)	7440-09-7	200
Rubidium (Rb)	7440-17-7	10
Selenium (Se)	7782-49-2	40
Silver (Ag)	7440-22-4	70
Strontium (Sr)	7440-24-6	10
Thallium (Tl)	7440-28-0	20
Thorium (Th)	7440-29-1	10
Tin (Sn)	7440-31-5	60
Titanium (Ti)	7440-32-6	50
Vanadium (V)	7440-62-2	50
Zinc (Zn)	7440-66-6	50
Zirconium (Zr)	7440-67-7	10

Source: Refs. 1, 2, and 3
These data are provided for guidance purposes only.

TABLE 2

SUMMARY OF RADIOISOTOPE SOURCE CHARACTERISTICS

Source	Activity (mCi)	Half-Life (Years)	Excitation Energy (keV)	Elemental Analysis Range	
Fe-55	20-50	2.7	5.9	Sulfur to Chromium	K Lines
				Molybdenum to Barium	L Lines
Cd-109	5-30	1.3	22.1 and 87.9	Calcium to Rhodium	K Lines
				Tantalum to Lead	K Lines
				Barium to Uranium	L Lines
Am-241	5-30	432	26.4 and 59.6	Copper to Thulium	K Lines
				Tungsten to Uranium	L Lines
Cm-244	60-100	17.8	14.2	Titanium to Selenium	K Lines
				Lanthanum to Lead	L Lines

Source: Refs. 1, 2, and 3

TABLE 3

SUMMARY OF X-RAY TUBE SOURCE CHARACTERISTICS

Anode Material	Recommended Voltage Range (kV)	K-alpha Emission (keV)	Elemental Analysis Range	
Cu	18-22	8.04	Potassium to Cobalt	K Lines
			Silver to Gadolinium	L Lines
Mo	40-50	17.4	Cobalt to Yttrium	K Lines
			Europium to Radon	L Lines
Ag	50-65	22.1	Zinc to Technicium	K Lines
			Ytterbium to Neptunium	L Lines

Source: Ref. 4

Notes: The sample elements excited are chosen by taking as the lower limit the same ratio of excitation line energy to element absorption edge as in Table 2 (approximately 0.45) and the requirement that the excitation line energy be above the element absorption edge as the upper limit (L2 edges used for L lines). K-beta excitation lines were ignored.

TABLE 4

EXAMPLE PRECISION VALUES

Analyte	Average Relative Standard Deviation for Each Instrument at 5 to 10 Times the Lower Limit of Detection					
	TN 9000	TN Lead Analyzer	X-MET 920 (SiLi Detector)	X-MET 920 (Gas-Filled Detector)	XL Spectrum Analyzer	MAP Spectrum Analyzer
Antimony	6.54	NR	NR	NR	NR	NR
Arsenic	5.33	4.11	3.23	1.91	12.47	6.68
Barium	4.02	NR	3.31	5.91	NR	NR
Cadmium	29.84[a]	NR	24.80[a]	NR	NR	NR
Calcium	2.16	NR	NR	NR	NR	NR
Chromium	22.25	25.78	22.72	3.91	30.25	NR
Cobalt	33.90	NR	NR	NR	NR	NR
Copper	7.03	9.11	8.49	9.12	12.77	14.86
Iron	1.78	1.67	1.55	NR	2.30	NR
Lead	6.45	5.93	5.05	7.56	6.97	12.16
Manganese	27.04	24.75	NR	NR	NR	NR
Molybdenum	6.95	NR	NR	NR	12.60	NR
Nickel	30.85[a]	NR	24.92[a]	20.92[a]	NA	NR
Potassium	3.90	NR	NR	NR	NR	NR
Rubidium	13.06	NR	NR	NR	32.69[a]	NR
Strontium	4.28	NR	NR	NR	8.86	NR
Tin	24.32[a]	NR	NR	NR	NR	NR
Titanium	4.87	NR	NR	NR	NR	NR
Zinc	7.27	7.48	4.26	2.28	10.95	0.83
Zirconium	3.58	NR	NR	NR	6.49	NR

These data are provided for guidance purposes only.
Source: Ref. 4

[a] These values are biased high because the concentration of these analytes in the soil samples was near the lower limit of detection for that particular FPXRF instrument.

NR Not reported.

NA Not applicable; analyte was reported but was below the established lower limit detection.

TABLE 5

EXAMPLES OF PRECISION AS AFFECTED BY SAMPLE PREPARATION

Analyte	Average Relative Standard Deviation for Each Preparation Method		
	In Situ-Field	Intrusive- Undried and Unground	Intrusive- Dried and Ground
Antimony	30.1	15.0	14.4
Arsenic	22.5	5.36	3.76
Barium	17.3	3.38	2.90
Cadmium[a]	41.2	30.8	28.3
Calcium	17.5	1.68	1.24
Chromium	17.6	28.5	21.9
Cobalt	28.4	31.1	28.4
Copper	26.4	10.2	7.90
Iron	10.3	1.67	1.57
Lead	25.1	8.55	6.03
Manganese	40.5	12.3	13.0
Mercury	ND	ND	ND
Molybdenum	21.6	20.1	19.2
Nickel[a]	29.8	20.4	18.2
Potassium	18.6	3.04	2.57
Rubidium	29.8	16.2	18.9
Selenium	ND	20.2	19.5
Silver[a]	31.9	31.0	29.2
Strontium	15.2	3.38	3.98
Thallium	39.0	16.0	19.5
Thorium	NR	NR	NR
Tin	ND	14.1	15.3
Titanium	13.3	4.15	3.74
Vanadium	NR	NR	NR
Zinc	26.6	13.3	11.1
Zirconium	20.2	5.63	5.18

These data are provided for guidance purposes only.
Source: Ref. 4

[a] These values may be biased high because the concentration of these analytes in the soil samples was near the lower limit of detection.

ND Not detected.
NR Not reported.

TABLE 6

EXAMPLE ACCURACY VALUES

Analyte	Instrument															
	TN 9000				TN Lead Analyzer				X-MET 920 (SiLi Detector)				XL Spectrum Analyzer			
	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec.	SD	n	Range of % Rec.	Mean % Rec	SD	n	Range of % Rec.	Mean % Rec.	SD
Sb	2	100-149	124.3	NA	--	--	--	--	--	--	--	--	--	--	--	--
As	5	68-115	92.8	17.3	5	44-105	83.4	23.2	4	9.7-91	47.7	39.7	5	38-535	189.8	206
Ba	9	98-198	135.3	36.9	--	--	--	--	9	18-848	168.2	262	--	--	--	--
Cd	2	99-129	114.3	NA	--	--	--	--	6	81-202	110.5	45.7	--	--	--	--
Cr	2	99-178	138.4	NA	--	--	--	--	7	22-273	143.1	93.8	3	98-625	279.2	300
Cu	8	61-140	95.0	28.8	6	38-107	79.1	27.0	11	10-210	111.8	72.1	8	95-480	203.0	147
Fe	6	78-155	103.7	26.1	6	89-159	102.3	28.6	6	48-94	80.4	16.2	6	26-187	108.6	52.9
Pb	11	66-138	98.9	19.2	11	68-131	97.4	18.4	12	23-94	72.7	20.9	13	80-234	107.3	39.9
Mn	4	81-104	93.1	9.70	3	92-152	113.1	33.8	--	--	--	--	--	--	--	--
Ni	3	99-122	109.8	12.0	--	--	--	--	--	--	--	--	3	57-123	87.5	33.5
Sr	8	110-178	132.6	23.8	--	--	--	--	--	--	--	--	7	86-209	125.1	39.5
Zn	11	41-130	94.3	24.0	10	81-133	100.0	19.7	12	46-181	106.6	34.7	11	31-199	94.6	42.5

Source: Ref. 4. These data are provided for guidance purposes only.

n: Number of samples that contained a certified value for the analyte and produced a detectable concentration from the FPXRF instrument.

SD: Standard deviation; NA: Not applicable; only two data points, therefore, a SD was not calculated.

%Rec.: Percent recovery.

-- No data.

TABLE 7

EXAMPLE ACCURACY FOR TN 9000[a]

Standard Reference Material	Arsenic			Barium			Copper			Lead			Zinc		
	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.	Cert. Conc.	Meas. Conc.	%Rec.
RTC CRM-021	24.8	ND	NA	586	1135	193.5	4792	2908	60.7	144742	149947	103.6	546	224	40.9
RTC CRM-020	397	429	92.5	22.3	ND	NA	753	583	77.4	5195	3444	66.3	3022	3916	129.6
BCR CRM 143R	--	--	--	--	--	--	131	105	80.5	180	206	114.8	1055	1043	99.0
BCR CRM 141	--	--	--	--	--	--	32.6	ND	NA	29.4	ND	NA	81.3	ND	NA
USGS GXR-2	25.0	ND	NA	2240	2946	131.5	76.0	106	140.2	690	742	107.6	530	596	112.4
USGS GXR-6	330	294	88.9	1300	2581	198.5	66.0	ND	NA	101	80.9	80.1	118	ND	NA
NIST 2711	105	104	99.3	726	801	110.3	114	ND	NA	1162	1172	100.9	350	333	94.9
NIST 2710	626	722	115.4	707	782	110.6	2950	2834	96.1	5532	5420	98.0	6952	6476	93.2
NIST 2709	17.7	ND	NA	968	950	98.1	34.6	ND	NA	18.9	ND	NA	106	98.5	93.0
NIST 2704	23.4	ND	NA	414	443	107.0	98.6	105	106.2	161	167	103.5	438	427	97.4
CNRC PACS-1	211	143	67.7	--	772	NA	452	302	66.9	404	332	82.3	824	611	74.2
SARM-51	--	--	--	335	466	139.1	268	373	139.2	5200	7199	138.4	2200	2676	121.6
SARM-52	--	--	--	410	527	128.5	219	193	88.1	1200	1107	92.2	264	215	81.4

Source: Ref. 4. These data are provided for guidance purposes only.

[a] All concentrations in milligrams per kilogram.

%Rec.: Percent recovery; ND: Not detected; NA: Not applicable.

-- No data.

TABLE 8

EXAMPLE REGRESSION PARAMETERS FOR COMPARABILITY[1]

	Arsenic				**Barium**				**Copper**			
	n	r^2	Int.	Slope	n	r^2	Int.	Slope	n	r^2	Int.	Slope
All Data	824	0.94	1.62	0.94	1255	0.71	60.3	0.54	984	0.93	2.19	0.93
Soil 1	368	0.96	1.41	0.95	393	0.05	42.6	0.11	385	0.94	1.26	0.99
Soil 2	453	0.94	1.51	0.96	462	0.56	30.2	0.66	463	0.92	2.09	0.95
Soil 3	—	—	—	—	400	0.85	44.7	0.59	136	0.46	16.60	0.57
Prep 1	207	0.87	2.69	0.85	312	0.64	53.7	0.55	256	0.87	3.89	0.87
Prep 2	208	0.97	1.38	0.95	315	0.67	64.6	0.52	246	0.96	2.04	0.93
Prep 3	204	0.96	1.20	0.99	315	0.78	64.6	0.53	236	0.97	1.45	0.99
Prep 4	205	0.96	1.45	0.98	313	0.81	58.9	0.55	246	0.96	1.99	0.96

	Lead				**Zinc**				**Chromium**			
	n	r^2	Int.	Slope	n	r^2	Int.	Slope	n	r^2	Int.	Slope
All Data	1205	0.92	1.66	0.95	1103	0.89	1.86	0.95	280	0.70	64.6	0.42
Soil 1	357	0.94	1.41	0.96	329	0.93	1.78	0.93	—	—	—	—
Soil 2	451	0.93	1.62	0.97	423	0.85	2.57	0.90	—	—	—	—
Soil 3	397	0.90	2.40	0.90	351	0.90	1.70	0.98	186	0.66	38.9	0.50
Prep 1	305	0.80	2.88	0.86	286	0.79	3.16	0.87	105	0.80	66.1	0.43
Prep 2	298	0.97	1.41	0.96	272	0.95	1.86	0.93	77	0.51	81.3	0.36
Prep 3	302	0.98	1.26	0.99	274	0.93	1.32	1.00	49	0.73	53.7	0.45
Prep 4	300	0.96	1.38	1.00	271	0.94	1.41	1.01	49	0.75	31.6	0.56

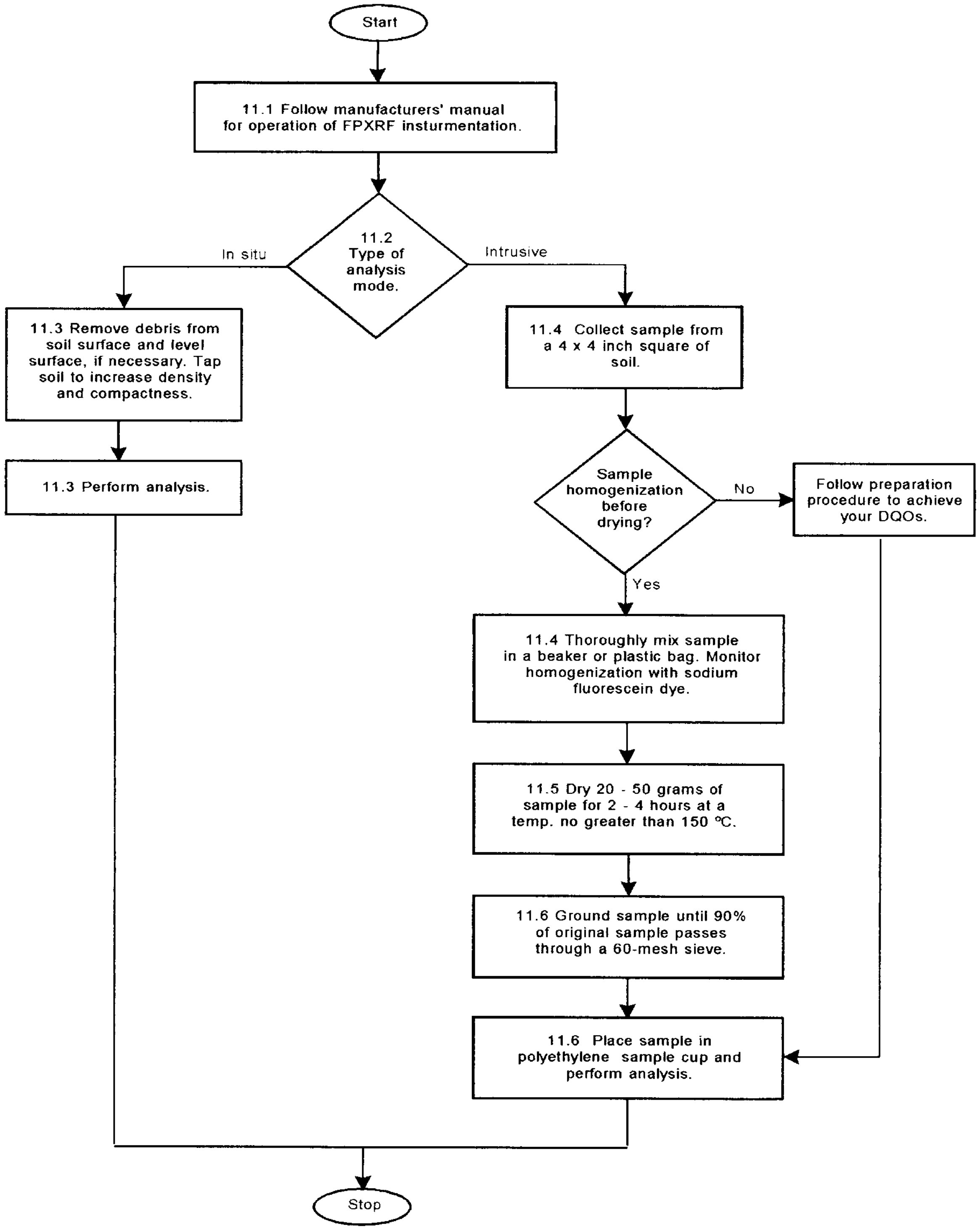
Source: Ref. 4. These data are provided for guidance purposes only.

[1] Log-transformed data

n: Number of data points; r^2: Coefficient of determination; Int.: Y-intercept

— No applicable data

FIELD PORTABLE X-RAY FLUORESCENCE SPECTROMETRY FOR THE DETERMINATION OF ELEMENTAL CONCENTRATIONS IN SOIL AND SEDIMENT



APPENDIX B

FIELD SAMPLING DATA SHEETS

Maul Foster & Alongi, Inc.

7223 NE Hazel Dell Avenue, Suite B, Vancouver, WA 98665 (360) 694-2691 Fax. (360) 906-1958

Soil Field Sampling Data Sheet

Client Name		**Sample Location**			
Project Number		**Sampler**			
Project Name		**Sampling Date**			
Sampling Event		**Sample Name**			
Sub Area		**Sample Depth**			
FSDS QA:		**Easting**		**Northing**	
				TOC	

Sample Information

Sampling Method	Sample Type	Sample Category	PID/FID	Sampling Time	Container Code	#
(1) Backhoe	Liquid	Composite			2 oz. soil	
					4 oz. soil	
					8 oz. soil	
					Other	
					Total Containers	0

Sample Description:

General Sampling Comments

Sampling Method Code:

(1) Backhoe, (2) Hand Auger, (3) Drill Bit Cutting Head, (4) Geoprobe, (5) Split Spoon, (6) Shelbey Tube, (7) Grab, (8) Other (Specify)

Signature ______________________________

Maul Foster & Alongi, Inc.

7223 NE Hazel Dell Avenue, Suite B, Vancouver, WA 98665 (360) 694-2691 Fax. (360) 906-1958

Water Field Sampling Data Sheet

Client Name		**Sample Location**	
Project #		**Sampler**	
Project Name		**Sampling Date**	
Sampling Event		**Sample Name**	
Sub Area		**Sample Depth**	
FSDS QA:			

Easting		**Northing**		**TOC**	

Hydrology/Level Measurements

					(Product Thickness)	(Water Column)	(Gallons/ft x Water Column)
Date	**Time**	**DT-Bottom**	**DT-Product**	**DT-Water**	**DTP-DTW**	**DTB-DTW**	**Pore Volume**

(0.75" = 0.023 gal/ft) (1" = 0.041 gal/ft) (1.5" = 0.092 gal/ft) (2" = 0.163 gal/ft) (3" = 0.367 gal/ft) (4" = 0.653 gal/ft) (6" = 1.469 gal/ft) (8" = 2.611 gal/ft)

Water Quality Data

Purge Method	Time	Purge Vol (gal)	Flowrate l/min	pH	Temp (C)	E Cond (uS/cm)	DO (mg/L)	EH	Turbidity
Final Field Parameters									

Methods: (1) Submersible Pump (2) Peristaltic Pump (3) Disposable Bailer (4) Vacuum Pump (5) Dedicated Bailer (6) Inertia Pump (7) Other (specify)

Water Quality Observations:

Sample Information

Sampling Method	Sample Type	Sampling Time	Container Code/Preservative	#	Filtered
	Groundwater		VOA-Glass		
			Amber Glass		
			White Poly		
			Yellow Poly		
			Green Poly		
			Red Total Poly		
			Red Dissolved Poly		
			Total Bottles	0	

General Sampling Comments

Signature ______________________________

APPENDIX E

PLAN SHEET

LEGEND

—	EXISTING CONTOURS
▩	EXCAVATION AREA (LCA - 3 FT DEPTH)
◬	EXISTING CONCRETE SURFACE
▒	EXISTING ASPHALT SURFACE
▨	EXISTING BUILDING

CONSTRUCTION NOTES

GENERAL

1. Implement erosion control plans consistent with the requirements of the Washington Department of Ecology's General Permit to Discharge Stormwater Associated with Construction Activity.
2. Submit clean backfill source documentation to engineer 3 days prior to start of excavation activities for approval.
3. Upon completion of the project, the site shall be left in a clean and safe condition, having met all of the terms of these contract documents.
4. If necessary, construction permit from the City of Sunnyside will be obtained by others. Contractor shall be responsible for all other necessary permits, including but not limited to any disposal permits, prior to initiating work.

SITE ACCESS AND UTILITIES

1. Control access to the site using temporary fencing, gates, markers and signs to control and warn authorized visitors and workers of construction activities and unsafe areas. Unauthorized visitors shall not be allowed. The site shall be kept secured during all work activity.
2. Contractor shall maintain and preserve utilities traversing and within the Limits of Work. Underground utilities exposed by excavation work shall be secured by Contractor.

EXCAVATION

1. Excavation shall not be conducted without the presence of the site engineer.
2. The area shall be excavated to the lateral extents shown on this plan and to a minimum depth of 3-ft bgs, or to the extent the field engineer indicates.
3. Field samples using XRF and methods described in the sampling and analysis plan will be performed by the site engineer during construction at the extents of the lead characteristic area (LCA) excavations. These samples will inform the final boundaries of the LCAs.
4. LCA soil shall be stockpiled on an impervious surface onsite in an engineer approved stockpile area for characterization for disposal.
5. Upon characterization, soil will be placed directly into trucks, covered and transported to the appropriate landfill for disposal.
6. Total estimated excavation volume: 11 cy

BACKFILL, GRADING, AND FINAL SURFACE:

1. Following engineer approval, backfill the excavation area with acceptable material pre-approved by engineer.
2. The following must be met for materials to be considered acceptable as backfill:
   - 2.1. Clean import from a local source that has been accepted by the engineer.
   - 2.2. Provide a written, notarized certification from the landowner of proposed off-site borrow source stating that the borrow site has never been contaminated with hazardous or toxic materials and include detailed historical information on past borrow site use as well as analytical laboratory test data.
3. Final grade shall match existing grade.
4. Final surface shall be minimum 6 inches of 1-1/4" minus crushed gravel.

EROSION CONTROL

1. Prior to any site work, contractor shall identify any additional measures that need to be taken to protect storm drainage systems, adjacent land, or waterways.
2. LCA Stockpile shall be protected against runoff and wind erosion by application of an appropriate cover during disposal characterization.
3. Contractor shall protect storm drainage inlets that are located within the immediate vicinity or adjacent to any construction activity (i.e. LCA stockpile areas) onsite using a regular flow silt sack insert to prevent sediment from entering the storm drainage system.

M A U L F O S T E R A L O N G I
1329 NORTH STATE STREET
SUITE 301
BELLINGHAM, WA 98225
PHONE: (360) 594-6250
www.maulfoster.com

JUSTIN LEE CLARY
37246

REMEDIAL ACTION—SOIL REMOVAL
FORMER CREAM WINE PROPERTY
PORT OF SUNNYSIDE
SUNNYSIDE, WASHINGTON

ISSUE	DATE	DESCRIPTION
####	####	####
---	---	---
VALUE	VALUE	VALUE
VALUE	VALUE	VALUE
VALUE	VALUE	VALUE
VALUE	VALUE	VALUE
VALUE	VALUE	VALUE

PROJECT: 0346.04
DESIGNED: C. LAMB
DRAWN: C. LAMB
CHECKED: J. CLARY

SCALE
0 30' 60'
NOTE: BAR IS ONE INCH ON ORIGINAL DRAWING. IF NOT ONE INCH ON THIS SHEET, ADJUST SCALE ACCORDINGLY.

SHEET TITLE
CIVIL & SITE EXCAVATION PLAN

PRELIMINARY

SHEET
C1.0

PLOTTED ON: 2013-07-02 11:51 AM PLOTTED BY: Connor Lamb FILENAME: G:\00_MFA Civil 3D\00_PROJECTS\0346.04-Port of Sunnyside\PLANS\C1.0 Civil & Site Excavation Plan.dwg

APPENDIX F

CHEMICAL DEMAND CALCULATION

EHC-L® Liquid ISCR Reagent Demand Calculations

FMC ENVIRONMENTAL SOLUTIONS

Customer:	**MFA**	26-Jun-2013
Contact:	**Heather Hirsch**	
Site Location:	**Eastern WA**	
Proposal Number:	**FA12-690**	

PRODUCT OVERVIEW

EHC-L® is a cold-water soluble formulation of EHC® that is specially designed for injection via existing wells or hydraulic injection networks for the treatment of a wide range of groundwater contaminants. The base composition is controlled-release organic carbon with an organo-iron compound (both food-grade).


Part 1

Packaging:

EHC-L is delivered in 2 parts and mixed together with water in the field.

Part 1: Liquid emulsion delivered in 55-USG drums, filled with 50 USG / 420 lbs per drum.
Part 2: Water soluble powder with the organo-iron compound and other additives delivered in 24.6 lb bags.


Part 2

SITE INFORMATION / ASSUMPTIONS

	Value	Unit	Comment
Treatment Area Dimensions:			
Width of targeted zone (perpendicular to gw flow)	100	ft	customer supplied
Length of targeted zone (parallel to gw flow)	200	ft	customer supplied
Depth to top of treatment zone	0	ft bgs	customer supplied
Treatment zone thickness	20	ft	customer supplied
Treatment volume	400,000	ft3	calculated value
Total Porosity	35	%	default value
Groundwater volume	140,000	ft3	calculated value
Soil bulk density	90	lbs/ft3	default value
Soil mass	18,000	ton	calculated value
Transport characteristics:			
Treatment time / design life for one application	1	years	default value
Linear groundwater flow velocity	0	ft/year	calculated value
Distance of inflowing gw over design life	0	ft	calculated value
Effective porosity for groundwater flow	20	%	default value
Volume of water passing region over design life	0	ft3	calculated value
Soil type	medium		customer supplied
Fraction organic carbon in soil, foc	0.005		estimated value

CONTAMINANTS OF CONCERN (COCs)

Constituent	**GW (mg/L)**	**Soil* (mg/kg)**	**Total COI Mass** (lb)**
PCE	0.0072	0.009468	0.4

*Unless provided, sorbed concentrations were roughly estimated based on expected groundwater concentrations, foc and Koc values. For a more refined estimate, it is recommended that actual values be verified via direct sampling of the targeted treatment interval.

**The total COI mass was estimated based on concentrations in soil and groundwater within the targeted area plus expected contributions from inflowing groundwater over the projected design life.

GEOCHEMICAL DATA

Competing Electron Acceptors	**GW (mg/L)**	**Soil* (mg/kg)**
Dissolved oxygen	3.6	0
Nitrate (as N)	105	0
Manganese (dissolved)	0.5	0
Iron (III)	0.5	0
Sulfate	237	0
Carbonate Alkalinity (as CaCO3)	0	0

*Unless provided, soil concentrations were roughly estimated based on expected groundwater concentrations, foc and Koc/Kd values. For a more refined estimate, it is recommended that actual values be verified via direct sampling of the targeted treatment interval.

ORP (mV)	7.3
pH	140

STOICHIOMETRIC DEMAND CALCULATIONS

	GW (mg/L)	**Soil (mg/kg)**
H2 Demand from COIs	0.0003	0.0005
H2 Demand from Competing Electron Acceptors	56.7872	0.0000
Total H2 Demand	56.7876	0.0005

H2 Demand from Soil within Targeted Area	0.02	lb
H2 Demand from GW within Targeted Area	496.40	lb
H2 Demand from Influx over Design Life	0.00	lb
Total Estimated H2 Demand	496.42	lb

EHC-L DEMAND CALCULATIONS

The Stoichiometric demand for the targeted area was calculated using available data presented above, noting that the Stoichiometric demand represents minimum requirements and require a complete geochemical data set to be calculated accurately. Therefore, the resulting EHC-L concentration in groundwater required to meet the estimated Stoichiometric demand was compared to our minimum guideline of targeting at least 500 mg/L TOC in groundwater, selecting the higher number.

	Value	**Unit**
Concentration EHC-L in GW to meet H2 demand	650.5	mg/L
Safety factor*	5	
Recommended conc. of EHC-L in pore water	3,253	mg/L
Mass of EHC-L required	28,432	lbs
Mass EHC-L per container	420	lbs
Number of Containers / Bags of Mix	68	containers
Mass EHC-L (rounded up based on container size)	28,560	lbs
Mass of EHC-L Mix (dry component)	1,675	lbs

*A safety factor has been applied to account for uncertainties in data and variability in the rate and extent of hydrogen consumption.

OPTIONAL pH BUFFER

If groundwater pH is below 6.5, we recommend that the EHC-L injectate be pH buffered to create optimal conditions for microbial growth. Based on previous experience, potassium bicarbonate, a fully soluble buffer, could be applied at a rate of 50 lbs per 1,000 gallons of EHC L injectate to neutralize the ambient pH to circum-neutral. However, it would be recommended to conduct a pH titration test to confirm the site-specific buffering capacity of the soil.

	Value	**Unit**
Mass potassium bicarbonate per 50 USG EHC-L	25	lbs/drum
Mass of potassium bicarbonate to add	1,700	lbs

OPTIONAL DHC INOCULANT

Although not typically required for ISCR, DHC inoculants have shown to improve removal kinetics, in particular for potential daughter products such as cis-DCE and VC. The DHC will be added after EHC-L application, once favorable redox conditions (ORP < -75 mV, DO <0.2 mg/L, pH between 6 and 8.5) have been attained. The DHC inoculant will contain at least 5 x10E10 cfu/L of live bacteria including high numbers of dehalococcoides species with known abilities to biodegrade DCE. The target density of DHC cells in the treated aquifer is 1x10E6 cfu/L.

	Value	**Unit**
Dechlorinating consortium concentration in inoculant	5.00E+10	DHC/L
Design final concentration after dilution in aquifer	1.00E+06	DHC/L
Volume of Inoculant Required	80	L

COST ESTIMATE

Item	Quantity	Unit	Price	Cost
EHC-L [1, 2]	28,560	lbs	$1.58	$45,125
Shipping Estimate [3]	1	lump sum	$5,800	$5,800
Sub Total Cost				**$50,925**
Optional items:				
pH Buffer [4]	1,700	lbs	$2.50	$4,250
DHC Inoculum (incl. minimum) [4]	80	L	$90	$7,200
TOTAL COST [5]				**$62,375**

1) Price valid for 90 days from date at top of document. Terms: net 30 days.

2) Any applicable taxes not included. Please provide a copy of your tax exempt certificate or resale tax number when placing your order. In accordance with the law, applicable state and local taxes will be applied at the time of invoicing if FMC has not been presented with your fully executed tax exemption documentation.

3) Shipping rate provided is an estimate. Standard delivery time can vary from 1-3 weeks from time of order, depending upon volume. Expedited transport can be arranged at extra cost. Unless requested otherwise, costs assume standard ground transport via truck, with no need for a lift gate or pallet jack.

4) Price excludes shipping.

5) All sales are per FMC's Terms and Conditions.

Disclaimer:

The estimated dosage and recommended application methodology described in this document are based on the site information provided to us, but are not meant to constitute a guaranty of performance or a predictor of the speed at which a given site is remediated. The calculations in the Cost Estimate regarding the amount of product to be used in your project are based on stoichiometry or default minimum guideline values, and do not take into account the kinetics, or speed of the reaction. Note that the Stoichiometric mass represents the minimum anticipated amount needed to address the constituents of concern (COCs). As a result, these calculations should be used as a general approximation for purposes of an initial economic assessment. FMC recommends that you or your consultants complete a comprehensive remedial design that takes into consideration the precise nature of the COC impact and actual site conditions.

INSTALLATION

The EHC-L will be delivered as two components, which will be mixed together in the field. The first component, a 25% liquid emulsion of carbon substrate, will be provided in 55-USG drums, with 50 USG/190 litres per drum. The second component is the EHC-L mix which contains the ferrous iron powder, and is delivered as a dry powder and added to the liquid component in the field. The EHC-L mix is proportioned so that one bag (24.5 lbs / 11.1 kg) of EHC L mix is added per drum.

Depending on the application method, between 10% and 100% of the effective porosity is normally targeted during EHC-L injection, with a higher percent pore fill normally targeted during low-flow injections into wells and injection networks. This is in contrast to applications via direct push technology (DPT) where normally around 10 to 15% is targeted. To facilitate the desired injection volume, the EHC-L components will be diluted in the field.

The below table shows examples of mixing recipes for a 55-USG drum of EHC-L and the resulting total injection volume and percent pore fill. Alternative packaging options are available upon request and the below mixing recipe may be scaled depending on mix batch and packaging size.

EHC-L Mixing Recipe (per 50 USG drum)

Dilution:	**3-fold**	**10-fold**	**25-fold**
Volume EHC-L emulsion per drum (USG)	50	50	50
Mass EHC-L mix (lbs)	24.6	24.6	24.6
Volume water (USG)	100	450	1,200
Resulting total volume (USG)	150	500	1,250
Resulting EHC-L concentration	9.7%	2.9%	1.2%
Total volume water (USG)	6,800	30,600	81,600
Total injection volume (USG)	10,200	34,000	85,000
Resulting injection volume to total pore volume	1.0%	3.2%	8.1%