GeoEngineers
17425 NE Union Hill Road, Suite 250
Redmond, Washington 98052
425.861.6000

December 6, 2018

Washington State Department of Ecology
Toxics Cleanup Program
3190 160th Ave SE
Bellevue, Washington 98008

Attention: Diane Escobedo

Subject: Request for Opinion – Soil Vapor Intrusion Evaluation Work Plan
WES Building Associated with Alderwood Laundry and Dry Cleaner Site
Lynnwood, Washington
VCP Project No. NW3066
GEI File No. 17787-001-11

On behalf of the Lynnwood Public Facilities District (PFD), we are requesting Washington State Department of Ecology's (Ecology) review and opinion on the Soil Vapor Intrusion Evaluation Work Plan at the Washington Energy Services (WES) Property. located at 3909 196th Street SW in Lynnwood, Washington (Snohomish County Tax Parcel 00372600401701 "WES Property"). Portions of the WES Property are part of the former Alderwood Laundry and Dry Cleaners (ALDC) Site. The Lynnwood PFD, owner of the eastern-adjacent property, is conducting an independent cleanup of the ALDC Site through Ecology's Voluntary Cleanup Program.

Sincerely,
GeoEngineers, Inc.

Cris J. Watkins
Project Manager

Dana Carlisle, PE
Principal

CJW:DLC:cje

Attachment:
Soil Vapor Intrusion Work Plan dated November 13, 2018

cc: Grant Dull, Executive Director, Lynnwood Public Facilities District
Bill Joyce, Joyce Ziker Parkinson PLLC

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

ATTACHMENT
Soil Vapor Intrusion Work Plan

Soil Vapor Intrusion Evaluation Work Plan

Washington Energy Services Building
3909 196th Street SW
Lynnwood, Washington
Alderwood Laundry and Dry Cleaner VCP NW3066
GEI File No. 17787-001-11

for

Lynnwood Public Facilities District

November 13, 2018

GeoEngineers
Earth Science + Technology

Soil Vapor Intrusion Evaluation Work Plan

Washington Energy Services Building
3909 196th Street SW
Lynnwood, Washington
Alderwood Laundry and Dry Cleaner VCP NW3066
GEI File No. 17787-001-11

for
Lynnwood Public Facilities District

November 13, 2018

GeoEngineers

17425 NE Union Hill Road, Suite 250
Redmond, Washington 98052
425.861.6000

Soil Vapor Intrusion Evaluation Work Plan

Washington Energy Services Building
3909 196th Street SW
Lynnwood, Washington

Alderwood Laundry and Dry Cleaner VCP NW3066
GEI File No. 17787-001-11

November 13, 2018

Prepared for:

Lynnwood Public Facilities District
3815 196th Street SW, Suite 136
Lynnwood, Washington 98036

Attention: Grant Dull

Prepared by:

GeoEngineers, Inc.
17425 NE Union Hill Road, Suite 250
Redmond, Washington 98052
425.861.6000

Cris J. Watkins
Environmental Scientist

Neil F. Morton
Senior Environmental Scientist

DANA L. CARLISLE
STATE OF WASHINGTON
29634
REGISTERED
PROFESSIONAL ENGINEER
11-13-18

Dana Carlisle, PE
Principal

DAC:CJW:NFM:cje

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

GeoEngineers

Table of Contents

1.0 INTRODUCTION AND BACKGROUND

The purpose of this Soil Vapor Intrusion (VI) Assessment Work Plan is to describe proposed sub-slab soil vapor and indoor air sampling intended to evaluate the potential for soil vapor intrusion of volatile organic compounds (VOCs) related to dry cleaning solvents into the Washington Energy Services (WES) Building located at 3909 196TH Street SW in Lynnwood, Washington (Snohomish County Tax Parcel 00372600401701 "WES Property"). The Lynnwood Public Facilities District (PFD), owner of the eastern-adjacent property, is conducting an independent cleanup of the former Alderwood Laundry and Dry Cleaners (ALDC) Site with oversight provided under the Washington State Department of Ecology's (Ecology) Voluntary Cleanup Program (VCP). The ALDC previously operated in a tenant space on property currently owned by the PFD. Based on findings included in the Remedial Investigation Report (RI Report) for the ALDC Site dated March 7, 2018, portions of the WES Property are included within the area identified as the ALDC Site. The general vicinity of the WES Property is shown in Figure 1. The layout of the building and features associated with the WES Building and the former dry cleaner on the eastern-adjacent PFD property are shown in Figure 2.

Remedial investigations completed on behalf of the PFD have included explorations on the WES Property and collection of soil, soil gas and groundwater samples for chemical analysis of dry cleaner-related solvents. Based on the sampling completed, dry cleaning-related solvents (i.e., tetrachloroethylene [PCE] and trichloroethene [TCE]) were detected in subsurface soil/soil vapor/groundwater samples collected from the eastern portion of the WES Property. Potential indoor air vapor intrusion risk associated with the WES Building was initially evaluated in 2016 as part of the RI. The initial evaluation, completed in accordance with Ecology's published guidance as of 2016, incorporated a conservative numeric model that used available PCE data for soil vapor and groundwater samples that had been collected on the WES Property. The initial VI evaluation concluded that predicted indoor air concentrations of contaminants of concern, including PCE and breakdown products TCE, 1,1-dichloroethene (1,1-DCE), cis- and trans 1,2-DCE and vinyl chloride were acceptable based on commercial uses of the WES Building.

Earlier this year the PFD requested Ecology's review and opinion on the RI Report. In Ecology's Opinion Letter dated June 4, 2018, Ecology indicated that additional VI assessment was recommended for the WES Building. Ecology noted the following in their letter: that there is a potential for unidentified shallow perched groundwater under the WES Building that could affect vapor concentrations, that the presence of several utility corridors on the WES Property may present preferential pathways for soil vapor, that the concentration of PCE in MW-7 groundwater adjacent to the WES Building is elevated, and that the soil vapor sample (SG-1) results adjacent to the WES Building may underestimate concentrations immediately under the building. More recent guidance published by Ecology in 2018 suggests evaluating potential VI using multiple lines of evidence, including collection of sub-slab soil vapor and indoor air samples to validate results of predictive modelling.

2.0 OBJECTIVE

The objective of the vapor intrusion assessment is to collect data regarding the nature and extent of potential vapor intrusion impacts in the WES Building resulting from PCE and related compounds in the subsurface, to identify if conditions are protective of human health as required by the Model Toxics Control Act (MTCA).

The Work Plan includes the following general tasks designed to meet the objectives of the assessment. Section 3.0 of the Work Plan presents detailed descriptions of the proposed scope and sampling activities.

- Conduct a physical survey of the building characteristics and building interior and the Property to refine the preliminary proposed sampling locations.
- Install sub-slab soil vapor sampling vapor pins and collect sub-slab soil vapor samples.
- Collect indoor air and outdoor ambient air samples.
- Interpret the data and present the findings in a Vapor Intrusion Evaluation Report for the WES Building.

3.0 VAPOR INTRUSION EVALUATION SCOPE

The VI evaluation for the WES Building will be conducted following Ecology's "Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action," updated April 2018 (Draft VI Guidance) and other related Ecology guidance. Specifically, the evaluation will follow Ecology's Tier II Assessment methodology as described in this document and requested by Ecology in their June 2018 letter.

Identification of potential indoor sources within commercial businesses is critical to evaluating whether vapor intrusion is occurring. Commercial operations such as those currently conducted in the WES Building may result in indoor air sources of VOCs, which could potentially bias indoor air sampling and affect interpretation/use of the indoor air sampling data. For example, carpeting or cleaning agents are known to emit VOCs. Therefore, the first step of the evaluation is to conduct a survey of the building characteristics and interior.

Current and historic site figures were used to identify the locations of subsurface potential preferential pathways. Underground utilities entering the building or adjacent to the building are typically backfilled with pea gravel or similar materials. These types of backfill are often much more permeable than native soils and can allow for vapors to accumulate or be transported under structures. The locations of these features were considered in selecting proposed sample locations for the VI assessment. Figure 2 shows the layout of the WES Building and readily identifiable current and historic subsurface preferential pathways.

The WES Building was formerly an automotive dealership and service center. Activities in the building included automotive maintenance as well as body repair and painting. As noted in the RI Report for the ALDC, automotive service activities may have historically used VOCs. Based on historical information for the WES Property as presented in the RI for ALDC, Figure 3 shows the areas of the WES Building previously used for automotive service-related activities, and the locations of documented historic waste storage and tanks. A historic drain sump and trench (see Figures 2 and 3) with a connection to the storm drain system was present in the building during the automotive uses of the WES building. These historic use areas were considered in the selection of proposed sample locations for this VI assessment.

Sub-slab soil vapor, indoor air and outdoor air sampling are planned to evaluate the potential for vapor intrusion of PCE and related breakdown products (associated with probable past releases on the adjacent property from the ALDC) into the WES Building. Data collected through the sub-slab soil vapor and outdoor air sampling are used to assist in identifying the potential source(s) of chlorinated solvents if detected in the indoor air samples.

The rationale for the preliminary proposed sample locations is discussed below. Approximate sample locations are shown in Figures 2 and 3.

- **Indoor Air Samples (Seven Locations).** The proposed indoor air sample locations were selected for the purpose of evaluating indoor air quality in regularly occupied spaces across the footprint of building, with a slightly higher density of samples to be collected in areas closest to eastern portion of the building where the dry cleaner-related groundwater plume is known to exist. Indoor air sample locations are also proposed in the western portion of the building to provide adequate coverage and to support the interpretation of potential sources of indoor air contaminants (which include historic activities and current activities). Preferential pathways such as penetrations in the concrete floor and the locations of windows and doors that will be identified during the building survey may influence the final selection of proposed indoor air samples.
- **Sub-Slab Soil Vapor Samples (Ten Locations).** The proposed sub-slab soil vapor sample locations were selected for the purpose of evaluating contaminant concentrations in soil vapor across the footprint of building, with the focus on the areas closest to known groundwater impacts, past sampling locations and preferential pathways (e.g. former drainage trench, utility trenches).
- **Outdoor Air Samples (Two or Three Locations).** The proposed outdoor air sample locations have not yet been determined but will be selected based on the stated objective to evaluate outdoor air that may enter the building via doors and windows and the building heating, ventilation and air conditioning (HVAC) systems. The proposed locations will be selected to be upwind based on wind direction the day of sampling and will include the HVAC system air intake to more accurately estimate outdoor air influence on indoor air quality.

Samples will be analyzed for PCE and breakdown products: TCE, 1,1-DCE, cis- and trans 1,2-DCE and vinyl chloride by U.S. Environmental Protection Agency (EPA) Method TO-15 SIM (indoor and outdoor air) and EPA Method TO-15 (soil vapor). To assess sample integrity and for quality control, helium will also be analyzed (ASTM International [ASTM] Standard Practices Test Method D 1946).

The current Work Plan envisions one event of sub-slab soil vapor, indoor air and outdoor ambient air sampling. However, additional sampling events may be proposed, depending on the results from the first event. If additional events are proposed, sampling protocols will be similar to those outlined in this Work Plan.

3.1. Sampling Methodologies and Quality Assurance

The following methods will be used to collect the indoor air, outdoor air and sub-slab soil vapor samples. A more detailed sampling analysis plan (SAP) is presented in Appendix A and Vapor Pin™ installation procedures for the sub-slab soil vapor sampling are presented in Appendix B. The quality assurance project plan (QAPP) is included in this Work Plan as Appendix C.

3.1.1. Indoor Air and Outdoor Air Samples

- Indoor and outdoor air samples will be collected at the same time over an 8-hour period using evacuated 6-Litre Summa canisters, similar to that shown in Photo 1.
- Air sampling will be conducted using a vacuum gauge and an 8-hour flow controller.
- The canisters for indoor air samples will be placed on the ground and the canister intake situated approximately 3- to 5-feet aboveground to collect samples representative of the breathing zone for building occupants.
- Outdoor air samples will be collected near the air intake for the rooftop HVAC units that directs indoor air into the WES Building.

Photo 1. Summa Canister with Intake

- To the extent practicable, indoor air sampling will be conducted under conservative (i.e., “worst case”) conditions as recommended by Ecology guidance. Specifically, windows will be kept closed and ingress and egress activities will be minimized to the extent possible during sampling. Indoor air samples will be collected on a weekend or a holiday when the building is presumably not occupied; however, the HVAC system will operate at least 24 hours prior and during the sampling period as if the building were occupied to maintain normal indoor air temperatures. The intent is to obtain indoor air samples that are representative of normal conditions, but sample when few to no building occupants are present and few windows and exterior doors are opening and closing, to reduce potential interferences.

3.1.2. Sub-Slab Soil Vapor Samples

- The sub-slab samples will be collected using Vapor Pin™ sampling devices similar to the one shown on Photo 2. The Vapor Pin™ will be installed in general accordance with the manufacturers’ standard operating procedures (Appendix B), which involves drilling a hole through the concrete slab to insert the Vapor Pin™ and secure it in place with the silicone gasket.
- Pre-sampling quality control procedures (shut-in test, leak testing, and purging) and soil vapor sampling will not take place for at least 30 minutes hours following installation of the vapor pin.
- Sub-slab soil vapor samples will be collected using evacuated 1-liter Summa canisters.

Photo 2. Vapor Pin in Concrete Slab

3.2. Physical Survey

A physical survey will be conducted by field personnel within the building prior to sampling. The purpose of the physical survey is to obtain data that will allow a qualitative assessment of factors that potentially could influence air quality. The physical survey includes collecting data on aspects of the building configuration such as building layout, utility entrances into the building, visible remnants of the former shop drainage trench and sumps, HVAC system design, foundation conditions, building material types (e.g., recent carpeting/linoleum and/or painting), etc. The physical survey also includes collecting data related to products used in the building during WES operations and indoor storage of chemicals, paints and/or petroleum hydrocarbon products, etc. Results of the physical survey will be used to adjust sampling locations as necessary. The physical survey will be documented by completing the Building Survey Form in Appendix D[1].

3.3. Meteorological Data

Relevant meteorological data that can influence soil vapor concentration patterns will be collected prior to and during sampling. These data may be helpful qualitatively in data interpretation and in reconciling soil vapor sample data collected on multiple occasions.

Barometric pressure data over a 2-week time span around the sampling event will be reviewed, based on data from readily available data sources (e.g. regional weather stations). If feasible, the actual sampling event will be attempted on days with relative dropping atmospheric pressure.

General weather conditions such as wind speed, snow or ice cover, significant precipitation will be obtained at the time of sampling from using direct observation (e.g., for snow or ice cover) or readily available data sources (e.g., regional weather stations).

4.0 VAPOR INTRUSION EVALUATION METHODOLOGY

The VI evaluation will be conducted to evaluate what impact, if any, vapor intrusion is having on the indoor air at the WES Building. The VI evaluation will follow the Tier II Assessment methodology outlined in Section 3.2 of Ecology's Draft VI Guidance that recommends multiple lines of evidence, including groundwater, soil vapor and air data be considered when evaluating the potential for vapor intrusion.

As noted earlier, outdoor (ambient) air samples will be collected to estimate the ambient air background contribution to detected indoor air concentrations. Ecology's VI guidance states that detected indoor air concentrations can be adjusted (that is, corrected) by subtracting the detected outdoor air concentrations from the detected indoor air concentrations. Initially, the air and soil vapor data will be compared to MTCA Method B indoor air cleanup levels and MTCA Method B sub-slab soil vapor screening levels, respectively. The indoor air data will also be compared to MTCA Method B air remediation levels based on commercial/occupational worker exposure assumptions, following a methodology allowed under Ecology guidance to better reflect exposures to an adult worker. The commercial/occupational worker remediation levels will be used to evaluate whether the indoor air concentrations, adjusted to account for contributions from outdoor air, are protective of workers and visitors in the WES Building.

[1] This form was adapted from guidance provided in the Interstate Technology Regulatory Council (ITRC) Technical and Regulatory Guidance, Vapor Intrusion Pathway: A Practical Guideline, dated January 2007.

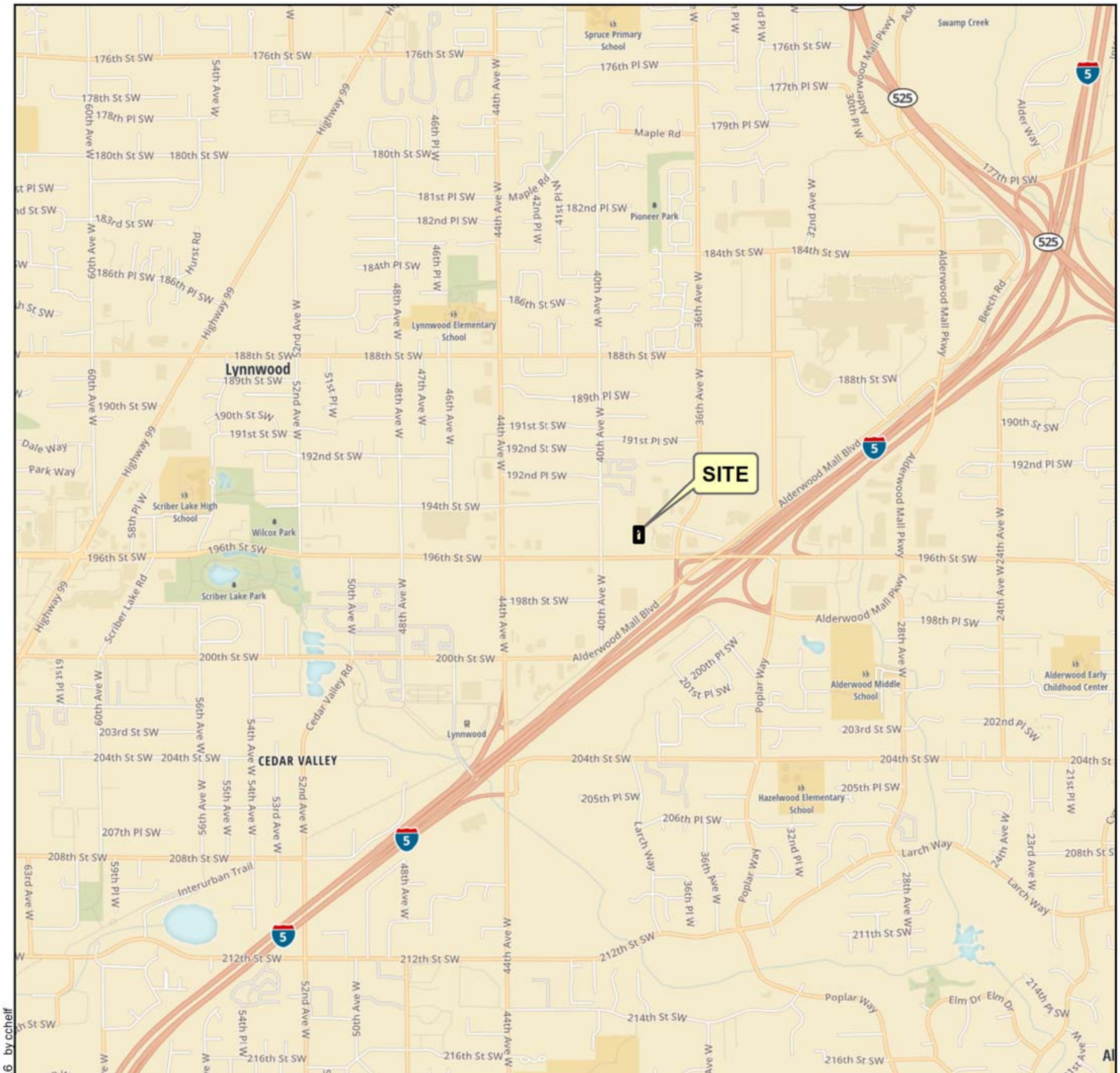
5.0 REFERENCES

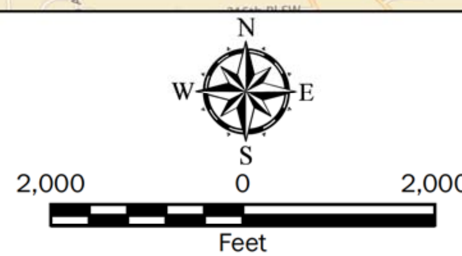
Washington State Department of Ecology (Ecology). 2007. Model Toxics Control Act (MTCA) Statute and Regulation. MTCA Cleanup Regulation Chapter 173-340 WAC. Compiled by Washington State Department of Ecology Toxics Cleanup Program, Publication No. 94- 06. Revised November. http://www.ecy.wa.gov/biblio/9406.html.

Washington State Department of Ecology (Ecology). 2018. "Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action, Review Draft," October 2009, updated April 2018.

FIGURES

GeoEngineers





Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Mapbox Open Street Map, 2016

Projection: NAD 1983 UTM Zone 10N

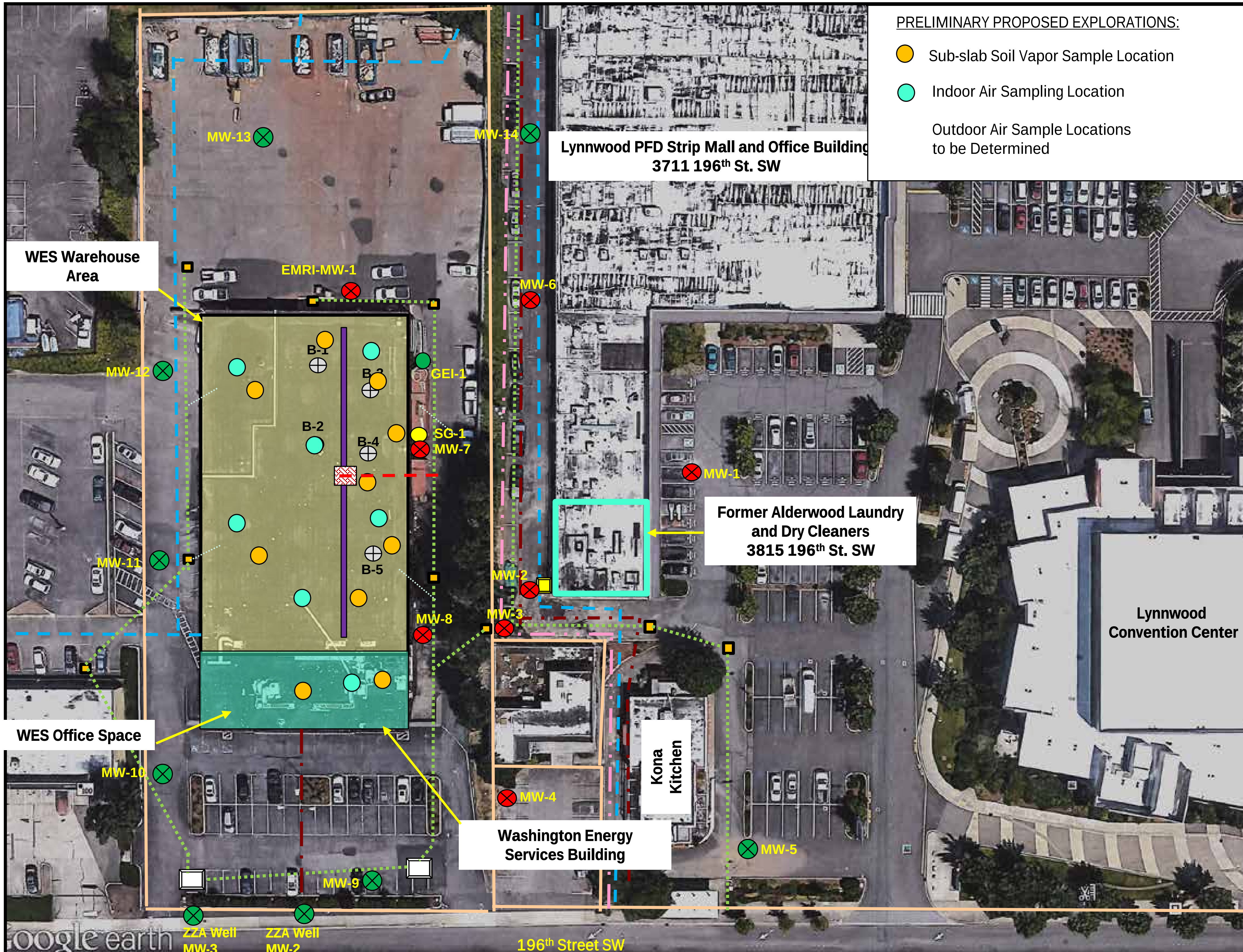
P:\17\17787001\GIS\1778700105_F1_VicinityMap.mxd Date Exported: 04/27/16 by ccheff

Vicinity Map

Alderwood Laundry and Dry Cleaners
3815 196th St SW
Lynnwood, Washington

GEOENGINEERS

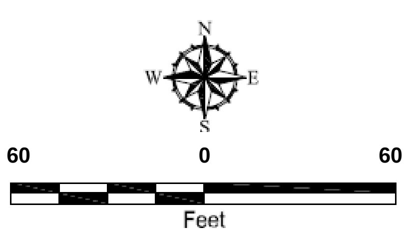
Figure 1



LEGEND:

- MW-5 Existing Monitoring Well – No MTCA Exceedance in Groundwater (as of 2018)
- MW-7 Existing Monitoring Well – MTCA Exceedance In Groundwater (as of 2018)
- GEI-1 GeoEngineers Soil Boring
- SG-1 GeoEngineers Soil Vapor Sample
- B-5 Soil Boring by GCI (December 1993)
- Parcel Line
- Existing Storm Drain
- Existing catch basin
- Existing Sewer Line
- Existing Water Line
- Existing Gas Line
- Existing oil water separator
- Existing concrete grease trap
- Auto shop concrete drainage trench
- Auto shop drainage trench sump
- Auto Shop discharge piping connected to storm drain
- Approximate footprint of Former Alderwood Laundry and Dry Cleaners

MTCA Model Toxics Control Act



Notes:

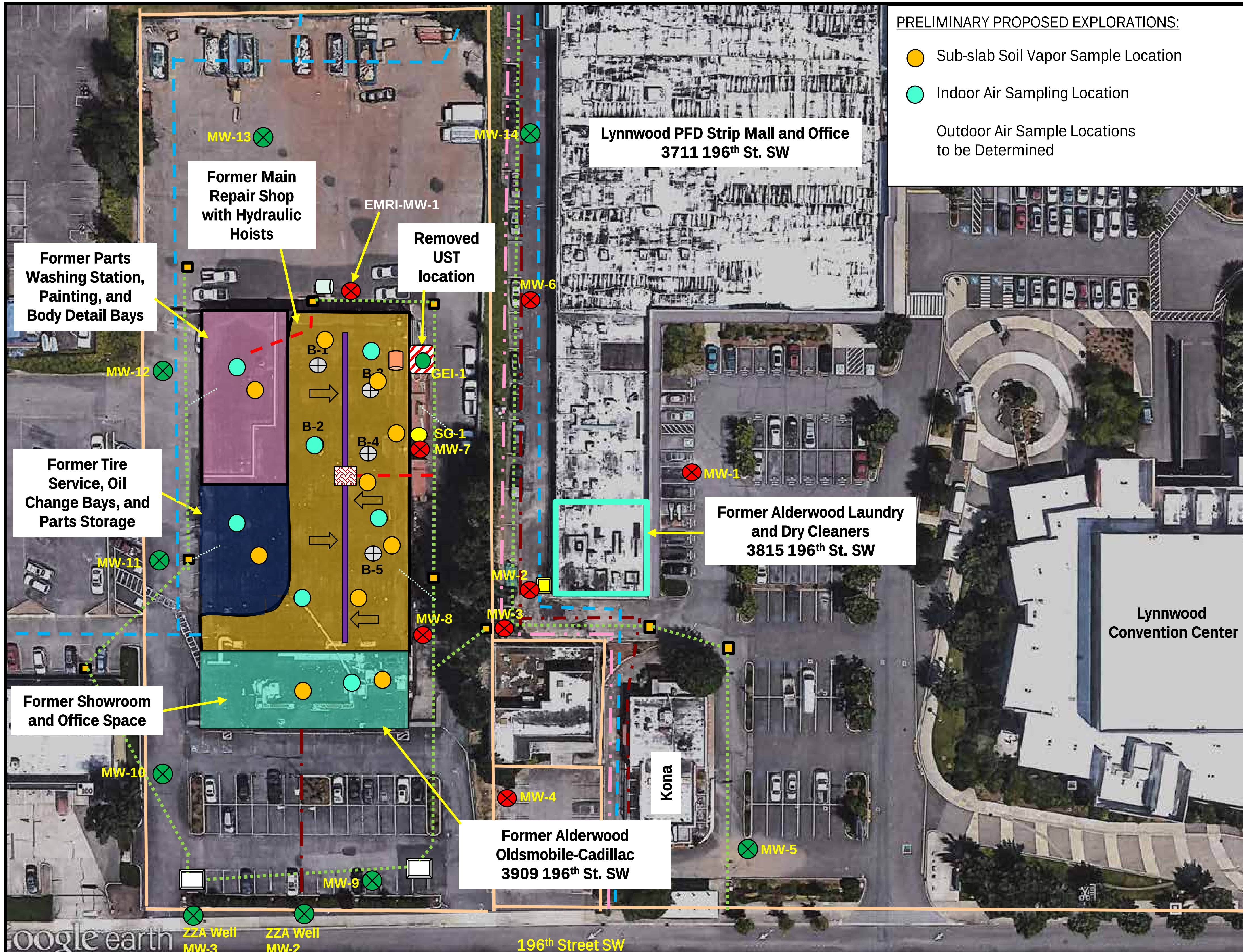
1. The locations of all features shown are approximate.
2. This drawing is only for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Proposed Sample Locations – WES Building

Former Alderwood Laundry and Dry Cleaners Site, Lynnwood, Washington

GeoEngineers

Figure 2



PRELIMINARY PROPOSED EXPLORATIONS:

- Sub-slab Soil Vapor Sample Location
- Indoor Air Sampling Location
- Outdoor Air Sample Locations to be Determined

LEGEND:

- MW-5 — Existing Monitoring Well – No MTCA Exceedance in Groundwater (as of 2018)
- MW-7 — Existing Monitoring Well – MTCA Exceedance In Groundwater (as of 2018)
- GEI-1 — GeoEngineers Soil Boring
- SG-1 — GeoEngineers Soil Vapor Sample
- B-5 — Soil Boring by GCI (December 1993)
- Former 500-gallon Waste Oil UST Removal & approx. limits of 1991 Petroleum-contaminated Soil Excavation
- Parcel Line
- Existing Storm Drain
- Existing catch basin
- Existing Sewer Line
- Existing Water Line
- Existing Gas Line
- Existing concrete grease trap
- Existing oil water separator
- Auto Shop discharge piping connected to storm drain
- Auto shop concrete drainage trench
- Auto shop drainage trench sump
- Car dealership service area slope toward drainage trench
- Former 465 gallon Used Oil Aboveground Storage Tank
- Former 250 gallon New Oil Aboveground Storage Tank
- Approximate footprint of Former Alderwood Laundry and Dry Cleaners
- UST — Underground Storage Tank
- MTCA — Model Toxics Control Act

60 0 60

Feet

Notes:

1. The locations of all features shown are approximate.
2. This drawing is only for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Former Automotive Dealership Building Features on WES Property

Former Alderwood Laundry and Dry Cleaners Site, Lynnwood, Washington

GeoEngineers

Figure 3

APPENDICES

GeoEngineers

APPENDIX A
Sampling Analysis Plan

APPENDIX A
SAMPLING ANALYSIS PLAN

Sub-Slab Soil Vapor Probe Installation

Sub-slab soil vapor samples will be collected inside the building using Vapor Pin™ sampling devices. The Vapor Pins™ are installed following the manufacturers' standard operating procedures (SOPs) attached to this appendix. The Vapor Pins™ will be left in place with flush-mounted stainless-steel covers for potential future use if necessary.

General installation procedures for the sub-slab sampling device were as follows:

- Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding. A subcontractor will perform a private utility locate to clear the sub-slab soil vapor sample locations.
- Set up vacuum to collect drill cuttings.
- Drill a 1.5-inch-diameter hole at least 1.75 inches into the slab.
- Drill a 5/8-inch-diameter hole through the slab and approximately 1 inch into the underlying soil to form a void.
- Remove the drill bit, brushed the hole with the bottle brush, and removed the loose cuttings with the vacuum.
- Place the lower end of sampling device assembly into the drilled hole. Place the small hole located in the handle of the extraction/installation tool over the sampling device to protect the barb fitting and cap and tapped the sampling device into place using a dead blow hammer. Make sure the extraction/installation tool is aligned parallel to the sampling device to avoid damaging the barb fitting.
- During installation, the silicone sleeve forms a slight bulge between the slab and the sample device shoulder creating a seal. Place a protective cap on sampling device to prevent vapor loss prior to sampling.
- Cover the sampling device with a stainless-steel secured cover.
- Allow at least 60 minutes for the sub-slab soil vapor conditions to equilibrate prior to sampling.

Sub-Slab Soil Vapor Sampling Procedure

The following procedure is followed to collect sub-slab soil vapor samples:

- Connect new fluoropolymer (Teflon®) tubing to the sub-slab soil vapor probe, using the barb fitting on the top of the sampling device.
- Connect the tubing (aboveground) to a sampling manifold.
- Vacuum test the sampling manifold (shut-in test) by briefly introducing a vacuum to the aboveground portion of the sampling train and checking for loss of vacuum. If vacuum loss is observed, connections and fittings in the sample train are checked and adjusted, then vacuum-tested again. This test is repeated until the sampling train has demonstrated that tightness is achieved.

- A tracer gas shroud (clear plastic bag) is placed around the entire sample train (that is, the sub-slab soil vapor probe where it enters the ground surface, the 6-liter Summa canister and associated tubing and manifold).
    - The shroud is charged (filled) with a tracer gas (spec-grade 99.995 percent helium gas) and the tracer gas concentration within the shroud is measured using a hand-held monitor (Dielectric MGD-2002 Multi-Gas Leak Detector), which is capable of measuring helium in air to a concentration of 0.5 percent) prior to, during and after completion of the sampling event. To charge the shroud a Teflon tube with a ball valve is inserted under the shroud to connect with the compressed helium bottle. This same tube is used to monitor the helium concentration within the shroud periodically throughout the sampling process. The purpose of the periodic monitoring is to make sure helium is in contact with the sample train and the ground surface while the sub-slab vapor sample is collected.
- The sampling train (aboveground and belowground components) is purged using a vacuum purge pump or a multi-gas meter. Purge volumes are calculated based on the flow rate of the purge pump and the volume of the soil vapor probe and sample train. After purging three sampling train volumes, the helium concentration within the sampling train is measured and recorded. If the helium concentration in the sample train is greater than or equal to 5 percent of the helium concentration in the shroud, the bentonite seal is re-applied, fittings re-tightened, and the previous purging and measurement tests are repeated (Cal-EPA/DTSC 2015).
- The soil vapor sample is obtained using a 1-liter evacuated Summa canister (with approximately 30 inches of mercury vacuum set by the laboratory) and tedlar bag (helium analysis) with a regulated flow rate of less than or equal to approximately 200 milliliters per minute (Cal-EPA/DTSC 2015). The canister is filled with soil vapor for approximately 5 minutes or until a vacuum equivalent of approximately 5 inches of mercury remains in the Summa canister, whichever comes first. The initial and final canister vacuums are recorded on a soil vapor sampling field form.
- The canisters are provided by the subcontracted analytical laboratory.

Air Sampling Methodology

Indoor and outdoor air samples are obtained by placing a laboratory-supplied evacuated 6-liter Summa canister equipped with an 8-hour flow controller. Tubing was connected to each canister and was used to elevate the sample intake into the breathing zone at approximately 4 to 5 feet above the ground surface. Initial canister pressure, start date and start time are recorded on a field data form. The inlet valve on the canister is opened to collect the sample. The canisters are filled until a vacuum equivalent of between 4 and 10 inches of mercury remained in each canister. At that time, the sample team closes the inlet valve and records the canister pressure, stop date and stop time on the field data form. Canisters are then prepared and delivered to the laboratory under chain-of-custody procedures for chemical analysis.

Table A-1

Test Methods, Sample Containers, Preservation and Hold Times For Air and Soil Vapor Samples

Washington Energy Services Building

Lynnwood, Washington

Matrix	Analytes	Analysis Method	Bottle Size	Preservation	Holding Times
Air	VOCs	EPA TO-15 (SIM)	6 Liter Summa Canister	None	30 days
Soil Vapor	VOCs	EPA TO-15	1 Liter Summa Canister	None	30 days
	Helium	ASTM-D1946	1 Liter Summa Canister	None	30 days

Notes:

Extraction holding time is based on elapsed time from date of sample collection.

VOCs = volatile organic compounds

EPA = U.S. Environmental Protection Agency

ASTM = ASTM International Standard Practices

Table A-2

Quality Control Samples - Type and Frequency For Air and Soil Vapor Samples

Washington Energy Services Building

Lynnwood, Washington

Matrix	Field QC			Laboratory QC			
	Field Duplicates	Trip Blanks	Rinseate	Laboratory/Method Blanks	LCS/LCSD	MS/MSD	Lab Duplicates
Air	None Proposed	None Proposed	Not Applicable	1 per batch	1 per batch	Not Applicable	Not Applicable
Soil Vapor	None Proposed	None Proposed	Not Applicable	1 per batch	1 per batch	Not Applicable	Not Applicable

Notes:

An analytical batch is defined as a group of samples taken through a preparation procedure and sharing a method blank, LCS, and lab duplicate.

No more than 20 field samples can be contained in one batch.

LCS = Laboratory control sample

MS = Matrix spike sample

MSD = Matrix spike duplicate sample

QC = Quality Control

Table A-3

Methods of Analysis and Target Reporting Limits for Air and Soil Vapor Samples

Washington Energy Services Building

Lynnwood, Washington

Matrix	Air		Soil Vapor	
Analysis Method	**EPA TO-15 (SIM)**		**EPA TO-15**	
Analyte	**MTCA Method B Air Cleanup Level (µg/m³)**	**Target Reporting Limit - 6 L (µg/m³)[1]**	**MTCA Method B Soil Vapor Screening Level (µg/m³)**	**Target Reporting Limit - 1 L (µg/m³)[1]**
Tetrachloroethene (PCE)	9.62	0.14	321	2.8
Trichloroethene (TCE)	0.37	0.11	12.3	2.2
1,1-Dichloroethene	91.4	0.079	3,050	1.58
cis-1,2-Dichloroethene	not available	0.079	not available	1.58
trans-1,2-Dichloroethene	not available	0.079	not available	1.58
Vinyl chloride	0.28	0.051	9.33	1.4

Notes:

[1] Laboratory reporting limits were obtained from Pace Analytical, a Washington State Department of Ecology-approved laboratory.

µg/m³ = microgram per cubic meter

EPA = United State Environmental Protection Agency

GeoEngineers

APPENDIX B
Vapor Pin™ Standard Operation Procedure

Standard Operating Procedure Installation and Extraction of the Vapor Pin®

Updated March 16, 2018

Scope:

This standard operating procedure describes the installation and extraction of the VAPOR PIN® for use in sub-slab soil-gas sampling.

Purpose:

The purpose of this procedure is to assure good quality control in field operations and uniformity between field personnel in the use of the VAPOR PIN® for the collection of sub-slab soil-gas samples or pressure readings.

Equipment Needed:

- Assembled VAPOR PIN® [VAPOR PIN® and silicone sleeve(Figure 1)]; Because of sharp edges, gloves are recommended for sleeve installation;
- Hammer drill;
- 5/8-inch (16mm) diameter hammer bit (hole **must** be 5/8-inch (16mm) diameter to ensure seal. It is recommended that you use the drill guide). (Hilti™ TE-YX 5/8" x 22" (400 mm) #00206514 or equivalent);
- 1½-inch (38mm) diameter hammer bit (Hilti™ TE-YX 1½" x 23" #00293032 or equivalent) for flush mount applications;
- ¾-inch (19mm) diameter bottle brush;
- Wet/Dry vacuum with HEPA filter (optional);
- VAPOR PIN® installation/extraction tool;
- Dead blow hammer;
- VAPOR PIN® flush mount cover, if desired;
- VAPOR PIN® drilling guide, if desired;
- VAPOR PIN® protective cap; and
- VOC-free hole patching material (hydraulic cement) and putty knife or trowel for repairing the hole following the extraction of the VAPOR PIN®.

Figure 1. Assembled VAPOR PIN®

Installation Procedure:

1) Check for buried obstacles (pipes, electrical lines, etc.) prior to proceeding.

2) Set up wet/dry vacuum to collect drill cuttings.

3) If a flush mount installation is required, drill a 1½-inch (38mm) diameter hole at least 1¾-inches (45mm) into the slab. Use of a VAPOR PIN® drilling guide is recommended.

4) Drill a 5/8-inch (16mm) diameter hole through the slab and approximately 1-inch (25mm) into the underlying soil to form a void. Hole **must** be 5/8-inch (16mm) in diameter to ensure seal. It is recommended that you use the drill guide.

5) Remove the drill bit, brush the hole with the bottle brush, and remove the loose cuttings with the vacuum.

6) Place the lower end of VAPOR PIN® assembly into the drilled hole. Place the small hole located in the handle of the installation/extraction tool over the vapor pin to protect the barb fitting, and tap the vapor pin into place using a dead blow hammer (Figure 2). Make sure the installation/extraction tool is aligned parallel to the vapor pin to avoid damaging the barb fitting.

Figure 2. Installing the VAPOR PIN®

During installation, the silicone sleeve will form a slight bulge between the slab and the VAPOR PIN® shoulder. Place the protective cap on VAPOR PIN® to prevent vapor loss prior to sampling (Figure 3).

Figure 3. Installed VAPOR PIN®

7) For flush mount installations, cover the vapor pin with a flush mount cover, using either the plastic cover or the optional stainless-steel Secure Cover (Figure 4).

Figure 4. Secure Cover Installed

8) Allow 20 minutes or more (consult applicable guidance for your situation) for the sub-slab soil-gas conditions to re-equilibrate prior to sampling.

9) Remove protective cap and connect sample tubing to the barb fitting of the VAPOR PIN®. This connection can be made using a short piece of Tygon™ tubing to join the VAPOR PIN® with the

Nylaflow tubing (Figure 5). Put the Nylaflow tubing as close to the VAPOR PIN® as possible to minimize contact between soil gas and Tygon™ tubing.

Figure 5. VAPOR PIN® sample connection

10) Conduct leak tests in accordance with applicable guidance. If the method of leak testing is not specified, an alternative can be the use of a water dam and vacuum pump, as described in SOP Leak Testing the VAPOR PIN® via Mechanical Means (Figure 6). For flush-mount installations, distilled water can be poured directly into the 1 1/2 inch (38mm) hole.

Figure 6. Water dam used for leak detection

11) Collect sub-slab soil gas sample or pressure reading. When finished, replace the protective cap and flush mount cover until the next event. If the sampling is complete, extract the VAPOR PIN®.

Extraction Procedure:

1) Remove the protective cap, and thread the installation/extraction tool onto the barrel of the VAPOR PIN® (Figure 7). Turn the tool clockwise continuously, don't stop turning, the VAPOR PIN® will feed into the bottom of the installation/extraction tool and will extract from the hole like a wine cork, DO NOT PULL.

2) Fill the void with hydraulic cement and smooth with a trowel or putty knife.

Figure 7. Removing the VAPOR PIN®

- Prior to reuse, remove the silicone sleeve and protective cap and discard. Decontaminate the VAPOR PIN® in a hot water and Alconox® wash, then heat in an oven to a temperature of 265° F (130° C) for 15 to 30 minutes. For both steps, **STAINLESS – ½ hour, BRASS 8 minutes**

3) Replacement parts and supplies are available online.

APPENDIX C
Quality Assurance Project Plan

APPENDIX C
QUALITY ASSURANCE PROJECT PLAN

Introduction

This Quality Assurance Project Plan (QAPP) has been prepared to identify the air sampling and analysis methods to be performed during the indoor air, outdoor air and soil vapor sampling for the WES Building located in Lynnwood, Washington.

Field Documentation

Soil Gas and Air Sample Containers and Labeling

The Field Coordinator will manage field protocols related to sample collection, handling and documentation. Soil gas, Indoor and outdoor air samples will be submitted for chemical analysis of tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), cis-1,2-DCE, trans-1,2-DCE and vinyl chloride by U.S. Environmental Protection Agency (EPA) Method TO-15 SIM and EPA Method TO-15. Soil gas samples will also be analyzed for helium by ASTM International [ASTM] Standard Practices Test Method D 1946 for quality control leak detection purposes.

Sample containers are listed in Table A-1. Sample containers will be labeled with the following information at the time of sample collection.

- Project number
- Sample name, which will include a reference to the building name, sample type (indoor, outdoor or soil vapor) and sample date
- Date and time of collection
- Samplers initials

Sample collection activities will be noted on the field logs and the Field Coordinator will monitor consistency between sample containers/labels, field logs, and chain of custody forms. Sample numbering conventions are described below:

Sample Labeling – Each sample will be labeled with the building name (WES), sample type and location number (sub-slab soil gas, indoor or outdoor) and the year, month, day of sample collection. For example, if an indoor air sample is collected on March 17, 2017, the sample identification would be WES-IA1-170317.

Outdoor air samples will be identified as “OA” and sub-slab soil vapor samples will be identified as “SS.”

Sample Handling

Samples will be placed in the canister shipping container after collection. Each sample will be documented on an air or soil vapor sample collection form including sample name, sample collection date and time, canister identification and canister vacuum.

Field personnel will provide for the security of samples from the time the samples are collected until the samples have been received by the courier service or laboratory personnel. A chain of custody form will be completed for each group of samples being shipped to the laboratory per standard chain of custody protocol. Samples will be transported and delivered to the analytical laboratory in the laboratory provided shipping container. The samples will be transported by a shipping company.

Field Observations Documentation and Records

Field documentation provides important information about potential problems or special circumstances surrounding sample collection. Field personnel will record information for each air sample on field logs and will maintain a daily field report. Entries in the field logs will be made in pencil or water-resistant ink on water-resistant paper, and corrections will consist of line-out deletions. Individual logs and reports will become part of the project files at the conclusion of the field work.

At a minimum, the following information will be recorded during the collection of each sample.

- Sample location and description
- Sampler's name(s)
- Date and time of sample collection
- Sample matrix (indoor air, outdoor air or soil vapor)
- Type of sampling equipment used
- Field instrument (e.g., photoionization detector [PID]) readings
- Weather conditions (temperature, barometric pressure, wind direction, wind speed, and humidity) from a local weather station
- Surface conditions (presence of standing water and/or non-vegetative cover)
- Groundwater elevation measurements in monitoring wells in close proximity to the soil gas probes will be documented during soil gas sampling
- Field observations and details that are pertinent to the integrity/condition of the samples (e.g., performance of the sampling equipment, etc.)

In addition to the sampling information, the following specific information will also be recorded in the field log for each air sample or in a daily field report:

- Sampling team members
- Time of arrival/entry on site and time of site departure
- Other personnel present at the site
- Summary of pertinent meetings or discussions with contractor personnel
- Deviations from sampling plans and Health and Safety Plan
- Air monitoring results
- Changes in field personnel and responsibilities with reasons for the changes
- Levels of safety protection

The handling, use, and maintenance of field logs and reports are the Field Coordinator's responsibility.

Decontamination

Non-disposable tools and equipment will not be required for air sampling, so decontamination will not be required.

Disposal of Investigation-Derived Waste

Incidental waste to be generated during sampling activities includes items such as gloves, sample tubing, paper towels and similar expended and discarded field supplies. These materials are considered *de minimis* and will be disposed in a local trash receptacle or county disposal facility.

Quality Assurance and Quality Control

Environmental measurements will be conducted to produce data that are scientifically valid, of known and acceptable quality and that meet established objectives. QA/QC procedures will be implemented so that the precision, accuracy, representativeness, completeness and comparability (PARCC) of the data generated meet the specified data quality objectives within standard industry guidelines as described in Tables A-1 through A-3.

Field Quality Control

Field duplicates are not planned for this sampling effort. Trip blanks and rinseate blanks are not required for air sampling.

Data Management and Documentation

Data logs and data report packages will be located in the project file system in GeoEngineers' Sharepoint. Laboratory data reports will include internal laboratory quality control checks and sample results. Data logs and packages that are anticipated to be generated during the investigation include laboratory data report packages, field report, field sampling data sheets, site plan of sample locations and chain-of-custody forms.

Analytical data will be supplied to GeoEngineers in both electronic data deliverable (EDD) format and PDF format. The PDF will serve as the official record of laboratory results. The EDDs will contain only data reported in the hard copy reports (e.g., only reportable results).

Upon receipt of the analytical data, the EDD will be uploaded to a project database and reduced into summary tables for each group of analytes and media. Upon completion of the summary tables, the accuracy of the data reduction will be verified using the hard copy of the data received from the laboratory. Any exceptions will be noted, and corrections will be made.

Data Validation and Usability

Upon receipt of the sample data from the laboratory, the data will be validated and evaluated for usability.

Environmental Information Management System Submittal

Chemical analytical results for air and soil vapor samples collected will be submitted to the Ecology Environmental Information Management (EIM) database.

Appendix D
Building Survey Form

BUILDING SURVEY FORM

This form must be completed for each building involved in indoor air testing.

Preparer's Name ______________________________________ Date/Time Prepared _______________

Preparer's Affiliation __________________________________ Phone No.________________________

Purpose of Investigation____

1. OCCUPANT:

Interviewed: Y / N

Last Name: ___________________________ First Name: ___________________________

Address: ____

County: __________________

Home Phone: _____________________ Office Phone: _____________________

Number of Occupants/persons at this location _______ Age of Occupants ________________________

2. OWNER OR LANDLORD: (Check if same as occupant ___)

Interviewed: Y / N

Last Name: ___________________________ First Name: ___________________________

Address: ____

County: __________________

Home Phone: _____________________ Office Phone: _____________________

3. BUILDING CHARACTERISTICS

Type of Building: (Circle appropriate response)

Residential | Commercial/Multi-use | Other: __________________

If the property is residential, type? (Circle appropriate response)

2-Family	3-Family	
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Other:________________	

If multiple units, how many? ________

If the property is commercial, type?

Business Type(s) ____

Does it include residences (i.e., multi-use)? Y / N If yes, how many? ______

Other characteristics:

Number of floors______ Building age______

Is the building insulated? Y / N How air tight? Tight / Average / Not Tight

4. BASEMENT AND CONSTRUCTION CHARACTERISTICS (Circle all that apply)

Above grade construction:	wood frame	concrete	stone	brick
Foundation type:	crawlspace	slab-on-grade	other ________________	
Foundation walls:	poured	block	stone	other ________
Foundation walls:	unsealed	sealed	sealed with _________________	

If building has a crawlspace, please answer the following questions:

1) Does the crawlspace have air vents leading out of the house or building? Y / N
2) **Crawl space vents:** always open always closed open/closed based on season
3) **Crawlspace floor:** N/A dirt concrete other ________
4) Is the crawlspace lined with a plastic liner (vapor barrier)? Y / N
5) **Position of the liner:** On ground Attached to floor joist Attached to foundation
6) **Condition of liner:** whole partial torn
7) **Crawlspace is:** wet damp dry moldy

If house or building is slab-on-grade, please answer the following questions:

1) **Concrete floor:** unsealed sealed sealed with _________________
2) **Concrete floor:** uncovered covered covered with _________________

If the house or building has a sump, please answer the following questions:

1) **Water in sump?** Y / N / not applicable
2) **Sump lined?** Y / N / not applicable lined with _________________

Lowest level depth below grade: ________(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

____

____

____

5. HEATING, VENTING and AIR CONDITIONING (Circle all that apply)

Type of heating system(s) used in the house or building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard	
Space Heaters	Stream radiation	Radiant floor	
Electric baseboard	Wood stove	Outdoor wood boiler	Other ___________

The primary type of fuel used is:

Natural Gas	Fuel Oil	Kerosene
Electric	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: ____________________________

Where is Boiler/furnace/air conditioning located:

Are there air distribution ducts present? Y / N

Describe the air intakes (where applicable), supply and cold air return ductwork, and their condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

____

____

____

6. OCCUPANCY

Is lowest level occupied? Full-time Occasionally Seldom Almost Never

<u>Level General Use of Each Floor (e.g., family room, store, laundry, workshop, storage)</u>

1st Floor ____

2nd Floor ____

7. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY

a. Is there an attached garage? Y / N

b. Does the garage have a separate heating unit? Y / N / NA

c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, atv, car) Y / N / NA Please specify____________________

d. Has the building ever had a fire? Y / N When?___________________

e. Is a kerosene or unvented gas space heater present? Y / N Where? __________________

f. Is there a workshop or hobby/craft area? Y / N Where & Type? ________________

g. Is there smoking in the building? Y / N How frequently? _______________

h. Have cleaning products been used recently? Y / N When & Type? ________________

i. Have cosmetic products been used recently? Y / N When & Type? __________________

j. Has painting/staining been done in the last 6 months? Y / N Where & When? _________________

k. Is there new carpet, drapes or other textiles? Y / N Where & When? _________________

l. Have air fresheners been used recently? Y / N When & Type? __________________

m. Is there a kitchen exhaust fan? Y / N If yes, where vented?______________

n. Is there a bathroom exhaust fan? Y / N If yes, where vented?______________

o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N

p. Has there been a pesticide application? Y / N When & Type?___________________

Are there odors in the house or building? Y / N

If yes, please describe: ____

Do any of the house or building occupants use solvents at work? Y / N
(e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist)

If yes, what types of solvents are used? ____

If yes, are their clothes washed at work? Y/ N

Do any of the house or building occupants regularly use or work at a dry-cleaning service? (Circle appropriate response)

Yes, use dry-cleaning regularly (weekly)	No
Yes, use dry-cleaning infrequently (monthly or less)	Unknown
Yes, work at a dry-cleaning service	

Is there a radon mitigation system for the house/building? Y / N Date of Installation: __________

Is the system active or passive? Active/Passive

8. FLOOR PLANS

Draw a plan view sketch of the basement and first floor of the house/building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the house/building does not have a basement, please note.

Basement:

First Floor:

9. OUTDOOR PLOT (Draw a sketch of the area surrounding the house/building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.)

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.

10. PRODUCT INVENTORY FORM Make & Model of field instrument used:

List specific products found in the residence that have the potential to affect indoor air quality.

Location	Product Description*	Comments	PID Reading

* Describe the condition of the product containers as **Unopened (UO), Used (U),** or **Deteriorated (D)** ** Photographs of the **front and back** of product containers can replace the handwritten list of chemical ingredients. However, the photographs must be of good quality and ingredient labels must be legible.