Vapor Intrusion Investigation – Birmingham Block Building

Howe Parcel
University of Washington - Tacoma
Tacoma, Washington
UW CPD Project No. 205864
Facility Number 1334

for
University of Washington

August 11, 2020

GeoEngineers
Earth Science + Technology

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1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

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UW CPD Project No. 205864
Facility Number 1001/4539
GeoEngineers File No. 0183-109-04

August 11, 2020

Prepared for:

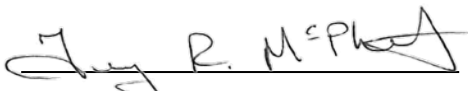
University of Washington
Environmental Health and Safety
Environmental Programs Office
PO Box 354110
Seattle, Washington 98195-4410

Attention: Steve Harrison

Prepared by:

GeoEngineers, Inc.
1101 South Fawcett Avenue, Suite 200
Tacoma, Washington 98402
253.383.4940

Tricia S. DeOme, LG
Senior Environmental Geologist



Terry R. McPhetridge, LG, LHG
Principal

CJG:TSD:TRM:tt:ch

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1.0 INTRODUCTION

This report presents the results of the supplemental vapor intrusion (VI) investigation at the University of Washington – Tacoma (UWT) Birmingham Block building along Pacific Avenue in Tacoma, Washington in June 2020. This investigation is a follow-up to the previous VI evaluation at the subject property in May 2017.

The Birmingham Block (BB) building is located within the Howe Parcel plume. Volatile organic compounds (VOC) concentrations (primarily tetrachloroethene [PCE] and trichloroethene [TCE]) are present in groundwater within the Howe Parcel plume. In 2017, Washington State Department of Ecology (Ecology) requested a vapor intrusion evaluation be conducted within the UWT buildings and Federal Courthouse due to the presence of TCE and vinyl chloride in the groundwater during degradation of the PCE in the groundwater. Sampling of soil vapor, indoor air and outdoor air was performed in May 2017 at four buildings within the Howe Parcel plume to evaluate conditions for tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethene (1,1-DCE), cis-1,2-DCE, trans-1,2-DCE and vinyl chloride. One indoor air sample and one outdoor air sample collected at the BB building indicated TCE was detected at concentrations greater than MTCA Method B cleanup level (CUL) for indoor air of a commercial space for a full-time [adult] worker of 4.1 µg/m^3. Ecology requested additional air sampling be performed in the BB building due to the high concentrations of TCE present in the two 2017 air samples.

The buildings and surrounding area are shown in Figure 1. The approximate lateral extent of the PCE and TCE groundwater plumes are shown in Figure 2. Background information for buildings and 2017 investigation are summarized in the report titled "Vapor Intrusion Investigation, Howe Parcel, University of Washington – Tacoma, Tacoma, Washington," dated July 26, 2018.

2.0 2017 VAPOR INTRUSION INVESTIGATION

TCE was detected at concentrations greater than the MTCA Method B CUL for indoor air of a commercial space for full-time workers in two air samples collect during the 2017 event. The air samples included one indoor air sample H-BB-IA1 collected in the BB building and one heating, ventilation and air conditioning (HVAC) intake outdoor sample H-BB, BHS, WCG-OA1 collected on the Joy building roof. The indoor sample H-BB-IA1 was identified as an indication of vapor intrusion because the adjusted indoor air TCE concentration (calculated from the indoor air TCE concentration of sample H-BB-IA1 minus the outdoor air TCE concentration of sample H-BB, BHS, WCG-OA1) was less than the MTCA Method B CUL. Furthermore, TCE was not detected in the subslab samples in the area.

3.0 FIELD INVESTIGATIONS

3.1. Pre-Sampling Activities

A site visit was performed on June 30, 2020 to visual survey interior of the BB building to evaluate access to sample locations and potential indoor air sources. Indoor air quality can be impacted by ambient (outdoor) air contamination or commercial products emitting VOCs (Ecology 2016). The survey results are included in Appendix A. Additional building information is summarized in the GeoEngineers' report titled

'Vapor Intrusion Investigation, Howe Parcel' dated July 26, 2018. Building information and changes observed to buildings since the time of the July 26, 2018 report are provided in the following list.

- UWT representatives indicated in 2017 that the HVAC system intake located on the Joy building roof serves the BB, BHS and WCG buildings. It appears that the HVAC system on the BB building roof in fact feeds the BB building based on information provided by UWT representatives in 2020.
- The ground floor in the area that was resampled is a former restaurant/cafe that is currently vacant. Restaurant equipment including stoves, ovens, and furniture have been removed and the walls did not appear to be recently painted.
- The roofs on the BB and Joy buildings are tar-coated flat roofs with abundant bird guano. Cleaning chemicals were not observed on the roofs.

3.2. Air Sampling

A total of three air samples were collected on June 3, 2020. Air samples were collected within the BB building and outside near the HVAC intakes on the BB and Joy buildings (ambient air). Indoor air sample H-BB-IA1R was collected inside the BB building at the location of the 2017 air sample location H-BB-IA1. Outdoor air sample H-JoyRoof-OA1 was collected from the HVAC intake on the roof of the Joy building and outdoor air sample H-BBRoof-OA1 was collected from the HVAC intake on the roof of the BB building. The approximate air sampling locations are shown in Figure 2.

The air samples were obtained by placing 6-liter Summa canisters equipped with an 8-hour flow controller at the locations. Outdoor air was sampled for evaluation because it represents another potential source of air contamination from general environmental sources (in addition to common indoor sources) that could impact air inside the building. The barometric pressure was measured with an INW Baroscout located in GeoEngineers Tacoma office. Sampling procedures are described in Appendix A. Graph of the barometric pressure is shown in Appendix B.

3.2.1. Weather Conditions

The weather conditions were partly cloudy with a temperature in the mid 60's °F and wind directions to the north-northwest in the morning hours and west-northwest in the afternoon during sampling activities performed on June 3, 2020. The barometric pressure generally stable during most of the sampling event with a drop observed in the last few hours of the sampling event.

4.0 CHEMICAL ANALYTICAL RESULTS AND VAPOR INTRUSION EVALUATION

The indoor air and outdoor air samples were submitted to Fremont Analytical, Inc. in Seattle, Washington for chemical analysis of PCE, TCE, 1,1-dichloroethene (1,1-DCE), cis-1,2-DCE, trans-1,2-DCE and vinyl chloride by EPA Method TO-15 SIM (indoor and outdoor air). The chemical analytical packages and data validation are included in Appendix C.

4.1. Indoor and Outdoor Air Results

PCE, TCE, and other PCE breakdown products (1,1-DCE, trans-1,2-DCE, cis-1,2-DCE and vinyl chloride) were not detected in the three analyzed air samples.

5.0 CONCLUSION

PCE and other breakdown products (1,1-DCE, trans-1,2-DCE, cis-1,2-DCE and vinyl chloride) were not detected in the one indoor air sample collected in the BB building and the two outdoor air samples collected at the HVAC systems at the BB and Joy buildings. It does not appear that vapor intrusion is occurring at these locations due to the underlying PCE and TCE groundwater plumes based on the results of this investigation.

6.0 LIMITATIONS

We have prepared this report for the University of Washington regarding the vapor intrusion (VI) evaluation at the UWT Birmingham Block building located along Pacific Avenue in Tacoma, Washington.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express or implied, should be understood.

Please refer to Appendix D titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

7.0 REFERENCES

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Table 1

Summary of BB Building Indoor and Outdoor Air Sampling Chemical Analytical Data - June 2020

University of Washington - Tacoma - Howe

Tacoma, Washington

Building	Sample Identification[1]	Sample Date	Sample Type	Ratio of PCE to TCE[2]	VOCs (µg/m^3)[3]						
					PCE	TCE	Adjusted TCE[4]	1,1-DCE	cis-1,2-DCE	Trans-1,2-DCE	Vinyl Chloride
Birmingham Block	H-BB-IA1	5/3/2017	Indoor Air	0.27	**1.42**	**5.19**	0	0.0357 U	0.0793 U	0.0238 U	0.217 U
	H-BB-IA1R	6/3/2020		N/A	0.339 U	0.0914 U	N/A	0.0357 U	0.0793 U	0.0238 U	0.217 U
GWP, BHS, WCG Intake	H-BB, BHS, WCG-OA1	5/3/2017	Outdoor Air	0.29	**2.06**	**7.09**	N/A	0.0357 U	**0.430**	**0.0368**	0.217 U
	H-JoyRoof-OA1	6/3/2020		N/A	0.339 U	0.0914 U	N/A	0.0357 U	0.0793 U	0.0238 U	0.217 U
BB Intake	H-GWP-OA1	5/3/2017	Outdoor Air	7.17	**1.32**	**0.184**	N/A	**0.104**	**0.543**	**0.111**	0.217 U
	H-BBRoof-OA1	6/3/2020		N/A	0.339 U	0.0914 U	N/A	0.0357 U	0.0793 U	0.0238 U	0.217 U
MTCA Method B Indoor Air Cleanup Level (µg/m^3)[9,10]					**9.6**	**0.37**	**0.37**	**91**	**NE**	**NE**	**0.28**
MTCA Method B Calculated Indoor Air Remediation Level for Commercial Space Visitors (Adults and Children)[9,11]					**NC**	**7.7**	**7.7**	**NC**	**NC**	**NC**	**NC**
MTCA Method B Indoor Air Remediation Level for Commercial Space Full-Time Workers (Adults)[8,9]					**NC**	**4.1**	**4.1**	**NC**	**NC**	**NC**	**NC**
MTCA Method B Indoor Air Remediation Level for Commercial Space Part-Time Workers (Adults)[8,10]					**NC**	**7.0**	**7.0**	**NC**	**NC**	**NC**	**NC**
EPA Region 10 Air Concentrations for Short-Term Exposure For Commercial Space (Adults)[11]					**NE**	**8.4**	**8.4**	**NE**	**NE**	**NE**	**NE**

Notes:

[1] Sample identification Howe-Building/Location-Sample Type-Sample Number (i.e., H-BB-IA1 = Howe-BB Building-Indoor Air- Sample 1).

[2] The ratio of tetrachloroethene (PCE) to trichloroethene (TCE) is calculated using the PCE concentration divided by the TCE concentration.

[3] Samples were analyzed by United States Environmental Protection Agency (EPA) method TO-15-SIM.

[4] Adjusted trichloroethene (TCE) concentration is equal to the indoor air TCE concentration minus the outdoor air TCE concentration. If the calculated concentration is negative, then the concentration is presented as "0".

[5] Unrestricted Land Use and Commercial Space Visitor indoor air remediation levels (adults and children) were calculated using the Method B formula in Table 8 of MTCA guidance "Trichloroethylene Toxicity Information and MTCA Cleanup Levels (TCE), CAS # 79-01-6" dated September 2012. Both levels were calculated using this formula to account for increased toxicity in children relative to adults using age dependent adjustment factors in accordance with EPA's Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. EPA/630/R-03/00F, March 2005. The only parameter modified in the Method B formula was exposure frequency. See Footnotes 8 and 9 for difference in exposure frequency between unrestricted land use and commercial space visitors.

[6] Model Toxics Control Act (MTCA) Method B Air Cleanup Level for Unrestricted Land Use (children and adults) based on an exposure frequency value of 1 (which assumes exposure 24 hours per day, 365 days per year).

[7] MTCA Method B Indoor Air Remediation Level for Commercial Space Visitors (children and adults) is based on an exposure frequency value of 0.047 (assumes 4 hours per day and 104 days per year [2 days per week]).

[8] The Commercial Space worker air levels (adults) were calculated using MTCA Method B air cleanup level Equation 750-2. The only parameters modified in the Method B formula was exposure frequency and exposure duration. The commercial worker exposure duration used was 20 years, which is consistent with the exposure duration for MTCA Method B industrial soil cleanup levels. See Footnotes 10 and 11 for the difference in exposure frequency between full-time and part-time workers.

[9] MTCA Method B Indoor Air Remediation Level for Commercial Space Full-Time Worker (adults) is based on an exposure frequency of 0.23 (assumes 8 hours per day and 250 days per year).

[10] 10 MTCA Method B Indoor Air Remediation Level for Commercial Space Part-Time Worker (adults) based on an exposure frequency of 0.13 (assumes 8 hours per day and 146 days per year).

[11] EPA, 2012, OEA Recommendations Regarding Trichloroethylene Toxicity in Human Health Risk Assessments, EPA Region 10, Office of Environmental Assessment, December 13, 2012.

U = analyte was not detected at a concentration greater than the laboratory reporting limit

NE = Not Established

N/A = Not applicable

ppt = Parts per trillion

IA = Indoor Air

NC = Not Calculated

EPA = United States Environmental Protection Agency

BB = Birmingham Block

BHS = Birmingham Hay & Seed

GWP = Garretson Woodruff & Pratt

OA = Outdoor Air

UT = Utility Tunnel

PCE = Tetrachloroethene

TCE = Trichloroethene

DCE = Dichloroethene

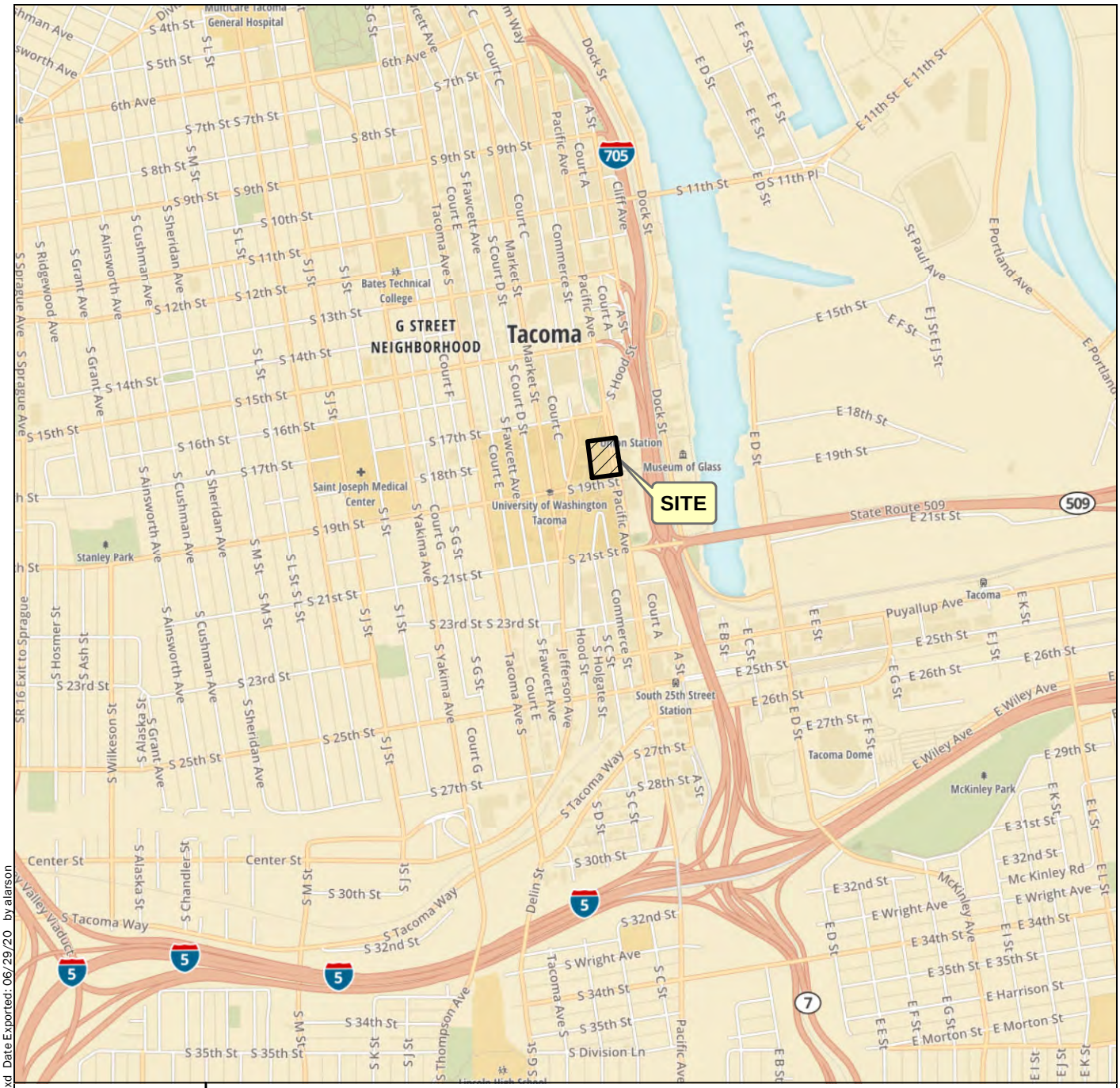
VOCs = Volatile organic compounds

µg/m^3 = microgram per cubic meter

GC/TCD = gas chromatography/thermal conductivity detector

WCG = West Coast Grocery

Bold font type indicates the analyte was detected at a concentration greater than the laboratory reporting limit.



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: ESRI Data & Maps

Projection: NAD 1983 UTM Zone 10N

Vicinity Map

Birmingham Block Resampling Event
University of Washington - Tacoma
Tacoma, Washington

GeoEngineers

Figure 1

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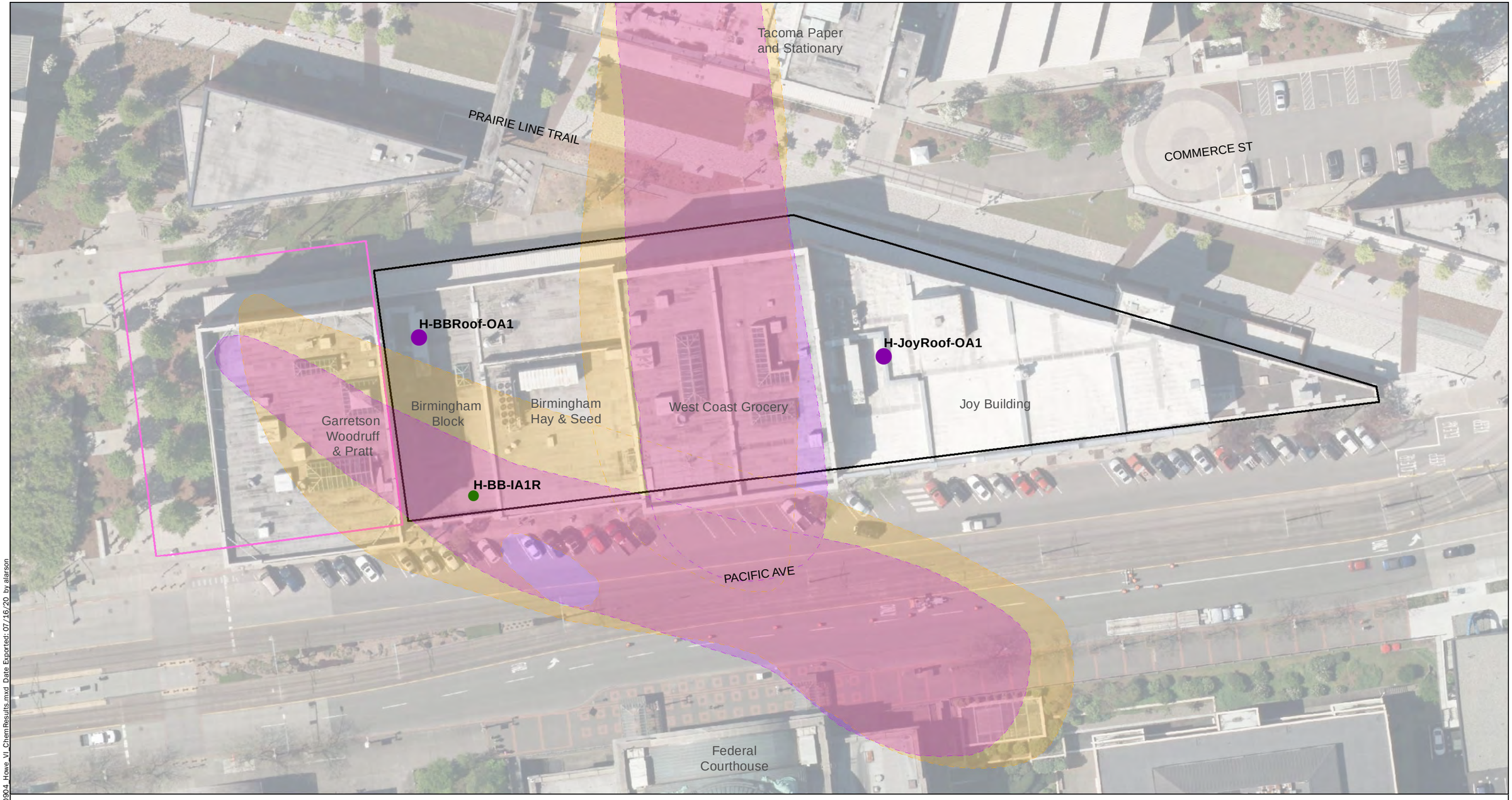

Notes:

1. UWT - University of Washington Tacoma
   µg/L = microgram per liter
   PCE = tetrachloroethene
   TCE = trichloroethene
   RIGSL = remedial investigation groundwater screening level protective of indoor air
2. The locations of all features shown are approximate.
3. 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: Aerial imagery provided by City of Tacoma, 2015.
Projection: NAD 1983 HARN StatePlane Washington South FIPS 4602 Feet

Legend

- Indoor Air Sample
- Outdoor Air Sample
- Site Boundary
- Former Howe Parcel Location
- September 2019 Approximate Lateral Extent of TCE Detected In Groundwater at Concentrations Greater Than RIGSL (5 µg/L)
- September 2019 Approximate Lateral Extent of PCE Detected In Groundwater at Concentrations Greater Than RIGSL (5 µg/L)

N W S E

50 0 50
Feet

Chemical Analytical Results

Birmingham Block Resampling Event
University of Washington - Tacoma
Tacoma, Washington

GeoEngineers

Figure 2

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APPENDIX A
Field Program and Building Survey

APPENDIX A
FIELD PROGRAM AND BUILDING SURVEY

Air Sampling Methodology

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

BUILDING SURVEY FORM

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

Preparer's Name PAUL ROBINETTE Date/Time Prepared 0730

Preparer's Affiliation GEO ENGINEERS Phone No. 253-383-4942

Purpose of Investigation _____

1. OCCUPANT: NONE

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: PIERCE

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) None - was previously a restaurant

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

Other characteristics:

Number of floors 3 4 Building age >40

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~~ Basement, 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: 15 (feet)

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

floor is tiled, in fact

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 HVAC

The primary type of fuel used is:

Natural Gas	Fuel Oil	Kerosene
(Electric)	Propane	Solar
Wood	Coal	

Domestic hot water tank fueled by: Electric

Where is Boiler/furnace/air conditioning located: on roof of building

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.

HVAC in good condition – intake on roof
4 – ceiling vents

6. OCCUPANCY

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

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

1st Floor retail / restaurant - currently empty

2nd Floor classrooms / offices

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? OUTSIDE

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

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

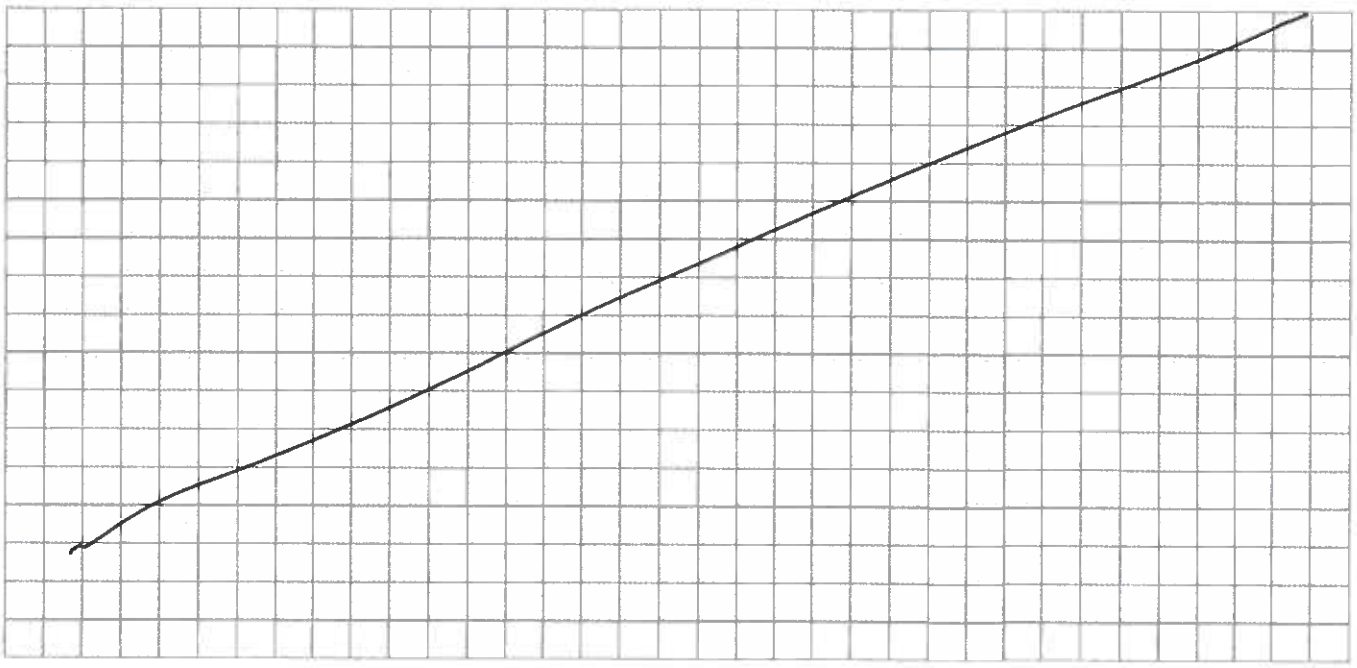
Is there a radon mitigation system for the house/building? Y (N) Date of Installation: _____

Is the system active or passive? Active/Passive

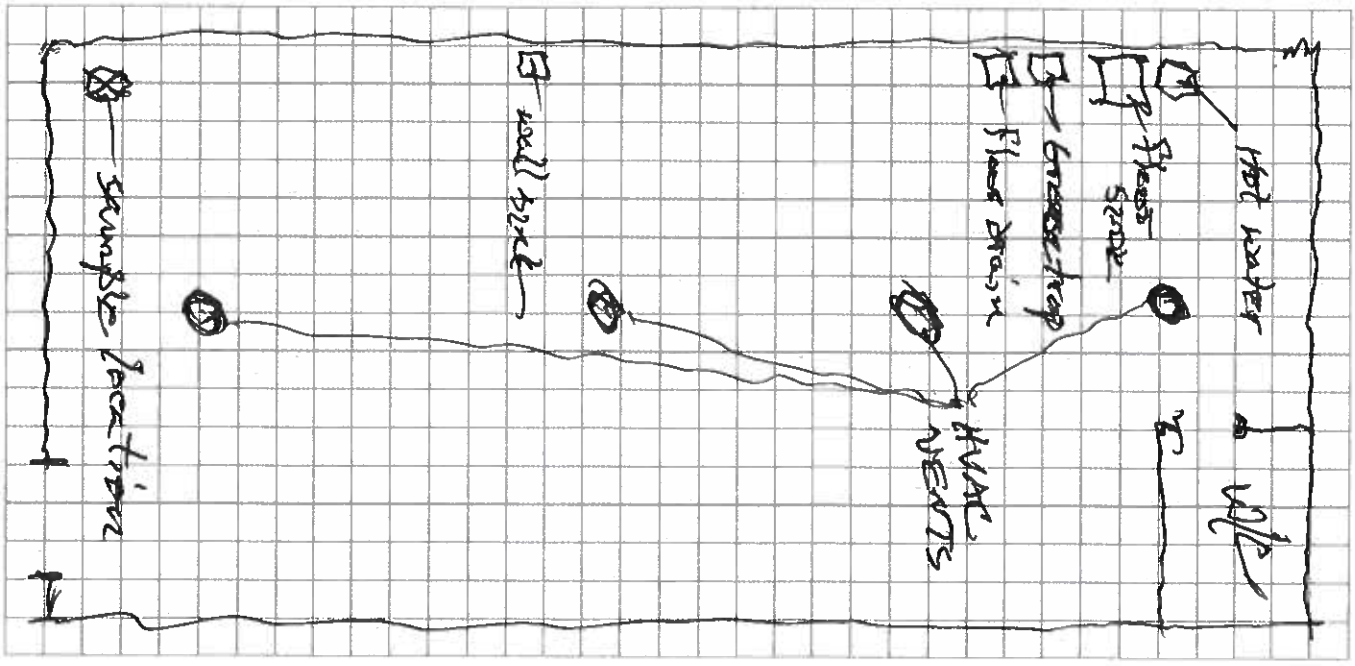
8. FLOOR PLANS

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:

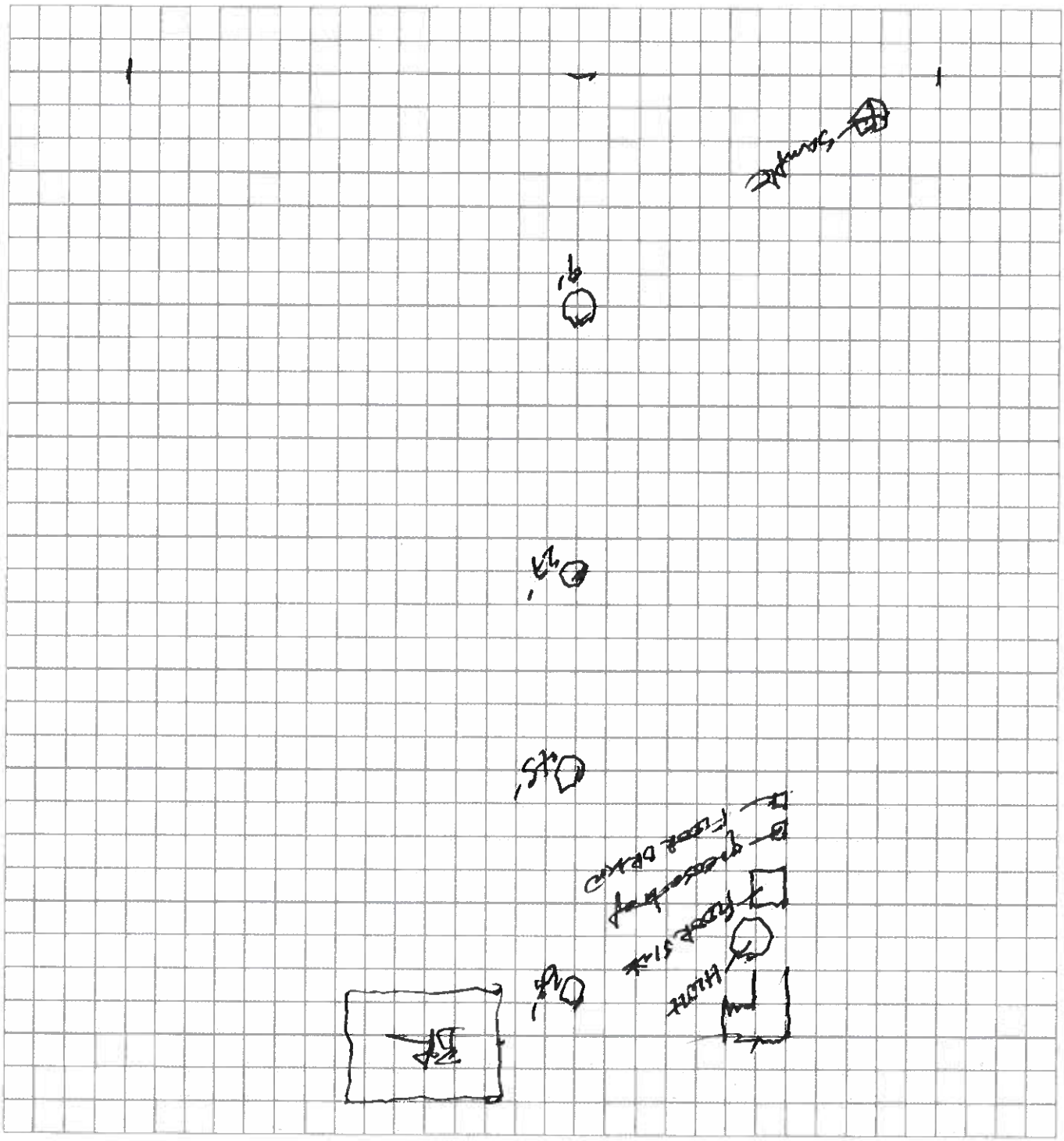


First Floor:



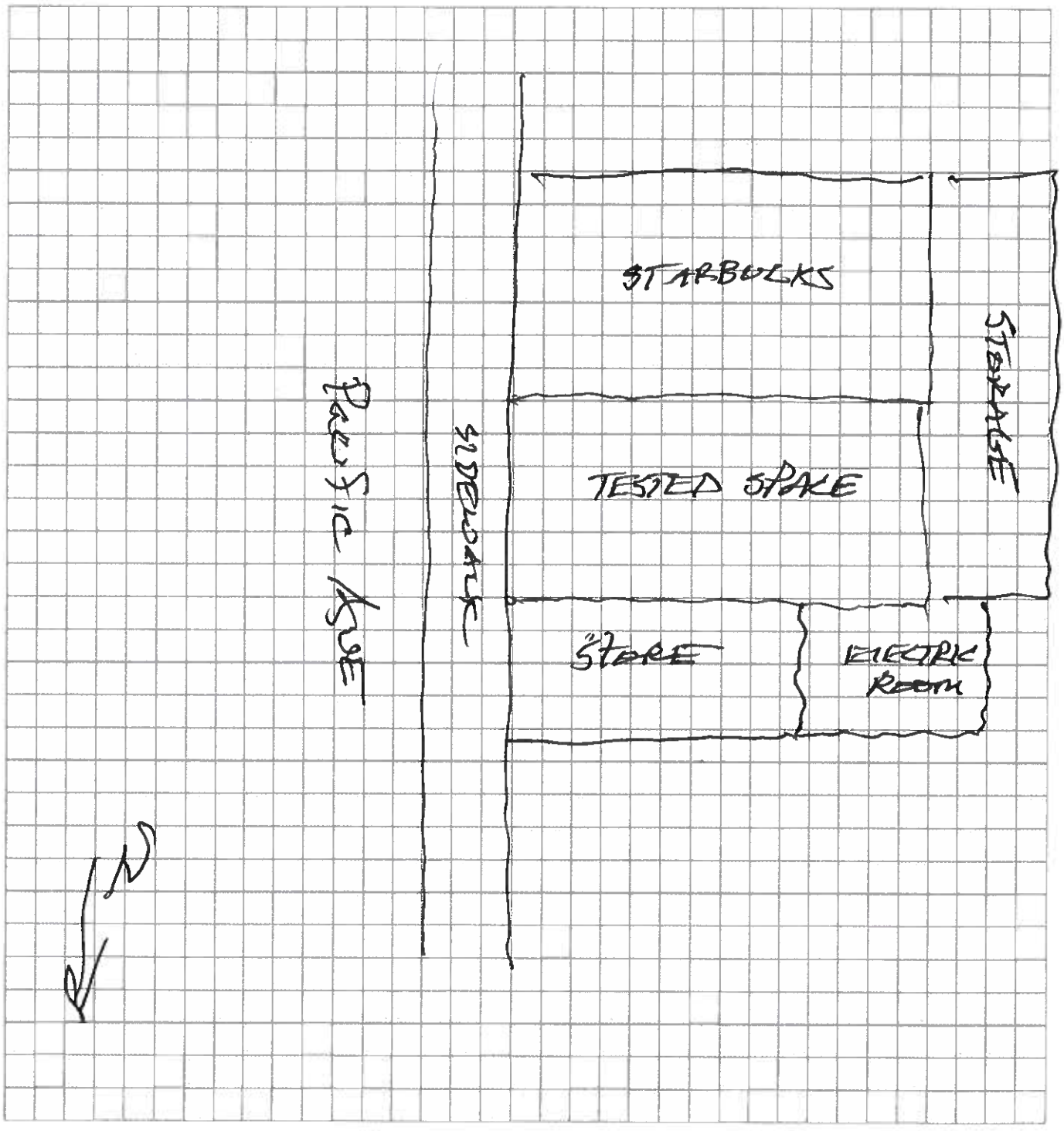
9. OUTDOOR PLOT (Draw a sketch of the area surrounding the house/building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s) and PID meter readings.)

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.



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.

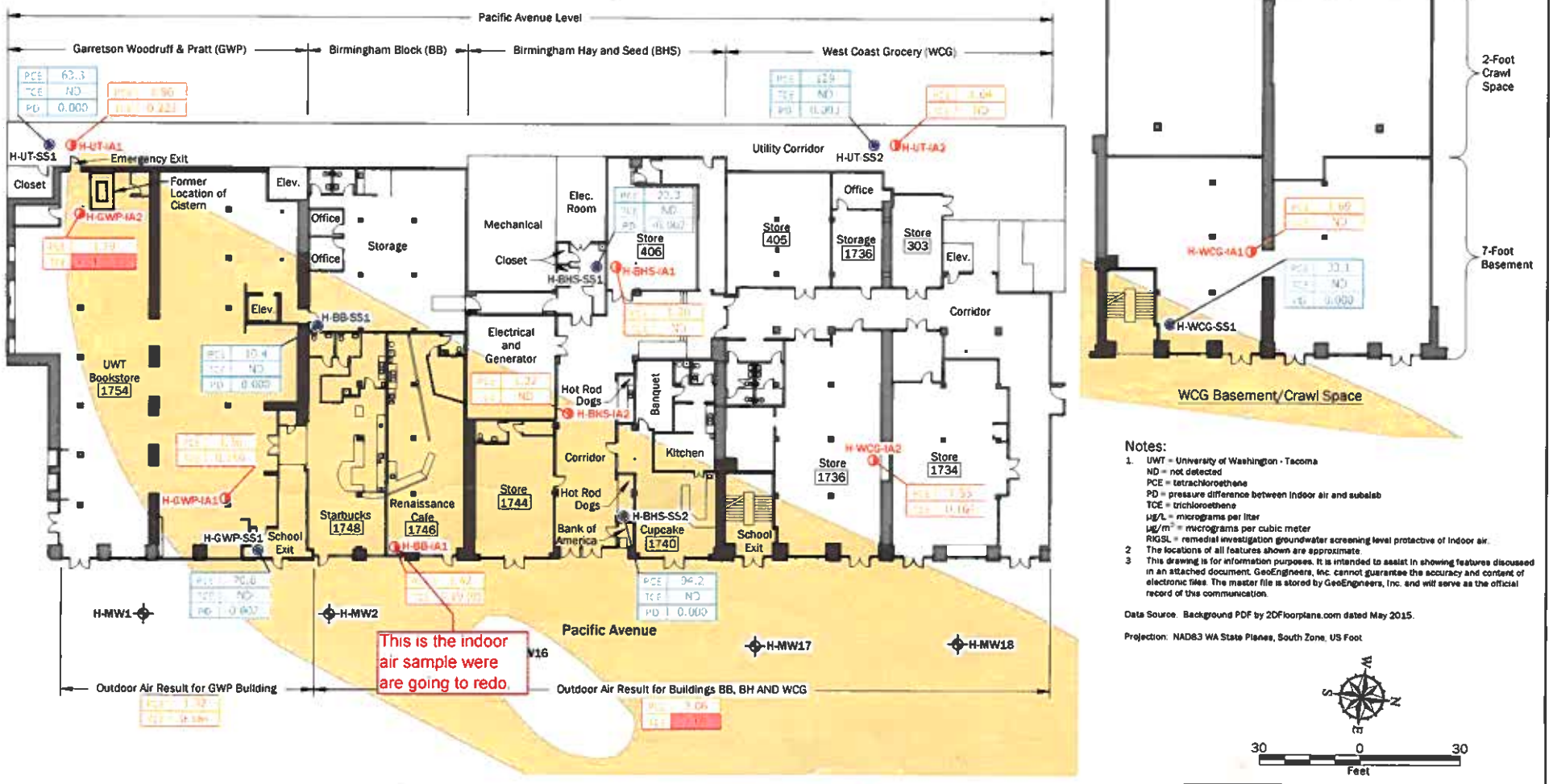


10. PRODUCT INVENTORY FORM Make & Model of field instrument used: None

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.



Notes:

1. UWT = University of Washington - Tacoma
   ND = not detected
   PCE = tetrachloroethene
   PD = pressure difference between indoor air and subslab
   TCE = trichloroethene
   µg/L = micrograms per liter
   µg/m³ = micrograms per cubic meter
   RIGSL = remedial investigation groundwater screening level protective of indoor air.
2. The locations of all features shown are approximate.
3. 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: Background PDF by 2DFloorplans.com dated May 2015.

Projection: NAD83 WA State Planes, South Zone, US Foot

30 0 30
Feet

Legend

- H-MW1 — Existing Monitoring Well
- H-WCG-SS3 — Subslab Vapor Sample
- H-WCG-IA4 — Indoor Air Sample
- March 2017 and May 2018 Approximate Lateral Extent of PCE Detected at Concentrations Greater Than RIGSL (5 µg/L)

Indoor Air Results / Subslab Results

- PCE Concentration in µg/m³
- TCE Concentration in µg/m³
- Pressure Differential in Inches of Water

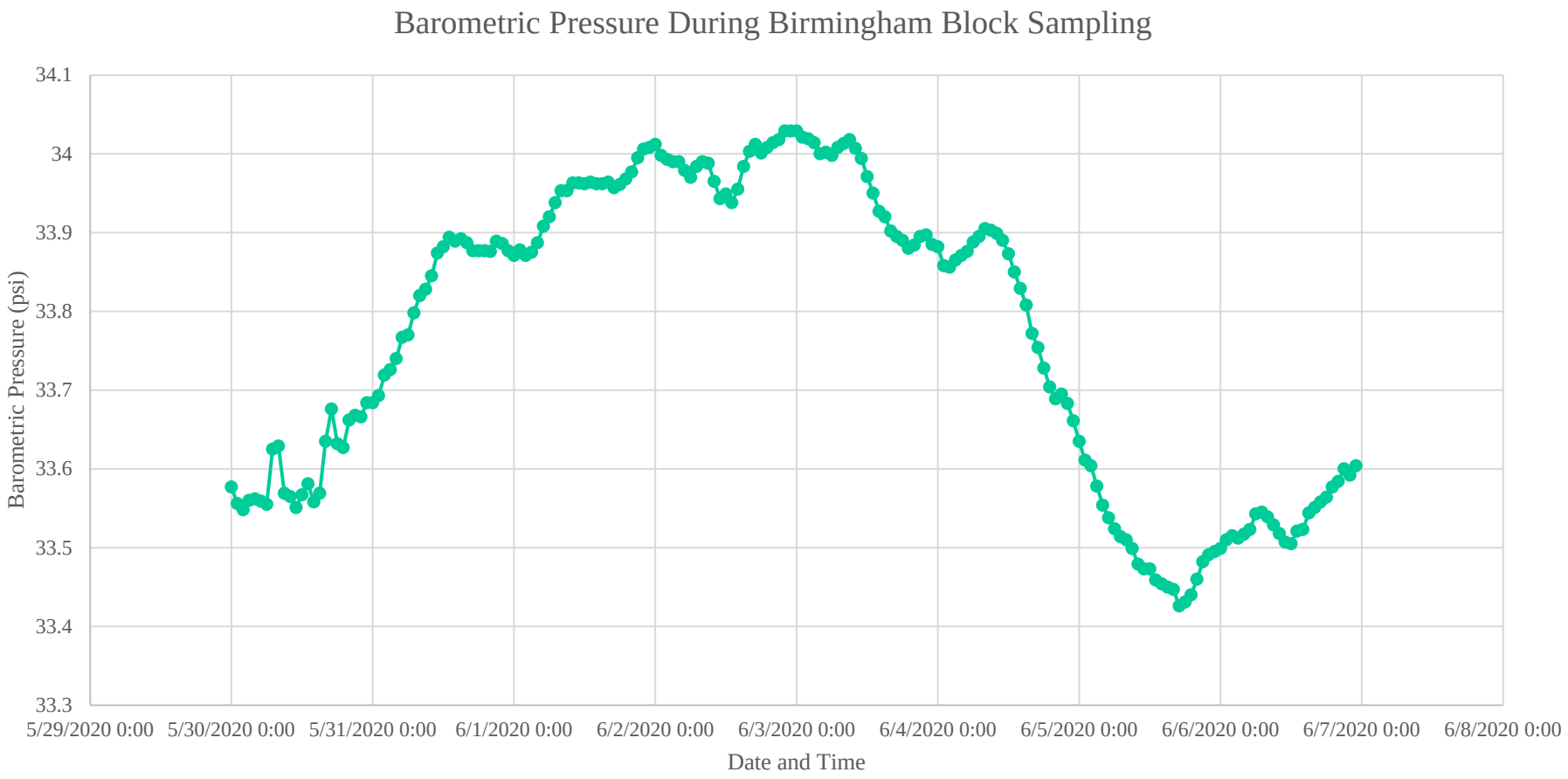
Text highlighted in red indicates detected concentration greater than MTCA Method B indoor air cleanup levels. Concentrations in parenthesis is the adjusted TCE concentration after outdoor air concentraion removed. TCE concentrations were only adjusted if the detected TCE concentration exceeded the MTCA Method B indoor air cleanup level.

UWT Building Site Plan
Chemical Analytical Results

Howe Vapor Intrusion Investigation
University of Washington - Tacoma
Tacoma, Washington

GeoEngineers | Figure 4

APPENDIX B
Barometric Pressure Graphs



Summary of Barometric Pressure During Air Sampling

Birmingham Block Resampling Event
University of Washington - Tacoma
Tacoma, Washington

GeoEngineers

Figure B-1

Notes:

Psi = pounds per square inch
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: INW Baroscout in GeoEngineers Tacoma office

APPENDIX C
Chemical Analytical Program

Data Validation Report

1101 Fawcett Avenue, Suite 200, Tacoma, Washington 98402, Telephone: 253.383.4940, Fax: 253.383.4923 www.geoengineers.com

Project: University of Washington – Tacoma, Howe Vapor Intrusion Evaluation
June 2020 Air Samples

GEI File No: 0183-109-10

Date: July 28, 2020

This report documents the results of a United States Environmental Protection Agency (USEPA)-defined Stage 2A data validation (USEPA Document 540-R-08-005; USEPA, 2009) of analytical data from the analyses of air samples collected as part of the June 2020 sampling event, and the associated laboratory quality control (QC) samples. The samples were obtained from the former Howe Parcel Site located at 1754 Pacific Avenue on the University of Washington – Tacoma (UWT) campus in Tacoma, Washington.

Objective and Quality Control Elements

GeoEngineers, Inc. (GeoEngineers) completed the data validation consistent with the USEPA Contract Laboratory Program National Functional Guidelines for Organic Superfund Methods Data Review (USEPA, 2017) (National Functional Guidelines) to determine if the laboratory analytical results meet the project objectives and are usable for their intended purpose. Data usability was assessed by determining if:

- The samples were analyzed using well-defined and acceptable methods that provide reporting limits below applicable regulatory criteria;
- The precision and accuracy of the data are well-defined and sufficient to provide defensible data; and
- The quality assurance/quality control (QA/QC) procedures utilized by the laboratory meet acceptable industry practices and standards.

The laboratory data was reviewed for the following QC elements:

- Data Package Completeness
- Chain-of-Custody Documentation
- Holding Times and Canister Vacuum/Pressure
- Surrogate Recoveries
- Method Blanks
- Matrix Spikes/Matrix Spike Duplicates
- Laboratory Control Samples/Laboratory Control Sample Duplicates
- Laboratory Duplicates

Validated Sample Delivery Groups

This data validation included review of the sample delivery group (SDG) listed below in Table 1.

TABLE 1: SUMMARY OF VALIDATED SAMPLE DELIVERY GROUPS

Laboratory SDG	Samples Validated
2006105	H-BB-IAIR, H-BBRoof-OA1, H-JoyRoof-OA1

Chemical Analysis Performed

Fremont Analytical, Inc. (Fremont), located in Seattle, Washington, performed laboratory analysis on the air samples using the following method:

- Volatile Organic Compounds (VOCs) by Method USEPA TO-15-SIM

Data Validation Summary

The results for each of the QC elements are summarized below.

Data Package Completeness

Fremont provided the required deliverables for the data validation according to the National Functional Guidelines. The laboratory followed adequate corrective action processes and the identified anomalies were discussed in the relevant laboratory case narrative.

Chain-of-Custody Documentation

Chain-of-custody (COC) forms were provided with the laboratory analytical reports. The COCs were accurate and complete when submitted to the laboratory.

Holding Times and Canister Vacuum/Pressure

The sample holding time is defined as the time that elapses between sample collection and sample analysis. Maximum holding time criteria exist for each analysis to help ensure that the analyte concentrations found at the time of analysis reflect the concentration present at the time of sample collection. Established holding times were met for the requested analysis.

The sample canisters are prepared at the laboratory with approximately 30 inches of mercury (inHg) vacuum. In the field, the sample canisters are filled for approximately 30 minutes or until a vacuum equivalent of approximately 5 inHg remains in the sample canister, whichever comes first.

There are two reasons for this:

- The more sample volume collected within the sample canister, the less inert nitrogen air that is added by the laboratory to create a necessary positive pressure within the sample canister (5 pounds per square inch), resulting in less dilution of the sample.
- Allows for determination of leakage (loss of sample volume) from the sample canister between the field and receipt at the laboratory.

The final canister vacuum is recorded in the field and by the laboratory upon receipt. In the field, the final vacuum on the sample canisters were generally between 8 and 10 inHg. At the laboratory, the final vacuum on the sample canisters were generally between 8 and 10 inHg. The final canister vacuums between the field and laboratory readings were acceptable within + or – 5 inHg and no anomalies were identified.

Surrogate Recoveries

A surrogate compound is a compound that is chemically similar to the organic analytes of interest, but unlikely to be found in an environmental sample. Surrogates are used for organic analyses and are added to the samples, standards, and blanks to serve as an accuracy and specificity check of each analysis. The surrogates are added to the samples at a known concentration and percent recoveries are calculated following analysis. The surrogate percent recoveries for field samples were within the laboratory control limits.

Method Blanks

Method blanks are analyzed to ensure that laboratory procedures and reagents do not introduce measurable concentrations of the analytes of interest. A method blank was analyzed with each batch of samples, at a frequency of 1 per 20 samples. For the sample batches, method blanks for the applicable methods were analyzed at the required frequency. None of the analytes of interest were detected above the reporting limits in the method blanks.

Matrix Spikes/Matrix Spike Duplicates

Since the actual analyte concentration in an environmental sample is not known, the accuracy of a particular analysis is usually inferred by performing a matrix spike (MS) analysis on one sample from the associated batch, known as the parent sample. One aliquot of the sample is analyzed in the normal manner and then a second aliquot of the sample is spiked with a known amount of analyte concentration and analyzed. From these analyses, a percent recovery is calculated. Matrix spike duplicate (MSD) analyses are generally performed for organic analyses as a precision check and analyzed in the same sequence as a matrix spike. Using the result values from the MS and MSD, the relative percent difference (RPD) is calculated. The percent recovery control limits for MS and MSD analyses are specified in the laboratory documents, as are the RPD control limits for MS/MSD sample sets.

The laboratory did not perform MS/MSD sample sets because the air sampling method USEPA TO-15-SIM does not require an internal accuracy and precision test sample aside from the LCS and laboratory duplicate samples.

Laboratory Control Samples/Laboratory Control Sample Duplicates

A laboratory control sample (LCS) is a blank sample that is spiked with a known amount of analyte and then analyzed. An LCS is similar to an MS, but without the possibility of matrix interference. Given that matrix interference is not an issue, the LCS/LCSD control limits for accuracy and precision are usually more rigorous than for MS/MSD analyses. Additionally, data qualification based on LCS/LCSD analyses would apply to the samples in the associated batch, instead of just the parent sample. The percent recovery control limits for LCS and LCSD analyses are specified in the laboratory documents, as are the RPD control limits for LCS/LCSD sample sets.

One LCS analysis should be performed for every analytical batch or every 20 field samples, whichever is more frequent. The frequency requirements were met for each analysis and the specified acceptance criteria were met.

Laboratory Duplicates

Internal laboratory duplicate analyses are performed to monitor the precision of the analyses. Two separate aliquots of a sample are analyzed as distinct samples in the laboratory and the RPD between the two results is calculated. Duplicate analyses should be performed once per analytical batch. If one or more of the samples used has a concentration less than five times the reporting limit for that sample, the absolute

difference is used instead of the RPD. The RPD control limits are specified in the laboratory documents. Laboratory duplicates were analyzed at the proper frequency and the specified acceptance criteria were met.

Overall Assessment

As was determined by this data validation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the surrogate and LCS percent recovery values. Precision was acceptable, as demonstrated by the laboratory duplicate RPD values.

No analytical results were qualified. All data are acceptable for the intended use.

References

U.S. Environmental Protection Agency (USEPA). "Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use," EPA-540-R-08-005. January 2009.

U.S. Environmental Protection Agency (USEPA). "Contract Laboratory Program National Functional Guidelines for Organic Superfund Methods Data Review," EPA-540-R-2017-002. January 2017.

3600 Fremont Ave. N.
Seattle, WA 98103
T: (206) 352-3790
F: (206) 352-7178
info@fremontanalytical.com

GeoEngineers - Tacoma
Tricia DeOme
1101 S Fawcett Ave
Tacoma, WA 98401

RE: UWT
Work Order Number: 2006105

June 24, 2020

Attention Tricia DeOme:

Fremont Analytical, Inc. received 4 sample(s) on 6/5/2020 for the analyses presented in the following report.

Volatile Organic Compounds-EPA Method TO-15 (SIM)

This report consists of the following:

- Case Narrative
- Analytical Results
- Applicable Quality Control Summary Reports
- Chain of Custody

All analyses were performed consistent with the Quality Assurance program of Fremont Analytical, Inc. Please contact the laboratory if you should have any questions about the results.

Thank you for using Fremont Analytical.

Sincerely,

Brianna Barnes
Project Manager

Fremont Analytical

Date: *06/24/2020*

CLIENT: GeoEngineers - Tacoma
Project: UWT
Work Order: 2006105

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Date/Time Collected	Date/Time Received
2006105-001	H-BB-IAIR	06/03/2020 12:36 PM	06/05/2020 7:50 AM
2006105-002	H-JoyRoof-OA1	06/03/2020 2:54 PM	06/05/2020 7:50 AM
2006105-003	H-BBRoof-OA1	06/03/2020 3:00 PM	06/05/2020 7:50 AM
2006105-004	17648		06/05/2020 7:50 AM

Note: If no "Time Collected" is supplied, a default of 12:00AM is assigned

Case Narrative

WO#: **2006105**
Date: **6/24/2020**

CLIENT: GeoEngineers - Tacoma
Project: UWT

I. SAMPLE RECEIPT:
Samples receipt information is recorded on the attached Sample Receipt Checklist.

II. GENERAL REPORTING COMMENTS:
Air samples are reported in ppbv and ug/m3.

The validity of the analytical procedures for which data is reported in this analytical report is determined by the Laboratory Control Sample (LCS) and the Method Blank (MB). The LCS and the MB are processed with the samples to ensure method criteria are achieved throughout the entire analytical process.

III. ANALYSES AND EXCEPTIONS:
Exceptions associated with this report will be footnoted in the analytical results page(s) or the quality control summary page(s) and/or noted below.

Standard temperature and pressure assumes 24.45 = (25C and 1 atm).

6/24/2020: Revision 1 includes additional analysis requested by client.

Qualifiers:

* - Flagged value is not within established control limits
B - Analyte detected in the associated Method Blank
D - Dilution was required
E - Value above quantitation range
H - Holding times for preparation or analysis exceeded
I - Analyte with an internal standard that does not meet established acceptance criteria
J - Analyte detected below Reporting Limit
N - Tentatively Identified Compound (TIC)
Q - Analyte with an initial or continuing calibration that does not meet established acceptance criteria (<20%RSD, <20% Drift or minimum RRF)
S - Spike recovery outside accepted recovery limits
ND - Not detected at the Reporting Limit
R - High relative percent difference observed

Acronyms:

%Rec - Percent Recovery
CCB - Continued Calibration Blank
CCV - Continued Calibration Verification
DF - Dilution Factor
HEM - Hexane Extractable Material
ICV - Initial Calibration Verification
LCS/LCSD - Laboratory Control Sample / Laboratory Control Sample Duplicate
MB or MBLANK - Method Blank
MDL - Method Detection Limit
MS/MSD - Matrix Spike / Matrix Spike Duplicate
PDS - Post Digestion Spike
Ref Val - Reference Value
RL - Reporting Limit
RPD - Relative Percent Difference
SD - Serial Dilution
SGT - Silica Gel Treatment
SPK - Spike
Surr - Surrogate

Client: GeoEngineers - Tacoma
WorkOrder: 2006105
Project: UWT

Client Sample ID: H-BB-IAIR
Lab ID: 2006105-001A
Sample Type: Summa Canister

Date Sampled: 6/3/2020
Date Received: 6/5/2020

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Analyte	Concentration (ppbv)	Concentration (ug/m³)	Reporting Limit (ppbv)	Reporting Limit (ug/m³)	Qual	Method	Date/Analyst
1,1-Dichloroethene (DCE)	<0.00900	<0.0357	0.00900	0.0357		EPA-TO-15SIM	06/12/2020 IH
cis-1,2-Dichloroethene	<0.0200	<0.0793	0.0200	0.0793		EPA-TO-15SIM	06/12/2020 IH
Tetrachloroethene (PCE)	<0.0500	<0.339	0.0500	0.339		EPA-TO-15SIM	06/12/2020 IH
trans-1,2-Dichloroethene	<0.00600	<0.0238	0.00600	0.0238		EPA-TO-15SIM	06/12/2020 IH
Trichloroethene (TCE)	<0.0170	<0.0914	0.0170	0.0914		EPA-TO-15SIM	06/12/2020 IH
Vinyl chloride	<0.0850	<0.217	0.0850	0.217		EPA-TO-15SIM	06/12/2020 IH
Surr: 4-Bromofluorobenzene	91.5 %Rec	--	70-130	--		EPA-TO-15SIM	06/12/2020 IH

Client: GeoEngineers - Tacoma
WorkOrder: 2006105
Project: UWT

Client Sample ID: H-JoyRoof-OA1
Lab ID: 2006105-002A
Sample Type: Summa Canister

Date Sampled: 6/3/2020
Date Received: 6/5/2020

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Analyte	Concentration (ppbv)	Concentration (ug/m³)	Reporting Limit (ppbv)	Reporting Limit (ug/m³)	Qual	Method	Date/Analyst	
1,1-Dichloroethene (DCE)	<0.00900	<0.0357	0.00900	0.0357		EPA-TO-15SIM	06/12/2020	IH
cis-1,2-Dichloroethene	<0.0200	<0.0793	0.0200	0.0793		EPA-TO-15SIM	06/12/2020	IH
Tetrachloroethene (PCE)	<0.0500	<0.339	0.0500	0.339		EPA-TO-15SIM	06/12/2020	IH
trans-1,2-Dichloroethene	<0.00600	<0.0238	0.00600	0.0238		EPA-TO-15SIM	06/12/2020	IH
Trichloroethene (TCE)	<0.0170	<0.0914	0.0170	0.0914		EPA-TO-15SIM	06/12/2020	IH
Vinyl chloride	<0.0850	<0.217	0.0850	0.217		EPA-TO-15SIM	06/12/2020	IH
Surr: 4-Bromofluorobenzene	89.1 %Rec	--	70-130	--		EPA-TO-15SIM	06/12/2020	IH

Client: GeoEngineers - Tacoma
WorkOrder: 2006105
Project: UWT

Client Sample ID: H-BBRoof-OA1
Lab ID: 2006105-003A
Sample Type: Summa Canister

Date Sampled: 6/3/2020
Date Received: 6/5/2020

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Analyte	Concentration (ppbv)	Concentration (ug/m³)	Reporting Limit (ppbv)	Reporting Limit (ug/m³)	Qual	Method	Date/Analyst	
1,1-Dichloroethene (DCE)	<0.00900	<0.0357	0.00900	0.0357		EPA-TO-15SIM	06/24/2020	AD
cis-1,2-Dichloroethene	<0.0200	<0.0793	0.0200	0.0793		EPA-TO-15SIM	06/24/2020	AD
Tetrachloroethene (PCE)	<0.0500	<0.339	0.0500	0.339		EPA-TO-15SIM	06/24/2020	AD
trans-1,2-Dichloroethene	<0.00600	<0.0238	0.00600	0.0238		EPA-TO-15SIM	06/24/2020	AD
Trichloroethene (TCE)	<0.0170	<0.0914	0.0170	0.0914		EPA-TO-15SIM	06/24/2020	AD
Vinyl chloride	<0.0850	<0.217	0.0850	0.217		EPA-TO-15SIM	06/24/2020	AD
Surr: 4-Bromofluorobenzene	81.7 %Rec	--	70-130	--		EPA-TO-15SIM	06/24/2020	AD

Work Order: 2006105
CLIENT: GeoEngineers - Tacoma
Project: UWT

QC SUMMARY REPORT

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Sample ID: **LCS-R60058**	SampType: **LCS**	Units: **ppbv**	Prep Date: **6/24/2020**	RunNo: **60058**
Client ID: **LCSW**	Batch ID: **R60058**		Analysis Date: **6/24/2020**	SeqNo: **1202510**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Vinyl chloride	1.96	0.0850	2.000	0	97.9	70	130				
1,1-Dichloroethene (DCE)	1.81	0.00900	2.000	0	90.5	70	130				
trans-1,2-Dichloroethene	1.83	0.00600	2.000	0	91.7	70	130				
cis-1,2-Dichloroethene	1.71	0.0200	2.000	0	85.3	70	130				
Trichloroethene (TCE)	1.68	0.0170	2.000	0	84.2	70	130				
Tetrachloroethene (PCE)	1.82	0.0500	2.000	0	91.0	70	130				
Surr: 4-Bromofluorobenzene	4.14		4.000		104	70	130				

Sample ID: **MB-R60058**	SampType: **MBLK**	Units: **ppbv**	Prep Date: **6/24/2020**	RunNo: **60058**
Client ID: **MBLKW**	Batch ID: **R60058**		Analysis Date: **6/24/2020**	SeqNo: **1202511**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Vinyl chloride	ND	0.0850									
1,1-Dichloroethene (DCE)	ND	0.00900									
trans-1,2-Dichloroethene	ND	0.00600									
cis-1,2-Dichloroethene	ND	0.0200									
Trichloroethene (TCE)	ND	0.0170									
Tetrachloroethene (PCE)	ND	0.0500									
Surr: 4-Bromofluorobenzene	3.26		4.000		81.4	70	130				

Sample ID: **2006105-003AREP**	SampType: **REP**	Units: **ppbv**	Prep Date: **6/24/2020**	RunNo: **60058**
Client ID: **H-BBRoof-OA1**	Batch ID: **R60058**		Analysis Date: **6/24/2020**	SeqNo: **1202513**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Vinyl chloride	ND	0.0850						0		30	
1,1-Dichloroethene (DCE)	ND	0.00900						0		30	
trans-1,2-Dichloroethene	ND	0.00600						0		30	
cis-1,2-Dichloroethene	ND	0.0200						0		30	
Trichloroethene (TCE)	ND	0.0170						0		30	
Tetrachloroethene (PCE)	ND	0.0500						0		30	

Work Order: 2006105
CLIENT: GeoEngineers - Tacoma
Project: UWT

QC SUMMARY REPORT

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Sample ID: **2006105-003AREP** SampType: **REP** Units: **ppbv** Prep Date: **6/24/2020** RunNo: **60058**
Client ID: **H-BBRoof-OA1** Batch ID: **R60058** Analysis Date: **6/24/2020** SeqNo: **1202513**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	3.22		4.000		80.4	70	130		0		

Work Order: 2006105
CLIENT: GeoEngineers - Tacoma
Project: UWT

QC SUMMARY REPORT

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Sample ID: **LCS-R59826**	SampType: **LCS**	Units: **ppbv**	Prep Date: **6/12/2020**	RunNo: **59826**
Client ID: **LCSW**	Batch ID: **R59826**		Analysis Date: **6/12/2020**	SeqNo: **1197307**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Vinyl chloride	1.90	0.0850	2.000	0	94.9	70	130				
1,1-Dichloroethene (DCE)	1.69	0.00900	2.000	0	84.5	70	130				
trans-1,2-Dichloroethene	1.90	0.00600	2.000	0	94.9	70	130				
cis-1,2-Dichloroethene	1.84	0.0200	2.000	0	92.2	70	130				
Trichloroethene (TCE)	1.88	0.0170	2.000	0	93.8	70	130				
Tetrachloroethene (PCE)	1.93	0.0500	2.000	0	96.6	70	130				
Surr: 4-Bromofluorobenzene	4.00		4.000		100	70	130				

Sample ID: **MB-R59826**	SampType: **MBLK**	Units: **ppbv**	Prep Date: **6/12/2020**	RunNo: **59826**
Client ID: **MBLKW**	Batch ID: **R59826**		Analysis Date: **6/12/2020**	SeqNo: **1197308**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Vinyl chloride	ND	0.0850									
1,1-Dichloroethene (DCE)	ND	0.00900									
trans-1,2-Dichloroethene	ND	0.00600									
cis-1,2-Dichloroethene	ND	0.0200									
Trichloroethene (TCE)	ND	0.0170									
Tetrachloroethene (PCE)	ND	0.0500									
Surr: 4-Bromofluorobenzene	3.63		4.000		90.7	70	130				

Sample ID: **2006105-001AREP**	SampType: **REP**	Units: **ppbv**	Prep Date: **6/12/2020**	RunNo: **59826**
Client ID: **H-BB-IAIR**	Batch ID: **R59826**		Analysis Date: **6/12/2020**	SeqNo: **1197310**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Vinyl chloride	ND	0.0850						0		30	
1,1-Dichloroethene (DCE)	ND	0.00900						0		30	
trans-1,2-Dichloroethene	ND	0.00600						0		30	
cis-1,2-Dichloroethene	ND	0.0200						0		30	
Trichloroethene (TCE)	ND	0.0170						0		30	
Tetrachloroethene (PCE)	ND	0.0500						0		30	

Work Order: 2006105
CLIENT: GeoEngineers - Tacoma
Project: UWT

QC SUMMARY REPORT

Volatile Organic Compounds-EPA Method TO-15 (SIM)

Sample ID: **2006105-001AREP** SampType: **REP** Units: **ppbv** Prep Date: **6/12/2020** RunNo: **59826**
Client ID: **H-BB-IAIR** Batch ID: **R59826** Analysis Date: **6/12/2020** SeqNo: **1197310**

Analyte	Result	RL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	RPD Ref Val	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	3.65		4.000		91.4	70	130		0		

Sample Log-In Check List

Client Name:	**GEIT**	Work Order Number:	**2006105**
Logged by:	**Clare Griggs**	Date Received:	**6/5/2020 7:50:00 AM**

Chain of Custody

1.	Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
2.	How was the sample delivered?	Client		

Log In

3.	Coolers are present?	Yes ☐	No ☑	NA ☐
		Air Samples		
4.	Shipping container/cooler in good condition?	Yes ☑	No ☐	
5.	Custody Seals present on shipping container/cooler? (Refer to comments for Custody Seals not intact)	Yes ☐	No ☐	Not Present ☑
6.	Was an attempt made to cool the samples?	Yes ☐	No ☐	NA ☑
7.	Were all items received at a temperature of >2°C to 6°C *	Yes ☐	No ☐	NA ☑
8.	Sample(s) in proper container(s)?	Yes ☑	No ☐	
9.	Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
10.	Are samples properly preserved?	Yes ☑	No ☐	
11.	Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
12.	Is there headspace in the VOA vials?	Yes ☐	No ☐	NA ☑
13.	Did all samples containers arrive in good condition(unbroken)?	Yes ☑	No ☐	
14.	Does paperwork match bottle labels?	Yes ☑	No ☐	
15.	Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
16.	Is it clear what analyses were requested?	Yes ☑	No ☐	
17.	Were all holding times able to be met?	Yes ☑	No ☐	

Special Handling (if applicable)

18.	Was client notified of all discrepancies with this order?	Yes ☐	No ☐	NA ☑

Person Notified: _____ Date: _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

19. Additional remarks:

Item Information

* Note: DoD/ELAP and TNI require items to be received at 4°C +/- 2°C

Air Chain of Custody Record & Laboratory Services Agreement

Fremont Analytical
3600 Fremont Ave N.
Seattle, WA 98103
Tel: 206-352-3790
Fax: 206-352-7178

Date: 6/3/20 Page: 1 of: 1

Laboratory Project No (Internal): 2006105

Project Name: DLST

Special Remarks:

Client: GeoEngineers

Project No: 0183-109-10

Address: 1101 Fawcett Ave Suite

Location: TACOMA, WA

City, State, Zip: TACOMA, WA 98402

Collected by: PAUL ROBICHETTE

Telephone: 253-383-4940

Reports to (PM): TRICIA DeDone

Air samples are disposed of one week after report is submitted to client unless otherwise requested. ☐ OK to Dispose ☐ Hold (fees may apply)

Fax: 253-383-4923

Email (PM): tdedone@geoengineers.com

	Sample Name	Canister / Flow Reg Serial #	Sample Date & Time	Sample Type (Matrix) *	Container Type **	Fill Time / Flow Rate	Internal: Initial Evacuation Pressure (mtorr)	Field Initial Sample Pressure ("Hg)	Field Final Sample Pressure ("Hg)	Analysis: VOCs TO15 SCAN	VOCs TO15 SCAN LL	VOCs TO15 SIM	Siloxanes TO15	Sulfur TO15	Sulfur Ext. TO15	APH TO15	Helium	Major Gases 3C	Comments	Internal: Final Pressure ("Hg)
1	H-BB-1AIR	32813 Canister / FR8-15 Flow Reg	6/3/20 Date / 1236 Time	IA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-8 Pressure / 6/3 Date			X							PCE, TCE, 1,1-DCE, cis-1,2-DCE trans-1,2-DCE, vinyl chloride	-8
2	—	17648 Canister / FR8-30 Flow Reg	Date / Time		6L	8 hr	10mtorr Pressure / 5/22/2020 Date	Pressure / Date	Pressure / Date											-20
3	H-BB, BHS-WCG-OAIR	15901 Canister / FR8-09 Flow Reg	6/3/20 Date / 1454 Time	AA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-8 Pressure / 6/3 Date			X								-8
4	H-GWP-OAIR	15425 Canister / FR8-20 Flow Reg	6/3/20 Date / 1500 Time	AA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-10 Pressure / 6/3 Date			X								-10
5		Canister / Flow Reg	Date / Time				Pressure / Date	Pressure / Date	Pressure / Date											

* Matrix Codes: AA = Ambient Air IA = Indoor Air L = Landfill S = Subslab / Soil Gas

** Container Codes: BV = 1 Liter Bottle Vac 6L = 6L Canister 1L = 1L Canister CYL = High Pressure Cylinder F = Filter S = Sorbent Tube TB = Tedlar Bag

I represent that I am authorized to enter into this Agreement with Fremont Analytical on behalf of the Client named above, that I have verified Client's agreement to each of the terms on the front and backside of this Agreement.

Turn-Around Time:
- [x] Standard
- [ ] 3 Day
- [ ] 2 Day
- [ ] Next Day
- Same Day ____ (specify)

Relinquished	Date/Time	Received	Date/Time
x	6/4/20	x	6/4/20
Relinquished	Date/Time	Received	Date/Time
x		x	6/5/20 0250

Air Chain of Custody Record & Laboratory Services Agreement

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3600 Fremont Ave N.
Seattle, WA 98103
Tel: 206-352-3790
Fax: 206-352-7178

Date: 6/3/20 Page: 1 of: 1

Laboratory Project No (Internal): 2006105

Project Name: DLST

Special Remarks: edits per T.D. 6/8/20 -cg

Project No: 0183-109-10

Client: GeoEngineers

Address: 1101 Fawcett Ave Suite

Location: TACOMA, WA

City, State, Zip: TACOMA, WA 98402

Collected by: PAUL ROBICHETTE

Telephone: 253-383-4940

Reports to (PM): TRICIA DeDone

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Email (PM): tdedone@geoengineers.com

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1	H-BB-1AIR	32813 Canister / FR8-15 Flow Reg	6/3/20 Date / 1236 Time	IA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-8 Pressure / 6/3 Date			X							PCE, TCE, 1,1-DCE, cis-1,2-DCE trans-1,2-DCE, vinyl chloride	-8
2	"H-JoyRoof-OA1"	17648 Canister / FR8-30	Date / Time		6L	8 hr	10mtorr Pressure / 5/22/2020 Date	Pressure / Date	Pressure / Date											-20
3	~~H-BB, BHS-WC6-OAIR~~	15901 Canister / FR8-09 Flow Reg	6/3/20 Date / 1454 Time	AA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-8 Pressure / 6/3 Date			X								-8
4	~~H-GLof-OAIR~~ "H-BBRoof-OA1"	15425 Canister / FR8-20 Flow Reg	6/3/20 Date / 1500 Time	AA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-10 Pressure / 6/3 Date			X							ON HOLD	-10
5		Canister / Flow Reg	Date / Time				Pressure / Date	Pressure / Date	Pressure / Date											

* Matrix Codes: AA = Ambient Air IA = Indoor Air L = Landfill S = Subslab / Soil Gas

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- Same Day ____ (specify)

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x	6/4/20	x	6/4/20
Relinquished	Date/Time	Received	Date/Time
x		x	6/5/20 0250

Air Chain of Custody Record & Laboratory Services Agreement

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3600 Fremont Ave N.
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Tel: 206-352-3790
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Date: 6/3/20 Page: 1 of: 1

Laboratory Project No (Internal): 2006105

Project Name: DLST

Special Remarks: edits per T.D. 6/8/20 -cg

Project No: 0183-109-10

Client: GeoEngineers

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Telephone: 253-383-4940

Fax: 253-383-4923

Location: TACOMA, WA

Collected by: PAUL ROBICHETTE

Reports to (PM): TRICIA DeDone

Email (PM): tdedone@geoengineers.com

Analyze "H-BBRoof-OA1" per T.D. 6/19/2020 -BB

Air samples are disposed of one week after report is submitted to client unless otherwise requested. ☐ OK to Dispose ☐ Hold (fees may apply)

	Sample Name	Canister / Flow Reg Serial #	Sample Date & Time	Sample Type (Matrix) *	Container Type **	Fill Time / Flow Rate	Internal: Initial Evacuation Pressure (mtorr)	Internal: Field Initial Sample Pressure ("Hg)	Internal: Field Final Sample Pressure ("Hg)	Analysis: VOCs TO15 SCAN	VOCs TO15 SCAN LL	VOCs TO15 SIM	Siloxanes TO15	Sulfur TO15	Sulfur Ext. TO15	APH TO15	Helium	Major Gases 3C	Comments	Internal: Final Pressure ("Hg)
1	H-BB-1AIR	32813 Canister / FR8-15 Flow Reg	6/3/20 Date / 1236 Time	IA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-8 Pressure / 6/3 Date			X							PCE, TCE, 1,1-DCE, cis-1,2-DCE trans-1,2-DCE, vinyl chloride	-8
2	"H-JoyRoof-OA1"	17648 Canister / FR8-30	Date / Time		6L	8 hr	10mtorr Pressure / 5/22/2020 Date	Pressure / Date	Pressure / Date											-20
3	~~H-BB, BHS-WC6-OAIR~~	15901 Canister / FR8-09 Flow Reg	6/3/20 Date / 1454 Time	AA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-8 Pressure / 6/3 Date			X								-8
4	~~H-GLOF-OAIR~~ "H-BBRoof-OA1"	15425 Canister / FR8-20 Flow Reg	6/3/20 Date / 1500 Time	AA	6L	8 hr	10mtorr Pressure / 5/22/2020 Date	-30 Pressure / 6/3 Date	-10 Pressure / 6/3 Date			X							~~ON HOLD~~	-10
5		Canister / Flow Reg	Date / Time				Pressure / Date	Pressure / Date	Pressure / Date											

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x	6/4/20	x	6/4/20
Relinquished	Date/Time	Received	Date/Time
x		x	6/5/20 0250

APPENDIX D
Report Limitations and Guidelines for Use

APPENDIX D
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report. Please confer with GeoEngineers if you need to know more about how these "Report Limitations and Guidelines for Use" apply to your project or property.

Read These Provisions Closely

It is important to recognize that environmental engineering and geoscience practices (geotechnical engineering, geology and environmental science) are less exact than other engineering and natural science disciplines. GeoEngineers includes these explanatory "limitations" provisions in our reports to help reduce the risk of misunderstandings or unrealistic expectations that lead to disappointments, claims and disputes.

Environmental Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for the exclusive use of University of Washington. This report is not intended for use by others, and the information contained herein is not applicable to other properties.

GeoEngineers structures its services to meet the specific needs of its clients. For example, an ESA study conducted for a property owner may not fulfill the needs of a prospective purchaser of the same property. Because each environmental study is unique, each environmental report is unique, prepared solely for the specific client and property. Use of this report is not recommended for any purpose or project other than as expressly stated in this report.

This Environmental Report is Based on a Unique Set of Project-Specific Factors

This report has been prepared for the vapor intrusion (VI) evaluation at the University of Washington – Tacoma (UWT) building Birmingham Block building in Tacoma, Washington. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this Project. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your Project,
- not prepared for the specific site explored, or
- completed before Project changes were made.

If changes to the Project or property occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations in the context of such changes. Based on that review, we can provide written modifications or confirmation, as appropriate.

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1 Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

Reliance Conditions for Third Parties

This report was prepared for the exclusive use of the party(ies) to whom this report is addressed. No other party may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed Project scope, schedule and budget, our services have been executed in accordance with our Agreement with the Client and generally accepted environmental practices in this area at the time this report was prepared.

Understand That Geotechnical Issues Have Not Been Addressed

Unless geotechnical engineering was specifically included in our scope of service, this report does not provide any geotechnical findings, conclusions, or recommendations, including but not limited to, the suitability of subsurface materials for construction purposes.

Do Not Separate Documentation from the Report

Environmental reports often include supplemental documentation, such as maps, figures and table. Do not separate such documentation from the report. Further, do not, and do not permit any other party to redraw or modify any of the supplemental documentation for incorporation into other professionals' instruments of service.

Environmental Regulations Change and Evolve

Some substances may be present in the vicinity of the subject property in quantities or under conditions that may have led, or may lead, to contamination of the subject property, but are not included in current local, state or federal regulatory definitions of hazardous substances or do not otherwise present current potential liability. GeoEngineers cannot be responsible if the standards for appropriate inquiry, or regulatory definitions of hazardous substances, change or if more stringent environmental standards are developed in the future.

Uncertainty May Remain Even After This Investigation is Completed

Performance of an investigation is intended to reduce uncertainty regarding the potential for contamination in connection with a property, but no investigation can wholly eliminate that uncertainty. Our interpretation of subsurface conditions in this study is based on field observations and chemical analytical data from widely spaced sampling locations. It is always possible that contamination exists in areas that were not explored, sampled or analyzed.

Subsurface Conditions Can Change

This environmental report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the subject property, by new releases of hazardous substances, new information or technology that become available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. Please contact GeoEngineers before applying this report for its intended purpose so that GeoEngineers may evaluate whether changed conditions affect the continued applicability of the report.

Soil and Groundwater End Use

The cleanup levels referenced in this report are site- and situation-specific. The cleanup levels may not be applicable for other properties or for other on-site uses of the affected soil and/or groundwater. Note that hazardous substances may be present in some of the on-site soil, vapor and/or groundwater at detectable concentrations that are less than the referenced cleanup levels. GeoEngineers should be contacted prior to the export of soil or groundwater from the subject property or reuse of the affected soil or groundwater on-site to evaluate the potential for associated environmental liabilities. GeoEngineers will not assume responsibility for potential environmental liability arising out of the transfer of soil and/or groundwater from the subject property to another location, or the reuse of such soil and/or groundwater on-site in any instances that we did not recommend, know of, or control.

Most Environmental Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations and chemical analytical data from widely spaced sampling locations at the subject property. Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions throughout the property. Actual subsurface conditions may differ significantly from those indicated in this report. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Do Not Redraw the Exploration Logs

Environmental scientists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in an environmental report should never be redrawn for inclusion in other design documents. Only photographic or electronic reproduction that preserves the entire original boring log is acceptable, but separating logs from the report can create increase the risk of potential misinterpretation.

Biological Pollutants

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this Project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.