1201 3rd Avenue, Suite 2600
Seattle, Washington 98101
206.287.9130

ANCHOR QEA

Memorandum

October 5, 2020

To: Dale Myers, Washington State Department of Ecology

From: Stephen Strehl; Halah Voges, PE; and Nathan Soccorsy

cc: Clara Chen and Hubert Chen, Tahn Associates, LLC

Re: Vapor Intrusion Evaluation: Carson Cleaners, Inc.

1 Introduction

As part of an environmental cleanup of the former Chevron 90129 gas station located at 4700 Brooklyn Avenue NE in Seattle, Washington, chlorinated volatile organic compounds (CVOCs) were discovered in the southwest portion of the Chevron property and its perimeter along NE 47th Street. In a letter dated November 7, 2019 (Appendix A), the Washington State Department of Ecology (Ecology) subsequently asked Tahn Associates, LLC, the current owner of the property located at 4701 Brooklyn Avenue NE that formerly operated as a dry cleaner under the name Carson Cleaners, Inc. (Carson Cleaners), to investigate potential Vapor Intrusion (VI) risks at the following four Subject Properties depicted in Figure 1:

- Former Carson Cleaners facility, located at 4701 Brooklyn Avenue NE (Ecology Facility/Site No. 15518216; CSID 14878)
- Christ Episcopal Church, located at 4548 Brooklyn Avenue NE
- Bank of America Financial Center, located at 4701 University Way NE
- Mixed commercial and residential unit, located at 4557 University Way NE

In accordance with the Ecology request, a VI Evaluation Work Plan (VI WP) was prepared on behalf of Tahn Associates, LLC, by Anchor QEA and approved by Ecology on January 14, 2020 (Anchor QEA 2020a). The VI WP detailed the characterization methods for ambient and indoor air, and shallow and sub-slab soil gas at the Subject Properties. Implementation of the VI WP was delayed as a result of the global COVID-19 pandemic.

Reconnaissance of the Subject Properties was required to determine the actual sampling locations. A VI WP Addendum (Anchor QEA 2020b) was submitted to Ecology dated June 30, 2020. The VI WP Addendum described the reconnaissance conducted on May 28, 2020, and proposed sample locations for Ecology's review and approval. Immediately following Ecology's approval of the VI WP Addendum on July 7, 2020, sampling coordination activities commenced to implement the utility locating, sampling, and analysis in accordance with the approved VI WP and VI WP Addendum.

2 Field Activities Summary

This section describes the utility clearance event and the sampling activities to collect indoor air, ambient air, sub-slab soil gas, and shallow exterior soil gas samples at the Subject Properties. Sampling locations are shown in Figure 2.

2.1 Utility Clearance

Before field activities commenced, all proposed exterior soil boring and interior sub-slab soil gas locations were checked for underground utilities. On July 20, 2020, APS Locators, a professional underground utility locator licensed in the state of Washington, used ground-penetrating radar and passive utility-locating devices and cleared the locations for drilling.

Based on the location of identified utilities, the proposed exterior boring location at the mixed commercial and residential unit was moved from the northern end of the alleyway to a location approximately 40 feet south and 3 feet into the alleyway from the east wall of the Christ Episcopal Church property.

2.2 Sampling Activities

The installation of sub-slab soil gas vapor pins, sampling of sub-slab soil gas, and sampling of indoor air were performed on July 23, 2020, at the target locations at the Subject Properties. As detailed in the VI WP, sub-slab soil gas vapor pins were not installed at the Bank of America Financial Center.

The shallow exterior soil gas drilling activities and ambient air sampling were performed on July 24, 2020, at the target locations at the Subject Properties. Despite the relocation process described earlier in the utility clearance section, the exterior soil gas sampling location did not ultimately allow enough clearance from utilities based on discussion with the drillers in the field to safely advance a boring. Therefore, as a deviation from the approved VI WP, no exterior shallow soil gas boring was advanced in the alleyway. All other shallow exterior soil gas samples were advanced at the approved target locations.

Sample types, locations, and nomenclature at each of the Subject Properties are summarized as follows:

- Christ Episcopal Church: Sub-slab soil gas sample SS-01, indoor air sample IA-01, exterior soil gas sample SG-01
- Mixed commercial and residential unit: Sub-slab soil gas sample SS-02, indoor air sample IA-02
- Former Carson Cleaners facility: Sub-slab soil gas sample SS-03, indoor air sample IA-03, exterior soil gas sample SG-03, and ambient air sample AA-01
- Bank of America Financial Center: Indoor air sample IA-04, exterior soil gas sample SG-04

Samples were submitted to ALS Environmental and were analyzed for the analytes specified in the VI WP (Anchor QEA 2020a).

2.3 Site Geology Observations

Soil types observed during the exterior soil gas drilling activities included fill material, consisting primarily of brown poorly sorted fine to coarse sand, some fine to medium silty sand, and fine to medium sub-rounded gravels to 5 feet below ground surface. No native material was encountered. Neither the groundwater table nor perched groundwater were encountered during the drilling activities.

3 Data Quality Assessment

All vapor data were validated according to Level 2A guidelines by Anchor QEA. All laboratory quality control sample results were within laboratory control limits. Data qualifiers were applied to the data during final validation as applicable. No data were rejected based on validation results, and all data are acceptable as reported and usable as qualified. Data validation reports are included in Appendix B.

4 Sampling Results

This section summarizes the investigation results, including indoor air, ambient air, and soil vapor analytical results. Sampling locations are shown in Figure 2 and laboratory reports are included in Appendix C.

4.1 Indoor Air Results

Complete indoor air analytical results are presented in Table 1 and summarized as follows:

- None of the indoor air samples exceeded Model Toxics Control Act (MTCA) Method B Indoor Air Cleanup Levels (unrestricted) or the trichloroethylene (TCE) Indoor Air Action Level for short-term exposures.
- The most frequently detected analyte was tetrachloroethene (PCE), which was detected above the method reporting limit (MRL) at three of the four locations, ranging from 1.2 to 3.7 micrograms per cubic meter (µg/m^3). PCE was not detected in the mixed-use building.
- Cis-1,2-dichloroethene and TCE were detected between the MRL and the method detection limit (MDL), at 0.22 and 0.12 µg/m^3, respectively, in the Bank of America building (these data were qualified as estimates).
- Vinyl chloride and trans-1,2-dichloroethene were not detected above the MDL in any of the buildings.

4.2 Sub-Slab Soil Gas Results

Complete sub-slab soil gas analytical results are presented in Table 2 and summarized as follows:

- PCE was detected at all three sub-slab sample locations, ranging from 4.1 to 61 µg/m^3. There is no applicable PCE screening criterion. However, based on the indoor air results, these sub-slab concentrations do not pose a long-term, chronic vapor intrusion risk.
- TCE was detected at one sub-slab sample location (SS-03) at a concentration of 2.6 µg/m^3, which is an order of magnitude less than the Residential Short-Term VI Screening Level for sub-slab soil gas of 67 µg/m^3.
- Vinyl chloride was detected between the MRL and MDL (SS-01) at a concentration of 0.23 µg/m^3. There is no applicable vinyl chloride screening criterion. However, based on the indoor air results, this sub-slab detection does not pose a long-term, chronic vapor intrusion risk.
- There were no detections of trans-1,2-dichloroethene or cis-1,2-dichloroethene in sub-slab soil gas.

4.3 Exterior Shallow Soil Gas Results

Complete exterior soil gas analytical results are presented in Table 3 and summarized as follows:

- PCE was detected in two of three shallow exterior soil gas samples at concentrations ranging from 0.56 to 41,000 µg/m^3. There is no applicable PCE screening criterion.
- TCE was detected in one sample between the MRL and MDL at 89 µg/m^3. There is no applicable TCE screening criterion.
- Vinyl chloride, trans-1,2- dichloroethene, and cis-1,2-dichloroethene were not detected in shallow exterior soil gas.

4.4 Ambient Air Results

Complete ambient air analytical results are presented in Table 4. There were no detections of CVOCs in ambient air.

5 Results Interpretation and Recommendations

Tahn Associates, LLC, has implemented a vapor intrusion evaluation in accordance with the VI WP as required by the Ecology letter dated November 7, 2019. The results show there is no short-term risk of exposure to TCE via vapor intrusion as contemplated in the letter. Detections of CVOCs may warrant further investigation in consultation with Ecology. However, no further action is required in response to the subject letter.

6 References

Anchor QEA, 2020a. *Vapor Intrusion Evaluation, Work Plan Revision 1*. Prepared for Tahn Associates, LLC. February 2020.

Anchor QEA, 2020b. *Vapor Intrusion Evaluation Work Plan Addendum: Carson Cleaners, Inc*. June 2020.

EPA (U.S. Environmental Protection Agency), 1991. *A Guide to Principal Threat and Low Level Threat Wastes*. Superfund Publication 9380.3-06FS. November 1991.

EPA, 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*. EPA Office of Solid Waste and Emergency Response. EPA-540-R-05-012; OSWER 9355.0-85. December 2005.

Tables

Table 1
Indoor Air Sampling Results

Sample ID	Location	Sample Type	Chemical Names	Results (µg/m^3)	CLARC VI Method B (Unrestricted Land Use) Indoor Air Cleanup Level Unrestricted Land Use (Chronic; µg/m^3)	Unrestricted Land Use TCE Indoor Air Action Level (Short-term; µg/m^3)[1]
CC-IA-01-072320	Church Property	Indoor Air	Vinyl Chloride	0.79 U	0.3	---
			Trans-1,2-Dichloroethene	0.10 U	---	---
			Cis-1,2-Dichloroethene	0.10 U	---	---
			Trichloroethene (TCE)	0.10 U	0.37	2.0
			Tetrachloroethene (PCE)	**2.30**	9.60	---
CC-IA-02-072320	Mixed-Use Building	Indoor Air	Vinyl Chloride	0.081 U	0.3	---
			Trans-1,2-Dichloroethene	0.11 U	---	---
			Cis-1,2-Dichloroethene	0.11 U	---	---
			Trichloroethene (TCE)	0.10 U	0.37	2.0
			Tetrachloroethene (PCE)	0.098U	9.60	---
CC-IA-03-072320	Carson Cleaners	Indoor Air	Vinyl Chloride	0.08 U	0.3	---
			Trans-1,2-Dichloroethene	0.10 U	---	---
			Cis-1,2-Dichloroethene	0.11 U	---	---
			Trichloroethene (TCE)	0.10 U	0.37	2.0
			Tetrachloroethene (PCE)	**3.70**	9.60	---
CC-IA-04-072320	Bank of America	Indoor Air	Vinyl Chloride	0.086 U	0.3	---
			Trans-1,2-Dichloroethene	0.11 U	---	---
			Cis-1,2-Dichloroethene	0.11 U	---	---
			Trichloroethene (TCE)	0.11 U	0.37	2.0
			Tetrachloroethene (PCE)	**1.20**	9.60	---

Notes:

1. Washington State Department of Ecology Implementation Memorandum 22, Publication No. 18-09-047. October 2019.

Bold: detection above method detection limit

µg/m^3: microgram per cubic meter

U: not detected above method detection limit

J: estimated result

Table 2

Sub-Slab Soil Gas Sampling Results

Sample ID	Location	Sample Type	Chemical Names	Results (µg/m^3)	Short-Term TCE Subsurface Screening Levels	
					Residential Short-Term VI Screening Level for Sub-Slab Soil Gas (µg/m^3)	Non-Residential Short-Term VI Screening Level for Sub-Slab Soil Gas (µg/m^3)
CC-SS-01-072320	Church Property	Sub-Slab Soil Gas	Vinyl Chloride	0.088U	--	--
			Trans-1,2-Dichloroethene	0.11 U	--	--
			Cis-1,2-Dichloroethene	0.12 U	--	--
			Trichloroethene (TCE)	0.11 U	67.0	250
			Tetrachloroethene (PCE)	**4.10**	--	--
CC-SS-02-072320	Mixed-Use Building	Sub-Slab Soil Gas	Vinyl Chloride	0.092 U	--	--
			Trans-1,2-Dichloroethene	0.12 U	--	--
			Cis-1,2-Dichloroethene	0.12 U	--	--
			Trichloroethene (TCE)	0.12 U	67.0	250
			Tetrachloroethene (PCE)	**18**	--	--
CC-SS-03-072320	Carson Cleaners	Sub-Slab Soil Gas	Vinyl Chloride	0.089 U	--	--
			Trans-1,2-Dichloroethene	0.12 U	--	--
			Cis-1,2-Dichloroethene	0.12 U	--	--
			Trichloroethene (TCE)	**2.60**	67.0	250
			Tetrachloroethene (PCE)	**61**	--	--

Notes:

Bold: detection above method detection limit

µg/m^3: microgram per cubic meter

U: not detected above method detection limit

J: estimated result

Table 3

Shallow Exterior Soil Gas Results

Sample ID	Location	Sample Type	Chemical Names	Results (µg/m^3)
CC-SG-01-072420	Church Property	Shallow Exterior Soil Gas	Vinyl Chloride	0.37 U
			Trans-1,2-Dichloroethene	0.48 U
			Cis-1,2-Dichloroethene	0.48 U
			Trichloroethene (TCE)	0.46 U
			Tetrachloroethene (PCE)	0.44U
CC-SG-03-072420	Carson Cleaners	Shallow Exterior Soil Gas	Vinyl Chloride	23 U
			Trans-1,2-Dichloroethene	30 U
			Cis-1,2-Dichloroethene	30 U
			Trichloroethene (TCE)	29U
			Tetrachloroethene (PCE)	**41000**
CC-SG-04-072420	Bank of America	Shallow Exterior Soil Gas	Vinyl Chloride	0.092 U
			Trans-1,2-Dichloroethene	0.12 U
			Cis-1,2-Dichloroethene	0.12 U
			Trichloroethene (TCE)	0.12 U
			Tetrachloroethene (PCE)	**160**

Notes:

Bold: detection above method detection limit

µg/m^3: microgram per cubic meter

U: not detected above method detection limit

J: estimated result

Table 4

Ambient Air Sampling Results

Sample ID	Location	Sample Type	Chemical Names	Results (µg/m^3)
CC-AA-00-072420	Carson Cleaners	Ambient Air	Vinyl Chloride	0.083 U
			Trans-1,2-Dichloroethene	0.11 U
			Cis-1,2-Dichloroethene	0.11 U
			Trichloroethene (TCE)	0.10 U
			Tetrachloroethene (PCE)	0.10 U

Notes:

Bold: detection above method detection limit

µg/m^3: microgram per cubic meter

U: not detected above method detection limit

J: estimated result

Figures

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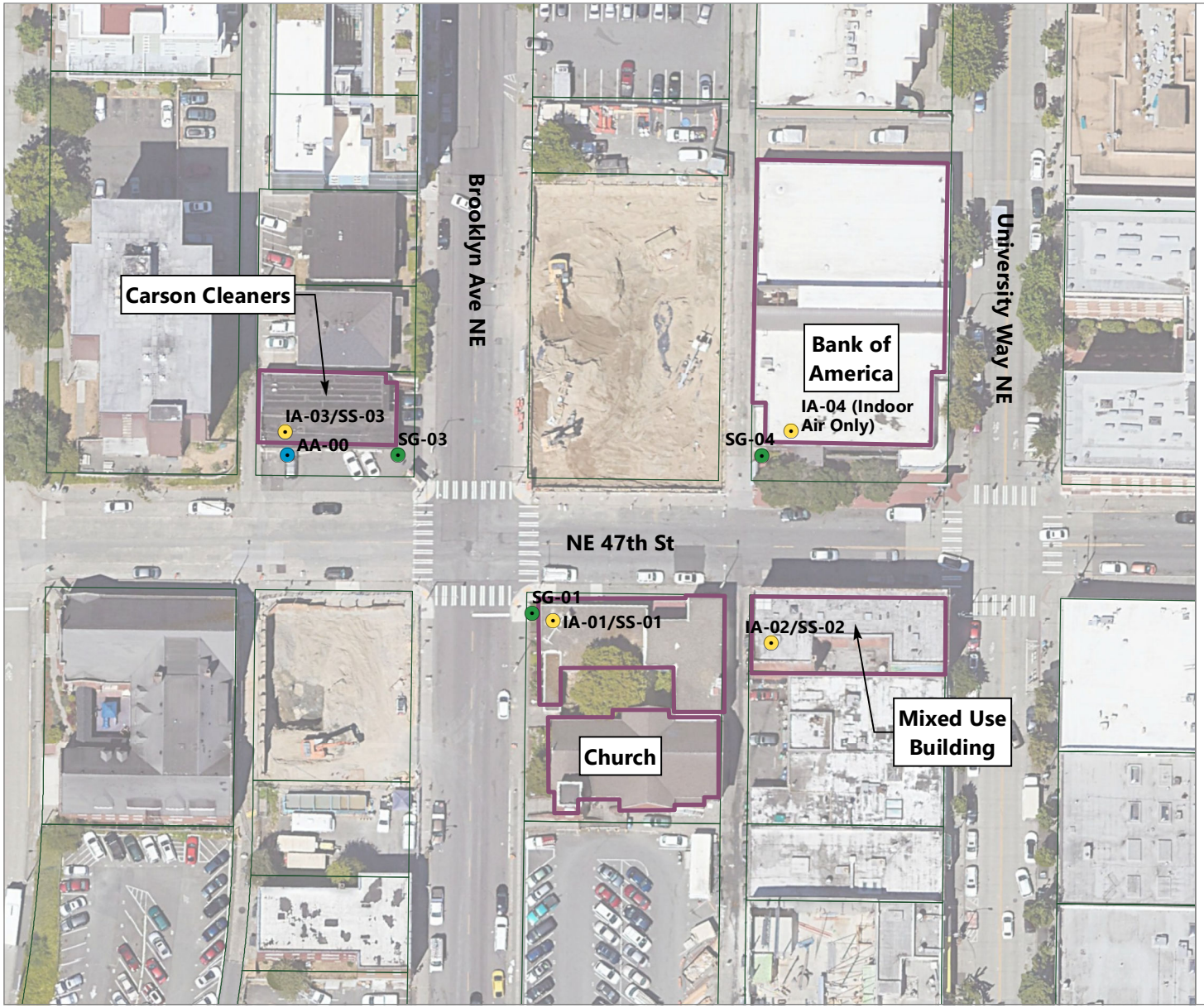
ANCHOR QEA

Figure 1
Site Location
Vapor Intrusion Evaluation
Former Carson Cleaners Facility



LEGEND:

- Parcel
- Building

Sampling Locations

- Ambient Air
- Exterior Boring
- Interior Sample (indoor air/sub-slab location)

NOTES:

1. As noted in the report, the planned shallow soil gas station in the alley between the mixed use and church was not practicable due to proximity to utilities.
2. Locations are approximate.

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ANCHOR QEA

Figure 2
Sampling Locations
Vapor Intrusion Evaluation
Former Carson Cleaners Facility

Appendix A
Ecology Letter (November 2019)

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Ave SE • Bellevue, WA 98008-5452 • 425-649-7000
711 for Washington Relay Service • Persons with a speech disability can call 877-833-6341

November 7, 2019

Clara Chen
Tahn Associates, LLC
644 164th Place NE
Bellevue, WA 98008

Re: Request for Evaluation of Trichloroethylene Risks at the following Site:

- **Site Name:** Carson Cleaners
- **Site Address:** 4701 Brooklyn Ave NE, Seattle, WA 98105
- **Facility/Site No.:** 15518216
- **CSID No.**: 14878

Dear Clara Chen:

Our records indicate that this Site is contaminated with trichloroethylene (TCE), or with tetrachloroethylene (PCE) that can break down into TCE. TCE is a toxic organic chemical that can volatilize from contaminated soil or groundwater and potentially enter nearby buildings as a vapor. The presence of TCE in indoor air can result in health impacts to building occupants, the most urgent of which are to pregnant women. U.S. EPA has concluded that brief exposures to TCE in air may affect women in the first trimester of pregnancy by increasing the risk of heart malformations to a developing fetus.[1]

Ecology's Implementation Memo No. 22 titled "*Vapor Intrusion (VI) Investigations and Short-term Trichloroethene (TCE) Toxicity*" (attached) provides important information including indoor air action levels[2] (Section 4 – Table 1) as well as recommendations (Section 5) for determining whether environmental contamination is causing elevated levels of TCE in indoor air.

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[1] See U.S. EPA, August 2014, Office of Solid Waste and Emergency Response Memorandum: Compilation of Information Relating to Early/Interim Actions at Superfund Sites and the TCE IRIS Assessment.

[2] The short-term indoor air action levels are higher than Ecology's long-term indoor air cleanup levels.

To protect human health, Ecology requests that:

1. Within 30 days from the date of this letter, you provide Ecology with any existing information regarding contamination at the site that you have not already submitted.

    - The only data we have received to date has been collected as part of investigations on the adjacent Chevron 90129 site (Facility/Site No. 8196648, CSID No. 10632). This data includes concentrations of chlorinated solvents, including TCE, in groundwater above cleanup levels.

2. Within 60 days, you submit a sampling and analysis plan for your vapor intrusion evaluation to Ecology for review. The goal of your evaluation it to determine whether environmental contamination at the site has resulted in TCE concentrations from vapor intrusion above the short-term indoor air action levels.

    - From the most recent data we have received (see figure below), groundwater contamination above the screening levels in Implementation Memo 22 extends down NE 47th Street to at least University Way NE. This puts multiple residential and commercial buildings within the 100 foot lateral screening distance, the area where there is the greatest risk of exposure to chlorinated solvents via vapor intrusion. All of these buildings should be considered in your evaluation.

    - Your evaluation should include a combination of soil vapor, indoor air, and ambient air sampling. General guidance on conducting a vapor intrusion evaluation including these types of samples is available online at: https://fortress.wa.gov/ecy/publications/documents/0909047.pdf.

    - We ask that you coordinate with Tim Bishop and Cheryl Cameron of Chevron Environmental Management Company, the project managers for the adjacent Chevron 90129 site, as you develop your sampling and analysis plan. They are copied on this letter, and may be reached via email at TimBishop@chevron.com and Cheryl.Cameron@chevron.com.

3. Within 90 days, you conduct sampling and submit the results of your evaluation to Ecology. Include recommendations on what actions, if any, are necessary to reduce TCE concentrations to below the appropriate short-term indoor air action level.

    - Multiple rounds of sampling may be necessary to complete the short-term TCE investigation. If that is that case, we expect that the first round of sampling will be completed within 90 days, and that a schedule for any additional sampling will be included in the sampling and analysis plan.

Ecology's Next Steps:

Depending on the site specific circumstances, Ecology may:

1. Continue to provide technical assistance as necessary for evaluating and/or remediating short-term TCE risks.
2. Notify appropriate local, state or Federal health agencies to discuss possible health risks and any necessary public notifications.
3. Identify potentially liable parties and require additional remedial action pursuant to RCW 70.105D, such as: a) issuing an enforcement order, b) pursuing an Ecology conducted cleanup with cost recovery, or c) seeking judicial review.
4. Pursue other options necessary to adequately cleanup contamination at the site.

Contact Information

Ecology is committed to working with you to accomplish the prompt and effective actions necessary at the Site. If you have any questions about this request, please contact me at (425) 649-7040 or kim.wooten@ecy.wa.gov.

Sincerely,

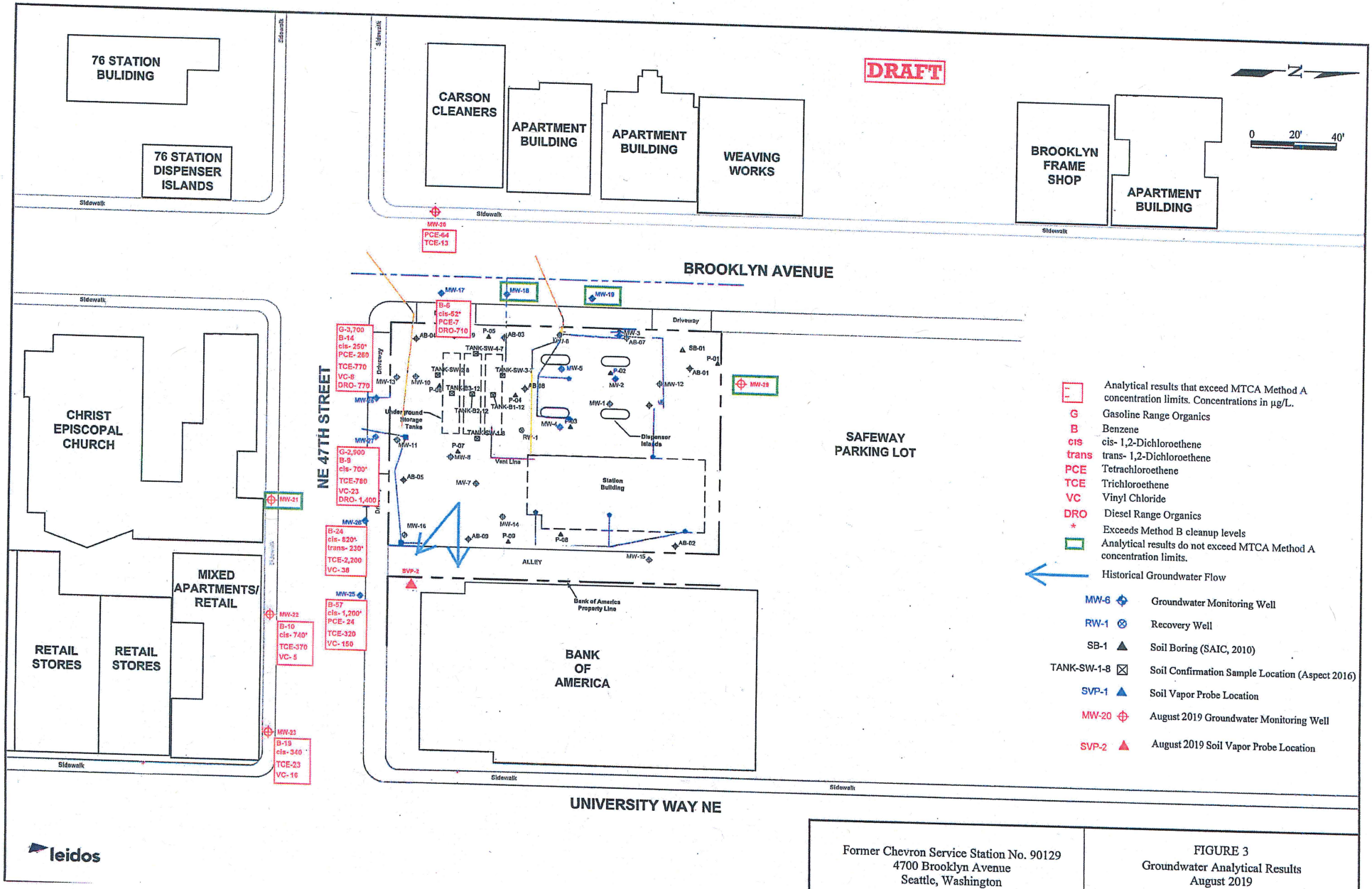
Kim Wooten

Kim Wooten
Toxicologist
Toxics Cleanup Program, Northwest Regional Office

Enclosure: Implementation Memo No. 22

By certified mail: 9171 9690 0935 0136 9544 72

cc: Steve Chianglin, Chianglin Law Firm PLLC
Allyson Bazan, Assistant Attorney General
Dale Myers, Ecology
Eric Hetrick, Chevron Environmental Management Company
Cheryl Cameron, Chevron Environmental Management Company
Tim Bishop, Chevron Environmental Management Company



leidos

Former Chevron Service Station No. 90129
4700 Brooklyn Avenue
Seattle, Washington

FIGURE 3
Groundwater Analytical Results
August 2019

DATE: 10/28/19 | DRAWING:

DEPARTMENT OF ECOLOGY
State of Washington

Vapor Intrusion (VI) Investigations and Short-term Trichloroethene (TCE) Toxicity

Implementation Memorandum No. 22

Date: October 1, 2019

To: Interested Persons

From: Jeff Johnston, Section Manager
Information & Policy Section
Toxics Cleanup Program

Contact: Policy & Technical Support Unit, Headquarters, Lacey, WA

Attachments: A - Response to comments on the November 21, 2018, review draft of this memo.

Accommodation Requests: To request ADA accommodation including materials in a format for the visually impaired, call Ecology at 800-826-7716. Persons with impaired hearing may call Washington Relay Service at 711. Persons with speech disability may call TTY at 877-833-6341.

Table of Contents

Acronyms and Abbreviations

Acronym or Abbreviation	Definitions
APU	air purification units
ATSDR	Agency for Toxic Substances and Disease Registry
CLARC	Ecology's Cleanup Levels and Risk Calculation data tables
COPC	contaminant of potential concern
CPF	carcinogenic potency factor
CSM	(vapor intrusion) Conceptual Site Model
DoD	United States Department of Defense
DTSC	California Department of Toxic Substances Control
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
HI	non-carcinogenic Hazard Index
HQ	non-carcinogenic Hazard Quotient
HVAC	heating, ventilation, and air conditioning
IRIS	EPA's Integrated Risk Information System
µg/l	micrograms per liter
µg/m³	micrograms per cubic meter
MTCA	Model Toxics Control Act
NAPL	non-aqueous phase liquids
QA	quality assurance
RCW	Revised Code of Washington
RfD	reference dose
RI	Remedial Investigation
RME	reasonable maximum exposure (RME) means the highest exposure that can be reasonably expected to occur for a human or other living organisms at a site under current and potential future site use
SAP	Sampling and Analysis Plan
SL	screening level
TCE	trichloroethene or trichloroethylene
TCP	Toxics Cleanup Program
Tier I	term used in Ecology's 2009 draft VI guidance to describe VI assessments employing subsurface (groundwater and soil gas) VOC measurements
Tier II	term used in Ecology's 2009 draft VI guidance to describe VI assessments employing indoor air VOC measurements
µg/l	micrograms per liter
µg/m^3	micrograms per cubic meter
VI	vapor intrusion
VOC	volatile organic compound
WAC	Washington Administrative Code

1.0 Purpose and Applicability

The purpose of this memorandum is to supplement the 2009 Draft Vapor Intrusion Guidance[1] produced by the Washington State Department of Ecology (Ecology) and provide recommendations pertaining to cleanup sites contaminated with trichloroethene (TCE).

Specifically, this memorandum:

1. Provides indoor air Action Levels that are protective of short-term exposures to TCE.

2. Provides the default (non-site-specific) subsurface vapor intrusion (VI) screening levels that are protective of the short-term indoor air TCE action levels.

3. Identifies options for effectively and rapidly responding to those situations where TCE concentrations caused by VI in indoor air are above action levels.

4. Establishes the goal to keep indoor air TCE concentrations (caused by VI) below short-term action levels at Model Toxics Cleanup Act (MTCA) cleanup sites in Washington state.

5. Provides guidance and recommendations for those scenarios where a) VI-caused TCE indoor air concentrations exceed, or may exceed, the short-term action levels, and b) the building being investigated is regularly occupied by female residents or workers of child-bearing age.

Unless otherwise specified, this document applies to any cleanup site where TCE is a subsurface contaminant of concern and a VI pathway is being, or should be, evaluated. This includes sites under direct Ecology oversight; sites where Ecology is responsible for the investigation and cleanup; and sites in the independent cleanup process. Although the memorandum refers in a number of instances to investigation and outreach activities that assume direct Ecology involvement at the site, when this is not the case (as noted in Section 5.2) the parties performing the site investigation and cleanup should independently complete the recommended steps outlined in the memorandum.[2]

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[1] *Draft Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action* (Ecology 2009): https://fortress.wa.gov/ecy/publications/SummaryPages/0909047.html.

[2] In later portions of the memorandum, we use the term "responsible party" to refer to the party who is conducting remedial actions at the site. In many cases the responsible party will be a person meeting the statutory definition of a "potentially liable person" (see RCW 70.105D.040).

WAC 173-340-200 of the MTCA rule defines the terms "cleanup," cleanup action," "interim action," and "remedial action." Remedial action (or "remedy") means "any action or expenditure consistent with the purposes of [MTCA statute] Chapter 7.0.105D RCW to identify, eliminate, or minimize any threat posed

NOTE: In some buildings, indoor workers are routinely exposed to elevated indoor air concentrations of volatile organic compounds (VOC) as part of a manufacturing or other business-related process. When the same VOCs are also present in subsurface contamination, these scenarios commonly pose difficulties to investigators who are attempting to quantify VI-only contributions to indoor air contamination. Another challenge: as long as manufacturing or other business-related processes result in indoor VOC levels much higher than those potentially caused by VI, the affected receptors will only minimally benefit from actions taken to curtail just the VI contributions.

Implementation Memorandum No. 22 does not provide guidance or recommendations for scenarios where business-related processes persistently contaminate the building's indoor air with TCE, and the resulting TCE concentrations significantly exceed any VI contributions. If this scenario is (or appears to be) present at the site, Ecology should be consulted before proceeding further with the VI evaluation.[3]

by hazardous substances to human health or the environment including any investigative and monitoring activities with respect to any release or threatened release of a hazardous substance and any health assessments or health effects studies conducted in order to determine the risk or potential risk to human health."

[3] See also Ecology's Implementation Memorandum No. 21: *Frequently Asked Questions (FAQs) Regarding Vapor Intrusion (VI) and Ecology's 2009 Draft VI Guidance* (Ecology 2018b), available at: https://fortress.wa.gov/ecy/publications/SummaryPages/1809046.html

2.0 How this Memo is Organized

When TCE is present in soils, groundwater, or soil gas, VI assessments should determine if indoor air concentrations exceed cleanup levels based on chronic exposure. Assessments should also, however, be designed to determine if indoor air concentrations are higher than action levels protective of toxic, non-cancer effects caused by short-term exposures to the chemical. This memorandum provides guidance and recommendations for such short-term exposure scenarios.

Section 3.0 provides background on the 2009 draft vapor intrusion guidance, and the major updates to the document since.

Section 4.0 identifies Ecology's short-term indoor air action levels. It also includes short-term TCE soil gas and groundwater screening levels, which are calculated to be protective of the indoor air action levels.

Section 5.0 discusses VI investigations at TCE sites, and outlines Ecology's expectations regarding assessments of possible short-term, indoor air TCE, action level exceedances.

Section 6.0 outlines Ecology's expectations regarding appropriate responses and response timeframes, when VI-caused indoor air TCE concentrations exceed action levels.

Section 7.0 describes notifications and other outreach-related tasks that responsible parties should perform at TCE sites where VI may be resulting in indoor air concentrations that exceed action levels.

3.0 Background

In 2009, Ecology prepared the draft VI guidance titled *Guidance for Evaluating Soil Vapor Intrusion in Washington State: Investigation and Remedial Action.* A public comment period in the fall of 2009 provided an opportunity for the public to review and give us feedback on the draft document. Although a number of public comments were received, Ecology did not formally respond to the comments or revise and finalize the draft guidance. Nevertheless, the draft VI guidance has been relied on by Ecology staff, environmental consultants, and others who are responsible for assessing VI and ensuring that indoor receptors are protected from VI-related air contamination.

Since 2009, parts of the draft guidance have been updated or otherwise superseded by TCP Implementation Memoranda. Specifically:

1. **Updated and revised VI cleanup and screening levels.** Tables in Appendix B of the 2009 draft guidance contained VI indoor air cleanup levels and soil gas and groundwater screening levels. In 2009, the indoor air cleanup levels in Appendix B corresponded to standard, WAC 173-340-750 Method B and C air cleanup levels, calculated with reference doses (RfDs) and/or cancer potency factors (CPFs) obtained at that time from IRIS and other Environmental Protection Agency (EPA) toxicity databases. Soil gas and groundwater screening levels were calculated to be protective of these indoor air cleanup levels.

   As of 2016, the Appendix B tables in the 2009 draft guidance are outdated and should not be relied upon. The VI indoor air cleanup and groundwater and soil gas screening levels in Ecology's Cleanup Levels and Risk Calculation (CLARC) data tables[4] replace the 2009 tables and should be used instead. The CLARC table values are based on the most current Method B and C air cleanup levels and, for sub-slab soil gas screening levels, an attenuation factor different (that is, lower) than the value used to generate the Appendix B tables.

2. **Updated and revised Ecology guidance related to petroleum VI (PVI) screening.** TCP Implementation Memorandum No. 14 (Ecology 2016) embodies new EPA recommendations for assessing sites where the only volatile subsurface contaminants of concern are those petroleum hydrocarbons that are associated with a fuel release. Implementation Memo No. 18 (Ecology 2018) also primarily applies to releases of petroleum-containing fuels. It establishes generic TPH air cleanup levels and

[4] Available at: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Contamination-clean-up-tools/CLARC (Ecology 2018a)

corresponding soil gas screening levels. It provides additional guidance for developing PVI sampling plans for Tier I and Tier II, and discusses potential PVI threats to buildings that will be constructed in the future. These memoranda were specifically developed for sites where PVI is a potential concern.

3. **Developed frequently asked questions (FAQs) on whether specific portions of the 2009 draft VI guidance are still applicable.** TCP Implementation Memo No. 21 (Ecology 2018) answers a number of questions regarding technical and policy changes that have occurred since the draft guidance was issued.

Since Ecology's 2009 draft VI guidance was prepared, EPA has concluded that brief exposures to TCE may cause serious health problems.[5] Short-term inhalation exposures to TCE in indoor air have the potential to cause serious heart defects in a developing fetus. The damage can occur early in a pregnancy, possibly before the pregnancy is recognized.

While much of the draft 2009 guidance document is applicable to sites where TCE vapor intrusion is a possibility, there are several issues that are not considered in the draft guidance but should be evaluated, due to the potential for harm from short-term exposure. These issues are:

1. Response speed. Actions to protect a fetus from unacceptable TCE exposures should occur as rapidly as possible after discovering the contamination—that is, within days or weeks, depending on the likelihood and degree of potential exposure.

2. Focus on women of childbearing age (which includes pregnant women). The developing fetus is sensitive to the effects of short-term TCE exposure, and preventing harm to the fetus relies on reducing the mother's exposure.

3. Public outreach. Promptly contacting people who live and work near TCE contamination is crucial for three reasons: 1) to identify women of childbearing age; 2) to explain the potential health hazards to building occupants and, 3) if warranted by site-specific conditions, to obtain permission to access buildings for property-specific investigation and exposure-reduction activities. Whenever possible, outreach activities should be conducted in collaboration with public health departments.

This degree of urgency, and the need for more intensive outreach to specific individuals, is not typically required at most MTCA sites. These issues are further discussed in Sections 5 through 7, following the discussion of Ecology's recommended short-term TCE action and screening levels.

[5] *Memorandum: Compilation of Information Relating to Early/Interim Actions at Superfund Sites and the TCE IRIS Assessment* (USEPA 2014).

4.0 VI Screening and Action Levels for TCE

4.1. Indoor air action levels for TCE

Indoor air cleanup levels—which are used during Tier I and Tier II vapor intrusion assessments to determine whether further sampling, interim actions, or cleanup actions are indicated—are provided in the CLARC data tables.[6] These concentrations are the same concentrations as the standard cancer and non-cancer Method B and C air cleanup levels in CLARC's *Air* data tables.

Air cleanup levels for TCE are lower than indoor air action levels for short-term indoor exposures. Cleanup levels apply to long-term (at least one year) average air concentrations for the entire population comprised of all genders and ages. Short-term indoor air action levels, on the other hand, only apply to three-week average concentrations for women of childbearing age. The average indoor air TCE concentration due to VI over **any** three-week interval should not exceed the applicable action level.

VI indoor air cleanup levels for long-term TCE exposures, and action levels for short-term exposures to women of childbearing age, are provided in Table 1 below. The table's Indoor Air Cleanup and Action Levels are compared to average indoor air TCE concentrations that result solely from site-contaminated soil gas (that is, vapor) intrusion. In some cases, this will mean that contributions to indoor air measurements from non-VI sources, such as outdoor or indoor sources, will need to be distinguished from those due solely to subsurface sources.

The short-term Action Levels for TCE in Table 1 are based on values recommended by EPA Region 10 (December 13, 2012, memorandum) and EPA Region 9 (July 9, 2014 memorandum).[7] Region 10's 2012 memorandum states that, pursuant to an IRIS toxicological review, exposure to TCE can cause fetal cardiac malformations during a 21-day gestation window. To protect against the possibility of this occurring, the average concentration of TCE in residential indoor air should not exceed 2.0 µg/m^3 during any 21-day period of time in a given year. For commercial / industrial settings, where the receptors of concern are workers, indoor air TCE should not exceed 8 µg/m^3. The Region 9 memorandum identifies "accelerated" and "urgent response action levels" for residents and workers. The "accelerated" levels range from 2 to 8 µg/m^3; the "urgent" levels vary from 6 to 24 µg/m^3. The range of levels for both categories accounts for the varied lengths of time that receptors are expected to be exposed.

[6] Cleanup Levels and Risk Calculation (CLARC). https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx

[7] For the Region 9 and 10 memoranda, see: https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Vapor-intrusion-overview

Table 1. Vapor intrusion indoor air cleanup and action levels for TCE

Level of Concern	Concentration ($\mu g/m^3$)	Risk Basis
TCE Indoor Air Cleanup Levels Chronic (mean long-term air concentration for RME receptor)*		
Method B (unrestricted land use)	**0.37**	Cancer risk 1E-6
	0.91	Hazard quotient 1
Method C (industrial land use)	**6.3**	Cancer risk 1E-5
	2.0	Hazard quotient 1
TCE Indoor Air Action Levels Short-term (maximum 3-week mean concentration for women of childbearing age)		
Unrestricted (residential) land use	**2.0**	Noncarcinogenic effect based on 24 hours/day, 7 days/week
Workplace scenario (commercial or industrial)	**7.5**	Noncarcinogenic effect based on 45-hour work week

* These values are available in CLARC (Ecology 2018a).

A number of other EPA Regions and states, including Massachusetts, New Jersey, New Hampshire, Minnesota, Ohio, Alaska, and Connecticut, have also adopted short-term TCE levels and recommended responses. These levels and response timeframes vary.

Consistent with EPA Region 10, TCE Action Levels in Table 1 are intended for comparison to the highest VI-caused indoor air levels averaged over any 21-day period. Ecology recognizes, however, that the fetal health effects that potentially arise from a short-term exposure to TCE could possibly result from an exposure to action level concentrations over a period less than three weeks. As of the date of this memo, we do not know how short this period could be, or whether shorter periods would only be harmful if TCE concentrations were significantly higher than Action Levels. Therefore, while this memorandum advocates comparing our Action Levels to measurements (or estimates) of average 21-day concentrations, Ecology also recommends that, if any 24-hour or 8-hour measurements of average indoor air TCE concentrations exceed Table 1's Action Levels (for residents or workers, respectively), prompt action should be taken to either reduce those concentrations, or reduce the degree to which women of childbearing age are exposed. Ecology will revisit this recommendation as more information becomes available about health effects attributable to short-term TCE exposures.

Table 1 is limited to providing a residential short-term TCE indoor air Action Level and a short-term Action Level for commercial/industrial workers. The residential concentration is intended to protect women of childbearing age who reside in the building and are continuously exposed to indoor air contaminated by VI. The commercial/industrial Action Level is protective of women

of childbearing age who work full-time shifts up to 45 hours per week.[8] However, other women of childbearing age who occupy a building where VI is occurring may also be receptors of concern. For example, visitors to a building, part-time workers in a building, or students within a school building could potentially be exposed to contaminated indoor air over extended periods of time.

Table 1's short-term Action Levels should be used to determine whether prompt and protective actions like interim actions should be implemented (see WAC 173-340-430). **These Action Levels are not MTCA Method B or C air Cleanup Levels**. Furthermore, the MTCA regulations require that cleanup levels be established for one of two specific land uses: *unrestricted* or *industrial* site use.

4.2. VI short-term screening levels for TCE in groundwater and soil gas

CLARC's data tables also provide groundwater and soil gas screening levels that can be used to assess the potential VI threat posed by a subsurface source. As for the VI indoor air cleanup levels, these concentrations are based on chronic exposures. CLARC's groundwater screening levels are intended to be protective of corresponding indoor air cleanup levels, and assume there will be 1,000-times attenuation between groundwater VOC concentrations (in equilibrium with vapor concentrations) and indoor air levels. CLARC's sub-slab soil gas screening levels are also expected to be protective of indoor air cleanup levels. They assume there will be 33-times attenuation between soil gas VOC concentrations just below a building's slab and indoor air levels. (For further discussion on this, see the note box following Table 2 in this section.)

VI groundwater and sub-slab soil gas screening levels protective of short-term TCE indoor air action levels are presented in Table 2 below. These screening levels embody the same attenuation assumptions used to calculate the chronic subsurface screening levels provided in CLARC (as discussed above). In summary:

- The short-term VI screening levels for groundwater and soil gas are higher than CLARC's VI TCE screening levels, which are calculated for chronic indoor exposures.

- For residential buildings, the short-term screening level for groundwater is about twice as high as CLARC's chronic-based non-carcinogenic screening level (8 µg/l versus 3.8 µg/l, respectively), and approximately five times higher than CLARC's carcinogenic screening level (8 µg/l versus 1.6 µg/l).

[8] The protection this paragraph refers to is the protection of the developing fetus. Exposures to TCE can also, of course, potentially affect the health of women themselves. Indoor "protection" for the women themselves should be assessed using the indoor air cleanup levels in the CLARC data tables, not the short-term action levels.

- Similarly, the short-term screening level for TCE in soil gas is about twice as high as CLARC's chronic-based non-carcinogenic sub-slab screening level (67 µg/m³ versus 31 µg/m³), and a little more than five times higher than CLARC's carcinogenic sub-slab screening level (67 µg/m³ versus 12 µg/m³).

Table 2. Vapor intrusion subsurface screening levels for short-term exposures to TCE

Short-term TCE Subsurface Screening Levels	Concentration	Basis
groundwater (in µg/l)		
residential short-term VI Screening Level for groundwater	**8**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • residential indoor scenarios
non-residential short-term VI Screening Level for groundwater	**31** **1.**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • commercial/industrial workplace scenarios
soil gas (in µg/m³)		
residential short-term VI Screening Level for sub-slab soil gas	**67**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • residential indoor scenarios
non-residential short-term VI Screening Level for sub-slab soil gas	**250**	• TCE as a non-carcinogen • receptor of concern: women of childbearing age • commercial/industrial workplace scenarios

NOTE: The 2009 draft guidance differentiates between the amount of soil gas-to-indoor air attenuation that should be assumed for soil gas VOC concentrations that are located immediately below the building (like sub-slab), versus those concentrations that are at significantly greater distances below ground surface (called "deep"). CLARC's VI data tables also make this distinction. "Deep" soil gas screening levels in CLARC assume 100-times attenuation between soil gas VOC concentrations and indoor air levels.

However, EPA's *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA June 2015) does not recommend that soil gas levels be assumed to attenuate more than 33 times, regardless of depth. As a result, Ecology is re-evaluating the appropriateness of a deep soil gas VI screening level that assumes more than

33-times attenuation. At the time this memo was published, we are not withdrawing the recommended deep soil gas VI screening levels in CLARC, but:

1. These levels should not be used to assess the potential for an indoor air exceedance of the short-term TCE action level, and

2. For other assessment purposes (such as assessing the potential for an exceedance of a chronic-based indoor air cleanup level) the requisite 15-foot or greater separation distance should be applied to the depth of the vadose zone between the building foundation (not the ground surface) and the deep soil gas measurement. The short-term TCE Screening Levels identified in Table 2—referred to as "sub-slab" and calculated with an attenuation factor of 0.03—may also be compared to deeper soil gas sample measurements.

5.0 VI Investigation

Ecology's 2009 draft VI Guidance should generally be followed when investigating and addressing TCE vapor intrusion. But as noted in Section 3.0 above, the draft guidance does not discuss short-term inhalation exposures to TCE. The following investigation recommendations refer specifically to sites where TCE is a potential VI concern.

5.1. Identify any site buildings where VI may potentially result in indoor TCE concentrations above the short-term action level.

NOTE: The discussion in Section 5.1 assumes that indoor air sampling for TCE has not been conducted. If indoor air has already been sampled, and indoor TCE concentrations due to VI exceed the applicable short-term action level, appropriate responses are described and discussed in Section 6. If indoor air was sampled and TCE concentration measurements were below the short-term action level, the VI assessment team should determine whether those measurements represent the highest 3-week average indoor TCE concentration. Please see Section 5.4.

Determining which buildings are a potential concern is commonly accomplished by mapping site areas where TCE is, or may be, present in soils or shallow groundwater. Buildings above or close to these areas can then be identified. In parts of the site where soils are contaminated with TCE, soil gas samples are typically collected and analyzed.[9] Ecology's 2009 VI Guidance, CLARC's VI soil gas Screening Levels, and Table 2's short-term soil gas Screening Levels above, can then be used to determine if VI could potentially result in indoor air cleanup level or action level exceedances (respectively) at nearby buildings.

Regardless of whether the potential subsurface VI source is contaminated soils or shallow groundwater, soil gas samples can be collected below or near a building, and the measured TCE levels can be used to determine the potential for an indoor exceedance of indoor air cleanup levels and/or action levels. However, if TCE concentrations in shallow groundwater are above CLARC's VI Screening Levels, or if significant soil contamination or residual non-aqueous phase liquid (NAPL) is close to a building and likely to contain elevated TCE concentrations, investigators should not delay indoor air sampling (see section 5.3). When these conditions are

[9] *De minimis* levels of TCE in vadose zone soils (i.e., above the seasonal low water table) are unlikely to pose a VI threat. WAC 173-340-740(3)(b)(iii)(C)(III) defines such levels as concentrations no higher than concentrations "derived for protection of groundwater for drinking water beneficial use under WAC 173-340-747(4)." Concluding that TCE levels in soils are this low requires adequate characterization of vadose zone contamination.

present, the first indoor sampling event(s) should be a site priority and performed immediately, without waiting for a preliminary soil gas investigation.[10]

In areas where soils are not contaminated and shallow groundwater is the only potential VI source, the 2009 draft VI guidance, groundwater VI Screening Levels in CLARC, and short-term groundwater Screening Levels in Table 2 can be used to distinguish between buildings where VI could potentially result in exceedances of indoor air cleanup (chronic) or action (short-term) levels, and those where exceedances are highly unlikely.

In addition to the exceedance of subsurface VI screening levels, there may be other building- or site-specific reasons for suspecting that indoor air TCE concentrations could exceed the short-term action level. For instance, at some building locations, contaminated shallow groundwater may be the only potential VI source and TCE concentrations in this groundwater may be below the short-term screening level. However, the short-term groundwater screening levels assume a certain amount of attenuation and dilution of vapor-phase TCE between the groundwater surface and the indoor environment. While these are conservative assumptions for most buildings, they may not be if:

- There are preferential subsurface pathways that may result in higher soil gas VOC levels below the building than the short-term groundwater screening levels assume, or if

- There may be a higher soil gas flowrate into the building than the short-term groundwater (and soil gas) screening levels assume.[11]

[10] Ecology does not recommend that soil gas sampling be initiated at this point to determine if TCE concentrations exceed short-term soil gas screening levels. This is because it takes time to prepare (and approve) soil gas SAPs; obtain access; schedule and mobilize the related work; and, review the sampling results. Indoor air sampling should not be delayed while these activities are being performed. During or immediately following the first indoor air sampling event, however, it is prudent to obtain soil gas data.

[11] The short-term groundwater Screening Levels assume that vapor-phase TCE concentrations will attenuate by a factor of 1000 between soil gas levels immediately above (and in equilibrium with) contaminated groundwater and indoor air. This is generally a conservative assumption, but may over-predict the degree of subsurface attenuation in certain cases. Ecology's 2009 draft VI guidance describes the conditions where this may occur (e.g., sites with a very thin vadose zone (shallow water table); the presence of subsurface conduits capable of transporting elevated soil gas levels to areas directly below the building with minimal attenuation; etc.)

The short-term soil gas Screening Levels assume that vapor-phase TCE concentrations will attenuate by a factor of at least 33 times between soil gas levels immediately below the building and indoor air. Again, this is usually a conservative assumption. However, less attenuation is possible if the building or its foundation allows soil gas to enter interior spaces relatively unimpeded (which may occur, for example, when slab or basement wall penetrations or large cracks provide preferential conduits for entry).

5.2. Notify and involve Ecology

This memorandum presumes that Ecology will be involved throughout the VI evaluation process, including owner/tenant notifications, the initial building visit, indoor air sampling, data analysis, and post-sampling decision-making described in the rest of this section and in Sections 6 and 7. We have therefore identified certain recommended actions and decisions below as being responsibilities of both the party conducting the remedial actions (the responsible party) and Ecology.[12] However, in those cases where the responsible parties are acting independently and choose not to involve Ecology during some or all of these actions and decisions, they should complete the applicable and recommended steps in this memorandum themselves.

Regardless of whether Ecology oversees the site throughout the cleanup process, or whether another party independently conducts the remedial actions:

1. Ecology should be contacted as soon as the responsible party determines that women of childbearing age are current building occupants and indoor air sampling is needed to assess the potential for a short-term TCE action level exceedance (see Section 5.3 below).

2. If an Ecology staff person has already been assigned to the site, this is the individual who should be notified. Otherwise, the responsible party should contact their local Ecology regional office. They should not wait for Ecology's response before moving to the next steps of the investigation / response process. Find Ecology's contact information at https://ecology.wa.gov/About-us/Get-involved/Report-an-environmental-issue

5.3. Prepare for indoor air sampling

As soon as one or more site buildings have been identified as a location where VI may potentially result in indoor air TCE concentrations above the short-term action level, investigators should quickly plan for the next assessment steps—unless they already know that women of child-bearing age do not regularly occupy the buildings. At this point in the investigation, it is only *potentially possible* that indoor TCE concentrations actually exceed the Action Level, but several actions should occur without delay: notify building owners/tenants, determine if exceedances are occurring, and – if needed – take actions to protect the potential receptors.

1. **Contact building owner and/or tenant.** The owner/tenant of the building should be contacted to determine if women of childbearing age are current occupants, and to schedule a building and property visit. This initial contact should occur soon after the

[12] Please see footnote in Section 1.0 regarding use of the term "responsible party" in this memorandum.

building has been identified as potentially at risk. The owner and tenant(s) of these buildings should be notified that there is the *possibility* that VI-caused indoor air TCE concentrations exceed the acceptable chronic and/or short-term screening/action levels.

2. **Schedule a building visit.** If women of childbearing age are current building occupants, a building visit should be scheduled as soon as possible. During this visit Ecology and the responsible party will need to be prepared to discuss the potential TCE risk, explain how we would like to proceed, and answer exposure-related and other questions.[13] If the responsible party does not own the building, they should also be prepared at this time to request building access for the purpose of collecting indoor air samples. Interactions with building owners and tenants during the period preceding indoor air sampling are further discussed in Section 7.0 below.

3. **Prepare and finalize a SAP.** Following the visit to the building and property, an indoor air Sampling and Analysis Plan (SAP) should be expeditiously prepared, reviewed, and finalized.[14] The SAP should include a site/building-specific VI conceptual site model (CSM) that serves as the basis for the selection of data quality objectives and sampling design. The VI CSM, as discussed in our draft 2009 VI guidance document and in Section 5.4 of EPA's 2015 *Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA June 2015), is a combination of information, assumptions, and hypotheses that investigators use to support evaluations of the adequacy of available site-specific information, and guide the identification of critical data gaps.

4. **Schedule indoor air sampling.** After SAP finalization the first indoor air sampling event should be immediately scheduled. It should not be delayed to coincide with more desirable seasonal or meteorological conditions.[15]

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[13] Please see Section 7.1's discussion of VI-related risk communications.

[14] This assumes that: a) an exceedance of the short-term TCE indoor air action level has not yet been measured, and b) the responsible party has decided not to pursue a "preemptive" response action. If an exceedance of the action level has already been measured, no additional pre-mitigation sampling may be needed. See Section 6.0 for a description of appropriate response actions.

Preemptive mitigation is a term often used to describe VI mitigation efforts implemented without (or prior to) confirmation that VI-caused indoor air contamination exceeds acceptable levels. When preemptive mitigation has been chosen as the next step in Section 5.3, indoor air sampling is not typically conducted until after mitigation has been implemented. See Section 7.8 of EPA's OSWER VI guidance document (USEPA June 2015) for additional information about preemptive mitigation.

[15] The SAP should acknowledge the time-related considerations associated with determining if a short-term action level is being exceeded, and propose the respective timeframes and due dates for obtaining and reviewing data.

5.4. Determine if 3-week average indoor air TCE concentrations exceed the short-term action level.

For those buildings occupied by women of child-bearing age, the VI investigation should provide sufficient information to determine whether 3-week average indoor air TCE concentrations ever exceed the short-term action level. This is unlikely to be evident from a single indoor air sampling event unless that event coincides with a period when maximum VI impacts are occurring. Because VI impacts can vary significantly over time, and because this variability cannot be easily predicted, it is essentially impossible to schedule an indoor sampling event that can be confidently assumed to coincide with, or otherwise represent, the highest 3-week average VI impact on air quality, unless the sampling program is designed to intentionally create near-maximum VI conditions.[16] Unless TCE concentrations measured during the first sampling event exceed the short-term indoor air action level, often the investigation will require multiple sampling events.

This memorandum does not provide indoor sampling guidance. For recommendations related to sampling methodologies, please refer to:

- Ecology's Implementation Memorandum No. 21 (Ecology 2018)
- Relevant portions of the Tier II discussion in Ecology's 2009 draft VI guidance
- Section 6.4 of EPA's VI guidance (USEPA 2015)
- Recent state guidance documents, such as New Jersey's *VI Technical Guidance* (NJDEP 2018).

When the receptor of concern is a current occupant of the building, and air samples are being analyzed at an off-site laboratory, expedited turn-around times should be requested. For at least

[16] Generally, this is accomplished by inducing significant building depressurization just prior to the sampling event. Various degrees of depressurization, as well as positive pressurization, are typically induced to track indoor air concentration responses. (DOD 2017, McHugh 2017, and Johnson 2016.) The building depressurization methodologies that have utilized a blower-door approach, and have been subsequently described in the literature, can successfully meet project objectives. However, the methodology: a) is likely to be more successful at smaller and simpler buildings (architecturally, and in terms of interior design), and b) should not be assumed to result in higher, VI-caused, indoor air concentrations once significant depressurization has been achieved.

Even when conditions conducive to relatively extreme VI impacts are not intentionally created, they may fortuitously occur during a sampling event. That is, significant building depressurization may be "naturally" occurring during any given sampling event and this degree of depressurization may correspond to *worst case*-type VI-caused indoor air concentrations. At many sites and site buildings this often coincides with periods when indoor air temperatures are much higher than outdoor temperature. Continuously measuring pressure differentials of cross-slab or cross-first floor (for buildings with crawlspaces) throughout the indoor air sampling event can provide measurements that demonstrate the degree of building pressurization relative to the subsurface during the event. These measurements can be recorded regardless of the air sampling methodology used (such as canisters, passive diffusive samplers, or more real-time measuring devices).

the first sampling event, the goal should be to receive the laboratory's sampling data within three business days.

Immediately after the data have been received, they should be initially reviewed by the receiver and shared with other members of the decision-making team (such as the Ecology site manager,[17] if the responsible party's consultant receives the laboratory data). For at least the first indoor air sampling event the goal should be to share these results with the decision-making team within seven days from the time of sample collection. The objective of the decision-making team's review is to then determine, as soon as possible, if: 1) the relevant TCE short-term indoor air Action Levels listed in Table 1 are being exceeded, and 2) VI is the likely cause.

The immediate review, and the decisions arising from that review, will not have the benefit of a sampling-data quality assessment or validation. These activities will typically occur later, when the results of the sampling event are being integrated into some form of VI evaluation report. It is possible, then, that a later assessment of data quality will lead to a conclusion that VI is *not* causing short-term indoor air action level exceedances, and that the earlier determination was incorrect. However, if the receptors of concern are current occupants of the building, the importance of providing timely information to those receptors should outweigh the potential that the information provided might later need to be revised.

It should also be emphasized that this section (Section 5.0) is specifically devoted to recommendations related to the potential for short-term inhalation exposures to TCE. As discussed in Section 4.0, CLARC's VI Indoor Air Cleanup Levels for TCE are lower concentrations than action levels established to be protective of short-term indoor exposures. This is because the Indoor Air Cleanup Levels in CLARC are based on chronic VI-caused exposures. Remedial actions such as VI mitigation may therefore be needed to protect long-term indoor exposures, regardless of whether the short-term indoor air TCE action level is exceeded.

[17] If an Ecology site manager has not been assigned to the project, the results should be sent to the designated Regional contact.

6.0 Responding to Exceedances of the Short-term TCE Indoor Air Action Level

If VI is causing an exceedance of the TCE short-term indoor air action level, prompt action is needed. Such actions should be taken in consultation with the building's owner (and tenant, if applicable). Protecting people inside affected buildings is a high priority and any needed action should not be delayed. If additional, follow-up indoor air or other sampling is scheduled before the selected action is fully implemented, this sampling must be conducted in a manner that does not interfere with efforts to quickly and effectively reduce indoor exposures to TCE.

Systems for mitigating vapor intrusion

VI *mitigation* generally refers to actions whose purpose is to reduce VI-caused indoor air contamination, and these actions often focus on reducing the amount of contaminated soil gas entering the building.[18] Mitigation systems creating **depressurization** of the sub-slab zone or crawlspace will often be the most effective approach for reducing VI impacts (until subsurface cleanup permanently remediates the source of elevated soil gas concentrations). However, these types of mitigation, which are intended to minimize entry of contaminated soil gas into the building, can take weeks to design, construct, and fully implement. Additional time is then needed to demonstrate that target VOC concentrations in indoor air have actually been achieved.

Active VI mitigation systems such as sub-slab and sub-membrane depressurization are often able to reduce VI-caused TCE indoor air contamination to concentrations below the short-term action levels. But before the mitigation system has been successfully implemented, TCE concentrations will, or may, be above these levels. If a woman of childbearing age lives or works in an area of the building where elevated TCE concentrations are present, and does not re-locate, she will continue to be exposed to them. Mitigation should therefore be designed and implemented as quickly as possible,[19] and other actions should be considered that would effectively reduce exposures during the interim.

[18] Subsurface remediation, on the other hand, includes cleanup actions designed to reduce soil gas VOC levels. Although these actions will also reduce VI-caused indoor air contamination, they are not typically referred to as VI "mitigation" unless they can be implemented (and are successful) within a relatively short timeframe.

[19] The mitigator who will likely perform the work should be identified early (e.g., during the investigation's planning phase). His/her availability for constructing the mitigation system, if needed, should also be verified at this early stage.

EPA-recommended actions and MTCA cleanups

Prompt actions to reduce TCE exposures include the recommended responses described in EPA Region 9's 2014 TCE Memorandum under two headings: "Implementation of early or interim measures to mitigate TCE inhalation exposure," and "Tiered response action" (USEPA 2014). Many of the recommendations in these sections of the Memorandum are appropriate to use as a guide for selecting proper response actions in Washington state. However, three of Region 9's recommendations should be clarified in terms of their applicability at MTCA cleanup sites:

1. The recommendation to increase building pressurization/ventilation.

Positively pressurizing the building (with respect to the subsurface) can create a pressure barrier to advective flow of soil gas into the structure and mitigate VI impacts. However, it will not always be possible or sufficiently effective. Likewise, increasing ventilation can dilute VI impacts if the outdoor-to-indoor air exchange rate is increased. But it may not be practicable to increase the ventilation rate enough to reduce indoor air TCE below screening/action levels. Moreover, if the methods to increase the outdoor-to-indoor air exchange rate result in greater building depressurization, VI impacts may actually be exacerbated.

NOTE: At some buildings the owner/tenant may be able to quickly adjust HVAC settings to create these pressure or ventilation rate conditions. However, unless follow-up monitoring of indoor air quality is performed, there is no way to tell if TCE concentrations have been reduced to an acceptable level.

2. The recommendation to seal potential conduits.

It is possible that a single foundation or building feature is primarily responsible for the degree of vapor intrusion, leading to short-term indoor air TCE action level exceedances. For instance, there could be an uncovered earthen floor in part of the building. There could be an uncovered/unsealed basement, or a first floor sump or (disconnected) floor drain. There could be unsealed utility line penetrations at ground level or sub-grade. If the building has a crawlspace, there could be relatively large and unsealed first floor openings around pipes or wiring that run between the two levels. The crawlspace could also be walled-in, preventing any significant sub-floor ventilation and dilution of soil gas emissions.

Often, however, it won't be obvious where the most significant soil gas entry points are located. For this reason, conduit sealing measures are commonly combined with more effective mitigation actions.

In terms of the prompt action needed to respond to TCE action level exceedances, Ecology recommends that sealing efforts be:

a) Focused on any easily observable and obvious major routes by which soil gas is likely entering the building;
b) Only undertaken as the initial response if the sealing activity can be completed quickly; and
c) Promptly followed up with indoor air sampling to verify the sealing's effectiveness.

3. The recommendation to respond differently, based on whether the "urgent" response action level has been exceeded.

The EPA Region 9 Memorandum states that the response to exceeding an "accelerated" action level should be "completed and confirmed within a few weeks." If the higher "urgent" action level is also exceeded, the response time should be reduced to "a few days."

Ecology agrees that, all else being equal, there should be a greater sense of urgency when TCE concentrations are much higher than the short-term action level established for the site and building. It is also true that the types of responses likely to be effective will often partly depend on how high the indoor air TCE concentrations are. But Ecology believes any exceedance of the short-term action level merits prompt action. This means that once an exceedance is apparent, the site team should quickly decide on the preferred response action, and then immediately propose this action to the building's owner/tenant.

If VI is causing an exceedance of the TCE short-term indoor air action level, the action to be taken should be quickly determined in consultation with the building's owner (and, if applicable, the tenant). The goal should be to reduce TCE exposures for women of childbearing age as soon as possible. This may require that a "stop-gap" response be taken right away, while plans for long-term mitigation proceed on a parallel track. Stop-gap responses include actions such as temporarily relocating the receptor, and installing effective indoor air treatment.

Carbon-based indoor air VOC treatment devices (sometimes referred to as air purification units [APUs] or "air cleaners") can be installed relatively quickly. These devices can be used for extended periods, but their typical, or niche, VI application is temporary use. Often they are operated only while a more permanent form of mitigation is being designed/constructed. As discussed in EPA's 2017 *Engineering Issue*, which describes these devices, indoor air treatment can be accomplished with portable air cleaning units or HVAC in-duct systems (USEPA 2017).

The former usually employs a built-in air circulation fan and sorbent bed, with carbon serving as the sorbent.

Indoor air treatment devices may or may not be able to quickly reduce TCE concentrations to acceptable levels within certain airspaces. Regardless of the treatment device selected, it cannot be assumed that the installed units will *sustainably* reduce indoor air TCE to concentrations below the short-term action level. As noted in EPA's 2017 *Engineering Issue*, this must be confirmed with air sampling.[20]

[20] In the EPA 2017 *Engineering Issue* discussion of treatment systems, Attachment A lists a large number of VOC air cleaners by brand name. In 2014, California's DTSC reported use of Air Rhino and AirMedic Vocarb stand-alone air purifiers. The New Hampshire Department of Environmental Services and Massachusetts Department of Environmental Protection reported use of portable Austin HealthMate units in 2015 and 2016, respectively. (See "TCE Vapor Intrusion Case Study" presented at the 2015 NEWMOA conference, http://www.newmoa.org/events/event.cfm?m=157 and the October 2016 Field Assessment and Support Team (FAST): "An Expedited Approach to the Investigation and Mitigation of the Vapor Intrusion Pathway.").

Ecology does not endorse these particular products. We are including these references only to indicate that the products have been used in at least three states to reduce VI-caused indoor air contamination.

7.0 Working with people who are affected by vapor intrusion

This section, as well as Sections 5.0 and 6.0, discusses interactions with the owners and occupants of buildings where vapor intrusion is, or may be, contaminating indoor air with TCE. In the simplest case, the building is a single-family residence owned by the occupants. The responsible party and Ecology are then interacting primarily with a head of household. But various other scenarios are common, such as:

a. The building may be a single-family residence that is owned by someone who resides elsewhere.
b. The building may be occupied by a single business, which also owns the property.
c. The building may be occupied by a single business, which does not own the property or building.
d. The building may be occupied by multiple businesses, none, or only one, of which owns the property or building.

In some cases, the property where the building is located will be owned by the responsible party; in other cases, not.

Throughout this memorandum, we've used the term "building owners/tenants" when referring to notifications, access requests, information sharing, and other interactions with the affected public. We use this term for economy and simplicity, but recognize that owners are not always building occupants and receptors, and building occupants are not always owners or tenants. Women of childbearing age who occupy a building could be owners, tenants, employees or other workers, students, or visitors.

For communication purposes, it is helpful for the responsible party and Ecology to have no more than two designated "building contacts." Communications about scheduling building visits, obtaining access, sharing sampling data and data evaluations, and consultations concerning any response actions, can then be limited to a small number of individuals (who may or may not be potential "receptors"). It will be incumbent upon these building contacts to not only disseminate the information they receive from the responsible party and Ecology to (other) building occupants who are potentially being exposed, but to relay those occupants' concerns and questions back to us.

7.1. Outreach before indoor air sampling

As discussed in Section 5.1, any site buildings where VI may potentially result in indoor TCE concentrations above the short-term action level should be identified based on subsurface sampling and other site data. When such a building is identified and women of childbearing age are occupants, the planning, notification, and pre-sampling activities described in Section 5.3 should be performed. This includes a visit to the building itself.

In addition to obtaining the building and receptor-behavior information usually needed to prepare a VI indoor air SAP, during building visits Ecology and the responsible party should:[21]

1. Verify whether women of childbearing age regularly occupy the building. If they do (especially for non-residential buildings) the areas where these women spend most of their time, and the hours they are typically present in the building, should be ascertained.

2. Determine if women of childbearing age may be occupants in the foreseeable future, even if they're not currently present.

3. Discuss site contamination and how vapor intrusion can potentially contaminate indoor air; discuss what we propose to do next and the need for sampling access; answer their questions.

During the building visit, Ecology and the responsible party will need to be prepared for questions the occupants may have regarding potential short-term (and long-term) TCE health effects and how to reduce their exposures. Decisions should be made during the planning period (described in Section 5.3) about how and when this information should be provided, and who should communicate it.

Ecology staff are expected to only answer the most basic health-related VI questions. In general, the public should routinely be referred to local health departments or family physicians for the answers to questions that require toxicological or medical expertise.

Washington's state and local health departments are generally more familiar with local communities and their concerns than Ecology site management staff. Health departments also have more expertise at conveying health-related information. If women of childbearing age are potentially exposed to site-related TCE contamination, it is recommended that site managers and

[21] As noted in Section 5.2, this memorandum assumes Ecology will be involved throughout the VI evaluation process. When this is not the case, parties performing the site investigation and cleanup should independently complete the recommended steps outlined in this memorandum.

the responsible party rapidly coordinate with state/local health departments. These agencies can better explain potential health hazards to building occupants and/or help gain access to buildings for investigation and remediation if needed. If Ecology has assigned a Community Outreach and Environmental Education Specialist (COEES) to the site, the site manager should additionally confer with this individual during the pre-sampling period.[22]

Before any indoor air sampling can occur, the party performing that sampling must obtain the owner's/tenant's consent.[23] Typically during VI investigations, this consent is documented in an "access agreement," which also usually specifies the conditions under which access is granted. Finalizing an access agreement can occasionally be a lengthy process for various reasons. Sometimes it is difficult to make timely contact with the building owner or tenant. Sometimes the owner will elect to get the advice of legal counsel before entering into an agreement. There can be protracted negotiations regarding considerations such as access-related payment, or other site-specific issues. While securing access is normally the duty of the responsible party, Ecology may become involved with disputes or delays when the health threat relates to a short-term exposure to site contamination. The parties must realize that Ecology will make best efforts, including—if needed—exercising its legal authorities, to ensure access agreements are finalized as soon as possible.

7.2. Outreach after indoor air sampling

Indoor air sampling results, together with other lines of evidence, should indicate whether VI is causing an exceedance of the TCE short-term indoor air action level. Once the indoor air sampling data have been received from the laboratory (assuming no "real time" sampling was performed), the responsible party and Ecology should 1) discuss the results, 2) make a preliminary decision as to whether VI is likely to be resulting in a TCE short-term action level exceedance, 3) agree on next steps, and then 4) contact the building owner/tenant.

As discussed in Section 5.4, when women of childbearing age are current occupants of the building, this decision-making and outreach process should begin as soon as the data are initially received, without waiting for data quality assessment. In these cases the goal should be to quickly determine the likelihood of a TCE short-term indoor air action level exceedance and then inform building owners/tenants of the sampling results. Unless owners, tenants, and other

[22] Ecology's COEESs are typically not assigned to independent cleanup sites, including those in the Voluntary Cleanup Program (VCP). However, if a COEES has been assigned to a site where VI is causing, or may potentially result in, indoor TCE concentrations above the short-term action level, their assistance can improve communications with the owners, tenants, and occupants of the affected buildings (as well as other members of the concerned public).

[23] With limited exceptions, such as emergency situations.

concerned building occupants would prefer to wait until the quality of sampling data has been rigorously assessed and validated, they should be notified of sampling results soon after the results arrive from the laboratory.[24]

The responsible party and/or Ecology should tell the building owner/tenant what the sampling results indicate and what (at that time) the next steps should be. During this discussion, it is important to:

1. Explain how we have reached our conclusions.

2. Honestly differentiate between what is known (e.g., the results from this single sampling event), what we have inferred from the information we have collected, and what is not known, and

3. Urge the owner/tenant to share and explain these results–as well as plans for follow-up actions–with concerned building occupants. This includes all women of child-bearing age who live or work in affected portions of the building.

Coordinating with the site's assigned COEES and state/local health departments is critical at this stage and can improve the effectiveness of these communications.

If sampling data indicate that VI is likely to be causing an exceedance of the TCE short-term indoor air action level, and if a woman of childbearing age is a building occupant, the proper response should be quickly determined in consultation with the building's owner (and tenant, if applicable). Section 6.0 of this memo refers to various response actions that may apply. The selected action will depend on a number of building-specific factors, such as how high the indoor air TCE concentrations appear to be, and the preferences of the building's owner/tenant and receptors of concern. Promptly reaching, and carrying out, a mutually acceptable decision may require the involvement of state/local health departments.

If measured levels of indoor air TCE are below the action level, however, the next proposed step may simply be to schedule a re-sampling event for the future.[25]

[24] When the data are shared this quickly, the building occupants should be informed of the possibility that the implications of the sampling results could change following evaluation of the data quality. Should this occur, the owner/tenant would then be immediately notified by the responsible party and/or Ecology.

[25] Typically, a sampling report is prepared after the data have been quality assured (QA'ed) and validated. A copy of the report, and a copy of any Ecology response letter(s), should usually be provided to the building owner/tenant.

8.0 References

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Attachment A

Response to comments on the November 18, 2018, review draft of Implementation Memo No. 22: *Vapor Intrusion (VI) Investigations and Short-term Trichloroethene (TCE) Toxicity*

A public comment period was held from November 21, 2018, through January 7, 2019, for the review draft of this document. The comments received during that period helped inform modifications made to the final version of the document (dated October 1, 2019) and are summarized below. A number of editorial changes were also made to the review draft that are not reflected in this response to comments document.

1. Comments regarding the Environmental Protection Agency's (USEPA's) 2014 Memorandum: *Compilation of Information Relating to Early/Interim Actions at Superfund Sites and the TCE IRIS Assessment*, and the discussion of short-term inhalation exposures to TCE in Section 3 of Ecology's Implementation Memorandum 22. In particular, a commenter suggested clarifying in the third-to-last paragraph of this Section that the reference to EPA's 2014 Memorandum has limited applicability to certain statements made in later portions of the paragraph.

Response – To better distinguish the citation to EPA's 2014 Memorandum and that document's content from later statements in the paragraph, Ecology has made changes to the language in this part of Section 3.0, and removed the last sentence contained in the draft version of the third-to-last paragraph.

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2. Comments regarding Section 4 of Implementation Memorandum No. 22, and in particular:

a. The use of different default exposure assumptions–and different screening values–than used by EPA Region 9; and
b. Distinguishing between receptors of concern (women of child-bearing age versus the developing fetus).

Response – Implementation Memorandum No. 22's indoor air TCE action levels, listed in Table 1 of the document, are based the assumptions that a woman carrying a developing fetus could be exposed to indoor air TCE concentrations:

a) In a home for 24-hours per day, every day of the week throughout the year; and,
b) In the workplace for 45-hours per week, 260 days per year.

EPA Region 10's December 13, 2012, Memorandum, which served in part for the action levels we selected, recommends levels of 2 µg/m3 for residential settings and 8.4 µg/m3 for commercial/industrial settings. Ecology chose the same residential value for Implementation Memorandum 22. For the commercial/industrial action level, however, we opted to assume an additional five hours of weekly exposure. For this reason our commercial/industrial action level (7.5 µg/m3) is 12.5% lower than Region 10's corresponding level.

The commenter is correct that when Implementation Memorandum No. 22 refers in Section 4.1 to the protection of women of childbearing age against unacceptable short-term TCE exposures, our concern is for the developing fetus. The short-term action level concentrations cannot be assumed to be sufficiently protective of the woman herself. Ecology has therefore made changes to the third-to-last and second-to-last paragraphs of Section 4.1 to better clarify the action levels' applicability.

Since the close of the public comment period, other changes were made to Implementation Memorandum No. 22 based on comments received from Seattle & King County Public Health and Ecology's Toxics Cleanup Program. Among the substantive changes:

(1) Language was added to Section 3.0 to clarify that the "focus on women of childbearing age" includes pregnant women; and

(2) Language was added to Section 1.0 – similar to the statements in Section 5.2 – noting that when Ecology is not directly involved in the management of a cleanup site where TCE is a contaminant of concern, the parties performing the site investigation and cleanup should independently perform the Memorandum's recommended steps; and

(3) Language was added to Section 7.0 noting that Ecology's Community Outreach and Environmental Education Specialists (COEESs) are typically not assigned to independent cleanup sites, including those in the Voluntary Cleanup Program (VCP).

Appendix B
Data Validation Report

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Data Validation Report – EPA Stage 2A

September 15, 2020

Project: Carson Cleaners Vapors Intrusion Evaluation

Project Number: 200544-01.01

This report summarizes the review of analytical results for 11 air samples collected on July 23 and 24, 2020. The samples were collected by Anchor QEA, LLC, and submitted to ALS Environmental (ALS) in Simi Valley, California. The samples were analyzed for the following parameters:

- Volatile organic compounds (VOCs) by U.S. Environmental Protection Agency (EPA) method TO-15

ALS sample data group (SDG) number P2004153 was reviewed in this report. Sample IDs, matrices, and analyses are presented in Table 1.

Table 1
Sample IDs, Matrices, and Analyses

Sample ID	Lab Sample ID	Matrix	Analysis
CC-SS-01-072320	P2004153-001	Air	VOCs
CC-IA-01-072320	P2004153-002	Air	VOCs
CC-SG-01-072420	P2004153-003	Air	VOCs
CC-SS-02-072320	P2004153-004	Air	VOCs
CC-IA-02-072320	P2004153-005	Air	VOCs
CC-SS-03-072320	P2004153-006	Air	VOCs
CC-IA-03-072320	P2004153-007	Air	VOCs
CC-SG-03-072420	P2004153-008	Air	VOCs
CC-IA-04-072320	P2004153-009	Air	VOCs
CC-SG-04-072420	P2004153-010	Air	VOCs
CC-AA-00-072420	P2004153-011	Air	VOCs

Data Validation and Qualifications

The following comments refer to the laboratory's performance in meeting the quality assurance/quality control guidelines outlined in the analytical procedures. Laboratory results were reviewed using the laboratory control limits and the following guidelines:

- EPA National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2017)

Unless noted in this report, laboratory results for the samples listed in Table 1 were within quality control criteria.

Field Documentation

Field documentation was checked for completeness and accuracy. The chain-of-custody forms were signed by ALS at the time of sample receipt.

Holding Times and Sample Preservation

Samples were appropriately preserved and analyzed within holding time.

Laboratory Method Blanks

Laboratory method blanks were analyzed at the required frequencies. All method blanks were free of target analytes.

Field Quality Control

No field quality control samples were required to be collected with these samples.

Laboratory Control Samples and Laboratory Control Sample Duplicates

Laboratory control samples (LCSs) were analyzed at the required frequencies. All analyses resulted in recovery values within laboratory control limits. No laboratory control sample duplicates (LCSDs) were analyzed with these sample sets.

Matrix Spike and Matrix Spike Duplicate Samples

LCSs were analyzed in place of matrix spike (MS). Recoveries were within laboratory control limits. No matrix spike duplicate samples (MSDs) were analyzed with these sample sets.

Laboratory Duplicates

Laboratory duplicates were not analyzed with these sample sets.

Method Reporting Limits

Reporting limits were acceptable as reported. Values were reported as undiluted, or when reported as diluted, the reporting limit accurately reflects the dilution factor.

Overall Assessment

As was determined by this evaluation, the laboratory followed the specified analytical methods, and all requested sample analyses were completed. Accuracy was acceptable as demonstrated by the laboratory control sample recovery values. Precision could not be determined for this data. All data are acceptable as reported.

References

EPA (U.S. Environmental Protection Agency), 2017. *National Functional Guidelines for Superfund Organic Methods Data Review*. Office of Superfund Remediation and Technology Innovation. United States Environmental Protection Agency. EPA-540-R-2017-001. January 2017.

Appendix C
Laboratory Report

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LABORATORY REPORT

September 8, 2020

Nathan Soccorsy
Anchor QEA, LLC
720 Olive Way, Suite 1900
Seattle, WA 98101

RE: Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01

Dear Nathan:

Your report P2004153 has been amended for the samples submitted to our laboratory on July 28, 2020. The report was amended to report the EPA TO-15 analysis down to the MDL. This correction has been indicated by the "Revised Page" footer located at the bottom right corner of each affected page.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

ALS | Environmental

By Hayden Akers at 5:14 pm, Sep 08, 2020

Hayden Akers
Project Manager

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Client: Anchor QEA, LLC Service Request No: P2004153
Project: Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01

CASE NARRATIVE

The samples were received intact under chain of custody on July 28, 2020 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Volatile Organic Compound Analysis

The samples were analyzed for volatile organic compounds in accordance with EPA Method TO-15 from the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition (EPA/625/R-96/010b), January, 1999. This procedure is described in laboratory SOP VOA-TO15. The analytical system was comprised of a gas chromatograph / mass spectrometer (GC/MS) interfaced to a whole-air preconcentrator. This method is included on the laboratory's NELAP and DoD-ELAP scope of accreditation. Any analytes flagged with an X are not included on the NELAP or DoD-ELAP accreditation.

The containers were cleaned, prior to sampling, down to the method reporting limit (MRL) reported for this project. For projects requiring DoD QSM 5.1 compliance canisters were cleaned to <1/2 the MRL. Please note, projects which require reporting below the MRL could have results between the MRL and method detection limit (MDL) that are biased high.

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ALS Environmental – Simi Valley

CERTIFICATIONS, ACCREDITATIONS, AND REGISTRATIONS

Agency	Web Site	Number
Alaska DEC	http://dec.alaska.gov/eh/lab.aspx	17-019
Arizona DHS	http://www.azdhs.gov/preparedness/state-laboratory/lab-licensure-certification/index.php#laboratory-licensure-home	AZ0694
Florida DOH (NELAP)	http://www.floridahealth.gov/licensing-and-regulation/environmental-laboratories/index.html	E871020
Louisiana DEQ (NELAP)	http://www.deq.louisiana.gov/page/la-lab-accreditation	05071
Maine DHHS	http://www.maine.gov/dhhs/mecdc/environmental-health/dwp/professionals/labCert.shtml	2018027
Minnesota DOH (NELAP)	http://www.health.state.mn.us/accreditation	1776326
New Jersey DEP (NELAP)	http://www.nj.gov/dep/enforcement/oqa.html	CA009
New York DOH (NELAP)	http://www.wadsworth.org/labcert/elap/elap.html	11221
Oregon PHD (NELAP)	http://www.oregon.gov/oha/ph/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx	4068-007
Pennsylvania DEP	http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx	68-03307 (Registration)
PJLA (DoD ELAP)	http://www.pjlabs.com/search-accredited-labs	65818 (Testing)
Texas CEQ (NELAP)	http://www.tceq.texas.gov/agency/qa/env_lab_accreditation.html	T104704413-19-10
Utah DOH (NELAP)	http://health.utah.gov/lab/lab_cert_env	CA016272019-10
Washington DOE	http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html	C946

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Anchor QEA, LLC Service Request: P2004153

Project ID: Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01

Date Received: 7/28/2020

Time Received: 09:30

Client Sample ID	Lab Code	Matrix	Date Collected	Time Collected	Container ID	Pi1 (psig)	Pf1 (psig)	TO-15 - VOC Cans
CC-SS-01-072320	P2004153-001	Air	7/23/2020	00:00	SC00372	-2.74	3.86	X
CC-IA-01-072320	P2004153-002	Air	7/23/2020	00:00	SC01765	-1.15	4.17	X
CC-SG-01-072420	P2004153-003	Air	7/24/2020	11:00	AS01358	-2.65	4.71	X
CC-SS-02-072320	P2004153-004	Air	7/23/2020	00:00	AS00848	-2.92	4.28	X
CC-IA-02-072320	P2004153-005	Air	7/23/2020	00:00	SC00980	-1.67	3.80	X
CC-SS-03-072320	P2004153-006	Air	7/23/2020	12:30	SC01547	-2.69	4.09	X
CC-IA-03-072320	P2004153-007	Air	7/23/2020	00:00	SC01880	-1.40	4.02	X
CC-SG-03-072420	P2004153-008	Air	7/24/2020	00:00	AC02062	-2.85	4.24	X
CC-IA-04-072320	P2004153-009	Air	7/23/2020	00:00	SC01721	-1.87	4.66	X
CC-SG-04-072420	P2004153-010	Air	7/24/2020	12:00	AS00514	-3.00	4.31	X
CC-AA-00-072420	P2004153-011	Air	7/24/2020	11:00	AS01377	-1.99	3.75	X

Air - Chain of Custody Record & Analytical Service Request

Page 1 of 4

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10 Day-Standard

ALS Project No. P2004153

Company Name & Address (Reporting Information)	ANCHOR QEA 1201 3RD AVE, #2600 SEATTLE, WA 98101
Project Name	CARSON CLEANERS VAPOR INTRUSION EVALUATION
Project Number	200544-01.01
Project Manager	NATHAN SOCCORSY
P.O. # / Billing Information	200544-01.01 / LEISA SCHUMACHER LSCHUMACHER@ANCHORQEA.COM
Phone	206 287 9130
Fax	—
Email Address for Result Reporting	LABDATA@ANCHORQEA.COM
Sampler (Print & Sign)	STEPHEN STRETH
ALS Contact	NICOLE BRYSON

Analysis Method

Client Sample ID	Laboratory ID Number	Date Collected	Time Collected	Canister ID (Bar code # - AC, SC, etc.)	Flow Controller ID (Bar code # - FC #)	Canister Start Pressure "Hg	Canister End Pressure "Hg/psig	Sample Volume	TO-15 (VOCs) - PCE, TCE, cis 1,2DCE, trans 1-2DCE, VC		Comments e.g. Actual Preservative or specific instructions
CC-SS-01-072320	1	7-23-20		SC00372		29	5		X		
CC-IA-01-072320	2	7-23-20		SC01765		29	3		X		
CC-SG-01-072420	3	7-24-20	1100	AS01358		29	5		X		
CC-SS-02-072320	4	7-23-20		AS00848		29	5		X		
CC-IA-02-072320	5	7-23-20		SC00980		32	5		X		
CC-SS-03-072320	6	7-23-20	1230	SC01547		30	4		X		
CC-IA-03-072320	7	7-23-20		SC01880		29	4		X		
CC-SG-03-072420	8	7-24-20		AC02062		28	5		X		
CC-IA-04-072320	9	7-23-20		SC01721		30	5		X		
CC-SG-04-072420	10	7-24-20	1200	AS00514		32	7		X		DO NOT DROP BELOW 7 Hg
CC-AA-00-072420	11	7-24-20	1100	AS01377		30	5		X		

Report Tier Levels - please select

Tier I - Results (Default if not specified) X
Tier II (Results + QC Summaries) ____
Tier III (Results + QC & Calibration Summaries) ____
Tier IV (Data Validation Package) 10% Surcharge ____

EDD required Yes / No
Type: ____ Units: ____

Chain of Custody Seal: (Circle) INTACT BROKEN ABSENT

Project Requirements (MRLs, QAPP)

	Date	Time		Date	Time
Relinquished by: (Signature) STEPHEN STRETH	7-27-20	11:30	Received by: (Signature)	7/28/20	930
Relinquished by: (Signature)	Date:	Time:	Received by: (Signature)	Date:	Time:

Cooler / Blank Temperature ____ °C

5 of 20

ALS Environmental

Sample Acceptance Check Form

Client: Anchor QEA, LLC Work order: P2004153

Project: Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01

Sample(s) received on: 7/28/20 Date opened: 7/28/20 by: DENISE.POSADA

Note: This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

		Yes	No	N/A
1	Were **sample containers** properly marked with client sample ID?	☒	☐	☐
2	Did **sample containers** arrive in good condition?	☒	☐	☐
3	Were **chain-of-custody** papers used and filled out?	☒	☐	☐
4	Did **sample container labels** and/or tags agree with custody papers?	☒	☐	☐
5	Was **sample volume** received adequate for analysis?	☒	☐	☐
6	Are samples within specified holding times?	☒	☐	☐
7	Was proper **temperature** (thermal preservation) of cooler at receipt adhered to?	☐	☐	☒
8	Were **custody seals** on outside of cooler/Box/Container?	☒	☐	☐
	Location of seal(s)? _____ Sealing Lid?	☒	☐	☐
	Were signature and date included?	☒	☐	☐
	Were seals intact?	☒	☐	☐
9	Do containers have appropriate **preservation**, according to method/SOP or Client specified information?	☐	☐	☒
	Is there a client indication that the submitted samples are **pH** preserved?	☐	☐	☒
	Were **VOA vials** checked for presence/absence of air bubbles?	☐	☐	☒
	Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it?	☐	☐	☒
10	**Tubes:** Are the tubes capped and intact?	☐	☐	☒
11	**Badges:** Are the badges properly capped and intact?	☐	☐	☒
	Are dual bed badges separated and individually capped and intact?	☐	☐	☒

Lab Sample ID	Container Description	Required pH *	Received pH	Adjusted pH	VOA Headspace (Presence/Absence)	Receipt / Preservation Comments
P2004153-001.01	6.0 L Source Can					
P2004153-002.01	6.0 L Source Can					
P2004153-003.01	6.0 L Silonite Can					
P2004153-004.01	6.0 L Silonite Can					
P2004153-005.01	6.0 L Source Can					
P2004153-006.01	6.0 L Source Can					
P2004153-007.01	6.0 L Source Can					
P2004153-008.01	6.0 L Ambient Can					
P2004153-009.01	6.0 L Source Can					
P2004153-010.01	6.0 L Silonite Can					
P2004153-011.01	6.0 L Silonite Can					

Explain any discrepancies: (include lab sample ID numbers): _____

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-SS-01-072320** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-001

Test Code: EPA TO-15 Date Collected: 7/23/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC00372

Initial Pressure (psig): -2.74 Final Pressure (psig): 3.86

Canister Dilution Factor: 1.55

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	**0.23**	0.84	0.088	**0.090**	0.33	0.035	**J**
156-60-5	trans-1,2-Dichloroethene	ND	0.84	0.11	ND	0.21	0.029	
156-59-2	cis-1,2-Dichloroethene	ND	0.82	0.12	ND	0.21	0.029	
79-01-6	Trichloroethene	ND	0.84	0.11	ND	0.16	0.021	
127-18-4	Tetrachloroethene	**4.1**	0.81	0.11	**0.61**	0.12	0.016	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-IA-01-072320** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-002

Test Code: EPA TO-15 Date Collected: 7/23/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC01765

Initial Pressure (psig): -1.15 Final Pressure (psig): 4.17

Canister Dilution Factor: 1.39

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.75	0.079	ND	0.29	0.031	
156-60-5	trans-1,2-Dichloroethene	ND	0.75	0.10	ND	0.19	0.026	
156-59-2	cis-1,2-Dichloroethene	ND	0.74	0.10	ND	0.19	0.026	
79-01-6	Trichloroethene	ND	0.75	0.10	ND	0.14	0.019	
127-18-4	Tetrachloroethene	**2.3**	0.72	0.096	**0.35**	0.11	0.014	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-SG-01-072420** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-003

Test Code: EPA TO-15 Date Collected: 7/24/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Silonite Canister Volume(s) Analyzed: 0.25 Liter(s)
Test Notes:
Container ID: AS01358

Initial Pressure (psig): -2.65 Final Pressure (psig): 4.71

Canister Dilution Factor: 1.61

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	3.5	0.37	ND	1.4	0.14	
156-60-5	trans-1,2-Dichloroethene	ND	3.5	0.48	ND	0.88	0.12	
156-59-2	cis-1,2-Dichloroethene	ND	3.4	0.48	ND	0.86	0.12	
79-01-6	Trichloroethene	ND	3.5	0.46	ND	0.65	0.086	
127-18-4	Tetrachloroethene	**0.56**	3.3	0.44	**0.083**	0.49	0.066	**J**

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-SS-02-072320** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-004

Test Code: EPA TO-15 Date Collected: 7/23/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Silonite Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AS00848

Initial Pressure (psig): -2.92 Final Pressure (psig): 4.28

Canister Dilution Factor: 1.61

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	**0.13**	0.87	0.092	**0.049**	0.34	0.036	**J**
156-60-5	trans-1,2-Dichloroethene	ND	0.87	0.12	ND	0.22	0.030	
156-59-2	cis-1,2-Dichloroethene	ND	0.85	0.12	ND	0.22	0.030	
79-01-6	Trichloroethene	ND	0.87	0.12	ND	0.16	0.022	
127-18-4	Tetrachloroethene	**18**	0.84	0.11	**2.6**	0.12	0.016	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-IA-02-072320** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-005

Test Code: EPA TO-15 Date Collected: 7/23/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC00980

Initial Pressure (psig): -1.67 Final Pressure (psig): 3.80

Canister Dilution Factor: 1.42

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.77	0.081	ND	0.30	0.032	
156-60-5	trans-1,2-Dichloroethene	ND	0.77	0.11	ND	0.19	0.027	
156-59-2	cis-1,2-Dichloroethene	ND	0.75	0.11	ND	0.19	0.027	
79-01-6	Trichloroethene	ND	0.77	0.10	ND	0.14	0.019	
127-18-4	Tetrachloroethene	ND	0.74	0.098	ND	0.11	0.014	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-SS-03-072320** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-006

Test Code: EPA TO-15 Date Collected: 7/23/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC01547

Initial Pressure (psig): -2.69 Final Pressure (psig): 4.09

Canister Dilution Factor: 1.56

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.84	0.089	ND	0.33	0.035	
156-60-5	trans-1,2-Dichloroethene	ND	0.84	0.12	ND	0.21	0.029	
156-59-2	cis-1,2-Dichloroethene	ND	0.83	0.12	ND	0.21	0.030	
79-01-6	Trichloroethene	**2.6**	0.84	0.11	**0.48**	0.16	0.021	
127-18-4	Tetrachloroethene	**61**	0.81	0.11	**8.9**	0.12	0.016	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-IA-03-072320** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-007

Test Code: EPA TO-15 Date Collected: 7/23/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC01880

Initial Pressure (psig): -1.40 Final Pressure (psig): 4.02

Canister Dilution Factor: 1.41

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.76	0.080	ND	0.30	0.031	
156-60-5	trans-1,2-Dichloroethene	ND	0.76	0.10	ND	0.19	0.026	
156-59-2	cis-1,2-Dichloroethene	ND	0.75	0.11	ND	0.19	0.027	
79-01-6	Trichloroethene	ND	0.76	0.10	ND	0.14	0.019	
127-18-4	Tetrachloroethene	**3.7**	0.73	0.097	**0.55**	0.11	0.014	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-SG-03-072420** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-008

Test Code: EPA TO-15 Date Collected: 7/24/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 0.0040 Liter(s)
Test Notes: 0.0020 Liter(s)
Container ID: AC02062

Initial Pressure (psig): -2.85 Final Pressure (psig): 4.24

Canister Dilution Factor: 1.60

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	220	23	ND	85	8.9	
156-60-5	trans-1,2-Dichloroethene	ND	220	30	ND	55	7.5	
156-59-2	cis-1,2-Dichloroethene	ND	210	30	ND	53	7.6	
79-01-6	Trichloroethene	**89**	220	29	**17**	40	5.4	**J**
127-18-4	Tetrachloroethene	**41,000**	420	55	**6,100**	61	8.1	**D**

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.
D = The reported result is from a dilution.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-IA-04-072320** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-009

Test Code: EPA TO-15 Date Collected: 7/23/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: SC01721

Initial Pressure (psig): -1.87 Final Pressure (psig): 4.66

Canister Dilution Factor: 1.51

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.82	0.086	ND	0.32	0.034	
156-60-5	trans-1,2-Dichloroethene	ND	0.82	0.11	ND	0.21	0.028	
156-59-2	cis-1,2-Dichloroethene	**0.22**	0.80	0.11	**0.056**	0.20	0.029	**J**
79-01-6	Trichloroethene	**0.12**	0.82	0.11	**0.022**	0.15	0.020	**J**
127-18-4	Tetrachloroethene	**1.2**	0.79	0.10	**0.17**	0.12	0.015	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
J = The result is an estimated concentration that is less than the MRL but greater than or equal to the MDL.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-SG-04-072420** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-010

Test Code: EPA TO-15 Date Collected: 7/24/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Silonite Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes: 0.10 Liter(s)
Container ID: AS00514

Initial Pressure (psig): -3.00 Final Pressure (psig): 4.31

Canister Dilution Factor: 1.62

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.87	0.092	ND	0.34	0.036	
156-60-5	trans-1,2-Dichloroethene	ND	0.87	0.12	ND	0.22	0.030	
156-59-2	cis-1,2-Dichloroethene	ND	0.86	0.12	ND	0.22	0.031	
79-01-6	Trichloroethene	ND	0.87	0.12	ND	0.16	0.022	
127-18-4	Tetrachloroethene	**160**	8.4	1.1	**23**	1.2	0.16	**D**

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.
D = The reported result is from a dilution.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**
Client Sample ID: **CC-AA-00-072420** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P2004153-011

Test Code: EPA TO-15 Date Collected: 7/24/20
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: 7/28/20
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Silonite Canister Volume(s) Analyzed: 1.00 Liter(s)
Test Notes:
Container ID: AS01377

Initial Pressure (psig): -1.99 Final Pressure (psig): 3.75

Canister Dilution Factor: 1.45

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.78	0.083	ND	0.31	0.032	
156-60-5	trans-1,2-Dichloroethene	ND	0.78	0.11	ND	0.20	0.027	
156-59-2	cis-1,2-Dichloroethene	ND	0.77	0.11	ND	0.19	0.027	
79-01-6	Trichloroethene	ND	0.78	0.10	ND	0.15	0.019	
127-18-4	Tetrachloroethene	ND	0.75	0.10	ND	0.11	0.015	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

RESULTS OF ANALYSIS

Client: **Anchor QEA, LLC**

Client Sample ID: **Method Blank** ALS Project ID: P2004153

Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P200731-MB

Test Code: EPA TO-15 Date Collected: NA

Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: NA

Analyst: Lusine Hakobyan Date Analyzed: 7/31/20

Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 1.00 Liter(s)

Test Notes:

Canister Dilution Factor: 1.00

CAS #	Compound	Result µg/m³	MRL µg/m³	MDL µg/m³	Result ppbV	MRL ppbV	MDL ppbV	Data Qualifier
75-01-4	Vinyl Chloride	ND	0.54	0.057	ND	0.21	0.022	
156-60-5	trans-1,2-Dichloroethene	ND	0.54	0.074	ND	0.14	0.019	
156-59-2	cis-1,2-Dichloroethene	ND	0.53	0.075	ND	0.13	0.019	
79-01-6	Trichloroethene	ND	0.54	0.072	ND	0.10	0.013	
127-18-4	Tetrachloroethene	ND	0.52	0.069	ND	0.077	0.010	

ND = Compound was analyzed for, but not detected above the laboratory detection limit.

MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

ALS ENVIRONMENTAL

SURROGATE SPIKE RECOVERY RESULTS

Client: **Anchor QEA, LLC**
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Project ID: P2004153

Test Code: EPA TO-15
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date(s) Collected: 7/23 - 7/24/20
Analyst: Lusine Hakobyan Date(s) Received: 7/28/20
Sample Type: 6.0 L Summa Canister(s) / 6.0 L Silonite Canister(s) Date(s) Analyzed: 7/31/20
Test Notes:

Client Sample ID	ALS Sample ID	1,2-Dichloroethane-d4 Percent Recovered	Toluene-d8 Percent Recovered	Bromofluorobenzene Percent Recovered	Acceptance Limits	Data Qualifier
Method Blank	P200731-MB	**99**	**100**	**100**	70-130	
Lab Control Sample	P200731-LCS	**99**	**98**	**100**	70-130	
CC-SS-01-072320	P2004153-001	**99**	**99**	**98**	70-130	
CC-IA-01-072320	P2004153-002	**99**	**99**	**99**	70-130	
CC-SG-01-072420	P2004153-003	**100**	**100**	**98**	70-130	
CC-SS-02-072320	P2004153-004	**98**	**98**	**99**	70-130	
CC-IA-02-072320	P2004153-005	**100**	**100**	**97**	70-130	
CC-SS-03-072320	P2004153-006	**99**	**99**	**97**	70-130	
CC-IA-03-072320	P2004153-007	**97**	**99**	**98**	70-130	
CC-SG-03-072420	P2004153-008	**99**	**100**	**99**	70-130	
CC-IA-04-072320	P2004153-009	**99**	**98**	**97**	70-130	
CC-SG-04-072420	P2004153-010	**96**	**100**	**98**	70-130	
CC-AA-00-072420	P2004153-011	**99**	**99**	**96**	70-130	

Surrogate percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly from the on-column percent recovery.

ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY

Client: **Anchor QEA, LLC**
Client Sample ID: **Lab Control Sample** ALS Project ID: P2004153
Client Project ID: **Carson Cleaners Vapor Intrusion Evaluation / 200544-01.01** ALS Sample ID: P200731-LCS

Test Code: EPA TO-15 Date Collected: NA
Instrument ID: Tekmar AUTOCAN/Agilent 5975Cinert/6890N/MS16 Date Received: NA
Analyst: Lusine Hakobyan Date Analyzed: 7/31/20
Sample Type: 6.0 L Summa Canister Volume(s) Analyzed: 0.125 Liter(s)
Test Notes:

CAS #	Compound	Spike Amount µg/m³	Result µg/m³	% Recovery	ALS Acceptance Limits	Data Qualifier
75-01-4	Vinyl Chloride	212	**209**	**99**	61-129	
156-60-5	trans-1,2-Dichloroethene	214	**217**	**101**	65-122	
156-59-2	cis-1,2-Dichloroethene	212	**213**	**100**	64-120	
79-01-6	Trichloroethene	216	**208**	**96**	70-114	
127-18-4	Tetrachloroethene	208	**213**	**102**	64-120	

Laboratory Control Sample percent recovery is verified and accepted based on the on-column result.
Reported results are shown in concentration units and as a result of the calculation, may vary slightly.