# Health Consultation

MODESTO DRY CLEANER INVESTIGATION:
"Jerry's Drapery Service" and "Hi-Grade Drive-In Cleaners"
MODESTO, CALIFORNIA

**Prepared by:**

**Site Assessment Section**
**California Department of Public Health**
**under a Cooperative Agreement with the**
**U.S. Department of Health and Human Services –**
**Agency for Toxic Substances and Disease Registry**

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## Abbreviations and Acronyms

ATSDR - Agency for Toxic Substances and Disease Registry
Cal-EPA - California Environmental Protection Agency
CDPH - California Department of Public Health
CREG - cancer risk evaluation guide
DTSC - (California) Department of Toxic Substances Control
EPA - U.S. Environmental Protection Agency
HQ - hazard quotient
$\mu g/m^3$ - micrograms per cubic meter
LOAEL – Lowest Observed Adverse Effect Level
MRL - minimal risk level (ATSDR)
NOAEL – No Observed Adverse Effect Level
PCE - tetrachloroethylene, PERC
RfC - reference concentration RSL - regional screening level
RMEG – reference dose media evaluation guide
SL - screening level
SVE - soil vapor extraction (system)
TCE - trichloroethylene
VOC – volatile organic compound

## Summary

**INTRODUCTION**

The Site Assessment Section (SAS) of the California Department of Public Health (CDPH) is working with the federal Agency for Toxic Substances and Disease Registry (ATSDR) under a cooperative agreement to investigate releases of hazardous waste and evaluate if contamination could harm public health.

In April 2010, the California Environmental Protection Agency's (Cal-EPA) Department of Toxic Substances Control (DTSC) asked SAS for help in responding to a community member in Modesto. The person had health concerns about potential exposures to volatile organic compound (VOC) releases from dry cleaning operations near their home. SAS staff met with the person and responded to the concerns. In addition, SAS reviewed the entire data set available for dry cleaner releases in Modesto. Twenty-three sites were identified and will be evaluated in health consultations. This health consultation provides more information about releases near two of these dry cleaners: former "Jerry's Drapery Service" (123 Phoenix, "Jerry's") and former "High-Grade Drive-In Cleaners" (1915 Yosemite Blvd, "Hi-Grade").

It is very important to CDPH and ATSDR that the Modesto community has all available information about potential exposures from former dry cleaners. We are committed to providing the best scientific information available and to promoting the health of the community.

The Jerry's and Hi-Grade dry cleaners operated from 1971-1973 and 1959 to the early 1980s, respectively. Since 2001, the City of Modesto has investigated volatile chemicals released from dry cleaners into the local soil and groundwater, including releases at Jerry's and/or Hi-Grade. Sometimes volatile chemicals can enter buildings by way of soil gas, a process called "vapor intrusion." SAS evaluated soil gas and indoor air data to determine if exposures from breathing indoor air might pose health risks for nearby residents or workers in these former dry cleaning buildings.

SAS reached two conclusions about the former Jerry's and Hi-Grade dry cleaners.

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| **CONCLUSION 1** | There is not enough information to determine whether breathing PCE in indoor air at the former Hi-Grade or Jerry's buildings, at 1925 Yosemite Blvd., in homes or other buildings nearby, could have harmed people's health if the exposure lasted for a long time (years). However, based on the high concentration of PCE in soil gas at some locations (2002-2016), it is likely that concentrations of PCE in indoor air were elevated in some buildings. |
| **BASIS FOR CONCLUSION 1** | High concentrations of PCE were found in soil gas at 5 ft. depth in the past (up to 700,000 $\mu g/m^3$). However, indoor air measurements were only available for one location and one sampling event (1925 Yosemite Blvd on 7/17/2012). This is not sufficient to determine representative indoor air conditions for long term exposures for workers in this building, other workers in nearby buildings, or residents in other buildings, in the past or present. PCE was found at low concentrations indoors, but the sources (vapor intrusion or other indoor sources) cannot be determined. The conditions that cause vapor intrusion differ from building to building (slab on grade, crawl space, heating and ventilation settings) and indoor air concentrations cannot be predicted from soil gas concentrations alone. The concentrations of PCE in indoor air in homes, the former Jerry's and Hi-Grade buildings, or in other buildings for this period are unknown and SAS is unable to quantify the health risks based on soil gas concentrations. |
| **NEXT STEPS FOR CONCLUSION 1** | SAS recommends that<br>1. The City of Modesto, under DTSC oversight, offers sampling of indoor air in homes and businesses in locations where the estimated PCE concentration in indoor air (based on 5 ft. soil gas concentrations) exceeds the DTSC Screening Level of 2 $\mu g/m^3$ for businesses or 0.46 $\mu g/m^3$ for homes. This is currently the case for buildings within an approximate radius of 500 ft. from Hi-Grade. Indoor air should be collected during multiple seasons and together with soil gas samples.<br>2. The City of Modesto, under DTSC oversight, delineates the soil gas plume: the area where the estimated PCE concentration in indoor air (based on 5 ft. soil gas concentrations) exceeds the DTSC Screening Level of 2 $\mu g/m^3$ for businesses or 0.46 $\mu g/m^3$ for homes. The corresponding soil gas concentrations are 67 $\mu g/m^3$ for businesses and 15 $\mu g/m^3$ for homes.<br>3. Workers and residents review the factsheets on vapor intrusion included in this health consultation and determine if they can take simple steps, such as increasing ventilation, to reduce potential exposures and improve |

indoor air quality.

4. Workers or residents who might have been exposed in the past, and who have health or exposure concerns related to these dry cleaners, might want to contact their physician and give them a copy of this health consultation. The physician may contact SAS and we can refer them to additional resources.

SAS will continue to reach out to the community near the dry cleaners under investigation to determine the community's outreach and information needs. SAS can offer printed material, community meetings or educational workshops, depending on the community's preference.

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| **CONCLUSION 2** | Estimated PCE concentration in indoor air (based on 2016 soil gas concentrations at 5 ft. depth) exceeded the DTSC-Screening Level for homes (0.46 $\mu g/m^3$) and businesses (2 $\mu g/m^3$) after the soil vapor extraction system (SVE) ran for one year and was turned off. |
| **BASIS FOR CONCLUSION 2** | The most recent soil gas data from 2016 showed that estimated PCE concentrations in indoor air exceeded the DTSC-Screening Level for businesses of 2 $\mu g/m^3$ in five out of six sampling locations, and the DTSC-SL for homes of 0.46 $\mu g/m^3$ in all sampling locations. The SVE was supposed to run for 24 months but only ran for 12 months (January 2014 – January 2015) due to licensing delays and subsequent vandalism. |
| **NEXT STEPS FOR CONCLUSION 2** | SAS recommends that<br>1. The City of Modesto, under DTSC oversight, continues operation of the SVE until soil gas concentrations are stably below the concentration which correlates to the indoor air DTSC-Screening Level for businesses of 2 $\mu g/m^3$ or 0.46 $\mu g/m^3$ for homes.<br><br>SAS will work with DTSC and the City of Modesto to periodically review indoor air and soil gas data as needed, to ensure that the vapor intrusion remediation and mitigation measures are effective and indoor air concentrations for VOCs are safe for workers and residents.<br><br>SAS plans to write health consultations for the remaining 19 dry cleaners that were identified. |

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| **LIMITATIONS** | Indoor air samples were available for only one commercial building that was sampled once in 2012. Indoor air samples are not available for the former Hi-Grade or Jerry's building, or for any homes. No current soil gas information is available: the most recent data sets are from 2016. The extent of the volatile organic compound (VOC) plume in soil gas is unknown due to insufficient soil gas data. |
| **FOR INFORMATION** | If you have questions about this health consultation, you may contact Sarah Kuo, CDPH at Sarah.Kuo@cdph.ca.gov or at (510) 620-3671 |

## Background and Statement of Issues for the Modesto Dry Cleaner Investigation: "Jerry's" and "Hi-Grade Cleaners"

The Site Assessment Section (SAS) within the California Department of Public Health (CDPH) prepared this Health Consultation (HC) under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). SAS investigates releases of hazardous wastes and evaluates if contamination could harm public health. We want the Modesto community to have all available information about potential exposures to tetrachloroethylene (PCE) from 23 former dry cleaners and we are committed to providing the best scientific information available and to promoting the health of the community.

Since 2001, the City of Modesto has investigated contaminants released from dry cleaners into the local soil and groundwater. Starting in 2002, the City and the California Department of Toxic Substances Control (DTSC) entered into oversight agreements to investigate and cleanup former dry cleaner sites. Under these agreements and DTSC oversight, the City has conducted investigations at several dry cleaners to determine PCE concentrations in soil, soil gas, groundwater, and indoor air. At several former and current dry cleaners, the City built mitigation systems to remove PCE from the subsurface and potentially improve indoor air and groundwater conditions. This was done under the Voluntary Cleanup Agreement for the former Service Cleaners, which was amended in October of 2011 to include Jerry's and Hi-Grade [1].

In April 2010, DTSC requested assistance from SAS to help in responding to a Modesto community member who had health concerns about potential exposure to volatile organic compound (VOC) releases from dry cleaning operations near their home. DTSC and the city provided us with environmental data collected at or near various dry cleaners throughout Modesto. SAS responded to the initial request of the community member, and later reviewed the entire dataset. We identified 23 dry cleaners where concentrations of PCE in soil gas exceeded the DTSC Screening Level (DTSC-SL) for soil gas (residential, current use) of 230 micrograms per cubic meter ($\mu g/m^3$) [2]. Appendix A includes a map showing those dry cleaners (Figure A1). We began public health assessment activities to investigate vapor intrusion concerns from releases near these 23 dry cleaners, reached out to the Modesto community (see below), and determined what information the community wants regarding vapor intrusion.

In February 2018, CDPH and ATSDR published the HC for Service Cleaners and Sparkleen Laundry. This document serves as a template for the remaining evaluations and is available on our SAS webpage (http://cdph.news/SAS) in English and Spanish, together with information on vapor intrusion. The second HC focuses on the former "Jerry's Drapery Service" (123 Phoenix Avenue, "Jerry's") and former "High-Grade Drive-In Cleaners" (1915 Yosemite Blvd, "Hi-Grade") (Figure 1). SAS plans to write additional HCs for the remaining 19 dry cleaners. The HCs will evaluate the potential for exposures from vapor intrusion and identify actions needed to protect public health. Following the completion of the HCs, we initially proposed writing a public health assessment. However, ATSDR determined that a public health assessment would not provide additional information about exposures or actions to protect people's health.

Throughout this process, the community can contact us with questions and concerns. SAS can provide printed materials, community meetings or educational workshops, depending on the preference of the community.

Site history
Jerry's operated from 1971 to 1973. The site, which according to building department records includes addresses 119, 121, and 123 Phoenix Ave, was occupied by Tuner Service Co TV Repair from 1974 to at least 1986. Prior to Jerry's, there was a coin-operated laundry called Econ-O-Wash at the address from the late 1950s to the early 1960s. Hi-Grade operated from about 1959 to the early 1980s when the building appears to have been demolished. The site was a used car sales lot from approximately 1983 to 2010 when the used car lot structures were also demolished. The site is currently vacant, fenced, and mostly paved [3]. SAS evaluated the available data for Jerry's and Hi-Grade together because they are located close to each other.

Soil
The lithology of the soils found at the site from the ground surface to approximately 80 ft. below ground surface (bgs) is a mixture of soil types ranging from clay to gravelly sand.

Hydrogeology
Based on groundwater samples collected in 2002, the first occurrence of groundwater at the former Hi-Grade and Jerry's sites was observed at a depth of approximately 64 ft. bgs. The water table aquifer in the Modesto area includes both consolidated and unconsolidated alluvial sediments. Groundwater is typically first encountered at depths ranging from 35 to 65 ft. bgs in the alluvial sediments in the Modesto area [3].

## Community Concerns and Outreach Activities

We contacted the communities near the 23 dry cleaners through informal interviews during site visits and public availability meetings. We also met with representatives of the City of Modesto, the Stanislaus County Department of Public Health and Environmental Resources, and Modesto physicians. During these outreach activities, SAS received calls from community members concerned about the safety of their drinking water, soil, and air. We responded to each community member, explained that this investigation is focused on the inhalation pathway from vapor intrusion, and provided them with a contact in the City of Modesto's Drinking Water Program. We explained that community members are not likely to come into contact with soil contaminated by VOC releases from dry cleaners. That is because the sites do not have bare or unpaved soil, or the dry cleaners have perimeter area fencing that prevents access to the soil.

In October 2018, we met with community members in Modesto and other cites, to determine what information the communities would like to receive regarding vapor intrusion (see below) and by what means. Based on this information, we revised our Vapor Intrusion Webpage (http://cdph.news/vaporintrusion).

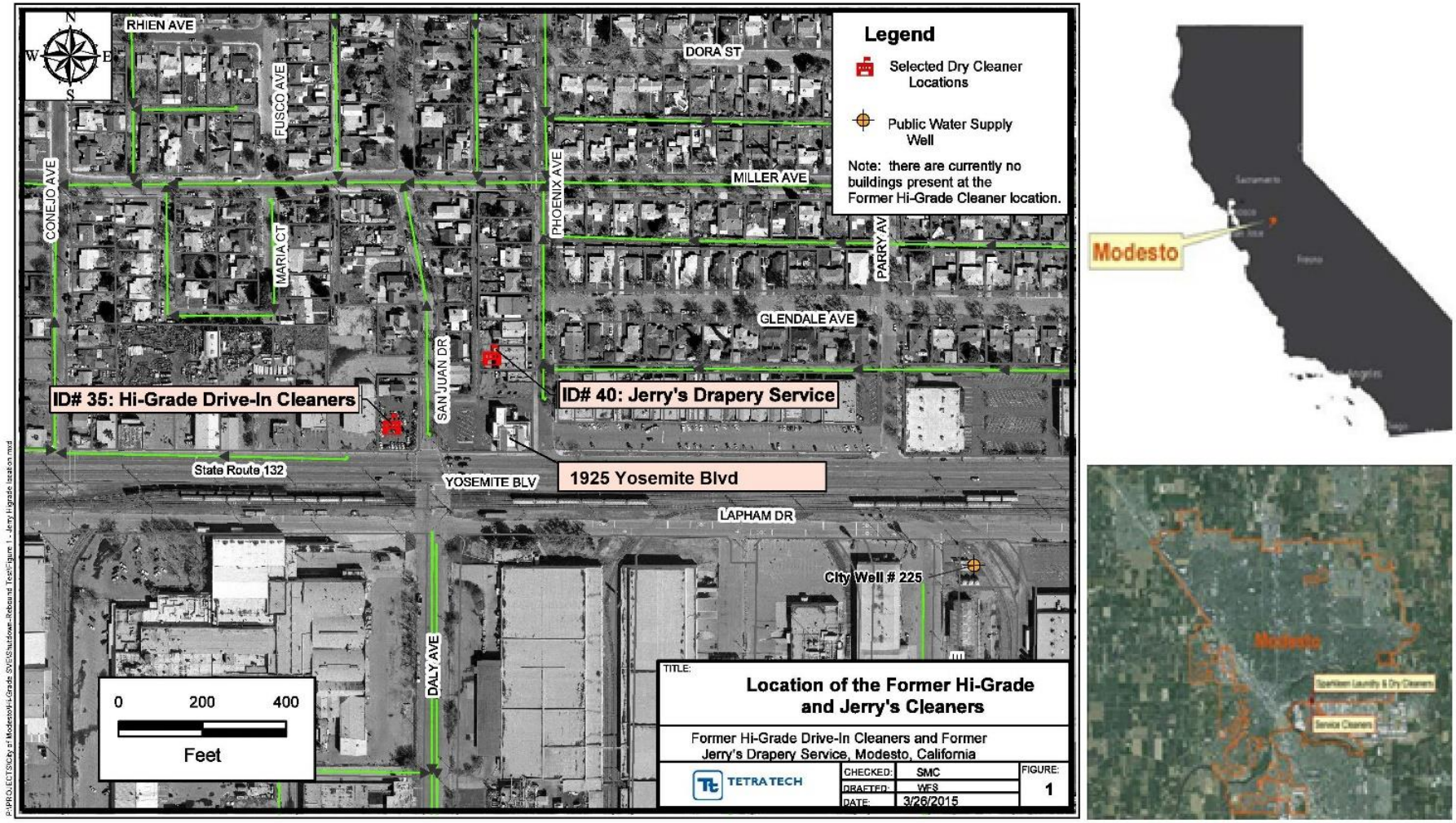


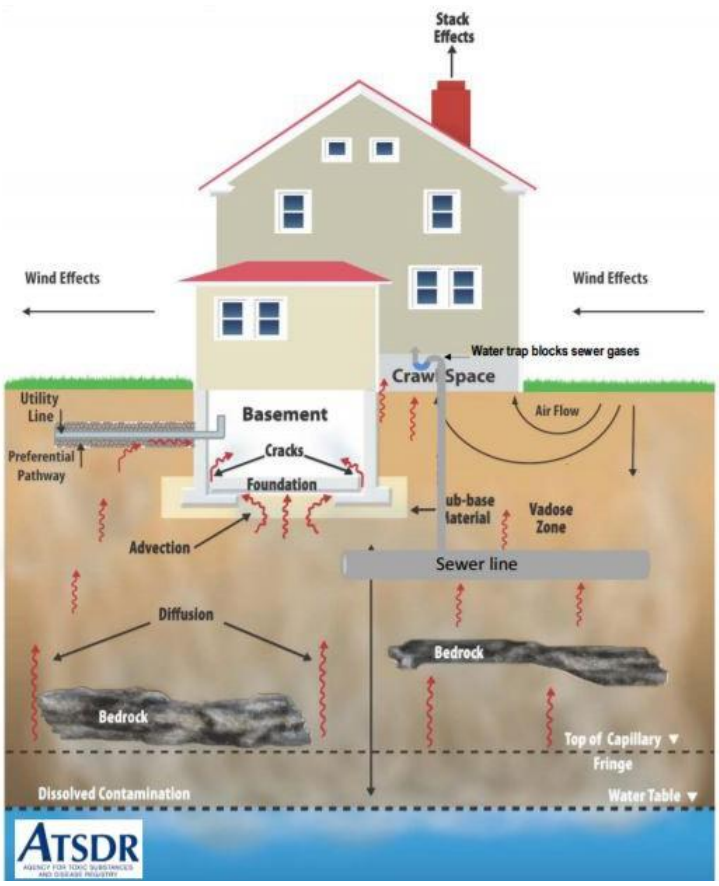

**Figure 1. Locations of the Former Jerry's and Hi-Grade Cleaners**

[4]

## The Vapor Intrusion Pathway

For this investigation, SAS looked at how soil contamination could affect the indoor air in nearby homes and the former dry cleaner buildings through a process called “vapor intrusion.” Vapor intrusion occurs when solvents in soil release gases into air spaces. This “soil gas” can travel under buildings and enter buildings through cracks in the slab, foundation, or basement floor; through sewer lines, or through other openings. Solvents in groundwater can also contribute to soil gas. The City of Modesto and DTSC are investigating how soil, soil gas, and groundwater were affected by the releases in the past. Figure 2 shows how contamination from below ground can enter homes. Many factors determine whether soil gas can enter a building, including the following:

- the soil type and moisture content (how much water is in the soil)
- the air conditioning/heating settings in the building
- how long residents keep the windows open (ventilation rate)
- the type and condition of the floor (presence of a basement, crawl space or slab on grade, how many cracks in the concrete, holes for utilities)




**How did the dry cleaners contaminate the soil?**

All soils contain numerous tiny air pockets (soil gas), like the air spaces in a sponge. When dry cleaning solvents were released into the soil, these solvents evaporated and PCE vapor moved into the soil gas.

**What happens to the PCE in soil gas?**

The gas can move through the soil and through cracks and openings in foundation slabs, entering the indoor air of homes, a process called “vapor intrusion.”

**Figure 2. Vapor Intrusion Pathways**

[5]

To best evaluate vapor intrusion concerns, we used many sources of information. These included the site history, indoor air and soil gas samples, soil type, sampling depth, and the type and condition of foundation. This is called a "multiple lines of evidence" approach. SAS used indoor air when available, and soil gas data from 5 ft. depth.

The dry cleaning solvent detected at the highest concentrations is called tetrachloroethylene, perchloroethylene, perc or PCE. Over time, PCE can break down into other chemicals, such as trichloroethylene (TCE) and vinyl chloride.

**Tetrachloroethylene or PCE**

Many household cleaning products, solvents, and paint thinners contain tetrachloroethylene (PCE). The U.S. Environmental Protection Agency (EPA) found an average concentration of 20.7 $\mu g/m^3$ (microgram per cubic meter) of PCE in 2,195 measurements of indoor air in homes taken from 1990-2005 [6]. A 2009 study of 108 new homes in California found an average of 0.6 $\mu g/m^3$ PCE in indoor air [7]. It is very hard to determine what part of PCE in a home or work place is from vapor intrusion and how much is from outdoor air or household products. PCE and its breakdown products are commonly found in outdoor air in areas where vapor intrusion is not a concern. In 2013, the median outdoor PCE concentration at 117 monitoring stations nationwide was 0.08 $\mu g/m^3$ [8]. Possible indoor sources for PCE in indoor air include, but are not limited to, dry-cleaned clothes, cleaning materials, and solvents.

## Investigation and Cleanup Activities at Jerry's and Hi-Grade

Starting in 2001, the City of Modesto collected soil gas and other environmental data to investigate dry cleaner releases throughout Modesto [9]. In this HC, we evaluated soil gas data from 2002-2016 and indoor air data from 2012.

Soil gas

Soil gas samples are collected by inserting a hollow probe into the soil and drawing the vapors out with a vacuum pump. Soil gas samples were collected by the City of Modesto from depths of 5 - 55 ft. at many locations in 2002, 2012, and from 2014 - 2016. Figures A2-A4 in Appendix A show locations for soil gas samples taken between 2012 and 2016. Generally, the soil gas samples collected closest to the dry cleaners and deeper than 10 ft., had the highest concentrations of PCE: up to 2,600,000 $\mu g/m^3$ at 55 ft. in 2002 [9], up to 1,500,000 $\mu g/m^3$ at 23 ft. in 2012 [4], and up to 650,000 $\mu g/m^3$ at 45 ft. in 2014 [10]. The highest concentration of PCE at 5 ft. was 700,000 $\mu g/m^3$ in 2012 [4]. Table B4 in Appendix B list the PCE concentrations in soil gas samples closest to the surface, at 5 ft. depth.

Soil Vapor Extraction System (SVE)

The high concentrations of PCE in soil gas resulted in the 2012 sampling of indoor air in one commercial building and the installation of a large pilot soil vapor extraction (SVE) system by

the City of Modesto under DTSC oversight. This system removes soil gas from the ground and prevents soil gas from entering nearby buildings. The soil gas is cleaned before it is released. From January 31, 2014 through January 30, 2015, 12 soil vapor extraction wells (Appendix A, Figure A2) operated continuously with temporary shut downs for repairs and maintenance. About 200 pounds of PCE were removed from soil gas [11]. In January 2015, the SVE system was shut down to comply with permitting requirements from the San Joaquin Valley Air Pollution Control District (SJVAPD). Delays in the permitting process and subsequent vandalism of the SVE equipment have prevented the system from being restarted [11] to complete the 24 months pilot test. After the shutoff, the concentrations of PCE in soil gas have increased at all locations within a radius of 250 ft. of the dry cleaners. At one location, PCE concentrations at 5 ft. depth increased from 29 $\mu g/m^3$ (4/30/2015) to 360 $\mu g/m^3$ (8/5/2015). The most recent measurement for this location was 129 $\mu g/m^3$ (1/28/2016) (IA4-VMP-2, Appendix B, and Table B3). The highest PCE concentration in soil gas after the SVE was shut off was 12,000 $\mu g/m^3$ found at 5 ft. depth (IA4-VMP-2) [11]. One breakdown product from PCE was detected in one soil gas sample at 5 ft. depth: TCE was found at 7.9 $\mu g/m^3$ at IA4-VMP-7, (5/9/2012) [4]. Vinyl chloride or other breakdown products were not detected in soil gas at 5 ft. In addition to dry-cleaning related compounds, other VOCs were detected in soil gas (Appendix B, Table B4).

Indoor air

On July 17, 2012, TetraTech, under the direction of the City of Modesto, collected indoor air samples at 1925 Yosemite Boulevard. This property is a commercial building used as a training center and is located across the former Hi-Grade building. Air samples were collected in 6-liter Summa canisters (a stainless-steel vacuum container). Summa canisters were placed in the bathroom, the training room, and in the main office area. The PCE concentrations found were 2.4 $\mu g/m^3$, 1.1 $\mu g/m^3$, and 1.0 $\mu g/m^3$, respectively (Appendix B, Table B3). Breakdown products from PCE were not detected in any of the indoor air samples [4]. In addition to PCE, other VOCs were detected in soil gas (Appendix B, Table B2). Of these, none exceeded the DTSC Screening Level for workers (see below).

Outdoor air

One outdoor (ambient) air sample was collected at 1925 Yosemite Boulevard on 7/17/2012. PCE or its breakdown products were not detected, but petroleum-related VOCs were found (Appendix B, Table B1, B2) [4].

## Exposure Evaluation

Current exposures to workers or residents could not be evaluated because indoor air measurements are not available. Past exposures for residents could not be evaluated because indoor air measurements are not available. Past exposures of workers could not be thoroughly evaluated because indoor air measurements were collected only once in 2012, in one building near the former dry cleaners. Overall, the available data sets are not sufficient to draw conclusions regarding long term exposures or potential health effects for workers or residents. SAS evaluated the available indoor air data and the available soil gas data to determine the

potential for vapor intrusion.

**Workers at 1925 Yosemite Blvd. on July 17, 2012**

The indoor air measurements were compared with screening levels (SL) that are considered safe for workers: the DTSC-SL for workers is 2.0 µg/m$^3$ for potential cancer outcome and 180 µg/m$^3$ for non-cancer outcomes. Note that in 2019, DTSC changed the non-cancer SL for PCE from 150 µg/m$^3$ to 180 µg/m$^3$ [2]. We evaluated the potential cancer risk and non-cancer outcomes.

The potential cancer risk is calculated using the measured indoor air concentration and the California-specific toxicity factors in EPA's RSL calculator (Appendix C). The result is the estimated additional cancer risk per 1 million people exposed over a lifetime to this concentration. As a baseline or starting point toward further evaluation and risk management, the "point of departure" risk is one additional cancer case in 1 million people (1.0E-06).

To evaluate non-cancer health concerns, we calculated the ratio of contaminant concentration to the DTSC-SL, known as the "hazard quotient" (HQ)[1]. A hazard quotient above 1 indicates a potential for non-cancer health concerns from long-term exposures (years). However, a hazard quotient above 1 does not necessarily mean that adverse health effects will occur.

**Table 1: Indoor air concentrations of PCE and exposure evaluation**

| Sampling Date | Location | PCE in Indoor Air (µg/m$^3$)* | Non-cancer outcome (Hazard Quotient) | Cancer outcome (risk) |
|---|---|---|---|---|
| 7/17/2012 | Restroom | 2.4 | <1 | 1.2 E-06 |
| 7/17/2012 | Classroom | 1.1 | <1 | < 1E-06 |
| 7/17/2012 | Office | 1.0 | <1 | < 1E-06 |

*DTSC SL for workers: non-cancer: 180 µg/m$^3$, cancer: 2.0 µg/m$^3$ [4]

If these concentrations represented long-term exposures (years), the potential cancer risks are below the point of departure risk for the office and classroom. Only the sample in the bathroom slightly exceeded the DTSC SL for cancer (risk of 1.2 in one million) and none of the PCE concentrations exceeded the non-cancer SL. However, based on this single sampling event we cannot draw conclusions about long-term exposures. Breakdown products from PCE were not

[1] Cal-EPA's DTSC: Human Health Risk Assessment Note 3:
"Ratios of the concentration of a particular chemical in a medium (e.g. soil, water, or air) to its risk-based concentration are calculated and the ratio is summed across all chemicals and media to estimate a total risk and hazard for the site." - https://www.dtsc.ca.gov/AssessingRisk/upload/HHRA-Note-3-June-2018.pdf

detected.

**Use of soil gas data to determine the potential for vapor intrusion**

It is difficult to determine what indoor air concentrations can be expected based only on soil gas concentrations. Per ATSDR guidance, no specific conclusions about health hazards (cancer risk or non-cancer hazard) can be drawn from estimates modeled on soil gas alone. Please refer to page 12 of the Service-Sparkleen HC on our webpage (https://goo/gl/rviVvS), for a more detailed discussion.

To determine if a vapor intrusion concerns exists, SAS used the soil gas concentrations and the following steps:

1. The soil gas concentrations at 5 ft. depth were multiplied with 0.03, EPA's "Recommended Vapor Attenuation Factor for Risk-based Screening of the Vapor Intrusion Pathway" for near source, exterior soil gas [12]. This attenuation factor is based on EPA's analysis of 913 buildings with vapor intrusion concerns. It relates the soil gas concentration to the estimated indoor air concentration.
2. The estimated indoor air concentration is used to screen sites for further evaluation. SAS used the DTSC-Modified Screening Levels (DTSC-SLs) for indoor air [2], since the DTSC-SLs are lower (more health protective) than ATSDR's Cancer Risk Evaluation Guide (CREG) of 3.8 $\mu g/m^3$. The DTSC-SLs for cancer outcome represent the concentration of a chemical in air associated with a one in a million risk (1.0E-06) for developing cancer from that chemical (point of departure risk). The DTSC-SL for PCE in a commercial setting (business) is 2 $\mu g/m^3$; the DTSC-SL for a residential setting (home) is 0.46 $\mu g/m^3$.
3. If the estimated indoor air concentration is above the DTSC-SL of 2 $\mu g/m^3$ for businesses or 0.46 $\mu g/m^3$ for homes, vapor intrusion could be a concern for nearby buildings, and further investigation is needed. Based on the DTSC-SLs and the EPA attenuation factor, we also calculated the corresponding soil gas concentrations for businesses: 67 $\mu g/m^3$ (2.0 $\mu g/m^3$ / 0.03), and for homes: 15 $\mu g/m^3$ (0.46 $\mu g/m^3$ / 0.03).

**Soil gas data from 2002 and 2012-2016**

*2002*

The evaluation of the 2002 soil gas data showed vapor intrusion could be a concern and that further investigation of vapor intrusion near Jerry's and Hi-Grade was needed (Appendix A, Figure A2, Appendix B, Table B3).

*2012-2016*

A total of 69 soil gas samples were collected during 2002-2016 at 5 ft. depth from seven locations along Yosemite Boulevard, San Juan Drive, Phoenix Avenue, and an alleyway behind Jerry's (Appendix B, Table B3; locations shown in Appendix A, Figure A2). PCE was found at concentrations ranging from 14 $\mu g/m^3$ (about 250 ft. North East of Hi-Grade at IA-VMP-5 in April of 2015) to 700,000 $\mu g/m^3$ (less than 50 ft. West of Hi-Grade at IA4-VMP-2 in May of 2015) (Appendix B, Table B3). Soil gas sampling locations closest to Hi-Grade (IA4-VPM-1, -2, -4, -10) in 2012-2014 had the highest PCE concentrations. PCE concentrations dropped

significantly during the operation of the SVE, specifically in soil gas locations close the dry cleaners. PCE concentrations at locations farthest from Hi-Grade (IA4-VMP-7, 8, and 9) and from 2014 on, were lower. PCE concentrations increased after the SVE was turned off. The estimated indoor air concentration from 67 out of 69 soil gas samples exceeded the DTSC SL for homes (0.46 $\mu g/m^3$). The DTSC-SL for businesses was exceeded in 63 out of 69 samples (Appendix B, Table B3). The distance of the soil gas sampling locations to the nearest home varied from less than 50 ft. to about 100 ft.

TCE was found at only one location at 5 ft. (IA4-VMP-7, 125 ft. 375 ft. Northeast of Hi-Grade in May of 2012) at a concentration of 7.9 $\mu g/m^3$. Additional breakdown products of PCE such as 1,2 DCE, 1,1 DCE, and vinyl chloride were not found in any soil gas samples.

In 2016 (after the SVE was shut off) all six sampling locations had soil gas concentrations where the estimated indoor air concentration exceeded the DTSC-SL for homes, and five out of six soil gas locations exceeded the DTSC-SL for businesses. The only location below the DTSC-SL of 2 $\mu g/m^3$ was 250 ft. east of Hi-Grade at IA4-VMP-6. Since the indoor air concentrations at all locations are estimated to be above the DTSC-SL for homes, indoor air samples should be collected and the potential for vapor intrusion should be further evaluated.

In addition to PCE, other VOCs were identified in soil gas at 5 ft. depth (Appendix B, Table B4). Particularly, chemical compounds belonging to the Total Petroleum Hydrocarbon (TPH) family were detected. The estimated indoor air concentrations are discussed below:
Benzene exceeded ATSDR's CREG of 4.3 $\mu g/m^3$ at soil gas sampling locations IA4-VMP-2,-6, and IA4-SB-5. The highest concentration was measured at IA4-VMP-6 at 270 $\mu g/m^3$ in May of 2012 (indoor air estimate of 8.1 $\mu g/m^3$). Benzene concentrations seemed to be higher around 15 ft. depth, and closer to Jerry's (IA4-VMP-6, -11, and IA4-SB-5). Other TPH compounds including xylenes, toluene, 2-butanone, acetone, were detected, but did not exceed screening levels. According to ATSDR's Public Health Statement on TPH, TPH compounds are generally introduced into the environment through the variety of crude oils and petroleum-based products such as gasoline, kerosene, fuel oil, mineral oil, and asphalt. TPH are also a light non-aqueous phase liquids (LNAPLs) which mean that they have a lower density than water and are likely to "float" on top of the groundwater [13].
Chlorinated compounds such as chloroform were also found at 5 ft. depth. Concentrations for chloroform exceeded ATSDR's CREG of 1.4 μg/m3 at IA4-VMP-5, -7, and IA4-SB-5. The highest concentration of chloroform was 280 $\mu g/m^3$, found at IA4-SB-5 in October of 2002 (indoor air estimate of 8.4 $\mu g/m^3$). Chloroform concentrations were higher at soil gas samples below 45 ft. and seemed to be highest to the East of Jerry's, away from Hi-Grade. According to ATSDR's Public Health Statement on chloroform, most chloroform in the environment comes from industry. Chloroform is used to make other chemicals and can be released from chemical companies and paper mills [13]. Heptane, Ethanol, 2,2,4-Trimethylpentane, and 4-Ethyltoluene were found in soil gas, but no screening levels are available.

**Discussion of PCE and other VOCs in indoor air**

PCE in indoor air was found at concentrations below the DTSC-SL of 2 $\mu g/m^3$ in the office and classroom and slightly higher than the DTSC-SL in the bathroom (7/17/2012). PCE was not

found in the ambient air, but it was detected in nearby soil gas on 5/9/2012 (Appendix A, Figure A2 and A3; Appendix B, Table B3) from 2,200 μg/$m^3$ (IA4-VMP-7), to 130,000 μg/$m^3$ (IA4-VMP-4). Based on these soil gas concentrations, the expected indoor air concentrations would range from 66 μg/$m^3$ to 3,900 μg/m3. However, concentrations in this magnitude were not found at 1925 Yosemite Blvd. The soil gas measurements were taken two months before the indoor air samples and the closest soil gas sampling location is approximately 150 ft. away. During these two months, soil gas conditions or building conditions (heating/AC/ventilation) could have changed, or vapor intrusion is not a significant concern for this building. PCE is also commonly found in indoor air from indoor sources. Vapor intrusion is dependent on many variables that change from building to building, with the seasons, and the residents' uses. We cannot predict the indoor air concentrations in neighboring buildings based on indoor air at 1925 Yosemite Blvd, or soil gas concentrations.

Toluene, ethyl benzene, and xylenes were found indoors, but none of their detected concentrations surpassed their screening levels. They are commonly found in indoor air from auto exhaust (from the garage), cleaners, building materials, cigarettes, and other combustion processes such as cooking [15].

**Discussion of VOCs in outside air**

PCE or its breakdown products were not detected in outside air. Benzene, toluene and xylene were detected in outside air and did not surpass screening levels. Benzene is commonly found in outdoor air from gas stations, auto exhaust, and other fuel sources (Total Petroleum Hydrocarbons, TPH). According to the EPA's data from their Air Quality System, the average level for Benzene in outdoor air in 2009 was around 1 μg/$m^3$ [16].

## Health Effects Evaluation

*Potential health effects of PCE*

ATSDR published information on the toxicity of PCE in the *Toxicological Profile for Tetrachloroethylene* [6]. Whether or not health effects occur depends on many factors:

- how much PCE a person is exposed to (dose),
- how often and how long exposure occurs (duration),
- exposures to other chemicals,
- the age, sex, diet, genetic traits, lifestyle and health status of the person exposed.

In its review [6], ATSDR found that depending upon the concentration, exposure to PCE might harm the nervous system, liver, kidneys and reproductive system; be harmful to unborn children; and increase the risk for certain cancers.

The toxicological studies of PCE try to identify the concentration in air at which no adverse effects are observed (No Observed Adverse Effect Level - NOAEL), or the concentration at which for the first time an adverse effect is observed (Lowest Observed Adverse Effect Level - LOAEL). These concentrations are determined for acute (short term), intermediate, and chronic (long term) exposures, for humans and animal species. ATSDR's evaluation of human

chronic inhalation exposures to PCE is based on a study of changes in color vision in workers (dry cleaners and ironers) [6]. The LOAEL in this study was determined to be 7.3 ppm (volume), which is equivalent to 49,500 µg/m$^3$. The highest concentration found in indoor air at 1925 Yosemite Blvd. was 2.4 µg/m$^3$, which is significantly lower than the occupational LOAEL. ATSDR converted the occupational LOAEL to continuous exposure for a LOAEL of 1.7 ppm or 11,500 µg/m$^3$.

For this investigation, CDPH used DTSC's commercial screening level for cancer (2 µg/m$^3$) to evaluate measured indoor air concentrations for workers. CDPH used the commercial DTSC-SL (2 µg/m$^3$) and the residential DTSC-SL (0.46 µg/m$^3$) to compare to estimated indoor air concentrations based on soil gas, to determine if vapor intrusion could be a concern. The DTSC-based screening level for soil gas are 67 µg/m$^3$ for businesses (2 / 0.03) and 15 µg/m$^3$ (0.46 / 0.03) after accounting for EPA's soil gas attenuation factor of 0.03.

PCE and its breakdown products can be measured in blood and urine. However, the detection of PCE or its metabolites cannot predict the kind of health effects that might develop from that exposure. Because PCE and its metabolites leave the body fairly rapidly, the tests need to be conducted within days after exposure. For exposures related to the dry cleaner releases, CDPH is concerned about long-term exposures that exceed the screening levels for indoor air. Exposures to PCE below the screening levels are considered safe. The ATSDR *Toxicological Profile for Tetrachloroethylene* [6] states the following, with regards to exposures exceeding the screening levels:

"*People who are exposed for longer periods of time to lower levels of tetrachloroethylene in air may have changes in mood, memory, attention, reaction time, or vision. Studies in animals exposed to tetrachloroethylene have shown liver and kidney effects, and changes in brain chemistry, but we do not know what these findings mean for humans. Tetrachloroethylene may have effects on pregnancy and unborn children. Studies in people are not clear on this subject, but studies in animals show problems with pregnancy (such as miscarriage, birth defects, and slowed growth of the baby) after oral and inhalation exposure*.

*Exposure to tetrachloroethylene for a long time may lead to a higher risk of getting cancer, but the type of cancer that may occur is not well-understood. Studies in humans suggest that exposure to tetrachloroethylene might lead to a higher risk of getting bladder cancer, multiple myeloma, or non-Hodgkin's lymphoma, but the evidence is not very strong. In animals, tetrachloroethylene has been shown to cause cancers of the liver, kidney, and blood system. It is not clear whether these effects might also occur in humans, because humans and animals differ in how their bodies handle tetrachloroethylene*." [6].

From the few studies available, we do not know if children are more susceptible than adults to the effects of PCE.

**Can the toxicological evaluation predict who will develop cancer or other health effects?**

No. The estimated exposures from the toxicological evaluation are based on mathematical models that rely on available information such as types of contaminants and concentrations, the characteristics of the population (children or residents or workers), and research studies that are often based on animal studies with very high exposures.

In contrast to non-cancer outcomes, no safe dose is associated with carcinogens. We each experience many exposures throughout our lifetime. The evaluations of potential non-cancer and cancer outcomes in a health consultation like this cannot predict if any one person will develop health effects. These health assessment and lifetime cancer risk calculations enable us to assess the level of concern related to the exposure, based on the concentration and toxicity of a substance. SAS uses these calculations to make recommendations that reduce exposures and protect public health.

*Cancer*

Cancer is a common disease. The National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program states that the lifetime risk for men and woman of being diagnosed with cancer is about 40 cases in 100 people, or 40% (for all cancer sites, diagnosis at some point in life, based on 2009–2011 data). This corresponds to 400,000 cases in 1 million people [18]. The calculated cancer risk is the theoretical chance of developing cancer from a lifetime of exposure. As a baseline for risk management, the "point of departure" risk is one additional cancer case in 1 million people.

For this site, the highest cancer risk for workers was 1.2 in 1 million, based on one indoor air sampling event in 2012. An SVE system was installed in 2014 and was shut off in January 2015. It removed 200 lbs. of PCE from soil gas, but the indoor air concentrations and potential health risks before and after 2012 are unknown.

## Conclusions

SAS reached the following two conclusions in this health consultation:

1. **There is not enough information to determine whether breathing PCE in indoor air at the former Hi-Grade or Jerry's buildings, at 1925 Yosemite Blvd., in homes or other buildings nearby, could have harmed people's health if the exposure lasted for a long time (years). However, based on the high concentration of PCE in soil gas at some locations (2002-2016), it is likely that concentrations of PCE in indoor air were elevated in some buildings.**

   High concentrations of PCE were found in soil gas at 5 ft. depth in the past (up to 700,000 $\mu g/m^3$). However, indoor air measurements were only available for one location and one sampling event (1925 Yosemite Blvd on 7/17/2012). This is not sufficient to determine representative indoor air conditions for long term exposures for workers in this building, other

workers in nearby buildings, or residents in other buildings, in the past or present. PCE was found at low concentrations indoors, but the sources (vapor intrusion or other indoor sources) cannot be determined. The conditions that cause vapor intrusion differ from building to building (slab on grade, crawl space, heating and ventilation settings) and indoor air concentrations cannot be predicted from soil gas concentrations alone. The concentrations of PCE in indoor air in homes, the former Jerry's and Hi-Grade buildings, or in other buildings for this period are unknown and SAS is unable to quantify the health risks based on soil gas concentrations.

2. **Estimated PCE concentration in indoor air (based on 2016 soil gas concentrations at 5 ft. depth) exceeded the DTSC-Screening Level for homes (0.46 µg/m$^3$) and businesses (2 µg/m$^3$) after the soil vapor extraction system (SVE) ran for one year and was turned off.**

   The most recent soil gas data from 2016 showed that estimated PCE concentrations in indoor air exceeded the DTSC-Screening Level for businesses of 2 µg/m3 in five out of six sampling locations, and the DTSC-SL for homes of 0.46 µg/m3 in all sampling locations. The SVE was supposed to run for 24 months but only ran for 12 months (January 2014 – January 2015) due to licensing delays and subsequent vandalism.

## Recommendations

SAS recommends that

- The City of Modesto, under DTSC oversight, offers sampling of indoor air in homes and businesses in locations where the estimated PCE concentration in indoor air (based on 5 ft. soil gas concentrations) exceeds the DTSC Screening Level of 2 µg/m$^3$ for businesses or 0.46 µg/m$^3$ for homes. This is currently the case for buildings within an approximate radius of 500 ft. from Hi-Grade. Indoor air should be collected during multiple seasons and together with soil gas samples.

- The City of Modesto, under DTSC oversight, delineates the soil gas plume: the area where the estimated PCE concentration in indoor air (based on 5 ft. soil gas concentrations) exceeds the DTSC Screening Level of 2 µg/m$^3$ for businesses or 0.46 µg/m$^3$ for homes. The corresponding soil gas concentrations are 67 µg/m$^3$ for businesses and 15 µg/m$^3$ for homes.

- The City of Modesto, under DTSC oversight, continues operation of the SVE until soil gas concentrations are stably below the concentration which correlates to the indoor air DTSC-Screening Level for businesses of 2 µg/m$^3$ or 0.46 µg/m$^3$ for homes.

- Workers and residents review the factsheets on vapor intrusion included in this health consultation and determine if they can take simple steps, such as increasing ventilation, to reduce potential exposures and improve indoor air quality.

- Workers or residents who might have been exposed in the past, and who have health or

exposure concerns related to these dry cleaners, might want to contact their physician and give them a copy of this health consultation. The physician may contact SAS and we can refer them to additional resources.

## Public Health Action Plan

1. SAS will work with DTSC and the City of Modesto to periodically review indoor air and soil gas data as needed, to ensure that the vapor intrusion remediation and mitigation measures are effective and indoor air concentrations for VOCs are safe for workers and residents.

2. SAS will continue to reach out to the community near the dry cleaners under investigation to determine the community's outreach and information needs. SAS can offer printed material, community meetings or educational workshops, depending on the community's preference.

3. SAS plans to write health consultations for the remaining 19 dry cleaners that were identified.

## Report Preparation

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## Appendix A. Figures

**Figure A1. Extent of Dry Cleaner Investigation in Modesto (23 dry cleaners)**

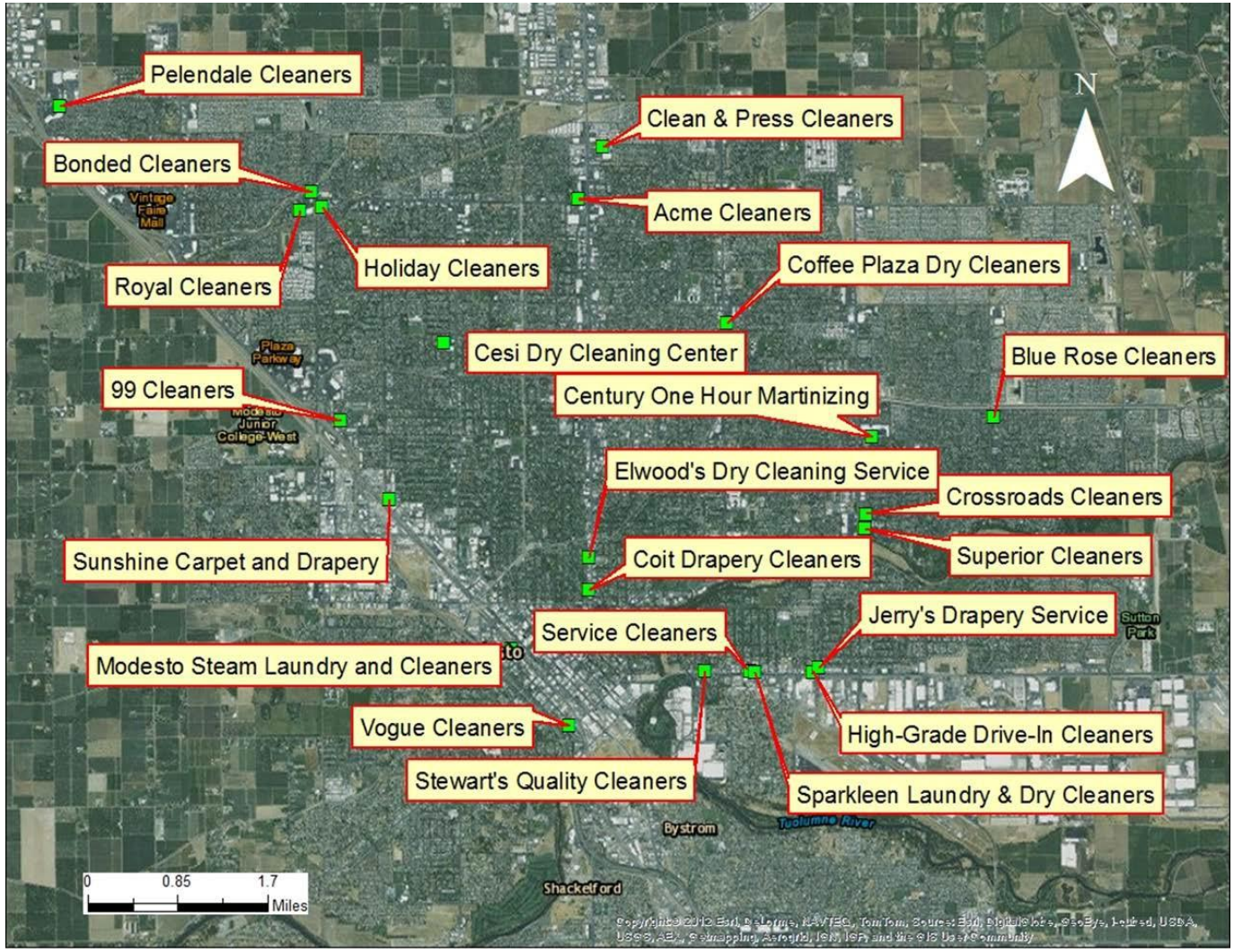


**Figure A2: Soil Gas Sampling Locations (2014 – 2016)**

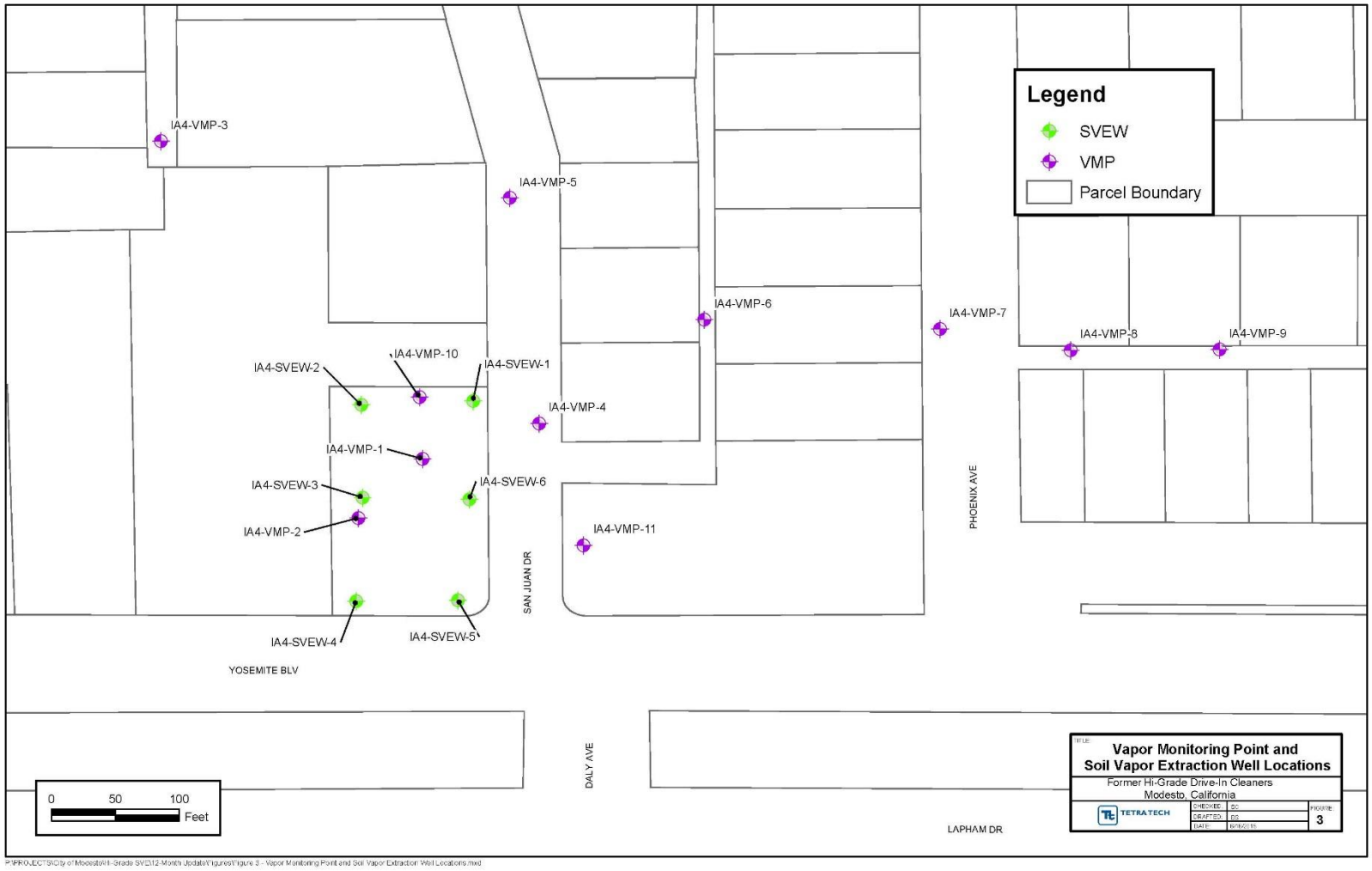


**Figure A3: Soil Gas Sampling Locations (2012)**

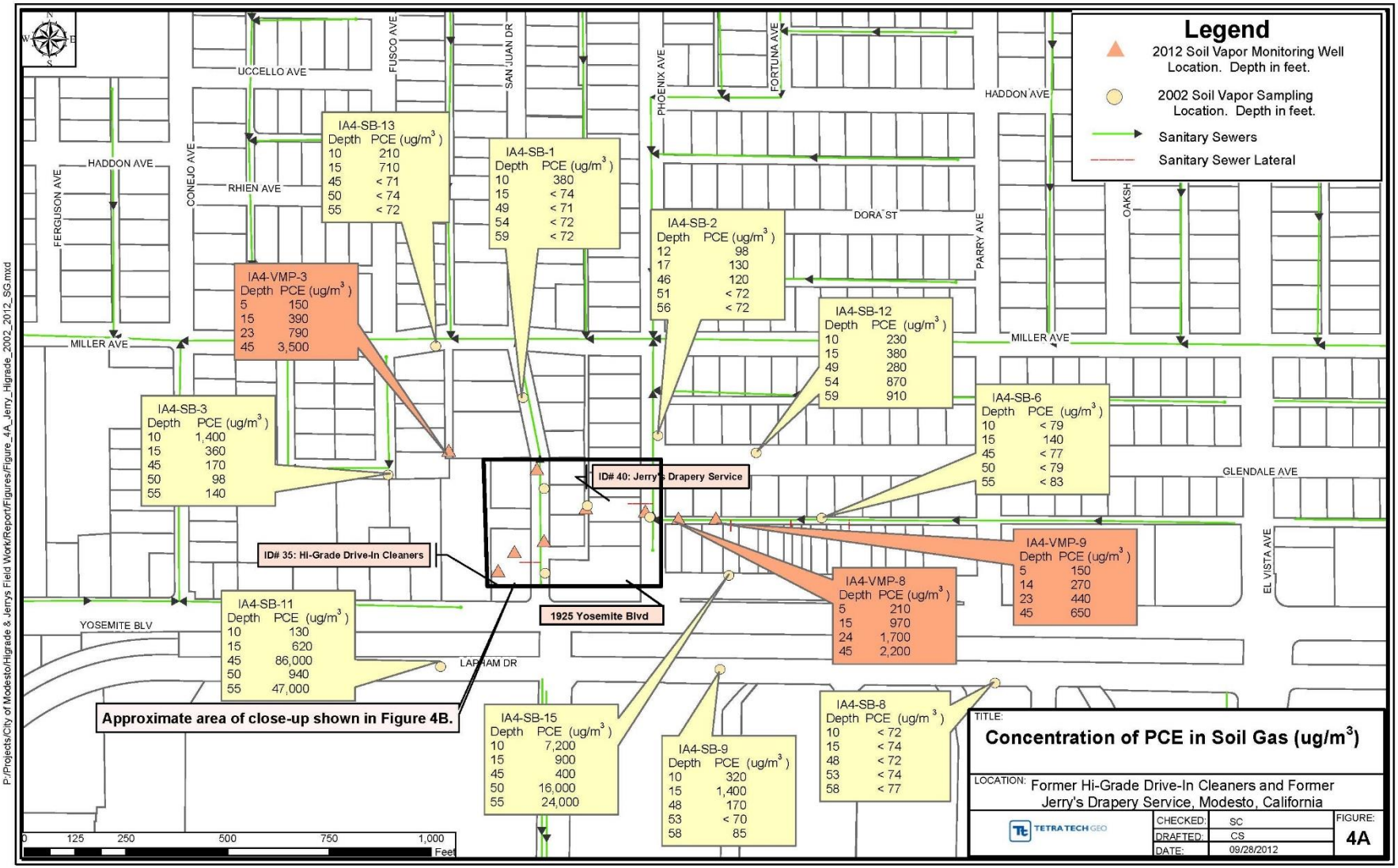
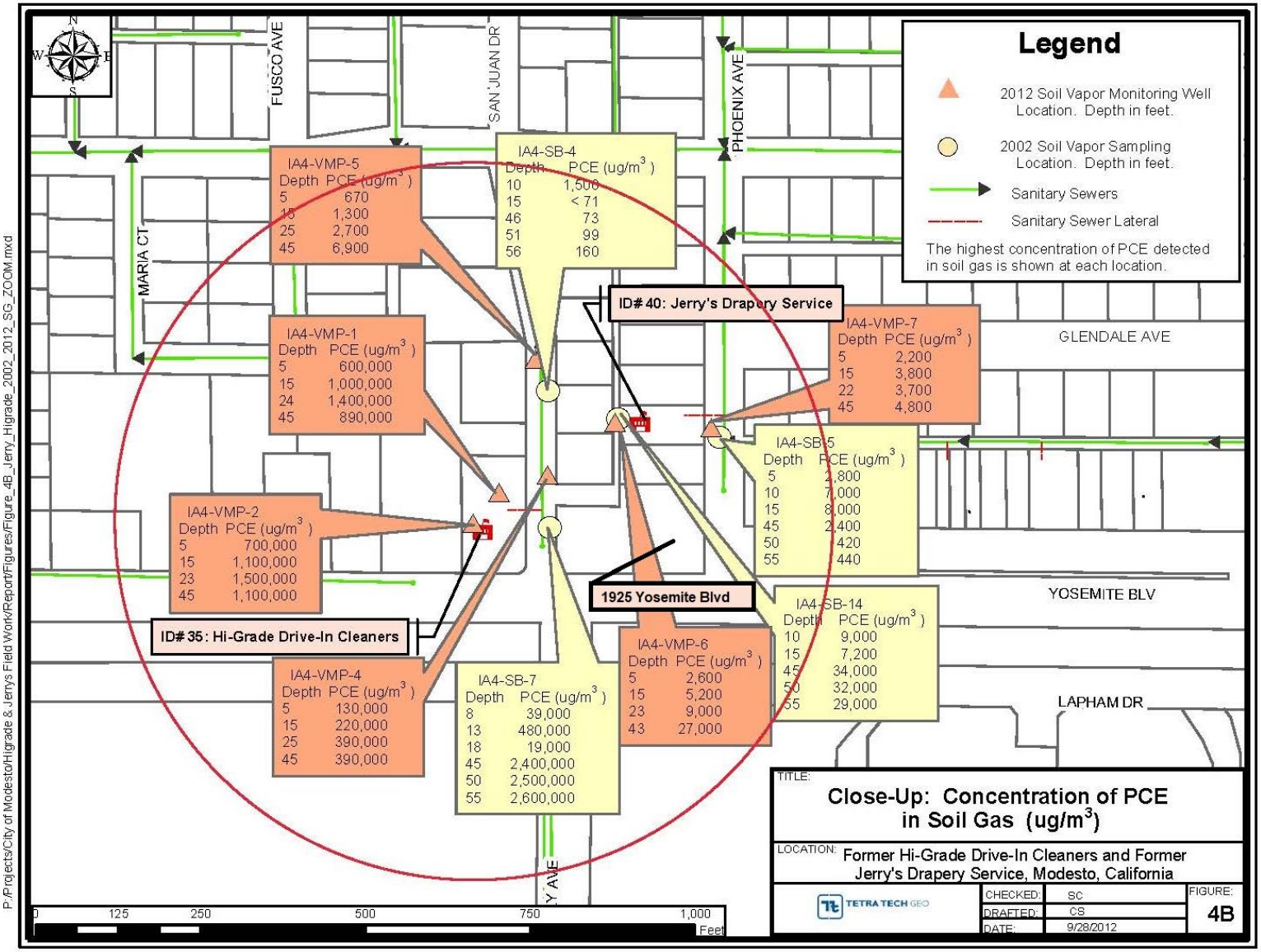


**Figure A4: PCE Concentrations in soil gas at 5 to 45 ft. depth within a 500 ft. radius of Hi-Grade (2012)**




Source: [4]

## Appendix B. Tables

**Table B1. PCE-related VOCs in indoor and outdoor air at 1925 Yosemite Blvd, Modesto, CA**

| Sample Location | Date | PCE | TCE | 1,1,1-TCA | cis 1,2-DCE | trans 1,2-DCE | 1,1-DCE | Vinyl Chloride |
|---|---|---|---|---|---|---|---|---|
| Office | 7/17/2012 | 1.0 | <0.18 | <0.18 | <0.13 | <0.67 | <0.067 | <0.043 |
| Restroom | 7/17/2012 | 2.4 | <0.18 | <0.18 | <0.13 | <0.67 | <0.067 | <0.043 |
| Classroom | 7/17/2012 | 1.6 | <0.18 | <0.19 | <0.14 | <0.68 | <0.068 | <0.044 |
| Outdoor | 7/17/2012 | <0.23 | <0.18 | <0.19 | <0.14 | <0.68 | <0.068 | <0.044 |
| DTSC-SL (cancer, commercial) | | 2.0 | 0.22** | 530 | 35 | 350 | 310* | 0.16 |

Source: [4, 2]
*noncancer commercial
**ATSDR CREG
< smaller than detection limit provided in ref [4]
PCE: Tetrachloroethylene
TCE: Trichloroethylene
1,1,1 TCA: 1,1,1-Trichloroethane
Cis 1,2 DCE: Cis 1,2 Dichloroethene
Trans 1,2 DCE: Trans 1,2 Dichloroethene
1,1 DCE: 1,1 Dichloroethene

**Table B2. VOCs detected in Indoor Air and Outdoor Air at 1925 Yosemite Blvd, Modesto, CA (2012)**

| Location | Compound | Concentration ($\mu g/m^3$) |
|---|---|---|
| Office | Toluene | 1.40 |
| | Tetrachloroethylene (PCE) | 1.00 |
| | Ethyl Benzene | 0.19 |
| | m,p-Xylene | 0.40 |
| | o-Xylene | 0.15 |
| Restroom | Toluene | 1.60 |
| | Tetrachloroethylene (PCE) | **2.40** |
| | Ethyl Benzene | 0.22 |
| | m,p-Xylene | 0.61 |
| | o-Xylene | 0.20 |
| Classroom | Toluene | 1.60 |
| | Tetrachloroethylene (PCE) | 1.10 |
| | Ethyl Benzene | 0.19 |
| | m,p-Xylene | 0.52 |
| | o-Xylene | 0.18 |
| Outdoor Ambient | Benzene | 0.27 |
| | Toluene | 0.72 |
| | o-Xylene | 0.33 |

Source: [4, 13, 18]
DTSC-SLs for workers
Toluene (non-cancer): 1,300 $\mu g/m^3$
PCE, tetrachloroethylene (cancer): 2.0 $\mu g/m^3$
Ethyl benzene (ATSDR Chronic EMEG/MRL): 8,700 $\mu g/m^3$
m,o,p-xylene (ATSDR RMEG): 3,300 $\mu g/m^3$
EMEG – Environmental media exposure guide
RMEG – RfD (reference dose)-based media evaluation guide
MRL – Minimal risk levels

**Table B3. PCE concentrations in soil gas samples taken at 5 ft. depth, estimated indoor air concentrations, and distance to Hi-Grade dry cleaners, Modesto, California (2002-2016)**

| Sampling Location | Sampling Date | PCE in soil gas ($\mu g/m^3$) | Estimated indoor air concentrations * ($\mu g/m^3$) | Approximate Distance to Center of Former Hi-Grade | Soil Vapor Extraction Unit |
|---|---|---|---|---|---|
| IA4-VMP-2 | 5/9/2012 | 700,000.0 | **21,000.00** | <50 ft. | Off |
| | 1/16/2014 | 370,000.0 | **11,100.00** | | Off |
| | 4/29/2014 | 22,000.0 | **660.00** | | **On** |
| | 7/30/2014 | 17,000.0 | **510.00** | | **On** |
| | 7/30/2014 | 16,000.0 | **480.00** | | **On** |
| | 1/27/2015 | 670.0 | **20.10** | | **On** |
| | 4/30/2015 | 970.0 | **29.10** | | Off |
| | 8/5/2015 | 12,000.0 | **360.00** | | Off |
| | 8/5/2015 | 11,000.0 | **330.00** | | Off |
| | 11/11/2015 | 7,500.0 | **225.00** | | Off |
| | 1/28/2016 | 4,300.0 | **129.00** | | Off |
| IA4-VMP-1 | 5/9/2012 | 600,000.0 | **18,000.00** | 50 ft. | Off |
| | 5/9/2012 | 560,000.0 | **16,800.00** | | Off |
| | 1/16/2014 | 540,000.0 | **16,200.00** | | Off |
| | 1/16/2014 | 300,000.0 | **9,000.00** | | Off |
| | 1/16/2014 | 300,000.0 | **9,000.00** | | Off |
| | 4/29/2014 | 4,900.0 | **147.00** | | **On** |
| | 4/29/2014 | 4,100.0 | **123.00** | | **On** |
| | 7/30/2014 | 3,400.0 | **102.00** | | **On** |
| | 1/27/2015 | 200.0 | **6.00** | | **On** |
| | 1/27/2015 | 190.0 | **5.70** | | **On** |
| | 1/27/2015 | 26.0 | 0.78 | | **On** |
| | 4/30/2015 | 920.0 | **27.60** | | Off |
| | 4/30/2015 | 920.0 | **27.60** | | Off |
| | 8/5/2015 | 6,000.0 | **180.00** | | Off |
| | 11/11/2015 | 2,900.0 | **87.00** | | Off |
| | 11/11/2015 | 2,700.0 | **81.00** | | Off |
| | 2/11/2016 | 1,600.0 | **48.00** | | Off |
| IA4-SB-7 (at 8 ft.) | 10/3/2002 | 39,000.0 | **1,170.00** | 100 ft. | Off |
| | 10/3/2002 | 39,000.0 | **1,170.00** | | Off |
| IA4-VMP-4 | 5/9/2012 | 130,000.0 | **3,900.00** | 125 ft. | Off |

| Sampling Location | Sampling Date | PCE in soil gas ($\mu g/m^3$) | Estimated indoor air concentrations * ($\mu g/m^3$) | Approximate Distance to Center of Former Hi-Grade | Soil Vapor Extraction Unit |
|---|---|---|---|---|---|
| | 1/16/2014 | 80,000.0 | **2,400.00** | | Off |
| | 4/29/2014 | 3,800.0 | **114.00** | | **On** |
| | 7/30/2014 | 2,500.0 | **75.00** | | **On** |
| | 1/27/2015 | 82.0 | **2.46** | | **On** |
| | 4/30/2015 | 470.0 | **14.10** | | Off |
| | 8/5/2015 | 1,700.0 | **51.00** | | Off |
| | 11/11/2015 | 930.0 | **27.90** | | Off |
| | 1/28/2016 | 720.0 | **21.60** | | Off |
| IA4-VMP-10 | 1/16/2014 | 140,000.0 | **4,200.00** | 125 ft. | Off |
| | 4/29/2014 | 1,400.0 | **42.00** | | **On** |
| | 7/30/2014 | 640.0 | **19.20** | | **On** |
| | 4/30/2015 | 290.0 | **8.70** | | Off |
| | 8/5/2015 | 940.0 | **28.20** | | Off |
| | 11/11/2015 | 520.0 | **15.60** | | Off |
| | 1/28/2016 | 360.0 | **10.80** | | Off |
| IA4-VMP-11 | 1/16/2014 | 20,000.0 | **600.00** | 150 ft. | Off |
| | 4/29/2014 | 2,700.0 | **81.00** | | **On** |
| | 7/30/2014 | 1,300.0 | **39.00** | | **On** |
| | 1/27/2015 | 52.0 | 1.56 | | **On** |
| | 4/30/2015 | 170.0 | **5.10** | | Off |
| | 8/5/2015 | 530.0 | **15.90** | | Off |
| | 11/11/2015 | 380.0 | **11.40** | | Off |
| | 1/28/2016 | 320.0 | **9.60** | | Off |
| IA4-VMP-5 | 5/9/2012 | 670.0 | **20.10** | 250 ft. | Off |
| | 4/30/2015 | 14.0 | 0.42 | | Off |
| IA4-VMP-6 | 5/9/2012 | 2,600.0 | **78.00** | 250 ft. | Off |
| | 1/16/2014 | 1,400.0 | **42.00** | | Off |
| | 4/29/2014 | 490.0 | **14.70** | | **On** |
| | 7/30/2014 | 350.0 | **10.50** | | **On** |
| | 1/27/2015 | 14.0 | 0.42 | | **On** |
| | 4/30/2015 | 25.0 | 0.75 | | Off |
| | 8/5/2015 | 85.0 | **2.55** | | Off |
| | 11/11/2015 | 55.0 | 1.65 | | Off |

| Sampling Location | Sampling Date | PCE in soil gas (µg/m$^3$) | Estimated indoor air concentrations * (µg/m$^3$) | Approximate Distance to Center of Former Hi-Grade | Soil Vapor Extraction Unit |
|---|---|---|---|---|---|
| | 1/28/2016 | 32.0 | 0.96 | | Off |
| IA4-VMP-3 | 5/9/2012 | 150.0 | **4.50** | 300 ft. | Off |
| IA4-SB-5 | 10/3/2002 | 2,800.0 | **84.00** | 375 ft. | Off |
| | 10/3/2002 | 2,800.0 | **84.00** | | Off |
| IA4-VMP-7 | 5/9/2012 | 2,200.0 | **66.00** | 375 ft. | Off |
| IA4-VMP-8 | 5/9/2012 | 210.0 | **6.30** | 500 ft. | Off |
| IA4-VMP-9 | 5/9/2012 | 150.0 | **4.50** | 500 ft. | Off |
| **Comparison Values** | DTSC-SL (commercial/business, cancer outcome) | | 2 | | |

Source: [4, 9, 10, 11, 18]
* soil gas concentration x 0.03 (EPA Screening Attenuation Factor)
SVE system in operation during
the sampling. Abbreviations:
PCE: tetrachloroethylene
µg/m3: micrograms per cubic meter
**Bolded** concentrations exceed the DTSC-SL for businesses of 2 µg/m$^3$

**Table B4. Non-dry cleaner related VOCs in soil gas found at 5 ft. in Modesto, CA (2002-2016)**

| Location | Date | Compound | Soil Gas Concentration ($\mu g/m^3$) | Estimated indoor air Concentrations * |
|---|---|---|---|---|
| IA4-SB-5 | 10/3/2002 | Benzene | 170.0 | **5.10** |
| | 10/3/2002 | Benzene | 170.0 | **5.10** |
| | 10/3/2002 | Chloroform | 280.0 | **8.40** |
| | 10/3/2002 | Chloroform | 280.0 | **8.40** |
| | 10/3/2002 | Isopropanol | 920.0 | 27.60 |
| | 10/3/2002 | Isopropanol | 920.0 | 27.60 |
| | 10/3/2002 | m,p-Xylene | 67.0 | 2.01 |
| | 10/3/2002 | m,p-Xylene | 67.0 | 2.01 |
| | 10/3/2002 | Toluene | 220.0 | 6.60 |
| | 10/3/2002 | Toluene | 220.0 | 6.60 |
| IA4-VMP-1 | 2/11/2016 | 1,2,4-Trimethylbenzene | 6.1 | 0.18 |
| | 1/27/2015 | Acetone | 46.0 | 1.38 |
| | 4/30/2015 | Acetone | 39.0 | 1.17 |
| | 4/29/2014 | Benzene | 7.7 | 0.23 |
| | 7/30/2014 | Benzene | 9.1 | 0.27 |
| | 1/27/2015 | Benzene | 3.8 | 0.11 |
| | 1/27/2015 | Benzene | 5.5 | 0.17 |
| | 1/27/2015 | Benzene | 31.0 | 0.93 |
| | 4/30/2015 | Benzene | 4.0 | 0.12 |
| | 4/30/2015 | Benzene | 4.2 | 0.13 |
| | 8/5/2015 | Benzene | 59.0 | 1.77 |
| | 4/29/2014 | Cumene | 17.0 | 0.51 |
| | 4/29/2014 | Cumene | 26.0 | 0.78 |
| | 7/30/2014 | Cumene | 41.0 | 1.23 |
| | 1/27/2015 | Cumene | 16.0 | 0.48 |
| | 1/27/2015 | Cumene | 16.0 | 0.48 |
| | 1/27/2015 | Cumene | 19.0 | 0.57 |
| | 4/30/2015 | Cumene | 17.0 | 0.51 |
| | 4/30/2015 | Cumene | 18.0 | 0.54 |
| | 8/5/2015 | Cumene | 50.0 | 1.50 |
| | 11/11/2015 | Cumene | 9.8 | 0.29 |
| | 11/11/2015 | Cumene | 9.6 | 0.29 |
| | 2/11/2016 | Cumene | 21.0 | 0.63 |
| | 1/27/2015 | Ethanol | 16.0 | 0.48 |
| | 11/11/2015 | Ethanol | 10.0 | 0.30 |

| Location | Date | Compound | Soil Gas Concentration ($\mu g/m^3$) | Estimated indoor air Concentrations * |
|---|---|---|---|---|
| | 11/11/2015 | Ethanol | 8.9 | 0.27 |
| | 4/30/2015 | Hexane | 4.6 | 0.14 |
| | 5/9/2012 | Styrene | 1500.0 | 45.00 |
| | 5/9/2012 | Toluene | 1300.0 | 39.00 |
| IA4-VMP-10 | 7/30/2014 | Acetone | 110.0 | 3.30 |
| | 4/30/2015 | Acetone | 160.0 | 4.80 |
| | 8/5/2015 | Acetone | 69.0 | 2.07 |
| | 11/11/2015 | Acetone | 33.0 | 0.99 |
| | 1/28/2016 | Acetone | 68.0 | 2.04 |
| | 4/29/2014 | Benzene | 7.7 | 0.23 |
| | 7/30/2014 | Benzene | 7.2 | 0.22 |
| | 4/30/2015 | Benzene | 110.0 | 3.30 |
| | 8/5/2015 | Benzene | 6.9 | 0.21 |
| | 11/11/2015 | Benzene | 8.4 | 0.25 |
| | 1/28/2016 | Benzene | 7.1 | 0.21 |
| | 4/29/2014 | Cumene | 27.0 | 0.81 |
| | 7/30/2014 | Cumene | 22.0 | 0.66 |
| | 4/30/2015 | Cumene | 39.0 | 1.17 |
| | 8/5/2015 | Cumene | 6.6 | 0.20 |
| | 11/11/2015 | Cumene | 6.9 | 0.21 |
| | 7/30/2014 | Ethanol | 20.0 | 0.60 |
| | 4/30/2015 | Ethanol | 27.0 | 0.81 |
| | 4/30/2015 | Toluene | 9.7 | 0.29 |
| IA4-VMP-11 | 4/29/2014 | Acetone | 52.0 | 1.56 |
| | 7/30/2014 | Acetone | 49.0 | 1.47 |
| | 1/27/2015 | Acetone | 70.0 | 2.10 |
| | 4/30/2015 | Acetone | 46.0 | 1.38 |
| | 8/5/2015 | Acetone | 35.0 | 1.05 |
| | 11/11/2015 | Acetone | 51.0 | 1.53 |
| | 1/28/2016 | Acetone | 46.0 | 1.38 |
| | 4/29/2014 | Benzene | 22.0 | 0.66 |
| | 7/30/2014 | Benzene | 15.0 | 0.45 |
| | 1/27/2015 | Benzene | 110.0 | 3.30 |
| | 4/30/2015 | Benzene | 48.0 | 1.44 |
| | 8/5/2015 | Benzene | 13.0 | 0.39 |
| | 11/11/2015 | Benzene | 75.0 | 2.25 |

| Location | Date | Compound | Soil Gas Concentration ($\mu g/m^3$) | Estimated indoor air Concentrations * |
|---|---|---|---|---|
| | 1/28/2016 | Benzene | 58.0 | 1.74 |
| | 7/30/2014 | Chloroform | 9.9 | 0.30 |
| | 8/5/2015 | Chloroform | 5.7 | 0.17 |
| | 4/29/2014 | Cumene | 38.0 | 1.14 |
| | 7/30/2014 | Cumene | 37.0 | 1.11 |
| | 1/27/2015 | Cumene | 33.0 | 0.99 |
| | 4/30/2015 | Cumene | 32.0 | 0.96 |
| | 8/5/2015 | Cumene | 22.0 | 0.66 |
| | 11/11/2015 | Cumene | 20.0 | 0.60 |
| | 1/28/2016 | Cumene | 32.0 | 0.96 |
| | 7/30/2014 | Ethanol | 21.0 | 0.63 |
| | 1/27/2015 | Ethanol | 19.0 | 0.57 |
| | 4/30/2015 | Ethanol | 21.0 | 0.63 |
| IA4-VMP-2 | 4/30/2015 | 2,2,4-Trimethylpentane | 11.0 | 0.33 |
| | 4/29/2014 | Benzene | 150.0 | **4.50** |
| | 1/27/2015 | Benzene | 6.2 | 0.19 |
| | 4/30/2015 | Benzene | 4.0 | 0.12 |
| | 4/29/2014 | Cumene | 88.0 | 2.64 |
| | 1/27/2015 | Cumene | 21.0 | 0.63 |
| | 1/28/2016 | Cumene | 15.0 | 0.45 |
| IA4-VMP-3 | 5/9/2012 | 1,2,4-Trimethylbenzene | 3.9 | 0.12 |
| | 5/9/2012 | Acetone | 46.0 | 1.38 |
| | 4/30/2015 | Acetone | 97.0 | 2.91 |
| | 5/9/2012 | Benzene | 42.0 | 1.26 |
| | 4/30/2015 | Benzene | 45.0 | 1.35 |
| | 4/30/2015 | Carbon Disulfide | 29.0 | 0.87 |
| | 5/9/2012 | Cumene | 150.0 | 4.50 |
| | 4/30/2015 | Cumene | 120.0 | 3.60 |
| | 5/9/2012 | Toluene | 4.3 | 0.13 |
| IA4-VMP-4 | 7/30/2014 | 2-Butanone (Methyl Ethyl Ketone) | 18.0 | 0.54 |
| | 4/29/2014 | Acetone | 170.0 | 5.10 |
| | 7/30/2014 | Acetone | 340.0 | 10.20 |
| | 1/27/2015 | Acetone | 82.0 | 2.46 |
| | 4/30/2015 | Acetone | 120.0 | 3.60 |
| | 8/5/2015 | Acetone | 39.0 | 1.17 |

| Location | Date | Compound | Soil Gas Concentration ($\mu g/m^3$) | Estimated indoor air Concentrations * |
|---|---|---|---|---|
| | 4/29/2014 | Benzene | 48.0 | 1.44 |
| | 7/30/2014 | Benzene | 46.0 | 1.38 |
| | 7/30/2014 | Chloroform | 32.0 | 0.96 |
| | 4/29/2014 | Cumene | 40.0 | 1.20 |
| | 7/30/2014 | Cumene | 53.0 | 1.59 |
| | 4/30/2015 | Cumene | 7.4 | 0.22 |
| | 8/5/2015 | Cumene | 7.1 | 0.21 |
| | 7/30/2014 | Ethanol | 28.0 | 0.84 |
| | 1/27/2015 | Ethanol | 9.2 | 0.28 |
| | 4/30/2015 | Ethanol | 14.0 | 0.42 |
| | 7/30/2014 | Toluene | 12.0 | 0.36 |
| IA4-VMP-5 | 5/9/2012 | 1,2,4-Trimethylbenzene | 6.8 | 0.20 |
| | 5/9/2012 | 4-Ethyltoluene | 4.2 | 0.13 |
| | 5/9/2012 | Acetone | 36.0 | 1.08 |
| | 4/30/2015 | Acetone | 56.0 | 1.68 |
| | 5/9/2012 | Benzene | 28.0 | 0.84 |
| | 4/30/2015 | Benzene | 22.0 | 0.66 |
| | 5/9/2012 | Carbon Disulfide | 20.0 | 0.60 |
| | 5/9/2012 | Chloroform | 29.0 | 0.87 |
| | 4/30/2015 | Chloroform | 52.0 | **1.56** |
| | 5/9/2012 | Cumene | 110.0 | 3.30 |
| | 4/30/2015 | Cumene | 70.0 | 2.10 |
| | 5/9/2012 | Ethanol | 7.3 | 0.22 |
| | 4/30/2015 | Ethanol | 22.0 | 0.66 |
| | 5/9/2012 | Freon 11 | 4.5 | 0.14 |
| | 5/9/2012 | m,p-Xylene | 6.7 | 0.20 |
| | 5/9/2012 | Toluene | 6.9 | 0.21 |
| IA4-VMP-6 | 5/9/2012 | 1,2,4-Trimethylbenzene | 6.6 | 0.20 |
| | 5/9/2012 | 2,2,4-Trimethylpentane | 6.5 | 0.20 |
| | 5/9/2012 | Acetone | 81.0 | 2.43 |
| | 1/16/2014 | Acetone | 81.0 | 2.43 |
| | 4/29/2014 | Acetone | 90.0 | 2.70 |
| | 7/30/2014 | Acetone | 68.0 | 2.04 |
| | 4/30/2015 | Acetone | 83.0 | 2.49 |
| | 8/5/2015 | Acetone | 37.0 | 1.11 |
| | 5/9/2012 | Benzene | 270.0 | **8.10** |

| Location | Date | Compound | Soil Gas Concentration ($\mu g/m^3$) | Estimated indoor air Concentrations * |
|---|---|---|---|---|
| | 1/16/2014 | Benzene | 11.0 | 0.33 |
| | 4/29/2014 | Benzene | 17.0 | 0.51 |
| | 7/30/2014 | Benzene | 16.0 | 0.48 |
| | 1/27/2015 | Benzene | 11.0 | 0.33 |
| | 4/30/2015 | Benzene | 14.0 | 0.42 |
| | 8/5/2015 | Benzene | 8.5 | 0.26 |
| | 11/11/2015 | Benzene | 11.0 | 0.33 |
| | 1/28/2016 | Benzene | 5.1 | 0.15 |
| | 5/9/2012 | Cumene | 290.0 | 8.70 |
| | 1/16/2014 | Cumene | 49.0 | 1.47 |
| | 4/29/2014 | Cumene | 80.0 | 2.40 |
| | 7/30/2014 | Cumene | 86.0 | 2.58 |
| | 1/27/2015 | Cumene | 40.0 | 1.20 |
| | 4/30/2015 | Cumene | 72.0 | 2.16 |
| | 8/5/2015 | Cumene | 66.0 | 1.98 |
| | 11/11/2015 | Cumene | 27.0 | 0.81 |
| | 1/28/2016 | Cumene | 22.0 | 0.66 |
| | 1/27/2015 | Ethanol | 9.0 | 0.27 |
| | 5/9/2012 | Freon 12 | 7.4 | 0.22 |
| | 5/9/2012 | Heptane | 6.4 | 0.19 |
| | 5/9/2012 | Toluene | 17.0 | 0.51 |
| IA4-VMP-7 | 5/9/2012 | 1,2,4-Trimethylbenzene | 8.2 | 0.25 |
| | 5/9/2012 | Acetone | 44.0 | 1.32 |
| | 5/9/2012 | Benzene | 20.0 | 0.60 |
| | 5/9/2012 | Carbon Disulfide | 22.0 | 0.66 |
| | 5/9/2012 | Chloroform | 59.0 | **1.77** |
| | 5/9/2012 | Cumene | 78.0 | 2.34 |
| | 5/9/2012 | m,p-Xylene | 5.8 | 0.17 |
| | 5/9/2012 | Toluene | 8.2 | 0.25 |
| IA4-VMP-8 | 5/9/2012 | 2-Propanol | 13.0 | 0.39 |
| | 5/9/2012 | Acetone | 58.0 | 1.74 |
| | 5/9/2012 | Benzene | 48.0 | 1.44 |
| | 5/9/2012 | Chloroform | 30.0 | 0.90 |
| | 5/9/2012 | Cumene | 150.0 | 4.50 |
| | 5/9/2012 | Ethanol | 32.0 | 0.96 |
| | 5/9/2012 | Toluene | 6.5 | 0.20 |

| Location | Date | Compound | Soil Gas Concentration (µg/m$^3$) | Estimated indoor air Concentrations * |
|---|---|---|---|---|
| IA4-VMP-9 | 5/9/2012 | 1,2,4-Trimethylbenzene | 9.2 | 0.28 |
| | 5/9/2012 | Benzene | 21.0 | 0.63 |
| | 5/9/2012 | Chloroform | 26.0 | 0.78 |
| | 5/9/2012 | Cumene | 78.0 | 2.34 |
| | 5/9/2012 | m,p-Xylene | 6.0 | 0.18 |
| | 5/9/2012 | Toluene | 7.0 | 0.21 |

Sources: [4, 9, 10, 11]

* soil gas concentration x 0.03 (EPA Screening Attenuation Factor)

**Bolded** concentrations exceed the ATSDR CREG

Benzene = 4.3 µg/m$^3$

Chloroform = 1.4 µg/m3

## Appendix C. Health Risk Equations and Toxicity Factors

## The EPA regional screening level (RSL) calculator is available online at: https://epa-prgs.ornl.gov/cgi-bin/chemicals/csl_search

The following steps are used to calculate potential cancer and non-cancer risks using the RSL calculator:

1. Open RSL calculator.
2. Select:
    - Screening Level Type: Regional Screening Levels (RSLs)
    - Hazard Quotient: 1
    - Target Risk: 10-6
    - Scenario: Indoor Worker
    - Media: air
    - Screening Level Choice: Site Specific
        - Select Chemical Info Type: User-provided
    - Risk output: yes
    - RfD/RfC type: chronic
    - Chemicals: type Tetrachloroethylene(then click on name to select)
    - Select All Chemicals: No
    - Retrieve
3. Type in measured or estimated concentration of PCE
4. Change the Chronic Inhalation Reference Concentration ($mg/m^3$) (RfC) to 3.5E-02
5. Change the Inhalation Unit Risk ($\mu g/m^3$) (IUR) to 6.1E-06
6. Retrieve.
7. Scroll down for Site-Specific Indoor Worker Risk for Air (carcinogenic and noncarcinogenic)

Cal-EPA Inhalation Unit Risk = 6.1E-06 $(\mu g/m^3)^{-01}$ [1]
Cal-EPA Reference Exposure Level = 35 $\mu g/m^3$ (used instead of EPA RfC in the equations below)

Figure: RSL equation for resident and indoor worker air inhalation (all default parameters)

## Resident Air Equations

- Noncarcinogenic
  - Inhalation

$$SL_{res\text{-}air\text{-}nc}\left(\mu g/m^3\right) = \frac{THQ \times AT_{res\text{-}a}\left(\frac{365\ days}{year} \times ED_{res}\left(26\ years\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{res}\left(\frac{350\ days}{year}\right) \times ED_{res}\left(26\ years\right) \times ET_{res}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)}}$$

- Carcinogenic
  - Inhalation

$$SL_{res\text{-}air\text{-}ca}\left(\mu g/m^3\right) = \frac{TR \times AT_{res}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{EF_{res}\left(\frac{350\ days}{year}\right) \times ED_{res}\left(26\ years\right) \times ET_{res}\left(\frac{24\ hours}{day}\right) \times \left(\frac{1\ day}{24\ hours}\right) \times IUR\left(\frac{\mu g}{m^3}\right)^{-1}}$$

## Indoor Worker Air Equations

### Noncarcinogenic

- Inhalation

$$SL_{iw\text{-}air\text{-}nc}\left(\mu g/m^3\right) = \frac{THQ \times AT_{iw}\left(\frac{365\ days}{year} \times ED_{iw}\left(25\ years\right)\right) \times \left(\frac{1000\ \mu g}{mg}\right)}{EF_{iw}\left(\frac{250\ days}{year}\right) \times ED_{iw}\left(25\ years\right) \times ET_{iw}\left(\frac{8\ hours}{24\ hours}\right) \times \frac{1}{RfC\left(\frac{mg}{m^3}\right)}}$$

### Carcinogenic

- Inhalation

$$SL_{iw\text{-}air\text{-}ca}\left(\mu g/m^3\right) = \frac{TR \times AT_{iw}\left(\frac{365\ days}{year} \times LT\left(70\ years\right)\right)}{EF_{iw}\left(\frac{250\ days}{year}\right) \times ED_{iw}\left(25\ years\right) \times ET_{iw}\left(\frac{8\ hours}{24\ hours}\right) \times IUR\left(\frac{\mu g}{m^3}\right)^{-1}}$$

**Abbreviations from RSL User Guide**

https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide-may-2016

| | | |
|---|---|---|
| RfC | Chronic Inhalation Reference Concentration ($mg/m^3$) | Contaminant-specific |
| IUR | Chronic Inhalation Unit Risk $(\mu g/m^3)^{-1}$ | Contaminant-specific |
| TR | target risk 1 x $10^{-6}$ | Determined in this calculator |
| THQ | target hazard quotient (1) | Determined in this calculator |
| ATres-a | Averaging time - resident soil adult (days) | 365 x EDres = 9490 |
| ATw | Averaging time - composite worker (days) (carcinogenic) | 365 x LT = 25550 |
| EFres | Resident Exposure Frequency (days/year) | 350 |
| EFw | Composite Worker Exposure Frequency (days/year) | 250 |
| EDres | Resident Exposure Duration (years) | 26 |
| EDw | Composite Worker Exposure Duration - (years) | 25 |
| ETres | Resident Exposure Time (hours/day) | 24 |
| ETw | Composite Worker Exposure Time (hours/day) | 8 |