Health Consultation

Vapor Intrusion of Tetrachloroethylene (PCE) and Trichloroethylene (TCE) in Residential and Commercial Buildings

Site Location: East Central Phoenix (ECP) – 32nd Street and Indian School Road

ARIZONA DEPARTMENT OF ENVIRONMENTAL QUALITY (ADEQ)
PHOENIX, MARICOPA COUNTY, ARIZONA

Prepared by the
Arizona Department of Health Services

December 19, 2016
HEALTH CONSULTATION

Vapor Intrusion of Tetrachloroethylene (PCE) and Trichloroethylene (TCE) in Residential and Commercial Buildings in East Central Phoenix

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Arizona Department of Health Services
Office of Environmental Health
Environmental Health Consultation Services
## Executive Summary

### Purpose:
This report was written in response to a request from the Arizona Department of Environmental Quality (ADEQ). In 2000 and 2001, ADEQ placed six sites in East Central Phoenix (ECP) on the Water Quality Assurance Revolving Fund (WQARF) registry. At several of the sites, contamination has been discovered in association with several dry cleaners. ADEQ requested assistance from the Arizona Department of Health Services (ADHS) to evaluate health concerns associated with vapor intrusion in residential and commercial buildings of tetrachloroethylene (PCE) and trichloroethylene (TCE) at ECP - 32nd Street and Indian School Road.

### Background and Statement of Issues:
ECP – 32nd Street and Indian School Road was placed on the WQARF registry in May 2000. The current contaminants of concern in the area are PCE and TCE. PCE and TCE can emit vapor and move from contaminated groundwater through air pockets in the soil into buildings. The vapors may accumulate in homes and other occupied buildings to levels that may cause health effects. This movement of contaminants into buildings is called “vapor intrusion”. ADEQ has asked ADHS to analyze the data and determine the health risks associated with the concentrations of PCE and TCE taken at the August 2013, February 2014, September – October 2015, and August 2016 sampling events.

### Conclusions and Recommendations:
Based on the data, there is no inherent public health concern from PCE. 2 of the sampling locations contained PCE levels above the acute MRL, but over 130 times below the LOAEL. Therefore, no short-term, non-cancerous public health concern is expected. All sampling locations contained PCE levels below the chronic MRL. As a result, no long-term, non-cancerous public health concern is expected. The estimated cancer risk did not exceed the EPA target risk range of \(10^{-6}\) to \(10^{-4}\), so no cancerous public health concern is expected from PCE.

Based on the data, ADHS believes that there is a potential public health concern from TCE. An acute MRL for TCE has not been developed, therefore short-term non-cancerous risk was not analyzed in this report. 3 of the residences contain TCE levels above the chronic MRL. There is a potential public health concern because the TCE indoor air concentrations were highly variable and the averaged concentrations were above the health guideline. However, the elevated TCE concentrations are not likely to be due to vapor intrusion. For the 3 sampling locations: 32-F-024, 32-F-044, and 32-F-067, ADHS will make available health education materials to residents regarding ways to reduce TCE exposure from common sources in residences. The estimated cancer risk did not exceed the EPA target risk range of \(10^{-6}\) to \(10^{-4}\), so no cancerous public health concern is expected from TCE.
Purpose

This report was written in response to a request from the Arizona Department of Environmental Quality (ADEQ). In 2000 and 2001, ADEQ placed six sites in East Central Phoenix (ECP) on the Water Quality Assurance Revolving Fund (WQARF) registry. Cleanup and investigative work at these sites is funded and managed by the state’s Superfund program. At several of the sites, contamination has been discovered in association with several dry cleaners. As a result, ADEQ has requested assistance from the Arizona Department of Health Services (ADHS) to evaluate health concerns associated with vapor intrusion of tetrachloroethylene (PCE) and trichloroethylene (TCE) in residential and commercial buildings at 32nd Street and Indian School Road.

Background and Statement of Issues

About WQARF: The Remedial Projects Section of ADEQ identifies, assesses, and remediates soil, groundwater and surface water contaminated with hazardous substances (ADEQ 2013B). They use the WQARF, created under the Environmental Quality Act of 1986, to support hazardous substance cleanup efforts in the state. Since the sites in ECP were placed on the WQARF registry, several remedial investigation activities have been conducted, and include researching facilities that have used hazardous substances, installing and sampling groundwater monitoring wells, and distributing questionnaires concerning the use of hazardous substances.

About the 32nd Street site: In 1989, East Central Phoenix (ECP) - 32nd Street and Indian School Road was part of the ECP study area, where soil gas surveys had been conducted at multiple facilities to determine whether a release of contaminants to the subsurface had occurred. After subsequent sampling, the site was placed on the WQARF registry in May 2000. The site has two separate areas of groundwater contamination, as can be seen in Appendix A. The plumes are bounded by East Monterosa Street to the north, 30th Street to the west, Clarendon Avenue to the south, and 32nd Place to the east. ADEQ initiated a soil vapor extraction (SVE) and an early response action (ERA), and approximately 3,100 pounds of PCE were removed by December 2006. Short-term SVE pilot tests were conducted at Maroney’s Cleaners, the former Viking Cleaners facility, and near the corner of 31st Street and Fairmont Avenue in order to determine the feasibility of SVE at these locations. Construction of the SVE system near Maroney’s and the former Viking’s Cleaner facility were completed in 2014. In 2015 and 2016, groundwater wells were installed to further characterize the PCE plume.

Statement of Issues: The current contaminants of concern in the area are tetrachloroethylene (PCE) and trichloroethylene (TCE). Actions have been taken to reduce groundwater migration and contamination, and to prevent soil gas exposure.

Currently, public drinking water supply is not impacted by the site. The drinking water supplied by the City of Phoenix distribution system is primarily from surface water (95%) and limited groundwater (5%) from outside the East Central Phoenix (ECP) - 32nd Street and Indian School area. Therefore, exposure through water ingested is not considered in this health consultation.
PCE and TCE can emit vapor and move from contaminated groundwater through air pockets in the soil into buildings. The vapors may accumulate in homes and other occupied buildings to levels that may cause health effects. This movement of contaminants into a building is called *vapor intrusion*. For more information on this, please see the “*Exposure Pathway Analysis*” section.

Several indoor air and soil gas sampling events were conducted to determine the levels of exposure at residences, and to account for seasonal fluctuations. Residents were asked in a questionnaire to provide information regarding the structure of the residences and factors that could influence indoor air quality.

- In the week of August 26-30, 2013, ADEQ collected instantaneous and 24-hour indoor air samples in the East Central Phoenix (ECP) - 32nd Street and Indian School area for PCE and TCE. A few confirmation samples were also collected on October 8, 2013.
- In February 2014, a second vapor intrusion and indoor air sampling event occurred to evaluate data for seasonal fluctuations and for confirmation of the 2013 results.
- Several subsequent indoor air monitoring events occurred at the former Viking Cleaners facility, the most recent occurring from September 28 to October 12, 2015. Continuous indoor air monitoring and confirmation canister sampling for PCE occurred at the September – October 2015 event.
- In August 2016, follow-up indoor air samples were collected because some data from the previous sampling events suggested that indoor air concentrations of PCE and/or TCE at a few sites could be above health-based guidelines.

**Discussion**

*General Assessment Methodology*

ADHS generally follows a three-step methodology to assess public health issues related to environmental exposures. First, ADHS obtains representative environmental data for the site of concern and compiles a comprehensive list of site-related contaminants. Second, ADHS identifies exposure pathways, and then uses health-based comparison values to find those contaminants that do not have a realistic possibility of causing adverse health effects. For the remaining contaminants, ADHS reviews recent scientific studies to determine if exposures are sufficient to impact public health.

*Environmental Data*

2013 and 2014 Indoor Air Samples:
ADHS reviewed the laboratory results submitted by ADEQ for PCE and TCE concentrations at 32nd Street and Indian School Road. The data from August 2013 included PCE and TCE sampling results for residences, businesses, and a school located within the site. Each sampling location was given a building ID number. The data from February 2014 included PCE and TCE sampling results from a similar subset of residences and businesses to the August 2013 sampling event. Locations were chosen based on residential access, which caused some differences
between the August and February subsets (see Appendix B for a few maps of the 32\textsuperscript{nd} Street and Indian School Road area).

A combination of grab samples and 24-hour indoor air confirmation samples were taken at these locations. All samples were collected within the breathing zone: 3-6 feet above the ground. For grab samples, instantaneous indoor air samples were collected in vapor-tight glass syringes and analyzed within 30 minutes of collection. Analysis was performed by vapor chromatography using an ultra-sensitive electron capture detector (ECD), following EPA Method TO-14. The mobile laboratory was provided by H&P Mobile Geochemistry, Inc. and was certified by ADHS State Laboratory Services for this analytical method prior to the sampling event.

24-hour indoor air sample locations were chosen randomly and added where residents were willing to allow a canister to be left behind, and where there were no obvious practices in the house that might affect data collection. 24-hour air samples were collected in selected structures in passivated 6-liter canisters over approximately a 24-hour period. Canisters were deployed in the breathing zone and away from open windows, doors, or ventilation vents, if possible. Samples were analyzed for PCE and TCE using EPA Method TO-15 by Calscience Environmental Laboratories in Garden Grove, California.

**2015 Indoor Air Samples:**
ADHS also reviewed the laboratory results from the September – October 2015 indoor air monitoring event that occurred at the former Viking Cleaners facility. In 2014, ADEQ completed construction of SVE remediation systems near the Maroney’s Cleaners site and behind the former Viking’s Cleaners facility. The two objectives of the September – October 2015 event were: 1) to collect data to further evaluate whether structures lying over the PCE soil vapor plume are at risk from vapors migrating upward from the soil vapor contamination and into indoor air at residences and commercial buildings, and 2) to evaluate whether the operation of the heating, ventilation and air conditioning (HVAC) system and restricting ambient air flow through the former Viking Cleaners facility contributed to the elevated indoor air PCE concentrations measured during the June 2014 event. Continuous monitoring (approx. 45 minutes between samples) of the air occurred for 15 days at five locations inside and outside the former Viking Cleaners facility. The continuous monitoring system consisted of a gas chromatograph with an electron capture detector (ECD), a stream selection valve, a sample injection valve with one cubic centimeter sample loop, and a computerized data acquisition system. Over 400 analyses were performed at each of the five sampling locations. In addition to this EPA Method TO-14 PCE analysis, confirmation grab indoor air samples were collected in passivated 400 mL canisters and analyzed using EPA Method TO-15 by H&P Mobile Geochemistry, Inc.

**2016 Indoor Air Samples:**
ADHS reviewed the laboratory results submitted on September 27, 2016 from the August 2016 indoor air monitoring event that occurred at locations that showed elevated TCE levels in the 2014 sampling event. Indoor and outdoor air samples were collected over an approximate time period of 24 hours in passivated canisters. Samples were analyzed for PCE and TCE using EPA Method TO-15 by Eurofins/Calscience in Garden Grove, California.
Since the September – October 2015 event provides the most recent PCE data on the former Viking Cleaners facility, this data will be used in lieu of the data collected at the August 2013 / February 2014 sampling events at the facility. For the other residences and businesses (as well as the TCE data on the former Viking Cleaners facility), the August 2013 / February 2014 data will be analyzed since it is still the most recent data collected at these locations. The 2016 data that was taken at four residences was also taken into consideration.

Exposure Pathway Analysis

Identifying exposure pathways is important in a health consultation because adverse health impacts can only happen if people are exposed to contaminants. The presence of a contaminant in the environment does not necessarily mean that people are actually coming into contact with that contaminant. Exposure pathways have been divided into three categories: completed, potential, and eliminated.

There are five elements considered in the evaluation of exposure pathways: (1) a source of contamination, (2) a medium such as soil or groundwater through which the contaminant is transported, (3) a point of exposure where people can contact the contaminant, (4) a route of exposure by which the contaminant enters or contacts the body, and (5) a receptor population. Completed pathways exist when all five elements are present and indicate that exposure to a contaminant has occurred in the past and/or is occurring presently. In a potential exposure pathway, one or more elements of the pathway cannot be identified, but it is possible that the element might be present or might have been present. In eliminated pathways, at least one of the five elements is or was missing, and will never be present. Completed and potential pathways, however, may be eliminated when they are unlikely to be significant.

For this case, complete and potential exposure pathways may be present as a result of people in East Central Phoenix inhaling air that contains levels of PCE and TCE. This is an effect of vapor intrusion, which is the migration of volatile chemicals from contaminated soil and groundwater plumes into buildings. Volatile chemicals are shown to enter buildings through cracks in the foundation and openings for utility lines. Atmospheric conditions and building ventilation are shown to influence vapor intrusion. (See Appendix C for a diagram of vapor intrusion.)

Other typical exposures to chemicals include ingestion and dermal contact from using water for domestic purposes. However, there are no private drinking water wells in the area, and the local water companies draw water from various sources regulated by EPA Maximum Contaminant Levels (MCLs). Therefore, drinking and domestic uses will not be discussed further in this report.
Table 1 summarizes the pathways for this case:

**Table 1. Exposure Pathway Evaluation**

<table>
<thead>
<tr>
<th>Location</th>
<th>Source</th>
<th>Media</th>
<th>Point of Exposure</th>
<th>Route of Exposure</th>
<th>Estimated Exposed Population</th>
<th>Time Frame</th>
<th>Type of Exposure Pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Central Phoenix</td>
<td>Dry cleaners</td>
<td>Vapor Intrusion from Soil and Groundwater</td>
<td>Indoor Air</td>
<td>Inhalation</td>
<td>Residents, Workers, Students</td>
<td>Past</td>
<td>Potential</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Current</td>
<td>Completed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Future</td>
<td>Potential</td>
</tr>
</tbody>
</table>

**Description of Health-based Comparison Values**

The health-based comparison values (CVs) are screening tools used with environmental data relevant to the exposure pathways. The health-based CVs are concentrations of contaminants that the current public health literature suggests are “unlikely to pose a risk to human health.” These comparison values are quite conservative, because they include ample safety factors that account for the most sensitive populations. ADHS typically uses comparison values as follows: if a contaminant is never found at levels greater than its CV, ADHS concludes the levels of corresponding contamination are unlikely to pose a risk to human health. If, however, a contaminant is found at levels that are greater than its comparison value, ADHS designates the pollutant as a contaminant of concern and examines potential human exposures in greater detail.

Comparison values are based on extremely conservative assumptions. Depending on site-specific environmental exposure factors (e.g. duration and amount of exposure) and individual human factors (e.g. personal habits, occupation, and/or overall health), exposure to levels greater than the comparison value may or may not lead to a health effect. Therefore, the comparison values should not be used to predict the occurrence of adverse health effects, but can be used to identify which contaminants should be investigated further.

To evaluate potential health risks from PCE and TCE concentrations, ADHS used Minimal Risk Levels (MRLs) and Cancer Risk Evaluation Guides (CREGs) developed by ATSDR. An MRL is an estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to cause measurable noncancerous adverse health effects. A CREG is an estimated contaminant concentration that would be expected to cause no more than one excess cancer in a million \(10^{-6}\) persons exposed during their lifetime (70 years). They are calculated from EPA’s unit risk values for inhalation exposures (ATSDR 2005).
Comparison to Health-based Comparison Values

To conduct the health hazard analysis, the sample results taken at each sampling location were averaged to determine two average contaminant concentrations at each sampling location. One average contaminant concentration was calculated from the grab sample results, which are used to measure acute exposure. The other average contaminant concentration was calculated from the 24-hour air sample results, which are used to measure chronic exposure. If the sample contained a concentration below the detection limit, a concentration value of half the detection limit was assumed. For example, if a particular sample was determined to have a concentration of below the detection limit of 3.4 µg/m³, then its concentration would be assumed to be 1.7 µg/m³.

The results of these samples and their corresponding health-based comparison values are shown in Tables 2 and 3 below:

### Table 2. Comparison to Health-Based Comparison Values for PCE

<table>
<thead>
<tr>
<th>Exposure Length</th>
<th>Detected frequency</th>
<th>Detected range¹ (µg/m³)</th>
<th>Comparison Value (µg/m³)</th>
<th>Source of CV</th>
<th># of samples exceeding CV (µg/m³)</th>
<th>Is it a Contaminant of Concern?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term</td>
<td>59/149</td>
<td>ND² – 86</td>
<td>41</td>
<td>Acute MRL</td>
<td>2</td>
<td>Yes</td>
</tr>
<tr>
<td>Long-term</td>
<td>32/49</td>
<td>ND – 52</td>
<td>41; 3.8</td>
<td>Chronic MRL; CREG</td>
<td>0; 16</td>
<td></td>
</tr>
</tbody>
</table>

¹ Detection limit was 3.4 µg/m³ for grab samples, 2.3 µg/m³ for 24-hr samples  
² Not detected

### Table 3. Comparison to Health-Based Comparison Values for TCE

<table>
<thead>
<tr>
<th>Exposure Length</th>
<th>Detected frequency</th>
<th>Detected range¹ (µg/m³)</th>
<th>Comparison Value (µg/m³)</th>
<th>Source of CV</th>
<th># of samples exceeding CV (µg/m³)</th>
<th>Is it a Contaminant of Concern?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-term</td>
<td>109/154</td>
<td>ND² – 50</td>
<td>N/A³</td>
<td>N/A</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Long-term</td>
<td>10/49</td>
<td>ND – 12</td>
<td>2.1; 0.24</td>
<td>Chronic MRL; CREG</td>
<td>3; 10</td>
<td></td>
</tr>
</tbody>
</table>

¹ Detection limit was 2.2 µg/m³ for grab samples, 1.8 µg/m³ for 24-hr samples  
² Not detected  
³ Not applicable (acute MRL for TCE has not been developed)

Both PCE and TCE were selected for further evaluation because their current concentrations at certain sampling locations were above their respective health-based comparison values.
Uncertainty and Variability of Indoor Air Measurements

Volatile organic compounds (VOCs) are found in common household products, such as paints, wood preservatives, aerosol sprays, cleansers, disinfectants, and air fresheners. (EPA 2016) VOCs can also be emitted as gases into the air as a source of indoor air contamination. If this were to occur, vapor intrusion might not be an important source of the detected VOCs, and a sub-slab depressurization (mitigation) system would not reduce indoor air VOCs.

There were a few cases (Building ID #s 32-F-183, 32-F-186, 32-F-201, 32-F-211, 32-F-226) where the presence of air fresheners may have skewed results – for those buildings, the grab sample value was ignored and only the 24-hr sample value was used after several air fresheners were unplugged. ADHS reviewed the Indoor Air Sampling Questionnaire and Building Inventory taken at the 2014 and 2016 sampling events. At one household (32-F-067), acrylic gel/paint and a surface safe adhesive remover (Goo Gone) were identified as potential sources of TCE in the residence.

Indoor air measurements can vary temporally and spatially. The indoor air levels of VOCs can vary because of indoor air pressure changes due to the use of a heating or air conditioning system, as well as seasonal phenomena. The ability of soil gas to enter homes is dependent on many factors such as the type of building construction, number and size of cracks in the building foundation/basement, and type of soil below and around the buildings (EPA 2012).

A stack effect commonly results due to the indoor to outdoor air temperature differential (EPA 2012). The stack effect tends to cause more sub-slab soil gas to enter homes at a greater rate during the summer months in Phoenix, when the temperature differential between indoor and outdoor air is greater. Therefore, the actual indoor PCE and TCE concentrations arising from vapor intrusion can be expected to vary throughout the year, and may be higher or lower than what was observed during any individual sampling event. Sampling events were taken in August 2013 and February 2014 to account for seasonal phenomena. Samples taken at the same location tended to have higher PCE and TCE concentrations during the August sampling event than the February sampling event. During the hot summer months in Phoenix, fresh air exchange is reduced because homes are closed more tightly in order to prevent heat from entering the house.

Tetrachloroethylene (PCE)

One contaminant of concern at 32nd Street and Indian School Road is tetrachloroethylene (PCE). PCE is a clear, colorless, nonflammable solvent that readily evaporates at room temperature. PCE is widely used in the dry cleaning of fabrics and the degreasing and drying of metals. It is found in a variety of consumer products such as brake and wood cleaners, glues, laundry aids, paint removers, and suede protectors. PCE is a nonflammable, colorless liquid at room temperature. It evaporates easily into the air and has a sharp, sweet-smelling odor. Most people can smell PCE in air at levels in excess of 7,000 µg/m³ (ATSDR 2014).

Acute effects of PCE inhalation include irritation of the upper respiratory tract and eyes, as well as kidney dysfunction. Chronic inhalation exposure can lead to neurological effects, impairments in cognitive and motor neurobehavioral functioning, liver damage, and development and
reproductive effects. The International Agency for Research on Cancer (IARC) has classified PCE as probably carcinogenic to humans (Group 2A), and dry cleaning workers exposed to PCE have shown increased frequencies of bladder cancer, non-Hodgkin lymphoma, and multiple myeloma (EPA 2012).

Non-Cancer Health Effects:

Short-term (<14 days):

To determine short term non-cancer risk at each sampling location, sample concentrations are compared to the acute Minimal Risk Level (MRL). ATSDR established an acute MRL of 41 µg/m³ for PCE. Grab samples were taken at 149 sampling locations and analyzed for PCE. 90 of the 149 sampling locations contain PCE levels at or below the detection limit, which is 3.4 µg/m³. 57 of the 149 sampling locations contain PCE levels above the detection limit but below the MRL, and do not present a short-term, non-cancerous public health concern. 2 of the 154 sampling locations contain PCE levels above the MRL. The MRL is over 300 times lower than the Lowest Observed Adverse Effect Level (LOAEL) due to uncertainty and modifying factors used in the MRL derivation (ATSDR 2014). The LOAEL for PCE is 1.7 ppm (= 11,530 µg/m³), above which it was shown to cause color vision decrements in a chronic-duration epidemiological study by Cavalleri et al. (1994). As shown in Table 4, these 2 sampling locations contain PCE levels over 130 times below the LOAEL, so no observed adverse health effects are predicted.

Table 4: Sampling Locations above the Acute MRL for PCE

<table>
<thead>
<tr>
<th>Sampling Location</th>
<th>Location Type</th>
<th>Average PCE Conc. (µg/m³)</th>
<th>Acute MRL (µg/m³)</th>
<th>LOAEL (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-F-228</td>
<td>Residence</td>
<td>55.85</td>
<td>41</td>
<td>11530</td>
</tr>
<tr>
<td>32-M-005</td>
<td>Residence</td>
<td>86</td>
<td>41</td>
<td>11530</td>
</tr>
</tbody>
</table>

Long-term (>365 days):

To determine long term non-cancer risk at each sampling location, sample concentrations are compared to the chronic Minimal Risk Level (MRL). ATSDR established a chronic MRL of 41 µg/m³ for PCE, above which an increase in reticulocytes was observed in mice (ATSDR 2014). 24-hour air samples were taken at 49 sampling locations and analyzed for PCE. 16 of the 49 sampling locations had a PCE concentration below the detection limit, which is 2.3 µg/m³. 33 of the 49 sampling locations contained PCE levels above the detection limit but below the MRL, and do not present a long-term, non-cancerous public health concern.

Cancer Health Effects:

To determine cancer risk at each sampling location, the average chronic contaminant concentration was multiplied by an inhalation unit risk (IUR) for that chemical, which can be
found on EPA’s Integrated Risk Information System (IRIS). The IUR for PCE is $2.6 \times 10^{-7}$ per µg/m$^3$. The result is a unitless number known as the cancer risk. See below for the cancer risk equation.

$$CR = C \times IUR$$

CR = cancer risk (unitless)
C = contaminant concentration (µg/m$^3$)
IUR = inhalation unit risk (µg/m$^3$)$^{-1}$

The cancer risk at the 49 sampling locations ranged from $2.99 \times 10^{-7}$ to $1.35 \times 10^{-5}$. These sampling locations all present a cancer risk below $10^{-4}$, meaning that they would be expected to cause no more than one excess cancer in 10,000 persons exposed during their lifetime (70 years). EPA has established a target risk range of between 1 additional cancer risk in 1,000,000 exposed individuals to 1 excess cancer risk in 10,000 exposed individuals ($10^{-6}$ to $10^{-4}$). See Figure 1 for a cancer risk graphic.

![Cancer Risk Graphic](image.png)

**EPA’s Target Risk Range**

**Figure 1. Cancer Risk Graphic [top: cancer risk, bottom: excess cancer cases]**

The actual risk is likely to be lower because exposure is likely to be intermittent, depending on the duration of residential or occupational exposure. The excess cancer risk from PCE is within EPA’s target risk range.

**Trichloroethylene (TCE)**

Trichloroethylene (TCE) is the other main contaminant of concern. TCE is a colorless liquid used as a solvent and metal degreasing agent, and it is also a breakdown product of PCE. TCE was closely associated with the automotive and metal-fabricating industries from the 1950s to 1970s (ATSDR 2014). It can also be found in some household products such as paint removers, adhesives, spot removers, and rug cleaning fluids. TCE is a clear, colorless solvent, and has a somewhat sweet odor. Most people can smell TCE in air at levels in excess of 540,000 µg/m$^3$ (ATSDR 2014).
Central nervous system effects are the primary effects noted from acute and chronic inhalation exposure to TCE. Symptoms may include dizziness, headache, sleepiness, and nausea. TCE is classified by the IARC as probably carcinogenic to humans (Group 2A), and has been associated with kidney, liver, cervix and lymphatic cancers in humans (EPA 2000).

The US EPA determined an inhalation RfC of 2 µg/m$^3$ based on immunological effect (decreased thymus weight in adult mice), and critical heart effect (increased cardiac malformation in rat fetuses) from oral exposure studies (EPA 2015).

Non-Cancer Health Effects:

Short-term (<14 days):

An acute MRL for TCE has not been developed by ATSDR due to the lack of adequate human or animal data for exposures <14 days in duration (ATSDR 2015). Therefore, short-term non-cancer risk was not analyzed in this report.

Long-term (>365 days):

ATSDR has established a chronic MRL of 2.1 µg/m$^3$ for TCE. 24-hour air samples were taken at 49 sampling locations and analyzed for TCE. 46 of the 49 sampling locations contain TCE concentrations below 2.1 µg/m$^3$, and do not pose a potential non-cancerous health risk. 3 of the 49 sampling locations contain TCE levels above the MRL. The MRL is 10 times lower than the 99th percentile estimate of a human equivalent concentration (HEC$_{99}$) due to an interspecies extrapolation uncertainty factor used in the MRL derivation. In this case, the HEC$_{99}$ of 21 µg/m$^3$ represents the lower bound benchmark dose lower confidence limit (BMDL$_{01}$), above which increased fetal cardiac malformations was found in Sprague-Dawley rats (EPA 2012). As shown in Table 5, these 3 sampling locations contain TCE level above the chronic MRL but below the BMDL$_{01}$.

Table 5: Sampling Locations above the Chronic MRL for TCE

<table>
<thead>
<tr>
<th>Sampling Location</th>
<th>Location Type</th>
<th>2014 TCE Conc. (µg/m$^3$)</th>
<th>2016 TCE Conc. (µg/m$^3$)</th>
<th>Average TCE Conc. (µg/m$^3$)</th>
<th>Chronic MRL (µg/m$^3$)</th>
<th>BMDL$_{01}$ (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-F-024</td>
<td>Residence</td>
<td>5.1</td>
<td>0.9$^1$</td>
<td>3.0</td>
<td>2.1</td>
<td>21</td>
</tr>
<tr>
<td>32-F-044</td>
<td>Residence</td>
<td>6.3</td>
<td>0.9$^1$</td>
<td>3.6</td>
<td>2.1</td>
<td>21</td>
</tr>
<tr>
<td>32-F-067</td>
<td>Residence</td>
<td>4.2</td>
<td>0.9$^1$</td>
<td>2.55</td>
<td>2.1</td>
<td>21</td>
</tr>
</tbody>
</table>

$^1$ Value below detection limit, concentration of half the detection limit assumed

The elevated indoor TCE levels are likely not due to vapor intrusion as discussed below, but due to the presence of other common sources in the residences. ADHS evaluated the soil vapor samples collected in 2013 to determine if soil vapors have the potential to pose an unacceptable vapor intrusion exposure. The TCE soil gas concentrations in the areas surrounding the above
three residences, were determined to be less than 55 µg/m³, which is below the soil vapor screening level of 70 µg/m³ for TCE. This indicates that the vapor intrusion exposure pathway is not likely to be a concern.

See Table 6 below.

Table 6: Vapor Intrusion Determination for the 3 Sampling Locations

<table>
<thead>
<tr>
<th>Sampling Location</th>
<th>TCE Soil Gas Conc.</th>
<th>2014 TCE Indoor Air Conc.</th>
<th>2016 TCE Indoor Air Conc.</th>
<th>Is there a VI concern?</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-F-024</td>
<td>Low</td>
<td>5.1</td>
<td>ND (0.9)</td>
<td>No</td>
</tr>
<tr>
<td>32-F-044</td>
<td>Low</td>
<td>6.3</td>
<td>ND (0.9)</td>
<td>No</td>
</tr>
<tr>
<td>32-F-067</td>
<td>Low</td>
<td>4.2</td>
<td>ND (0.9)</td>
<td>No</td>
</tr>
</tbody>
</table>

Based on the evaluation, there is a potential public health concern because the TCE indoor air concentrations were highly variable and the averaged concentrations were above the health guideline, which have increased risk to affect the most sensitive population (fetus). However, the elevated TCE concentrations are not likely to be due to vapor intrusion. In addition, TCE concentrations may vary due to non-vapor intrusion factors. For these three residences, ADHS recommends to reduce exposure to TCE by limiting the use of paint removers, adhesives, spot removers, rug cleaning fluids, and other household products that may contain TCE.

Cancer Health Effects:

To determine cancer risk at each sampling location, the average chronic contaminant concentration was multiplied by an inhalation unit risk (IUR) for that chemical, which can be found on EPA IRIS. The IUR for TCE is 4.1 x 10⁻⁶ per µg/m³. The result is a unitless number known as the cancer risk. See below for the cancer risk equation.

\[
CR = C \times IUR
\]

\(CR = \) cancer risk (unitless)
\(C = \) contaminant concentration (µg/m³)
\(IUR = \) inhalation unit risk (µg/m³)

The cancer risk at the 49 sampling locations ranged from 3.69 x 10⁻⁶ to 1.48 x 10⁻⁵. These sampling locations all present a cancer risk below 10⁻⁴, meaning that they would be expected to cause no more than one excess cancer in 10,000 persons exposed during their lifetime (70 years). EPA has established a target risk range of between 1 additional cancer risk in 1,000,000 exposed individuals to 1 excess cancer risk in 10,000 exposed individuals (10⁻⁶ to 10⁻⁴). See Figure 1 for a cancer risk graphic.

*ADHS cannot provide a realistic cancer estimation for the sampling locations 32-F-024, 32-F-044, and 32-F-067 due to sample variation.*
The actual risk is likely to be lower because exposure is likely to be intermittent, depending on the duration of residential or occupational exposure. The excess cancer risk from TCE is within EPA’s target risk range.

Child Health Considerations

ADHS considers children in its evaluations of all exposures, and uses health guidelines that are protective of children. In general, ADHS assumes that children are more susceptible to chemical exposures than adults. Children may be more sensitive to the effects of pollutants than adults. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. The comparison values (CVs) used in this health consultation were developed to be protective of susceptible populations such as children.

Conclusions and Recommendations

Based on the data, there is no inherent public health concern from PCE. 2 of the sampling locations contained PCE levels above the acute MRL, but over 130 times below the LOAEL. Therefore, no short-term, non-cancerous public health concern is expected. All sampling locations contained PCE levels below the chronic MRL. As a result, no long-term, non-cancerous public health concern is expected. The estimated cancer risk did not exceed the EPA target risk range of \(10^{-6}\) to \(10^{-4}\), so no cancerous public health concern is expected from PCE.

Based on the data, ADHS believes that there is a potential public health concern from TCE. An acute MRL for TCE has not been developed, therefore short-term non-cancerous risk was not analyzed in this report. 3 of the residences contain TCE levels above the chronic MRL. There is a potential public health concern because the TCE indoor air concentrations were highly variable and the averaged concentrations were above the health guideline. However, the elevated TCE concentrations are not likely to be due to vapor intrusion. For the 3 sampling locations: 32-F-024, 32-F-044, and 32-F-067, ADHS will make available health education materials to residents regarding ways to reduce TCE exposure from common sources in residences. The estimated cancer risk did not exceed the EPA target risk range of \(10^{-6}\) to \(10^{-4}\), so no cancerous public health concern is expected from TCE.
References


Preparers of Report

Arizona Department of Health Services, Office of Environmental Health

Kaleb Tsang, Risk Assessor

Reviewers of Report

Arizona Department of Health Services, Office of Environmental Health

Matthew Roach, Program Manager
Jennifer Botsford, Program Manager
Hsin-I Lin, Toxicologist
Kayla Iuliano, Epidemiologist
Appendices

Appendix A: ECP 32\textsuperscript{nd} Street and Indian School Road Map

Appendix B: Maps of ECP Area

Figure 1: Fairmount Area Indoor Air Screen
Figure 2: Maroney Area Indoor Air Screen
Figure 3: Viking Area Indoor Air Screen
Appendix C: Vapor Intrusion - Migration of Soil Vapors to Indoor Air


Figure 1. Migration of Soil Vapors to Indoor Air

This figure depicts the migration of volatile chemicals from contaminated soil and groundwater plumes into buildings. Volatile chemicals are shown to enter buildings through cracks in the foundation and openings for utility lines. Atmospheric conditions and building ventilation are shown to influence vapor intrusion.