

# **Health Consultation**

**FORMER CUSTOM CLEANERS  
AIR SAMPLING RESULTS EVALUATION  
MEMPHIS, SHELBY COUNTY, TENNESSEE**

July 18, 2014

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## Foreword

This document summarizes an environmental public health investigation performed by the Environmental Epidemiology Program of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

*Evaluate Exposure:* Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

*Evaluate Health Effects:* If people have the potential to be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

*Make Recommendations:* Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of the Environmental Epidemiology Program in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be action items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

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## Introduction

The Tennessee Department of Environment and Conservation (TDEC) Division of Remediation's (DoR) Memphis Field Office (MFO) asked the Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) to review the results of indoor air testing at the former Custom Cleaners Site located at 3517 Southern Avenue in Memphis, Tennessee, (the site). The review was done to evaluate whether the air quality poses a health concern to any occupant of the former Custom Cleaners (DoR ID No. 79-897). The evaluation was also done to provide useful information on site conditions to the building owner, to those who may be involved with building renovation, or be future tenants of the building. TDEC had concerns about indoor air quality inside the former Custom Cleaners building. Most recently, the former Custom Cleaners was occupied by Sherri's Discount Arts.

The Discount Arts owner contacted TDEC MFO by phone on June 27, 2013. She indicated she recently became ill from an unknown cause. The Discount Arts owner also indicated a dry cleaning facility operated in the building before she leased the building. When the Discount Arts owner first leased the space in 1999 or 2000, "barrels" and drycleaning equipment remained at the site (TDEC 2013). TDEC MFO received a follow-up email on July 15, 2013, from the Discount Arts owner reporting numbers labeled on the barrels that she reportedly encountered (TDEC 2013). One of the numbers the tenant reported corresponded to the Chemical Abstract Service (CAS) number for carbon tetrachloride. Another number reported by the tenant was close to the CAS number for the drycleaning solvent tetrachloroethylene (perc or PCE). During the course of initial investigation activities, TDEC MFO obtained historical file information from TDEC's Division of Solid Waste Management (DSWM) for Custom Cleaners at 3517 Southern Avenue. Per the information provided in TDEC DSWM's files, the property owner disposed of spent PCE filters and liquid associated with the drycleaner in 1999 in accordance with DSWM's regulations.

TDEC MFO staff conducted soil-gas testing in September 2013 around the outside of the Discount Arts building. The testing was done close to the building to understand if there were any previous spills or leaks of drycleaning chemicals to soil at the site. Additionally, TDEC MFO staff conducted indoor air sampling in September and October 2013 in the Discount Arts leased space and in an upstairs office and storage area that was reportedly used as a temporary living area. Indoor air was sampled using both passive diffusion and 24-hour time integrated Summa canister samplers.

TDH EEP conducted this vapor intrusion evaluation after review of the indoor air testing results received from TDEC MFO. EEP's review was based on samples collected during the September and October 2013 sampling event. The vapor intrusion evaluation was intended to understand what, if any, risk site contamination might be to current and future users of the site building.

Indoor air sampling results showed the volatile organic compounds (VOCs) PCE and its breakdown product trichloroethylene (TCE). Other VOCs found in minor amounts included acetone, methylene chloride, cyclohexane, methyl ethyl ketone (MEK), n-Hexane, trichlorofluoromethane, dichlorofluoromethane, and chloromethane. Petroleum-related chemicals such as toluene, ethylbenzene, xylene, and 1,2,4-trimethylbenzene were also found in the indoor air samples. PCE levels were above indoor air screening levels established by the Agency for

Toxic Substances and Disease Registry (ATSDR) and U.S. Environmental Protection Agency (EPA).

An ambient or outdoor air sample was collected using passive diffusion sorbent tubes provided by Beacon Environmental Services of Forest Hill, Maryland. Chemicals found in the outdoor air sample included PCE and the petroleum hydrocarbon chemicals benzene, toluene, ethylbenzene, and xylenes (BTEX).

## **Background**

The site is in a residential and commercial area of east Memphis. The former Custom Cleaners is located at 3517 Southern Avenue in Memphis, Tennessee 38111, in a small strip mall. The street addresses for the strip mall are 3511 to 3517 Southern Avenue. The strip mall was on a 1949 fire insurance map for the area. The investigation area focused on an approximate 3,400 square foot retail building located on an approximate 0.62 acre parcel located on the south side of Southern Avenue near the intersection of Highland Avenue (Figure 1).

The site is accessible and located in an area with high pedestrian traffic due to the proximity to the University of Memphis. The nearest residential properties include apartment complexes approximately 400 feet to the east and single family residential properties approximately 325 feet south of the site (TDEC 2013).

According to information available through the Shelby County, Tennessee, Assessor of Property, the building was built in 1943. TDEC MFO obtained information regarding historical businesses at or near 3517 Southern Avenue from the R.L. Polk City Directory (TDEC 2013). This information showed dry cleaning or laundry facilities were located at or near 3517 Southern Avenue as early as 1933 and as recently as 1993. Numerous other businesses such as auto repair facilities, service stations, lumber companies, machine shops, furniture repair facilities, woodworking facilities, etc. were also historically located in this area between 1933-1993. Further investigation by TDEC MFO indicated the property had been used as a laundry or drycleaner since the mid-1950s. The site was operated as a drycleaner for about 45 years before it closed in March 1999 (TDEC 2013). Sharri's Discount Arts operated in the former cleaner's space from about 1999 to 2014.

### ***Findings of Previous Investigations***

The site was a former drycleaner. The Discount Arts owner indicated when they began leasing the space in 1999 or 2000 drycleaning equipment and drums were still present. TDEC records indicated the property owner had the waste within the drums properly disposed at a permitted treatment storage and disposal facility in 1999 (TDEC 2014). The Discount Arts owner reported the site to TDEC MFO on June 27, 2013.

TDEC staff visited the site on June 28, 2013. The Discount Arts owner indicated to TDEC staff that strong odors developed inside the site building, especially when the outside temperature was elevated. The Discount Arts owner stated the odors seemed stronger in the front bathroom and along the wall where reportedly drums were stored (TDEC 2013). The reported drum storage was against the western wall around a garage door, likely a loading and unloading area. During

the June 28, 2013, TDEC site visit, MFO personnel noted the floor in the northern-most bathroom is now covered with linoleum tile.

The TDEC MFO representative did not find any unusual odors during the site visit. A vapor intrusion building survey was completed before beginning indoor air screening. This survey included information about the building and its occupants, as well as a sketch of the facility. A photoionization detector (PID) able to read in parts per million (ppm) was used to screen the building for elevated organic vapors. This screening did not show conclusive evidence of elevated vapor concentrations. This included areas where VOCs were being used and stored as part of the art supply business.

Detections of organic vapors were found in ambient air around the outside of the building slightly higher than the minor intermittent values found in the interior of the building.

TDEC visited the site again on September 13, 2013, to conduct additional PID screening. The PID was used inside and outside of the building to evaluate proposed future soil-gas and indoor air sample locations. No elevated levels of VOCs were detected inside or outside the building. During the site visit, TDEC noticed the area upstairs above the art supply sales floor appeared lived in. The Discount Arts owner indicated she had been living upstairs in the building Monday through Friday.

In late September through early October 2013, TDEC conducted a passive soil-gas survey. Nine boreholes were drilled to depths ranging from 18- to 24-inches below ground surface (Figure 1) outside and close to the site building. The boreholes were drilled to these depths to ensure native soil was encountered. A soil-gas sampler was installed in the upper 12 inches of each borehole inside an aluminum sleeve that lined the borehole. The sleeve was used to block horizontal migration of vapors within the borehole so that only vapors migrating vertically were detected. The borehole containing the sampler and sleeve was then capped to prevent intrusion of ambient air. Six of the eight onsite locations were beneath asphalt or concrete and two locations on the east side of the site building were in grassy areas. One background location was in a grassy area (Merrie Embry, TDEC MFO, personal communication, July 16, 2014. PCE, TCE, cis-1,2-DCE, trans-1,2-dichloroethylene (trans-1,2-DCE), benzene-toluene-ethylbenzene-xylene (BTEX), methylene chloride, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were found in the onsite soil-gas samples.

These results revealed there was the potential for vapor intrusion of chemicals in the soil-gas to migrate into the indoor air of the building. Indoor air testing conducted during the same time frame as the passive soil-gas testing indicated the presence of several constituents in indoor air, including PCE and TCE. Indoor air levels of PCE were above both ATSDR and EPA health comparison values. Due to the presence of PCE and daughter products in the subsurface and indoor air, TDEC MFO planned to further investigate the former Custom Cleaners site. The presence of PCE in indoor air is potentially due to vapor intrusion from the subsurface. However, TDEC MFO was unable to rule out any background or potentially contributing sources of PCE in the building during the time of the investigation activities due to the limitations of the PID screening activities and the building use as an art supply store. Both TDH EEP and TDEC DoR evaluated the indoor air results and indicated to the tenant that it was not advisable to live

**Figure 1**  
**Sample Locations**  
**Former Custom Cleaners Site,**  
**DoR# 79-897**



**Legend**

**Indoor/Ambient Air Locations**

**Name**

- ▲ CC10-0913IAP
- ▲ CC11-0913IAP
- ▲ CC12-0913IAP
- ▲ CC13-0913IAP

**PSG Locations**

**Name**

- CC01-0913PSG
- CC02-0913PSG
- CC03-0913PSG
- CC04-0913PSG
- CC05-0913PSG
- CC06-0913PSG
- CC07-0913PSG
- CC08-0913PSG

CC11-0913IAP is located in the upstairs portion of the building.

**Source:**



Map created by Merrie Embry, Project Manager  
TDEC-Division of Remediation  
October 7, 2013



or reside at her current place of business. Both TDH EEP and TDEC DoR did not ask her to limit her business operations in any way. Based upon information conveyed to TDEC MFO by the property owner's legal counsel, the tenant vacated the building in early February 2014. Personnel from TDEC MFO and TDEC DoR's Dry Cleaner Environmental Response Program (DCERP) visited the site on February 2, 2014, and confirmed the building appeared to be vacant (TDEC 2014). As of mid-May 2014, the site owner had not entered the site into TDEC DoR's DCERP Program.

## **Discussion**

### **Introduction to Chemical Exposure**

To determine whether persons have been or are likely to be exposed to chemicals, TDH EEP evaluates mechanisms that could lead to human exposure. Chemicals released into the environment have the potential to cause harmful health effects. Nevertheless, a release does not always result in exposure. People can only be exposed to a contaminant if they come into contact with it. If there is no contact with a contaminant, no exposure occurs. Therefore, no exposure-related health effects could occur. An exposure pathway contains five parts:

- a source of contamination,
- contaminant transport through an environmental medium,
- a point of exposure,
- a route of human exposure, and
- a receptor population.

An exposure pathway is considered complete if there is evidence that all five of these elements have been, are, or will be present at the site. An exposure pathway is considered incomplete if one of the five elements is missing.

The source is the place where the chemical was released. For this site, the potential source is spills from past activities performed at the site. The environmental media (such as, soil, surface water, groundwater, or air) transport the contaminants. For this site, the chemicals are potentially transported through the soil and indoor air. The point of exposure is the place where persons come into contact with the contaminated media. Indoor air is the potential point of exposure for this site. The route of exposure (for example, ingestion, inhalation, or dermal contact) is the way the contaminant enters the body. For this site, if the indoor air has measureable levels of VOCs, the route of exposure would be breathing of indoor air.

Physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will be harmed. A chemical's ability to affect health is controlled by a number of other factors, including:

- the amount of the chemical that a person is exposed to (dose),
- the length of time that a person is exposed to the chemical (duration),
- the number of times a person is exposed to the chemical (frequency),
- the person's age and health status, and

- the person's diet and nutritional habits.

For this site, building tenants, customers, workers, and employees are the people who would be exposed if vapor intrusion was occurring. The customers of the store would be far less exposed to the chemicals in the indoor air because they would only spend a limited amount of time in the store, maybe one hour per week. Building tenants, workers, and employees would have a higher likelihood of exposure based upon the amount of time spent in the building. The property is zoned commercial.

### **Vapor Intrusion**

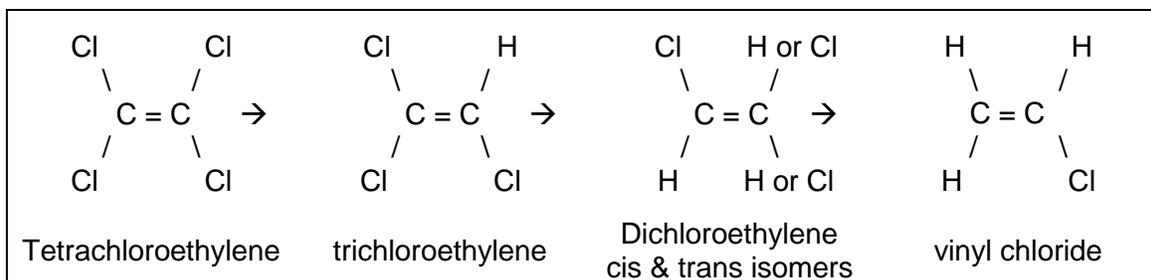
Volatile and semi-volatile chemicals can evaporate from impacted subsurface soil and groundwater beneath a building and move toward areas of lower chemical levels such as in the atmosphere, utility conduits, or basements. This process is called vapor intrusion. Subsurface vapors can enter a building due to two main factors: environmental effects and building effects. Some examples of these effects are barometric pressure changes, wind load, temperature currents, or depressurization from building exhaust fans. Chemicals can migrate up and enter indoor air through foundation slabs, crawl spaces, or basements. The chemical migration depends on the construction of the building, unsealed joints or cracks in the foundation, the building's heating and ventilation characteristics, and other building design and operational elements. The amount of movement of the vapors into the building is difficult to measure and depends on soil type, chemical properties, building design and condition, and pressure differences between the outside and inside air (ITRC 2007). Upon entry into a structure, chemical vapors mix with the existing air through the natural or mechanical ventilation of the building.

Vapors may accumulate in buildings to levels that pose safety hazards, health risks, or odor problems. Vapor intrusion has been documented in buildings with basement, crawlspace, or slab-on-grade foundation types. Vapor intrusion can be an acute health hazard. Usually, indoor vapor levels are low. Low levels of vapors, breathed over a long period of time, may or may not be a chronic health concern.

### **Drycleaner Solvent Explanation**

The process of drycleaning is not truly dry, but it uses so little water that it has come to be known as drycleaning. Instead of water, chemical solvents are used in the cleaning process. The most commonly used solvent for drycleaning is PCE. It is a colorless liquid and has sweet smell (ATSDR 1997). PCE is a volatile organic compound. It will quickly evaporate into a gas at room temperature. Therefore, for this evaluation we will focus on PCE and its chemical breakdown products.

As its name implies, PCE has four chlorine anions on a two-carbon molecule. The molecule breaks down once it enters the soil or groundwater through chemical and microbial processes into other chlorinated volatile organics. Each of these breakdown chemicals has slightly different chemical properties and toxicities. The following diagram is an example of how one chemical can break down to form another.



In this example, PCE can break down to TCE, and then to dichloroethylene (DCE), and then to vinyl chloride (VC). The only way to truly know the ratio of these breakdown chemicals is to collect environmental samples. The degradation products TCE and cis-1,2-DCE, have been noted in passive soil-gas samples collected at the site. PCE appears to be the dominant chemical present in site soil-gas. The solvents, PCE and TCE were carefully considered in developing this report.

## Environmental Sampling

### *Passive Soil-Gas*

As mentioned previously, TDEC conducted a passive soil-gas survey in late September through early October 2013. The chemicals present in the highest amounts were PCE, TCE, cis-1,2-DCE, and trans-1,2-DCE.

Passive soil-gas data collected could not be put into any model as the soil-gas data collected were qualitative in nature. They also could not be compared to any ATSDR or EPA soil screening levels as there are none established for passive soil-gas measurements. PCE passive soil-gas levels ranged from about 24 nanograms on the north side of the building to over 228,000 nanograms at the west side of the building. TCE passive soil-gas levels ranged from 13 nanograms at the northwest corner of the building to over 32,400 nanograms on the western side of the building.

### *Indoor Air Sampling*

During the 2013 sampling event, TDEC MFO sampled indoor air in the Discount Arts store and in the upstairs portion of the building, where the tenant was reportedly living. Four indoor air Summa canister samples were collected by TDEC inside the Discount Arts store on October 1, 2013. Summa Sample 1 was collected in the northeastern portion of the building in the art supply store. Summa Sample 2 was collected upstairs portion of the building. Summa Sample 3 was collected in the west-center of the art supply store. Summa Sample 4 was collected in the southern area of the art supply store (TDEC 2013).

The canisters were placed at least 4 feet above the floor and were fitted with 24-hour flow controllers provided by the testing laboratory. Samples were tested for all EPA method TO-15 compounds. Samples were shipped in their appropriate containers under chain-of-custody procedures to the testing laboratory, ESC Lab Sciences, of Mount Juliet, Tennessee.

In addition to the 24-hour Summa canister samples, Beacon Environmental Services (Beacon) passive diffusion (PD) indoor air samplers were placed in various areas of the building and allowed to passively collect indoor air samples for 14 days. The Beacon PD samplers were placed in the same areas as the Summa canisters. These PD samplers were placed on September 25, 2013, and retrieved on October 9, 2013. The PD samplers were analyzed in Beacon's laboratory in Forest Hill, Maryland, using EPA method TO-17 to obtain VOC results. Beacon Sample 1 was collected in the northeast corner of the former Custom Cleaners building. Beacon Samples 2 and 3 were collected upstairs. Beacon Sample 3 is a duplicate sample of Beacon Sample 2. Beacon Sample 4 was collected in the west side of the building. Beacon Sample 5 was collected inside the southern area of the building. Beacon Sample 6 was collected outside the building and was an ambient or outdoor air sample.

### **Comparison Values**

To evaluate exposure to a hazardous substance, health assessors often use health comparison values. If the chemical concentrations are below the comparison value, then health assessors can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the comparison values (ATSDR 2013a) for a particular chemical, then further evaluation is needed. The chemicals evaluated in this health consultation were PCE and TCE.

ATSDR develops Minimal Risk Levels (MRLs) using conservative assumptions. ATSDR uses the term 'conservative' to refer to values that are protective of public health in essentially all situations. Environmental Media Evaluation Guidelines (EMEGs) are calculated by ATSDR from their MRLs. EMEGs consider non-cancer adverse health effects (ATSDR 2013a) and are used for comparison to the indoor air data that was collected. Exposure durations are defined as acute (14 days or less), intermediate (15–364 days), and chronic (365 days or more) exposures. ATSDR does not use serious health effects, such as irreparable damage to the liver or kidneys, or birth defects, as a basis for establishing EMEGs. Chronic EMEGs assume exposure for 24 hours per day, 7 days per week, 52 weeks, 365 days per year, over a 70-year lifetime exposure. A reference concentration, or RfC, is an estimate of a daily inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of negative health effects during a lifetime of exposure. In January 2013, ATSDR adopted the EPA's RfC for TCE as their chronic inhalation MRL.

It should be noted chemicals found at levels above their respective comparison values do not necessarily represent a health threat. Instead the results of the comparison value screening identify those chemicals that warrant a more detailed, site-specific evaluation (ATSDR 2013b). ATSDR has cancer risk evaluation guides (CREGs) for cancer health effects evaluation. ATSDR residential indoor air comparison values are shown in Table 1.

EPA's Regional Screening Levels (RSLs) for commercial and industrial air inhalation were used in evaluating the results of the indoor air testing (EPA 2013). EPA commercial and industrial indoor air comparison values are shown in Table 1 for the chemicals found in the indoor air related to the former drycleaning operations. EPA commercial and industrial screening values were used because the building has always been commercial or industrial use and the building

tenants and customers of the business are the primary receptors of concern at the site. The Beacon PD ambient air sample had low levels of the petroleum hydrocarbon chemicals benzene, toluene, ethylbenzene, and xylenes. The presence of these hydrocarbon compounds in outdoor air is not unusual as the sample was located in an urban environment near the intersection of two, 4-lane city streets. Because measured levels of 1,2,4-trimethylbenzene and other petroleum hydrocarbon chemicals mentioned above in the Summa and Beacon PD samples were minor and were not related to the former drycleaner, the detections of these chemicals were not evaluated. ATSDR comparison values and EPA RSLs for both non-cancer and cancer health effects were used as comparison values for the chemicals tested.

<b>Table 1.</b> ATSDR and EPA indoor air comparison values for chemicals found in the indoor air at the former Custom Cleaners building at 3517 Southern Avenue, Memphis, TN. Indoor air comparison values are shown in parts per billion (ppb).					
Chemical	Acronym	ATSDR Chronic EMEG (non-cancer) (in ppb)	ATSDR CREG (10 <sup>-6</sup> excess cancer risk) (in ppb)	EPA Industrial RSL non-cancer health effects (in ppb)	EPA Industrial RSL (10 <sup>-6</sup> excess cancer risk) (in ppb)
tetrachloroethylene	PCE	40	0.57	2.7	7
trichloroethylene	TCE	0.37	0.045	0.16	0.56
Notes:					
ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2013). Chronic non-cancer exposure comparison values (exposure greater than 365 days) used to determine if chemical concentrations warrant further health-based screening.					
ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2013). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people (10 <sup>-6</sup> risk) over a 70-year lifetime.					
EPA Industrial RSL = Environmental Protection Agency Regional Screening Level (EPA 2014). The screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are considered by EPA to be protective for humans (including sensitive groups) over a 70-year lifetime.					

PCE and its breakdown chemical TCE were of special interest at the site and were evaluated because they are thought to be “*reasonably anticipated to be human carcinogens*” (IARC 1995, NTP 2011). Several VOCs were identified in soil-gas samples. PCE and TCE were the most harmful chemicals found in the indoor air. PCE is readily absorbed following inhalation and oral exposure as well as from direct exposure to the skin. For this site, we are concerned with the inhalation of PCE from vapor intrusion into indoor air. Compared to pulmonary and ingestion exposure, uptake of PCE vapors by the skin is minimal (ATSDR 1997a, 1997b).

## Results

### *Summa Canister Samples*

Indoor air testing results showed detections of PCE in all 4 Summa canister samples and TCE in 1 Summa canister sample out of 4. PCE measurements were similar at all locations ranging from 26 to 32 parts per billion (ppb). No outdoor air samples were collected using Summa canisters for comparison purposes. Table 2 shows the results of the indoor air sampling. Sample detection limits were very low, at 0.2 ppb. It is unknown if any of the art supply materials in the building contributed any PCE or TCE to the indoor air. An outdoor air sample was collected using the Beacon PD samplers and the results of that sample are shown in Table 3.

<b>TABLE 2.</b> Indoor air Summa canister sampling results for the former Custom Cleaners building at 3517 Southern Avenue, Memphis, Shelby County, TN. Site-related chemicals are shown. TDEC MFO collected the indoor air samples, over 24 hours from September 30, 2013 to October 1, 2013 using Summa canisters (TDEC 2013). General locations of indoor air samples are shown on Figure 1. Values are reported in parts per billion (ppb).					
Chemical / Sampling Data and Location Name	Acronym	Sample 1 CC-10 Indoor air (north end)	Sample 2 CC-11 Indoor air (upstairs apartment)	Sample 3 CC-12 Indoor air (west center)	Sample 4 CC-13 Indoor air (south end)
tetrachloroethylene	PCE	32	28	31	26
trichloroethylene	TCE	0.2	<0.2	<0.2	<0.2
Modifiers:					
<0.2 = Not detected in the air sample. Numerical values represent the analytical reporting limit.					
0.2 = Measurement in air that is above one or more comparison values.					

### *Beacon Passive Diffusion Samples*

Indoor air testing results showed detections of PCE in all 5 indoor Beacon PD samples and in the 1 outdoor PD sample. TCE was also detected in all 5 indoor air samples, but at very low amounts. TCE was not detected in the outdoor sample. PCE measurements were similar at 4 of the 5 locations, ranging from 38 to 45.2 ppb. The highest level was found at the Sample 1 location in the northeast corner of the building, at 63.4 ppb. TCE was detected in the indoor air at estimated levels ranging from 0.16 to 0.19 ppb. Beacon PD sample results are shown in Table 3. Again, it is unknown if any of the art supply materials in the building contributed any PCE or TCE to the indoor air.

## Health Risk Evaluation

For this health consultation, the evaluation of the health risk at the site will consider the chemicals that have been confirmed to be present in the indoor air potentially related to the former cleaning operations and have potential health risks. This included PCE and TCE. TCE

**TABLE 3.** Indoor air Beacon Environmental Passive Diffusion sampling results for the former Custom Cleaners building at 3517 Southern Avenue, Memphis, Shelby County, TN. Site-related chemicals are shown. TDEC MFO collected the indoor air samples, over 14 days from September 25, 2013 to October 9, 2013 (TDEC 2013). General locations of indoor air samples are shown on Figure 1. Values are reported in parts per billion (ppb).

Chemical / Sampling Data and Location Name	Acronym	Sample 1 CC100913 Indoor air (northeast corner)	Sample 2 CC110913 Indoor air (upstairs)	Sample 3 CC110913-D Duplicate Indoor air (upstairs)	Sample 4 CC120913 Indoor air (west side)	Sample 5 CC130913 Indoor air (south end)	Sample 6 CC140913 Outdoor air
tetrachloroethylene	PCE	63.4 <i>D</i>	45.2 <i>D</i>	45.1 <i>D</i>	44.7 <i>E</i>	37.9 <i>D</i>	1
trichloroethylene	TCE	0.18 <i>J</i>	0.16 <i>J</i>	0.16 <i>J</i>	0.19 <i>J</i>	0.16 <i>J</i>	ND

Modifiers:

ND = Not detected in the air sample.

*D* = Indicates original sample was diluted and the result is the corresponding measurement.

*E* = Indicates the sample result exceeded the linear range of the calibration of the instrument.

*J* = Indicates the measured value is below the limits of quantification and is an estimated value.

was considered because its comparison values are very low; lower than the detection limits of the testing. It appears that residual PCE and possibly TCE contamination remains in soil, soil vapor and perhaps groundwater beneath the site building. Based on both the soil-gas and indoor air testing results, the process of vapor intrusion may be occurring at the site.

### ***Indoor Air Non-Cancer Evaluation***

Levels of PCE detected by both the Summa and the Beacon PD sampling methods were above its respective ATSDR and EPA non-cancer indoor air health comparison values (ATSDR 2013a, EPA 2014). Levels of TCE using both sampling methods were found below its ATSDR non-cancer health comparison value but at or above its EPA non-cancer screening value.

The measured levels equate to a Hazard Index of less than 1 to greater than 1. A Hazard Index of less than 1 means that there should not be non-cancer health effects to an individual who is breathing air, drinking the water, or coming into contact with the chemical. A Hazard Index of greater than 1 is not considered safe for chronic long-term exposure. More indoor air sampling data would be required to fully evaluate the non-cancer health risk due to the measured amounts of PCE and TCE. A sampling event conducted when the building is vacant would eliminate the potential for background sources to contribute both PCE and TCE to the indoor air.

### ***Indoor Air Cancer Evaluation***

PCE was detected in indoor air using Summa canisters ranged from 26 ppb to 32 ppb. The average PCE value for the 4 Summa samples collected inside the former Custom Cleaners was 29.25 ppb. PCE indoor air concentrations were compared to ATSDR's CREG for one excess cancer in one million people health risk comparison value of 0.57 (ATSDR 2013a) and EPA's commercial/industrial RSL for an excess lifetime cancer risk (ELCR) of one in a million of 7ppb (EPA 2014). Measured PCE levels were about 46 to 56 times higher than its ATSDR CREG and about 4 times greater than its EPA commercial/industrial cancer health effects RSL. Therefore, further analysis was done using the inhalation unit risk value for PCE.

The measured PCE levels using the Beacon PD samplers ranged from 37 to 63 ppb. The average PCE value of the 5 indoor air Beacon samples was 47.26 ppb. Again, these indoor air concentrations were compared to ATSDR's CREG for one excess cancer risk in one million people of 0.57 ppb (ATSDR 2013a) and EPA's commercial/industrial RSL for an excess lifetime cancer risk of one in a million of 7 ppb (EPA 2014). Measured PCE levels were about 68 to 110 times higher than its ATSDR CREG and 5 to 9 times higher than its EPA commercial/industrial cancer health effects RSL.

An estimated risk was calculated using the measured Summa sample PCE levels and EPA's inhalation unit risk (IUR). The IUR was calculated based on exposure to a chemical 24 hours per day, 7 days per week, for 365 days per year. Using the highest PCE concentration of 32 ppb ( $220 \mu\text{g}/\text{m}^3$ ) and the average PCE concentration of 29 ppb ( $197 \mu\text{g}/\text{m}^3$ ), and multiplying them by the IUR for PCE of  $2.6 \times 10^{-7} (\mu\text{g}/\text{m}^3)^{-1}$ , ELCRs of  $5.7 \times 10^{-5}$  and  $5.1 \times 10^{-5}$  were calculated. Therefore, the estimated ELCRs due to PCE would be between 5 and 6 extra cancers in 100,000 people, in addition to the background cancer risk. The normal every day risk of having cancer in

the U.S. is 1 in 2 for men and 1 in 3 for women (NTP 2011). This possible extra cancer risk is low when added to the background risk and is considered acceptable by EPA (1991). It is however, approaching an unacceptable risk level endpoint.

Using the PCE levels measured with the Beacon PD method, the highest measured concentration was 63.4 ppb (approximately  $430 \mu\text{g}/\text{m}^3$ ) and the average PCE concentration of 47.26 ppb ( $321 \mu\text{g}/\text{m}^3$ ). These results were multiplied by the IUR for PCE of  $2.6 \times 10^{-7} (\mu\text{g}/\text{m}^3)^{-1}$ . Calculated ELCRs due to PCE were between  $1.1 \times 10^{-4}$  and  $8.3 \times 10^{-5}$ . Therefore, the estimated ELCRs due to PCE would be between 1 extra cancer in 10,000 people and 8 extra cancers in 100,000 people, in addition to the background cancer risk. The normal every day risk of having cancer in the U.S. is 1 in 2 for men and 1 in 3 for women (NTP 2011). This possible extra cancer risk is low when added to the background risk. It is however, at an unacceptable risk level endpoint.

Considering the PCE indoor air results of both testing methods, full time workers would have less of an ELCR as they would not be working in the store 24 hours per day, 7 days per week, 365 days per year. The PCE ELCRs calculated above were modified to reflect a full time worker working 10 hours a day, 6 days per week, for 50 weeks a year. For full time workers, ELCRs are calculated to be between approximately 4 extra cancers in 100,000 people and 4 extra cancers in 1 million people. This range of ELCRs is within EPA's acceptable cancer risk range.

To more fully evaluate the TCE levels in the former Custom Cleaners, an estimated risk was calculated using the measured TCE levels and its EPA IUR. The highest level of TCE found was 0.2 ppb ( $1.1 \mu\text{g}/\text{m}^3$ ). Using the TCE concentration of  $1.1 \mu\text{g}/\text{m}^3$  and multiplying it by the IUR for TCE of  $4.1 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$  provides an estimated ELCR. The calculated ELCR for TCE in the former Custom Cleaners from this equation is  $4.5 \times 10^{-6}$ . Therefore, the estimated ELCR due to TCE would be between 4 and 5 extra cancers in 1 million people, in addition to the background cancer risk. The normal every-day risk of having cancer in the U.S. is 1 in 2 for men and 1 in 3 for women (NTP 2011). This calculated possible extra cancer risk is negligible overall when added to the background risk and is considered acceptable by EPA (1991).

Using the estimated TCE levels measured with the Beacon PD method, the highest measured concentration was 0.19 ppb ( $1.01 \mu\text{g}/\text{m}^3$ ). The average TCE concentration was 0.17 ppb ( $0.91 \mu\text{g}/\text{m}^3$ ). Using the TCE concentrations of  $1.01 \mu\text{g}/\text{m}^3$  and  $0.91 \mu\text{g}/\text{m}^3$  and multiplying them by the IUR for TCE of  $4.1 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$  provides an estimated ELCR. The calculated ELCRs for TCE from this equation are  $4.1 \times 10^{-6}$  and  $3.7 \times 10^{-6}$ . Therefore, the estimated ELCR due to TCE would be approximately 4 extra cancers in 1 million people, in addition to the background cancer risk. The normal every-day risk of having cancer in the U.S. is 1 in 2 for men and 1 in 3 for women (NTP 2011). This calculated possible extra cancer risk is negligible overall when added to the background risk and is considered acceptable by EPA (1991). Full time workers working 10 hours each day, 6 days each week, for 50 weeks each year would also have a negligible excess cancer risk, about 2 extra cancers in 1 million people.

It should be pointed out that recent studies have led to a re-evaluation of TCE non-carcinogenic effects. Using the recent study data, the EPA predicts that there is a small risk of fetal heart malformations for pregnant women exposed to TCE at  $21 \mu\text{g}/\text{m}^3$ . The EPA used an uncertainty factor of 10 to obtain the RfC of  $2 \mu\text{g}/\text{m}^3$  (ATSDR 2012; U.S. EPA 2013a), or 0.37 ppb. There is also a 1988 study by the NTP (2011) that determined humans exposed to  $30 \mu\text{g}/\text{m}^3$  of TCE in

air are at risk of developing kidney damage from inhalation of air with TCE (EPA 2011). The TCE levels within the former Custom Cleaners are below this level as well as EPA's RfC level.

The process of vapor intrusion may be occurring at the site. Exposure to the levels of PCE found in the building is not recommended for long periods of time. The Discount Arts business owner was reportedly living upstairs in the building. TDH EEP and TDEC DoR evaluated the indoor air results and indicated to the tenant that it was not advisable to live or reside at her then current place of business. Based upon information conveyed to TDEC MFO by the property owner's legal counsel, the tenant vacated the building in early February 2014. Personnel from TDEC DoR and DCERP visited the site on February 2, 2014 and confirmed the building appeared to be vacant (TDEC 2014).

## **Child Health Considerations**

Clients of the Discount Arts business were generally students that attended a nearby university. It is unknown if there were any children that visited the art supply store or attended art classes that were sometimes held at the store. Children may be more sensitive to the carcinogenic effects of PCE than adults (IRIS 2011). However, children would likely not be part of the population that would normally be present inside the building.

To protect public health, it would be prudent not to establish a future child care facility in the building where the populations would be exposed to the measured levels of PCE unless mitigation measures were used to make the building safe for this type of occupancy.

## **Limitations and Uncertainties in Vapor Intrusion**

Having and following an accepted protocol for conducting indoor air investigations is important. A general protocol was developed for this investigation. Still, even a good protocol cannot remove all limitations and uncertainties related to vapor intrusion investigations.

Several characteristics of buildings may influence the indoor air testing. Some examples of limitations and uncertainties include the unavailability of an "as built" drawing for this building. The number of breaks in floor slabs or utility perforations entering the building were also variables that could influence test results. For example, the exact amount of contamination under the building is an unknown. The amount and frequency of vapor off-gassing is likely not constant. It is unknown if there were background amounts of the chemicals in the indoor air.

A building inventory of chemicals and possible sources was performed. There was a limitation in measuring any off-gassing from background sources as the PID used was limited to reading in ppm. The use of cleaning products in the building that sometimes contain many of the same chemicals that are tested for could influence the results of the testing.

TDEC indicated that the heating, ventilation, and air conditioning (HVAC) system was operating in the downstairs portion of the building during the testing. Indoor temperatures were rather warm, ranging from 78 to 83 degrees Fahrenheit. Only fans were running upstairs. HVAC

systems mix some air from outside the building with indoor air. The concentrations of chemicals in the indoor air would likely be less during operation of the HVAC system.

All conclusions and recommendations presented in this Health Consultation were based on the results of the indoor air testing completed on October 1, 2013. Levels of chemicals in the indoor air of the site building could vary depending on vapor flux, precipitation events, and seasonal effects. If additional tests were performed, there is a possibility of different results.

What happened in the past at the site or other nearby sites is another uncertainty. The amounts and locations of any or all spills from the former drycleaner were likely undocumented. Basic handling practices of chemicals were different during the time period that the former drycleaner business in the building operated. It is unknown if there were sumps located on the interior of the building. Drums of stored chemicals as reported by the tenant were properly disposed of. It is also not known if the drycleaner was disassembled safely, chemicals properly disposed of, and the machinery dismantled after the drycleaner ceased operation. Historic industries were located on nearby sites. It is unknown if there are legacy environmental concerns remaining from those industries.

## Conclusions

**Conclusion 1:** *TDH EEP concluded no one should be living in the former Custom Cleaners unless mitigation measures were used to reduce or eliminate the amount of PCE levels in the indoor air of the building.*

Indoor air testing revealed that levels of PCE were above both non-cancer and cancer health screening levels. The PCE levels were considered too high for full-time occupancy. The non-cancer and cancer screening levels are based on breathing the indoor air 24-hours each day, 7-days each week, for a minimum of 30 years. As a result of the indoor air testing, TDEC contacted the tenant (owner of the Discount Arts business). The tenant was reportedly living above the Discount Arts store. Both TDH EEP and TDEC DoR evaluated the indoor air results and indicated to the tenant that it was not advisable to live or reside at her then current place of business. The tenant vacated the building in early February 2014. Personnel from TDEC MFO and DCERP visited the site on February 2, 2014 and confirmed the building appeared to be vacant. The tenant did not live above the store for the period of time the screening levels are based on.

**Conclusion 2:** *EEP concluded that before full time workers or part time customers use the former Custom Cleaners building, additional indoor air sampling, source removal, or mitigation should be completed based on the levels of PCE and TCE.*

PCE and TCE indoor air levels were above both non-cancer and cancer comparison levels. Workers and customers of any business located in the building would be exposed to elevated levels of PCE and TCE. It would be a prudent public health action to perform additional indoor air sampling, source removal, mitigation measures before the building is occupied.

***Conclusion 3:*** *TDH EEP cannot conclude what the source of the PCE was in the former Custom Cleaners building.*

Passive soil-gas sampling suggested high concentrations of PCE in soil-gas around the outside of the former Custom Cleaners building. Subsequent indoor air sampling in the building showed levels of PCE above ATSDR and EPA indoor air health comparison values. More indoor and sub-slab air sampling events should be scheduled to fully understand the environmental conditions inside and beneath the building.

## **Recommendations**

The focus of this health consultation was to make sure the indoor air breathed by workers and visitors to the building will not lead to harmful health effects. Based on the results of this indoor air sampling investigation, TDH EEP has the following recommendations:

1. TDH EEP recommended that no one live in the former Custom Cleaners building. PCE levels were greater than the both ATSDR and EPA health screening values and considered too high for full-time occupancy.
2. Steps should be taken by the building owner to reduce the amount of PCE and TCE in the indoor air of the building to levels protective of public health before it is rented or leased to another business.
3. TDEC or the building owner should conduct additional indoor air sampling to monitor levels of chemicals in indoor air after remedial measures are undertaken.
4. Based on the levels found in the soil-gas surrounding the building, other properties in the area of the former Custom Cleaners should be evaluated by TDEC or the property owner to identify potential receptors.
5. EEP recommends that TDEC take necessary steps to avoid establishing residences, a child care facility, or a clinic on the property unless the appropriate mitigation measures were taken to make the building safe for this type of occupancy.

## **Public Health Action Plan**

The public health action plan for the former Custom Cleaners building contains a list of actions that have been or will be taken by TDH EEP and other agencies. The purpose of the public health action plan is to ensure that this health consultation identifies public health concerns and offers a plan of action designed to mitigate and prevent harmful health effects that result from breathing, eating, drinking, or touching hazardous substances in the environment. Included is a commitment on the part of EEP to follow up on this plan to ensure that it is implemented.

Public health actions that have been taken by TDH's EEP include:

- Reviewed indoor air data from the former Custom Cleaners building.
- Conferred with TDEC MFO personnel and TDEC's Risk Assessor regarding the elevated levels of chemicals identified in the indoor air. All concluded it would be prudent if the owner of the Discount Arts business not both work and live in the building. Advised the Discount Arts owner of this recommendation.
- Participated in a follow up phone call with the Discount Arts owner recommending that she not live upstairs in the building.
- Prepared this Health Consultation.

Public health actions that will be taken include:

- TDH EEP will provide a copy of this health consultation to the Discount Arts owner and to the owner of the property.
- TDH EEP will provide copies of this health consultation to state and federal government agencies interested in the site.
- TDH EEP will maintain dialogue with ATSDR, TDEC, EPA, and other interested stakeholders to safeguard public health.
- TDH EEP staff will be available to answer questions regarding the interpretation of the indoor air results and to review additional environmental data, as requested to ensure safe reuse of the site.

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## Appendix A: Glossary of Terms and Acronyms

**adverse health effect:** A change in body function or cell structure that might lead to disease or health problems.

**ATSDR:** Agency for Toxic Substances and Disease Registry.

**cancer:** Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

**cancer risk:** The theoretical excess risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower. The excess cancer risk is often expressed as  $1 \times 10^{-6}$  for one excess cancer in 1 million people.

**carcinogen:** A substance that may cause cancer.

**chronic exposure:** Contact with a substance that occurs over a long time (more than 1 year).

**Comparison Value (CV):** Calculated concentration of a substance in air, water, food, or soil unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

**concentration:** The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

**Cancer Risk Evaluation Guide (CREG):** soil, water, or air comparison values prepared by ATSDR used to identify concentrations of cancer-causing substances unlikely to result in an increase of cancer rates in an exposed population.

**contaminant:** A substance that is present in an environment where it does not belong.

**detection limit:** The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

**Excess Lifetime Cancer Risk (ECLR):** The additional risk that someone may have of getting cancer if that person is exposed to cancer-causing chemicals.

**EEP:** Environmental Epidemiology Program of the Tennessee Department of Health.

**Environmental Media Evaluation Guide (EMEG):** Concentrations of substances in water, soil, or air developed by ATSDR to which humans may be exposed during a specified period of time (acute, intermediate, chronic) without experiencing adverse non-cancer health effects.

**EPA:** United States Environmental Protection Agency.

**epidemiology:** The study of the distribution and determinants of disease or health status in a population; the study of the occurrence and causes of health effects in humans.

**exposure:** Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute exposure), of intermediate duration, or long-term (chronic exposure).

**exposure pathway:** The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: 1. a source of contamination (such as an abandoned business), 2. an environmental media and transport mechanism (such as movement through groundwater), 3. a point of exposure (such as a private well), 4. a route of exposure (eating, drinking, breathing, or touching), and 5. a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

**groundwater:** Water beneath the Earth's surface in the spaces between soil particles and between rock surfaces.

**hazard:** A source of potential harm from past, current, or future exposures.

**health consultation:** A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.

**inhalation:** The act of breathing. A hazardous substance can enter the body this way.

**Inhalation Unit Risk (IUR):** The excess lifetime cancer risk estimated to result from continuous (24-hour per day, 7 days per week, 365 days per year) exposure to a chemical at a concentration of 1 microgram per cubic meter ( $\mu\text{g}/\text{m}^3$ ) in air.

**intermediate duration exposure:** Contact with a substance that occurs for more than 14 days and less than a year.

**migration:** Chemical movement from one location to another.

**Minimal Risk Level (MRL):** An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects.

**PID:** photoionization detector

**ppb:** parts per billion.

**ppm:** parts per million

**reference dose:** An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

**Regional Screening Level (RSL):** comparison levels prepared by the U.S. EPA that are chemical-specific concentrations for individual contaminants in air, drinking water, and soil that may warrant further investigation or site cleanup.

**remediation:** Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a site.

**risk:** The probability that something will cause injury or harm. For non-carcinogen health effects, it is evaluated by comparing an exposure level over a period to a reference dose derived from experiments on animals. For carcinogenic health effects, risk is estimated as the incremental probability of an individual developing cancer over a lifetime (70 years) as a result of exposure to a potential carcinogen.

**route of exposure:** The way people come into contact with a hazardous substance. Three routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact).

**sample:** A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population. An environmental sample, such as a small amount of soil or water, might be collected to measure contamination in the environment at a specific location.

**soil-gas:** Gaseous elements and compounds in the small spaces between particles of earth and soil. Such gases can be moved or driven out under pressure.

**solvent:** A liquid capable of dissolving or dispersing another substance (for example, acetone or mineral spirits).

**TDEC:** Tennessee Department of Environment and Conservation

**tetrachloroethylene (PCE or Perc):** A chemical this is a nonflammable liquid at room temperature. It is a colorless liquid and has a sweet smell. It is widely used as a solvent and is the most common chemical used in drycleaning garments.

**toxicological profile:** An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

**toxicology:** The study of the harmful effects of substances on humans or animals.

**trichloroethylene (TCE):** A chemical this is a nonflammable liquid at room temperature. It is also called TCE. It is a manufactured chemical that is widely used to remove grease from metal parts. Trichloroethylene is also an ingredient in other consumer products. It evaporates easily into the air from surface water and has a somewhat sweet odor.

**$\mu\text{g}/\text{m}^3$** : micrograms per cubic meter. Air results are usually measured in both  $\mu\text{g}/\text{m}^3$  and ppb.

**vapor intrusion**: The process by which volatile chemicals migrate from an underground source into the indoor air of buildings.

**Volatile Organic Compounds (VOCs)**: Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, dichloroethylene, toluene, trichloroethylene, methylene chloride, methyl chloroform, and vinyl chloride.

## Certification

This Public Health Consultation: *Former Custom Cleaners, Air Sampling Results Evaluation, Memphis, Shelby County, Tennessee*, was prepared by the Tennessee Department of Health's Environmental Epidemiology Program. It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was prepared.



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