# Public Health Assessment

**Final Release**

**EAST TROY CONTAMINATED AQUIFER**

**TROY, MIAMI COUNTY, OHIO**

EPA FACILITY ID: OHSFN0507962

**Prepared by the**
**Ohio Department of Health**

APRIL 22, 2011

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

# PUBLIC HEALTH ASSESSMENT

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# SUMMARY

## Introduction

The Health Assessment Section (HAS) at the Ohio Department of Health (ODH), in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR), seeks to assist the Troy, Ohio community by using the best environmental science, providing accurate health information, and taking public health actions to prevent harmful exposures and disease related to toxic substances.

This public health assessment (PHA) is the HAS's evaluation of environmental data regarding the contaminated groundwater plumes in the eastern portion of Troy, Ohio in order to assess past, present, and future impacts on public health. This site, known as the East Troy Contaminated Aquifer, was added to the U.S. EPA's Superfund National Priorities List (NPL) in September 2008. This report is an update of an earlier health consultation completed in July 2008 and reviews the available environmental sampling data collected by the Ohio EPA and the U.S. EPA regarding the contamination of groundwater, soil and indoor air at the East Troy Contaminated Aquifer site.

## Overview

The ODH reached two conclusions about the East Troy Contaminated Aquifer site in Troy, Ohio.

## Conclusion 1

**The ODH concludes that the aquifer's contaminated groundwater could harm people's health in the future.**

## Basis for Decision

The reason for this concern is based upon the potential for the contamination to impact Troy's drinking water supply if actions are not taken to mitigate potential exposures to chlorinated solvents. Area groundwater has been contaminated by the chlorinated solvents trichloroethylene (TCE), tetrachloroethylene (PCE) and their degradation byproducts, as documented by the Ohio EPA and the U.S. EPA. The contaminated groundwater plumes are migrating towards the well fields that supply Troy's drinking water. A breakdown product of TCE and PCE, cis-1,2-dichloroethylene (cis-1,2-DCE), has been detected in the nearest municipal well located within a quarter of a mile from the likely source area. Cis-1,2-DCE, in turn, can degrade into vinyl chloride, a known human carcinogen. At the current time, cis-1,2-DCE and vinyl chloride have not been detected in the finished city drinking water supply and do not pose a health hazard to city residents. The municipal water supply serves about 28,000 people, who could potentially be exposed to contaminated drinking water in the future.

## Next Steps

The source(s) of the contaminated groundwater plumes need to be fully identified and either isolated and contained or removed. The U.S. EPA remedial investigation and feasibility study (RI/FS) will provide this information and develop ways to best mitigate or eliminate the contamination associated with the contaminated groundwater plumes. Field work for the RI/FS began in the summer 2010 with the collection of groundwater samples in residential neighborhoods. Additional groundwater sampling, along with soil sampling, sub-slab soil gas sampling, and indoor air sampling in homes will begin in the spring 2011.

## Conclusion 2

**The ODH cannot currently conclude whether breathing volatile organic compounds (VOCs) in the indoor air of untested properties in Troy could harm people's health. The information needed in order to make a decision is not currently available. The critical environmental data will be collected as part of the proposed U.S. EPA remedial investigation.**

## Basis for Decision

Sub-slab soil gas and indoor air samples from homes and buildings in and around the contaminant plumes are needed in order to assess the public health impact of exposures.

The indoor air in 16 homes and one school sampled by the U.S EPA in 2006 was found to have levels of PCE and/or TCE above health-based screening levels recommended by the HAS/ATSDR. These levels were based on a theoretical increased risk of developing cancer from breathing air containing low levels of PCE and/or TCE for 30 years or more. In 2007, the U.S. EPA took action to vent the volatile organic compounds (VOCs) from below the structure slab to above the roof line at 16 residences and a school. Following installation and operation of vapor abatement systems at these locations, the chemicals of concern were no longer detected in indoor air in these structures. The systems were only intended to be a temporary solution to mitigate exposure.

However, only about 20 percent of the homes and buildings in the area of concern have been sampled. It is likely that other homes and buildings in this area could be at risk through the vapor intrusion pathway and have levels of PCE or TCE above health-based screening levels. In order to assess the public health impact of exposures, additional sub-slab soil gas and indoor air samples in the eastern portion of Troy are needed. More data will become available following the U.S. EPA remedial investigation.

## Next Steps

The East Troy Contaminated Aquifer site has been placed on the U.S. EPA's National Priorities List (NPL) of Superfund sites. The U.S. EPA has taken the lead to conduct a remedial investigation and feasibility study (RI/FS) at this site under its Superfund authority. Homes and other buildings that may be at risk of exposure due to vapor intrusion will be sampled, along with homes that were not sampled as part of the 2007 U.S. EPA removal. Homes and other buildings with existing vapor abatement systems will also be sampled to confirm the systems are operating properly. The details of this plan are currently being developed.

## For More Information

For information about this site, including site remediation, please see the U.S. EPA site fact sheet available at: http://www.epa.gov/region5/sites/troyvoc/. You can also call the Health Assessment Section at the ODH at 614-466-1390 for information on the East Troy Contaminated Aquifer site.

## PURPOSE AND HEALTH ISSUES

In June 2006, the Health Assessment Section (HAS) of the Ohio Department of Health (ODH) was asked by the U.S. EPA to assist in evaluating the health impacts of elevated levels of volatile organic compounds (VOCs) in the groundwater, soil gas, and indoor air of residential and commercial properties on the east side of Troy, Ohio. The results of an environmental study funded by the city of Troy indicated the presence of the volatile organic compound tetrachloroethylene (perchloroethylene or PCE) in indoor air samples collected from several public buildings, including the Troy police station, a church, and a school. The Ohio EPA requested assistance from the U.S. EPA in order to carry out a time-critical removal action in the neighborhood to address these concerns.

With assistance from the Agency for Toxic Substances and Disease Registry (ATSDR), the HAS provided health-based screening levels for indoor air in residential and non-residential buildings to the U.S. EPA and proposed that interim measures be taken at those properties that exceeded the screening criteria in order to reduce or eliminate exposure to site-related contaminants via the vapor intrusion pathway (HAS/ATSDR 2006). The U.S. EPA sampled 85 homes and businesses in the area during 2006-2007. The U.S. EPA installed vapor abatement systems at 17 locations where screening values were exceeded in June-July 2007, conducted post-installation sampling at all 17 locations, implemented upgrades as necessary, and confirmed that indoor air levels were below the ATSDR and HAS indoor air screening levels as of April 17, 2008 (U.S. EPA's completion date). The HAS produced a health consultation on July 29, 2008, documenting the vapor intrusion into a number of residences and a school and concluded that until the source(s) of contamination was identified and removed or abated, the site posed a public health hazard to nearby residents in the future (HAS/ATSDR 2008).

The East Troy Contaminated Aquifer site was proposed for addition to the U.S. EPA's Superfund National Priorities List (NPL) on September 19, 2007 (U.S. EPA 2007), and officially listed as a NPL site on September 3, 2008 (U.S. EPA 2008c). Because a public health assessment is required at all sites proposed for or listed on the U.S. EPA's NPL, this public health assessment is an update to the 2008 health consultation and reviews the available environmental sampling data collected by the Ohio EPA and the U.S. EPA regarding the contamination of groundwater, soil and indoor air at the East Troy Contaminated Aquifer site. The HAS makes conclusions and recommendations for additional actions that may be necessary to protect the public's health.

## BACKGROUND

### Site Location and Description

The East Troy Contaminated Aquifer (ETCA) site consists of an area on the east side of Troy, Ohio, along the western bank of the Great Miami River (Figure 1). The site boundaries and all contamination source(s) have not yet been identified. Existing data indicate that the site includes at least a twelve square block area where volatile organic compounds (VOCs) have been identified in groundwater, soils, soil gas, and indoor air of residential, public and commercial properties (U.S. EPA 2008d). The area includes residential neighborhoods with primarily single-family homes, along with public, commercial and industrial properties. A majority of homes in the area are in excess of 70-years old and are multi-story houses, most with concrete-floored basements. Industrial facilities (Hobart Cabinet, Spinnaker Products) are located to the north along Water Street, adjacent to the Great Miami River. Commercial properties are located primarily to the west towards Market Street and downtown Troy. Two churches, three schools, and a police station are also within the area impacted by the VOC plume. In 2006-2007, the U.S. EPA investigated the vapor intrusion concerns in a 24-block portion of the city east of Market Street, south of the Great Miami River, west of Williams Street, and north of Race Drive (Figures 1 & 4).

**Demographics and Land Use**

The East Troy Contaminated Aquifer site is located in Troy, Miami County, Ohio. The area affected by vapor intrusion identified previously by the U.S. EPA had a population of 1,263 living in 548 housing units. In the area of the site, 129 (10 percent) are adults aged 65 and older, and 133 (10 percent) are children aged 6 and younger (HAS 2008). The census track which includes the plume area in the eastern portion of Troy, Ohio, is Census Tract 3652, which has a total population of about 3,900 and includes an area south of the of the east Troy area. Of the 1,537 occupied housing units, 57.9 percent are owner-occupied housing units and 42.1 percent are renter-occupied housing units. According to income levels in 1999, 9.6 percent of the households in this census tract are below the poverty level. About 12,400 people reside within a one-mile radius of the site (U.S. Census Bureau 2000).

Over 400 residences in the plume area were notified by the U.S. EPA of the vapor intrusion concerns in 2006. The U.S. EPA was able to obtain access to and conduct sub-slab soil gas and indoor air sampling in about 20 percent of the residences and buildings in the area. Of a total of 85 locations tested from July 2006 through April 2007, 16 residences and one school (20 percent of the total) were affected by the migration of volatile chemicals from soil and groundwater into the indoor air of these structures.

The City of Troy uses ten (10) production wells to draw water from sand and gravel aquifers underlying the Great Miami River: five (5) wells in the East Well Field and five (5) wells in the West Well Field (Figure 1). All ten of these production wells draw water from the same sand and gravel aquifer on the opposite side of the Great Miami River from the VOC-contaminated groundwater plumes. The groundwater flow direction is from southwest to northeast toward the Great Miami River. The contaminated ground water plumes have detections of TCE and PCE at levels greater than the U.S. EPA's federal drinking water standard or maximum contaminant level (MCL) of 5 parts per billion (ppb). These plumes are migrating toward the well fields that supply Troy's drinking water. A contamination byproduct, cis-1,2-dichloroethylene (cis-1,2-DCE), has been detected in two municipal wells located within a quarter mile of the site in the East Well Field. Low concentrations of chlorinated VOCs have also been detected in samples of raw water from production well 12W in the West Well Field; however, the sources of contamination of each well field are currently thought to be different. Overall, the municipal water supply serves about 28,000 people primarily living in the City of Troy who could potentially be exposed to contaminated drinking water.

## Area Geology and Hydrogeology

The area of concern is located on the level floodplain of Great Miami River. Groundwater-bearing sands and gravels fill a buried bedrock valley under the river and adjacent portions of the city to depths in excess of 140 feet. Groundwater from these floodplain sand and gravel deposits serves as the primary source of drinking water for the city and its residents. City public water supply wells are located on the north side of the Great Miami River, within 1,000 feet of the identified groundwater contamination area (Figure 1). City water wells draw water from underground sand and gravel at depths of between 80 and 125 feet below the ground surface. Individual water wells can pump up to 2,100 gallons of water per minute (ODNR well logs, 2007). All of the residents in the area of concern obtain their drinking water from the city of Troy public water supply (city of Troy, pers. comm. 2006). Cis-1,2 DCE and TCE have been detected in the City of Troy east municipal well field since 1988 (U.S. EPA. 2008b). It important to note that these chemicals are not detected in the treated (i.e. "finished") Troy drinking water and currently do not pose a health hazard to city residents (Thomas Funderburg, City of Troy, personal communication, July 5, 2010). Groundwater flow in the area is naturally to the southeast, following the course of river. However, groundwater pumping by the city's water wells and high-yield industrial production wells in the area does influence groundwater flow locally, pulling the groundwater to the north towards the individual wells in the well field.

In the vicinity of the city of Troy well field, the depth to the groundwater surface is only 11 to 15 feet below the ground surface (ODNR well logs, 2007). The Ohio EPA indicated that the water table in the vicinity of Franklin and Clay Streets, on the south side of the Great Miami River, was between 15 and 17 feet below the ground surface (personal communication, 2006). The intervening soils usually consists of  a thin layer of topsoil (less than 2 feet thick) and a clay layer of variable thickness (0-12 feet thick) followed by highly porous and permeable sand and gravel down to the water table (ODNR well logs, 2007). The floors of most basements in area homes appear to penetrate the upper clay layer and extend into the underlying sand and gravel layer.

## Ohio EPA Groundwater Investigation

The Ohio EPA conducted groundwater monitoring in 2002, 2003 and 2004 to determine if groundwater contaminants posed a threat to water quality in the well field. Groundwater sample results indicated that the aquifer was contaminated with tetrachloroethylene (perchloroethylene or PCE). PCE concentrations were greater than 800 parts per billion (ppb) in groundwater along Franklin Street and greater than 40 ppb in groundwater along Water Street (Figure 2).

In 2006, the Ohio EPA completed soil-gas and monitoring well sampling along Franklin and Main Streets on the city's east side. PCE levels were found to be as high as 801 ppb in groundwater and as high as 58 ppb in soil-gas in soils under residential yards along Franklin Street (Figure 3, Ohio EPA 2006).

The Ohio EPA requested assistance from the U.S. EPA in conducting an assessment of the East Troy plume site to determine the extent of vapor intrusion under the neighborhood and, as part of a Time-Critical Removal Action, to mitigate impacted homes, schools and businesses.

**U.S. EPA Soil Gas/Indoor Air Investigation**

From July through September 2006, as part of the Time-Critical Removal Action, the U.S. EPA collected sub-slab and indoor air samples from the east Troy residential area near Franklin Street in order to determine the extent of vapor intrusion under area homes, schools and businesses. Vapor intrusion is the movement of volatile chemicals and gases from soil and groundwater into the indoor air of homes and commercial buildings. A total of 19 locations were sampled, including 14 residences, 3 schools, a church, and the City of Troy Police Station.
Along with representatives of the U.S. EPA and the Ohio EPA, HAS staff met individually with residents and representatives of St. Patrick's Church and Troy City Schools to discuss their sub-slab and indoor air sampling results at Troy City Center on August 24, 2006. The HAS presented information on the toxicology of PCE and answered health-related questions.

The HAS participated in a public meeting hosted by the U.S. EPA on October 25, 2006 at the Van Cleve School. At this meeting, the U.S. EPA updated residents on its investigation of chemical pollution beneath sections of Troy, Ohio and offered free sub-slab and indoor air sampling to the residents of the neighborhood. The HAS presented information on PCE, the chemical of concern, and its toxicology and answered health-related questions from the audience. Further expanding the vapor intrusion investigation, the U.S. EPA sent letters to 400 residents in December 2006, asking for access to conduct sub-slab and indoor air sampling. About 60 additional residents, or about 15 percent of the total, signed access agreements for the U.S. EPA sub-slab and indoor air sampling. It must be emphasized that the testing was voluntary, dependent upon the owner, who can allow or deny access to the residence.

From July 2006 through April 2007, during Phase 1 and Phase 2 sampling activities, the U.S. EPA collected sub-slab and indoor air samples from a total of 85 locations, which included 78 residences, 2 churches, 4 schools and the Troy Police Station. All owners of properties with elevated indoor air levels (16 residential locations and one elementary school – see table below and Figure 4) were contacted regarding their results. The HAS attended several meetings conducted by the U.S. EPA in February 2007 and May 2007 to explain sample results to impacted residents and property owners, answer related health questions, and discuss the installation of the proposed sub-slab vapor abatement systems.

**U.S. EPA Removal Action**

The U.S. EPA, the HAS and the Ohio EPA met with 16 property owners and school representatives on May 31, 2007 with a plan to design and install a vapor abatement system (VAS) at each location. The HAS staff were available to answer health questions from owners at this time. Property owners and school representatives signed agreements with the U.S. EPA for the VAS installation.

Vapor abatement systems were installed at 16 residences in June-July 2007, and a multi-unit vapor abatement system was installed in the St. Patrick's school July 9-17, 2007. The school's system went into operation on July 17 and following consultations with the HAS, 10-day confirmation samples were collected for the sub-slab gas and indoor air in the school on July 25,

2007. Preliminary results from the confirmation sampling were received by the HAS on July 31, 2007 and indicated that the system was working. Results indicated that sub-slab levels of PCE had been reduced from 230 ppb to 2.3 ppb. Indoor air levels of the solvents PCE and trichloroethylene (TCE) were at undetectable levels. School was scheduled to resume by the middle of the month. The HAS provided the school staff with a draft letter they could use to communicate the results of the system operation to parents prior to the start of the school year. The HAS participated in a meeting on Friday August 3, 2007 between the U.S. EPA, its contractors, and representatives of the St. Patrick's advisory board to discuss the results of the installation and subsequent operation of the vapor abatement system in the St. Patrick Elementary School.

Most of the impacted residences also showed reductions in PCE and TCE after installation of the vapor abatement systems. However, six of the residences still exceeded the HAS/ATSDR screening levels one month after installation of the vapor abatement systems. The contractor added dampers to draw basement air for some residences and increased fan size in others in order to reach screening level requirements. One of these homes had holes in the floor and a sub-slab sample had not been collected. Additional system upgrades were required for four residences in October 2007 and again in January and February 2008. All 16 residences were in compliance (no indoor air exceedances of HAS/ATSDR screening levels) by April 2008. The indoor air quality at the St. Patrick School has remained in compliance since July 2007 based on subsequent air monitoring (U.S. EPA 2008a).

**Table 1. Chemicals Detected in Indoor Air from 17 Locations in Troy, Ohio**

| ***Chemical*** | ***Range of Detections (ppb)*** | ***Average (ppb)*** | ***Frequency of Detections[1]*** | ***# Above Comparison Value*** | ***Comparison Value[2] (ppb)*** |
|---|---|---|---|---|---|
| PCE | 1.3 – 22 | 5.5 | 14/17 | 14 | 1.2 |
| TCE | 0.51 – 1.3 | 0.9 | 4/17 | 4 | 0.4 |

Source: U.S. EPA 2007

ppb = parts per billion
PCE – Perchloroethylene, also known as tetrachloroethylene
TCE – Trichloroethylene
[1] – Out of a total number of buildings in which systems were installed.
[2] – U.S. EPA 2002 OSWER Draft Vapor Intrusion Guidance (based on $10^{-5}$ and $10^{-4}$ cancer risks for PCE and TCE, respectively.

## NPL Site Listing and HRS Documentation Record

The U.S. EPA proposed the East Troy Contaminated Aquifer site for addition to the Superfund National Priorities List (NPL) on September 19, 2007 (U.S. EPA 2007) and added it to the Superfund NPL on September 3, 2008 (U.S. EPA 2008c). Adding the site to the NPL allows the U.S. EPA to study site conditions further, identify possible sources of the contamination, and develop a comprehensive strategy to address all locations and sources of the VOC contamination. In their Hazard Ranking System (HRS) Documentation Record, the U.S. EPA speculates that there are at least two sources of contamination in the impacted area:

***Source 1*** – A contaminated soil source under the Spinnaker property due to previous TCE releases. Soil was removed at the Spinnaker property in 1995, but soil samples collected in 2005 indicated about 9,000 square feet of soil contamination. One hundred and twenty-nine soil samples from 41 soil borings were analyzed at this site (see table below).

**Table 2. Chemicals Detected in Soil at Source 1 – Contaminated Soil Source Area**

| ***Chemical*** | ***Range of Detections (ppb)*** | ***Average (ppb)*** | ***Frequency of Detections*** | ***Frequency Above Comparison Value*** | ***Soil Screening Level* (ppb)*** |
|---|---|---|---|---|---|
| PCE | 10.4 – 931 | 146 | 57/134 | 57 | 2.3 |
| TCE | 68.6 – 133,000 | 3950 | 65/134 | 65 | 1.8 |
| cis-1,2-DCE | 6.1 – 14,900 | 1690 | 12/134 | 11 | 21 |

Source: U.S. EPA HRS Documentation Record 2008

*MCL-based Protection of Groundwater Soil Screening Level (SSL) from RSL Summary Table Nov 2010
ppb – parts per billion
PCE – Tetrachloroethylene
TCE – Trichloroethylene
Cis-1,2-DCE – Cis-1,2-dichloroethylene

***Source 2*** – A PCE plume with no identified source located upgradient and underneath the Spinnaker property (U.S. EPA 2008b). The chemicals detected include tetrachloroethylene (PCE), trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE), and vinyl chloride (VC). Analytical results of groundwater samples within the plume area show the presence of chlorinated chemicals, primarily PCE, TCE, cis-1,2-DCE, and vinyl chloride in the groundwater. (see table below).

**Table 3. Chemicals Detected in Groundwater at Source 2 – Contaminated Plume**

| ***Chemical*** | ***Range of Detections (ppb)*** | ***Average (ppb)*** | ***Frequency of Detections*** | ***Frequency Above Comparison Value*** | ***MCL (ppb)*** |
|---|---|---|---|---|---|
| PCE | ND – 78 | 21 | 9/25 | 6 | 5 |
| TCE | ND – 34 | 6 | 11/25 | 3 | 5 |
| cis-1,2-DCE | ND – 69 | 16 | 14/25 | 0 | 70 |
| Vinyl chloride | ND – 6.6 | 3 | 3/25 | 1 | 2 |

Source: U.S. EPA HRS Documentation Record 2008

ppb – parts per billion or micrograms per liter
MCL – Maximum Contaminant Level for drinking water (EPA)
ND – non detect
PCE – Tetrachloroethylene
TCE – Trichloroethylene
Cis-1,2-DCE – Cis-1,2-dichloroethylene

**U.S. EPA Remedial Investigation and Feasibility Study (RI/FS)**

Once the ETCA site was placed on the NPL, the U.S. EPA took the lead to conduct a Remedial Investigation (RI) and Feasibility Study (FS) of the site under its Superfund authority. The purpose of the RI is to collect the data needed to determine the type and extent of contamination at a site and assess human risk from exposure to toxic chemicals. A FS is a process for developing, evaluating, and selecting a cleanup plan to deal with the contaminants identified at the site. The RI/FS is currently underway and will allow the U.S. EPA to determine the type and extent of contamination at the site and the best way to clean up this environmental contamination.

## DISCUSSION

### Exposure Pathways

In order for the public to be exposed to elevated levels of chemical contaminants in and around the Troy site, they must first come into contact with the contaminated groundwater, soils or air. To come into contact with the contaminated media, there must be a completed exposure pathway. A completed exposure pathway consists of five main parts, all of which must be present for a chemical exposure to occur.

A **completed exposure pathway** consists of five main parts:

1. **A Source of Contamination** (a chemical release, landfills, and others);
2. **Environmental Transport** (the way chemicals move away from the source through air, water, soil, food chain);
3. **Point of Exposure** (a place where people come into physical contact with the chemical, e.g., soil, air, groundwater, surface water, sediment, food);
4. **Route of Exposure** (how people come into physical contact with the chemical, e.g., breathing, drinking, eating, touching); and
5. **A Population at Risk** (people likely to come into physical contact with site-related chemicals).

Physical contact with a chemical contaminant does not necessarily result in adverse health effects. A chemical's ability to affect a resident's health is also controlled by a number of factors including:

- How much of the chemical a person is exposed to (dose).
- How long a person is exposed to the chemical (duration of exposure).
- How often a person is exposed to the chemical (frequency).
- The toxicity of the chemical of concern (how a chemical affects the body).

Other factors affecting a chemical's likelihood of causing adverse health effects upon contact include the resident's:

- Past exposure to toxic chemicals (occupation, hobbies, etc.)
- Smoking, drinking alcohol, or taking certain medications

- Current health and nutritional status
- Age and gender
- Family medical history

***Groundwater Pathway***

Water for the City of Troy is supplied by two well fields, the East Well Field and the West Well Field, located on the east bank of the Great Miami River (Figure 1). Each uses five production wells to draw water from the sand and gravel aquifer, the sole source of drinking water in the area, to the water treatment plant. Low concentrations of chlorinated VOCs have been detected in samples of raw water from production wells in both well fields; these include wells 14 and 18 in the East Well Field, and well 12W in the West Well Field. The sources of contamination of each well field are currently thought to be different.

> Groundwater is water that is located below the surface of the earth in spaces between rock and soil. Groundwater supplies water to wells and springs and is a substantial source of water used in the United States. Thirty percent of the Ohio population, or about 3½ million Ohioans, drink water from a community water system that uses groundwater (U.S. EPA 2009). The water supply in Troy comes from a buried valley sand and gravel aquifer, where water from up to 10 wells is blended and treated prior to being pumped to community water system users.

East Well Field

The East Troy Contaminated Aquifer site consists of at least two distinct groundwater plumes, which are moving toward the Great Miami River. On the other side of the river are the City of Troy's municipal wells, which serve approximately 28,000 people. Cis-1,2-DCE, a breakdown product of PCE, has been detected in two municipal wells (PW-14 and PW-18) located within 0.25 to 1 mile of the site. Certified laboratory reports from over 206 samples from these two wells have had 59 detections of cis-1,2-DCE above the reporting limit of 0.5 ppb or 0.5 µg/L, as noted in the table below. The U.S. EPA has established a maximum contaminant level (MCL) of 70 ppb for cis-1,2-DCE in drinking water. However, after blending water from all the wells, the final drinking water samples do not have detectable levels of cis-1,2-DCE. Although the plume has the potential to directly impact the public drinking water supply, current non-detectable levels of cis-1,2-DCE in the finished drinking water do not currently pose a health hazard to city residents.

**Table 4. Detections of Cis-1,2-DCE in East Well Field Production Wells from 1999 to 2010**

| *Production Well* | *Range of Detections (ppb)* | *Average (ppb)* | *Frequency of Detections* | *Frequency Above Comparison Value* | *MCL (ppb)* |
|---|---|---|---|---|---|
| PW-14 | ND – 0.6 | 0.5 | 6/102 | 0 | 70 |
| PW-18 | ND – 1.38 | 0.9 | 53/104 | 0 | 70 |

Source: Tim B. Ray, City of Troy Water Treatment Plant, personal communication, July 19, 2010.

ppb – parts per billion
ND – non detect
MCL – Maximum Contaminant Level for drinking water (EPA)

West Well Field
Of the ten production wells that the City of Troy uses to draw water from, five wells are in the West Well Field. Of the wells in the West Well Field, production well 12W (PW-12W) has historically shown detections of cis-1,2-DCE, PCE, and TCE. The source of this contamination is not associated with the East Troy Contaminated Aquifer Site. However, it is part of a federal site assessment of the West Troy Contaminated Aquifer conducted by the Ohio EPA, where contaminated groundwater on the west side of the river is migrating toward PW- 12W. PCE has been detected in PW-12W above the EPA MCL about 45 percent of the time from 1999 to 2009. Trace levels (0.5 – 0.8 ppb) of PCE have also been detected in the plant tap water 5 times out of the 60 monthly VOC monitoring periods during the last five years (2005 to 2009). PW-12W was shut down in January 2010 and remains out of service. The City of Troy finished tap water does not currently show any detections of PCE.

**Table 5. Detections in West Well Field Production Well 12W from 1999-2009**

| *Chemical* | *Range of Detections (ppb)* | *Average (ppb)* | *Frequency of Detections* | *Frequency Above Comparison Value* | *MCL (ppb)* |
|---|---|---|---|---|---|
| Cis-1,2-DCE | ND – 1.3 | 0.7 | 54/98 | 0 | 70 |
| PCE | ND – 7.3 | 4.9 | 96/98 | 44 | 5 |
| TCE | ND – 0.9 | 0.7 | 76/98 | 0 | 5 |

Source: Source: Tim B. Ray, City of Troy Water Treatment Plant, personal communication, July 19, 2010.

ppb – parts per billion
ND – non detect
MCL – Maximum Contaminant Level for drinking water (EPA)

### *Vapor Intrusion Pathway*

PCE and TCE are volatile organic compounds (VOCs). VOCs are chemicals that can vaporize off of contaminated groundwater or soil and migrate as a gas to the indoor environment of nearby buildings.

Vapor intrusion is the movement of volatile chemicals and gases from soil and groundwater into the indoor air of homes and commercial buildings. Factors that favor the transport of these chemicals at the Troy site include: 1) elevated concentrations of PCE in groundwater and soil gas underlying residential and commercial portions of the city of Troy, 2) shallow depth to the groundwater table, and 3) intervening porous and permeable soils that readily facilitate movement of vapor-phase solvents up from underlying groundwater.

Access to 85 locations provided the collection by the U.S. EPA of sub-slab and indoor air samples at 78 homes, 2 churches and 4 schools and the Troy Police Station (U.S. EPA 2008a). Figure 4 shows the U.S. EPA indoor air sampling locations at the Troy plume site and marks those locations with PCE or TCE concentrations that were above long-term screening levels. Sixteen homes and one school had levels of PCE and/or TCE above long-term screening levels in 2006- 2007. All of these structures received vapor abatement systems (see Vapor Intrusion

Fact Sheet) from the U.S. EPA in 2007. Post-installation confirmation sampling conducted at these homes and the school indicated levels of PCE and TCE in these structures were below levels of health concern following installation and operation of these systems.

It is unknown how long the contamination has existed under the impacted neighborhood or whether or not residents were being exposed to these chemicals in the past via the vapor intrusion pathway. The source(s) of contamination are currently unknown. The aquifer was confirmed to be contaminated based on a report completed in 2002. Elevated levels of PCE were indicated in the soil gas in the residential area in 2006 (Ohio EPA 2006).

The indoor air pathway was determined to be complete and poses a public health hazard to nearby residents (HAS and ATSDR 2008). Only about 20 percent of the homes in the area were sampled and only a few received vapor abatement systems. It is likely that other nearby homes could be affected by the vapor intrusion pathway.

## Contaminants of Concern

The primary contaminants of concern at the Troy site include tetrachloroethylene, also known as perchloroethylene (PCE) and trichloroethylene (TCE). Other volatile organic compounds also present include cis-1,2-dichloroethylene (cis-1,2-DCE) and vinyl chloride (VC). These latter chemicals are the products of the breakdown of PCE and TCE in the environment.

## Health Evaluation

### *Tetrachloroethylene (PCE)*

<u>Discussion</u>
Tetrachloroethylene (also known as perchloroethylene, PCE or PERC) is a nonflammable liquid at room temperature and is widely used for dry cleaning of fabrics and for metal degreasing. Other major uses of PCE are as a solvent in some consumer products and as a building block to make other chemicals. It evaporates easily into the air and has a sharp, sweet-smelling odor. At levels in excess of 1 part PCE per million parts of air (1 ppm or 1,000 ppb), PCE's distinctive odor can be smelled by most people. Much of the PCE that gets into surface water and soil evaporates into the air. In the air, it is broken down by sunlight into other chemicals or brought back to the soil and water by rain. Because PCE can travel through soils quite easily, it can make its way into underground water, where it may remain for a long time. Under oxygen-poor conditions and with time, bacteria will break down some of the PCE that is in soil and groundwater, leading to the formation of breakdown products, including 1,2-dichloroethylene and vinyl chloride (Vogel and McCarty 1985). PCE in the environment is found most frequently in the air and less often in drinking water. It does not appear to bioaccumulate in fish or other animals that live in water. People are typically exposed to PCE from occupational sources, consumer products, and environmental sources (see Appendix B Fact Sheet for PCE).

The Ohio EPA investigations show that the groundwater in the general area of concern in Troy is contaminated with PCE, along with TCE and associated degradation byproducts. Cis-1,2-DCE has been detected in two municipal wells, PW-14 and PW-18, located across the Great Miami River to the northeast of the plume areas (U.S. EPA 2008b).

Health Effects Evaluation

*Acute Effects*

The HAS and the ATSDR jointly recommended 200 ppb as a level requiring an immediate response action to reduce exposures to PCE in the indoor air (HAS/ASTDR 2006). This level is the ATSDR acute minimal risk level (MRL), based on protection from neurological effects associated with acute (short-term) exposure to PCE.

A MRL is an estimate of daily human exposure to a substance that is not expected to cause non-cancer health effects during a specified duration of exposure.

A health consultation conducted by the HAS found that PCE concentrations in East Troy homes, schools and businesses do not pose a short-term health threat to the residents (HAS/ATSDR 2008). The levels of PCE detected in the indoor air of the basements of Troy are in the low part per billion (ppb) range (less than or equal to 22 ppb) and no non-cancer health effects are expected.

*Chronic Effects (Noncancer)*

Animal studies have reported effects on the liver, kidney, and central nervous system (CNS) from chronic inhalation exposure to PCE. The ATSDR has calculated a chronic-duration inhalation minimal risk level (MRL) of 40 ppb for PCE based on neurological effects in humans. The levels of PCE detected in the indoor air of the basements of Troy are in the low ppb range (up to 22 ppb PCE) and are below the chronic MRL (40 ppb).

*Cancer Risk*

PCE's classification as a human carcinogen is under review by the U.S. EPA. Although exposure to PCE has not been directly shown to cause cancer in humans, the U.S. Department of Health and Human Services has determined that PCE may reasonably be anticipated to be a carcinogen (National Toxicology Program, 2005). The International Agency for Research on Cancer (IARC) has classified PCE as a Group 2A carcinogen (IARC, 1995); probably carcinogenic to humans (limited human evidence, sufficient evidence in animals).

PCE tends to be retained in the body for a longer period of time than TCE, having limited ability to accumulate in fatty tissues (NIOSH, 1976; 1978). Once absorbed, a large percentage of PCE is eliminated unchanged in exhaled air; a small amount is metabolized in the liver and excreted in the urine as trichloroacetic acid (ATSDR 1997a). Several studies of workers at dry-cleaning businesses have suggested associations between the development of elevated occurrence of urinary tract, kidney, and cervical cancers and chronic exposures to high levels (parts per million range) of PCE and other dry-cleaning chemicals in the air at their places of work (Katz and Jowett, 1981; Brown and Kaplan, 1987). These studies were confounded by the presence of carbon tetrachloride, TCE, and several petroleum-based solvents, in addition to PCE, in these indoor air environments.

Health studies involving the ingestion of PCE in drinking water supplies are limited. PCE was identified as a chemical of concern in contaminated drinking water (along with the chlorinated solvent trichloroethylene) in environmental exposure studies of populations in Woburn, Massachusetts, selected towns in New Jersey, and Camp Lejeune in North Carolina. The Woburn, Massachusetts study (Lagakos et al. 1986), the New Jersey study (Fagliano et al. 1990), have associated exposure to these chemicals through ingestion of contaminated water with increased levels of leukemia in specific populations within these communities.

In a letter dated September 11, 2006 to the U.S. EPA, the ATSDR and the HAS jointly recommended 1.2 ppb as a screening level for residential indoor air for PCE. The 1.2 ppb screening level applies to homes and schools. For buildings that are not used for residences or where children are not continuously present, such as churches, commercial businesses and public buildings; then the recommended screening level for PCE for indoor air was 5 ppb. The levels for PCE were derived from target concentrations listed in the U.S. EPA "Office of Solid Waste and Emergency Response (OSWER) Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), 2002," based on a calculated theoretical cancer risk of $1 \times 10^{-5}$ (HAS/ATSDR 2006).

> Theoretical cancer risk can be defined as the number of additional cases of cancer in a population due to exposure to a toxic substance, usually written as a negative power of 10. For example, one additional case of cancer per one hundred thousand individuals is written as $1 \times 10^{-5}$.

Theoretical cancer risk due to exposure to PCE in indoor air in the homes of Troy was calculated to range from $1 \times 10^{-5}$ or 1 in 100,000 to $2 \times 10^{-4}$ or 2 in 10,000, based on a hypothetical exposure of 24 hours a day, 350 days/year for 30 years. The true risk is likely to be far less, considering that most people do not live in their basements and that exposure would usually be more intermittent. Of the residences and public buildings tested, 13 homes and one school (St. Patrick School) had exceeded the recommended 1.2 ppb health-based screening level for PCE and received sub-slab vapor abatement systems. Three other homes and the school exceeded the long-term screening level for TCE (HAS/ATSDR 2008).

***Trichloroethylene (TCE)***

Discussion

The primary use of trichloroethylene has been the degreasing of metal parts and its use has been closely associated with the automotive and metal-fabricating industries from the 1950's through the 1970's. It is an excellent solvent for removing greases, oils, fats, waxes, and tars. As a solvent it was used alone or blended with other solvents, such as PCE. These solvents were also added to adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners. When released to surface soils, TCE will form a gas faster than many other volatile organic compounds. It has been shown that the majority of the TCE spilled on top of soils will vaporize into the air. When TCE is released into the air, it degrades rapidly when exposed to light, with about half of it breaking down to other compounds within a week (ATSDR 1997b). TCE adsorption to soil is largely dependent on the organic carbon content of the soil, as soils with a higher organic carbon content tend to more effectively adsorb the TCE. TCE is known to be only slightly soluble in water, but there is ample evidence that dissolved TCE remains in groundwater for a long time. Studies show that TCE in water will rapidly form a gas when it comes into contact with air. In a sand and gravel aquifer, TCE in the groundwater would rapidly vaporize into the air spaces between soil grains above the water table. Studies indicate that it would then disperse by two primary routes; first, diffusion through the soil air spaces and then be re-adsorbed by groundwater or infiltrating rainwater, or second, it would migrate to the surface and be released to the atmosphere. The primary means of degradation of trichloroethylene in groundwater is by bacteria, but the breakdown product by this means is vinyl chloride, a known human carcinogen that potentially can be more of a health concern than TCE (Vogel and McCarty, 1985).

<u>Health Effects Evaluation</u>

*Acute Effects*

The ATSDR has established a 2,000 ppb acute MRL for TCE. The levels of TCE (up to 1.3 ppb TCE) detected in the indoor air of the basements of Troy do not pose a short-term health threat to the residents (HAS/ATSDR 2008).

*Chronic Effects (Noncancer)*

The ATSDR does not have a chronic-duration inhalation minimal risk level for TCE; however, the ATSDR has established a 100 ppb MRL based on protection from neurological effects to intermediate exposure (15-365 days) to TCE. The intermediate ATSDR value of 100 ppb has been used by the HAS as a "short term action level" that would trigger immediate action to reduce exposure levels in homes affected by vapor intrusion. The indoor air levels of TCE detected in Troy were in the low ppb range (up to 1.3 ppb TCE) and no non-cancer adverse health effects are expected at these levels (HAS/ATSDR 2008).

*Cancer Risk*

TCE was most recently classified by the U.S. EPA as a B2 carcinogen – a probable human cancer-causing agent. However, the cancer classification of TCE has been withdrawn and is currently under review by the U.S. EPA. The IARC has classified TCE as "*probably carcinogenic to humans" (Group 2A).*

Occupational exposure to TCE (up to 40,000 ppb in air), based on the analysis of seven workplace studies, was associated with excess incidences of liver cancer, kidney cancer, non-Hodgkin's lymphoma, prostate cancer and multiple myeloma, with the strongest evidence for the first three cancers (NTP 2005). Agreement between animal and human studies supports the conclusion that TCE is a potential kidney carcinogen. High doses (100,000-600,000 ppb in air) are needed to induce liver toxicity and cancer in animals; however, differences in the mode of action of the major metabolites in humans suggest that humans would be less susceptible to liver cancer than these laboratory animals (NAS 2006).

The health effects from drinking and inhaling low levels of TCE (in the single or double digit ppb range) over long periods of time remain poorly-documented and controversial (ATSDR 1997b).

A study of residents in Woburn, Massachusetts associated excessive cases of acute lymphocytic leukemia in male children with their mothers' exposure to elevated levels of TCE (183 – 267 ppb) in a public drinking water well over a course of 5 to 10 years (Lagakos et al. 1986). The impacted well also contained low levels (<50 ppb) of PCE, 1,2-DCE, and chloroform. Statistically significant excess leukemia cases in females were associated with residents exposed to TCE and other chemicals in their drinking water supply in New Jersey (Fagliano et al. 1990). ATSDR investigated exposures to high levels of TCE (up to 1,400 ppb), PCE (up to 215 ppb), and 1,2-DCE (up to 407 ppb) in the public drinking water supply at Camp Lejeune Marine base in North Carolina and found a subgroup of infants at risk for being small for gestational age (SGA). ATSDR is conducting a full study of specific birth defects and childhood cancers of children born to parents stationed at Camp Lejeune during 1968−1985 (ATSDR 2003).

In contrast, consecutive surveys of self-reported health effects from over 4,000 residents at 15 sites in five states exposed to TCE through their drinking water supplies (of levels of 3 to 24,000 ppb) for varying periods of time (7-20 years) failed to link these exposures with the development of excess cancer cases. Non-cancer health effects tentatively linked to these exposures included an increased incidence of strokes, increased incidence of diabetes, some increased incidence in liver and kidney disease, and urinary tract disorders (ATSDR, 1999).

A TCE concentration of 0.4 ppb was used as a screening level for residential indoor air, based on a calculated theoretical cancer risk of 1 in 10,000 ($10^{-4}$). The levels for TCE were derived from target concentrations listed in the U.S. EPA 2002 OSWER Draft Vapor Intrusion Guidance, based on an adult residential exposure scenario that assumes exposure of an individual for 24 hours per day for 350 days per year over a period of 30 or more years. A target concentration of 0.04 ppb, based on a $10^{-5}$ theoretical cancer risk, was below the laboratory's minimum detection limit (0.13 to 0.86 ppb); therefore, a concentration of 0.4 ppb, representing a $10^{-4}$ cancer risk, was recommended as the long-term screening level for TCE in indoor air.

The theoretical cancer risk due to exposure to TCE in indoor air in the homes of Troy was calculated to range from $1 \times 10^{-4}$ or 1 in 10,000 to $2 \times 10^{-4}$ or 2 in 10,000. The true risk is likely to be less, considering that exposure would usually be more intermittent. Further, other estimates of cancer risk may be lower due to the use of less conservative inhalation unit risk factors, which serve as an indication of the carcinogenicity of a substance. Three homes and the St. Patrick School in Troy, Ohio exceeded the long-term screening level for TCE (0.4 ppb) and received sub-slab mitigation systems (HAS/ATSDR 2008).

***1,2-Dichloroethylene (1,2-DCE)***

Discussion

1,2-Dichloroethylene (1,2-DCE), also called 1,2-dichloroethene, is a highly flammable, colorless liquid with a sharp, harsh odor. There are two forms of 1,2-dichloroethylene: cis-1,2-dichloroethylene and trans-1,2-dichloroethylene. Industrial quantities of 1,2-dichloroethylene are used to produce other chlorinated solvents and compounds. The odor threshold in air is about 17,000 parts per billion. The presence of 1,2-dichloroethylene in groundwater is most likely due to the biodegradation of other more highly chlorinated compounds tetrachloroethylene and trichloroethylene present in groundwater (ATSDR 1996). Groundwater samples (March 2007) have shown that cis-1,2-DCE was detected in two Troy municipal wells, PW-14 and PW-18 (U.S. EPA 2008b).

Health Effects Evaluation

*Acute Effects*
The levels of cis-1,2-DCE detected in East Troy do not pose an acute (immediate, short-term) health threat to the residents. Cis-1,2-DCE, a biodegradation product of PCE and TCE, was detected at levels below the reporting limit (less than 1 ppb) in drinking water. The U.S. EPA has established a maximum contaminant level (MCL) of 70 ppb for cis-1,2-DCE in drinking water. The ATSDR has established a minimal risk level (MRL) for cis-1,2-DCE of 1 mg/kg/day for acute oral exposure, based on hematological (related to the blood and blood forming organs) effects and a no-observed-adverse-effect level (NOAEL) of 97 mg/kg/day.

*Chronic Effects (Noncancer)*
The ATSDR does not have a minimal risk level for chronic (one year or more) exposure to cis-1,2-DCE. However, the ATSDR has established a MRL of 0.3 mg/kg/day for intermediate (15-365 days) exposure, based on a hematological study. The HAS and the ATSDR have jointly established a long-term screening level of 8.8 ppb for cis-1,2-DCE in residential indoor air, taken from OSWER Vapor Intrusion Guidance and based on non-cancer effects (U.S. EPA 2002). The levels of cis-1,2-DCE in Troy drinking water (below reporting limits) are not expected to harm people's long-term health because the concentrations are far below the maximum contaminant level of 70 ppb. Samples taken by a City of Troy consultant did not detect cis-1,2-DCE in the indoor air from the basements of a church school or police station in January 2006. Cis-1,2-DCE was also not detected in the soil gas samples taken by the Ohio EPA at the Troy site and analyzed in January 2006.

*Cancer Risk*
The U.S. EPA has given cis-1,2-DCE a "not classifiable" rating (D) as to its ability to cause cancer, since cancer effects have not been studied in humans or animals. Neither the NTP nor the IARC have classifications for this chemical.

***Vinyl Chloride (VC)***

Discussion
Vinyl chloride is a colorless man-made gas. Vinyl chloride is used to make a variety of plastic and vinyl products. Vinyl chloride breaks down in air within a few days and dissolves slightly in water. Vinyl chloride can migrate to groundwater and can be in groundwater due to the breakdown of other chemicals, such as trichloroethylene, tetrachloroethylene and trichloroethane. Exposure to vinyl chloride can occur through ingestion of drinking water and inhalation of water vapors during activities such as showering, bathing, and cooking. Small, still safe, amounts of vinyl chloride may be found in foods stored in materials containing polyvinyl chloride (PVC). No significant vinyl chloride exposure is expected from ingestion of drinking water (ATSDR 2006a).

Groundwater from temporary monitoring wells and permanent monitoring wells have been shown to be contaminated with vinyl chloride, indicating that vinyl chloride is present within the plume at the East Troy Contaminated Aquifer. One monitoring location exceeded the 2 ppb

MCL for vinyl chloride. Vinyl chloride was also detected at a concentration of 1.96 ppb in an extraction well (PW-3) located on the Spinnaker property (U.S. EPA 2008b).

<u>Health Effects Evaluation</u>

*Non-cancer Effects*

ATSDR has established a minimal risk level (MRL) of 0.003 mg/kg/day for chronic (one year or more) oral exposure to vinyl chloride, based on a no observed adverse effect level (NOAEL) of 0.17 mg/kg/day for noncancerous liver effects in female rats (ATSDR 2006). ATSDR has derived environmental drinking water guidelines of 100 ppb for an adult and 30 ppb for a child based on the MRL and default exposure assumptions. These guidelines represent concentrations of vinyl chloride in water which people may be exposed for a year or more without experiencing adverse health effects. The U.S. EPA has established a federal standard of 2.0 ppb for vinyl chloride in drinking water. Using the highest level detected in a production well of 1.96 ppb, an exposure dose for a 70 kg adult drinking 2 liters of water a day is 0.000056 mg/kg/day. This estimate is 50 times below ATSDR's MRL of 0.003 mg/kg/day; therefore, vinyl chloride is not expected to cause harmful noncancer health effects to residents. It is essential to keep in mind that vinyl chloride was not detected in the finished drinking water and currently does not pose a health hazard to residents through the drinking water pathway.

*Cancer Risk*

The development of cancer in humans as a result of vinyl chloride exposure has been demonstrated in a number of studies of workers in the vinyl chloride production industry. The strongest evidence comes from the cluster of reports of greater than expected incidences of liver angiosarcoma. The U.S. Department of Health and Human Services has determined that vinyl chloride is a known carcinogen. The International Agency for Research on Cancer (IARC) has determined that vinyl chloride is carcinogenic to people, and EPA has determined that vinyl chloride is a human carcinogen.

The U.S. EPA has estimated an oral cancer slope factor of 0.72 per mg/kg/day for continuous exposure during a lifetime (U.S. EPA 2010). The oral dose associated with a theoretical excess cancer risk of 1 possible excess cancer case in a population of 10,000 ($1 \times 10^{-4}$) is calculated to be 0.00014 mg/kg/day. Based on the highest level detected in a production well, the calculated exposure dose would not exceed cancer risk guidelines. In addition, vinyl chloride has not been detected in the finished drinking water. Therefore, no excess cancer risk due to exposure to vinyl chloride is expected at this site.

***Mixture Assessment***

Exposures to mixtures of both tetrachloroethylene and trichloroethylene are likely to be additive in nature in producing nervous system effects or noncancer and cancer kidney or liver effects (ATSDR 2004). However, TCE was not detected in most residences in Troy where PCE was the major contaminant of concern.

## HEALTH OUTCOME DATA

In addition to evaluating exposure and substance-specific toxicological information, the ODH may review available health outcome data, such as the number of reportable diseases or deaths in a community, as part of the public health assessment process.

**An evaluation of health outcomes is reasonable if there is:**

1) A current (or past) completed or potential exposure pathway.
2) A way to know the levels and length of exposure.
3) An identified exposed population.
4) Sufficient exposure to result in plausible health effects.
5) Information available at the geographic level necessary to compare to the exposed population.
6) A database on the health outcomes of interest likely to occur from exposure.

The ODH identified a completed exposure pathway via vapor intrusion route at the East Troy Contaminated Aquifer site. Seventeen residential and school locations exceeded the long term health-based screening levels for PCE and/or TCE in indoor air. However, no long or short term non-cancer health effects are known to occur at the low ppb-levels measured in homes in east Troy. The theoretical increase in cancer risk due to exposure to the highest levels found for PCE or TCE in indoor air was estimated to be about two additional cases of cancer in 30 years of exposure per ten thousand individuals (2 in 10,000). Based on the site area defined by the U.S. EPA time-critical removal action, the number of people potentially affected by vapor intrusion was 1,263 (HAS/ATSDR 2008). This number of people is not sufficient to measure one additional case of cancer per 10,000 individuals, usually used as a health guideline.

The ODH's Ohio Cancer Incidence Surveillance System (OCISS) and the Ohio State University (OSU) Comprehensive Cancer Center have compiled a series of county-level profiles of cancer incidence, mortality, stage at diagnosis, and cancer-related health behaviors. The profiles include cancer incidence rate information at the census tract level. The census tract which includes the plume area in the eastern portion of Troy in Miami County, Ohio, is Census Tract 3652, which has a total population of about 3,900 and includes an area south of the of the east Troy area (U.S. Census Bureau 2000). This census tract has one of the highest average annual (1996-2005) rates in Miami County for cancers of the lung and bronchus, but low incidence rates of colon and rectum cancer, female breast cancer, and prostate cancer. Exposure to PCE and TCE has not been linked with lung cancer. However, smoking is strongly associated with lung cancer, and Miami County has a higher self-reported percentage (23.7 percent) of people who smoke compared to the rest of Ohio. The diseases potentially linked to PCE and TCE exposures are liver and kidney cancers, which are available in this profile only at the county level, and therefore may not be useful for comparison to a smaller geographical area. The reported cases for these types of cancer are few in number and the county-wide incidence and mortality rates are similar to those reported for all of Ohio and the United States (ODH 2008). Based on the criteria above, there is not sufficient exposure to cause non-cancer health effects or a measureable increase in cancer rates to warrant a separate health study for the population on the east side of Troy. In Ohio, about one of three people will develop cancer in their lifetime, so every Ohio community is affected by cancer. More information regarding the county profile is available at: http://www.odh.ohio.gov/odhPrograms/dis/ociss/ci_surv1.aspx.

## COMMUNITY HEALTH CONCERNS

On May 12, 2010, the Ohio Department of Health (ODH), in cooperation with the ATSDR, released for public comment a draft of the Public Health Assessment (PHA) for the East Troy Contaminated Aquifer site. The draft PHA document was made available for public comment at the Troy-Miami Library in Troy, Ohio and on the ODH and ATSDR web sites. The comment period was extended until the end of July 2010 in order to coincide with the public meeting held by U.S. EPA on July 15, 2010. Comments were received from Thomas C. Funderburg, Assistant Director of Public Service and Safety, City of Troy via letter and Jon R. (Randy) Watterworth, Ohio EPA via e-mail. The main concern expressed by the city officials was that the language in the conclusion statement of the health assessment make clear that the chemicals of concern, although detected in the groundwater, are not present in the final treated drinking water and currently do not pose a health hazard to city residents. This final release PHA focuses on environmental data from sampling conducted prior to the listing of this site to the National Priorities List (NPL) in September 2008. The U.S. EPA will have new information as a result of the remedial investigation which began in 2010.

The ODH and the ATSDR identified a few community members' concerns through public meetings, individual meetings with affected residents and local authorities, and correspondence from past residents for this site. Following are the ODH's responses to the community concerns that were expressed most frequently or to a specific question from an individual regarding this site.

1. **Where do Troy residents get their drinking water and is it affected by the PCE plume?**

   The City of Troy obtains its drinking water from two municipal well fields: five wells in the East Well Field and five wells in the West Well Field. These wells, located near the Great Miami River at the Miami Shores Golf Course and at the Troy Municipal Park, have depths ranging from 44 to 132 feet. Well water is pumped to the water treatment plant where it is treated, disinfected, and filtered, prior to being pumped to consumers. The city's water system is susceptible to contamination because the wells are located at shallow depths in permeable sand and gravel deposits. Any surface spill of solvents or other hazardous chemicals can percolate through the permeable sand and gravel soils and contaminate groundwater. In eastern Troy, the contaminated ground water plumes are moving northeast toward the East Well Field (see Figure 1). The City of Troy routinely tests its water and uses monitoring wells as an early warning system and to study groundwater quality upgradient of the aquifer area under the municipal wells. The City of Troy finished drinking water from the plant tap does not currently show any detections of PCE and is safe to drink.

2. **How are Troy residents exposed to this plume and how long has this been going on?**

   In Troy, people can be exposed to volatile organic compounds (VOCs) like PCE by breathing in vapors that have entered their homes and buildings through vapor intrusion. In this process, vapors migrate from PCE-contaminated groundwater, move to the surface, and enter buildings through basement or foundation cracks, holes and pipes. Concentrations are usually highest in basements, especially when the basements are not vented. People become exposed to PCE by inhaling the vapors that have entered these buildings. Since the sampling of homes and buildings in Troy only began in the last few years and the source(s) of the contamination are unknown, it is difficult to say when exposures first occurred in the past. In order to assess current exposures to VOCs, more information is needed, including additional sub-slab and indoor air samples from residences in the eastern portion of Troy. More data will become available following the U.S. EPA remedial investigation.

TCE and cis-1,2 DCE have been detected in the City of Troy east municipal well field since 1988. In 2007, the Ohio EPA collected samples that show cis-1,2-DCE present in samples from two of the five production wells in Troy's East Well Field, while TCE was not detected. Historically cis-1,2-DCE has been detected in these wells (U.S. EPA. 2008b). PCE, TCE, and cis-1,2-DCE have been detected in one of the production wells (12W) in the west municipal well field over the past ten years. However, these same chemicals are not currently found in the City of Troy finished plant tap water.

3. **Several of our family members who spent their childhoods in east Troy in the 1950's - 1970's now have a specific type of lung cancer. Could this be due to exposure to the VOC plume in Troy?**

This question was responded to by the ATSDR's Region V Medical Officer, and the response, in part, follows:

"Although PCE has not been shown to cause cancer in people, the International Agency for Research on Cancer classifies PCE as a probable human carcinogen. The Department of Health and Human Services (DHHS) has also determined that PCE may reasonably be anticipated to be a cancer causing agent. Results of animal studies, performed at high doses, revealed that PCE can cause liver and kidney tumors and leukemia in animals. Some epidemiologic studies of workers exposed to PCE have found increases in the incidence of esophageal, urinary bladder, and cervical dancers and non-Hodgkin's lymphoma. An increased frequency of liver cancer and leukemia has not been found in workers. No reports could be found about a relationship between PCE and small cell lung cancer.

Small cell lung cancer makes up about 10-15 percent of the new cases of lung cancer each year. Thus, of the 175,000 new cases of lung cancer diagnosed each year, approximately 20,000 would be classified as a type of small-cell lung cancer. The cause of small cell lung cancer is almost exclusively believed to be tobacco smoke. Another risk factor for lung cancer is a family history of lung cancer. It is believed that individuals inherit a predisposition to small cell carcinoma such as the inability to adequately repair damaged DNA, suppress the growth of cancer, and the inability to detoxify cancer-causing chemicals.

Thus, from what is known about small cell carcinoma and on tetrachloroethylene, there does not appear to be a relationship between them." (ATSDR 2006b)

## CHILD HEALTH ISSUES

Both the HAS and the ATSDR recognize that children are inherently at a greater risk of developing illness due to exposure to hazardous chemicals given their smaller stature and developing body systems. Children are likely to breathe more air and consume more food and water per body weight than are adults. Children are also likely to have more opportunity to come into contact with environmental pollutants due to being closer to the ground surface and taking part in activities on the ground such as, crawling, sitting, and lying down on the ground.

Children's exposures and public health implications were considered in this evaluation.
As a result of special concerns with regard to children's exposures, a multi-unit vapor extraction system was installed at the St. Patrick Elementary School. The 90-day performance sampling was conducted on November 23, 2007, and none of the chemicals of concern were detected in the indoor air at the school.

## CONCLUSIONS

The HAS reached two conclusions for people exposed to volatile organic compounds in groundwater and indoor air at the East Troy Contaminated Aquifer site in Troy, Ohio:

1. The HAS concludes that the aquifer's contaminated groundwater could harm people's health in the future because the contamination may impact Troy's drinking water supply if actions are not taken to mitigate potential exposures to chlorinated solvents. The groundwater of the combined aquifer has been contaminated by TCE, PCE and its byproducts, as documented by the Ohio EPA and the U.S. EPA. The contaminated ground water plumes are migrating towards the well fields that supply Troy's drinking water. Cis-1,2-DCE, a breakdown product of TCE and PCE, has been detected in two municipal wells, PW-14 and PW-18, located within a quarter mile to one mile of the site. Another breakdown product, vinyl chloride, a known human carcinogen that often occurs with cis-1,2-DCE, has also been detected in the groundwater at the site. At the current time, cis-1,2-DCE and vinyl chloride have not been detected in the finished city drinking water supply and do not pose a health hazard to city residents. The municipal water supply serves about 28,000 people who could potentially be exposed to contaminated drinking water in the future.

2. The HAS cannot currently conclude whether breathing in volatile organic compounds (VOCs) in the indoor air of untested Troy properties could harm people's health. The information we need to make a decision is not available for many of the properties in the area impacted by vapor intrusion. In order to reach a conclusion, additional sub-slab and indoor air samples in the eastern portion of Troy are needed. More data will become available following the U.S. EPA remedial investigation.

    a. The groundwater plume under the eastern portions of the city of Troy may have been impacting these properties for an extended period of time. However there were no data indicating a vapor intrusion hazard in the neighborhood until recently.

b. In 2007, the U.S. EPA took action to vent the volatile organic compounds from below the structure slab to above the roof line at 16 residences and a school. Following installation and operation of the units in these homes and school, these chemicals of concern were no longer detected in indoor air in these structures. However, the vapor mitigation systems are only intended to be a temporary solution to reduce or eliminate short-term exposures.

c. Only about 20 percent of the homes and buildings in the area of concern have been sampled, and it is likely that other homes in this area could be at risk through vapor intrusion with vapor levels of these chemicals above the HAS/ATSDR health-based screening levels. Until the source(s) of contamination are identified and removed or remediated, the site poses a public health hazard to nearby residents in the future.

d. People breathing air containing low levels of PCE and/or TCE for 30 years or more could have slightly increased risks of developing certain types of cancer.

## RECOMMENDATIONS

1. The U.S. EPA should delineate the full extent of groundwater contamination and vapor intrusion contamination in the East Troy area.

2. The U.S. EPA should continue to take interim measures at the affected properties to reduce or eliminate the vapor intrusion pathway into homes and buildings and conduct follow-up sampling to determine if the systems continue to reduce levels of these contaminants in area homes, schools, and businesses to safe levels.

3. The U.S. EPA and the Ohio EPA should fully investigate, delineate and remediate or remove the possible sources of PCE and TCE in subsurface soils and groundwater in the impacted neighborhood.

## PUBLIC HEALTH ACTIONS

### Completed Actions

1. The U.S. EPA sampled sub-slab and indoor air in 85 structures in East Troy for site-related chemicals of concern. Sixteen residences and the St. Patrick School had levels of solvents PCE and TCE above HAS/ATSDR's conservative chronic screening values. U.S. EPA installed individual vapor abatement systems in all 16 homes and the school in August 2007.

2. The U.S. EPA has conducted follow-up sampling of the school's and residences' sub-slab and indoor air in 2007 and 2008 to insure continued effective operation of the installed vapor extraction systems.

3. The HAS and the ATSDR evaluated these sampling results to confirm that indoor air levels in homes and the school no longer pose a health threat to impacted residents, staff, and students.

4. The U.S. EPA proposed the East Troy Contaminated Aquifer Site on the National Priorities List (NPL) of Superfund hazardous waste sites in September 2007, and one year later in September 2008, the site was officially listed on the NPL.

5. The U.S. EPA held a public meeting to update residents about the investigation and cleanup of the groundwater in East Troy on July15, 2010.

6. The U.S. EPA began field work for a remedial investigation/feasibility study (RI/FS) in the summer 2010 with the collection of groundwater samples from monitoring wells.

**Future Actions**

1. The U.S. EPA will continue to conduct its remedial investigation to identify source(s) of groundwater contamination in the area and take steps to mitigate or eliminate this contamination. The remedial investigation will be conducted in two phases: Phase I will include groundwater samples and soil samples. Phase II sampling will include the collection of sub-slab vapor samples under homes and indoor air sampling in homes, and other sampling to address data gaps, if needed.

2. The HAS will continue to review additional sampling results to insure that contamination in the East Troy community does not pose an acute or chronic health threat to area residents.

## PREPARERS OF THE REPORT

Health Assessment Section
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## CERTIFICATION

The Ohio Department of Health prepared this Public Health Assessment, East Troy Contaminated Aquifer Site, under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). At the time this Public Health Assessment was written, it was in accordance with approved methodology and procedures. Editorial review was completed by the Cooperative Agreement partner.

Technical Project Officer, Cooperative Agreement Team, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

Gregory V. Ulirsch for (AY)

Team Leader, Cooperative Agreement Team, CAPEB, DHAC, ATSDR

# FIGURES

**Figure 1**

**East Troy Contaminated Aquifer - Site Location Map**

**Figure 2**

**Ohio EPA Ground-Water Sampling Results**

## Figure 3

## Ohio EPA Soil-Gas, Indoor Air & Monitoring Well

**Figure 4**

**U.S. EPA Indoor Air Sampling Location Map**
**Troy, Ohio**

# APPENDICES

## Appendix A. Glossary of Terms

**Acute**
Occurring over a short time (compare with chronic).

**Acute exposure**
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

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

**Adsorption**
Adherence of the atoms or molecules of a gas or liquid to the surface of another substance, such as soil.

**Biodegradation**
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

**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**
A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

**Carcinogen**
A substance that causes cancer.

**Central nervous system**
The part of the nervous system that consists of the brain and the spinal cord.

**Chronic**
Occurring over a long time [compare with acute].

**Chronic exposure**
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure]

**Comparison value (CV)**
Calculated concentration of a substance in air, water, food, or soil that is 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.

**Completed exposure pathway** (see exposure pathway).

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

**Confounder**
A factor that is associated with the exposure that may also influence the outcome of a study. This factor by itself can also cause the effect or disease under study.

**Contaminant**
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

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

**Dose** (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

**EPA**
United States Environmental Protection Agency.

**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: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

**Feasibility study**
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

**Groundwater**
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces (compare with surface water).

**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 (compare with public health assessment).

**Ingestion**
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

**Inhalation**
The act of breathing. A hazardous substance can enter the body this way (see route of exposure).

**Intermediate duration exposure**
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

**Lowest-observed-adverse-effect level (LOAEL)**
The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.

**Metabolism**
The conversion or breakdown of a substance from one form to another by a living organism.

**Metabolite**
Any product of metabolism.

**Migration**
Moving 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 [see reference dose].

**National Priorities List (NPL)**
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The list is based primarily on the score a site receives from the Hazard Ranking System. The NPL is updated on a regular basis. A site must be on the NPL to receive money from the Trust Fund for remedial action.

**National Toxicology Program (NTP)**
Part of the Department of Health and Human Services. NTP develops and carries out tests to predict whether a chemical will cause harm to humans.

**No-observed-adverse-effect level (NOAEL)**
The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

**NPL** (see National Priorities List for Uncontrolled Hazardous Waste Sites)

**Plume**
A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

**Point of exposure**
The place where someone can come into contact with a substance present in the environment (see exposure pathway).

**ppb**
A unit of measurement of concentration: parts per billion.

**ppm**
A unit of measurement of concentration: parts per million.

**Public comment period**
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

**Public health assessment (PHA)**
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health (compare with health consultation).

**Public health hazard**
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances that could result in harmful health effects.

**Public health hazard categories**
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future (ATSDR uses five public health hazard categories).

**Public meeting**
A public forum with community members for communication about a site.

**Reference dose (RfD)**
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.

**Remedial investigation**
The CERCLA process of determining the type and extent of hazardous material contamination at a site.

**RfD** [see reference dose]

**Risk**
The probability that something will cause injury or harm.

**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].

**Safety factor**
Mathematical adjustments for reasons of safety when knowledge is incomplete. Typically set at ten, they are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use safety factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also called an uncertainty factor].

**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 [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

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

**Source of contamination**
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

**Substance**
A chemical.

**Superfund** [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and Superfund Amendments and Reauthorization Act (SARA)

**Surface water**
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

**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.

**Tumor**
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

**Vapor intrusion**
The movement of volatile chemicals and gases from soil and groundwater into the indoor air of homes and commercial buildings.

**Volatile organic compounds (VOCs)**
Organic compounds that evaporate readily into the air. VOCs include substances such as benzene, toluene, tetrachloroethylene (PCE), and trichloroethylene (TCE).

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

September 11, 2006

Steve Renninger
U.S. Environmental Protection Agency
Superfund Division, Emergency Response Branch
Cincinnati, OH

Dear Steve,

This letter is the response from the Ohio Department of Health (ODH) and the Agency for Toxic Substances and Disease Registry (ATSDR) to your request for health-based guidance to evaluate the results of air sampling of indoor air and subsurface for tetrachloroethylene (PERC) in the community of Troy (Miami County), Ohio.

The recommended screening levels presented in this letter are based on the understanding that exposures to PERC in this community has been on-going for some period of time, and that the removal of the source material will require an extensive effort that may not be accomplished in the near future. For those reasons, we have applied screening levels that are based more on chronic rather than acute exposures to this chemical. These are provided for residences, schools, commercial buildings, and public buildings. The application of these screening levels is considered by ODH and ATSDR to be protective of public health.

**Residences/Schools:**
The recommended health-based screening level for **residential indoor air** concentrations for PERC is **1.2 ppb**. This level is based on the EPA "Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils", at a $10^{-5}$ cancer risk. If the indoor PERC concentrations exceed 1.2 ppb, then an intervention strategy for reducing these levels should be initiated. Such a strategy should include the consideration of source control and installation of sub-slab depressurization systems to reduce the migration of vapors from the subsurface into indoor spaces. If the indoor PERC concentrations exceed **200 ppb**, then sub-slab depressurization systems should be installed as an immediate response action to reduce exposures. This level is the ATSDR Acute Minimal Risk Level, based on protection of neurological effects with short term exposure to PERC. We would recommend that this residential criterion also be applied to the evaluation of environments where children may occupy the space for a significant portion of the day, such as schools and daycare centers.

While data collected from sub-slab samples is an indication of contamination in subsurface soils levels that may migrate into indoor spaces, the determination of a public health hazard is generally based on more direct measures of inhalation exposure. A more definitive conclusion about the level of health hazard would require additional indoor air sampling. However, in cases where indoor air samples have not been collected and only **sub-slab** sampling data are available, then a health-based screening level of **12 ppb** is recommended as the initial comparison. Levels below this would not be considered to be of a health concern. If this level is exceeded, then indoor air sampling would be recommended. This sub-slab value is a conservative 10-fold adjustment of the indoor air screening concentration. Concentrations below this level would not be of a health concern. However, site-specific conditions indicate that periodic monitoring of contamination levels may be needed.

**<u>Non-residential buildings:</u>**

For building spaces that are not used for residences or where children are not continuously present, such as churches, **commercial** businesses and public buildings, then a recommended health-based screening level of PERC in **indoor air** is **5 ppb**. Concentrations below this level would not be considered to be a health concern. If the indoor air concentrations are greater than 5 ppb, then an intervention strategy for reducing these levels should be initiated. Such a strategy should include the consideration of source control and installation of sub-slab depressurization systems to reduce the migration of vapors from the subsurface into indoor spaces. If the indoor PERC concentrations exceed **840 ppb**, then sub-slab depressurization systems should be installed as an immediate response action to reduce exposures.

In cases where indoor air samples have not been collected and only **sub-slab** sampling data are available, then a health-based screening level for non-residential buildings of **50 ppb** is recommended as the initial comparison. Levels below this would not be considered to be of a health concern. If the levels exceed 50 ppb, then indoor air sampling would be recommended to verify the extent of vapor migration into indoor air and levels of exposure.

**<u>Recommendations</u>**

The indoor air and sub-slab sampling results for Franklin St., Franklin St., Franklin St., Clay St., the St. Patrick School, and the Forest Elementary School exceed these screening criteria. The contaminated groundwater in this area may have been impacting these properties for an extended period of time. The implementation of a long-term remedy to remove the source is unlikely to occur in the near future. Therefore, we recommend that interim measures be taken at these properties to disrupt the vapor intrusion pathway into homes may include installation of a sub-slab depressurization system, sealing cracks in walls and floors of the basement, and sealing or fixing drains that could be a pathway. These interim measures should be initiated while a long-term remedy such as source removal at the site is being planned.

The sub-slab sampling at the Troy Police Station and St. Patrick Church also exceed the non-residential screening levels. Interim measure should also be considered for these buildings to reduce vapor intrusion.

If you have questions, please contact Mark Johnson (312-353-3436) or Bob Frey (614-466-1069).

Sincerely,

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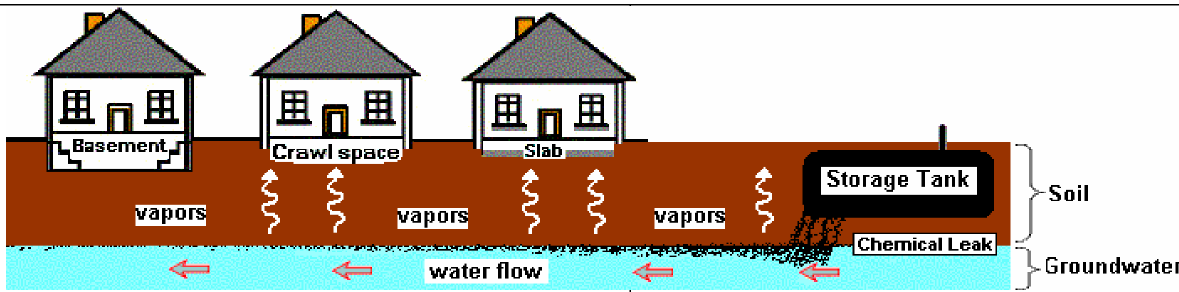
# Appendix C. Fact Sheets

Bureau of
Environmental Health
Health Assessment Section

"To protect and improve the health of all Ohioans"

# Vapor Intrusion

## Answers to Frequently Asked Health Questions




## What is vapor intrusion?

Vapor intrusion refers to the vapors produced by a chemical spill/leak that make their way into indoor air. When chemicals are spilled on the ground or leak from an underground storage tank, they will seep into the soils and will sometimes make their way into the groundwater (underground drinking water). There are a group of chemicals called volatile organic compounds (VOCs) that easily produce vapors. These vapors can travel through soils, especially if the soils are sandy and loose or have a lot of cracks (fissures). These vapors can then enter a home through cracks in the foundation or into a basement with a dirt floor or concrete slab.

## VOCs and vapors:

VOCs can be found in petroleum products such as gasoline or diesel fuels, in solvents used for industrial cleaning and are also used in dry cleaning. If there is a large spill or leak resulting in soil or groundwater contamination, vapor intrusion may be possible and should be considered a potential public health concern that may require further investigation.

Although large spills or leaks are a public health concern, other sources of VOCs are found in everyday household products and are a more common source of poor indoor air quality. Common products such as paint, paint strippers and thinners, hobby supplies (glues), solvents, stored fuels (gasoline or home heating fuel), aerosol sprays, new carpeting or furniture, cigarette smoke, moth balls, air fresheners and dry-cleaned clothing all contain VOCs.

## Can you get sick from vapor intrusion?

You can get sick from breathing harmful chemical vapors. But getting sick will depend on:
<u>How much</u> you were exposed to (dose).
<u>How long</u> you were exposed (duration).
<u>How often</u> you were exposed (frequency).
<u>How toxic</u> the spill/leak chemicals are.
<u>General Health, age, lifestyle:</u> Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposures.

VOC vapors at high levels can cause a strong petroleum or solvent odor and some persons may experience eye and respiratory irritation, headache and/or nausea (upset stomach). These symptoms are usually temporary and go away when the person is moved to fresh air.

Lower levels of vapors may go unnoticed and a person may feel no health effects. A few individual VOCs are known carcinogens (cause cancer). Health officials are concerned with low-level chemical exposures that happen over many years and may raise a person's lifetime risk for developing cancer.

## How is vapor intrusion investigated?

In most cases, collecting soil gas or groundwater samples near the spill site is done <u>first</u> to see if there is on-site contamination. If soil vapors or groundwater contamination are detected at a spill site, environmental protection and public health officials may then ask that soil vapor samples be taken from areas outside the immediate spill site and near any potential affected business or home. The Ohio Department of Health (ODH) does not usually recommend indoor air sampling for vapor intrusion before the on-site contamination is determined.

**(continued on next page)**

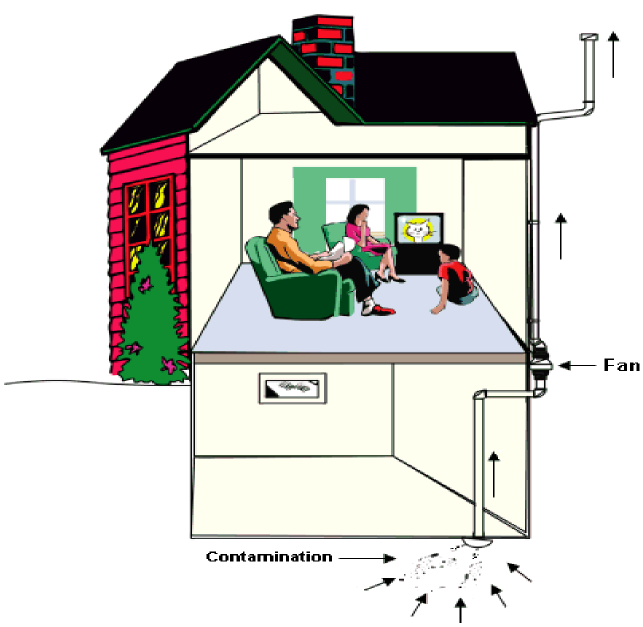
## How is vapor intrusion investigated? (continued)

Because a variety of VOC sources are present in most homes, testing will not necessarily confirm VOCs in the indoor air are from VOC contamination in soils at nearby spill site. But if additional sampling is recommended, samples may be taken from beneath the home's foundation (called sub-slab samples), to see if vapors have reached the home. Sub-slab samples are more reliable than indoor air samples and are not as affected by other indoor chemical sources. If there was a need for additional sampling on a private property, homeowners would be contacted by the cleanup contractor or others working on the cleanup site and their cooperation and consent would be requested before any testing/sampling would be done.

## What happens if a vapor intrusion problem is found?

If vapor intrusion is having an effect on the air in your home, the most common solution is to install a *radon mitigation system*. A radon mitigation system will prevent gases in the soil from entering the home. A low amount of suction is applied below the foundation and the vapors are vented to the outside. The system uses minimal electricity and should not noticeably affect heating and cooling efficiency. This mitigation system also prevents radon from entering the home, an added health benefit. Usually, the party responsible for cleaning up the contamination is also responsible for paying for the installation of this system. Once the contamination is cleaned up, the system should no longer be needed. In homes with on going radon problems, ODH suggests these systems remain in place permanently.

**Radon Mitigation System**




## What can you do to improve your indoor air quality?

As stated before, the most likely source of VOCs in indoor air comes from the common items that are found in most homes. The following helpful hints will help improve air quality inside your home:

- Do not buy more chemicals than you need and know what products contain VOCs.
- If you have a garage or an out building such as a shed, place the properly stored VOC-containing chemicals outside and away from your family living areas.
- Immediately clean and ventilate any VOC spill area.
- If you smoke, go outside and/or open the windows to ventilate the second-hand, VOC-containing smoke outdoors.
- Make sure all your major appliances and fireplace(s) are in good condition and not leaking harmful VOC vapors. Fix all appliance and fireplace leaks promptly, as well as other leaks that cause moisture problems that encourage mold growth.
- Most VOCs are a fire hazard. Make sure these chemicals are stored in appropriate containers and in a well-ventilated location and away from an open pilot light (flame) of a gas water heater or furnace.
- Fresh air will help prevent both build up of chemical vapors in the air and mold growth. Occasionally open the windows and doors and ventilate.
- Test your home for radon and install a radon detector.

## References:


Wisconsin Department of Health and Family Services, Environmental Health Resources, Vapor Intrusion, electronic, 2004.

New York State Department of Health, Center for Environmental Health, April 2003.

Ohio Department of Health, Bureau of Environmental Health, Indoor Environment Program, 2004.


## For more information contact: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# Tetrachloroethylene (PCE)

**Other names for tetrachloroethylene include PCE, perchloroethylene, PERC or tetrachloroethene.**

## What is PCE?

Tetrachloroethylene (also known as PCE, PERC or perchloroethylene) is a man-made chemical that is widely used for dry cleaning clothes and degreasing metal. It is also used to make other chemicals and can be found in some household products such as water repellents, silicone lubricants, spot removers, adhesives and wood cleaners. It easily evaporates (turn from a liquid to a gas) into the air and has a sharp, sweet odor. PCE is a nonflammable (does not burn) liquid at room temperature.

## How does PCE get into the environment?

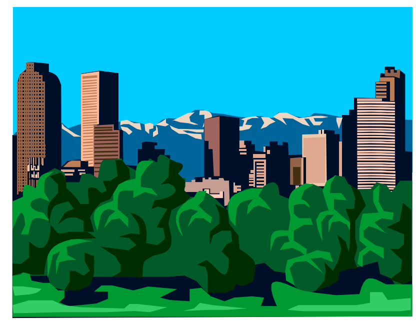
PCE can evaporate into the air during dry cleaning operations and during industrial use. It can also evaporate into the air if it is not properly stored or was spilled. If it was spilled or leaked on the ground, it may find its way into groundwater (underground drinking water).

People can be exposed to PCE from the environment from household products, from dry cleaning products and from their occupation (work). Common environmental levels of PCE (called background levels) can be found in the air we breathe, in the water we drink and in the food we eat. In general, levels in the air are higher in the cities or around industrial areas where it is used more than rural or remote areas.

The people with the greatest chance of exposure to PCE are those who work with it. According to estimates from a survey conducted by the National Institute for Occupational Safety and Health (NIOSH), more than 650,000 U.S. workers may be exposed. However, the air close to dry cleaning business and industrial sites may have levels of PCE higher than background levels. If the dry cleaning business or industry has spilled or leaked PCE on the ground, there may also be contaminated groundwater as well.

## What happens to PCE in the environment?

Much of the PCE that gets into surface waters or soil evaporates into the air. However, some of the PCE may make its way to the groundwater. Microorganisms can break down some of the PCE in soil or underground water. In the air, it is broken down by sunlight into other chemicals or brought back to the soil and water by rain. PCE does not appear to collect in fish or other animals that live in water.



## How can PCE enter and leave my body?

PCE can enter your body when you breathe contaminated air or when you drink water or eat food contaminated with the chemical. If PCE is trapped against your skin, a small amount of it can pass through into your body. Very little PCE in the air can pass through your skin into your body. Breathing contaminated air and drinking water are the two most likely ways people will be exposed to PCE. How much enters your body depends on how much of the chemical is in the air, how fast and deeply you are breathing, how long you are exposed to it or how much of the chemical you eat or drink.

Most PCE leaves your body from your lungs when you breathe out. This is true whether you take in the chemical by breathing, drinking, eating, or touching it. A small amount is changed by your body (in your liver) into other chemicals that are removed from your body in urine. Most of the changed PCE leaves your body in a few days. Some of it that you take in is found in your blood and other tissues, especially body fat. Part of the PCE that is stored in fat may stay in your body for several days or weeks before it is eliminated.

## Can PCE make you sick?

Yes, you can get sick from contact with PCE. But getting sick will depend upon:

- How much you were exposed to (dose).
- How long you were exposed (duration).
- How often you were exposed (frequency).
- General Health, Age, Lifestyle  Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposures.

## How can PCE affect my health?

Exposure to very high concentrations of PCE (particularly in closed, poorly ventilated areas) can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness and even death. Skin irritation may result from repeated or extended contact with it as well. These symptoms occur almost entirely in work (or hobby) environments when people have been accidentally exposed to high concentrations or have intentionally used PCE to get a "high." Normal background levels (or common environmental levels) will not cause these health affects.

## Does PCE cause cancer (carcinogen)?

In the United States, the National Toxicology Program (NTP) releases the *Report on Carcinogens* (RoC) every two years. The *Report on Carcinogens* (RoC) identifies two groups of agents: "Known to be human carcinogens" & "Reasonably anticipated to be human carcinogens."

PCE has been shown to cause liver tumors in mice and kidney tumors in male rats. There is limited evidence for the carcinogenicity of PCE in humans. PCE has been studied by observing laundry and dry-cleaning workers, who may also have been exposed to other solvents, especially trichloroethylene (TCE), but also petroleum solvents.

The *Eleventh Report on Carcinogens* (RoC) has determined that PCE may reasonably be anticipated to be a carcinogen.

## Reference:

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological Profile for tetrachloroethylene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service

Report on Carcinogens, Eleventh Edition; U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, 2006. http://ntp.niehs.nih.gov/ntp/roc/toc11.html

**Revised 08-21-06**

## Is there a medical test to show whether you have been exposed to PCE?

One way of testing for PCE exposure is to measure the amount of the chemical in the breath, much the same way breath-alcohol measurements are used to determine the amount of alcohol in the blood. Because PCE is stored in the body's fat and slowly released into the bloodstream, it can be detected in the breath for weeks following a heavy exposure. Also, PCE and trichloroacetic acid (TCA), a breakdown product of PCE, can be detected in the blood. These tests are relatively simple to perform but are not available at most doctors' offices and must be done at special laboratories that have the right equipment. Because exposure to other chemicals can produce the same breakdown products in the urine and blood, the tests for breakdown products cannot determine if you have been exposed to PCE or the other chemicals that produce the same breakdown chemicals.

## What has the federal government made recommendations to protect human health?

The EPA maximum contaminant level for the amount of PCE that can be in drinking water is 0.005 milligrams PCE per liter of water (0.005 mg/L).

The Occupational Safety and Health Administration (OSHA) have set a limit of 100 ppm for an 8-hour workday over a 40-hour workweek.

The National Institute for Occupational Safety and Health (NIOSH) recommends that PCE be handled as a potential carcinogen and recommends that levels in workplace air should be as low as possible.

**The Ohio Department of Health is in cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), Public Health Service, U.S. Department of Health and Human Services.**

**This pamphlet was created by the Ohio Department of Health, Bureau of Environmental Health, Health Assessment Section and supported in whole by funds from the Cooperative Agreement Program grant from the ATSDR.**

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# Trichloroethylene (TCE)

## (try- klor'oh eth'uh- leen)

## Answers to Frequently Asked Health Questions

## What is TCE?

TCE is man-made chemical that is not found naturally in the environment. TCE is a non-flammable (does not burn), colorless liquid with a somewhat sweet odor and has a sweet, “burning” taste. It is mainly used as a cleaner to remove grease from metal parts. TCE can also be found in glues, paint removers, typewriter correction fluids and spot removers.

The biggest source of TCE in the environment comes from evaporation (changing from a liquid into a vapor/gas) when industries use TCE to remove grease from metals. But TCE also enters the air when we use common household products that contain TCE. It can also enter the soil and water as the result of spills or improper disposal.

## What happens to TCE in the environment?

- TCE will quickly evaporate from the surface waters of rivers, lakes, streams, creeks and puddles.
- If TCE is spilled on the ground, some of it will evaporate and some of it may leak down into the ground. When it rains, TCE can sink through the soils and into the ground (underground drinking) water.
- When TCE is in an oxygen-poor environment and with time, it will break down into different chemicals such as 1,2 Dichloroethene and Vinyl Chloride.
- TCE does not build up in plants and animals.
- The TCE found in foods is believed to come from TCE contaminated water used in food processing or from food processing equipment cleaned with TCE.

## How does TCE get into your body?

- TCE can get into your body by breathing (inhalation) air that is polluted with TCE vapors. The vapors can be produced from the manufacturing of TCE, from TCE polluted water evaporating in the shower or by using household products such as spot removers and typewriter correction fluid.
- TCE can get into your body by drinking (ingestion) TCE polluted water.
- Small amounts of TCE can get into your body through skin (dermal) contact. This can take place when using TCE as a cleaner to remove grease from metal parts or by contact with TCE polluted soils.

## Can TCE make you sick?

Yes, you can get sick from TCE. But getting sick will depend on the following:

- How much you were exposed to (dose).
- How long you were exposed (duration).
- How often you were exposed (frequency).
- General Health, Age, Lifestyle Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposures.

## How does TCE affect your health?

### Breathing (Inhalation):

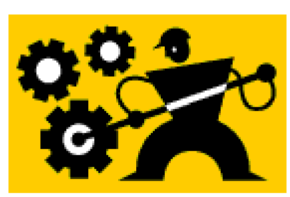
- Breathing high levels of TCE may cause headaches, lung irritation, dizziness, poor coordination (clumsy) and difficulty concentrating.
- Breathing very high levels of TCE for long periods may cause nerve, kidney and liver damage.

### Drinking (Ingestion):

- Drinking high concentrations of TCE in the water for long periods may cause liver and kidney damage, harm immune system functions and damage fetal development in pregnant women (although the extent of some of these effects is not yet clear).
- It is uncertain whether drinking low levels of TCE will lead to adverse health effects.

### Skin (Dermal) Contact:

- Short periods of skin contact with high levels of TCE may cause skin rashes.



## Does TCE cause cancer?

The National Toxicology Program's 11th Report on Carcinogens places chemicals into one of two cancer-causing categories: *Known to be Human Carcinogens* and *Reasonably Anticipated to be Human Carcinogens*.

The11th Report on Carcinogens states TCE is *"Reasonably Anticipated to be Human Carcinogen."*

The category *"Reasonably Anticipated to be Human Carcinogen"* gathers evidence mainly from animal studies. There may be limited human studies or there may be no human or animal study evidence to support carcinogenicity; but the agent, substance or mixture belongs to a well-defined class of substances that are known to be carcinogenic.

There are human studies of communities that were exposed to high levels of TCE in drinking water and they have found evidence of increased leukemia's. But the residents of these communities were also exposed to other solvents and may have had other risk factors associated with this type of cancer.

Animal lab studies in mice and rats have suggested that <u>high</u> levels of TCE may cause liver, lung, kidney and blood (lymphoma) cancers.

As part of the National Exposure Subregistry, the Agency for Toxic Substances and Disease Registry (ATSDR) compiled data on 4,280 residents of three states (Michigan, Illinois, and Indiana) who had environmental exposure to TCE. ATSDR found no definitive evidence for an excess of cancers from these TCE exposures.

The U.S. EPA is currently reviewing the carcinogenicity of TCE.

## Is there a medical test to show whether you have been exposed to TCE?

If you have recently been exposed to TCE, it can be detected in your breath, blood, or urine. The breath test, if done soon after exposure, can tell if you have been exposed to even a small amount of TCE.

Exposure to larger amounts is measured in blood and urine tests. These tests detect TCE and many of its breakdown products for up to a week after exposure. However, exposure to other similar chemicals can produce the same breakdown products in the blood and urine so the detection of the breakdown products is not absolute proof of exposure to TCE.

These tests aren't available at most doctors' offices, but can be done at special laboratories that have the right equipment. **Note:** Tests can determine if you have been exposed to TCE but cannot predict if you will experience adverse health effects from the exposure.

## Has the federal government made recommendations to protect human health?

The federal government develops regulations and recommendations to protect public health and these regulations can be enforced by law.

Recommendations and regulations are periodically updated as more information becomes available. Some regulations and recommendations for TCE follow:

- The Environmental Protection Agency (EPA) has set a maximum contaminant level for TCE in drinking water at 0.005 milligrams per liter (0.005 mg/L) or 5 parts of TCE per billion parts water (5 ppb).
- The Occupational Safety and Health Administration (OSHA) have set an exposure limit of 100 ppm (or 100 parts of TCE per million parts of air) for an 8-hour workday, 40-hour workweek.
- The EPA has developed regulations for the handling and disposal of TCE.

## References


Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological profile for TCE (electronic at **http://www.atsdr.cdc.gov/tfacts19.html** )

Report on Carcinogens, Eleventh Edition; U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, 2005 (2005 electronic at **http://ntp.niehs.nih.gov/ntp/roc/toc11.html** )



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# 1,2-Dichloroethene

## (also called cis- and trans- 1,2 DCE )

### Answers to Frequently Asked Health Questions

## What is 1,2 DCE?

1,2-Dichloroethene (1,2 DCE) is a highly-flammable, chlorinated, colorless liquid that has a sharp, harsh odor. There are no known products you can buy that contain 1,2 DCE. 1,2 DCE is used when mixing other chlorinated chemicals and is most often used to produce chemical solvents.

## How does 1,2 DCE enter the environment?

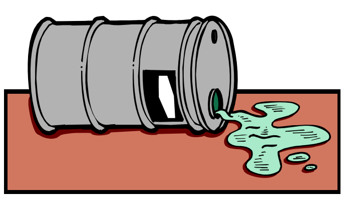
1,2 DCE is released to the environment from chemical factories that make or use this chemical, from landfills and hazardous waste sites that have a spill or leak, from chemical spills, from burning vinyl and from the chemical breakdown of other chlorinated chemicals in the underground drinking water (groundwater).

## What happens to 1,2 DCE when it enters the environment?

**Air:** When spilled on moist soils or in rivers, lakes and other bodies of water, most of the 1,2 DCE quickly evaporates into the air. 1,2 DCE quickly breaks down by reacting with the sunlight. In the air, it usually takes about 5-12 days for half of any amount spilled to break down.

**Water:** The 1,2 DCE found below soil surfaces in landfills or hazardous waste sites may dissolve in water during rain events and leak deeper in the soils, possibly contaminating the groundwater. Once in groundwater, it takes about 13-48 weeks for half of any amount spilled to break down.

**Soils:** Some 1,2 DCE trapped under ground may escape as soil-gas vapors. These vapors can travel through soils, especially if the soils are sandy and loose or have a lot of cracks (fissures). The vapors can then enter a home through cracks in the foundation or into a basement with a dirt floor or concrete slab. 1,2 DCE in groundwater will eventually break down into vinyl chloride and other chemicals, some of which are more hazardous to people than the 1,2 DCE.



## How can I be exposed to 1,2 DCE?

People who live in cities or suburbs are more likely to be exposed to 1,2 DCE than people living in rural areas. Most people who are exposed through air or water are exposed to very low levels, in the parts per billion (ppb) range. **Notes: "ppb" is a unit of measurement. Example: 1 part per billion (1 ppb) would be equal to having one bean in a pile of one billion beans.**

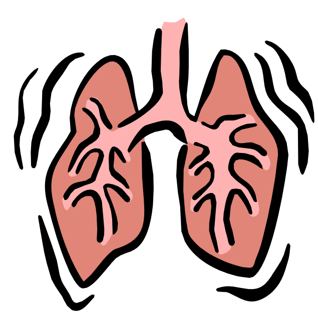
Human exposure to 1,2 DCE usually happens where the chemical has been improperly disposed of or spilled. Exposure mainly happens by breathing contaminated air or drinking contaminated water. If the water in your home is contaminated, you could also be breathing 1,2 DCE vapors while cooking, bathing or washing dishes.

The people who are most likely to be exposed to 1,2 DCE are people who work at factories where this chemical is made or used, people who work at a 1,2 DCE contaminated landfill, communities that live near contaminated landfills and hazardous waste sites.

## How does 1,2 DCE enter and leave my body?

Most 1,2 DCE enters the body through your lungs when you breathe contaminated air (inhalation), through your stomach and intestines when you eat contaminated food or water (ingestion), or through your skin upon contact with the chemical (dermal).

Once breathed or swallowed, it enters your blood rapidly. Once in your blood, it travels throughout your body. When it reaches your liver it is changes into several other break-down chemicals. Some of these chemicals are more harmful than 1,2 DCE.



## Can 1,2 DCE make me sick?

Yes, you can get sick from exposure to 1,2 DCE. However, getting sick will depend on many factors such as:

- How much you were exposed to (dose).
- How long you were exposed (duration).
- How often you were exposed (frequency).
- How toxic is the chemical of concern.
- General Health, Age, Lifestyle
  Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposures.

## How can exposure to 1,2 DCE affect my health?

Most information about exposure to 1,2 DCE is from occupational studies where workers were exposed at very high levels. Most environmental exposures to 1,2 DCE are at much lower than those in the workplace.

The short-term occupational studies of workers exposed to breathing high levels of 1,2 DCE found workers became nauseous (upset stomach) and drowsy/tired.

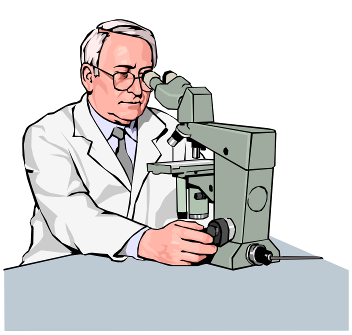
The long-term human health effects after exposure to low concentrations of 1,2 DCE are not known.

## Will exposure to 1,2 DCE cause cancer?

The U.S. EPA classifies 1,2 DCE as a Class D carcinogen. The U.S. EPA Class D category is used when the chemical is not classifiable to its human carcinogenicity (ability to cause cancer). This classification is made because there is no solid data that this chemical causes cancer in humans or animals.

## Is there a test to find out if I have been exposed to 1,2 DCE?

Tests are available to measure concentrations of 1,2 DCE in blood, urine and tissues. However, these tests aren't normally used to determine whether a person has been exposed to this compound. This is due to the fact that after you are exposed to 1,2 DCE, the breakdown products in your body that are detected with these tests may be the same as those that come from exposure to other chemicals. These tests aren't available in most doctors' offices, but can be done at special laboratories that have the right equipment.



## What recommendations has the federal government made to protect human health?

The federal government has developed regulatory standards and guidelines to protect people from possible health effects of 1,2 DCE in water and air.

**Water:** The EPA has established water quality guidelines to protect both aquatic life and people who eat fish and shellfish. The EPA Office of Drinking Water has set a drinking water regulation that states that water delivered to any user of a public water system shall not exceed 70 ppb for cis-1,2 DCE and 100 ppb trans-1,2 DCE. For very short-term exposures (1 day) for children, EPA advises that concentrations in drinking water should not be more than 4 ppm for cis-1,2 DCE or 20 ppm for trans-1,2 DCE. For 10-day exposures for children, EPA advises that drinking water concentrations should not be more than 3 ppm for cis-1,2 DCE or 2 ppm for trans-1,2 DCE. For industrial or waste disposal sites, any release of 1,000 pounds or more must be reported to the EPA.

**Air:** The National Institute for Occupational Safety and Health (NIOSH) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established guidelines for occupational exposure to cis- or trans-1,2 DCE. Average concentrations should not exceed 200 ppm in the air.

## References:


Agency for Toxic Substances and Disease Registry (ATSDR). 1996. Toxicological profile for 1,2-Dichloroethene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

U.S. Environmental Protection Agency, Integrated Risk Information System, II.A.1. Weight-of-Evidence Characterization


## Where Can I Get More Information?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Phone: (614) 466-1390


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**Bureau of Environmental Health**
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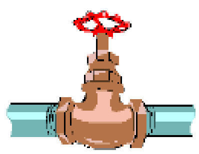
# Vinyl Chloride

**Answers to Frequently Asked Health Questions**

## What is vinyl chloride?

Vinyl chloride is a colorless, flammable gas with a mild, sweet odor. It does not occur naturally in the environment but is a man-made product that is used to make polyvinyl chloride (PVC).

Polyvinyl chloride (PVC) is used to make a variety of plastic products including pipes, wire and cable coatings, and packaging materials. Before the mid-1970s, vinyl chloride was used as a coolant, used as a propellant in aerosol spray cans and could be found in some cosmetics.



Vinyl chloride can also be produced as a by-product or when chlorinated solvents such as TCE & PCE chemically break down.

## How does vinyl chloride get in your body?

- By breathing (inhalation) vinyl chloride that has leaked from plastics industries, hazardous waste sites, and landfills.
- By breathing (inhalation) vinyl chloride in contaminated workplace air or having skin or eye contact.
- By breathing (inhalation) tobacco smoke from cigarettes or cigars.
- By drinking (ingesting) water from contaminated wells.

Most people begin to smell vinyl chloride in the air at 3,000 parts vinyl chloride parts per million (ppm) of air. However, this is too high a level to prevent adequate warning of exposure. Most people begin to taste vinyl chloride in water at 3.4 parts per million (ppm).

Before government regulations, vinyl chloride could get into food that was stored in materials containing PVC.

## How does vinyl chloride affect your health?

It is hard to know what levels of exposure to vinyl chloride can cause health problems. The kinds of health problems and extent of problems that are seen with exposure depend on many factors. These factors include:

- How much vinyl chloride a person is exposed to (dose).
- How long a person is exposed to the vinyl chloride (duration).
- How often a person is exposed to the vinyl chloride (frequency).
- How you were exposed (inhalation or drinking).

Most vinyl chloride you breathe or swallow will quickly enter your blood. When it reaches your liver, the liver will change it into other substances which also travel in your blood. Most of the vinyl chloride leaves your system through the urine within a day after entering your body. But the products made by the liver will take a little longer to leave your body.

## Short-term exposure effects:

Breathing high levels of vinyl chloride (much higher than what is normally in the environment) can cause a person to feel dizzy or become sleepy. Studies in animals show that extremely high levels of vinyl chloride can damage the liver, lungs, kidneys, and heart, and prevent blood clotting.

## Long-term exposure effects:

People who have breathed high levels (thousands of parts per million-ppm) vinyl chloride for several years under industrial conditions have changes in the structure of their liver. People that have worked with vinyl chloride have nerve damage and others have developed an immune reaction. Some workers exposed to very high levels of vinyl chloride have problems with the blood flow to their hands.

## Are there other health problems seen with exposure to vinyl chloride?

Some men who work with vinyl chloride have complained of a lack of libido (sex drive). Women who work with vinyl chloride have reported irregular menstrual periods and have developed high blood pressure during pregnancy. Vinyl chloride has not been shown to cause birth defects.

## Is there a test to find out if I have been exposed to vinyl chloride?

There are two tests which can measure vinyl chloride in your body. However, these tests are not routinely available at your doctor's office and must be done at special laboratories that have the right equipment.

Vinyl chloride can be measured in your breath and vinyl chloride's chief breakdown product, thiodiglycolic acid, can be measured in your urine. But exposure to other chemicals can also produce the same breakdown products in your urine.

Note that both the breath and urine test must be done shortly after exposure and these tests are not very helpful for measuring low levels of the chemical.

## Does vinyl chloride cause cancer?

The Department of Health and Human Services (HHS) has determined that vinyl chloride is a known carcinogen (causes cancer).

The International Agency for Research on Cancer (IARC) has determined that vinyl chloride is carcinogenic (causes cancer) to humans, and the Environmental Protection Agency (EPA) has determined that vinyl chloride causes cancer.

Studies of workers who breathed very high levels vinyl chloride for many years showed an increased risk of cancers of the liver. Also, brain, lung and some cancers of the blood may also be connected with breathing vinyl chloride.

## Has the federal government made recommendations to protect human health?

The federal government develops regulations and recommendations to protect public health and these regulations can be enforced by law.

The U.S. EPA requires that the amount of vinyl chloride in drinking water not exceed 0.002 ppm (parts per million).

The Food and Drug Administration (FDA) regulates the vinyl chloride content of plastics, because vinyl chloride may leak from plastic into foods or water.

## Reference

The Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for vinyl chloride, September, 1997.

## Where can I get more information?

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