Public Health Assessment

Public Comment Release

BEHR DAYTON THERMAL SYSTEMS VOC PLUME

DAYTON, MONTGOMERY COUNTY, OHIO

EPA FACILITY ID: OHN000510164

Prepared by the
Ohio Department of Health

NOVEMBER 6, 2013

COMMENT PERIOD ENDS: DECEMBER 20, 2013

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

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment-Public Comment Release was prepared by ATSDR 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. This document represents the agency's best efforts, based on currently available information, to fulfill the statutory criteria set out in CERCLA section 104 (i)(6) within a limited time frame. To the extent possible, it presents an assessment of potential risks to human health. Actions authorized by CERCLA section 104 (i)(11), or otherwise authorized by CERCLA, may be undertaken to prevent or mitigate human exposure or risks to human health. In addition, ATSDR's Cooperative Agreement Partner will utilize this document to determine if follow-up health actions are appropriate at this time.

This document has previously been provided to EPA and the affected state in an initial release, as required by CERCLA section 104 (i) (6) (H) for their information and review. Where necessary, it has been revised in response to comments or additional relevant information provided by them to ATSDR's Cooperative Agreement Partner. This revised document has now been released for a 45-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner will address all public comments and revise or append the document as appropriate. The public health assessment will then be reissued. This will conclude 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.

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Prepared by:

The Health Assessment Section
of the Ohio Department of Health
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Agency for Toxic Substances and Disease Registry

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SUMMARY

Introduction The Behr Dayton Thermal Systems VOC Plume site (the Behr site) is a groundwater contamination and vapor intrusion site impacted by chlorinated solvents that largely originate from the Behr-Dayton Thermal Products (former Chrysler Air Temp) facility in Dayton, Montgomery County, Ohio. Volatile organic compounds (VOCs) from the Behr-Dayton Thermal Products facility, located at 1600 Webster Street, are migrating off-site in the groundwater under residential areas in north Dayton south-southwest of the facility (Figure 1).

This health assessment document evaluates the environmental data collected by Ohio EPA, U.S. EPA, and Chrysler as part of the vapor intrusion and groundwater investigation at this site available at the time the site was listed on the NPL (April 8, 2009). The Health Assessment Section (HAS) of the Ohio Department of Health (ODH) has had a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR) since 1990. Under that agreement, HAS undertook the lead in completing this public health assessment (PHA). HAS makes conclusions and recommendations for additional actions that may be necessary to protect the public health.

HAS has also produced two Public Health Consultation documents as part of the Behr-Dayton site investigation: Initial U.S. EPA Investigation, Behr VOC Plume Site, August 1, 2008 and Chrysler Corporation, Phase I Area, Vapor Intrusion Investigation and Mitigation, September 30, 2008.

Conclusions HAS reached three separate conclusions in the PHA.

Conclusion 1: HAS concluded that before vapor abatement systems were installed, breathing indoor air contaminated with TCE above the established long-term screening levels for this site over the course of a lifetime could harm people's health. This was considered to be a public health hazard for homes in the McCook Field Neighborhood south of the Behr Dayton Thermal facility.

Basis for Decision: Breathing indoor air contaminated with TCE could increase the likelihood of harmful noncancer health effects and the development of certain types of cancer. Installation of the vapor abatement systems has lowered the concentrations of contaminants to levels that are not expected to cause adverse health effects upon exposure. These individual vapor abatement systems, however, are an interim action to mitigate or prevent current exposures and not a long-term cleanup solution for this site.

Conclusion 2: HAS concluded that before vapor abatement systems were installed, breathing indoor air contaminated with TCE for longer than two weeks but less than a year at four homes in the McCook Field Neighborhood south of the Behr Dayton Thermal Products facility could harm people's health.

Basis for Decision: Elevated levels of TCE detected in the indoor air in four homes could harm residents who breathe the indoor air. Potential adverse effects from breathing TCE include immunological effects, fetal heart malformations, kidney toxicity, and an increased risk of developing kidney cancer. Installation of the vapor abatement systems has lowered the concentrations of contaminants to levels that are not expected to result in any adverse health effects. However, installation and operation of the vapor abatement systems are an interim action to mitigate or prevent current exposures and do not fully address the contaminated groundwater plume under the neighborhood and the source of contamination at this site.

Next Steps: The U.S. EPA Emergency Response Branch, the HAS, Ohio EPA, and Public Health–Dayton and Montgomery County will continue oversight of the installation of the vapor abatement systems and the monitoring of indoor air contaminant levels for residents with and without installed systems. The Remedial Response Branch of the U.S. EPA will conduct a Remedial Investigation/ Feasibility Study (RI/FS) to determine the methods to be used to clean up the contamination at the site.

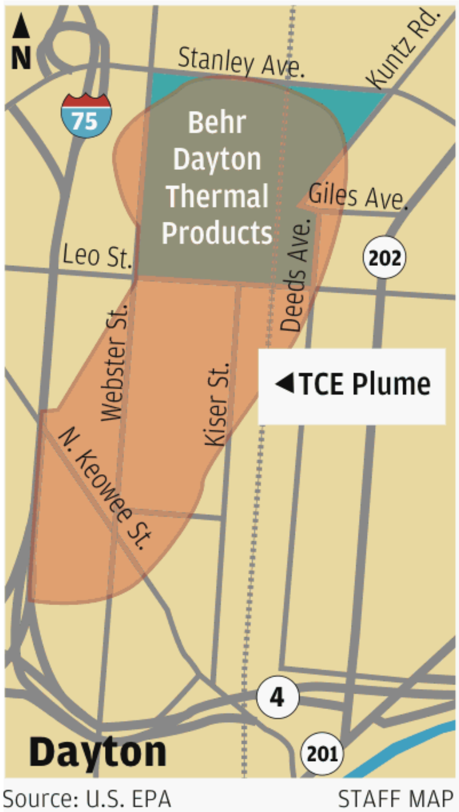
Conclusion 3: People using water from the Dayton public water supply for drinking, showering, or other household uses are currently not at risk for harmful health effects.

Basis for Decision: The drinking water monitoring program for the Dayton public water supplies indicates that no site-related contaminants have been found at levels of concern in their drinking water. However, during times of low groundwater elevation, such as during a drought, the contaminated groundwater from beneath the Behr Dayton Thermal Products facility could possibly be drawn into the municipal supply wells.

Next Steps: The City of Dayton will continue to monitor the well water from their wells north of the Behr Dayton facility for site related chemicals of concern.

For More Information If you have any concerns about your health, as it relates to exposure to TCE or 1,2-dichloroethylene (1,2-DCE), you should contact your health care provider. You can also call HAS at (614) 466-1390 and ask for information on the Behr VOC Plume site. For U.S. EPA information about the Behr Dayton VOC Plume site, see: http://www.epa.gov/region5/superfund/npl/ohio/OHN000510164.html.

STATEMENT OF ISSUES



The Behr Dayton Thermal Systems VOC Plume site (the Behr site) is a groundwater contamination and vapor intrusion site impacted by chlorinated solvents that largely originate at the Behr-Dayton Thermal Products (former Chrysler Air Temp) facility in Dayton, Montgomery County, Ohio. In 2002, Chrysler notified the Ohio Environmental Protection Agency (Ohio EPA) that volatile organic compounds (VOCs) from the Behr-Dayton Thermal Products facility, located at 1600 Webster Street, were migrating off-site in the groundwater under urban residential areas in north Dayton, south-southwest of the facility (Figure 1).

By 2006, the reported concentrations of contaminants detected in the groundwater migrating off-site led to Ohio EPA concerns that vapor-phase chlorinated solvents could migrate from the groundwater and travel through the soil gas and into homes and businesses in the neighborhood south of the Behr-Dayton facility (Figure 2). The concentrations of the solvent trichloroethylene (TCE) detected in the groundwater and soil gas sampled by Ohio EPA exceeded the U.S. EPA's Office of Solid Waste and Emergency Response (OSWER) Subsurface Vapor Intrusion Guidance (U.S. EPA 2002) screening levels for this chemical. Ohio EPA also had concerns that during periods of low groundwater elevation some of the contaminated groundwater could flow north toward the City of Dayton's well-field. The Ohio EPA requested U.S. Environmental Protection Agency (U.S. EPA) and HAS assistance to carry out a time-critical investigation in the neighborhood to address these concerns.

In October 2006, the U.S. EPA Emergency Response Branch On-Scene Coordinator requested the assistance of the Health Assessment Section (HAS) at the Ohio Department of Health to provide indoor air and sub-slab soil gas screening and action levels for the contaminants associated with the plume. ATSDR and HAS provided U.S. EPA with health-based screening levels for TCE and other volatile organic compounds (VOCs) for sub-slab soil gas and indoor air under and in residential and non-residential buildings. HAS proposed that interim measures be taken at those properties that exceeded these screening criteria to reduce or eliminate the vapor intrusion route as a pathway of concern. In the McCook Field Neighborhood, 395 residential and commercial buildings, including two schools, were sampled (Table 5). There were 205 sub-slab vapor abatement systems installed in buildings that exceeded sub-slab or indoor air screening levels (Figure 3). The operation of these systems over the last six years

has eliminated or reduced exposure to TCE in the indoor air for the short term. The HAS has participated in five U.S. EPA public meetings, two public health-related meetings, as well as a number of one-on-one meetings with residents of the McCook Field Neighborhood to discuss TCE and its possible health effects and answer health-related questions. As of January 2013, 228 properties have had a vapor abatement system installed (including those installed by U.S. EPA, Chrysler, and Behr), 6 properties need a mitigation system (install pending), and 13 properties where owners have not allowed the installations (denied a mitigation system).

Although other site-related contaminants are present, the U.S. EPA Emergency Response Branch's time-critical removal actions focused on TCE as the main contaminant of concern due to TCE's toxicity, low soil gas screening and indoor air action levels, and high concentrations detected in the groundwater and soil gas. The initial Ohio EPA and U.S. EPA sampling results detected TCE and cis-1,2-DCE above screening levels in the indoor air, whereas the other contaminants, e.g., vinyl chloride, were not found in the indoor air above screening levels. Decisions for time-critical actions were based on airborne concentrations of TCE detected in homes and businesses. Other contaminants, such as tetrachloroethylene or perchloroethylene (PCE), 1,2-dichloroethylene (1,2-DCE), and vinyl chloride will be evaluated during U.S. EPA's cleanup of the site. Other than the initial sampling results, the concentrations of these compounds are not generally known for all of the plume area. The Behr Dayton Thermal Systems VOC Plume site currently includes the Behr, the Aramark, and the Gem City Chemicals facilities, but will include any other facilities that are discovered as sources of groundwater contamination during U.S. EPA's Remedial Investigation.

BACKGROUND

Site Location

The Behr Dayton Thermal Systems VOC Plume site (the Behr site) is located in an older mixed urban industrial/commercial and residential portion of north Dayton, Montgomery County, Ohio. The Behr Dayton Thermal Systems VOC Plume site is a groundwater contamination plume largely originating from under the Behr-Dayton Thermal Products facility. Following regional groundwater flow, the groundwater contamination is migrating into the adjacent residential areas south and southwest of the facility (See Figure 1). However, during periods of low groundwater elevation, there is a concern that contaminated groundwater from the site could reverse its flow from south to north and enter the water supply for the City of Dayton (Randy Watterworth, Ohio EPA, personal communication, 2009). In 2007, the groundwater divide was located approximately along Stanley Avenue (the street on the north side of the Behr facility). North of the groundwater divide, groundwater was moving north towards the City of Dayton's Miami Well Field. South of the groundwater divide, groundwater flow is to the southwest (Ohio EPA 2010). The Behr-Dayton Thermal Products facility is about one mile south of the City of Dayton's Miami Well Field. The Behr Dayton Thermal Systems VOC Plume site is about two miles north of downtown Dayton and one mile north of the confluence of the Great Miami River and the Mad River. The site is about one mile east of the confluence of the Great Miami River and the Stillwater River.

Regional Hydrogeology and Groundwater Resources

The Behr Dayton Thermal Systems VOC Plume site is located in the Great Miami River valley. The Great Miami River flows across a deep bedrock valley that was cut into the limestone and shale bedrock. The receding Pleistocene glaciers back-filled these deep bedrock valleys with sand and gravel deposits and occasional layers of clay. These valley fill deposits typically range from 150 to 250 feet thick. The sand and gravel deposits are thickest near the present course of the Great Miami River and taper to 25 feet thick or less along the edges of the bedrock valley.

Poorly sorted clay tills were deposited as intermittent layers along with the sand and gravel beds in the former river valley. These clay lenses do not, however, form a continuous, impermeable confining layer. The groundwater that may be perched above these layers is not isolated from the groundwater beneath it. Soils under the site are porous and permeable sand and gravels (ODNR well logs 2001-2004). These sand and gravel deposits comprise a prolific buried valley aquifer system. The buried valley aquifer provides most of the region with an abundant supply of water for drinking and industrial use (MCD 2002). Seventy-six percent of the water used in the area is withdrawn from the buried valley sand and gravel aquifer. Most of the water withdrawn from the aquifer (67%) is used for public drinking water supplies (MCD 2002). This buried valley aquifer has been designated as a "Sole Source Aquifer." The U.S. EPA's Sole Source Aquifer designation is defined as an aquifer that supplies at least 50% of the drinking water consumed in the area overlying the aquifer.

Beginning in 2001, Chrysler sampled the groundwater from 75 on-site and off-site monitoring wells on a periodic basis. Chrysler reported that groundwater elevations indicated that the flow direction in the vicinity of the facility was from the northeast and turned to the southwest just south of the facility (U.S. EPA, 2006a). Regional groundwater flow in the buried valley aquifer system mimics the regional topographic gradient (MCD 2002). The depth to the water table near the site ranges from about 17 to 25 feet below ground surface (bgs). The intervening soils consist primarily of unconsolidated permeable, porous sands, gravels, and cobbles (ODNR well logs).

Demographics

The Behr Dayton Thermal Systems VOC Plume site lies within the McCook Field Neighborhood Planning District of the City of Dayton. The McCook Field Neighborhood is bounded to the west and north by the Great Miami River, to the south by the Mad River, and to the east by the Old North Dayton Neighborhood near the Baltimore and Ohio Railroad. In the 2000 census, there were a total of 2,107 people living in this district with 49 percent white, 47 percent African-American, and 4 percent other. In the McCook District at the time of the 2000 Census, 38 percent of the people were 17 years old or younger, 55 percent were between the ages of 18 and 64, and 5 percent were 65 years old or older. There was a total of 1,141 housing units with 836 households and an average of 2.47 persons per household. At the time of the 2000 census, 15 percent of the housing units were owner occupied, 58 percent were rented and 27 percent were vacant (Dayton 2003). Also from the 2000 Census, but based on 1999 income, 47 percent of the people (of all ages) living in the McCook District were living with incomes below the poverty level (City of Dayton 2000). Since the 2000 Census, the Dayton Metropolitan Housing project, located west of Interstate 75 and just southwest of the Behr facility, was closed and demolished in the summer of 2008, which likely had a significant impact on the demographics of the McCook Field Neighborhood Planning District. In the 2010 Census, there were 770 people living in the McCook Field Neighborhood Planning District, representing a decrease in population of 63 percent in the 10 years since the 2000 Census (City of Dayton 2012). The population in 2010 was now 80 percent white, 15 percent African-American, and 2 percent other. At the time of the 2010 Census, 20 percent of the people were 17 years old or younger, 69 percent were between the ages of 18 and 64, and 11 percent were 65 years old or older. In 2010, the number of total housing units dropped to 492 units. Of these, 28 percent were owner occupied, 44 percent were rented and 28 percent were vacant (City of Dayton 2012).

Land Use

The Behr VOC Plume area consists mostly of general and light industrial districts mixed with older neighborhoods of single family residential and commercial properties. The City of Dayton has zoned this area as a "general industrial district." The Behr facility is to the north on the north side of Leo Street (Figure 2). The areas to the immediate east and west of the site are occupied by industrial and commercial properties. There is a small park located on the south side of Lamar Street just south of the facility called Claridge Park. Some larger city parks can also be found further to the west along the Great Miami River such as Triangle Park and the McCook Field area.

There are a number of industries in addition to the Behr facility near the site, including, Aramark Uniform Services Inc., DAP Inc., Environmental Processing SVC, Gayston, Gem City Engineering, and GEM City Chemicals Inc. Existing groundwater data does not indicate that these other facilities are as significant a source of TCE contamination as the Behr facility (U.S. EPA 2009). However, the U.S. EPA RI will determine if these and/or other facilities in the area are significant or contributing sources of contaminants. Dayton's water supply wells are about one mile away, north-northeast of the site.

There were two elementary schools in the Behr VOC Plume area; the Kiser Elementary School and Van Cleve @ McGuffey Elementary School. The Kiser Elementary School is immediately east across the railroad tracks from the Behr Facility on Leo Street. Recent indoor air samples detected contaminants at concentrations below the action levels at Kiser Elementary School. The Kiser Elementary School is currently the only open nearby school. The Van Cleve @ McGuffey Elementary School was located at 1032 Webster Street, roughly 1,600 feet, south of the Behr facility. However, the school was closed and students were relocated in August 2007 to 132 Alaska Street after indoor air samples indicated TCE levels above action levels in the Webster Street building in June and July 2007. The school district demolished the Van Cleve @ McGuffey building in 2011 (U.S. EPA Behr VOC Plume Site progress update, Jan/Feb 2012).

Site History

Operational History

The Behr-Dayton Thermal Products facility manufactures vehicle air conditioning and engine cooling systems. Although the operations at the facility have remained consistent through its history, the facility ownership has changed several times. The Chrysler Corporation owned and operated the facility from 1937 until 2002. In 1998 Daimler-Benz and Chrysler Corporation merged forming the DaimlerChrysler Corporation (Chrysler) (U.S. EPA 2006a). In April of 2002, Behr America became the current owner of the Dayton facility. However, DaimlerChrysler Corporation assumed responsibility for the characterization and remediation of the Behr VOC Plume. In April 2009, Chrysler LLC petitioned for reorganization under Chapter 11 of the U.S. Bankruptcy Code and walked away from the site. Following discussions with U.S. EPA, Behr-Dayton Thermal in 2009 stepped up and assumed responsibility for maintaining the installed home vapor abatement systems and the off-site soil vapor extraction system.

It is likely that other sources of VOCs are present in the industrialized area surrounding the Behr facility. TCE and other contaminants have been detected in the groundwater up-gradient of the Behr property. Some nearby facilities where VOCs have been detected in the groundwater are Gem City Chemicals, DAP, Gayston, and Aramark. However, the levels of TCE are significantly greater in the groundwater beneath and directly south of the Behr property.

Previous Site Investigations

In 2002, Chrysler documented groundwater contamination beneath the facility with contaminant levels exceeding Ohio's Voluntary Action Program (VAP) cleanup standards. Also in 2002, Chrysler submitted a Human Health Risk Evaluation (HHRA) (Earth Tech 2002). The HHRA was the initial evaluation of human health risk based on the concentration of detected VOCs in the groundwater at off-site locations. The main contaminants of potential concern identified in the HHRA were TCE and PCE. The HHRA evaluated the groundwater below the facility and the groundwater moving off site separately. The HHRA also evaluated the risk from vapor intrusion using the Johnson-Ettinger Model (U.S. EPA 1991). The HHRA concluded that the risks due to vapor intrusion were marginal for non-carcinogenic hazards and carcinogenic risks and concluded "that an imminent and substantial health risk is not present" (Earth Tech 2002). The report further stated that residences within this plume area south-southwest of the facility are supplied with water from the Dayton's municipal water supplies and are not at risk of exposure to contaminants through their drinking water supply.

In response to the groundwater contamination documented in 2002, Chrysler contracted Earth Tech to design, install, and operate two systems for the remediation, one for the soil cleanup and one for cleanup of the groundwater contamination under the facility, with TCE as the main contaminant of concern.

On-Site Soil and Groundwater Remediation Systems

Chrysler installed an on-site Soil Vapor Extraction (SVE) system for the removal of contaminants from the soils. The SVE system began operation in October 2003 and continued operating through December 2005. An estimated 900 pounds of VOCs were removed from the soils (Earth Tech 2006).

In an attempt to remove contaminants from the groundwater, a remediation system consisting of six extraction wells and seven injection wells was installed. The capture zone of the six extraction wells reportedly extends as much as 300 feet to the south and 150 feet east of the Behr facility boundaries. Within this capture zone, contaminated groundwater is recovered and treated by a remedial groundwater system. Sodium lactate solution is injected into this system to break down chlorinated solvents before the groundwater is returned to the aquifer. The remedial groundwater system began operation in June 2004 and an estimated 1,031 pounds of VOCs were removed (Earth Tech 2006).

Up to 75 monitoring wells, on-site and in the surrounding area, were sampled for VOC analyses on a quarterly basis for Chrysler. Chrysler summarized the data in a report provided for Ohio EPA in September 2006. On-site well MW-010S had concentrations of TCE of 17,000 parts per billion (ppb) in 2003 and 10,000 ppb in 2006. Off-site monitoring wells in the residential area south of the facility had TCE levels over 100 times the MCL (5 ppb) in 2003; MW-28S = 9,600 ppb, MW-29S = 16,000 ppb, MW-33S = 1,900 ppb, MW-38S = 670 ppb, MW-39S = 400 ppb. These levels increased in concentration in 2006 to over 700 times the MCL in three wells: MW-28S = 3,900 ppb, MW-33S = 3,800 ppb, and MW-38S = 3,900 ppb (See Table 1).

Ohio EPA Discovery

In 2002, Chrysler notified Ohio EPA that the VOC plume from the Behr-Dayton Thermal Products facility was migrating off-site in the groundwater. The concentrations of TCE, vinyl chloride (VC), and cis-1,2-dichloroethylene (cis-1,2-DCE) in the groundwater exceeded the U.S. OSWER screening levels (U.S. EPA 2002) (See Table 1). Exceeding these guidance levels indicated that there was a potential for an unacceptable risk to area residents due to vapor intrusion, the migration of vapor phase VOCs from contaminated groundwater to soil gas to indoor air of area homes.

> The guidance levels are intended to provide recommendations to determine if there is a potential for unacceptable health risk to exposed residents, not to delineate the extent of risk or how to eliminate risk. The OSWER vapor intrusion evaluation process is designed to screen out sites that do not require further investigation or remediation and to focus attention on those sites that need further consideration of the vapor intrusion pathway.

In October 2006, Ohio EPA sampled the soil gas under the residential area south of the facility in response to the VOC concentrations in groundwater that exceeded the OSWER guidance levels. These seven soil gas samples were collected approximately one foot above the water table (17 feet below ground surface). Contaminant concentrations in these soil gas samples significantly exceeded the OSWER screening levels (U.S. EPA 2002) for TCE, cis-1,2-DCE, trans-1,2-dichloroethylene (trans-1,2-DCE), and 1,1-dichloroethylene (1,1-DCE) for shallow soil gas. The Ohio EPA soil gas sampling indicated that TCE was at levels up to 160,000 ppb, cis-1,2-DCE at levels up to 11,000 ppb, and 1,1-DCE up to 1,200 ppb under the north Dayton community (See Table 2). The soil gas sample locations are shown in Figure 5 of References HAS 2008a and HAS 2008b.

U.S. EPA Referral

Based on the results of the off-site soil gas investigation, Ohio EPA formally requested assistance from the U.S. EPA Emergency Response Branch on November 6, 2006 to conduct a time-critical vapor intrusion investigation at the Behr Dayton Thermal Systems VOC Plume site (U.S. EPA 2006a).

The U.S. EPA began their vapor intrusion investigation by sampling the sub-slab soil gas and indoor air in the McCook Field Neighborhood in November of 2006. (Figure 3 of References HAS 2008a, 2008b.) The soil gas can accumulate under basement floors or under cement slabs. Soil gas can migrate from beneath the basement floor or sub-slab into occupied portions of the building through cracks in the floor, joints between the floors and the wall, or any other openings in the floor. Sub-slab soil gas samples are collected by drilling a small diameter hole in the concrete floor and installing a sampling port. An evacuated canister or a pump is attached to the sampling port through a regulator which facilitates sample collection over a 24 hour period (sub-slab soil gas is sometimes collected over shorter time periods). The indoor air samples are typically collected in the basement or the first floor of a building using an evacuated stainless steel canister (also known as a summa canister) connected to a regulator which is adjusted to collect a sample over a 24 hour period.

ATSDR and HAS were asked to establish short-term action levels and long-term screening levels for the contaminants of concern for sub-slab soil gas and indoor air concentrations at the Behr Dayton Thermal Systems VOC Plume site. Short-term action levels and long-term screening levels were established for TCE, PCE, cis-1,2-DCE, trans-1,2-DCE, 1,1,1-trichloroethane (1,1,1-TCA), and VC. Exceeding a short-term action level would warrant immediate action to reduce exposure levels. These short-term action levels were derived from ATSDR's intermediate EMEGs (Environmental Media Evaluation Guides). Exceeding the EMEGs level will not necessarily cause adverse health effects, but prompt further evaluation to determine potential public health threat to residents. Intermediate EMEGs were developed for exposure durations of longer than two weeks but less than one year. Long-term screening levels were taken from the U.S. EPA OSWER Draft Vapor Intrusion Guidance levels at the 10^{-4} cancer risk level. Exceeding the long-term screening levels indicates that there is an increased potential to develop cancer due to exposure to the chemicals coming from the site.

For TCE, a residential indoor air screening level of 0.4 ppb and a short-term indoor air action level of 100 ppb were derived. The indoor air concentrations exceeded 0.4 ppb in 174 homes (see Table 5). TCE levels in the indoor air also exceeded the immediate action level of 100 ppb in four homes. A residential sub-slab provisional screening value of 4 ppb was derived based on EPA's attenuation factor of 0.1.

HAS recommended that different screening levels be applied to commercial and industrial locations, depending on whether or not the chemicals of concern for the Behr site were routinely used. For example, U.S. Occupational Safety and Health Administration (OSHA) standards should apply to businesses that routinely use these chemicals. For commercial settings where the contaminants of concern are not used, the residential screening levels are typically adjusted from a 168-hour week, residential exposure to a 40-hour work week, non-residential exposure.

Administrative Order on Consent

Upon reviewing the results of initial sampling, U.S. EPA met with Chrysler on November 17, 2006 to discuss an Administrative Order on Consent (AOC) and establish the scope of work for a proposed time critical removal action. The U.S. EPA's proposed time-critical removal actions focused on installing sub-slab vapor abatement systems in all residences that had indoor air TCE concentrations greater than 0.4 ppb (U.S. EPA 2006a). On December 19, 2006, the AOC was signed by U.S. EPA and Chrysler (U.S. EPA 2006a).

As indoor air and sub-slab sampling continued in 2007 and 2008, the vapor intrusion investigation area grew to include most of the McCook Field Neighborhood south of the Behr facility (south to the Great Miami River, and bounded to the east by Maryland Avenue and to the west by McCook Avenue) (Figure 3). However, in July 2009, Chrysler notified its environmental consultant that all work would be terminated at the site due to company bankruptcy. A Unilateral Administrative Order (UAO) was issued by U.S. EPA to Behr Dayton Thermal Products LLC (Behr Dayton), effective July 31, 2009. Behr Dayton then assumed responsibility for all vapor intrusion activities under an agreed work plan.

Off-Site Soil Vapor Extraction System

In an additional effort to reduce indoor air TCE levels below HAS screening and action levels in a one block area south of the facility, a Soil Vapor Extraction (SVE) system was installed by Chrysler in May, 2008. A SVE system applies a vacuum to an area of the subsurface soils (for the Behr site it is between 5 feet to 20 feet below ground surface) to remove vapor-phase contaminants for treatment or for collection and later disposal. SVE systems are designed to operate in porous permeable soils above the groundwater in areas with high soil gas contaminant concentrations.

The SVE treatment system is located on the south side of Leo Street (Figure 6 of Reference HAS 2008b) and consists of primarily of a vacuum system (with pumps, valves, controls, etc.) and a treatment system (two granular activated carbon vessels, heat exchanger if needed, air/water separator, etc.) (Chrysler 2008). The SVE system also has a system of piping (and valves, meters, etc.) connecting the extraction wells to vacuum pumps, a treatment system, and the vapor extraction wells. For the Behr off-site system, there are eleven vapor extraction wells.

After initial operation of the SVE system in late spring 2008, TCE levels were significantly reduced in both the indoor air and in the soil gas. The SVE has been connected to permanent power supply and has been operating daily since the end of July 2008.

Summary of Investigations and Mitigations

- Initial U.S. EPA Investigation, Behr VOC Plume Site, Public Health Consultation, August 1, 2008.

- Chrysler Corporation, Phase I Area, Vapor Intrusion Investigation and Mitigation, Public Health Consultation, September 30, 2008.

- Two schools in the area were sampled Kiser Elementary School and Van Cleve at McGuffey Road School. Van Cleve at McGuffey Road was the only structure requiring a sub-slab soil gas mitigation system. Vapor mitigation systems were installed; however, indoor air levels remained above the screening level. The Dayton City School Board decided to relocate students to another building outside the area affected by the Behr VOC Plume. The school was closed and eventually demolished in 2011.

- In November 2007 U.S. EPA initiated a U.S. EPA-lead cleanup in the McCook Field Neighborhood where Chrysler stated that they did not intend to conduct vapor intrusion sampling. U.S. EPA sampled 277 out of 336 locations within the McCook Field Neighborhood and installed 149 vapor abatement systems in residential homes (U.S. EPA pol rep #5 10/17/2008). Chrysler sampled 118 out of 156 structures and installed 56 vapor abatement systems (U.S. EPA, On-Scene Coordinator website, Behr VOC Plume Site – Chrysler, Site Profile, May 15, 2009 update). A total of 395 structures were sampled out of 492 and a total of 205 vapor abatement systems were installed.

Community Health Education Activities

HAS staff, in conjunction with the U.S. EPA On-Scene Coordinator and representatives of Public Health of Dayton and Montgomery County (PHDMC), have met on numerous occasions with residents impacted by the site. Several meetings were on a one-on-one basis with residents to discuss sampling results and health concerns related to exposure. HAS staff participated in five U.S. EPA public meetings open to all area residents in February 2007, November 2007, October 2008, September 2009, and July 2010. HAS, U.S. EPA, and PHDMC also met with the local community representatives of the Northeast Priority Board, the Dayton Environmental Advisory Board, the Local School Board, representatives of the Dayton Division of Environmental Management, and the Dayton City Manager. Meeting attendees were provided a short history of the site, an explanation of the vapor intrusion route, the status of the vapor intrusion investigation, and discussion of the toxicology and potential health concerns regarding exposure to TCE, the primary contaminant of concern. HAS provided residents with fact sheets on Exposure to Toxic Chemicals, the Vapor Intrusion Pathway, and the chemicals TCE and 1,2-DCE (See Appendix B).

In response to community members' cancer concerns, HAS requested a community cancer incidence assessment from the ODH Chronic Disease and Behavioral Epidemiology Section (CDBE). Results of the assessment were presented to the area residents in a Northeast Priority Board meeting on August 21, 2008 (ODH 2008). In addition, ODH HAS presented the results of the public health consultation for the site and made their fact sheets available. ATSDR's Division of Health Studies discussed the request for their involvement and information about health statistics and health studies at sites like the Behr site. The HAS and PHDMC helped arrange a physician's education meeting, which was held in August 2008 for local physicians at hospitals in the Dayton area. A second PHDMC/ATSDR/ODH-sponsored public health meeting was held on April 20, 2010 to further discuss residents' health concerns—specifically TCE toxicity and the results of the ODH community cancer assessment. ATSDR's physician Michelle Watters, MD, discussed health effects associated with TCE exposure and ODH's Robert Indian presented the results of the community cancer incidence assessment for the impacted community.

NPL Listing

The Behr Dayton Thermal Systems VOC Plume site was proposed to the U.S. EPA's National Priorities List (NPL or "Superfund") on September 3, 2008 and officially added to the NPL on April 9, 2009. Adding the site to the NPL allows the U.S. EPA to study site conditions further, determine the extent of the contamination, and develop a comprehensive strategy to address the source(s) of the contamination.

DISCUSSION

The primary contaminant of concern for the time-critical removal actions involving this groundwater plume is trichloroethylene (TCE). The chlorinated solvent tetrachloroethylene (PCE or perchloroethylene) has also been found in this plume, however, U.S. EPA's administrative order on consent with Chrysler and Behr for time-critical removal actions focused on TCE concentrations due to the higher concentrations found in the plume and TCE's perceived greater toxicity. With time and distance TCE and PCE eventually chemically break down in groundwater to form other contaminants of concern; vinyl chloride (VC) and 1,2-DCE. Due to the volatile nature of these compounds, the high concentrations found in the shallow groundwater samples, and the shallow depth to the groundwater in the McCook Field Neighborhood, the Behr VOC plume poses a vapor intrusion risk to nearby residents. Limited data is available on the concentrations of PCE, 1,2-DCE, and VC in the plume and soil gas, however, these contaminants, in addition to TCE, will be included as contaminants of concern during U.S. EPA's cleanup of the site.

The levels of TCE in the groundwater appear to be increasing in some of the off-site down-gradient wells, such as monitoring well MW-028S (See Figure 1) which had a TCE concentration of 3,900 ppb in 2006 that increased to 9,600 ppb in 2007.

Based on the contaminant concentrations in homes in the McCook Field Neighborhood, ATSDR and the HAS strongly recommended that the agencies take measures to monitor and reduce or eliminate any TCE exposure as soon as possible.

Exposure Pathways

For the public *to be exposed* to elevated levels of chemical contaminants in and around the Behr Dayton Thermal Systems VOC Plume site they must first come into contact with the contaminated groundwater, surface water, soils, sediment, 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,* which must be present for a chemical exposure to occur. These include:

1. A <u>Source</u> of the toxic chemicals of concern,
2. A method of <u>Environmental Transport</u>, which allows the chemical contaminant to move from its source through and across different media (e.g., soil, air, groundwater, surface water,

sediment),
3. A <u>Point of Exposure</u> where the residents come into direct physical contact with the chemical via a contaminated medium (on-site, off-site),
4. A <u>Route of Exposure</u>, which is how the residents come into physical contact with the chemical (e.g., breathing, drinking, eating, touching), and
5. A <u>Population at Risk</u> which are the people who could possibly come into physical contact with site-related chemicals.

Exposure pathways can also be characterized as to when the exposure occurred or might occur in the *Past, Present, or Future*.

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),
- How often a person is exposed to the chemical (frequency), and
- The toxicity of chemical the person is exposed to (how chemicals can make people sick).

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

- Personal habits,
- Diet,
- Age and sex,
- Current health status, and
- Past exposures to toxic chemicals (occupational, hobbies, etc.).

Site related chemicals of concern found in the groundwater plume under the Behr Dayton Thermal Systems VOC Plume site include TCE and 1,2-DCE.

Groundwater Pathway

The Behr Dayton Thermal Systems VOC Plume site is an area of groundwater contamination with associated vapor intrusion (Figure 1). The residents in the McCook Field Neighborhood obtain water from the Dayton public drinking water supply. In samples collected during the 2007 Site Inspection conducted by Ohio EPA, TCE and other breakdown compounds were detected in two Dayton Miami Well Field public water supply wells. This suggested that contaminants from the site might have migrated to the well field (Ohio EPA 2010). These contaminants were not found in the finished water provided to Dayton residents. Dayton water treatment processes remove these and other contaminants prior to distribution of the finished water. During the drought year of 2007, a groundwater divide developed near Stanley Avenue. Groundwater north of Stanley Avenue flowed to the north-northwest to the Dayton Miami Well Field. Groundwater south of Stanley Avenue flowed southwest towards Deeds Point (at the confluence of the Great Miami River and the Mad River). The position of the groundwater divide changes with water table variations. During times of drought and low water levels, the divide shifts south and the Dayton Miami Well Field captures groundwater from a larger area, which, in the past, included the Behr facility (Ohio EPA 2010).

Vapor Intrusion Pathway

The contaminants of concern, TCE and 1,2-DCE, are both volatile organic compounds (VOCs). Although typically found in the liquid-phase in groundwater, these compounds will readily become a gas on exposure to the air. These vapor-phase contaminants can migrate into the air spaces between soil particles and then into basements of nearby residences (Appendix B Vapor Intrusion fact sheet). Once in the basements, these chemical vapors can be distributed throughout the homes and into the breathing air of residents. Factors that favor this type of transport of these chemicals at the Behr site are 1) the shallow depth to the groundwater, 2) the highly permeable sand and gravel soils in this area, 3) the high concentrations of the contaminants in the shallow aquifer, and 4) the short horizontal distance from the source to the nearest basements. Since the depth to groundwater is shallow, 17 to 25 feet below ground surface at the Behr site, the vertical distance the contaminants will have to travel as a vapor to get into a basement is minimal. The Behr site is located in the Great Miami River valley and soils consist of highly permeable sands and gravel, allowing VOCs to vaporize from the groundwater into the soil gas and to readily migrate as soil gas to areas of lower vapor pressure at ground surface or beneath buildings. Also groundwater plumes with higher concentrations of volatile contaminants will typically generate higher concentrations of vapor-phase contaminants in the air spaces in the soils above the plume. The concentrations of the contaminants in the shallow groundwater at the Behr Dayton Thermal Systems VOC Plume site are high as indicated by the levels found in shallow monitoring wells with TCE levels from 94 to 16,000 ppb (11 out of 15 samples with detections); cis-1,2-DCE levels from 16 to 3,800 ppb (6 out of 15 samples with detections); and VC levels from 3 to 730 ppb (5 out 15 samples with detections) (DaimlerChrysler, 2006). These chemicals are considered sufficiently toxic and sufficiently volatile to pose a threat via the vapor intrusion pathway (U.S. EPA, 2002). Although VC was detected in the groundwater, results for soil gas and sub-slab soil gas did not exceed the screening levels used at the time. In addition, vinyl chloride was not detected in the indoor air. At the Behr site, TCE was detected as high as: 16,000 ppb in groundwater, 160,000 ppb in soil gas, 62,000 ppb in sub-slab soil gas, and 260 ppb in the indoor air (Tables 1–4). This indicated a direct connection between identified concentrations of TCE in groundwater, soil gas, sub-slab soil gas, and indoor air. The vapor intrusion pathway was determined to be complete and pose an unacceptable public health threat to nearby residents (U.S. EPA 2006a; HAS 2008a, 2008b).

Public Health Implications

The primary contaminants of concern at the Behr Dayton Thermal Systems VOC Plume site include trichloroethylene (TCE) and 1,2-dichloroethylene (1,2-DCE).

Trichloroethylene (TCE)

The primary industrial use of trichloroethylene (TCE) 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. These solvents were also added to adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners. When in surface soils, TCE will transform from a liquid to a gas faster than many other VOCs. It has been shown that the majority of the TCE spilled on soils close to the surface will vaporize into the air. When TCE is released into the air, it reacts relatively quickly in the presence of sunlight and oxygen, with about half of it breaking down to simpler compounds in about a week. TCE doesn't stick well to soil particles unless the soils have high organic carbon content. 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 adjacent soil grains. 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 as a gas to the surface and be released to the atmosphere. The primary means of degradation of TCE in groundwater is by bacteria, but a breakdown product by this means is vinyl chloride (VC), another known human carcinogen and likely more of a health concern than TCE (Vogel and McCarty 1985). However, VC was not found to be a health concern at this site.

Non-Cancer Health Effects

In September 2011, the U.S. EPA published a reference concentration (RfC) of 0.4 parts per billion (ppb) for chronic (long-term) inhalation exposure to TCE. The RfC is an EPA estimate, with uncertainty or safety factors built in, of a continuous inhalation exposure to the human population (including sensitive subgroups) that is unlikely to cause noncancerous health effects. The RfC for TCE is based on decreased thymus weight in female mice and increased fetal cardiac malformations in rats, with uncertainty (safety) factors built in. The chronic RfC of 0.4 ppb for TCE derived by EPA has now been adopted as the ATSDR chronic-duration inhalation minimal risk level (MRL) for TCE (ATSDR 2013). The effect level for fetal cardiac malformations, based on a human equivalent concentration (HEC) derived from rat studies, is 4 ppb for three weeks during pregnancy. Since there is such a small uncertainty factor (10) for fetal heart impacts, residential exposure to TCE in indoor air at around three times the RfC (1.2 ppb) becomes a concern for pregnant women. Therefore, breathing indoor air contaminated with TCE could increase the likelihood for noncancer health effects, i.e., fetal cardiac malformations and immunological effects.

> The MRL is an estimate of the daily human exposure to a substance that is not likely to cause noncancerous health effects over a specified duration of exposure.

Previously, HAS used 100 ppb as a short-term action level for non-cancer health effects, based on neurological effects in rats. ATSDR has recently rescinded this intermediate-duration (14 days to 1 year) MRL. Four homes sampled in 2006 and 2007 had indoor air levels of TCE exceeding this level. The highest indoor air level for TCE detected in the Phase I area at the Behr Dayton Thermal Systems VOC Plume site was 260 ppb. Sub-slab vapor abatement systems were installed in all four homes in February 2007. Ten- and 30-day confirmation sampling indicated that levels of TCE in the indoor air in these homes were reduced substantially very soon after installation and initial operation of these vapor abatement systems.

Cancer Risk

The U.S. EPA recently characterized TCE as *"carcinogenic in humans by all routes of exposure."* This conclusion is based on convincing evidence of a causal association between TCE exposure in humans and kidney cancer (U.S. EPA 2011). The International Agency for Research on Cancer (IARC) has recently classified TCE as carcinogenic to humans (Group 1) (Guha 2012). The National Toxicology Program (NTP) determined that TCE is "reasonably anticipated" to be a human carcinogen (NTP 2011).

Occupational exposure to high levels (greater than 100,000 ppb) of TCE in air, based on analyses of seven studies of worker populations, was associated with excess incidence of liver cancer, kidney cancer, non-Hodgkin's lymphoma, prostate cancer, and multiple myeloma in these workers. The strongest evidence for linking cancer in these workers to TCE exposure is for the first three of these cancers (NTP 2011). Agreement between human and animal studies supports the conclusion that TCE exposure may result in the development of kidney cancer. High doses are needed to cause liver toxicity and cancer in lab animals. Differences with regard to how humans and animals process TCE in the liver suggests that humans would be less susceptible to liver cancer from TCE exposures than the lab animals (NAS 2006).

The health effects, including increased cancer risks, from chronic exposure to low levels (single digit ppb range) of TCE in air and/or drinking remain poorly-documented and largely unknown. ATSDR has recently derived a Cancer Risk Evaluation Guide (CREG) of 0.045 ppb for exposure to TCE over a lifetime. CREGs are estimated contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a lifetime. The health effects due to exposure to TCE in air and established health-based guidelines are presented visually in the chart on the next page.

The U.S. EPA recently updated its health risk assessment for trichloroethylene in September 2011 (U.S. EPA 2011). The inhalation unit risk (IUR) was determined to be 4.1 x 10^{-6} per µg/m^3. This implies that about 4 excess cancer cases are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 microgram (µg) of the chemical per cubic meter (m^3) of air. Using this value and site-specific TCE concentrations, cancer risk from exposure to TCE can be estimated. Estimates of excess cancer risk are expressed as a proportion of the population that may be affected by a carcinogen during a lifetime of exposure. For example, an estimated risk of 1 x 10^{-6} predicts the probability of one additional cancer, over background, in a population of 1 million. Cancer risk can be estimated using the equation below:

Cancer Risk = Inhalation Unit Risk x Air Concentration

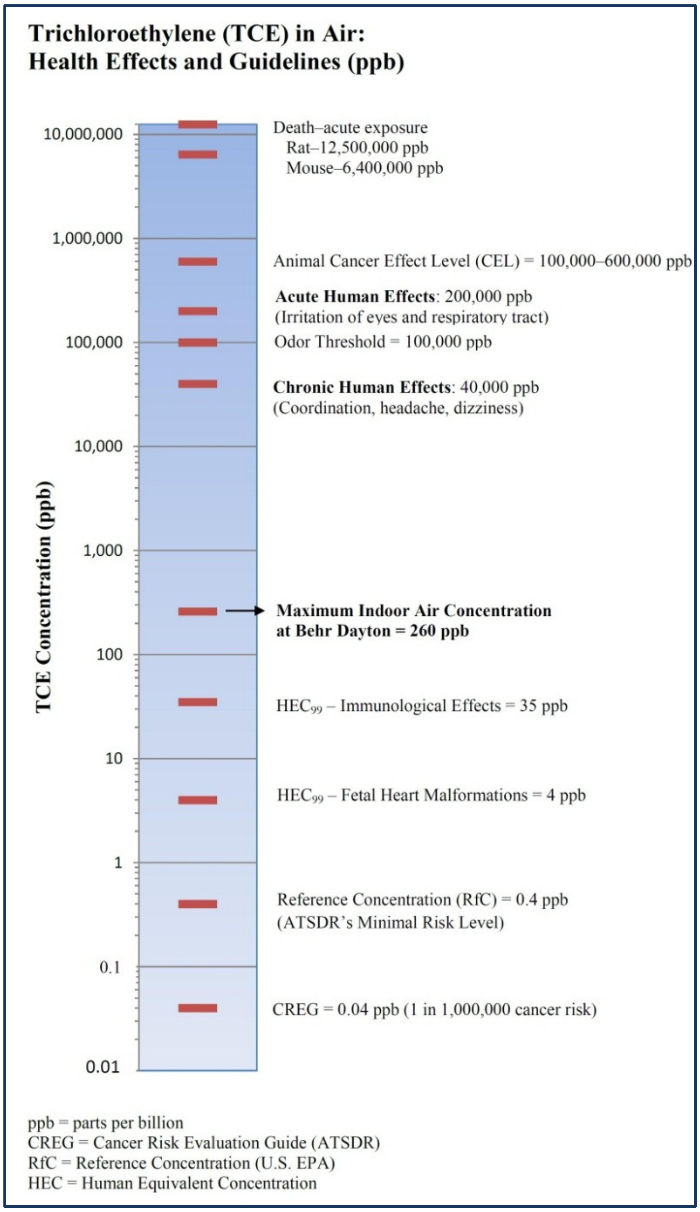
where,

Cancer Risk = estimated cancer risk (unitless)
Inhalation Unit Risk = $(\mu g/m^3)^{-1}$
Air Concentration = $\mu g/m^3$

Using the highest indoor air concentration of TCE (260 ppb or 1,400 µg/m^3) detected in the

Phase I area at the Behr Dayton Thermal Systems VOC Plume site and the IUR (4.1 x 10^{-6} per $\mu g/m^3$) for TCE, the lifetime cancer risk can be estimated as: Cancer risk = 4.1 x $10^{-6}/\mu g/m^3$ x 1,400 $\mu g/m^3$ = 5.7 x 10^{-3}. This represents about 6 possible excess cancer cases in a population of 1,000 over a lifetime of exposure. The actual or true risk is likely to be less because exposure is likely to be intermittent and less than a lifetime (70 years). The estimate of cancer risk calculated above is outside the target cancer risk range of 10^{-4} to 10^{-6} (1 in 10,000 to 1 in 1,000,000) suggested by the U.S. EPA.

Before mitigation, the indoor air concentrations at this site exceeded 0.4 ppb in 174 homes (see Table 5). After mitigation, proficiency air samples were taken to ensure that the residential mitigation systems were achieving a target concentration of 0.4 ppb TCE in indoor air or below. Based on the U.S. EPA's current toxicological review of TCE, an air concentration 0.4 ppb TCE corresponds to a lifetime cancer risk of about 1 x 10^{-5} (1 excess cancer per 100,000).



1,2-Dichloroethylene (DCE)

DCE has been manufactured as a chlorinated solvent, but at the Behr Dayton Thermal Systems VOC Plume site it is believed to result from the breakdown of the solvent TCE by bacteria in the groundwater. There are three different forms of DCE of concern at the Behr Dayton Thermal Systems VOC Plume site; 1,1-DCE, cis-1,2-DCE, and trans-1,2-DCE. TCE breaks down into 1,1-DCE or trans-1,2-DCE forms through minor transformation pathways and these forms are typically found in lower concentrations than the cis-1,2-DCE form. The major portion of the DCE by-product formed in the TCE breakdown is the cis-1,2-DCE form.

Low concentrations of trans-1,2-DCE and 1,1-DCE have been detected in the groundwater, soil gas, and indoor air at Behr Dayton Thermal Systems VOC Plume site. Trans-1,2-DCE is classified as having evidence that it does not cause cancer in humans and 1,1-DCE has been identified as a chemical that has suggestive evidence of carcinogenic potential. Trans-1,2-DCE and 1,1-DCE have not been found at concentrations in the indoor air at the Behr Dayton Thermal Systems VOC Plume site Phase I area that pose a health concern. Screening levels for trans-1,2-DCE and 1,1-DCE were 18 ppb and 50 ppb, respectively (See Table 4).

At the Behr Dayton Thermal Systems VOC Plume site, cis-1,2-DCE was detected at significantly higher concentrations than 1,1-DCE and trans-1,2-DCE. Cis-1,2-DCE is classified as a Class D Carcinogen because there is no data to indicate that this chemical promotes tumor formation in the body (ATSDR 1996). Although there is no human non-cancer exposure data for cis-1,2-DCE, non-cancer health effects are expected to be similar to exposure to trans-1,2-DCE. Exposure to high concentrations of trans-1,2-DCE depresses the central nervous system in humans. Inhalation of 1,700 to 2,220 parts per million (ppm) for 5 minutes or 1,200 ppm for 10 minutes of trans-1,2-DCE have caused nausea, drowsiness, fatigue, vertigo, and intracranial pressure in two human subjects (ATSDR 1996). Slight burning of the eyes was reported by two humans when exposed to 830 and 2,220 ppm trans-1,2-DCE for 30 minutes (ATSDR 1996).

The indoor air concentrations of cis-1,2-DCE in two of eight residences initially investigated at the Behr Dayton Thermal Systems VOC Plume site were above screening levels (Table 4). Sub-slab vapor abatement systems were installed in these two homes in February 2007. TCE was found at higher concentrations in the groundwater, soil gas, sub-slab, and the indoor air than DCE and the screening level for TCE (0.4 ppb) is significantly lower than the screening level for DCE (8.8 ppb). The effectiveness of the mitigation systems has focused on the goal of getting indoor air levels below the more conservative screening level for TCE. Chrysler installed an in-ground SVE system under the Phase I neighborhood in 2008 to try and better address the continuing exposure issues in these homes. This system continues to operate at the site (U.S. EPA Behr Dayton Site Profile 9/12/12).

Child Health Considerations

ATSDR and HAS recognize the unique vulnerabilities of children exposed to environmental contamination and 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. As part of this public health assessment, HAS considered the greater sensitivity of the children who live in the area of the Behr Dayton Thermal Systems VOC Plume site when drawing conclusions and making recommendations regarding health effects from exposure to chemicals related to the Behr Dayton Thermal Systems VOC Plume site.

EVALUATION OF HEALTH OUTCOME DATA

Because the increased risk of cancer that might be expected from exposure to solvents from the Behr Thermal Systems VOC Plume site is moderate and the probability of demonstrating an increased incidence of solvent associated cancer in a population of less than 1,000 people is even lower, it is unlikely any statistically significant increases in cancer would be found in the community due to the small population size.

However, community leaders and residents requested that ODH conduct a "community health study" to determine the impacts of the contamination on the health of area residents. At a public meeting in November 2007, HAS pointed out the difficulties of conducting such a study and producing meaningful results. HAS agreed to forward a request from the community to the ODH Chronic Disease & Behavioral Epidemiology Section (CDBE) and to ATSDR's Division of Health Studies in Atlanta, Ga.

At a public meeting in August 2008, ATSDR's Division of Health Studies described the limitations and difficulties associated with conducting health studies of communities exposed to low (part per billion) levels of short-lived chemicals like TCE and other chlorinated solvents. These included a lack of unique symptoms characteristic of TCE exposure, rapid elimination of these chemicals and their metabolites from the body, and minimal evidence of any kind of adverse health impacts at these low levels of exposure.

At that meeting, the ODH CDBE presented to the community the results of their community cancer incidence assessment for Census Tract 17, which nearly exactly matches the defined site-impacted community (ODH 2008). Total cancers for the community for the period 1996-2005 were significantly higher than expected, primarily on the basis of higher than expected cases of lung cancer and cancer of the larynx. The three cancers linked to TCE exposure were limited in number, with liver and non-Hodgkins Lymphoma above the expected rate but not significantly above expected, and a kidney cancer rate below the expected. Tobacco use was described as a likely risk factor for the excess lung and larynx cancer cases, with 18/20 lung cancers and 2/4 larynx cancers describing themselves as current or past smokers or users of smokeless tobacco.

COMMUNITY HEALTH CONCERNS

Following a community meeting in April 2010, ATSDR, ODH, and PHD&MC responded to community health concerns. Some of the answers given at the time have been updated (in italics) based on revised toxicological and other information regarding trichloroethylene.

1. **Can the cancer assessment be extended through 2007 or 2008? Can the data be updated every two years?**

   Yes, but the request needs to come from Public Health – Dayton & Montgomery County. There is typically a two-year lag time for a reporting year to be evaluated for completeness and quality assurance. The request will be reviewed by our Community Cancer Assessment Work Group and a response prepared back to Public Health. Questions to keep in mind are: (a) "Will additional years of analysis change the conclusions?"; (b) "Will additional years of analysis change the need for clean-up?"; and, (c) "How will the analysis contribute to improved cancer prevention and control for this community?"

   For information on recommended cancer screening guidelines from the American Cancer Society, please click on the following link: http://www.cancer.org/Healthy/FindCancerEarly/CancerScreeningGuidelines/american-cancer-society-guidelines-for-the-early-detection-of-cancer

2. **What would it take for any illnesses or diseases (including cancer) to be associated to the exposure to TCE?**

   Exposure to TCE could cause illness or disease if a person comes in contact with high enough doses. Getting sick from contact with TCE will depend on how much you were exposed to (dose), how long you were exposed (duration), how often you were exposed (frequency) and the general health, age and lifestyle of the individual. Based on studies of occupational exposure to TCE, we would not expect to see illness and disease caused by exposure to TCE at the levels detected in neighborhood homes as part of the US EPA vapor intrusion investigation at the Behr Dayton site.

   ATSDR currently regards 0.4 ppb in air as a minimal risk level (MRL) for TCE. Harmful noncancer health effects are not expected at this level. However, concentrations that are just ten times above this level may have potential noncancer health effects, such as fetal heart malformations, which would be a concern for pregnant women. Based on the EPA's revised toxicological review published in September 2011, an indoor air concentration of 0.4 ppb also represents one possible excess cancer case in a population of 100,000. A concentration of 4 ppb in air represents an estimated excess cancer risk of 1 in 10,000. This level is at the upper end of EPA's target cancer risk range (1 in 10,000 to 1 in 1,000,000).

3. **Statistically, how many cases of Hodgkin's Lymphoma, and liver and bile duct cancer are required for those types of cancers to be considered "significantly higher" than expected?**

   Keep in mind that when we use the term "statistically significant" we are talking about some level of probability. By convention we used a probability of 0.05 or five times out of a hundred in the analyses for the community in the vicinity of the Behr site. We know that chance is always a factor in who develops a type of cancer and where that person resides at diagnosis. What we essentially are asking is if this number of cases could have happened by chance alone less than five times out of a hundred (statistically significant at $p < 0.05$) or five or more times out of a hundred (not statistically significant at $p < 0.05$). To discuss the role of chance without discussing the level of probability is meaningless. Anything can always happen (or not happen) by chance. We need to address the issue of probability, i.e. likelihood that this event happened by chance alone.

- Based on the national background age-specific incidence rates of Hodgkin's Lymphoma and the age-specific demographics of the population in Census Tract 17, we would expect to see 0.50 cases of Hodgkin's Lymphoma. This is what the arithmetic tells us. Obviously you are never going to see a fraction of a case; you are going to see whole persons with this disease. However, if you follow the logic of the arithmetic you expect 0.5 and we observe 2 cases. This comes out to a ratio of 4 (2/0.5=4.0). Keep in mind that if we observed exactly what we would expect the ratio would be 1.0. Therefore we need to subtract 1.0 from the ratio, i.e. 4.0-1.0=3.0. This indicates that based on the arithmetic, we are seeing 3.0 times or 300% more cases than what would be expected. However, as noted above you never really expect to see a fraction of a case, so on a practical basis we would expect to see one and we have two. This ratio is not quite so dramatic, i.e. 2/1=2.0. Subtracting 1 leaves us 1.0 or 100% more than what we would expect. To test whether or not this observation could have happened by chance alone less than five times out of a hundred, we put 95% confidence interval on the ratio. Hopefully, this 95 times out of 100 now sounds familiar. If the 95% confidence intervals include one then this observation could have happened five or more times out of a hundred and we consider the ratio not statistically significant. If the 95% confidence interval does not include one then the observed number of cases compared to the expected number, is statistically significant at $p<0.05$, i.e. could have happened by chance alone less than five times out of 100. How many observed cases of Hodgkin's Disease would it take to be statistically significant at $p<0.05$? It would take 3 observed cases with 0.5 expected to be considered statistically significant at $p<0.05$: 3/0.5 = 6.0, 95% confidence intervals of 1.24-17.54. Please note the difficulty of working with fractions of expected cases. The relatively small numbers make explanation and understanding much more difficult.

- Again, based on national background age-specific incidence rates of Liver and Intrahepatic Bile Duct cancer we would expect to see (here we go with small number arithmetic again) 0.78 cases in the Census Tract 17 population. We observe three cases and the ratio is 3/0.78 or 3.85. Remember we need to subtract 1.0 (see above) to interpret the ratio, so we have 3.85–1.0=2.85 or we are seeing 285% more than what we would expect to see. Could this have happened by chance alone five or more times out of a hundred? The 95% confidence intervals on the ratio of 3.85 are 0.79 to 11.26. Since the 95% confidence intervals include 1.0 we conclude that "yes", this could have happened by chance alone five or more times out of a hundred. How many cases would it take to have the number of observed cases significantly higher than expected to be considered statistically significant at $p<0.05$? It would take four cases with 0.78 expected to be considered statistically significant at $p<0.05$: 4/0.78=5.13, 95% confidence interval of 1.40-13.12. Thus, this could have happened by chance alone less than five times out of a hundred. Again, please note the difficulty in dealing with fractions of cases.

4. **Why won't there be any other type of health studies?**

Taking into account the U.S. EPA sampling results detected low levels of the site-related chemicals in sub-slab and indoor air, ATSDR medical experts suggest biologic testing of residents (blood, hair, fluids, etc.) would not provide useful medical information and a health study would not be warranted or recommended. However, it is important to note that besides the traditional health study involving the collection of biological samples and surveys, other types of health activities and interventions that can be conducted have already been conducted for this Behr Dayton community, including ODH's *Cancer Incidence among Residents of Census Tract 17, Dayton, Montgomery County, Ohio, 1996-2005.*

5. **Can the local outreach programs be revisited or expanded?**

Public Health–Dayton and Montgomery County (PHDMC) can absolutely revisit local outreach if there is an identified need or specific request to conduct additional educational efforts. We would like to point out that PHDMC and the U.S. EPA have sponsored multiple one-on-one private meetings with area residents to inform them about the site contamination issues, the U.S. EPA investigation efforts, and individual resident sampling results. The U.S. EPA has sponsored multiple public meetings to inform and educate the community (02/08/07, 11/15/07, 10/08/08, 09/01/09, and 07/27/10). The City of Dayton Public Schools also sponsored a community meeting to discuss the contamination found in the Van Cleve/McGuffey School (08/02/07) and to educate and inform the parents, children and staff who attended the school. PHDMC has hosted two public health meetings to discuss specific health-related issues and to answer community questions (08/21/08 and 04/20/10). In August 2008, PHDMC and ATSDR initiated a medical provider outreach program in an effort to heighten local awareness of the issues related to potential chemical exposures from the Behr Dayton site. Also keep in mind that the U.S. EPA established a Command Center in the neighborhood (on Keowee Street) in 2007, where the community was invited to come into the office and ask questions about the site contamination or current site investigation activities.

6. **How much information is available about non-cancerous illnesses, diseases, or symptoms related to exposure to TCE vapors? Can all of these potential issues be shared in writing?**

The human health effects from long-term exposures to low levels of TCE are poorly documented and largely unknown. The purpose of the U.S. EPA investigation was to determine if the vapors from the contamination were impacting the sub-slab (the space under the basement or concrete slab) and the indoor air at levels that might pose a public health threat and to mitigate or eliminate exposures above health-based screening levels.

Chronic (long term) exposures to much higher levels of TCE in indoor air in occupational (worker) studies are associated with a variety of non-cancer health effects. These include reversible central nervous system (CNS) impacts, kidney and liver abnormalities, as well as higher incidence cancers of kidney, liver, and Hodgkin's Lymphoma.

In September 2011, the U.S. EPA listed noncancer critical effects including immunotoxicity and fetal cardiac malformations in deriving its revised reference concentration (RfC) for chronic inhalation exposure to TCE. The effect level for immunological effects, based on a *human equivalent concentration (HEC) derived from mice studies, is 35 ppb. The effect level for fetal cardiac malformations, based on a HEC derived from rat studies, is 4 ppb for three weeks during pregnancy. At 4 ppb TCE in air, a 1% response rate is expected for fetal heart malformations in humans. See U.S. EPA's Recent Final Assessment, along with the Toxicological Review of Trichloroethylene (Sept 2011), available on EPA's Integrated Risk Information System (IRIS) at: http://www.epa.gov/iris/.*

ATSDR has adopted 0.4 ppb as a chronic-duration inhalation minimal risk level (MRL) for TCE (ATSDR 2013). TCE concentrations in indoor air at this level or even several times above 0.4 ppb would not be expected to cause any harmful noncancer health effects.
To view the full ATSDR TCE ToxProfile *and the Addendum to the Profile*, visit the following ATSDR address at: http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=173&tid=30.

To view the ODH TCE fact sheet created for the lay general audience, visit the following Web address: http://www.odh.ohio.gov/~/media/ODH/ASSETS/Files/eh/HAS/tce.ashx.

7. **Could a nerve tumor (Schwannoma) be caused by exposure to TCE vapors?**
A schwannoma is a tumor formed from cells that develop from a Schwann cell. Schwann cells are support cells for the peripheral nerves. They provide a protective sheath for the nerves. A Schwann cell tumor can be either benign or malignant (cancerous). While schwannomas are most often found on cranial nerves in the head, they may also occur on any nerve in the body. Malignant schwannomas in peripheral nerves are rare and fall under a larger category of tumors called soft tissue sarcomas. Trichloroethylene (TCE) has not been associated with the development of schwannomas or soft tissue sarcomas. While the causes of schwannoma are not known, the risk factors include ages between 30 and 60, previous radiotherapy for cancer treatment, and some rare genetic conditions.

8. **Is there a formal recommendation (ATSDR, USEPA or other organization) to lower the indoor air action level for installation of a vapor abatement system?**

No. *In September 2011, the U.S EPA published a reference concentration (RfC) of 0.4 ppb for chronic (long-term) inhalation exposure to TCE for noncancer effects. ODH is currently recommending 0.4 ppb TCE as an indoor air screening level, which is the same as previously used at the Behr Dayton site.*

9. **How does the 0.4 ppb indoor air action level for installation of a vapor abatement system relate to the possible incidence of cancer? What about lower levels that may exist now, say 0.16 ppb?**

Based on the EPA's revised toxicological review published in September 2011, an indoor air concentration of 0.4 ppb represents a 1×10^{-5} *cancer risk for a lifetime (70 years) of exposure. An estimated cancer risk of* 1×10^{-5} *represents a possible one excess cancer case in a population of 100,000.*

Ambient air background levels of TCE in most urban areas likely exceed the 0.16 ppb level cited. *EPA's study on background indoor air in residences (June 2011) found TCE concentrations as high as 0.1–0.6 ppb* (95^{th} *percentile) in homes not affected by vapor* *intrusion. Some laboratory analyses may not be sensitive enough to detect down to 0.16 ppb with any kind of accuracy.*

10. **How are levels and lengths of exposure considered when the potential for incidences of illnesses of diseases are determined? For example, how would the home that had an indoor air reading of 260 ppb be considered?**

    To be conservative and protective of public health, the risk for developing cancer assumes a person is exposed to a chemical 24 hours per day, 7 days a week, for 350 days per year, over a period of 30 years. Due to the fact that a majority of individuals do not live in one spot and/or leave their residence on occasion, it is unlikely the 24-7-350 days for 30 years is a likely scenario for <u>most</u> people.

    The spilled chemicals near the Behr Dayton site may have been impacting the neighborhood for a longer period of time than the U.S. EPA investigation has been taking place. However, there is no data available for public health officials to evaluate and determine if levels in the past may have posed a health threat.

    The detection of TCE in indoor air at 260 ppb exceeded the short-term "action level" of 100 ppb for TCE established by the HAS. Exceeding this level required that action be taken as soon as possible to reduce exposure levels, either through improved ventilation, installation of a sub-slab depressurization unit or some other action that would reduce exposure until the source of the contamination can be identified and removed. At the Behr Dayton site, this was accomplished by the installation and operation of a sub-slab vapor abatement system in this particular home.

11. **What are the chances of cancer if TCE were in the drinking water? I found out the U.S. Marine Corps accidently gave us THFS to drink instead of regular drinking water. This happened in the 60's and I found out about 1.5 years ago. I have some things that worry me but not cancer at this time that I know of, but then again I have never been tested for cancer.**

    Getting cancer by breathing TCE through the vapor intrusion route or by ingesting it through contaminated drinking water will depend on the <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), and the <u>general health, age and lifestyle</u> of the individual. It is important to note that the residents of the McCook Field Neighborhood are not drinking TCE-contaminated water and the Dayton's public water supply is safe.

12. **Has it been determined if there is a danger for garden vegetables? Is eating vegetables grown in my back yard dangerous to my health?**

    The chemical TCE is in a class of chemicals called volatile organic compounds (VOC's). Fruits and vegetables grown in VOC-contaminated soils do not absorb (uptake) these type chemicals through their root system or leaves. Therefore, the site-related chemical contamination identified at the Behr Dayton site does not pose a problem for the residents living near the site who grow and eat vegetables from their gardens.

13. **Can someone supply specific health risk information for this community?**

The assessments of cancer in Census Tract 17 and Census Tract 40 were conducted to determine if the burden of cancer among residents is higher than what is expected for the non exposed communities and what types of cancer should be addressed in cancer prevention, early detection, and control programs. Both neighboring census tracks and state and national cancer data were used as comparison areas. *This public health assessment, prepared by the ODH under a cooperative agreement with ATSDR, provides site-specific health risk information, including fact sheets for the chemicals of concern, for this community.*

14. **Any preventative recommendations?**

The installation and maintenance of vapor mitigation systems in homes and businesses in the Behr Dayton community is a temporary but currently effective solution to a long-term problem. The source of problem is the TCE-contaminated groundwater and the vapors coming off that water and making their way into residential structures. The long-term solution to this problem will require actions to identify the source of the contaminants and remove them from the groundwater. The U.S. EPA Superfund Program is initiating an investigation to identify the source(s) of the groundwater contamination as a part of their Superfund activities. This investigation and the likely follow-up clean-up action will not be completed quickly, but will occur over time.

Living a healthy lifestyle is always recommended as a preventative health measure. Cigarette smoking is a major risk factor for both of the significant cancers found in the Behr Dayton community (lung and bronchus; larynx), and at least 90% of the lung cases and 50% of the larynx cases were self-reported from current or former tobacco users. As a cancer prevention strategy, we strongly encourage you to quit smoking, eat a sensible diet, increase your physical activity and follow the cancer screening guidelines.

15. **Are there any long-term health studies for low level long-term exposure? Other than cancer, what about headaches? Birth defects?**

The human health effects from low-level long-term exposures to TCE are largely unknown. Occupational (worker) studies of exposures to higher levels of TCE indicate that exposures may lead to an increased risk of developing certain cancers. Breathing high levels of TCE may cause headaches, but we would not expect to see headaches based upon the low levels of the site-related chemicals detected in the U.S. EPA sampling completed in the area to date.

Note that there are no documented relationships between inhalation exposure to TCE and miscarriage (birth defects) in the scientific literature. In contrast, it is well documented that miscarriages are associated with prenatal exposure to cigarette smoke. It is important to note that while some epidemiological studies have shown prenatal exposure to TCE in drinking water may increase the risk of miscarriage, other studies show no increased risk. Either way, exposure to TCE in drinking water is not currently a completed exposure pathway for the Behr Dayton community. *In September 2011, the U.S. EPA revised its toxicological review of TCE that included possible health effects from inhalation exposure to TCE. Animal studies* *indicate noncancer health effects from exposure to TCE that include immunological effects and fetal heart malformations.*

16. **Is there any free medical monitoring available to people who live in area?**

    If a resident in the Behr Dayton community believes they have a health problem or a medical condition, they should discuss their health problems with their family doctor or a qualified medical professional so he/she can properly diagnose and treat their illness. If someone does not have a primary care physician or a medical home, they are encouraged to contact one of the clinics operated by Community Health Centers of Greater Dayton (East Dayton Health Center, Corwin Nixon Health Center, or the Drew Health Center) for an appointment.

    It is important to note that ODH and ATSDR do not recommend "medical monitoring" for exposure to low levels of TCE found at the Behr Dayton site. The tests available are not helpful detecting low-levels of these chemicals in your body and the data provided from U.S. EPA's sampling indicate only low-level detections of these chemicals in area homes. Since these chemicals quickly break down and are not stored by the body, only recent high-dose exposures would likely result in detects.

CONCLUSIONS

1. HAS concluded that before vapor abatement systems were installed, breathing indoor air contaminated with TCE above the established long-term screening levels for this site over the course of a lifetime could harm people's health. This was considered to be a public health hazard for homes in the McCook Field Neighborhood south of the Behr Dayton Thermal facility. Breathing indoor air contaminated with TCE could increase the likelihood of harmful noncancer health effects and the development of certain types of cancer. Installation of the vapor abatement systems has lowered the concentrations of contaminants to levels that are not expected to cause adverse health effects upon exposure. These individual vapor abatement systems, however, are an interim action to mitigate or prevent current exposures and not a long-term cleanup solution for this site.

2. HAS concluded that before vapor abatement systems were installed, breathing indoor air contaminated with TCE for longer than two weeks but less than a year at four homes in the McCook Field Neighborhood south of the Behr Dayton Thermal Products facility could harm people's health. This was a public health hazard. Indoor air data showed levels of TCE that could harm residents who breathed the indoor air. Recent information from the U.S. EPA indicates potential noncancer health effects may include immunological effects and fetal heart malformations from chronic exposure to TCE. Installation of the vapor abatement systems has lowered the concentrations of contaminants to levels that are not expected to result in any adverse health effects.

3. Using water from the Dayton well-field currently is not expected to harm people's health. The drinking water monitoring program for the Dayton public water supplies indicates that no site-related contaminants have been found at levels of concern in their drinking water supply. However, during times of low groundwater elevation, such as during a drought, the contaminated groundwater from beneath the Behr Dayton Thermal Products facility could

possibly be drawn toward the municipal supply wells. The Dayton well field is already equipped with sophisticated treatment systems to treat water in the case of a drinking water contamination event. The City of Dayton continues to monitor the well water from their wells north of the Behr Dayton facility for site related chemicals of concern.

RECOMMENDATIONS

1. HAS recommends that the nature and extent of the groundwater contamination need to be more fully investigated. Details of groundwater flow direction and investigation of possible additional sources of contamination are areas that need further investigation. Dayton's well-field, one mile to the north, has a cone of influence very close to the northern edge of the Behr facility. Vigilant monitoring of the groundwater in this area is recommended to ensure that contaminants are not entering Dayton's water supply.

2. Sources of groundwater contamination need to be fully identified and actions should be taken to isolate and contain or remove this contamination to reduce levels of TCE in area groundwater.

3. HAS recommends that the installed vapor abatement systems be monitored at regular intervals to ensure that these systems continue to remove vapor-phase chemicals before they can enter the breathing air of residents and workers in the McCook Field Neighborhood.

4. Due to the number of mitigation systems installed in the neighborhood and the concentrations of contaminants expelled by these systems, the ambient air should be monitored to ensure that the ambient outdoor air is not at concentrations that pose a health concern.

PUBLIC HEALTH ACTION PLAN

Completed Actions

Chrysler initiated Voluntary Action Plan (VAP) cleanup on-site in 2002.

Chrysler notified Ohio EPA of contaminant plume migrating off-site in 2002.

Chrysler installed and began operation of an on-site SVE system in 2003.

Chrysler updated Ohio EPA of contaminant plume migration and the elevated levels found off-site. Staff at Ohio EPA became concerned with vapor intrusion potential in 2006. Ohio EPA decided to sample deep soil gas. The deep soil gas concentrations were above screening levels and they requested the assistance of U.S. EPA.

HAS and ATSDR provided screening levels for contaminants for indoor air and sub-slab soil gas for residential and commercial buildings in response to the U.S. EPA On-Scene Coordinator's request in 2006.

In December 2006, an Administrative Order on Consent (AOC) was establish requiring Chrysler to determine the extent of the contamination and mitigate homes determined to be contaminated via the vapor intrusion pathway.

U.S. EPA and Chrysler sampled indoor air and sub-slab soil gas. At locations where screening levels were exceeded they installed vapor abatement systems in 2007 and 2008. See Table 5 for a summary of the work performed.

A Community Cancer Assessment from ODH's Chronic Disease and Behavioral Epidemiology Section for the affected McCook Field Neighborhood south of the Behr facility was completed and presented at a public meeting on August 21, 2008.

Actions at this site are currently being pursued under U.S. EPA Remedial authorization to identify and remediate environmental impacts on air, land, and water and evaluate threats to public health in the north Dayton area. Chrysler LLC filed for bankruptcy in 2009 and walked away from the site. Behr-Dayton Thermal Systems assumed responsibility for maintaining the installed home vapor abatement systems and the off-site soil vapor extraction system.

HAS and ATSDR participated in numerous U.S EPA and Public Health–Dayton and Montgomery County public meetings. HAS discussed health concerns associated with the site and provided health education materials to residents.

As of January 2013, 228 properties have had a vapor abatement system installed (including those installed by U.S. EPA, Chrysler, and Behr), 6 properties need a mitigation system (install pending), and 13 properties have not allowed the installations (denied a mitigation system).

Ongoing Actions

Under the conditions of a U.S EPA unilateral order, Behr will continue the sub-slab and indoor air sampling and installation and maintenance of vapor abatement systems in the McCook Field Neighborhood.

Planned Actions

The U.S. EPA Superfund Program Remedial Investigation/Feasibility (RI/FS) Study began August 2008. EPA is currently continuing the RI/FS phase. The RI/FS will determine the nature and extent of site contamination and will identify and evaluate options to clean up the site contamination.

HAS will evaluate additional sub-slab soil gas and/or indoor air and ambient air data as it becomes available.

REPORT PREPARATION

This Public Health Assessment for the Behr Dayton Thermal Systems VOC Plume site was prepared by the Ohio Department of Health under a cooperative agreement with the federal

Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved agency methods, policies, and procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented.

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TABLES

Table 1. Initial Groundwater Monitoring Data, 2003 through 2006

Volatile Organic Compound	*MCL (µg/L)*	*OSWER (µg/L)*	*MW024S*	*MW025S*	*MW027S*	*MW028S*	*MW029S*	*MW030S*	*MW031S*
Sample Date			3/7/2006	3/7/2006	3/7/2006	3/9/2006	11/18/2003	3/8/2006	3/9/2006
1,1,1-Trichloroethane	200	3,100	0.8U	0.8U	0.8U	46	16U	0.8U	0.8U
1,1-Dichloroethylene	7	190	0.8U	0.8U	0.8U	4J	16U	0.8U	0.8U
Cis-1,2-Dichloroethylene	70	210	0.8U	1J	0.8U	94	3,800	0.8U	0.8U
Tetrachloroethylene	5	110	0.8U	1J	0.8U	4U	16U	0.8U	0.8U
Trans-1,2-Dichloroethylene	100	180	0.8U	0.8U	0.8U	4U	29J	0.8U	0.8U
Trichloroethylene	5	5	1U	16	1U	3,900	16,000	1U	1U
Vinyl Chloride	2	2	1U	1U	1U	5U	730	1U	1U

Volatile Organic Compound	*MCL (µg/L)*	*OSWER (µg/L)*	*MW032S*	*MW033S*	*MW034S*	*MW035S*	*MW036S*	*MW037S*	*MW038S*	*MW039S*
Sample Date			11/14/2003	3/9/2006	11/17/2003	11/15/2003	11/16/2003	3/8/2006	3/9/2006	11/9/2005
1,1,1-Trichloroethane	200	3,100	6	18J	0.8U	9	2J	3J	12J	6
1,1-Dichloroethylene	7	190	0.8U	4J	0.8U	0.8U	0.8U	0.8U	4U	6
Cis-1,2-Dichloroethylene	70	210	7	690	16	62	120	3J	810	190
Tetrachloroethylene	5	110	0.9J	4U	1J	3J	0.8U	2J	4U	0.8U
Trans-1,2-Dichloroethylene	100	180	0.8U	19J	0.9J	5J	3J	0.8U	19J	10
Trichloroethylene	5	5	250	3,800	220	220	720	120	3,900	310
Vinyl Chloride	2	2	1U	36	10	1U	1U	1U	18J	3J

µg/L – micrograms per liter

MCL – maximum contaminant level (U.S. EPA)

J – The associated value is an estimated quantity.

U – The analyte was analyzed for, but was not detected. The associated value is a sample quantitation limit.

OSWER – Action levels were derived from the U.S. EPA Draft Vapor Intrusion Guidance Document, 2002, based on target groundwater concentrations at the 10^{-4} risk level

Color	Meaning
(light blue)	Samples collected in 2006
(yellow)	Concentration exceeds MCL
(pink)	Concentration exceeds MCL and OSWER guidance levels
(orange)	Sample quantitation limit is above the MCL

Table 2. Initial Ohio EPA Soil Gas Data, October 2006

Volatile Organic Compound	*OSWER Screening Level*	*SG-01*	*SG-02*	*SG-03*	*SG-04*	*SG-05*	*SG-06*	*SG-07*
1,1,1-Trichloroethane	4,000	640	140*	1,300	1,500	160*	310	220
1,1-Dichloroethylene	500	300*	330*	1,200	780	10	12	ND
Cis-1,2-Dichloroethylene	88	10,000	11,000	5,400	4,800	410	1,200	400*
Tetrachloroethylene	120	33*	5	9	8	2	8	6
Trans-1,2-Dichloroethylene	180	770	390*	460*	210*	23	59*	34*
Trichloroethylene	4.1	120,000	70,000	160,000	140,000	13,000	16,000	12,000
Vinyl Chloride	110	92*	86*	45*	9	ND	2	ND

Results are in ppb – parts per billion

* – Value exceeds calibration range

ND – Indicates not detected at or above the EQL (estimated quantitation limit) value

Concentration exceeds OSWER's soil gas value

Table 3. Initial U.S. EPA Sub-Slab Soil Gas Data, Oct./Nov. 2006

Volatile Organic Compound	*Screening Level (ppb)*	*Action Level (ppb)*	*EPA-01*	*EPA-02*	*EPA-03*	*EPA-04*	*EPA-05*	*EPA-06*	*EPA-07*	*EPA-08*
1,1,1-Trichloroethane	4,000	7,000	11	260	140	17	140	39	25	900
1,1-Dichloroethylene	500	NA	4	52	45	ND	170	ND	ND	540
Cis-1,2-Dichloroethylene	88	2,000	57	3,100	2,900	2	7,900	170	ND	4,200
Tetrachloroethylene	120	2,000	ND	37	30	5	23	2.1	0.85	3.8
Trans-1,2-Dichloroethylene	180	2,000	3	130	130	ND	340	13	0.19	230
Trichloroethylene	4	1,000	980	18,000	16,000	260	62,000	3,700	49	62,000
Vinyl Chloride	110	300	ND	10	14	ND	79	ND	ND	6.7

Results are in ppb – parts per billion

ND – Indicates not detected at method detection limits

[Yellow] Concentration exceeds OSWER's Sub-Slab soil gas Screening Level were derived from the U.S. EPA Draft Vapor Intrusion Guidance Document, 2002, based on target indoor air concentration at the 10^{-4} risk level.

[Pink] Concentration exceeds HAS Short-term Sub-Slab soil gas Action Level, derived from the ATSDR Intermediate Environmental Media Evaluation Guide for air.

Table 4. Initial U.S. EPA Indoor Air Data, Oct./Nov. 2006

Volatile Organic Compound	*Screening Level[1] (ppb)*	*Action Level[2] (ppb)*	*EPA-01*	*EPA-02*	*EPA-03*	*EPA-04*	*EPA-05*	*EPA-06*	*EPA-07*	*EPA-08*
1,1,1-Trichloroethane	400	700	ND	1.4	0.99	0.5	1	4.9	ND	0.89
1,1-Dichloroethylene	50	NA								
Cis-1,2-Dichloroethylene	8.8	200	ND	11	8.3	0.19	20	0.21	ND	1.9
Tetrachloroethylene	12	200	ND	0.2	0.13	0.24	0.13	0.12	ND	0.17
Trans-1,2-Dichloroethylene	18	200	ND	0.5	0.34	ND	0.97	ND	ND	ND
Trichloroethylene	0.4	100	1.9	180	130	13	260	7.5	0.4	49
Vinyl Chloride	11	30	ND	ND	ND	ND	ND	ND	ND	ND

Results are in ppb – parts per billion
ND – Indicates not detected at method detection limits.

[Yellow] Concentration exceeds OSWER's Indoor Air Screening Level - derived from the U.S. EPA Draft Vapor Intrusion Guidance Document, 2002, based on target indoor air concentration at the 10^{-4} risk level.

[Pink] Concentration exceeds HAS's Short-term Indoor Air Action Level - derived from the ATSDR Intermediate Environmental Media Evaluation Guide (EMEG) for air.

[1] The screening levels listed were derived at the time this data was collected in 2006. Based on more recent toxicological information, the values for some chemicals have changed. At present, current values for tetrachloroethylene and vinyl chloride, for example, are lower than those listed; however, the sample results are still below the newer screening levels for these compounds.

[2] Action levels denoted levels that would trigger immediate action to reduce exposure and were based on ATSDR EMEGs in 2006. ATSDR's intermediate EMEG of 100 ppb for trichloroethylene in air was recently rescinded. The current EMEG is 0.4 ppb (rounded to one significant figure).

Table 5. Behr VOC Plume Vapor Intrusion Testing and Mitigation Summary, 2009

Mitigation Properties	*U.S. EPA*	*Chrysler*	*Total*
Total residences/commercial structures	336	156	492
Total properties tested	277	118	395
Properties that exceeded indoor air screening level (SL)	118	56	174
Properties exceeding SL that accepted mitigation	116	56	172
Properties that exceeded sub-slab screening level (SL)	46	7	53
Properties exceeding SL that accepted mitigation	33		33
Properties that denied access or were unresponsive	59	38	97
Properties that refused access	14		14
Properties that required no further action	91	55	146
Total vapor mitigation systems	**149**	**56**	**205**

FIGURES

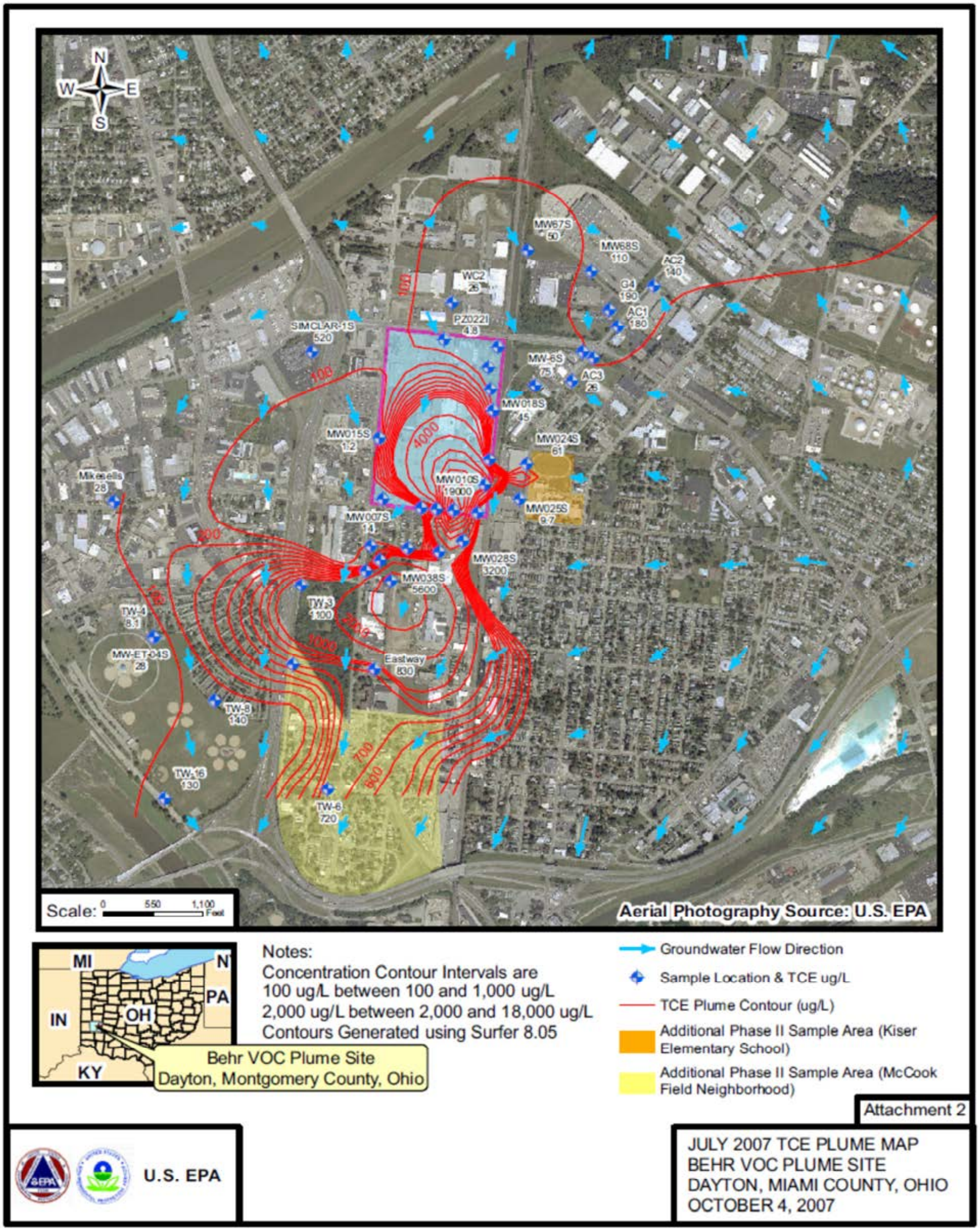

Figure 1. TCE Plume Map. Behr VOC Plume Site

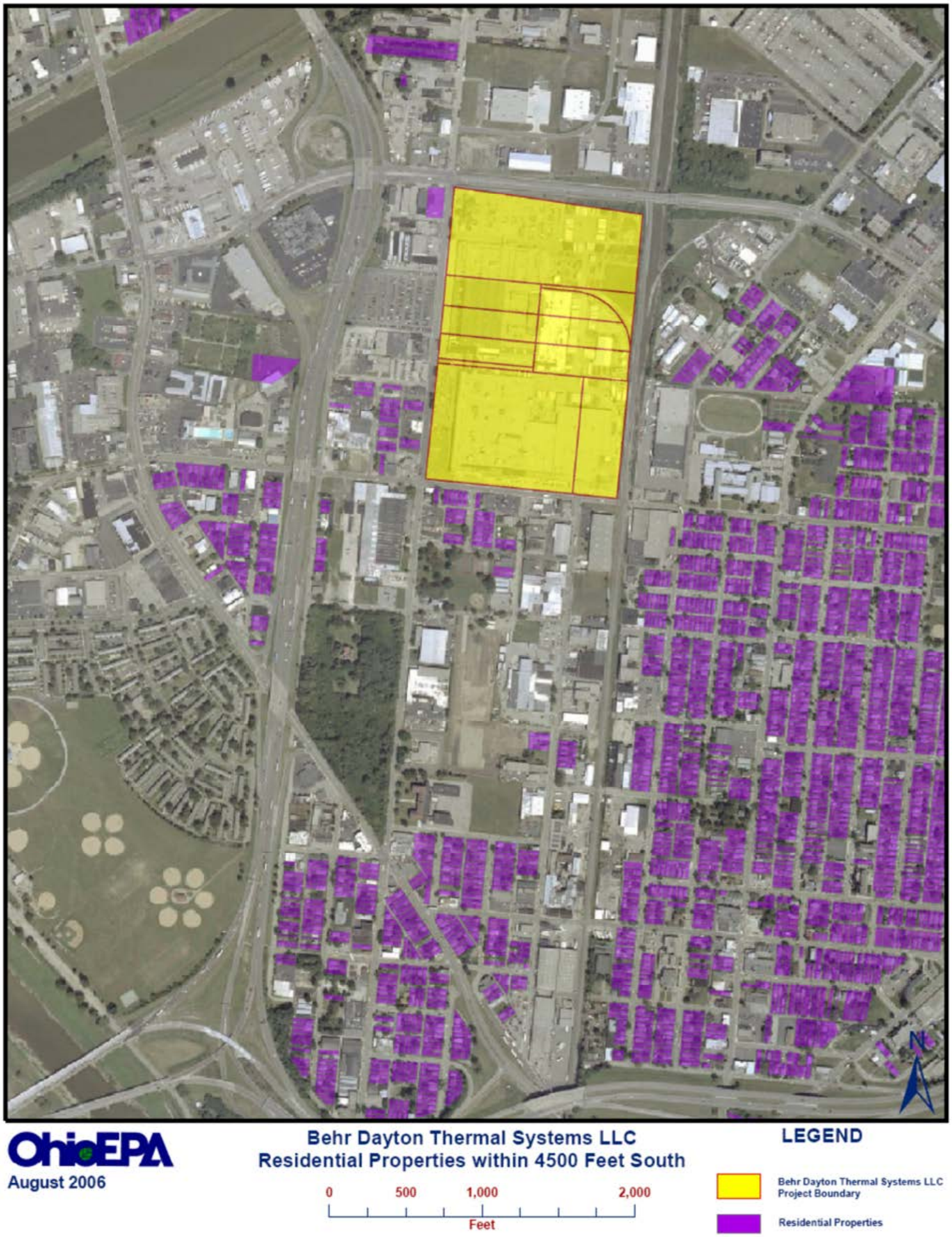

Figure 2. Residential Properties South of the Behr Dayton Facility

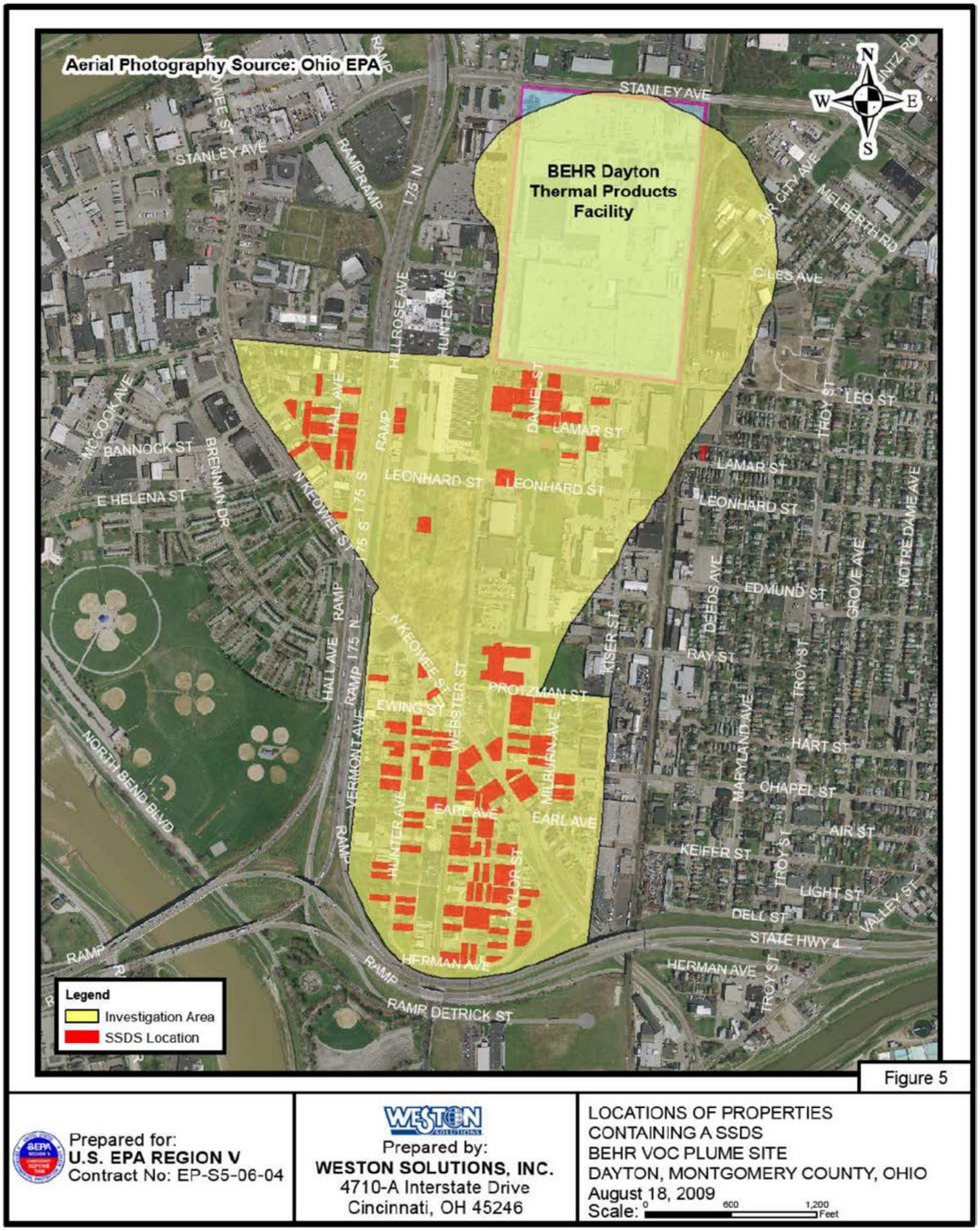

Figure 3. Behr Mitigation Location Map

SSDS = sub-slab depressurization system (vapor abatement system)

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).

Inhalation Unit Risk
The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to a substance at a concentration of 1 $\mu g/m^3$ (microgram per cubic meter) in air.

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 Concentration (RfC)
An EPA estimate, with uncertainty or safety factors built in, of the continuous, life-time inhalation exposure of human populations to a possible hazard that is not likely to cause noncancerous health effects.

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.

RfC [see reference concentration]

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).

Appendix B. Fact Sheets

Bureau of Environmental Health
Health Assessment Section

"To protect and improve the health of all Ohioans"

Exposure to Toxic Chemicals

Answers to Frequently Asked Health Questions

How are we exposed to chemicals?

We come in contact with many different chemicals every day that are non-toxic and normally do not cause health problems. But any chemical could become toxic if a person comes in contact with high enough doses. For example: Aspirin will cure a headache but too much aspirin becomes toxic and can cause serious health problems. You can get sick from contact with chemicals 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.

Other factors that increase health risks are:

- Current health status (if you are ill or healthy).
- Lifestyle, age, and weight.
- Smoking, drinking alcohol, or taking certain medicines or drugs.
- Allergies to certain chemicals.
- Past chemical exposure.
- Working in an industry/factory that makes or uses chemicals.

What is a completed exposure pathway?

Chemicals must have a way to get into a person's body to cause health problems. This process of those chemicals getting into our bodies is called an exposure pathway. A completed exposure pathway includes all of the following 5 links between a chemical source and the people who are exposed to that chemical.

(1) A Source of the chemical (where the chemical came from);
(2) Environmental Transport (the way the chemical moves from the source to the public. This can take place through the soil, air, underground drinking water or surface water);
(3) Point of Exposure (the place where there is physical contact with the chemical. This could be on-site as well as off-site);
(4) A Route of Exposure (how people came into the physical contact with the chemical. This can take place by drinking, eating, breathing or touching it);
(5) People Who Could be Exposed (people that live near a facility who are most likely to come into physical contact with the site-related chemical).

What are exposure routes?

There are three ways (routes) a person can come in contact with toxic chemicals. They include:

- Breathing (inhalation).
- Eating and drinking (ingestion).
- Skin contact (dermal contact).

Inhalation (breathing)

Chemicals can enter our body through the air we breathe. These chemicals can come in the form of dust, mist, or fumes. Some chemicals may stay in the lungs and damage lung cells. Other chemicals may pass through lung tissue, enter the bloodstream, and affect other parts of our body.

Ingestion (eating or drinking)

The body can absorb chemicals in the stomach from the foods we eat or the liquids we drink. Chemicals may also be in the dust or soil we swallow. These chemicals can enter our blood and affect other parts of our body.

Dermal (skin) Contact

Chemicals can enter our body through our skin. We can come in contact with water polluted by chemicals or touch polluted soil. Some chemicals pass through our skin and enter our bloodstream, affecting other parts of our body.

For more information contact:

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246 North High Street, 5th Floor
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Phone: 614-466-1390
Fax: 614-644-4556

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

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.

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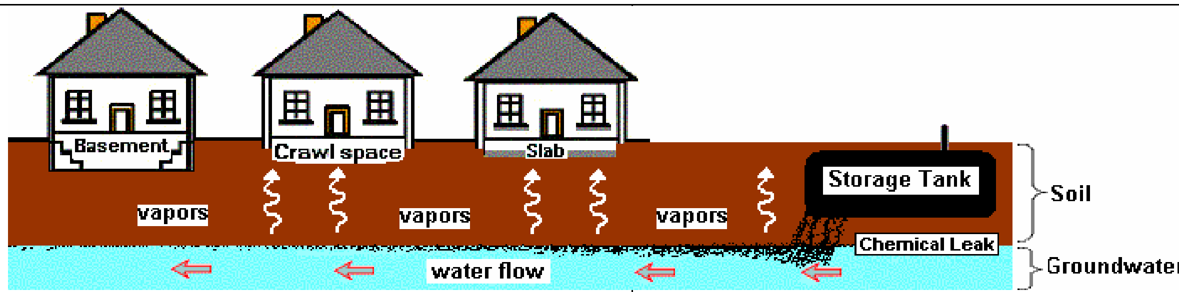
Bureau of
Environmental Health
Health Assessment Section

"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:
How much you were exposed to (dose).
How long you were exposed (duration).
How often you were exposed (frequency).
How toxic the spill/leak chemicals are.
General Health, age, lifestyle: 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 first 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)

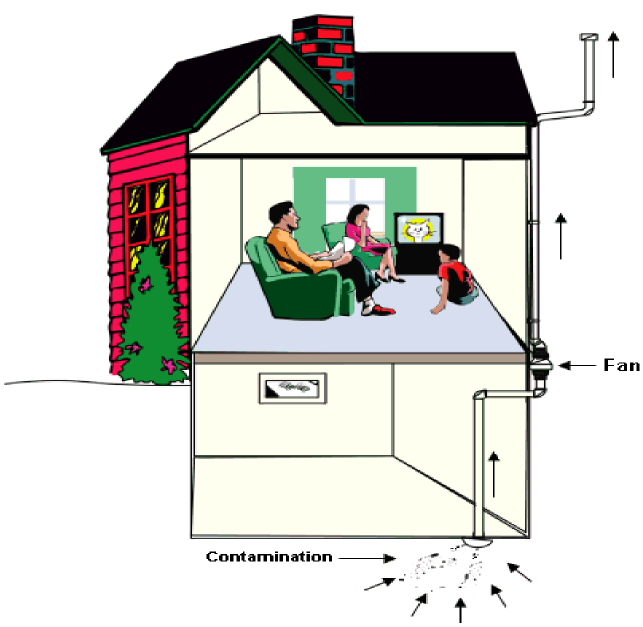
How is vapor intrusion investigated? (continued)

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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Bureau of
Environmental Health
Health Assessment Section

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Trichloroethylene (TCE)

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

Answers to Frequently Asked Health Questions

What is TCE?

TCE is a man-made chemical that is not naturally found in the environment. TCE is a non-flammable (does not burn), colorless liquid with a somewhat sweet odor and sweet, "burning" taste. It is mainly used as a cleaner in industry to remove grease from metal parts. TCE can also be found in common household items such as 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 or when we use common household products that contain TCE. It can also contaminate soils and groundwater (underground drinking water) as the result of spills or improper disposal.

What happens to TCE in the environment?

- Upon contact with the air, TCE quickly evaporates and breaks down in the sunlight and oxygen.
- TCE quickly evaporates from the surface waters of rivers, lakes, streams, creeks and puddles.
- If large amounts of TCE are spilled on the ground, some of it will evaporate and some of it may leak down into the soils. When it rains, TCE can be carried through the soils and into the groundwater (drinking water).
- When TCE-contaminated groundwater is in an anaerobic (without oxygen) environment and with time, it will break down into different chemicals such as 1,2 Dichloroethene (1,2 DCE) and Vinyl Chloride (VC).
- TCE does not build up in plants and animals.
- 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?

- Breathing (Inhalation): TCE can get into your body by breathing air contaminated with TCE vapors. The vapors can be released from the industrial use of TCE, from using household products that contain TCE, or by TCE contaminated water evaporating in the shower.
- Drinking (Ingestion): TCE can get into your body by drinking TCE contaminated water.
- Skin (Dermal): Small amounts of TCE can get into your body through skin contact. This can take place when using TCE as a cleaner-degreaser or by contact with TCE contaminated 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 the immune system and damage fetal heart development in pregnant women.
- 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 irritation and rash.

Does TCE cause cancer?

In September of 2011 the U.S. EPA revised their Integrated Risk Information System (IRIS) numbers for cancer and non-cancer effects for Trichloroethylene (TCE). The U.S. EPA newly revised IRIS document has classified TCE as "carcinogenic to humans." This classification is used when there is evidence between human exposure and cancer.

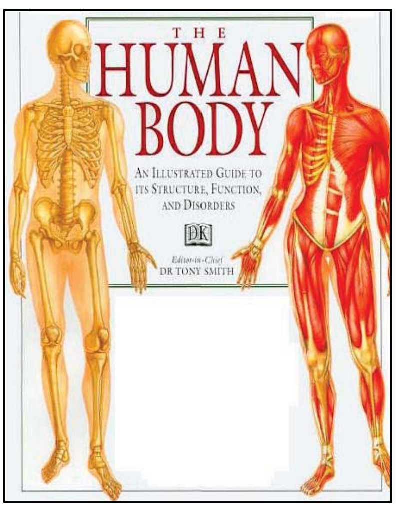
The National Toxicology Program's 12th Report on Carcinogens list TCE as *Reasonably Anticipated to be a Human Carcinogen*. **NOTE:** The 12th Report on Carcinogens was released prior to the release of the new EPA IRIS revision. It is likely the next Report on Carcinogens will reflect the EPA IRIS number changes.

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

Yes, medical testing is available to determine recent exposure(s).

- TCE can be measured in your breath, but only if you have been exposed to ***large*** amounts (part per million -- ppm levels).
- Blood or urine samples can also be used, but only if you have been exposed to ***large*** amounts (part per million -- ppm levels).

TCE in the human body:



When chemicals enter the human body, they typically get broken down and eliminated through normal bodily functions. Some of the break down products (called metabolites) of TCE can be measured in your blood or urine. However, some of the same metabolites in your blood and urine can also be produced as a result of exposure to similar chemicals and other sources (diet, medications, environment, etc.). For this reason, blood and urine testing is not always an accurate measure of exposure to TCE.

It is important to note TCE and TCE's metabolites usually leave the body shortly after exposure, so the testing would only be useful for recent exposures. Also, testing may not be useful or reliable in determining whether people have been exposed to low-doses of TCE or whether they will experience any harmful health effects.

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:

- ✓ On 09/28/2011 the U.S. EPA revised their Integrated Risk Information System (IRIS) numbers for Trichloroethylene (TCE) (CASRN 79-01-6) -- see below reference section for link --
- The Environmental Protection Agency (EPA) has set a maximum contaminant level (MCL) for TCE in drinking water at 0.005 milligrams per liter (0.005 mg/L) or 5.0 parts of TCE per billion parts water (5.0 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 a healthy adult, 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/ToxProfiles/tp.asp?id=173&tid=30

Report on Carcinogens, Twelfth Edition; U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, 2011 (electronic at http://ntp.niehs.nih.gov/ntp/roc/twelfth/roc12.pdf)

U.S. EPA Integrated Risk Information System (IRIS) for Trichloroethylene (TCE) (CASRN 79-01-6) http://www.epa.gov/iris/subst/0199.htm

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.

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Bureau of
Environmental Health
Health Assessment Section

"To protect and improve the health of all Ohioans"

1,2-Dichloroethene

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?

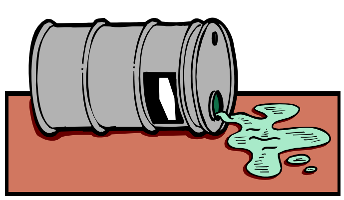
1,2 DCE is released to the environment from chemical factories that make or use this chemical, from landfills and hazardous waste sites that have a spill or leak, from chemical spills, from burning vinyl and from the chemical breakdown of other chlorinated chemicals in the underground drinking water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

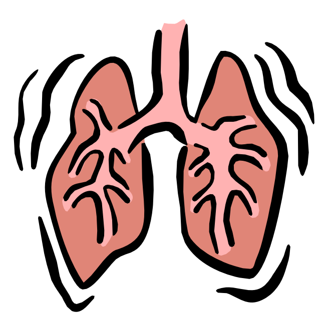
Human exposure to 1,2 DCE usually happens where the chemical has been improperly disposed of or spilled. Exposure mainly happens by breathing contaminated air or drinking contaminated water. If the water in your home is contaminated, you could also be breathing 1,2 DCE vapors while cooking, bathing or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

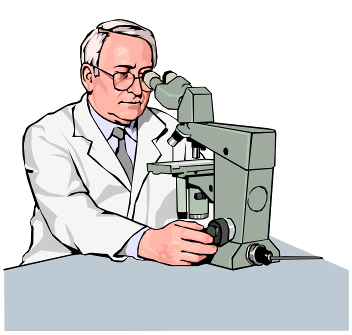
The long-term human health effects after exposure to low concentrations of 1,2 DCE are not known.

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?

Ohio Department of Health
Bureau of Environmental Health
Health Assessment Section
246 N. High Street
Columbus, Ohio 43215
Phone: (614) 466-1390

ATSDR AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

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