# Public Health Assessment for

**LANE STREET GROUND WATER CONTAMINATION SITE**
**ELKHART, ELKHART COUNTY, INDIANA**
**EPA FACILITY ID: INN000510229**
**AUGUST 8, 2011**

For Public Comment

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

**Comment Period Ends:**

SEPTEMBER 23, 2011

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 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 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. This revised document has now been released for a 30-day public comment period. Subsequent to the public comment period, ATSDR 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 which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Visit our Home Page at: http://www.atsdr.cdc.gov

# PUBLIC HEALTH ASSESSMENT

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ELKHART, ELKHART COUNTY, INDIANA

EPA FACILITY ID: INN000510229

Prepared by:

Site and Radiological Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

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# Summary

## Introduction

The Agency for Toxic Substances and Disease Registry's (ATSDR) top priority is to ensure that the people living on or near Lane Street in Elkhart, Indiana have the best information possible to safeguard their health.

Elevated levels of volatile organic compounds (VOCs), primarily trichloroethylene (TCE), were identified in the groundwater under properties along Lane Street in 2007; in 2009, the U.S. Environmental Protection Agency (EPA) proposed the Lane Street Ground Water Contamination site to the National Priorities List (NPL, or "Superfund"). ATSDR is required to conduct public health activities on all sites proposed to the NPL.

The purpose of this Public Health Assessment (PHA) is to determine whether the community may have been harmed by exposure to VOCs in well water (in the past or currently) and what public health actions need to be taken to reduce harmful exposures. Because of limited available data, ATSDR focused its evaluation on exposure to VOCs in residential well water. Other potential exposure pathways may be evaluated as more data are collected from the site.

## Conclusions

ATSDR reached three important conclusions in the PHA:

### Conclusion 1

People who drank water from private wells containing the highest levels of TCE at the Lane Street Ground Water Contamination site had an increased risk of adverse health effects. ATSDR considers the site a past public health hazard.

**Basis for conclusion**

ATSDR concluded that pregnant women who regularly drank and used water containing high levels of TCE (100 µg/L or more) might have had a theoretical increased risk of having babies with heart or other birth defects. Not all wells had TCE levels high enough to cause these effects.

**Next steps**

- Most homes were connected to municipal water in 2008 and are no longer using private wells. Municipal drinking water is monitored by the Elkhart Public Works and Utilities Department.
- ATSDR will explore options for providing information to the community on possible health effects from past TCE exposures.

**Conclusion 2**

Current exposures at the site are not expected to cause harm. However, exposure from wells still in use may pose a potential future public health hazard if contaminant levels increase.

**Basis for conclusion**

Almost all homes in the Lane Street area, and all homes with well water containing VOC levels above drinking water standards, have been switched to municipal water. One or two homes in the area may still be using wells for drinking water, but these wells did not show VOC contamination above drinking water standards. Because the source of the contamination has not been identified, it is unknown how TCE or related VOC levels might change in any wells still in use. Wells that have not shown harmful levels of contamination until now may become more contaminated in the future.

**Next Steps**

- Occupants in homes not connected to municipal water should have their well water tested regularly.
- ATSDR will evaluate additional data collected by EPA and update the findings of this PHA, if necessary.

**Conclusion 3**

More information is needed to assess whether VOCs may be building up in homes (vapor intrusion).

**Basis for conclusion**

EPA collected indoor air samples in two homes with elevated levels of TCE in well water. The samples were taken to identify whether vapors from underground contaminated water could be building up inside the homes. The samples indicated that TCE and related VOCs were not present at harmful levels at the two homes sampled. However, vapor intrusion can vary seasonally and from house to house.

**Next Steps**

- EPA should conduct additional sampling to verify that Lane Street residents are not being exposed to groundwater contaminants from vapor intrusion.

## For More Information

For further information about this public health assessment, please call ATSDR at 1-800-CDC-INFO and ask for information about the “Lane Street Ground Water Contamination Site”. If you have concerns about your health, you should contact your health care provider.

## List of Abbreviations

| | |
|---|---|
| ATSDR | Agency for Toxic Substances and Disease Registry |
| Cal-EPA | California Environmental Protection Agency |
| CREG | Cancer Risk Evaluation Guide |
| CV | Comparison Value |
| 1,1-DCA | 1,1-Dichloroethane |
| ECHD | Elkhart County Health Department |
| EMEG | Environmental Media Evaluation Guide |
| EPA | U.S. Environmental Protection Agency |
| IARC | International Agency for Research on Cancer |
| IDEM | Indiana Department of Environmental Management |
| IRIS | Integrated Risk Assessment System |
| LTHA | Lifetime Health Advisory |
| MCL | Maximum Contaminant Level |
| MRL | Minimal Risk Level |
| NPL | National Priorities List |
| OSHA | Occupational Safety and Health Administration |
| PCE | Tetrachloroethylene (or Perchloroethylene) |
| PHA | Public Health Assessment |
| RfD | Reference Dose |
| RSL | Regional Screening Level |
| RMEG | Reference Media Evaluation Guide |
| TCE | Trichloroethylene (or Trichloroethene) |
| µg/L | microgram per liter |
| VOC | Volatile Organic Compound |

## Purpose and Statement of Issues

The Agency for Toxic Substances and Disease Registry (ATSDR) prepared this public health assessment to evaluate, based on the information currently available, potential exposures to contaminants in drinking water from the Lane Street Ground Water Contamination site. This site is located in Elkhart County, Indiana. The properties on the site are either within or just outside the city limits of Elkhart.

The Elkhart County Health Department (ECHD) and the Indiana Department of Environmental Management (IDEM) alerted the U.S. Environmental Protection Agency (EPA) after discovering elevated levels of volatile organic compounds (VOCs), primarily trichloroethylene (TCE), in the groundwater under Lane Street in 2007. This was a concern because many homes in the area had private wells and used this groundwater as a drinking water source. Homes with levels of TCE higher than drinking water standards were provided with alternate water or filtration systems to remove contaminants, and almost all the homes in the area were added to the Elkhart municipal water system in fall 2008.

The EPA proposed the Lane Street Ground Water Contamination site for inclusion on the National Priorities List (NPL) in April 2009; the listing was finalized in September 2009. ATSDR is mandated by Congress to conduct public health activities on all sites proposed to the NPL.

## Background

### Introduction and Site Description

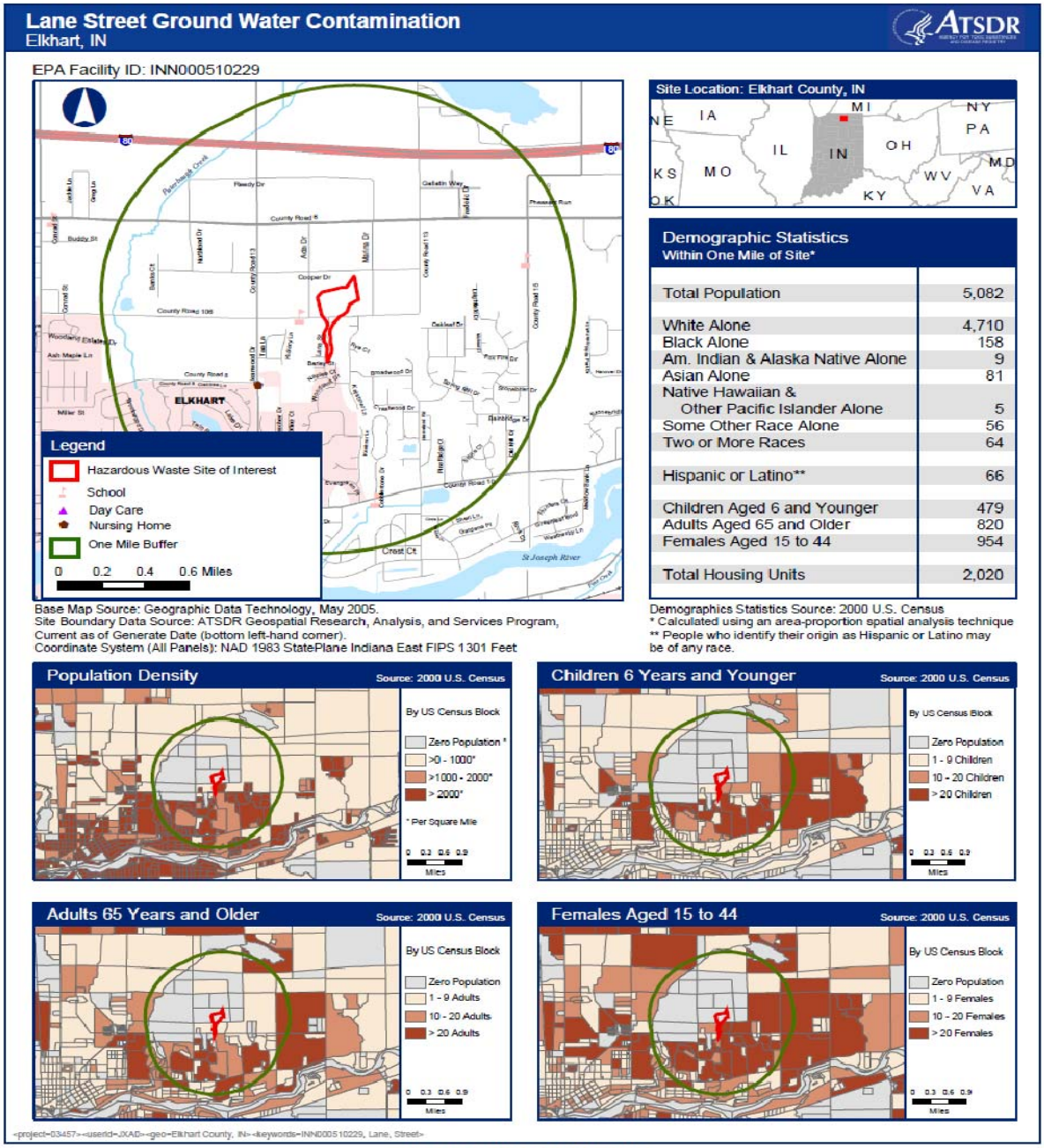
The Lane Street Ground Water Contamination Site ("the site", approximate location shown in Figure 1), is located around the intersection of Lane Street and County Road 106/Henke Street, in the northeast sector of the city of Elkhart, Indiana. Elkhart County is in North Central Indiana (USGS, 2009).

The site was proposed for the NPL in April 2009 due to elevated levels of VOCs, particularly TCE, in some private residential wells in the area. The discovery of this contamination resulted from community concerns about groundwater contamination at a nearby site, Geocel; however, the contamination around Lane Street is thought to be unassociated with the Geocel site. The source of the Lane Street groundwater contamination has not been determined.

### Demographics

Figure 1 shows that the estimated population within a one-mile radius of the site was about 5,000 people based on Census 2000 data. Among this population approximately 93% were White, 3% Black, 2% Asian, and a little over 1% were Hispanic or Latino. Children 6 years of age and younger accounted for approximately 9% of the population; 16% were adults 65 years of age and older, and 19% were women aged 15 to 44 years. The total housing units were estimated at 2,020. ATSDR identified 4 schools and 2 nursing homes within a one-mile radius of the site.

**Figure 1. Site Map and Demographic Information for the Lane Street Ground Water Contamination Site.**



## Land and Natural Resource Use

The exact site boundaries are still being determined, but the affected residential properties discussed in this report are primarily on Lane Street, a residential street less than a quarter mile long. The surrounding area consists of residential properties, some farmland to the west of Lane Street, and several commercial and industrial facilities to the north.

Before 2007, residents on Lane Street and in surrounding neighborhoods used private wells which pumped local groundwater for household use, including drinking water. Since 2008, most of these homes have been connected to the Elkhart municipal water system. This system provides treated drinking water obtained from three well fields that are continually monitored for contamination by Elkhart's Public Works and Utility Department (EPWUD, 2008). Regional groundwater flow is south-southwesterly – generally, from the industrial park north of County Road 106/ Henke Street towards Lane Street (IDEM, 2008).

### *Site History and Previous Investigations*

The groundwater contamination around Lane Street was identified in 2007 through investigations related to a nearby site. The company, Geocel Corporation, located approximately half a mile northeast of Lane Street, contacted IDEM and ECHD about possible groundwater contamination related to their operations. Geocel applied and was accepted into IDEM's Voluntary Remediation Program in July 2007. (IDEM, 2008).

On August 22, 2007, IDEM learned that a Lane Street resident, based on concerns about the reported Geocel contamination, had submitted samples of their well water to a private laboratory. The testing showed high levels of TCE and associated breakdown products (Weston, 2008). The TCE concentration exceeded the maximum contaminant level (MCL) for the National Primary Drinking Water Regulations, currently set at 5 micrograms per liter (µg/L) (Weston, 2008). However, because of different contaminant profiles (e.g., TCE was not identified in Geocel contamination), IDEM determined that Geocel was not the source of the contamination of the Lane Street resident's well water.

IDEM investigated well water in the area around Lane Street site in late August 2007 and found TCE exceeding drinking water standards in several wells. IDEM provided bottled water to 11 homes, including all whose wells exceeded drinking water standards, and contacted EPA to further investigate the issue. In September 2007, EPA confirmed the findings of elevated levels of TCE in several wells. (Weston, 2008). On the basis of these findings, EPA provided point-of-entry (whole house) or point-of-use (tap) filters to 13 residences; the units were installed by November 2007 (EPA, 2009a). Testing in December 2007 showed that the filters were effective in removing TCE from the well water (Esserman, 2008).

Also in December 2007, EPA sampled indoor air at 2 homes with elevated TCE concentrations in well water. This was to assess the possibility for vapor intrusion, where volatile compounds can evaporate from groundwater and travel up through cracks or other conduits to enter homes. No TCE was detected. (Weston, 2008)

In spring 2008, IDEM collected 132 groundwater samples from wells serving residences and businesses in the area and from "direct push" samples directly from groundwater (i.e., not from a permanent well). The results of this testing confirmed the previous findings of elevated TCE and other VOCs and assisted in further characterizing the extent of contamination. (IDEM, 2008).

In October 2008, 26 residents signed a "Compact Agreement" with the city of Elkhart to be connected to the municipal water system and were connected in November 2008 (EPA, 2009a).

### *Source of the Lane Street Groundwater Contamination*

The contamination source has not been fully determined. Area groundwater flow is generally from the industrial park towards Lane Street. As previously stated, the company Geocel is not thought to be responsible for the Lane Street contamination. The Geocel contamination is confined to a specific area east of Lane Street, and the contaminant profiles are different in the Geocel and Lane Street groundwater (IDEM, 2007a). TCE and related breakdown products are present in the groundwater under Lane Street, while the Geocel site released a different solvent, tetrachloroethylene (also known as perchloroethylene, or PCE). This solvent degraded to form vinyl chloride and other substances in groundwater associated with that site. However, numerous other industrial companies exist or once existed in the area, and some of the industrial companies' manufacturing processes use or used the chemicals found in the Lane Street groundwater. EPA is continuing its efforts to determine the source(s).

### *Other Hazardous Waste Sites in the Area*

Elkhart County has had four other sites listed on the NPL. Lane Street Ground Water Contamination is the fifth site listed. The other NPL sites are Himco Dump, the Main Street Well Field, Conrail Rail Yard, and Lusher Street Ground Water Contamination (EPA, 2011a). For more information on these sites, visit the ATSDR webpage at www.atsdr.cdc.gov. Other sites that are not listed on the NPL but were subjects of time critical removal or other actions include: the AccraPac Site, the Woodlawn Industrial Site, Sycamore Street, Geocel, Belmont-Huron Site, Gemeinhardt, and others. Many of these sites are groundwater contamination sites. Of the Elkhart area sites, only the Geocel site discussed in this document is close (about ½ mile) to the Lane Street site. All of the other sites are more than 2 miles from Lane Street.

## ATSDR Involvement

ATSDR is mandated by Congress to conduct an evaluation of sites proposed to EPA's NPL. This PHA is our evaluation of the Lane Street Ground Water site and its potential health implications. ATSDR visited the site and surrounding area from October 14-16, 2009. ATSDR contacted the Elkhart County Board of Commissioners to ensure they were aware of our upcoming visit. ATSDR gathered information on the Elkhart community and addressed any concerns expressed by board members or community members.

### *Individual Interviews to Collect Community Concerns*

From October 14-16, 2009, ATSDR staff conducted individual interviews with some of the residents of Lane Street. The goal was to identify questions about health related issues, contamination concerns, and community data. This information is important because it helps us focus this assessment to better address community concerns and questions related to the Lane Street site.

### *Meeting and Site Visit with ECHD, IDEM, and EPA*

On October 14, 2009, ATSDR staff met with ECHD, IDEM, and EPA to learn about the site. John Hulewicz, a representative and a supervisor from the ECHD, gave a drive-by tour of the site and surrounding area. The tour included Lane Street, the surrounding community, and nearby manufacturing companies. ATSDR learned the following during the visit:

- ECHD was aware of no health concerns expressed by residents, other than the initial concerns about safe drinking water.
- Information regarding background on the community, contamination, and possible future implications from ECHD and IDEM documentation, maps, and presentation.
- Some residences around Lane Street are still not connected to municipal water; those wells had not shown TCE levels above drinking water standards.

## Discussion

### Data Used

A major source of data evaluated in this report is the hazard ranking system package (EPA, 2009b). References listed in the package were provided by EPA Region 5, IDEM, and Elkhart County. These data sources describe groundwater sampling at many locations in the Lane Street area, including residences, businesses, and “direct push” samples collected directly from groundwater (not from a permanent well). The evaluation in this PHA focuses on residential wells only, from which long-term exposures were most likely. The residential private well sampling data evaluated in this PHA include:

- Sampling of 6 private wells by IDEM on August 23, 2007 (IDEM, 2007a): the report from this sampling event only included results for TCE, and raw laboratory results sheets were not available.
- Sampling of 25 private wells by IDEM on August 31, 2007 (IDEM, 2007b): ATSDR used raw laboratory results sheets from this sampling event available on IDEM’s web site (Heritage, 2007).
- Sampling of 10 private wells by EPA in September 2007 (Weston, 2008): ATSDR used results as summarized in Weston 2008, and raw laboratory results sheets were not available.

- Sampling of about 36 private wells by IDEM in April 2008 (IDEM, 2008): ATSDR used results as reported in raw laboratory results sheets included in IDEM's Site Inspection Report dated September 2008.
- ATSDR also considered limited indoor air sampling conducted by EPA in December 2007 and reported in the Site Inspection Report (Weston, 2008).

Note that the same well may have been sampled multiple times during each sampling event and may have been re-sampled in subsequent sample events. In addition, some of the above sampling events included residences on streets near Lane Street as well as Lane Street. For this evaluation, ATSDR did not consider samples collected from residences east of Lane Street. This area is considered part of a separate site (the Geocel site). ATSDR identified 30 residential wells which were part of the Lane Street Ground Water Contamination site and for which at least one set of sample results was available. A summary of these results will be presented shortly, but first the process by which ATSDR evaluates such environmental sampling data will be discussed.

**Pathway Analysis**

ATSDR determines whether people may have come into contact with chemicals from a site by examining exposure pathways. Exposure pathways consist of five elements which must all be present (in the past, now, or in the future) for exposure to occur. The five major elements and their relation to the Lane Street Ground Water site are listed below:

1. A contamination source: yes. Although the source of contamination for this site has not been identified, it is presumed because of the contamination present in groundwater.
2. Transport through an environmental medium: yes. VOC contamination has been measured in the groundwater beneath homes and businesses in the area.
3. An exposure point: yes, in the past. People obtained contaminated water from their private wells at drinking water and household taps.
4. An exposure route: yes. People drank the water and may have breathed in contaminant vapors from the water.
5. An exposed population: yes. People in the area used the water.

This analysis indicates that a complete exposure pathway existed in the past for those using contaminated well water. Twenty-six residences have been added to the municipal water system (EPA, 2009a). Any residential wells still in use that have not been tested or that may become contaminated in the future present a potentially complete exposure pathway. Completed exposure pathways are evaluated further by ATSDR to determine if there are health effects associated with the levels of exposure (ATSDR, 2005). For more information on ATSDR's pathway analysis process, please refer to Appendix A.

**Evaluation Process**

The process by which ATSDR evaluates the possible health impact of contaminants is summarized here and described in more detail in Appendix A.

- When presented with results of comprehensive environmental sampling for chemicals, ATSDR reduces the number of contaminants that need to be evaluated by screening the results for each chemical against *comparison values* (CVs)—concentrations of chemicals in the environment (air, water, or soil) below which no adverse human health effects are expected to occur. If a contaminant is present at a level higher than the corresponding CV, it does not mean that adverse health effects will occur; the contaminant is merely retained for the next step of evaluation.
- The next step of evaluation focuses on identifying which chemicals and exposure situations could be a health hazard. We calculate *exposure doses*—estimated amounts of a contaminant that people come in contact with and get into their bodies, on an equivalent body weight basis—under specified exposure situations, typically starting with "worst case" type assumptions to obtain the highest dose that could be expected. Each calculated exposure dose is compared against the corresponding *health guideline*, typically an ATSDR minimal risk level (MRL) or EPA Reference Dose (RfD), for that chemical. Health guidelines are considered safe doses; that is, if the calculated dose is at or below the health guideline, no adverse health effects would be expected.
- If the "worst case" exposure dose for a chemical is greater than the health guideline, then the exposure dose may be refined to more closely reflect actual exposures that occurred or are occurring at the site. The exposure dose is then compared to known health effect levels (for both cancer and non-cancer effects) identified in ATSDR's toxicological profiles or the scientific literature. *These comparisons are the basis for stating whether or not the exposure presents a health hazard.*

We limited the exposure evaluation of this public health assessment to VOCs detected in residential private wells. These compounds are known to be contaminants in the groundwater, and residential exposures are of highest concern. Comprehensive data on other potential contaminants of concern and exposure pathways are not available at this time.

**Contaminants of Concern**

Table 1 shows that several different VOCs were detected in at least one residential well at levels higher than drinking water CVs. The contaminants most frequently detected were TCE and 1,1-dichloroethane (1,1-DCA). These contaminants will be evaluated further in the ensuing sections of this report.

Tetrachloroethylene (PCE) is a VOC that is often associated with TCE because its degradation can form TCE. It was the solvent released from the nearby Geocel site. However, in the Lane Street-associated sampling, PCE was only detected in one sample of one well, and the low level detected was qualified as an estimated value by the laboratory – that is, the concentration was too low for the laboratory to precisely and accurately measure the exact concentration. ATSDR does not consider this single low detection to pose a concern at this site and will not evaluate PCE further.

Methylene chloride, similarly, was detected infrequently (in only 3 of 30 wells tested), and only slightly exceeded its CV in one instance. Methylene chloride is a very common

laboratory contaminant and was detected in the lab and field blanks associated with this sampling. In this case, ATSDR does not consider methylene chloride to be a site-related contaminant of concern and will not evaluate it further.

**Table 1. Contaminants Detected Above Comparison Values (CVs) in Lane Street Residential Wells**

| Contaminant | Highest Concentration Detected in Any Residential Well Sample, μg/L | # of Wells With Contaminant Detected | # of Wells With Contaminant Concentration Above the CV | CV in μg/L and Source* |
|---|---|---|---|---|
| Trichloroethylene (TCE) | 330 | 14 out of 30 | 9 out of 30 | 5 - MCL<br>6 - CREG |
| 1,1-Dichloroethane | 11 | 11 out of 30 | 9 out of 30 | 2.4 - RSL |
| Tetrachloroethylene | 0.09 | 1 out of 30 | 1 out of 30 | 5 - MCL<br>0.06 - CREG |
| Methylene Chloride | 7.1 | 3 out of 30 | 1 out of 30 | 5 - MCL |

*Please see Appendix A for definitions and additional information about CVs.
MCL = maximum contaminant level
CREG = cancer risk evaluation guide
RSL = regional screening level
Data sources: as summarized in "Data Used" section beginning on page 5.

### Evaluation of Exposure from Household Use of Residential Well Water

This exposure pathway was complete when people were still using wells that contained VOCs. We believe the subdivision was built in the late 1970s to mid-1980s. It is likely that the contamination present is relatively recent because TCE degradation products were not detected at higher levels than the TCE; however, because historical well testing is not available, we cannot confirm that the introduction of TCE into the groundwater here has only occurred recently. We also know that residences with contaminant levels above the MCL in their private wells were switched to bottled water or their well water was treated by filters beginning in 2007, and almost all area homes were connected to the municipal system in 2008.

ATSDR evaluated exposure to the maximum levels of TCE and other VOCs detected in private wells in 2007-2008. It is possible that contaminant levels in some wells were higher in the past. No data on past levels of VOCs are available, and there is no way today to measure the past levels of contamination.

VOC exposure could have occurred in several ways:

- *Ingestion:* People could have drunk the water or eaten food prepared using the water.

- *Inhalation:* People could have breathed in VOCs that volatilized (moved into the air) from well water during showering, bathing, or other household use.
- *Dermal Exposure:* People could have absorbed VOCs through their skin during showering, bathing, or other use.

Often, ingestion exposure is the most significant source of exposure to hazardous substances from a site. In the case of VOC contamination, however, inhalation and dermal exposures can make a significant contribution to the total exposure dose (that is, the total amount of contaminant that enters and can affect a person's body). A precise estimate of these non-ingestion exposures is seldom achievable. A common estimation is that non-ingestion exposures yield a contaminant dose comparable to the ingestion dose (ATSDR, 2005). This estimation may underestimate exposures to people who may be exposed to TCE from shower water for periods of 30 minutes or more per day. However, for the purposes of this evaluation, we doubled ingestion exposure doses estimated using measured water VOC concentrations and default assumptions for the amount of water consumed per day and other exposure parameters to account for additional exposure from inhalation and dermal exposures.

***Potential Health Effects from TCE Exposure***

People who used and drank water from residential wells with TCE levels below the MCL of 5 μg/L are unlikely to suffer any health effects from this exposure. Only 9 of the 30 residential wells tested in 2007-2008 had TCE levels higher than the MCL. Of those 9 wells, 3 wells had TCE levels at or below 20 μg/L; 3 had levels generally below 100 μg/L; and 3 had levels in the 200 to 300 μg/L range. For each of these exposures, the overall exposure dose of TCE was estimated for pregnant women and young children – considered the most sensitive to environmental toxins in many situations. Pregnant women were assumed to weigh 60 kg (132 pounds) and drink 2.5 liters of well water per day. Children were assumed to weigh 10 kg (22 pounds, the average weight of a one-year-old) and drink 1 liter of well water a day (EPA, 2009c).

As an example, the calculation of exposure of a child weighing 10 kg (22 pounds) drinking one liter per day of water containing 100 μg/L TCE follows. Multiplying by a factor of 2 to account for additional exposure from breathing in TCE from water and getting it on skin during bathing, the daily dose of TCE in milligrams TCE per kg of body weight per day (mg/kg/day) is estimated as:

$$2 \times \frac{100\frac{\mu g}{L} \times 0.001\frac{mg}{\mu g} \times 1\frac{L}{day}}{10kg} = 0.02\, mg/kg/day$$

Table 2 shows the exposure doses calculated for women or children drinking water with 20, 100, or 300 μg/L of TCE.

**Table 2. Estimated TCE Exposure Doses for Women and Children**

| | Weight (kg) | Amount of Water (Liters/day) | Total Exposure Dose (mg/kg/day) | | |
|---|---|---|---|---|---|
| | | | 20 μg/L TCE | 100 μg/L TCE | 300 μg/L TCE |
| Woman | 60 | 2.5 | .002 | .008 | .03 |
| Child | 10 | 1 | .004 | .02 | .06 |

Possible Noncancer Effects

Several epidemiologic studies describe noncancer effects associated with exposure to drinking water contaminated with TCE and other solvents. Note that a positive association does not mean causation. A study of a community in Arizona exposed to elevated levels (up to 239 μg/L) of TCE in drinking water showed an association between maternal exposure to TCE in water while pregnant and congenital heart defects in their newborns (Goldberg et al., 1990). A study of communities in northern New Jersey with drinking water containing TCE greater than 5 μg/L (and other solvents) reported an association between TCE level and oral cleft defects, central nervous system defects, and neural tube defects (Bove et al., 1995). A study of people in Woburn, Massachusetts exposed to up to 267 μg/L TCE in drinking water suggested an association between maternal exposure and a combination of eye and ear anomalies and a combination of central nervous system, chromosomal, and oral cleft anomalies in newborns (Lagakos et al., 1986). However, other researchers have questioned the unusual groupings of these anomalies, and all the studies are limited by the presence of other contaminants in the water which may have led to an association with the observed health effects. Other limitations include small sample sizes and poorly defined TCE exposure levels. Animal studies have confirmed some of the suggested noncancer effects from epidemiologic studies. Rat studies have indentified heart defects in newborn rats whose mothers were exposed to doses as low as 0.05 mg/kg/day (Johnson, 2003).

At water concentrations greater than 100 μg/L TCE, the estimated doses for pregnant women at this site may approach the lowest effect levels seen in animal studies. On the basis of animal studies and limited epidemiological studies, pregnant women who drank water from wells containing TCE above 100 μg/L, especially at the higher levels detected, may have had a greater risk of having children with heart or other birth defects.

Long-term animal studies showing adverse kidney effects, dermal effects, or decreased body weight all had effect levels thousands of times higher than the doses estimated for children at this site (ATSDR, 1997). Multiple studies have shown that these effects occurred at doses well above 100 mg/kg/day. Because estimated doses at this site are thousands of times smaller than this, it is unlikely that anyone drinking TCE-contaminated water at this site would have experienced these adverse health effects.

Possible Cancer Effects

The International Agency for Research on Cancer (IARC) has determined that TCE is a probable human carcinogen on the basis of epidemiological studies showing increased rates of liver cancer and non-Hodgkin's lymphoma, primarily in workers who were

exposed to TCE on the job, and animal studies showing increased numbers of liver and kidney tumors upon oral administration (IARC, 1995).

Studies on whether cancer is associated with drinking TCE-contaminated water have shown variable results. A study in Woburn, MA showed an association between childhood leukemia and consumption of water contaminated with TCE (maximum level 267 μg/L) and other solvents by the children's mothers while pregnant, but the association was not statistically significant. Looking only at a child's exposure after birth, there was no association between the child's consumption of TCE-contaminated water and leukemia diagnosis (Costas, 2002). Studies on New Jersey towns showed statistically significant associations with exposure to TCE levels greater than 5 μg/L and various leukemias and non-Hodgkin's lymphoma (Cohn et al, 1994). In contrast, a Finnish study showed no association between a number of cancers including leukemias and lymphomas in villages with drinking water contaminated with up to 220 μg/L TCE and other solvents (Vartiainen et al., 1993). Another study in Michigan showed significant increases in cancers, including leukemia, among people who drank water contaminated with TCE and other solvents (Freni and Bloomer, 1988). All these studies had limitations making their findings difficult to generalize; limitations included possible confounding effects of other solvents present in the water, difficulty in assigning individual exposures, and limited sample sizes.

EPA is currently reviewing its TCE health risk assessment. Because an oral cancer slope factor for TCE is not available in the EPA Integrated Risk Information System (IRIS), ATSDR's Division of Health Assessment and Consultation, with concurrence from their Office of Science, has provided interim guidance to ATSDR health assessors. The interim guidance instructs ATSDR to use an oral cancer slope factor developed by the California EPA (Cal-EPA), 0.0059 $(mg/kg/day)^{-1}$, for quantitative evaluation of TCE exposures (OEHHA, 2009).

The oral cancer slope factor is multiplied by the daily exposure dose to obtain the lifetime increased risk of cancer. Using the Cal-EPA oral cancer slope factor with the doses for women tabulated on the previous page, and assuming people were exposed to the highest concentrations of TCE (300 μg/L) for 40 years (conservatively high given the estimated age of the neighborhood), the predicted increased theoretical cancer risk to fall within EPA's general target risk range for risk management at Superfund sites (between 1 in 1,000,000 and 1 in 10,000). The actual risk of cancer from exposure to TCE at the site is probably even lower than predicted. Most wells did not contain TCE at the levels of the most-contaminated wells and people probably drank contaminated water for less than 40 years. Today, no one at the site is drinking water containing TCE at levels that would measurably increase the theoretical risk of cancer.

An EPA draft Toxicological Review for TCE is available, but no oral unit risk or oral cancer slope factor has been finalized at this time (EPA, 2009d). ATSDR's overall conclusions are based on noncancer effects for past exposures and on the fact that exposure to water containing elevated levels of TCE was stopped shortly after the

discovery of the contamination. Therefore, differences in agency cancer slope factors do not have a major effect on this PHA's conclusions and recommendations.

### *Potential Health Effects from 1,1-DCA Exposure*

People who used and drank water from residential wells with 1,1-DCA at the levels detected are unlikely to suffer any health effects from exposure. Only 9 of the 30 residential wells tested in 2007-2008 had 1,1-DCA levels higher than EPA's Regional Screening Level for tap water of 2.4 μg/L. The highest detected value in any well was 11 μg/L.

A 10-kg child, drinking water with the highest concentration (11 μg/L) of 1,1-DCA detected in private well water every day and also being exposed through inhalation and dermal exposure, is estimated to receive a total dose of 1,1-DCA of 0.002 mg/kg/day. A 60-kg woman would be estimated to receive a dose of 0.0009 mg/kg/day. These doses are thousands of times smaller than health effect levels observed in animal studies ranging from 80 to 270 mg/kg/day (Cal-EPA, 2003). It is unlikely that drinking water containing 1,1-DCA at the levels detected at the site would result in any observable adverse health effects.

EPA classifies 1,1-DCA as a possible human carcinogen based on limited evidence of carcinogenicity in rats and mice. Human data is not available (EPA, 1996). The animal study on which this conclusion was based did not provide conclusive evidence of carcinogenicity and EPA did not perform a quantitative assessment of the cancer risk. The doses of 1,1-DCA which resulted in an increased number of tumors in rats or mice were thousands of times higher than doses estimated for the Lane Street population (ATSDR, 1990). Cal-EPA has published an oral cancer slope factor for 1,1-DCA of 0.0057 $(mg/kg/day)^{-1}$ (OEHHA, 1992). Based on this slope factor and the other information available, the levels of 1,1-DCA detected in private well water at the site are unlikely to increase the risk of cancer to any measurable extent.

<u>Impact of VOCs in Wells Not Tested</u>

The risk of cancer or non-cancer health effects to the residents who did not have their water tested is unknown. The risk depends on the actual contaminant level in the well and how the water is used. If a residence is using well water, the water should be tested regularly. The residents could face an increased risk of health effects if the contaminant levels in their well water increase over time.

## Evaluation of Vapor Intrusion Potential

If VOC levels are high enough in groundwater and the groundwater is close enough to the surface, sometimes VOCs can move through the soil above the water table to reach the air. In some cases, the VOCs encounter cracks or utility lines that bring the contaminants into home interiors, such as basements, and the contaminant can build up indoors. This is known as *vapor intrusion*, and in some cases vapors from contaminants can reach levels that are of health concern.

EPA sampled indoor air in the two homes with elevated TCE levels measured in well water. TCE and 1,1-DCA were not detected. Two other volatile substances, benzene and 1,3-butadiene, were detected in one home at levels slightly exceeding air comparison values. These substances were not found in the Lane Street groundwater sampling. The main indoor sources of benzene are environmental tobacco smoke, stored fuels and paint supplies, and automobile emissions in attached garages (EPA, 2011b). The main indoor source of 1,3 butadiene is environmental tobacco smoke. It may also result from incomplete combustion of fuels and thus occur in automobile exhaust (EPA, 2002).

The fact that VOCs also present in contaminated groundwater were not detected in indoor air in these homes supports the hypothesis that vapor intrusion issues may not be a significant concern at the site. However, further sampling at more residences would be needed to ensure that this is the case.

### Child Health Considerations

ATSDR recognizes that infants and children might be more vulnerable than adults to exposures in communities with contaminated air, water, soil, or food. This potential vulnerability results from the following factors: 1) children are more likely to play outdoors and bring food into contaminated areas; 2) children are shorter and therefore more likely to contact dust and soil; 3) children's small size results in higher doses of chemical exposure per kg of body weight; and 4) developing body systems can sustain permanent damage if toxic exposures occur during critical growth stages. Because children depend completely on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests at the site.

ATSDR considered the special case of pregnant women in its evaluation because exposure during pregnancy to TCE, the major contaminant of concern at this site, may increase the risk of heart or other birth defects in the newborn children. In addition, because small children were potentially exposed to contaminated private well water, ATSDR estimated exposures based on a 1-year old child. A small child would have a higher exposure dose than older children or adults because of their smaller body weight. Conclusions based on exposure doses estimated for small children would therefore be protective for older children and non-pregnant adults.

### Health Outcome Data

Health outcome data can give a more thorough evaluation of the public health implications of a given exposure. Health outcome data can include mortality information (e.g., the number of people dying from a certain disease) or morbidity information (e.g., the number of people in an area getting a certain disease or illness). The review is most effective when (1) a completed human exposure pathway exists, (2) potential contaminant exposures are high enough to result in measurable health effects, (3) enough people are affected for the health effect to be measured, and (4) a database is available to identify rates of diseases plausibly associated with the exposure for populations of concern.

A review of health outcome data was not performed for this site. People are not currently being exposed to contaminants because homes found to have TCE-contaminated water were provided with bottled water or filtration systems soon after discovery of the contamination and were connected to municipal water in 2008. Although potential exposures in the past could have been high enough in a few homes to result in health effects, we do not have information about how long the contamination was present or the actual exposure levels. Even if we knew the levels of past exposure, the number of potentially exposed people would be too small to allow us to detect statistical differences in disease rates.

**Community Health Concerns**

ATSDR team members conducted in-depth interviews with 9 community members in Elkhart. The questionnaire used is included as Appendix B. Community members interviewed have lived there for a period ranging from six years through thirty-one years (when their homes were first built). Standard qualitative data analysis techniques were used to identify themes and code interviews accordingly. Interviews were audio recorded with the permission of residents- allowing interviewers to later double-check participant responses and capture direct quotes from those interviews. Below is a summary of community questions and concerns, with ATSDR responses, obtained from the interviews.

*1. How could my health be impacted by the Lane St Contamination Site?* We found that only a few homes had levels of TCE high enough to cause any health effects. Most people who drank water from the private wells, even the most contaminated ones, would not be expected to have any acute effects (effects from short term exposure). But pregnant women who regularly drank water containing high levels of TCE (100 µg/L or more) had an increased risk of having babies with heart or other birth defects. Except for the latter, ATSDR found that long term exposures at the site would be unlikely to cause an increased risk of other health effects in children or adults.

*2. How long were we exposed? What could be done to help individuals who were exposed?* We believe the contamination is relatively recent because TCE degradation products were not detected at higher levels than the TCE; however, there is no historical data on when VOCs began contaminating residential wells. Most homes were connected to municipal water in 2008, stopping exposure.

Tests to determine whether people were exposed recently are available, but not at most doctors' offices. Special laboratories with the right equipment can test levels of TCE. TCE can be detected in the blood or urine for up to 1 week after exposure (ATSDR, 1997). At this site, tests are not recommended because use of contaminated water stopped several years ago.

*3. Where can people go to get help and answers as it relates to chemical exposure and background information on the site?* People can visit their local health departments,

contact their doctor, gather information from the state, local, and federal websites listed in this assessment, or call 1-800-CDC-INFO.

*4. What if my doctor does not know what to do about exposure to contaminants?* If your doctor does not have this information, ATSDR can coordinate a consultation between your doctor and a physician specializing in environmental and occupational medicine. Please contact ATSDR Region 5 which serves the state of Indiana or ATSDR Headquarters. Our contact information is:

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*5. Is there information about numbers of specific types of cancer among Lane Street residents (within the last three years) including lymphoma and bile duct cancer? Is there information about specific organs (i.e., kidneys and liver) that could be affected by chemicals in groundwater in the Lane Street area?* The Indiana State Cancer Registry is notified and keeps records on cases of malignant cancer (except for certain skin and cervix), as well as other tumors and precancerous diseases (such as benign brain and CNS tumors) that are treated or diagnosed in Indiana. The information is usually collected from hospitals and reported annually to the Centers for Disease Control and Prevention's National Program of Cancer Registries and the North American Association of Central Cancer Registries. However, cancer registries on the smallest geographic unit usually provide data at the county or census tract level. The registry cannot provide data specified to Lane Street itself. More information can be found on the following websites:

- Indiana Cancer Registry: http://www.in.gov/isdh/24968.htm
- North American Association of Central Cancer Registries: http://www.naaccr.org/
- CDC National Program of Cancer Registries: http://www.cdc.gov/cancer.npcr

*6. How does TCE affect the liver and kidneys?* Animal studies have shown that high doses of TCE can cause enlargement of the liver or kidneys and can change the levels of various enzymes necessary for proper functioning of these organs. However, for the case of the Lane Street Site, ATSDR does not anticipate that exposures were high enough to cause effects for the liver and kidneys in children, teenagers, or adults.

*7. How do high levels of TCE affect children? Can children be affected after drinking the water for 15-20 years?* We do not believe that children drinking TCE-contaminated water at this site were exposed to TCE at levels high enough to cause short- or long-term health effects. Children born to women who drank and bathed in well water containing high levels of TCE while they were pregnant might have an increased risk of heart or other birth defects.

*8. Is it in the soil? Is it dangerous to the health of people/children/pets playing in the yard? How about when it rains or when it's hot outside and you see the vapors?* Most of the TCE deposited in surface waters or on soil surfaces evaporates quickly into the air, where it dissipates immediately and breaks down in a few days. TCE is very mobile in soil, so it can be washed down to subsurface regions where it will not degrade or evaporate quickly. The TCE below Lane Street moved from an as yet unidentified location, with subsurface groundwater flow. Therefore, the soils above the groundwater beneath Lane Street are most likely free of high amounts of TCE or other VOCs. Small amounts of TCE or other VOCs can slowly evaporate from the groundwater and move up through the soil to the atmosphere, but the amounts would be too small to cause any significant exposure to people, children, or pets present outside, even in hot weather. The only time this could potentially be a problem is if the small amounts of vapors coming from the groundwater move through the soil into a basement, house, or crawl space where they are trapped and build up to higher levels. In this report, ATSDR recommends further assessment of the potential for this phenomenon, called vapor intrusion, to occur at this site.

*9. Can it (contamination) become airborne and be toxic?* TCE and related VOCs can become airborne. These substances can be inhaled if contaminated water is used when taking showers, irrigating gardens, car washing, and using water for other household uses. All of these scenarios were possible while people were using water from contaminated private wells in the past. Our exposure estimates included a correction factor to account for additional exposures from inhalation exposures from these normal household uses. Municipal water was connected to 26 homes in the Lane Street area in November 2008, so the household use of contaminated water has stopped. VOCs can also evaporate from the subsurface groundwater and move up through the soil to enter homes; this is known as vapor intrusion. EPA collected air samples in December 2007 at two homes with high levels of contamination in their wells and found no evidence of vapor intrusion. In this report, ATSDR recommends further assessment of the potential for vapor intrusion to occur at this site.

*10. What effect did showering with contaminated water have on me and my kids? Is there any concern for my body? What test can I take (medical test)?* The exposure estimates in this report include a correction factor to account for additional exposures from skin exposure and breathing during household use of contaminated water, including showering. ATSDR found that exposure to the highest levels of contaminated water would be unlikely to increase the risk of cancer or cause noncancer health effects such as kidney or skin problems in children or adults. However, pregnant women who were exposed to the higher concentrations of TCE (100 µg/L or more) may have had an increased risk of having babies with heart or other birth defects.

Methods are available for measuring TCE or its metabolic byproducts in breath, blood, or urine (ATSDR, 1997). However, background levels of TCE in these biological matrices for the general population are not well defined, making it difficult to differentiate between normal background exposure and excess exposure. In addition, TCE is

efficiently metabolized in the human body, so detecting traces of exposures from weeks or years ago is not possible.

*11. Could an unborn baby be affected by contamination?* Yes, in the past pregnant women who drank and bathed in well water containing high levels of TCE (100 µg/L or more) might have had an increased risk of having babies with heart or other birth defects.

*12. "We lost our dog. Our dog was healthy in 2004. It developed cancer in its leg 2 years later and died in 2008. Ice tasted funny. Tasted like motor oil. Water had rainbow film like oil."*
We are sorry for the loss of your dog. Regarding TCE's association with cancer, long-term TCE exposure was shown to cause kidney cancer in rats and liver cancer in mice. No studies were found to indicate that TCE exposure may be associated with cancer in muscles or bones (ATSDR, 2007). Although there are many differences between how people and different species of animals are exposed and may develop cancer, we cannot tell whether your dog developed cancer from TCE. TCE in concentrated form has a somewhat sweet odor and a sweet, burning taste, but people would not be able to smell or taste the relatively low levels detected at Lane Street.

*13. After a year in our house we stopped drinking water (5 years ago). Could we have cancer? Did it affect our brains? Why?"* The increased risk of cancer depends on the concentration of the TCE and how long the exposure occurred. Current knowledge about TCE indicates that the levels and the length of exposure to TCE in the Lane Street area are too low to result in a detectable increased risk of cancer. With only one year of exposure, the increased risk of cancer would be so low as to be negligible. Very high exposures to TCE can affect the brain and nervous system; however, the concentrations of TCE present in wells at the Lane Street site are too low to have caused these effects.

**General Environmental Concerns**

*1. Could there be additional exposures in the future or long-standing problems?*
Residences are connected to municipal water that is regularly monitored and subject to local, state, or federal drinking water standards. People who aren't using contaminated well water can no longer be exposed to VOCs through general household water use. However, it is possible that some VOCs could evaporate from the groundwater, move up through the soil, and enter and build up in some homes – this is known as vapor intrusion. ATSDR is recommending additional sampling to confirm that vapor intrusion is not an issue for homes located above the known area of groundwater contamination. Also, EPA is currently investigating the site and will be developing options for cleanup.

*2. Who is responsible for this contamination and can it be cleaned up?* IDEM and the EPA started testing for contamination in 2007. The EPA is continuing its efforts to find the responsible party. The source may or may not be determined. There are several manufacturing companies in this area and it may be difficult to determine where the contamination originated. A number of techniques for cleaning VOC contamination from groundwater exist.

*3. Does groundwater affect the roots of the plants and vegetables we are growing?* TCE does not build up significantly in plants (ATSDR, 2003). The surface of the groundwater in this area is generally located 6 to15 feet below the ground surface, below the typical root zone of plants and vegetables (IDEM, 2008). If VOCs evaporated from the groundwater, they could move through the soil, but they are volatile and would generally continue moving through the soil until they were released to the atmosphere.

*4. Can we still be exposed to TCE even though we are now connected to municipal water?* There is now very little risk, if any, for exposure to TCE for Lane Street residents connected to municipal water. The city regularly monitors the municipal water, and the water is subject to state and federal drinking water standards. (For information on the municipal water quality, please contact the Elkhart Public Works and Utilities Department at (574) 293-2572 or visit http://www.elkhartindiana.org/department/index.asp?fDD=34-0. Homes that still use private wells have the potential to be exposed if the groundwater is or becomes contaminated. Limited testing has indicated vapor intrusion is not occurring in the homes with elevated levels of TCE in well water. However, ATSDR is recommending further sampling to confirm that vapor intrusion is not an issue for homes located above the known area of groundwater contamination.

*5. We are concerned about fumes; we have a water heater, water softener, and toilet tank; did TCE affect them and could it still be present in them?*
Once TCE or other VOCs evaporate into the air, they dissipate and are degraded relatively quickly. It is unlikely that these systems are so airtight that the vapors would build up to a significant level or have any effect on the systems. Now that homes are on municipal water free of VOC contamination, any vapors that would have been left are long dissipated.

*6. In pipes, we were told it (TCE) is slowly cleaned out, however the local health department stated that the contaminated groundwater was immediately eliminated when residents were connected to city water; is there more information on this*? Municipal water was connected in November 2008. Any TCE or TCE-contaminated water should have been flushed out of the homes' piping systems quickly.

*7. Given the number of contaminated sites in the area, how can authorities keep this from happening again?* There is no sure way of knowing if contamination will occur again. There are ways to try to prevent contamination by manufacturing companies keeping an active account of their chemicals and their amounts. Current environmental regulations are designed to reduce chances for environmental contamination to occur. Residents or workers can get involved by reporting illegal dumping or workplace practices to their local health departments and the state.

*8. Is there more information on the remediation process? When will more testing be done by the EPA?* EPA is the lead agency for the remediation process. The current EPA Region V Representative for the Lane Street Site is Bernie Schorle; he can be contacted

at 312-886-4746. EPA began further sampling in spring 2011. ATSDR is working with the EPA to ensure that further sampling is conducted to evaluate remaining public health issues.

*9. Residents that worked at one of the nearby companies were told not to drink the water because it causes cancer. Was the water safe to drink at my former job?* If you were told not to drink the water, there may have been a known problem with the water, but ATSDR does not have any data or information to confirm this or evaluate whether the water at your former place of employment was safe. In general, ATSDR's authority does not extend to active work facilities. The company you worked for may be able to provide information about past water quality issues.

## Conclusions and Next Steps

### Conclusions

ATSDR reached three important conclusions in the PHA:

**Conclusion 1**

People who drank water from private wells containing the highest levels of TCE at the Lane Street Ground Water Contamination site had an increased risk of adverse health effects. ATSDR considers the site a past public health hazard.

**Basis for conclusion**

ATSDR concluded that pregnant women who regularly drank and used water containing high levels of TCE (100 µg/L or more might have had a theoretical increased risk of having babies with heart or other birth defects. Not all wells had TCE levels high enough to cause these effects.

**Next steps**

- Most homes were connected to municipal water in 2008 and are no longer using private wells. Municipal drinking water is monitored by the Elkhart Public Works and Utilities Department.
- ATSDR will explore options for providing information to the community on possible health effects from past TCE exposures.

**Conclusion 2**

Current exposures at the site are not expected to cause harm. However, exposure from wells still in use may pose a potential future public health hazard if contaminant levels increase.

**Basis for conclusion**

Almost all homes in the Lane Street area, and all homes with well water containing VOC levels above drinking water standards, have been switched to municipal water. One or two homes in the area may still be using wells for drinking water, but these wells did not show VOC contamination above drinking water standards. Because the source of the contamination has not been identified, it is unknown how TCE or related VOC levels might change in any wells still in use. Wells that have not shown harmful levels of contamination until now may become more contaminated in the future.

**Next Steps**

- Occupants in homes not connected to municipal water should have their well water tested regularly.
- ATSDR will evaluate additional data collected by EPA and update the findings of this PHA, if necessary.

| | |
|---|---|
| **Conclusion 3** | More information is needed to assess whether VOCs may be building up in homes (vapor intrusion). |
| **Basis for conclusion** | EPA collected indoor air samples in two homes with the highest amounts of TCE in well water. The samples were taken to identify whether vapors from underground contaminated water could be building up inside the homes. The samples indicated VOCs were not present at harmful levels at the two homes sampled. However, vapor intrusion can vary seasonally and from house to house. |
| **Next Steps** | • EPA should conduct additional sampling to verify that Lane Street residents are not being exposed to groundwater contaminants from vapor intrusion. |

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# Appendix A. Explanation of Evaluation Process

## Screening Process

In evaluating these data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are health-based contaminant concentrations found in a specific media (air, soil, or water) and are used to screen contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone might inhale or ingest each day.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and noncancer health effects. Noncancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included, and the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are based on a one-in-a-million excess cancer risk for an adult exposed to contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and noncancer levels exist, we use the lower level to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

CVs used in preparing this document are listed below:

*Environmental Media Evaluation Guides (EMEGs)* are estimated contaminant concentrations in a media where noncarcinogenic health effects are unlikely. EMEGs are derived from the Agency for Toxic Substances and Disease Registry (ATSDR) minimal risk level (MRL).

*Cancer Risk Evaluation Guides (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. CREGs are calculated from U.S. Environmental Protection Agency (EPA) cancer slope factors (CSFs).

*Reference Media Evaluation Guides (RMEGs)* are estimated contaminant concentrations in a media where noncarcinogenic health effects are unlikely. RMEGs are derived from EPA's reference dose (RfD).

*Lifetime Health Advisories (LTHAs)* are derived by EPA from a drinking water equivalent level below which no adverse noncancer health effects are expected to occur over a 70-year lifetime.

*Maximum Contaminant Levels (MCLs)* are enforceable standards set by EPA for the highest level of a contaminant allowed in drinking water. MCLs are set as close to MCL goals (MCLGs, the level of a contaminant in drinking water below which there is no known or expected risk to health) as feasible using the best available treatment technology and taking cost into consideration.

*EPA Regional Screening Levels (RSLs)* are risk-based concentrations derived from standardized equations combining exposure information assumptions with EPA toxicity data. EPA considers RSLs to be protective for humans (including sensitive groups) over a lifetime.

Some CVs may be based on different durations of exposure. Acute duration is defined as exposure lasting 14 days or less. Intermediate duration exposure lasts between 15 and 364 days, and chronic exposures last 1 year or more. Comparison values based on chronic exposure studies are used whenever available. If an intermediate or acute comparison value is used, it is denoted with a small *i* or *a* before the CV (e.g., iEMEG refers to the intermediate duration EMEG).

**Determination of Exposure Pathways**

ATSDR identifies human exposure pathways by examining environmental and human components that might lead to contact with contaminants of concern (COCs). A pathway analysis considers five principal elements: a source of contamination, transport through an environmental medium, a point of exposure, a route of human exposure, and an exposed population. Completed exposure pathways are those for which the five elements are evident, and indicate that exposure to a contaminant has occurred in the past, is now occurring, or will occur in the future. Potential exposure pathways are those for which exposure seems possible, but one or more of the elements is not clearly defined. Potential pathways indicate that exposure to a contaminant could have occurred in the past, could be occurring now, or could occur in the future. The identification of an exposure pathway does not imply that health effects will occur. Exposures might be, or might not be, substantive. Therefore, even if exposure has occurred, is now occurring, or is likely to occur in the future, human health effects might not result.

ATSDR reviewed site history, information on site activities, and the available sampling data. On the basis of this review, ATSDR identified household use of private well water as the main pathway of concern at the Lane Street Ground Water Contamination site.

**Evaluation of Public Health Implications**

The next step is to take those contaminants present at levels above the CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using our assumptions of who goes on the site and how often they contact the site contaminants. The exposure dose is the amount of a contaminant that gets into a person's body. Following is a brief explanation of how we calculated the estimated exposure doses for the site.

***Ingestion of Groundwater***

The overall exposure dose of TCE was estimated for pregnant women and young children – considered the most sensitive to environmental toxins in many situations. Pregnant women were assumed to weigh 60 kg (132 pounds) and drink 2.5 liters of well water per day. Children were assumed to weigh 10 kg (22 pounds, the average weight of a one-year-old) and drink 1 liter of well water a day (EPA, 2009c).

**Noncancer Health Effects**

The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, and/or the use of the lowest study doses that resulted in harmful health effects (rather than the highest dose that did not result in harmful health effects). For noncancer health effects, the following health guideline values are used.

***Minimal Risk Level (MRLs) —Developed by ATSDR***

An MRL is an estimate of daily human exposure – by a specified route and length of time – to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

***Reference Dose (RfD) —Developed by EPA***

An RfD is an estimate, with safety factors built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause noncancerous health effects. RfDs can be found at http://www.epa.gov/iris.

If the estimated exposure dose for a chemical is less than the health guideline value, then the exposure is unlikely to cause a noncarcinogenic health effect in that specific situation. If the exposure dose for a chemical is greater than the health guideline, then the exposure dose is compared to known toxicologic values for that chemical and is discussed in more detail in the public health assessment (see Discussion section). These toxicologic values are doses derived from human and animal studies that are summarized in the ATSDR *Toxicological Profiles*. A direct comparison of site-specific exposure and doses to study-derived exposures and doses that cause adverse health effects is the basis for deciding whether health effects are likely or not.

**Cancer Health Effects**

The estimated risk of developing cancer resulting from exposure to the contaminants was calculated by multiplying the site-specific adult exposure dose by EPA's corresponding CSF (which can be found at http://www.epa.gov/iris ). The results estimate the maximum increase in risk of developing cancer after 70 years of exposure to the contaminant. For this site, we assumed 40 years as a conservative worst-case exposure duration, because the neighborhood was not built before the late 1970s. Therefore, the maximum increased

cancer risk was multiplied by the factor (40/70) to account for a less-than lifetime exposure.

The actual increased risk of cancer is probably lower than the calculated number, which gives a theoretical worst-case excess cancer risk. The method used to calculate EPA's cancer slope factor assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The method also assumes that no safe level exists for exposure. Little experimental evidence exists to confirm or refute those two assumptions. Lastly, the method computes the upper $95^{th}$ percent confidence limit for the risk. The actual cancer risk can be lower, perhaps by several orders of magnitude (EPA, 1989).

Because of uncertainties involved in estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data (ATSDR, 1993). Therefore, the carcinogenic risk is described in words (qualitatively) rather than giving a numerical risk estimate only. The numerical risk estimate must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure.

## Appendix B. Questionnaire for Community Interviews

1. How long have you lived here?
2. What do you see as the major problems facing the community of Elkhart regarding the Lane Street Ground Water Contamination Site and why?
    a. Listen for environmental concerns or health concerns related to the environment.
    b. If not mentioned ask: Do you think the environment of the community is a problem?
    c. Why/Why not?
3. How much do you know about the environment of the community? Are you worried that the environment in your community might be affecting people's health? Why / why not? (Listen for specific concerns).
    a. Probe for who they think might be responsible for causing the environmental problems).
4. Are you aware of any previous or current effort to address any environmental or environmental health concerns through a community-wide effort? If yes: Please describe what happened during that situation. Do you know who are/ were the key players? How effective do you think it was/is?
5. What / who do you think is causing the environmental problems in the community? (Listen for specifics—like a company or an industrial plant.
    a. Do you think that others in the community would agree with you? Why or why not? What problems do you think that others might list?
6. Do you think your community has the resources to address these concerns? What are those resources? Note: Listen and probe for:
7. On a scale of 1-5 (5 being very high; and 1 being very low) how concerned do you think the community is about the potential environmental hazard in Lane St.
8. Who do you think is responsible for addressing those concerns?
9. Do you think most people are upset about the environmental health of their community? Who are they upset with? Listen for what is or is not being done. Probe, if not mentioned: Do you think the community believes their health has been or could be impacted?

10. Has the state/local/federal government been responsive to the concerns?
11. Do you think the agencies are doing enough? Does the community?
12. What level of trust do you have in the government taking care of this issue? Listen for specific government agency or level (state/local/federal)
13. Do you think there is anything that a person can do to help change the environment here?? Probe: Do you think the average community member would agree with you?
14. What kind of information do you think the community needs to know? Probe: Any suggestions on the most effective strategies for communicating to your community about environmental health concerns?
    a. How would you like to be kept informed about our community involvement activities in your community?
        i. Direct mail
        ii. Internet
            1. e-cards
            2. web page

## Appendix C. Glossary of Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency in Atlanta, Georgia, with 10 regional offices in the United States. ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases from toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces laws to protect the environment and human health. This glossary defines words used by ATSDR in communications with the public. It is not a complete dictionary of environmental health terms. For additional questions or comments, call ATSDR's toll-free telephone number, 1-888-42-ATSDR (1-888-422-8737).

**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

**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].

**Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)**
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances. The Superfund Amendments and Reauthorization Act (SARA) later amended this law.

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

**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.

**Dermal**
Referring to the skin. For example, dermal absorption means passing through the skin.

**Dermal contact**
Contact with (touching) the skin [see route of exposure].

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

**Dose**
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.

**Environmental media**
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

**Epidemiologic study**
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

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

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

**Exposure pathway**
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: 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.

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

**Health outcome data**
Information from private and public institutions on the health status of populations. Health outcome data can include morbidity and mortality statistics, birth statistics, tumor and disease registries, or public health surveillance data.

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

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

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

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

**Metabolic byproduct**
Any product of metabolism.

**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].

**Morbidity**
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

**Mortality**
Death. Usually the cause (a specific disease, a condition, or an injury) is stated.

**National Priorities List for Uncontrolled Hazardous Waste Sites** (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

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

**Population**
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

**Prevention**
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

**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.

**Public health surveillance**
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

**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.

**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].

**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.

**Sample size**
The number of units chosen from a population or an environment.

**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)]

**Superfund Amendments and Reauthorization Act** (SARA)
In 1986, SARA amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

**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.

**Transport mechanism**
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

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

Other glossaries and dictionaries:
Environmental Protection Agency (http://www.epa.gov/OCEPAterms/) National Library of Medicine (NIH) (http://www.nlm.nih.gov/medlineplus/mplusdictionary.html)

For more information on the work of ATSDR, please contact:
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