

Health Consultation

Vapor Intrusion of PCE in a Residential Community

FORMER CRESCENT CLEANERS

EVANSVILLE, VANDERBURCH COUNTY, INDIANA

EPA FACILITY ID: IND981783616

OCTOBER 22, 2003

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation 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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HEALTH CONSULTATION

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Prepared by:

Indiana State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Background

The Region 5 Agency for Toxic Substances and Disease Registry (ATSDR) and the Indiana State Department of Health (ISDH) was asked by the Indiana Department of Environmental Management (IDEM) to evaluate possible health effects from exposures to elevated levels of perchloroethylene (also known as PCE, tetrachloroethylene, or PERC) detected in some Evansville, Indiana, residential houses. While investigating groundwater contamination associated with the Former Crescent Cleaners site in Evansville, Indiana, IDEM detected levels of PCE in groundwater up to 23,000 parts per billion (ppb) with groundwater depths at about 35 feet. In one soil sample, PCE was detected in concentrations as high as 9,500,000 ppb. Since the soil in this area is particularly sandy, IDEM evaluated the potential for PCE vapors from the groundwater infiltrating into nearby homes and businesses. IDEM continues to conduct additional sampling studies of contamination of indoor air, soil, and groundwater to characterize the extent of the PCE plume.

Crescent Cleaners, a dry-cleaner formerly located at 666 Lincoln Avenue, in Evansville, Vanderburgh County, Indiana, is a non-National Priorities List (NPL) site (see Figure). Crescent Cleaners operated in the neighborhood from 1933 until the mid-1980s. In the 1920s, the site was an automobile repair garage. The site is currently owned by Realty Asset Properties, Ltd. (Realty Asset). In 2000, as part of its condemned building demolition process, the city of Evansville initiated a Phase I/II Environmental Site Assessment of the property. The investigation indicated the presence of two underground storage tanks (USTs); these were removed in January of 2002. Subsequently, the PCE groundwater contamination and vapor-intrusion issue was revealed.

The Crescent Cleaners site is in an older area of Evansville that has primarily single-family residences. Typically, the homes date either from the early 1900s or were built within the last 10 years to provide low-income, single family housing; the homes on several lots have been razed. The community is on municipal water, so there is no direct contact with the contaminated groundwater.

In February 2003, a contractor retained by Realty Asset sampled the air in two residences and in a retail market. All three of these buildings were close to the former Crescent Cleaners. The highest level of PCE was detected in a home's living space, a bedroom, at 350 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), or 0.05 parts per million (ppm). PCE levels for both homes and the business exceeded the IDEM chronic risk screening criteria of $6.7 \mu\text{g}/\text{m}^3$, or 0.001 ppm, a value based on cancer risk. The highest level of PCE found exceeded the ATSDR comparison value of $270 \mu\text{g}/\text{m}^3$ (0.04 ppm), which is based on neurobiological (nerve) effects. Information on all data collected is presented in the *Discussion* section of this document.

In March 2003, IDEM repeated indoor air sampling at the three properties and also took samples at an elementary school across the street from the site. Levels in samples taken inside Lincoln Elementary School did not exceed detection limits for PCE. IDEM's testing confirmed the presence of PCE in the other three buildings. IDEM offered to provide temporary housing for

residents while an air treatment system was installed. In April 2003, to remove contaminants, IDEM installed slab depressurization systems at these two homes and at the one business.

In mid-April 2003, ambient air samples were collected near the site, and additional indoor air sampling was performed at the two homes, the business prior to remediation, Lincoln Elementary School, and seven additional properties in the vicinity of the site. Three additional homes were found to have PCE levels exceeding the IDEM chronic risk screening criteria. One of 15 samples at the elementary school had a PCE concentration of 12 $\mu\text{g}/\text{m}^3$ (0.002 ppm), which exceeded IDEM's screening value but was below the ATSDR health screening value. In late May 2003, IDEM tested the properties in which systems had been installed to mitigate the PCE in indoor air. In one residence, remediation was effective. In June 2003, modifications were made to the vapor mitigation systems in the other two buildings where the systems were not effective. Results from confirmatory indoor air samples collected in July 2003 were pending in October 2003. Slab depressurization systems were also installed in the three additional homes where PCE levels were found above the IDEM screening value. IDEM is continuing sampling to characterize the contamination and is seeking federal Environmental Protection Agency (USEPA) support in the investigation.

IDEM workers performing the environmental sampling have reported that residents have expressed concerns about possible health effects from PCE. IDEM workers referred these residents to the state and local health departments. No community meeting has yet been held concerning the site. IDEM's contact with residents has been through door-to-door discussions concerning findings and sampling needs. When sampling results are finalized, IDEM anticipates holding a public meeting to discuss additional actions. In July 2003, the Indiana State Department of Health (ISDH) conducted an initial site visit. ISDH is planning to conduct a needs assessment and to provide community members with information that will assist in answering their questions and in protecting their health.

Site Visit

On July 2, 2003, ISDH staff from the Environmental Epidemiology Section (EES) and a representative from the Region 5 office of ATSDR visited the Former Crescent Cleaners Site and the Vanderburgh County Health Department. The objective was to gather information about the community so that information could be presented to them in a way they want it, to gather health concerns, and to respond to questions concerning the site.

The median household income for residents within the ZIP code of the affected community is \$22,932.00. The accessibility of health care in the community is unclear. Lincoln Avenue is the dividing line for two census tracts. The 2000 U.S. Census shows that both tracts have over 50% African-American residents.

An attempt was also made to meet with residents and owners whose buildings were affected by indoor vapor intrusion from the Former Crescent Cleaners Site. Residents from four of the five homes were contacted.

The Crescent Cleaners building was razed two years ago, and the home that was connected to the cleaners was razed about one year ago; the foundation is all that remains. An alleyway exits on the west side of the property between the foundation and an adjacent home. A retail business is adjacent to the cleaner's foundation on the east side; the store has been there for twelve years.

During the visit, the owner of the retail business inquired about additional indoor air sampling. A vapor intrusion system had been installed in the building, but subsequent air sampling still found higher than normal levels of PCE. It was discovered that the intrusion system on the outside of the store had been vandalized. Through a local contractor, IDEM immediately made repairs. However, the owner questioned whether the system was now working effectively.

ISDH and ATSDR staff learned from interviews with the business owner and residents that they had not observed any health symptoms or health problems which they considered related to exposure to PCE. This, however, did not alleviate their concern regarding some potential health effects as a result of their past exposure. Little information had been previously provided that described PCE and its potential health effects. During the site visit, a PCE fact sheet was provided to all residents along with brochures that explained the EES Department at the ISDH and one entitled *Handling Household Chemicals: Staying Healthy and Safe*. A contact number for ISDH was also provided to allow residents to ask additional questions and to express concerns

Discussion

Environmental Data

IDEM provided environmental data from indoor air, groundwater, and soil studies for review. Indoor air in two homes, a retail business, and an elementary school in the neighborhood around the site was sampled over 24 hours using 6 liter SUMMA canisters (Table 1). To assess the effectiveness of the air treatment systems installed in April 2003, additional indoor air sampling was performed in May 2003. Seven additional homes had air sampling performed in April 2003; three of those homes had detectable concentrations of PCE above the IDEM chronic screening criteria (Table 2). These sites were in proximity to the Former Crescent Cleaners, but were not necessarily within the identified groundwater plume. In April 2003, ambient air sampling revealed PCE concentrations near the site were between 0.21 and 3.1 $\mu\text{g}/\text{m}^3$ (0.00003 and 0.0005 ppm).

Table 1. Indoor Air Sampling Results February through May 2003 at Initial Testing Locations

Structure	Occupants	Location	PCE Concentration ($\mu\text{g}/\text{m}^3$)			
			Feb 2003	Mar 2003	Apr 2003	May 2003 (post-remediation)
Residence 1	3 adults, 1 child	Basement	81.3	58.8	40	6.44
		Living room	NT	NT	17	20.1
		Bedroom	NT	7.7	9	NT
Residence 2	Adult, 3 children	1 st floor bedroom	312	350	260	3.52; 5.15
		Living room	NT	NT	270	ND
Retail Business	Workers, customers	Office	NT	32.8	60	145
		Main area	173	NT	79	110
Lincoln Elementary School	Staff, students	Basement, 1 st and 2 nd floor classrooms	NT	ND	ND, 12*	NT

Table based on data provided by IDEM. ND: non-detect, NT: not-tested; The IDEM acute screening criteria for an Immediate Action Level is $110 \mu\text{g}/\text{m}^3$. The IDEM chronic screening criteria is $6.7 \mu\text{g}/\text{m}^3$, based on a 10^{-5} cancer risk. The ATSDR Chronic Minimum Risk Level (MRL) value is $270 \mu\text{g}/\text{m}^3$ (40 ppb), based on neurobehavioral effects in dry cleaning workers. May 2003 results are post installation of the slab depressurization systems.

*Hallway of Lincoln Elementary school: $12 \mu\text{g}/\text{m}^3$, other 14 of 15 samples non-detect.

Convert $\mu\text{g}/\text{m}^3$ PCE to parts per million: $(\mu\text{g}/\text{m}^3 \times 24.45/165.83) \times 10^{-3}$

Table 2. Additional Residential Indoor Air Sampling Results April 2003, Locations with PCE Concentrations above the IDEM Chronic Screening Criteria.

Structure	Occupants	Location	PCE Conc. ($\mu\text{g}/\text{m}^3$)
Residence 3	2 adults, 6 mo infant	1 st floor living room	4.1, 10
		1 st floor bedroom	5, 15
		2 nd floor bedroom	15
		Basement	9.3
Residence 4	Adult, 3 children	Living room	16
		Bedroom	15
		Basement	38
Residence 5	Adult, 2 children	Living room	98
		Bedroom	94

Table based on data provided by IDEM. ND: non-detect, NT: not-tested; The IDEM acute screening criteria for an Immediate Action Level is $110 \mu\text{g}/\text{m}^3$. The IDEM chronic screening criteria is $6.7 \mu\text{g}/\text{m}^3$, based on a 10^{-5} cancer risk. The ATSDR Chronic Minimum Risk Level (MRL) value is $270 \mu\text{g}/\text{m}^3$ (0.04 ppm), based on neurobehavioral effects in dry cleaning workers.

IDEM's sampling of groundwater at the site revealed the water contained up to 23,000 ppb PCE at 35 feet below ground surface (bgs). In one soil sample, IDEM detected PCE in concentrations as high as 9,500,000 ppb. The buildings investigated for vapor intrusion do not necessarily follow the direction of migration of the groundwater plume. It is suspected that alternative pathways for the PCE vapor migration, such as sewer or underground utility lines, are present. IDEM has an ongoing investigation for soil, soil gas, and additional groundwater sampling to further characterize the PCE plume.

Human Exposure Pathways

To determine whether people are, could be, or have been exposed to PCE associated with the Former Crescent Cleaners site, ATSDR analyzed the exposure pathways (Table 3).

Table 3. Exposure Pathway for PCE from the Former Crescent Cleaner Site.

Source	Environmental Transport and Media	Chemical of Concern	Exposure Point	Exposure Route	Exposed Population	Time Frame	Status
Former Crescent Cleaners site	Vapor intrusion from soil gases contaminated by a groundwater plume	PCE	Residential buildings, schools, or other businesses	Inhalation	Residents, schoolchildren, and business employees and customers	Past Present Future	Complete Complete Complete

PCE was detected in indoor air samples taken from several residences, from the local elementary school, and from a local retail business. The likely PCE source is vapor intrusion from soil gases volatilizing from the groundwater plume from the Former Crescent Cleaners site. The groundwater plume of PCE detected on the site most likely resulted from spills of PCE used at the site and leaks from an underground PCE storage tank. Because the community uses municipal water, people would not come in direct contact with the PCE in the groundwater. Therefore, inhalation of contaminants coming from the soil gas, primarily into buildings, would be the primary route of exposure. The dry cleaners closed in the mid-1980s, so the spills or leaks of PCE would have occurred many years ago. In January 2002, two underground storage tanks were removed from the site. Thus, residents would have been exposed in the past, and in the absence of any remedial action to remove contamination, continue to be exposed. Additionally, over time, levels in buildings that are now below those of health concern could increase to harmful levels if actions are not taken to prevent that, and PCE could continue to move to buildings that are not currently contaminated.

ATSDR's chronic Minimum Risk Level (MRL) for inhalation of PCE is 270 $\mu\text{g}/\text{m}^3$ (or 0.04 ppm); this value is based on neurobehavioral effects. A study by Ferroni, et al., (1992) provided the basis for this MRL. In that study, 60 women exposed to PCE while employed in dry-cleaning shops for an average of 10.1 years were evaluated for neurobehavioral effects; blood samples and air samples were also collected. Thirty women employed at a cleaning plant that did not use solvents served as controls. The median PCE air concentration was 15 parts per million (ppm). The levels ranged from 1–67 ppm. The median PCE blood concentration was 145 milligrams/liter (mg/L), and the range was 12–864 mg/L. Compared with the control group, PCE exposed workers had significantly increased simple reaction times, shape comparison-vigilance and shape comparison-stress. The lowest observed adverse effect level (LOAEL) for increased reaction times was 15 ppm. Uncertainty factors for human variability (10x) and use of a LOAEL (10x) were incorporated as safety factors into the MRL. The highest level within a living space in a home was 350 $\mu\text{g}/\text{m}^3$, or 0.05 ppm. Although those levels were not likely to result in non-cancer, adverse health effects at that time, levels during cold months, especially

when there is snow cover, could be higher, and the potential for levels to be higher exists if the mitigation system fails.

The IDEM acute screening criteria for an Immediate Action Level is $110 \mu\text{g}/\text{m}^3$ (0.02 ppm), and the chronic screening criteria, based on a 10^{-5} cancer risk, is $6.7 \mu\text{g}/\text{m}^3$, or 0.001 ppm. The highest level found in the living space of one home was $350 \mu\text{g}/\text{m}^3$ (0.05 ppm). Exposure over a long period of time to the highest levels found in a home could result in an increased chance of developing cancer. The systems that were installed on the homes and the business reduced exposures and also substantially reduced the cancer risk for those exposed. However, PCE levels in groundwater remain high; therefore, the potential remains for indoor air levels to increase in homes and buildings that do not have depressurization systems (or that have failing systems) and for the contamination to spread to other homes and buildings. More toxicological information is presented in an attachment to this document.

Health Outcome Data

Affected residents have not provided ATSDR with any biological monitoring data, and it is assumed that none has been performed. Because of the limited number of residences involved, ATSDR believes the need for the analysis and interpretation of secondary health outcome data is not appropriate. One resident asked ISDH about testing, and ISDH explained that testing would not capture exposure to levels of PCE that were present in the home prior to installation of the depressurization system.

Based on the literature, it would be anticipated that given the current level of exposure to PCE, residents would have PCE-blood concentrations at or slightly above background readings. PCE-blood levels would reflect current exposures and would not be indicative of past or possible future exposures. Other blood and urine testing for effects are non-specific and not very sensitive for the low-level chronic exposure to PCE that occurs in this community. In all likelihood, no abnormalities in blood, liver, or kidney function attributable to this PCE exposure would be found. Medical evaluation and testing performed as part of an individual's regular preventive health screening and health maintenance is encouraged, but it is unclear whether any findings could be attributed to the chronic, low levels of PCE exposure found at this site.

That information, coupled with concern about the cost of traveling to a health care provider and paying for expensive testing, helped the resident decide not to have testing at this time. However, some residents may find that personal blood sampling is a more reassuring assessment of exposure. If their blood-PCE levels are lower, this could suggest that those people spent less time in the contaminated environment. Higher than expected blood-PCE levels could indicate that additional sources of exposure exist that should be avoided.

Community Health Concerns

During the site visit in July 2003, the residents and business owner raised the following questions and concerns about the site.

Are the kids playing in the vacant lots and alleys going to be affected by PCE?

Because a concrete slab covers the vacant lot and alley at the site, dermal exposure to PCE is not likely. At this site, inhalation is the primary route of exposure for PCE. Ambient air concentrations are below any public health levels of concern.

Has the underground tank been cleaned out or removed?

Yes, the two underground tanks from the site were removed on January 29, 2002, by EFS, a subcontractor to Paragon Environmental Services, thus eliminating a source of the PCE.

What would good quality furnace filters do to decrease the problem?

Typically, a furnace filter will not remove low level chemical contaminants from the home; its function is to keep the furnace free of dirt and dust particles. A carbon filter can remove organic contaminants from homes. The charcoal filters the vapors from the air. These charcoal filters must be specially purchased from a heating and cooling store and usually require a pre-filter as well.

How does this affect the health of those living in the home? In particular, how does this affect grandchildren and other children playing and sleeping in the home?

At the current concentrations, there is little likelihood of adverse health effects from the exposure to PCE in these homes. Concentrations of PCE below ATSDR's chronic Minimum Risk Level for inhalation of $270 \mu\text{g}/\text{m}^3$ (0.04 ppm) are not likely to result in any adverse non-cancer health effect, even if someone is exposed for many years. The IDEM chronic screening criteria, based on a 10^{-5} cancer risk, is $6.7 \mu\text{g}/\text{m}^3$ (0.001 ppm). This means that for a long term (usually 70 years) exposure there is a 1 in 100,000 chance of developing a cancer related to PCE.

While an individual's risk might be low, exposures should still be minimized. For an individual's home, installation of the slab depressurization systems will decrease exposure. Recommendations to residents for decreasing PCE concentrations in homes until a system is placed include:

(1) finding an alternate sleeping area in the home from the room having higher concentrations of PCE,

(2) closing the door to the contaminated room and opening a window to allow circulation of air in that area, and

(3) closing the air conditioning/heating vents in the affected room and opening windows to keep fresh air circulating.

Some individuals are concerned about the need for IDEM follow-up, specifically, by retesting after mitigation, by providing residents with test results, and by informing the residents of whether possible mitigation would be necessary.

Additional sampling was performed in July 2003, and results of that analysis are pending. The concerns about obtaining environmental testing results and future actions will be discussed with appropriate IDEM personnel.

There is some confusion about the availability of temporary relocation offered by IDEM.

After the March 2003 testing, IDEM offered to provide temporary housing to those residents who chose not to stay in their home until an air treatment system could be installed. These systems are now in place. As the investigation expands, this issue will be readdressed with IDEM and USEPA.

The business owner expressed concern about the impact of publicity resulting from a public availability session or meeting.

The community health education format is selected to best meet the needs of the community members, including the business owner and customers. To the extent possible, personal identifiers are removed from public documents. However, the overriding emphasis is to ensure that public health information is provided to the affected community.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are

dependent on adults for access to housing, for access to medical care, and for risk identification.

Thus, adults need as much information as possible to make informed decisions regarding their children's health.

Children have been and could continue to be exposed to PCE in the air of their homes. No studies were found to establish levels of exposure that might affect children; however, levels found to date in the homes and business are not expected to cause non-cancer adverse health effects in adults and, likely, not in children. Long-term exposure is undesirable because of a slight increased cancer risk, and exposures could increase to harmful levels if actions are not taken to prevent that.

Conclusions

Based on the indoor air sampling, the former Crescent Cleaners site poses a public health hazard because long-term exposure could have resulted in an increased cancer risk. Although mitigation systems were installed and one system was effective, the systems failed in one home and the business. Repairs were made, but test results are not yet available to determine their current effectiveness.

PCE levels could be present or increase over time in buildings that do not have mitigation systems, if mitigation systems are not maintained, or if the plume continues to migrate to other areas. Future exposures pose an indeterminate public health hazard.

Given the magnitude of the PCE groundwater contamination and the existence of alternative pathways, such as utility lines and pipe lines, for vapor migration, it is anticipated that other homes and businesses may now be affected or could be in the future. Without remedial activities, chronic exposure to PCE in the community will probably continue.

Although biological tests could be conducted for PCE, levels that might be found now could not be correlated with exposure to site-related PCE because the depressurization systems have likely reduced levels in indoor air to levels are similar to background levels.

Recommendations

- Identify other residences affected by the Former Crescent Cleaners, and further characterize the site and the extent of the contamination for both groundwater and soil vapor plumes.
- Provide community outreach and health education to residents about the potential effects of exposure and about methods to decrease exposure to PCE.
- Although blood-PCE testing is not recommended, provide support to local health care providers for evaluating test results for residents who independently have tests performed.

Public Health Action Plan

- ATSDR will coordinate with ISDH, IDEM, and USEPA to provide community outreach activities that provide information about the contamination, the health effects, and remedial activities. This could consist of a public meeting, individual consultations or both. This activity is anticipated in the fall of 2003, once individual home sampling results are compiled.
- IDEM and USEPA will continue its exposure investigation of the groundwater, soil, soil-gas, and indoor air to characterize the PCE plume and impact area and to evaluate appropriate remedial activities for the site. In addition to individual home slab depressurization systems to reduce current exposure, IDEM and USEPA will consider efforts to curtail migration such as soil removal and pump and treat systems.
- ATSDR's Region V Representatives and ISDH will provide technical advice or health education to health care providers, as needed, to address interpretation of any test results and other health effects as they relate to PCE exposure from this site.

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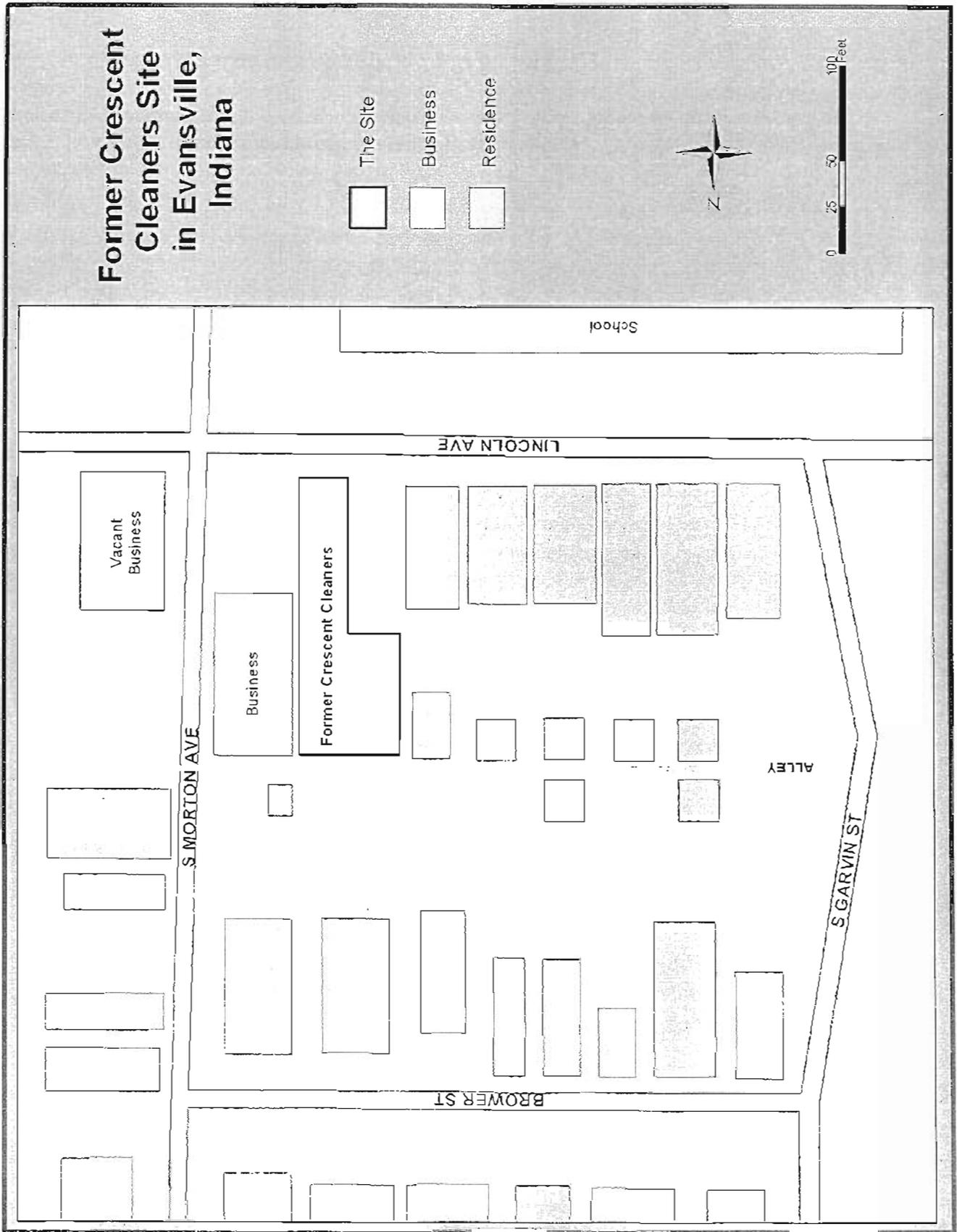
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Figure



Glossary

Acute - Occurring over a short time, usually 15 days or less

Chronic - Occurring over a short time, usually 365 days or more

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.

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.

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.

µg/m³ - Microgram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

Minimum 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), non-cancerous effects

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.

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.

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

Toxic - A chemical or physical agent (for example, radiation, heat, cold, microwaves) that, under certain circumstances of exposure, can cause harmful effects to living organisms.

Volatile - A term used to describe organic compounds that evaporate readily into the air. Volatile organic compounds include substances such as benzene, toluene, methylene chloride, and perchloroethylene.

Certification

This Former Crescent Cleaners Health Consultation was prepared by the Agency for Toxic Substances and Disease Registry and the Indiana State Health Department in cooperation with the Agency for Toxic Substances and Disease Registry. The health consultation is in accordance with guidelines and procedures present at the time the health consultation was begun.

Technical Project Officer
DHAC, SSAB, SPS

This health consultation has been reviewed by the Division of Health Assessment and Consultation, ATSDR. ATSDR concurs with the findings in the health consultation.

Chief, SPS, SSAB, DHAC, ATSDR

Attachment

Toxicological Information

Perchloroethylene (PCE) is a chlorinated hydrocarbon solvent. The major uses for PCE are in the dry-cleaning industry and in metal degreasing. PCE may enter the environment by evaporating in air during use, but it can also enter the soil, water, or air through spills or leaks from storage tanks and from waste sites. Consumer products, such as spot removers, fabric finishers, and water repellants, can also contain PCE. Off-gassing (release of vapors) of PCE also occurs from dry-cleaned clothing.

The primary route of exposure to PCE is through inhalation. The majority of inhaled vapor is absorbed through the lungs. Excretion primarily occurs through exhalation of the unchanged compound through the lung. About 2% of an absorbed dose is metabolized to trichloroacetic acid (TCA) and is excreted in the urine. This metabolism to TCA is inhibited by alcohol use. Some fat storage of PCE takes place. The physiological half-life of PCE is about three days. This means that after three days, the dosage originally present in the body after an exposure will be only half that amount.

Occupational studies have shown that chronic exposures to PCE adversely affect the central nervous system, liver, kidneys, and reproductive systems. Occupational exposures are typically at much higher concentrations than most residential indoor air exposures. Acute central nervous system effects at high concentrations (100 parts per million for seven hours) include headache, dizziness, and sleepiness. Results of animal studies, performed at high doses, revealed that PCE can cause liver and kidney tumors in animals. Although PCE has not been shown to cause cancer in people, the International Agency for Research on Cancer classifies PCE as a probable human carcinogen (cancer-causing agent).

The Occupational Safety and Health Administration (OSHA) permissible exposure limit is 100 ppm (680,000 $\mu\text{g}/\text{m}^3$) for an 8-hour workday, 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) has a threshold limit value of 25 ppm (170,000 $\mu\text{g}/\text{m}^3$) for an 8-hour time-weighted average. The occupational exposure levels are not considered protective to the general public; they are not designed to be protective of children, the elderly, or other adults who are not in good health.

Biological Exposure and Effects Monitoring

Exposure to PCE can be measured by testing exhaled breath, blood, or urine. TCA, a metabolic by-product of PCE, can also be measured in either the blood or urine. Exposures to other chemicals can also produce this break-down product. Ethanol consumption will also decrease the rate of PCE metabolism and influence the concentration of TCA.

Effects of PCE exposure have been studied in workers by Stewart, et al., (1981). They compared baseline and post-exposure complete blood count, liver function testing, blood urea nitrogen, and urinalysis of workers exposed to 0, 20, 100, or 150 ppm PCE for 1, 3, and 7.5 hours for 5 days for one week, with a subset also examined at 11 weeks. No difference was found from the baseline.

While non-specific to PCE exposure, change in visual contrast sensitivity is a sensitive indicator of neurotoxicity from organic solvents. A review article by Iregren, et al., (2002) determined that changes in color perception as measured by the Lanthony D15-desaturated panel was a sensitive test for effects of industrial chemical exposure.

Schreiber 2002 performed biological sampling and vision testing on family members living in two apartment buildings with dry-cleaning facilities. The PCE levels of indoor air samples from their apartments ranged from 0.1–1 ppm (650–6,100 $\mu\text{g}/\text{m}^3$). Afternoon blood PCE levels of 13 participants ranged from 1.1–18 $\mu\text{g}/\text{L}$, as compared to the background reference mean of 0.21 $\mu\text{g}/\text{L}$. Follow-up of the residents in one of the buildings, which had ceased operations for one month, revealed blood-PCE levels had decreased to background levels. The authors concluded that blood was a good biomarker for recent exposure to PCE, given that the blood correlated well with PCE levels in room air, personal air, and breath. A significantly lower group mean for visual contrast sensitivity across spatial frequencies was found in the exposed group. Results from the Lanthony Desaturated 15 Hue Color Discrimination test were suggestive of a possible trend towards worse color discrimination in the exposed group. Matched pair testing between exposed and control groups for vision testing showed no significant group difference for visual acuity suggesting that any changes were more likely neurological in origin because the groups were similar in optical refraction and ability to focus.

Background Exposure to Perchloroethylene

Background levels of PCE are generally higher in cities and industrial areas than in rural or remote areas. In rural areas, the background level of PCE is less than 0.001 ppm (6.8 $\mu\text{g}/\text{m}^3$). Indoor air levels of PCE of 0.0007–0.0009 ppm (5–6 $\mu\text{g}/\text{m}^3$) were found in the National Human Exposure Assessment Survey (NHEXAS) Phase I field study conducted in EPA Region 5 (Clayton 1999). Schreiber et al. (1993) found residential indoor air PCE levels ranged from several hundred to thousands of micrograms per cubic meter in residential buildings that housed dry-cleaning facilities.

In a study by Aggazzotti et al. (1994), PCE levels in the apartments of workers of dry-cleaners who lived well away from the dry-cleaning premises averaged 0.04 ppm (265 $\mu\text{g}/\text{m}^3$); control apartments had PCE levels of 0.0003 ppm (2 $\mu\text{g}/\text{m}^3$). Family members of the dry-cleaner workers had exhaled air concentrations of 0.03 ppm (225 $\mu\text{g}/\text{m}^3$), as compared to 0.0004 ppm (3 $\mu\text{g}/\text{m}^3$) in control subjects. Contributions to PCE in the worker households would be from exhaled air from the workers and off-gassing of vapors from the workers' clothing.