Health Consultation

FORMER EXPRESS CLEANERS
INDOOR AIR INVESTIGATION

HALES CORNER, MILWAUKEE COUNTY, WISCONSIN

SEPTEMBER 13, 2005

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

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HEALTH CONSULTATION

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HALES CORNER, MILWAUKEE COUNTY, WISCONSIN

Prepared by:

Wisconsin Department of Health and Family Services
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Summary

This health consultation evaluates the human health implications of soils and groundwater contaminated with solvents directly beneath the former Express Cleaners (FEC), in Hales Corners, Wisconsin. In November 2004, a coffee shop was opened at the FEC facility. Since people are not exposed to impacted soils or groundwater, these pathways are categorized as *no public health hazard*. The level of tetrachloroethylene (PCE) in shallow groundwater suggested the potential for vapor migration and intrusion, and warranted further investigations of the indoor air pathway.

The Wisconsin Department of Health and Family Services (DHFS) finds that the levels of PCE in indoor air at FEC are very low, unlikely to cause adverse health effects, and pose a *no apparent public health hazard* for employees and customers of the coffee shop. Indoor air investigations at FEC found slightly elevated levels of PCE and resulted in mitigation actions designed to reduce vapors entering the building. While the levels of PCE have decreased at FEC, very low levels of PCE continue to be present in indoor air. Air sampling data is unclear about the actual effectiveness of mitigation actions taken at FEC, however DHFS recommends the continued operation of the active sub-slab depressurization system as a precautionary measure that will assist with keeping PCE levels in indoor air as low as possible. DHFS offers to collect additional indoor air samples at FEC to determine whether a trend develops over time for PCE levels in indoor air.

Background

DHFS was requested by the Department of Natural Resources (DNR) and the current property owner to evaluate the human health implications of indoor air quality at a former retail dry cleaning business. The Former Express Cleaners (FEC) was located in a rental property at 5620 South 108th Street, Hales Corner, Milwaukee County, Wisconsin. This rental property is one of 14 contiguous rental units that occupy a "strip-mall" currently owned by Country Fair, LLC. The FEC facility was recently redeveloped and reopened in November 2004 as a retail coffee shop.

Past dry cleaning activities resulted in contaminated soils directly beneath the FEC rental property. Tetrachloroethylene, also referred to as perchloroethylene (PCE), is a chlorinated solvent still commonly used by the dry cleaning industry. Investigations of sub-surface soils beneath FEC detected PCE concentrations ranging between "no-detect" and 118 milligrams per kilograms (mg/kg). Shallow groundwater in the immediate vicinity of the FEC rental property also has elevated levels of PCE, with 145 µg/L found in a groundwater sample from beneath the property. The Wisconsin Public Health Drinking Water Quality Enforcement Standard for PCE is 5.0 µg/L (Wisconsin Administrative Code, 2001). PCE impacts to groundwater appear to be localized, and there are no known nearby drinking water wells. People are not exposed to

affected soils or groundwater and, as a result, PCE in groundwater and subsurface soils beneath FEC poses *no public health hazard*.

The concentrations of PCE in shallow groundwater beneath FEC exceeds the PCE screening levels, as cited in U.S. EPA's guidance on vapor migration and intrusion to the indoor air pathway (EPA 2002), and warranted further investigation of this pathway[1]. Under certain circumstances, chlorinated solvents in unsaturated soils or shallow groundwater can be released as vapors, migrate through soil pore spaces, and reach nearby buildings. Such vapors can then enter the indoor air of buildings through cracks in concrete foundations, spaces around utility lines or pipes, or via unfinished dirt floors. This pathway is referred to as "vapor migration and intrusion". If substantial amounts of solvent vapors reach the indoor air of a building, it is plausible that concentrations in indoor air can reach levels that may become an inhalation health concern for people who spend time in the building.

Due to the potential for PCE vapors being present inside of FEC, an indoor air sample was collected and analyzed for chlorinated volatile organic compounds, including PCE. The initial indoor air sample was collected in August 2003 from inside the FEC property, with PCE detected at 33.8 $\mu g/m^3$. This elevated level of PCE in indoor air at FEC suggests that PCE vapors from subsurface sources were possibly entering the indoor air of the building.

In response to the potential for vapor intrusion, several actions were taken at the FEC facility to prevent PCE sources beneath the concrete slab from releasing PCE vapors, which then could migrate to the indoor air of the FEC, where it could be inhaled and pose an unacceptable health risk. The vapor intrusion mitigation actions taken at FEC included: 1) applying an epoxy sealant vapor barrier to the concrete floor to prevent or reduce off-gassing of potential PCE residues in the concrete and seal any small cracks that are a possible preferential pathway from the migration of vapors up through the concrete floor; 2) installation of a sub-slab depressurization system (SSDS) that is similar to alleviating radon problems in indoor air, but which has also been effective in addressing vapor intrusion issues (Folkes 2002b); 3) Upgrading of the HVAC system (heating, ventilation, and air conditioning system); 4) upgrading the original SSDS; and 5) upgrading the floor sealant vapor barrier.

In coordination with the various mitigation actions at FEC, indoor air samples were collected to evaluate the impact each of these measures. These indoor air samples and mitigation actions are summarized in Table 1, which appears on Page 4.

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[1] The default EPA Region III risk-based concentration for PCE in a residential setting is 0.31 $\mu g/m^3$ (EPA 2004). A more appropriate screening value for PCE vapors in a commercial setting is 2.2 $\mu g/m^3$. This commercial screening value for indoor air inhalation exposures is based on the former inhalation cancer potency slope factor (iCSF) for PCE of 2.0×10^{-2} $(mg/kg/day)^{-1}$. The iCSF for PCE was established prior to U.S. EPA withdrawing PCE for review from their Integrated Risk Information System (IRIS). This screening value for PCE is equivalent to the value in the U.S. EPA Region III risk-based concentration table, as well as the U.S. EPA draft vapor intrusion guidance Table 2c value.

Table 1: Indoor Air Sampling at the Former Express Cleaners
Hales Corner, Wisconsin
All Concentrations in micrograms per cubic meter (µg/m^3)

Date	Concentrations of Tetrachloroethylene (PCE)					
	HVAC On	HVAC On; Original On-Slab Vapor Barrier	HVAC On; Original On-Slab Vapor Barrier; Original SSDS	HVAC On; Replaced On-Slab Vapor Barrier; New SSDS On	HVAC Off; Replaced On-Slab Vapor Barrier; New SSDS Off	HVAC On; Replaced On-Slab Vapor Barrier; New SSDS Off
08/11/03	33.8					
02/25/04		28.5				
04/21/04			nd			
08/5/04			11.5			
08/25/04			10.8			
11/3/04					14.9	
11/4/04						8.7
11/5/04				9.4		
11/24/04				16.0		
12/10/04						8.1*
01/10/05						22.0*
01/13/05						12.0*
01/21/05						11.0*

Notes: HVAC - Heating, Ventilation, and Air Conditioning System.
SSDS - Sub-Slab Depressurization System.
nd - not detected.
* - New Air-tight Door Installed inside rear entrance of the Former Express Cleaners.

Discussion

In summary, after mitigation measures were taken at FEC the levels of PCE slightly decreased in the indoor air, but low levels of PCE continued to be present in indoor air. The lowest post-mitigation levels of PCE in indoor air at FEC remained slightly higher than a target level for a commercial setting of 2.2 µg/m^3, which is based on a 1-in-1,000,000 excess lifetime cancer risk. Despite this, the low levels of PCE in indoor air of FEC are not a health concern for either employees or customers of the retail coffee shop and pose *no apparent human health hazard.*

DHFS concurs with the general findings of a human health risk assessment prepared in February 2005 by the owner's consultant (ENSR 2005), which concluded that under the current conditions and with the passive mitigation actions, compounds in the indoor air of FEC "do not pose a threat to public health."

PCE in indoor air can be a human health concern if people inhale very high concentrations over a long term, but the levels detected inside of FEC were very low and do not pose either a cancer or non-cancer human health concern. The U.S. EPA Reference Dose for PCE is 0.01 mg/kg/day, which was derived from studies that observed liver changes in laboratory mice that were exposed to PCE. If a worker over an 8 hour shift inhaled PCE at 33.8 $\mu g/m^3$, their daily exposure would be almost 100 times less than this Reference Dose. A Reference Dose is a value established by the U.S. EPA that is an estimate, with built in safety factors, of the maximum daily, life-time exposure to a chemical that is not likely to cause harmful health effects. Therefore, daily exposure to such a level of PCE is not expected to result in non-cancer health effects. With regard to PCE and cancer, laboratory studies of mice exposed to PCE also found higher rates of liver cancers. Some studies of dry cleaner workers suggests a connection between PCE exposure and increased risk of certain cancers, but the weight of the scientific evidence is not conclusive (ATSDR 1997). Previously, U.S. EPA classified PCE as a "B2 - Probable Human Carcinogen", but this carcinogen assessment was withdrawn by U.S. EPA in 1990 for further review. The highest level of PCE in FEC was 33.8 $\mu g/m^3$, which is over 10 times higher than a target level for a commercial setting of 2.2 $\mu g/m^3$, which is based on a 1-in-1,000,000 excess lifetime cancer risk.

While DHFS does not consider the post-mitigation PCE levels in the indoor air of FEC to be an inhalation health concern for either employees or customers of the coffee shop, the levels are slightly higher than what is preferred for a commercial setting. When estimating lifetime excess cancer risk due to exposures to known or suspected carcinogens, DHFS employs conservative exposure assumptions that are the most protective of human health. For people in a commercial setting, DHFS exposure assumptions are that adult workers will be present in the facility for 8 hours per day, 250 days per year, and for 25 years. For a residential setting, DHFS exposure assumptions are that people will be present in the home 24 hours per day, 365 days per year, for 70 years, from which derives a default residential screening value for PCE of 0.18 $\mu g/m^3$.

PCE in the indoor air of FEC was slightly higher than background levels typical for a commercial setting. It is important to note that PCE is commonly found in the indoor air of homes and offices. Vapors of chlorinated solvents can be emitted from various building materials and consumer products, and such background levels in indoor air can complicate vapor intrusion investigations and the interpretation of indoor air data. The highest level of PCE found inside FEC was 33.8 $\mu g/m^3$, which is higher than concentrations found in the indoor air of homes and non-industrial businesses where PCE is not typically used. A 1988 review of indoor air sampling data from 2,195 "residential and workplace environments" found a median PCE concentration of 5.0 $\mu g/m^3$ and an upper 75^{th} percentile of 11.0 $\mu g/m^3$ (Shah and Singh, 1988). Sexton et al (2004) investigated various solvents in homes of three communities in the

Minneapolis metropolitan area. For 292 indoor residential air samples with a 2-day average, PCE was detected in 97.6% of samples, with a median concentration of 2.9 $\mu g/m^3$, and a 90^{th} percentile concentration of 3.8 $\mu g/m^3$. In another indoor air study of 120 Denver area homes that were not affected by vapor intrusion, PCE was detected in 69.9% of 282 air samples, with a median concentration of 1.0 $\mu g/m^3$, and a 90^{th} percentile of 4.5 $\mu g/m^3$ (Kurtz & Folkes, 2002). Zhu et al (2005) examined solvents in the indoor air of 75 homes in Ottawa, Canada, and found PCE in 97% of homes, with a median concentration of 0.47 $\mu g/m^3$, an a 90^{th} percentile of 3.25 $\mu g/m^3$.

While a portion of the PCE in the indoor air of FEC may have been from background sources, the levels are slightly above what is typically found in the home or workplace and suggests PCE is also coming from at least one or more other sources, including vapor intrusion, the off-gassing from old building surfaces that PCE previously permeated, or back-drawing by the HVAC of vapors released from the SSDS exhaust vent on the roof. Furthermore, air sampling data and related adjustments to the various mitigation and air handling systems at FEC did not provide a clear understanding about the actual effectiveness of reducing indoor air PCE concentrations by the mitigation actions taken at the Former Express Cleaners. Folkes and Kurz (2002b) described similar mitigation actions in Colorado that had a 10 to 100 fold reduction of indoor air concentrations of solvents that were attributed to vapor intrusion. At FEC, a factor of 4 was the largest observed reduction between the pre- and post-mitigation actions.

The first two indoor air samples at FEC detected PCE at 33.8 and 28.5 $\mu g/m^3$. After the mitigation actions, three rounds of sampling measured PCE levels ranging at "no detect", 11.5 and 10.8 $\mu g/m^3$. This suggests that the mitigation actions taken (replacing finished wall surfaces, epoxy sealant to the floors and sub-slab depressurization system [SSDS]) had a positive effect, but it also appears that there may be a continuing release of PCE to indoor air via the soil vapor migration and intrusion pathway. There is often need for fine tuning these mitigation systems in order to completely prevent the vapor intrusion pathway. Given the epoxy applied to the concrete floor and the replacement of wall material, these actions seemed to rule out the off-gassing of PCE from the slab or wall board. However, at this stage, some additional actions were taken, including correcting problematic ceiling vent issues, installing vent fans into the two restrooms, additional work on the floor to ensure a complete seal, and the pump for the sub-slab depressurization system was moved outside. After these actions were taken, several more rounds of indoor air samples were collected to test the effectiveness of tuning the mitigation systems. The levels of PCE did not appear to subsequently decrease, and it was unclear why levels did not drop further.

To better understand this, DHFS staff collected additional air samples from FEC in November 2004. One sample was collected from inside the kitchen of the coffee shop and one of outdoor air on the roof, in between the vent stack of the SSDS and the intake of the HVAC. Another sample was collected outside and upwind of the FEC facility. When collecting the air sample on the roof, DHFS staff used a photo-ionization detector to screen air around the SSDS vent staff, and total solvent concentrations were approximately 7,000 parts per billion. This suggests that the SSDS was actively expelling solvents from the sub-slab airspaces beneath FEC. Laboratory

results of the November 2004 DHFS air samples found PCE levels at 16.0 µg/m^3 for indoor air in the kitchen, 30.5 µg/m^3 on the roof, and no detection for the background outdoor air sample. This indicated that the HVAC system may have been back-drawing impacted air being released from the SSDS. DHFS suggested that the vent stack be relocated or elevated in height to prevent the back-drawing of vapors into the HVAC system, but this has not been conducted as of the date of this health consultation. However, when a contractor later collected air samples from inside of the FEC, with the SSDS system not operating, PCE levels slightly increased and it was not understood why. Unfortunately, no roof or outdoor air samples were collected at that time. DHFS offered to the current property owner to study this further and collect additional indoor air samples, at DHFS' expense, yet the property owner has not requested such assistance from DHFS. DHFS recommends the continued operation of the active sub-slab depressurization system as a precautionary measure that will assist with keeping as low as possible the indoor air levels of PCE.

Child Health Considerations

DHFS recognizes that children can be especially sensitive to contaminants. Children are often at greater risk than adults to certain kinds of exposure from hazardous chemicals in the environment. Children engage in activities, such as playing outdoors and hand-to-mouth behaviors, that increase their exposure to hazardous substances. Being much smaller than adults and playing on their hands and knees, children breathe air close to the ground that can have more dust, soil particles, and vapors. Children have a lower body weight, but a higher intake rate which results in a greater dose to hazardous substances per unit body weight. Also, children's bodies are developing and have permanent damage if toxic exposures are high enough during critical growth stages. For that reason, DHFS considers children as one of the most sensitive population evaluated in this health consultation, and always takes into account children when evaluating exposures to contaminants.

At the FEC property, children have not been exposed to contaminants at levels that would be expected to be unsafe or potentially result in adverse health effects.

Conclusions

- Although soils and groundwater beneath the Former Express Cleaners have elevated levels of tetrachloroethylene, people do not have contact with these affected media. Therefore, there is *no public health hazard* from tetrachloroethylene in soil and groundwater.

- The current, post-mitigation levels of tetrachloroethylene in the indoor air at Former Express Cleaners are at very low levels, are not a health concern, and are a *no apparent public health hazard* for employees and customers of the current coffee shop.

Recommendations

- While air sampling data is unclear about the actual effectiveness of mitigation actions taken at the Former Express Cleaners, DHFS recommends the continued operation of the active sub-slab depressurization system as a precautionary measure that will assist with keeping as low as possible the indoor air levels of tetrachloroethylene.

Public Health Action Plan

- DHFS offered to the current property owner to collect additional indoor air samples at Former Express Cleaners, at DHFS' own expense, to determine whether a trend develops over time for tetrachloroethylene levels in indoor air. However, the property owner has not requested such assistance from DHFS.

- DHFS will continue to coordinate with the Department of Natural Resource and the Hales Corners Health Department to address and respond to health questions and concerns of the community and business owners.

- No other follow-up is necessary from DHFS regarding Former Express Cleaners.

References

Agency for Toxic Substances and Disease Registry (ATSDR). September 1997. Toxicological Profile for Tetrachloroethylene, Update. Atlanta, GA: U.S. Department of Health and Human Services. Available at: http://atsdr1.atsdr.cdc.gov/toxprofiles/tp18.html.

ENSR International. February 25, 2005. Draft Memorandum from JF Kabel to TP Cok. Risk Evaluation for Tetrachloroethylene Inhalation Exposure at the Former Express Cleaners Site.

Kurtz JP and Folkes DJ. July 2002a. Background Concentrations of Selected Chlorinated Hydrocarbons in Residential Indoor Air. Presented at the 9th International Conference on Indoor Air and Climate, Monterrey, California). EnviroGroup Ltd: Englewood, Colorado. Available at: http://www.envirogroup.com/publicationfour.htm.

Kurtz JP and Folkes DJ. July 2002b. Efficacy of Sub-Slab Depressurization for Mitigation of Vapor Intrusion of Chlorinated Organic Compounds. Presented at the 9th International Conference on Indoor Air and Climate, Monterrey, California). EnviroGroup Ltd: Englewood, Colorado. Available at: http://www.envirogroup.com/publicationthree.htm

New York State Department of Health (NYDOH). May 2003. Fact Sheet - Tetrachloroethylene in Indoor and Outdoor Air. Available at: http://www.health.state.ny.us/nysdoh/environ/btsa/fs_perc.htm.

Sexton K, Adgate JL, Ramachandran G, Pratt GC, Mongin SJ, Stock TH, and Morandi MT. 2004. Comparison of Personal, Indoor, and Outdoor Exposures to Hazardous Air Pollutants in Three Urban Communities. Environ Sci Technol 38(2): 423-430.

Shah JJ, and Singh HB. 1988. Distribution of Volatile Organic Chemicals in Outdoor and Indoor Air - A National VOC Data Base. Environ Sci Technol 22(12): 1381-1388.

U.S. Environmental Protection Agency (EPA). November 29, 2002. OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance). Available at: http://www.epa.gov/epaoswer/hazwaste/ca/eis/vapor.htm

U.S. EPA. October 8, 2004. Human Health Risk-Based Concentration Table. EPA Region III. Available at: http://www.epa.gov/reg3hwmd/risk/human/index.htm.

U.S. EPA. Integrated Risk Information System, Database for Risk Assessment. Available at: http://www.epa.gov/iriswebp/iris/index.html

Wisconsin Administrative Code. April 2001. Groundwater Quality. Chapter NR 140.10 WAC.

Zhu J, Newhook R, Marro L, and Chan CC. 2005 Selected Volatile Organic Compounds in Residential Air in the City of Ottawa, Canada. Environ Sci Technol 39(11): 3964-3971.

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Certification

This Health Consultation for the **Former Express Cleaners Indoor Air Investigation** was prepared by the Wisconsin Department of Health and Family Services under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved methodology and procedures existing at the time the Health Consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

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

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