Health Consultation

Exposure Investigation

REDI-QUIK DRY CLEANERS
VAPOR INTRUSION IN A PRIVATE RESIDENCE

WEST ALLIS, MILWAUKEE COUNTY, WISCONSIN

EPA FACILITY ID: WID076169226

JULY 6, 2006

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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Prepared by:

Wisconsin Department of Health and Family Services
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Summary

Elevated levels of tetrachloroethylene (PCE) were detected in the outdoor and indoor air of a West Allis household that is located next to a dry cleaner. These levels of PCE pose a *public health hazard* to residents due to a high increased lifetime excess cancer risk, but such levels are not likely to cause non-cancer health effects associated with much higher PCE exposures. PCE in soil vapors beneath the home demonstrates that vapor migration and intrusion to indoor air is a completed pathway. The levels of PCE in soil vapors beneath the home are high enough to pose a *future urgent public health hazard* to residents if the integrity of the basement floor is compromised and similar PCE levels are found in indoor air.

The homeowner should open basement windows to remove any vapors due to vapor intrusion. The Wisconsin Division of Public Health (DPH) suggests the family visit a physician for a medical checkup. DPH will conduct another round of indoor air sampling. Any excavations or digging into the basement floor should include measures to protect residential health. DPH recommends that the dry cleaner immediately shut down all exhaust venting to the north side of the building and right next to the home. DPH recommends that the dry cleaner investigate for vapor migration and intrusion to the indoor air in nearby homes; mitigate vapor intrusion impacts to the affected home; and investigate and take actions inside of the dry cleaner building to protect their workers from unnecessary PCE exposures.

Background

In January 2006, the Wisconsin Department of Natural Resources requested assistance from DPH to investigate for possible vapor migration and intrusion to the indoor air of a home next to the Redi-Quik Dry Cleaners (DNR Facility ID 241170490), an operating business establishment located at 9508 West Greenfield Avenue, West Allis, Milwaukee County (Figure 1).

Environmental investigations at the Redi-Quik property have found groundwater and soils contaminated with elevated levels of PCE, which is commonly used in the dry cleaning industry. Monitoring wells found shallow groundwater is contaminated with PCE as high as 45,000 μg/L (micrograms per liter) on the Redi-Quik property, and 708 μg/L on the residential property (Shaw 2004). Sub-surface soil borings detected PCE levels up to 3,900 μg/kg (micrograms per kilogram) at the Redi-Quik property, and 230,000 μg/kg at the residential property (Envirogen 2001). Soil boring data from a monitoring well approximately 10 feet from this house (MW-12) found PCE at 129,000 μg/kg. Investigations on the residential property have not ruled out whether PCE-contaminated sub-surface soils are in direct contact with the foundation of the home. Remediation actions to address PCE contamination have not been implemented at either the dry cleaner or residential properties.

The concentrations of PCE in shallow groundwater around the Redi-Quik property exceeds PCE screening levels, as cited in U.S. Environmental Protection Agency's (U.S. EPA) guidance on vapor migration and intrusion to the indoor air pathway (EPA 2002), and warrants further

investigation of this pathway. Under certain circumstances, chlorinated solvents in unsaturated soils or shallow groundwater can be released as vapors, which then migrate through soil pore spaces and reach nearby buildings. Such vapors can 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 chlorinated solvent vapors reach and accumulate in the indoor air of a building, solvent levels can become an inhalation health concern for people who live or work inside the building.

Indoor Air Investigations

In response to the DNR request, DPH staff first met with the owner of this West Allis home on February 9, 2006, and discussed the potential for vapor migration and intrusion into the home. The owner's family has lived at this residence since 1986. Shortly after moving into this home, the owner reported learning about contamination on the adjacent dry cleaner property. None of the family has developed diseases, illnesses, or symptoms associated with long term exposures to PCE. During this DPH visit, staff set up two 3M™ organic vapor passive diffusion monitors (OVM), one beneath the southwestern soffit of the house to monitor outdoor air, and one hanging from the ceiling joist in the basement to monitor indoor air. These OVMs were left in place at the home for 8 days, after which they were collected and placed inside of a sealed container and submitted to the Wisconsin State Laboratory of Hygiene (WSLH). Analysis by gas chromatography (OSHA Method 7) detected PCE in both samples, equivalent to 34.0 $\mu g/m^3$ (micrograms per cubic meter) in outdoor air and 503.2 $\mu g/m^3$ in indoor air (Table 1). Currently, DPH is comparing outdoor and indoor air data obtained from OVMs with data provided by sampling methods more commonly used for indoor air investigations, such as EPA Method TO-14a.

On March 8, 2006, DPH staff returned to the West Allis home and collected 4 air samples using 6-liter evacuated SUMMA® canisters. Three indoor air samples were collected; one each from the breathing zones of the kitchen and the bedroom, and one from 1 foot above the floor in the southeast corner of the basement. An outdoor air sample was also collected from the front porch. Each canister's regulator and restrictor were adjusted to draw samples over a 24-hour period and the canisters were collected on March 9th. The canisters were submitted to the WSLH for analysis by gas chromatography and mass spectroscopy (GC/MS) following EPA Method TO-14a (EPA 1999). PCE was detected in all indoor air samples, with 198.17 $\mu g/m^3$ in the bedroom, 183.67 $\mu g/m^3$ in the kitchen, and 231.60 $\mu g/m^3$ in the basement. PCE was also detected at 4.57 $\mu g/m^3$ in the outdoor air sample collected on the front porch (Table 1).

When visiting the West Allis home on both March 8th and 9th, DPH staff also screened indoor air and outdoor air with a photo-ionization detector (PID), which is able to measure total volatile organic compounds (VOC) in the single-digit, parts-per-billion range. The purpose of indoor air screening of the home was two-fold. First, this allowed DPH to identify any unusual levels of VOCs in air in order to alert WSLH technicians if samples had the potential for high concentrations and required additional dilution. Second, this allowed DPH to identify indoor

solvent sources or preferential vapor migration pathways in the home. Air screening inside of the first-floor living space of the home detected VOC concentrations ranging between 70 and 130 ppb (parts-per-billion). The basement had VOC concentrations in the breathing zone between 40 and 70 ppb. While there is no sump crock in the basement, air immediately above the floor drain had total VOCs ranging between 200 and 300 ppb. For outdoor air around the West Allis home, total VOCs were between 5 and 35 ppb. On March 9th, a dryer vent was operating on the north side of the Redi-Quik Dry Cleaner building. Air coming from this vent was screened with the PID at 4,700 to 5,800 ppb.

Table 1: Indoor and Outdoor Air Tetrachloroethylene (PCE) Concentrations
West Allis Home, Wisconsin

Sample ID	Lab Method	Media & Location	Sample Date	Sample Period	PCE Concentration ppb	PCE Concentration µg/m3	Comparison Value (µg/m³)
PH 3910	OSHA Method 7	Outdoor Air (SW Soffit)	2/9/06	8 days	5.0	34.00	0.31
PH 4001	OSHA Method 7	Indoor Air (Basement)	2/9/06	8 days	74.0	503.20	0.31
RQDC-IA-01	EPA TO-14a	Indoor Air (Bedroom)	3/8/06	24 hrs	29.143	198.17	0.31
RQDC-IA-02	EPA TO-14a	Indoor Air (Kitchen)	3/8/06	24 hrs	27.010	183.67	0.31
RQDC-IA-03	EPA TO-14a	Indoor Air (Basement)	3/8/06	24 hrs	34.059	231.60	0.31
RQDC-OA-04	EPA TO-14a	Outdoor Air (Front Porch)	3/8/06	24 hrs	0.672	4.57	0.31
RQDC-OA-02V	EPA TO-14a	Outdoor Air (Exhaust Vent)	4/10/06	Grab	27,446.26	186,634.57	0.31

On April 10, 2006, DPH staff collected a grab air sample from directly in front of and within 1 inch of a white dryer-type vent on the north side of the Redi-Quik building. At that time, equipment inside of the dry cleaner was not blowing exhaust air from the vent. The canister was submitted to the WSLH for analysis by GC/MS following EPA Method TO-14a. Laboratory analysis of this sample detected PCE at 186,634.57 µg/m³.

Sub-Slab Soil Vapor Investigation

On April 10th, 2006, DPH staff visited this West Allis home and installed 3 sample ports in the basement concrete floor (Figure 2). 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 add difficulty to the interpretation of indoor air data. When used jointly with data from outdoor and indoor air sampling, sub-slab soil gas samples can be used to distinguish indoor and outdoor VOC sources from PCE that may be entering a home from contaminated soils or groundwater. On April 10, DPH installed two sample ports (Port A and C) along the southern basement wall, which is closest to the Redi-Quik dry cleaner and areas of high soil contamination by PCE on the residential property. Sample Port A was placed 5 feet, 1 inch from the south wall and 4 feet, 4 inches from the east wall. Port C was placed 4 feet, 5 inches from the south wall, directly under the staircase leading to the main floor. DPH installed a third sample port (Port B) near to the northern basement wall in order to evaluate for varying PCE concentrations further from the source. Sample Port B was placed 12 feet, 4 inches from the west wall and 6 feet, 6 inches from the north wall.

Each soil vapor sample port consisted of a stainless steel, internally threaded tube, 3/8 inches in diameter and 2 ½ inches long, with a ½ inch diameter collar, which is manufactured by Entech Instruments, Inc (Figure 3). At each sample location a 3/8 inch diameter hole was bored though the concrete floor, which followed the drilling of a 1 inch deep and 1 inch diameter countersink hole. After drilling the 3/8 inch hole and when the drill tip came in contact with sub-slab soils, the tip was observed dry at Sample holes A and C, and wet at Sample hole B. A sample port was then inserted into each sample hole to be flush with the floor and sealed by filling the countersink with water-based, non-acrylic cement grout. Once the grout cured, DPH staff closed the sample port with a stainless steel bolt, and the recessed head was sealed with a rubber stopper.

On April 11th, DPH staff again visited the West Allis home, 24-hours later, to collect a soil vapor sample from each of the three sample ports using 6-liter evacuated SUMMA® canisters (Figure 4). The 24-hour delay in collecting the samples allowed sub-slab soil vapor conditions to re-stabilize after installation of the sample ports. Staff used stainless steel couplings and tubing to connect the sample port to the canister. This connection used a PID to purge basement indoor air from the tubing and couplings, as well as screen soil vapor samples for VOCs. To avoid contaminating indoor air, exhaust from the PID was captured in a mylar gas sample bag. Once VOC readings on the PID stabilized, basement air was considered purged and the valve connected to the PID was closed. The soil vapor sample was then collected over approximately 15 minutes by slowly opening the valve on the canister.

The canisters were submitted to WSLH for analysis by GC/MS following EPA Method TO-14a. PCE was detected in all sub-slab soil vapor samples, with 63,328.4 $\mu g/m^3$ at sample Port A, 14.89 $\mu g/m^3$ at sample Port B, and 2,030,160.40 $\mu g/m^3$ at sample Port C (Table 2).

Table 2: Sub-Slab Soil Vapor Concentrations of Tetrachloroethylene (PCE)
April 11, 2006
West Allis Home, Wisconsin

Sample ID	Sample Port	Sample Location in Basement	PID Screened Level (ppb)	PCE Concentration by Method TO-14	
				ppb	$\mu g/m^3$
RQDC-SSV-01	Port A	Southeast Corner	6,650	9,313.0	63,328.40
RQDC-SSV-02	Port B	North Room	187	2.19	14.89
RQDC-SSV-03	Port C	South Central	>199,000	298,553.0	2,030,160.40

Discussion

Residents of a West Allis home are inhaling indoor and outdoor air with elevated levels of PCE vapors that are originating from the nearby Redi-Quik dry cleaners. Residents do not have direct contact with contaminated sub-surface soils nor are they drinking PCE-contaminated groundwater. The concentration of PCE found in the indoor air of this West Allis home is a *public health hazard* for the residents because of a high increased excess lifetime cancer risk. PCE levels in outdoor air around this home were also elevated and pose a *public health hazard* to residents. PCE levels in outdoor and indoor air is not likely to cause non-cancer health effects associated with much higher PCE exposures. High PCE levels in soil vapors beneath the home demonstrate that vapor migration and intrusion to indoor air is a completed pathway of contamination coming from the adjacent dry cleaner. While residents are not exposed to PCE at the high levels found in soil vapors, should the integrity of the basement floor be compromised and such a level of PCE reach the indoor air of the home, this would pose a *future urgent public health hazard.*

Indoor Air

The PCE levels found inside the West Allis home represent an approximate 7-in-1,000 excess lifetime cancer risk level for a residential setting and represents a *public health hazard* to people living in this house. The highest level of PCE in the living space of this West Allis home was 198 $\mu g/m^3$, which is approximately 700 times higher than the maximum target PCE level for a residential setting (0.31 $\mu g/m^3$), which is based on a 1-in-1,000,000 increased excess lifetime cancer risk (EPA 2006b). Studies of dry cleaner workers indicates there may be a connection between PCE exposure and increased risk of certain cancers, but the weight of the scientific evidence is not conclusive and PCE is not currently classified by EPA as a known human carcinogen (ATSDR 1997). However, laboratory studies of mice exposed to PCE found increases in the rates of liver cancer when compared with unexposed mice. 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 and this currently is not classified. However, the National Toxicological Program has classified PCE as "Reasonably Anticipated to be a carcinogen based on sufficient evidence of carcinogenicity in experimental animals" (NTP 2005) and the International Agency for Research on Cancer classified PCE as "Probably Carcinogenic to Humans" (IARC 1995) Despite EPA's current carcinogencity status for PCE, DPH continues to rely on the cancer slope factor derived from this mice study when estimating increased human cancer risk due to PCE exposures.

At very high concentrations and breathed by people over a long term, PCE in indoor air can cause adverse, non-cancer health effects (affecting the central nervous system, liver, and kidney), but the levels detected inside of the West Allis home are not expected to cause such adverse, non-cancer health effects. The PCE level in the living space at the West Allis home was slightly above the U.S. EPA Reference Dose, yet slightly below the ATSDR MRL. The U.S. EPA Reference Dose for PCE is 0.01 mg/kg/day (milligrams per kilogram of body weight per day), which was derived from studies that found a "no observed adverse effect level" (NOAEL) for laboratory animals exposed to PCE (EPA 2006a). For a person breathing indoor air with PCE at 200 $\mu g/m^3$, their daily PCE exposure would be 0.057 mg/kg/day, which is 5 times above the 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. This Reference Dose was derived from laboratory studies that observed liver toxicity in mice and weight gain in rats when PCE doses exceeded 14 mg/kg/day. A safety factor of 1,000 was used to extrapolate this NOAEL for animals and derive a Reference Dose for humans. The indoor air PCE concentration of 200 $\mu g/m^3$ was less than the ATSDR chronic Minimal Risk Level (MRL) for PCE, which is 300 $\mu g/m^3$. A 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." The chronic MRL for PCE of 300 $\mu g/m^3$ was based on a study that observed unfavorable neurological responses in women who were exposed over a long term to PCE concentrations averaging 102,000 $\mu g/m^3$. At the lower PCE concentrations of 1,300 $\mu g/m^3$ the study did not observe such adverse neurological effects in workers. In summary, a long-term inhalation exposure to the level of PCE measured in the West Allis home is not expected to result in non-cancer health effects.

It is important to note that PCE is commonly found in the indoor air of homes and offices, but the levels of PCE in the indoor air of this West Allis house are not typical for a home and are apparently coming from a source outside the home. The highest level of PCE found inside the West Allis home was 231.60 $\mu g/m^3$ in the basement, which ranges 46 to 491 times higher than PCE concentrations typically found in the indoor air of homes and non-industrial businesses where PCE was not 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 90th 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 90th 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 90th percentile of 3.25 $\mu g/m^3$.

Outdoor Air

DPH sample results found elevated levels of PCE in outdoor air around the West Allis home and this poses a *public health hazard* to residents. In February 2006, an 8-day outdoor air sample from beneath the soffit at the southwest corner of the home and along driveway detected PCE at 34.0 $\mu g/m^3$. In March 2006, a 24-hour outdoor air sample collected from the front porch (east side of home) again detected PCE, this time at 4.57 $\mu g/m^3$. On April 10, DPH staff collected a grab air sample from directly in front of and within 1 inch of a white dryer-type vent on the north side of the Redi-Quik building. At that time equipment inside of the dry cleaner was not blowing exhaust air from the vent. Laboratory analysis of this sample detected PCE at 186,634.68 $\mu g/m^3$.

When residents leave and enter this West Allis home, they normally use the doorway on the south side of the home that directly accesses the driveway, and they continue breathing PCE vapors in outdoor air. Based on the limited outdoor air data from around the home, DPH assumes that residents in the driveway are regularly exposed to PCE concentrations similar to what was measured at the soffit sample location, which was 34.0 $\mu g/m^3$ and is equivalent to a 1-in-10,000 increased lifetime cancer risk. Residents in the driveway probably do not regularly breathe PCE concentrations at the level measured at the vent on the north side of the dry cleaner, which was 186,634.68 $\mu g/m^3$. When high levels of VOCs vapors are released to ambient air and varying atmospheric conditions, concentrations are quickly diluted and dispersed. However, PCE concentrations at other driveway locations may typically be even higher than was measured in the soffit sample point. Taking into account the PCE exposure residents are already receiving from the indoor air of their home, residents' breathing PCE in outdoor air around the West Allis home contributes to their overall PCE exposure and poses a *public health hazard.* It is possible that the levels of PCE in outdoor air around the home also affects the indoor air concentrations of PCE. In order to immediately reduce the overall PCE exposure to residents of the West Allis home, DPH recommends that dry cleaning operators at the Redi-Quik property immediately halt all active and passive exhaust venting to outdoor air on the north side of the building.

While it is possible that a portion of PCE detected in outdoor air of the West Allis home is coming from impacted sub-surface soils beneath the dry cleaner and residential properties, air screening and sample data near the home strongly suggests that the main source of PCE in outdoor air is from inside of the Redi-Quik Dry Cleaner building. Redi-Quik currently uses state-of-art, 4th generation dry cleaning equipment and processes that recovers and minimizes PCE release to indoor air. However, it is likely that any elevated PCE concentrations inside of

the Redi-Quik building are due to vapor intrusion coming from substantial PCE contamination located directly beneath the building's foundation. DPH recommends that the Redi-Quik Dry Cleaners investigate and take any necessary actions to ensure that the health of dry cleaner workers is protected from PCE exposures coming from the use of dry cleaning equipment or due to vapor intrusion inside of the dry cleaning building.

The PCE levels in outdoor air around the West Allis home are also well above PCE concentrations typically found in outdoor urban air. When Zhu et al. (2005) sampled solvents in the indoor air of homes in the City of Ottawa, they also sampled outdoor air and found a median PCE concentration of 0.015 $\mu g/m^3$, with a 90th percentile of 0.31 $\mu g/m^3$. Sexton et al. (2004) tested solvents in the outdoor air of the Minneapolis metropolitan area and found median PCE concentrations of 0.3 $\mu g/m^3$, and a 90th percentile of 0.7 $\mu g/m^3$. Shah and Singh (1988) found an outdoor air median PCE concentration of 0.35 $\mu g/m^3$, with an upper 75th percentile of 0.87 $\mu g/m^3$.

Sub-Slab Soil Vapors

The levels of PCE found in soil vapors directly beneath the West Allis home clearly demonstrates that vapor migration and intrusion to indoor air is a completed pathway of contamination coming from the adjacent Redi-Quik dry cleaner. Recent indoor air sampling and prior environmental investigations of this residential property found levels of PCE in groundwater and soils that were unusually high and are not apparently coming from other sources inside of the home. The concentration of PCE in the soil vapor sample from Port C of 2,030,160 $\mu g/m^3$ is extremely high, indicating that contaminated soils are either very close by or in direct contact with the foundation of the home.

While the highest level of PCE in the indoor air of this West Allis home was 231.6 $\mu g/m^3$, if the integrity of the concrete floor is compromised, residents could breathe an indoor air PCE level of 2,030,160 $\mu g/m^3$, this would pose a *future urgent public health hazard.* Such a level of PCE is 2,000 times above the ATSDR acute MRL of 1,000 $\mu g/m^3$. This MRL was derived from a human study that found an increased rate of reversible neurological effects on volunteers exposed to a PCE concentration of 340,000 $\mu g/m^3$ for 4 hours/day for 4 days (ATSDR 1977). Other human studies found non-reversible adverse neurological effects caused by exposures to PCE concentrations less than 2,030,160 $\mu g/m^3$. Such a PCE concentration also exceeds the NIOSH Immediately Dangerous to Life or Health (IDLH) of 1,020,000 $\mu g/m^3$ (or 150,000 ppb). The U.S. Occupational Safety and Health Administration defines an IDLH as "an atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere" (NIOSH 2006). Therefore, measures should be taken to ensure that the soundness of the basement floor remains intact and protected at the West Allis home. Any planned excavations or drilling activities into the basement floor should include rigorous ventilation and other measures to protect the health of workers and residents.

The wet sub-slab soils observed at Sample hole B and subsequent lower soil vapor PCE concentrations from Sample Port B suggests that one of several conditions may exist. One condition may be that PCE in soil vapors have not migrated this far north of the source. An alternative condition may be that saturated soils at this sample location inhibit the free movement of soil gas vapors. While further investigation may be needed to sort this out, the data from Sample Port B should not used to infer PCE has not migrated beyond the West Allis home and is not affecting other adjacent homes. Consequently, DPH continues to recommend that nearby homes be investigated for completion of the vapor migration and intrusion pathway.

Follow-up Actions

While the residents of the West Allis home are not likely to develop adverse health effects from these exposures to PCE, DPH recommends that, as a precautionary measure, the family visit their personal health care provider for baseline medical evaluation, which would include basic blood and urine panels and standard organ function tests. Dr. Henry Anderson, the DPH Chief Medical Officer for Environmental and Occupational Health, is available to consult with the family's health care provider regarding this medical screening and results. Dr. Anderson can be contacted at 608-266-1253.

Until the PCE sources of indoor air contamination at the West Allis home are clearly identified and a permanent mitigation system is installed, DPH suggests that whenever possible the homeowner ventilate the basement to remove any PCE vapors that may be building up due to vapor migration and intrusion. This ventilation can be done by opening two windows in the basement, each on opposite sides of the basement, and placing a fan at one location that blows air from the basement. It should be noted that rigorous basement ventilation can increase heating costs and during cold weather can result in damage to plumbing or other items inside of the house. Therefore, the homeowner needs to exercise good judgement on when to ventilate the basement.

Sub-slab depressurization systems are known to be effective at mitigating elevated indoor air solvent levels when the pathway is due to vapor migration and intrusion originating from contaminated groundwater or nearby subsurface soils. DPH requests that DNR direct the dry cleaner to implement a DNR-approved work plan that investigates for the "vapor migration and intrusion to the indoor air pathway" in nearby buildings may be affected. The dry cleaner should also implement a DNR-approved work plan to mitigate vapor intrusion impacts of the West Allis home, as well as other nearby homes where the vapor intrusion pathway is found to be completed. The dry cleaner should also copy DPH and homeowners on all reports and correspondence.

Whenever a home is investigated for possible vapor migration and intrusion, DHFS recommends the scope of work include indoor air sampling during winter months. Natural convective forces inside and around a home can create a pressure gradient between indoor air and the beneath the

basement foundation, resulting in a negative pressure on soil vapors beneath the slab and creating favorable conditions for vapor intrusion. During colder months the pressure differential can be even greater and increase the impact of vapor migration and intrusion.
The laboratory results from the EPA Method TO-14a provides extremely low detection limits for indoor air sampling. Many factors can easily cause these results to vary. While indoor air screening did not identify any potential sources of PCE or other solvents, DPH recommends that at least one week prior to the next round of sampling that the homeowner remove all paint cans and other liquid containers from inside the West Allis home. In May 2006, DPH plans to collect another round of indoor at the West Allis home.

Child Health Considerations

DPH 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.

The same family has lived at this residence since 1986, when one child was 1 year old. The second child was born in 1987 and has only lived in this home. These children have likely been exposed to elevated PCE levels for all or most of their lifetime. However, none of the adults or children have developed diseases, illnesses, or symptoms associated with long term exposures to PCE. As a precautionary measure, DPH recommends that all family members visit their physician for a standard medical checkup, including function screening of the liver and kidneys.

Conclusions

- PCE detected in the indoor air of a West Allis household poses a *public health hazard* to residents of the West Allis house due to a high increased excess lifetime cancer risk.

- The elevated levels of PCE in outdoor air around the West Allis home poses a *public health hazard* to residents due to an increased excess cancer risk.

- The levels of PCE in outdoor and indoor air of the West Allis home are similar to the U.S. EPA Reference Dose and ATSDR Minimal Risk Level for PCE and not likely to cause non-cancer health effects associated with much higher PCE exposures.

- The levels of PCE found in soil vapors beneath the West Allis home demonstrates that vapor migration and intrusion to indoor air is a completed pathway from the dry cleaner.

- The levels of PCE in soil vapors beneath the West Allis home are high enough to pose a *future urgent public health hazard* to residents if the integrity of the basement floor is compromised and such PCE levels occur in indoor air.

Recommendations

- As a precautionary measure, the homeowner's family should visit their physician for a standard medical checkup.

- The owner of the West Allis home should open basement windows and use a fan to remove any PCE vapors that may be accumulating up due to vapor intrusion.

- Any excavations or digging into the basement floor of the West Allis home should include measures to protect worker and residential health.

- Redi-Quik Dry Cleaners should investigate and take actions to protect their workers from unnecessary PCE exposures inside of the dry cleaning building.

- The owner of the Redi-Quik dry cleaner needs to:
    - Immediately shut down all active and passive exhaust venting to the north side of the building.
    - Implement a DNR-approved work plan to mitigate vapor intrusion impacts of nearby affected homes.
    - Implement a DNR-approved work plan to fully investigate the "vapor migration and intrusion to the indoor air pathway" for all potentially affected nearby homes.

Public Health Action Plan

- To verify the results of recent indoor air sampling, DPH will conduct another round of indoor air samples at the affected West Allis home.

- DPH will review and evaluate the human health implications of upcoming investigations on private properties adjacent to Redi-Quik dry cleaners.
- DPH will continue communicating and collaborating with homeowners, the DNR, and the West Allis Health Department to address public health questions and concerns related to contamination associated with the Redi-Quik dry cleaner property.

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Certification

This Exposure Investigation for the West Allis Vapor Intrusion in a Private Residence 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 investigation was begun. Editorial review was completed by the cooperative agreement partner.

Technical Project Officer, CAT, SPAB, DHAC

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

Team Leader, CAT, SPAB, DHAC, ATSDR

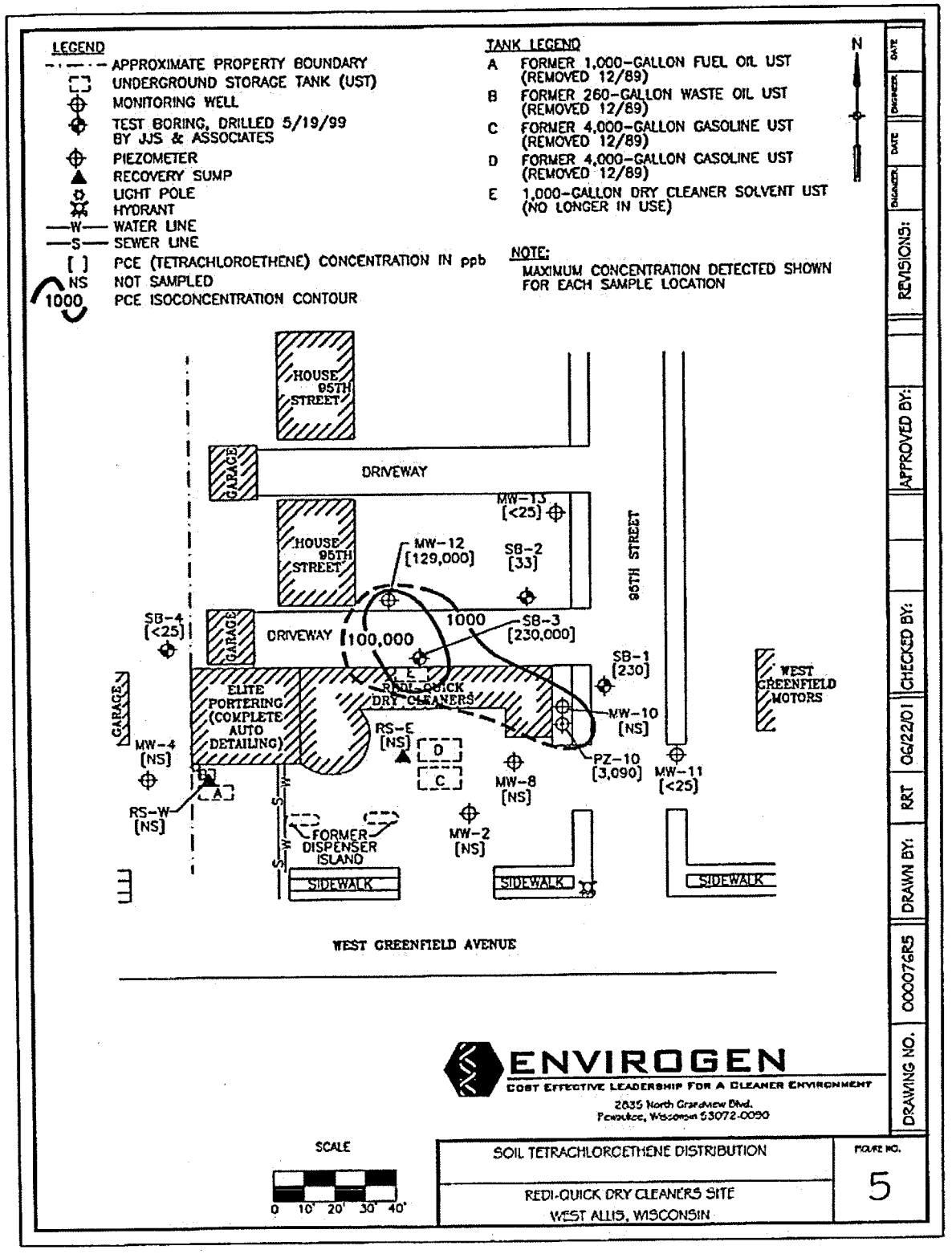

Figure 1: Redi-Quik Dry Cleaners, Surrounding Homes, and PCE Levels (Envirogen 2001)

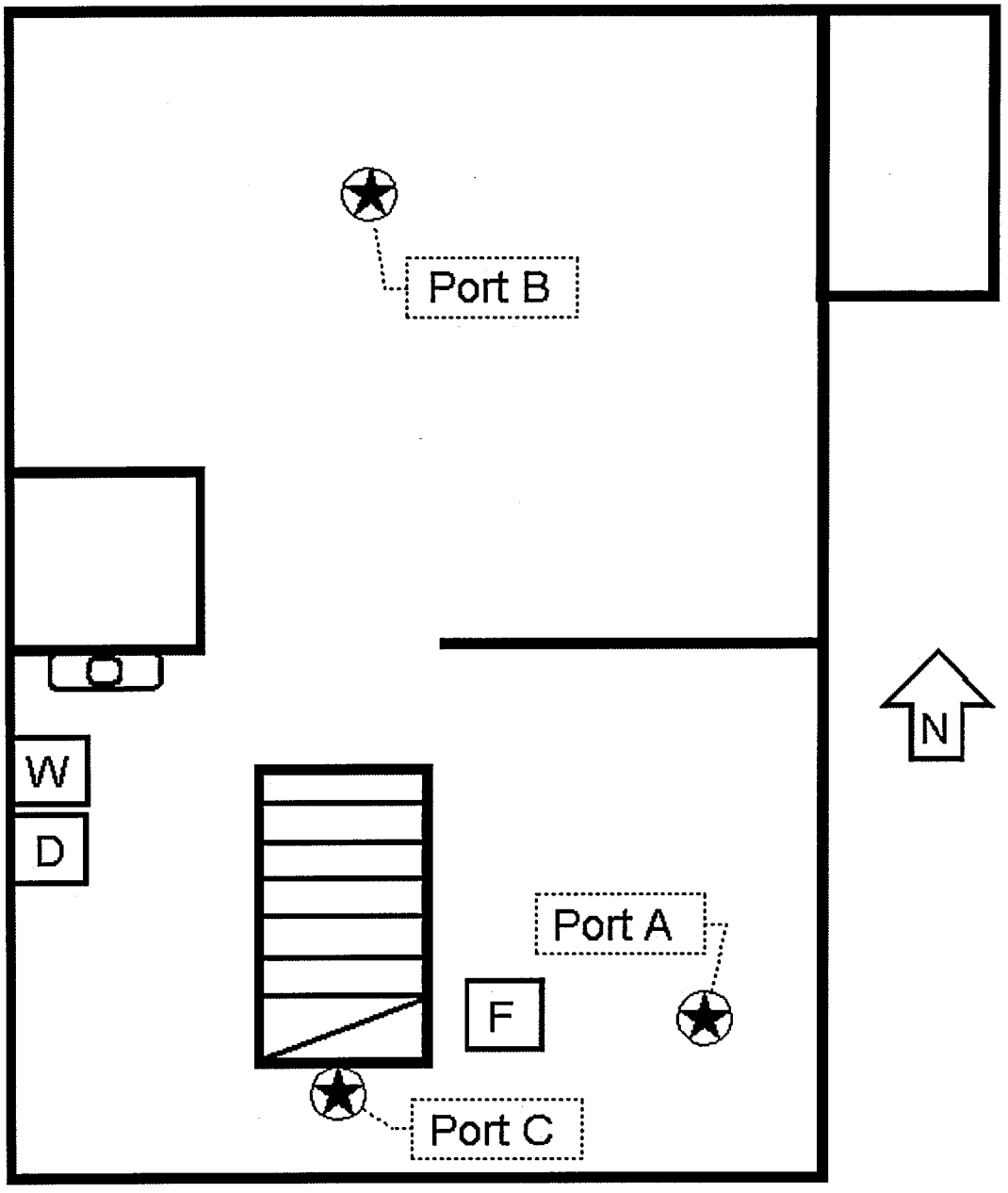

Figure 2: Sub-slab soil vapor sample locations in the basement, April 2006 (drawing not to scale).

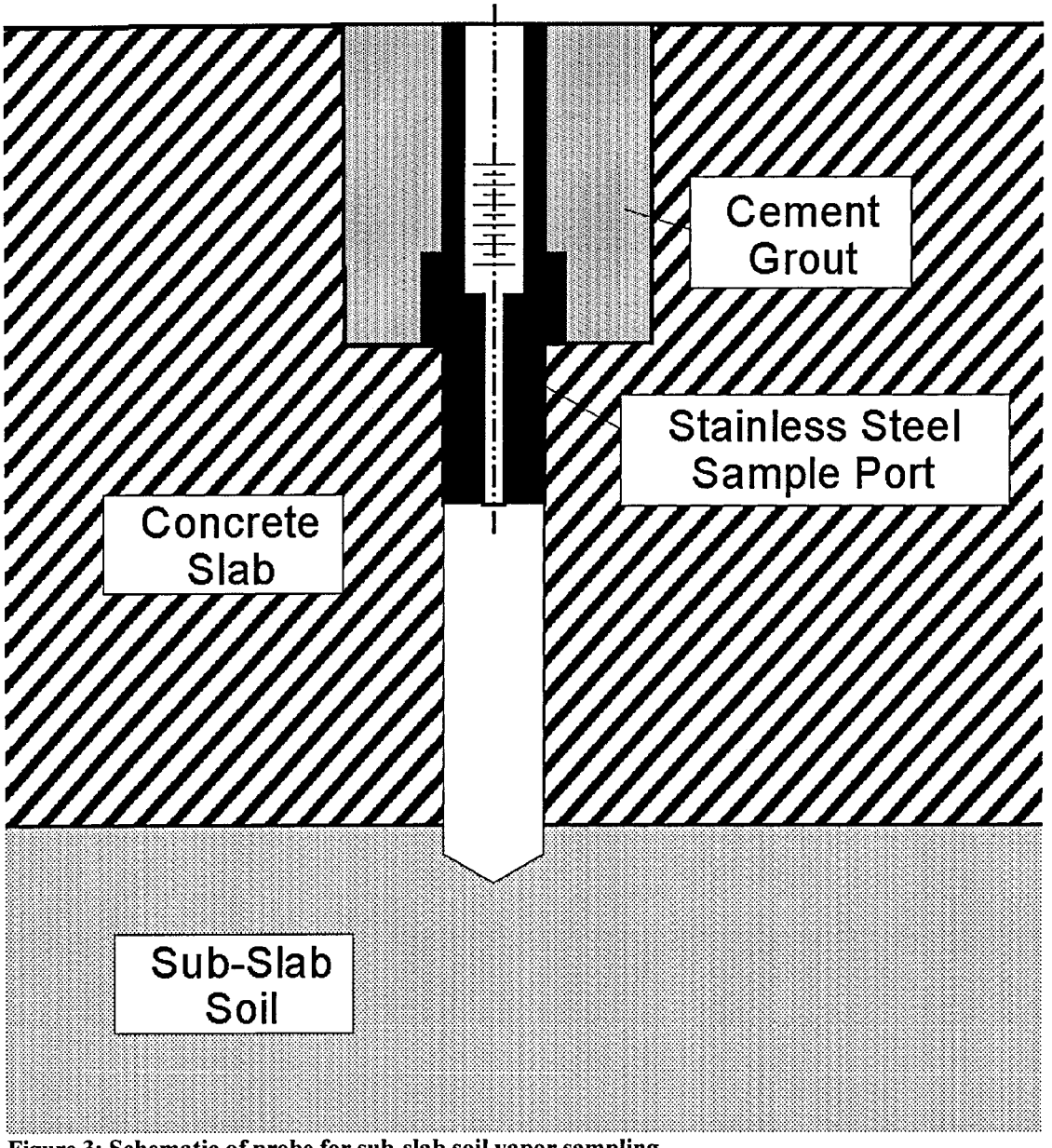

Figure 3: Schematic of probe for sub-slab soil vapor sampling.

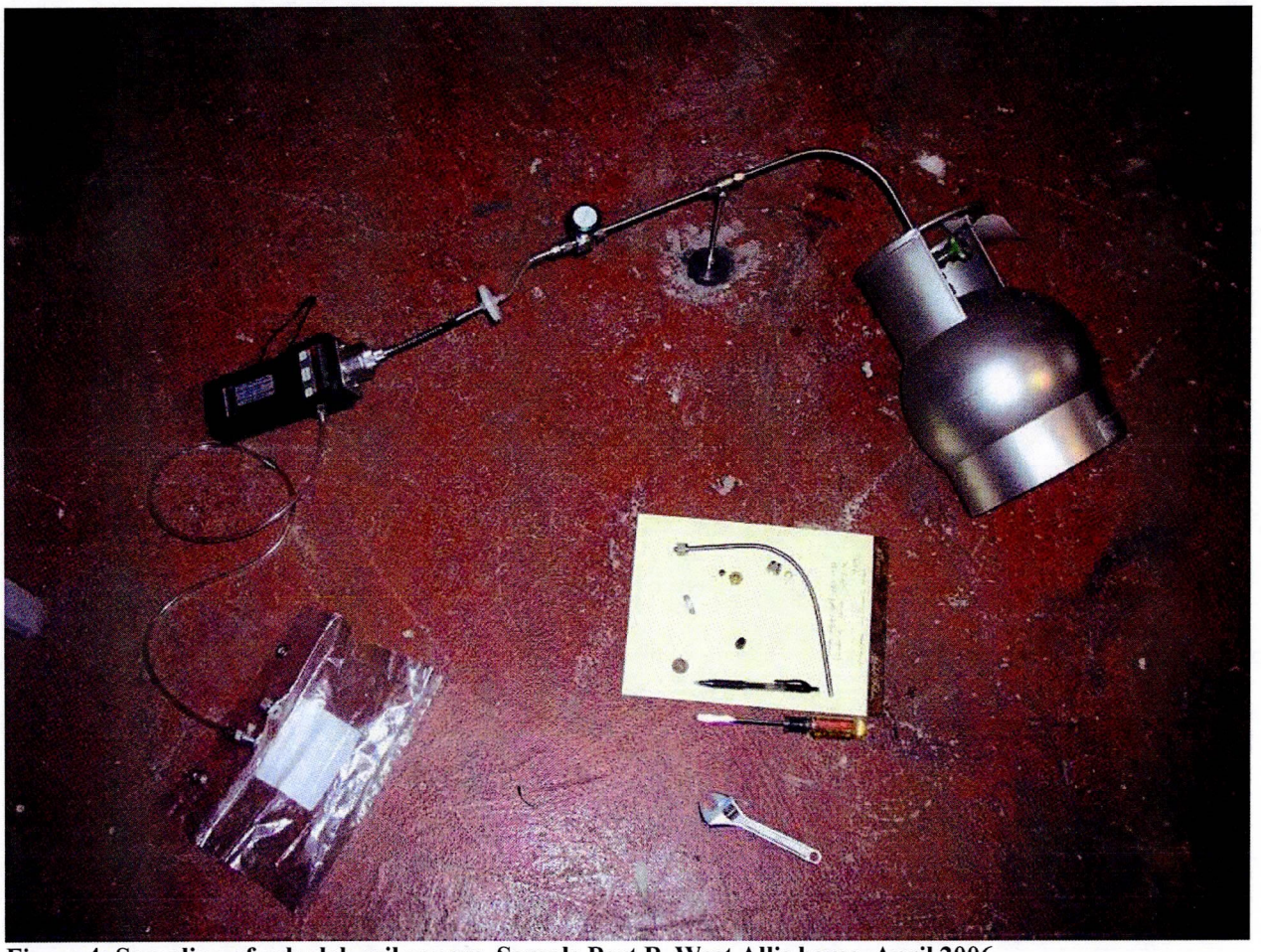

Figure 4: Sampling of sub-slab soil vapors, Sample Port B, West Allis home, April 2006.