

Health Consultation

KRAUS MODEL CLEANERS INDOOR AIR EVALUATION

MEMPHIS, SHELBY COUNTY, TENNESSEE

**Prepared by:
Tennessee Department of Health**

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Foreword

This document is an update summarizing an environmental public health investigation performed by the Environmental Epidemiology Program of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people have the potential to be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be actions items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

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Glossary of Terms

Acute: Occurring over a short time [compare with chronic].

Acute exposure: Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].

Additive effect: A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together.

Adverse health effect: A change in body function or cell structure that might lead to disease or health problems

Ambient: Surrounding (for example, *ambient* air).

Background level: An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

Cancer: Any one of a group of diseases that occur when cells in the body become abnormal and grow or multiply out of control.

Cancer risk: A theoretical risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

Carcinogen: A substance that causes cancer.

Chronic exposure: Contact with a substance that occurs over a long time (more than 1 year).

Comparison value (CV): Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

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

Contaminant: A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

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

EPA: United States Environmental Protection Agency.

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

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

Exposure pathway: The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

Groundwater: Water beneath the earth's surface in the spaces between soil particles and between rock surfaces.

Health consultation: A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical.

Inhalation: The act of breathing. A hazardous substance can enter the body this way.

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.

Intermediate duration exposure: Contact with a substance that occurs for more than 14 days and less than a year.

Migration: Moving from one location to another.

Minimal risk level (MRL): An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects.

No-observed-adverse-effect level (NOAEL): The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

Plume: A volume of a substance that moves from its source to places farther away from the source. Plumes can be described by the volume of air or water they occupy and the direction they move. For example, a plume can be a column of smoke from a chimney or a substance moving with groundwater.

Point of exposure: The place where someone can come into contact with a substance present in the environment.

ppb: Parts per billion.

Remediation: 1. Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a Superfund site; 2. for the Asbestos Hazard Emergency Response program, abatement methods including evaluation, repair, enclosure, encapsulation, or removal of greater than 3 linear feet or square feet of asbestos-containing materials from a building.

Remedial investigation: The CERCLA process of determining the type and extent of hazardous material contamination at a site.

Risk: The probability that something will cause injury or harm.

Route of exposure: The way people come into contact with a hazardous substance. Three routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact).

Sample: A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Soil-Gas: Gaseous elements and compounds in the small spaces between particles of the earth and soil. Such gases can be moved or driven out under pressure.

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

Source Area: The location of or the zone of highest soil or groundwater concentrations, or both, of the chemical of concern. The source of contamination is the first part of an exposure pathway.

Toxicological profile: An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology: The study of the harmful effects of substances on humans or animals.

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

SUMMARY

INTRODUCTION Ensuring the wellbeing of those living in, working in, or visiting Tennessee is a priority of the Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP).

EEP wrote this health consultation at the request of the Tennessee Department of Environment and Conservation (TDEC) Drycleaner Environmental Response Program (DCERP). It documents our review of an indoor air sampling conducted in July 2010 inside the former Kraus Model Cleaners and adjacent business suites that include a stamp and coin store and an ice cream store. These businesses are located in a two-story strip mall shopping center. It is likely that chemicals were released at the cleaners due to improper handling of drycleaner solvent and/or leaks from the former drycleaning machine. The drycleaner-related chemical has migrated into site soil and groundwater beneath the cleaner. The drycleaner-related chemical is known to migrate upward from soil and groundwater beneath buildings into the indoor air. Depending on the concentrations of the drycleaner-related chemical in the indoor air, there could be potential health effects to workers and/or customers from breathing the indoor air.

All data supplied for this health consultation was compared to Agency for Toxic Substances and Disease Registry (ATSDR) and U.S. Environmental Protection Agency (EPA) residential air comparison values. Comparison values are chemical concentrations based on toxicology below which no adverse health effects are predicted to occur. When a comparison value is exceeded, it does not immediately indicate that people would be expected to develop adverse health effects. Instead, it means further investigation is needed.

CONCLUSIONS EEP reached five conclusions in this health consultation:

Conclusion 1 TDH EEP cannot currently conclude whether breathing indoor air in the cleaner with the measured tetrachloroethylene (PCE) concentration could harm the health of the cleaner workers. Not all the information we need to make a decision is available.

Basis for Conclusion The exposure for a worker of the cleaner would be much less than the cautious 24 hours per day, 7 day per week, lifetime exposure on which the acceptable risk values are based on. PCE is no longer used as a drycleaner solvent chemical at the site. It is also not stored on-site. The source of the PCE in the cleaner is also unknown. It could be from vapor intrusion or it could be from off-gassing of PCE from clothing that is ready for pick up by customers. Members of the general public who are

customers of the former cleaner would have a limited exposure to PCE because they would spend only a short amount of time in the cleaner.

Next Steps

TDH EEP recommends that additional testing be completed. TDH EEP has had conversations with DCERP regarding collecting and testing additional air samples in suites of the strip mall and sub-slab soil-gas samples beneath the cleaner to gain a better idea of the amounts and origin of the drycleaner chemical in the indoor air of the building.

Conclusion 2

EEP concludes that the concentration of the drycleaner breakdown chemical trichloroethylene (TCE), in the indoor air of the cleaner is not expected to harm the health of workers or customers.

Basis for Conclusion

Indoor air in the cleaner also contained minor measured amounts of TCE. Breathing the very low levels of TCE in the indoor air of the cleaners would likely not lead to long-term exposure to workers putting in many hours over many years at the store. Customers of the cleaner would have a short and very limited exposure to TCE. They should not experience increased health effects from breathing the indoor air in the cleaner.

Next Steps

EEP recommends additional indoor air testing and sub-slab soil-gas testing in the cleaner and indoor air testing in the suites adjacent to the cleaner to more fully understand the amounts and origin of chemicals in the indoor air.

Conclusion 3

EEP concludes that the amount of PCE in the indoor air of the stamp and coin store suite is not expected to harm the health of workers or customers.

Basis for Conclusion

Indoor air in the stamp and coin store contained small amounts of PCE. The measured PCE concentration is not likely to lead to long-term exposure to workers, even putting in many hours over many years at the store. The measured amounts of PCE will also not likely result in a higher cancer risk from breathing indoor air. It is not known if the PCE measured in the stamp and coin store is from vapor intrusion or from migration of PCE off-gassing from clothing that is ready to be picked up by customers from the cleaner next door.

Next Steps

EEP recommends additional indoor air testing in this suite to more fully understand the concentrations of chemicals in the indoor air and their origin.

Conclusion 4

EEP concludes that the level of PCE measured in the ice cream store was below levels published by both ATSDR and EPA that would be expected to harm the health of adult workers or adult and children customers.

Basis for Conclusion There were very low measured amounts of PCE above the detection limits of the testing in the indoor air of the ice cream store. The measured amount of PCE in indoor air would not be expected to harm the health of the workers or adult and children customers of the ice cream store.

Next Steps TDH EEP recommends additional indoor air testing in this suite to more fully understand the concentrations of chemicals in the indoor air and their origin.

Conclusion 5 EEP cannot conclude whether breathing the indoor air in other business suites of the strip mall could harm the health of the workers or customers of these businesses. Not all the information we need to make a decision is available. There may or may not be measureable concentrations of PCE and PCE breakdown chemicals in other suites of the strip mall. TDH EEP will work with TDEC DCERP to gather the additional information.

Basis for Conclusion It is unknown if the drycleaned clothing awaiting pick up by customers is off-gassing PCE or if there is a definite vapor intrusion issue at the site. TDH EEP and DCERP have agreed additional testing is necessary and DCERP's contractor will provide the testing. Other suites may be evaluated in the future depending on the results of the proposed additional testing.

Next Steps Depending on the next round of indoor air sampling results, TDH EEP may recommend additional indoor air testing.

FOR MORE INFORMATION If you have any questions or concerns about your health, you should contact your healthcare provider. For more information on this site call TDEC DCERP at 615-532-0900 during normal business hours. For questions on health related topics of this site you can call TDH EEP at 615-741-7247 or toll free 1-800-404-3006. You can also email TDH EEP at eep.health@tn.gov.

Introduction

The Tennessee Department of Environment and Conservation's (TDEC) Drycleaner Environmental Response Program (DCERP) Facility ID No. D-79-137 (Figure 1) is a former drycleaner (the site) located at 5007 Black Road in Memphis, Shelby County, Tennessee, 38117. The site is located in a ground floor suite of a two-story retail strip mall (Figure 1). The drycleaner, Kraus Model Cleaners, began operation in approximately 1986. The cleaner ceased on-site drycleaning operations and became a laundry and drycleaning drop-off and pick-up location in March/April 2003. All drycleaning solvent was removed from the site by late-January 2004 (EnSafe 2004).

As part of their continued commitment to maintaining former drycleaner sites for safe new uses, the DCERP recommended indoor air sampling as a component of the Interim Action activities conducted at the site by the registered Drycleaner-Approved Contractor (DCAC), EnSafe Inc. (EnSafe) of Memphis, Tennessee (EnSafe 2010). The Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) was contacted in July 2010 by the DCERP to evaluate the results of indoor air sampling conducted by EnSafe. Indoor air testing was done in three suites of the strip mall by EnSafe on February 22, 2010. The three suites tested were the cleaner, an adjacent coin and stamp shop, and an adjacent ice cream store. DCERP asked EEP to review the indoor air testing results and to evaluate if vapor intrusion was a potential issue in the cleaner or adjacent suites. TDH EEP prepared this health consultation for the site based on the EnSafe (2010) indoor air sampling results.

Background

The site is located at 5007 Black Road, a side street near the intersection of Mendenhall Road and Poplar Avenue, in eastern Memphis, Tennessee (Figure 1). The cleaners formerly occupied two suites in a two-story retail strip center that is oriented in a north to south direction. Drycleaning operations were performed for approximately 17 years in the southern portion of the western half (rear), and the pick-up and drop-off reception area occupies the eastern half (front). The western half also housed washing machines, presses, clothing racks, and other miscellaneous equipment (Figure 2). All drycleaning is now performed off-site.

The cleaner operated in the building since its construction in approximately 1986 to 2003. Tetrachloroethylene (PCE) was reportedly always used as the drycleaning solvent (EnSafe 2004). The drycleaning machine used was not fitted with secondary containment until April 1994. A second drycleaning machine was also used at the cleaner sometime before 1994. A still, for the purpose of on-site distillation of the PCE, was also used. The second drycleaning machine and the still were also not fitted with secondary containment. The lack of secondary containment for the machines and the still likely led to release of the PCE solvent to the environment. During the years of its operation waste filters were tested after they were steam cleaned in the drycleaning machine to determine proper disposal requirements. The filters were tested for PCE via U.S. Environmental Protection Agency (EPA) toxicity characteristic leaching procedure methods to determine if they should be managed as a hazardous waste. None of the

analyses detected PCE above regulatory levels. Therefore, the filters were routinely disposed of in an outside Dumpster after they were cleaned (EnSafe 2005).

The site is bordered on the north by Black Road. Beyond Black Road are a restaurant and a movie theater. The site is bordered on the east by a parking lot, then retail stores including an office supply store and a health foods grocery store; on the south by remaining suites in the 5007 Black Road building (formerly occupied by a restaurant), then an access road and another restaurant; on the west by a multi-level office building housing an insurance company, and then Mendenhall Road (Figure 1).

In 2005, Kraus Model Cleaners renovated the site in order to divide the facility into two separate suites. The facility was divided into a northern suite and a southern suite, with Kraus Model Cleaners continuing to operate in the southern suite solely as a pick-up and drop-off location (EnSafe 2005). All drycleaning related equipment was removed from the site as part of the renovation. The organization of the former Kraus Model Cleaner suite is shown in Figure 2.

Upon completion of the renovations, the northern suite was leased and is currently operated by a separate business as an ice cream store. The adjacent suite to the south of the cleaner is a stamp and coin shop. A bistro restaurant was located in the suite to the south adjacent to the stamp and coin store. Access to the bistro restaurant could not be obtained for the February 2010 sampling, and it has since closed.

The second floor of the strip mall housing Kraus Model Cleaners has retail and service-oriented shops. The suite above the cleaner houses a jewelry store. Above the stamp and coin store is an unoccupied suite. There is a sign in the window that indicates a Mexican-style restaurant is to be moving into the suite. However, the consultant stated that this sign has been in the window for over a year with no action taking place (J. Broughton, EnSafe Inc., personal communication). A nail salon and a retail store are present in the suites above the ice cream store (EnSafe 2010). Indoor air was not tested in any of these second floor suites.

There is an elevator for the building. The elevator is located at the southeast corner of the former drycleaner suite. The former location of one of the drycleaner machines for the cleaner and the cleaner's former waste solvent storage location were immediately next to the elevator room. The elevator shaft is of an unknown depth. It is also unknown if the elevator shaft has a sump. The bottom of the elevator shaft was not accessible (EnSafe 2010).

DCERP has been involved in the investigation of the Kraus Model Cleaner since February 2004. Various reports on the environmental investigations performed at the site have been submitted to DCERP by EnSafe. Drycleaner solvent impacted soil and groundwater remains under the building. Concentrations of PCE and drycleaner solvent breakdown chemicals in groundwater were reported by EnSafe (2005) to be above EPA regional screening values (RSLs) for soil and Primary Drinking Water Maximum Contaminant Levels (MCLs).

In addition to the past environmental investigations, remedial actions have also been conducted. Multiple chemical oxidation product injections were conducted in 13 on-site injection points from 2007 to 2009 (EnSafe 2010) in an attempt to remediate site soil and groundwater.

Both soil and groundwater at the site were sampled after the injections to determine if the chemical oxidation product injected reduced the amount of drycleaner-related chemicals in soil and groundwater underneath the building. The drycleaner solvent and drycleaner solvent breakdown chemicals released to the soil at the cleaner have been reduced in concentration in the 5, 10, and 20 foot sample intervals by the remedial action activities. The PCE concentration remained the same in the 15 foot interval after the remedial actions.

Based on sampling data obtained by EnSafe (2009), the injections of chemical oxidation product have not resulted in remediating site groundwater. After the oxidation product injections, PCE concentrations have increased in groundwater samples collected from three of the four on-site wells.

The groundwater plume at the site appears to extend northward toward Black Road, based on data provided by EnSafe (2005). Groundwater monitoring wells ring the strip mall building housing the cleaner. Total depth of all four wells is approximately 97 feet below ground surface.

After the injections of the chemical oxidation product, indoor air sampling was conducted to determine if drycleaner solvent or breakdown chemicals in soil and groundwater were migrating into the indoor air of the former cleaner or adjacent business suites (Figure 3).

Discussion

Introduction to Chemical Exposure

To determine whether persons have been or are likely to be exposed to chemicals, TDH EEP evaluates mechanisms that could lead to human exposure. Chemicals released into the environment have the potential to cause harmful health effects. Nevertheless, a release does not always result in exposure. People can only be exposed to a contaminant if they come into contact with it. If no one comes into contact with a contaminant, then no exposure occurs, and thus, no health effects could occur. An exposure pathway contains five parts:

- a source of contamination,
- contaminant transport through an environmental medium,
- a point of exposure,
- a route of human exposure, and
- a receptor population.

An exposure pathway is considered complete if there is evidence that all five of these elements have been, are, or will be present at the site. An exposure pathway is considered incomplete if one of the five elements is missing.

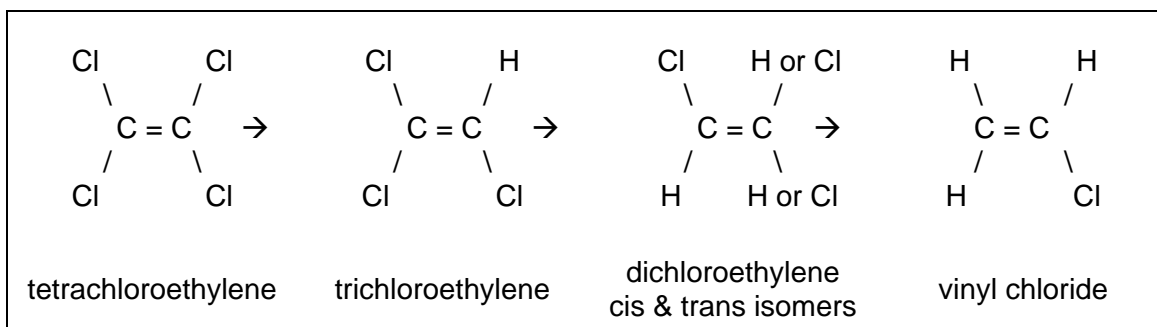
Physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will develop adverse health effects. A chemical's ability to affect public health is controlled by a number of other factors, including:

- the amount of the chemical that a person is exposed to (dose),
- the length of time that a person is exposed to the chemical (duration),
- the number of times a person is exposed to the chemical (frequency),
- the person's age and health status, and
- the person's diet and nutritional habits.

This consultation will evaluate breathing air containing the drycleaning solvent tetrachloroethylene (PCE) and its chemical breakdown chemicals, including trichloroethylene (TCE), in the former cleaner and in the adjacent suites. One potentially exposed population would be the workers in the cleaner who would likely work a standard 40 hour work week. A second potentially exposed population would be the workers in the adjacent ice cream store and those in the adjacent stamp and coin shop. A third potentially exposed population would be the customers of the cleaner, the ice cream store, and coin and stamp shop. The customers of all these shops would only be present for a short period of time.

Drycleaner Solvent Explanation

The process of drycleaning is not truly dry, but it uses so little water that it has come to be known as drycleaning. Instead of water, chemical solvents are used in the cleaning process. The most commonly used solvent for drycleaning is tetrachloroethylene or perc. It is colorless liquid and has sweet smell (ATSDR 1997). PCE is a volatile organic compound. It will quickly evaporate into a gas at room temperature. As its name implies, tetrachloroethylene has four chlorine anions on a two-carbon molecule. As these chlorine anions react, the molecule breaks down into other chlorinated volatile organics. Each of these breakdown chemicals has slightly different chemical properties and toxicities. The following diagram is an example of how one chemical can break down to form another.



For example, PCE can break down to TCE, then to dichloroethylene (DCE), and then to vinyl chloride (VC). The only way to truly know the ratio of these breakdown chemicals is to collect environmental samples. The drycleaner solvent, PCE, and all of its breakdown chemicals plus their isomers were carefully considered in developing this report.

Vapor Intrusion

Vapor intrusion is the movement of volatile chemicals from the subsurface into overlying buildings. Volatile chemicals in buried wastes and/or contaminated groundwater can emit vapors that migrate through subsurface soils and into the indoor air of overlying buildings.

Vapors may accumulate in buildings to levels that pose safety hazards, health risks, or odor problems. Vapor intrusion has been documented in buildings with basement, crawlspace, or slab-on-grade foundation types. Vapor intrusion can be an acute health hazard. Usually, indoor vapor levels are low. Low levels of vapors, breathed over a long period of time, may or may not be a chronic health concern.

Comparison Values

To evaluate exposure to a hazardous substance, health assessors often use comparison values. If the chemical concentrations are below the comparison value, then health assessors can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the comparison values (ATSDR 2010) for a particular chemical, then further evaluation is needed.

The Agency for Toxic Substances and Disease Registry's (ATSDR) develops minimal risk levels (MRLs) using conservative assumptions. ATSDR uses the term 'conservative' to refer to values that are protective of public health in essentially all situations. Environmental Media Evaluation Guidelines (EMEGs) are calculated by ATSDR from their MRLs. EMEGs consider non-cancer adverse health effects. Exposure durations are defined as acute (14 days or less), intermediate (15–365 days), and chronic (365 days or more) exposures. ATSDR does not use serious health effects, such as irreparable damage to the liver or kidneys, or birth defects, as a basis for establishing EMEGs. Chronic EMEGs assume exposure for 24 hours per day, 7 days per week, 52 weeks, 365 days per year, over a 70-year lifetime exposure. Exposure to a level above the EMEG does not necessarily mean that adverse health effects will occur (ATSDR 2007).

To understand if concentrations of the solvents PCE or TCE and their breakdown products could cause excess cancers in workers or visitors to the site, measured concentrations of these chemicals were also compared to ATSDR cancer risk evaluation guides (CREGs). The CREG comparison values are established for no more than one theoretical excess cancer in 1,000,000 people exposed during a 70-year lifetime. CREGs are calculated from EPA's cancer slope factors for oral exposures or unit risk values for inhalation exposures. These values are based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure.

EPA's residential inhalation Regional Screening Levels (RSLs) were also used in evaluating the results of the testing. EPA's residential inhalation comparison values were used instead of EPA industrial inhalation RSLs because the exposure to workers and visitors at the site is involuntary. The workers and visitors may not know that there are potential exposure issues at the site from previous use of solvents.

Environmental Sampling

Air sampling was conducted on February 22, 2010. The indoor air sampling was completed to determine if the drycleaner chemical, PCE, or its breakdown chemicals were present in the breathable air of the cleaner or the two adjacent suites. Three Summa canisters were used for the collection of indoor air samples. One Summa canister was placed in the former cleaner suite, one in the adjoining ice cream store, and one in the stamp and coin store. Access to the suite

adjoining the stamp and coin store (bistro restaurant) was not possible for the sampling event; therefore, no sample was collected from this location. Sample locations are presented on Figure 3. The Summa canisters were placed in each business at occupant breathing heights and collected over an approximately 8-hour time period during normal operating hours.

Air samples were analyzed for volatile organic compounds (VOCs) using EPA Method TO-15. This test includes PCE and its breakdown chemicals. All three samples were submitted to ALS Laboratory Group of Salt Lake City, Utah, for analysis. No outside air samples were collected as part of the February 2010 air sampling. Indoor air test results are summarized in Table 1.

Indoor Air Results

PCE in the indoor air of the former drycleaner was measured to be 230 parts per billion (ppb). TCE was also measured in the former cleaner at 0.55 ppb. No other PCE solvent breakdown chemicals were measured in the Kraus Model Cleaners air sample above their respective testing method reporting levels (Table 1). Reporting limits ranged from 0.11 ppb to 0.32 ppb.

PCE was measured in the indoor air of the stamp and coin shop at 24 ppb. All other PCE breakdown chemicals were below test method reporting limits. PCE was measured at a very low amount in the ice cream store, 0.69 ppb. All PCE breakdown chemicals were below test method reporting limits in the ice cream store.

The amount of PCE measured in the cleaner, the stamp and coin shop, and the ice cream store were all above the ATSDR CREG cancer comparison value of 0.06 ppb for a risk of 1×10^{-6} , but only exceeded the ATSDR EMEG non-cancer comparison value of 40 ppb in the sample collected from the former cleaner. TCE, detected in the sample from the former cleaner suite at 0.55 ppb, exceeded the EPA RSL comparison value of 0.22 ppb for a risk of 1×10^{-6} . TCE was not measured in the stamp and coin shop or the ice cream store.

Toxicology of Compounds of Interest

The compounds of interest at the site include tetrachloroethylene (PCE), trichloroethylene (TCE), cis-1,2-dichloroethylene (cis-1,2-DCE) and vinyl chloride (VC). These chemicals are classified as dense, non-aqueous phase liquids (DNAPLs) and can also readily travel through soil and enter into groundwater. TCE, cis-1,2-DCE, and VC are all breakdown chemicals of PCE.

Tetrachloroethylene (PCE)

PCE is a clear, colorless liquid said to produce a sharp, sweet smell. It evaporates very readily at room temperature. PCE is a synthetic chemical and is often used as a starting point for the manufacture of other chemicals (ATSDR 1997). This site purchased and used PCE as a solvent to dryclean clothes. People can detect the smell of PCE in the air at 1 part per million (ppm) or more. Background concentration of PCE in the environment is usually less than 1 ppb. The significance of exposure to small amounts of PCE is unknown, but to date, they appear to be relatively harmless (ATSDR 1997). PCE is readily absorbed following inhalation and oral exposure as well as from direct exposure to the skin. For this site, we are concerned with the

TABLE 1. Indoor air data for the Kraus Model Cleaner and two adjacent suites, Memphis, Shelby County, TN. All three samples were collected using Summa canisters over 8-hours on February 22, 2010. Values are reported in parts per billion (ppb). Health comparison values are based on chronic exposure duration (ATSDR 2010). ATSDR cancer risk evaluation guides (CREGs) (2010) and EPA residential inhalation regional screening levels (EPA 2010) are also shown. Health screening values are used to determine if chemical concentrations warrant further health-based screening. Data provided by EnSafe Inc., Memphis, TN, July 2010.

Chemical	Acronym	Ice Cream Store	Stamp & Coin Store	Former Kraus Model Cleaners	ATSDR EMEG (non-cancer)	ATSDR CREG or EPA RSL	
						(10 ⁻⁶ excess cancer risk)	(10 ⁻⁴ excess cancer risk)
		ppb	ppb	ppb	ppb	ppb	ppb
tetrachloroethylene	PCE	0.69	24	230	40	0.06 ^{EPA}	6 ^{EPA}
trichloroethylene	TCE	<0.32	<0.32	0.55	7.4 ^{EPA*}	0.22 ^{EPA}	22 ^{EPA}
cis-1,2-dichloroethylene	cis-1,2-DCE	<0.19	<0.19	<0.19	ngv	nc	nc
trans-1,2-dichloroethylene	trans1,2-DCE	<0.20	<0.20	<0.20	200 ⁱ	nc	nc
1,1-dichloroethene	1,1-DCE	<0.32	<0.32	<0.32	20 ⁱ	0.01	1
1,1-dichloroethane	1,1-DCA	<0.11	<0.11	<0.11	ngv	ngv	ngv
1,2-dichloroethane	1,2-DCA	<0.13	<0.13	<0.13	600	0.01	1
vinyl chloride	VC	<0.09	<0.09	<0.09	30 ⁱ	0.04	4

Notes:

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Minimum Risk Level / Environmental Media Evaluation Guide (ATSDR 2010). Chronic non-cancer exposure comparison values (exposure greater than 365 days).

ATSDR CREG = Agency for Toxic Substances and Disease Registry Cancer Risk Evaluation Guide (ATSDR 2010). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people.

97 **Bold** indicates an indoor air concentration that was the same or greater than both non-cancer comparison value for the chemical and the 1 in 1,000,000 excess cancer comparison value for the chemical.

8.9 *Italics* indicate indoor air detections of the chemical are greater than the 1 in 1,000,000 excess cancer comparison value for the chemical.

<0.32 = not detected in the air sample at the reporting limit concentration shown.

EPA Regional Screening Level for indoor air (EPA 2010)

EPA* = There is not a published EMEG or RSL for TCE. The results were compared to the EPA's provisional guidance (EPA 2001).

ⁱ = ATSDR comparison intermediate value for 15-365 days exposure; typically higher than a chronic value.

nc = not classified as to carcinogenicity.

ngv = no guidance value available.

inhalation of PCE from vapor intrusion into indoor air.

Studies of PCE toxicity for inhalation exposure suggest effects to the liver and kidneys with effects showing up with human lowest observed adverse-effects levels (LOAELs) at approximately 20 parts per million (ppm). PCE is “*reasonably anticipated to be a human carcinogen*” (IARC 1995, NTP 2001). The cancer risk posed by PCE has been under evaluation for some time within EPA and the health community. Its toxicity class is also under review.

Trichloroethylene (TCE)

TCE is a clear, colorless liquid said to produce a sharp, sweet odor and a sweet, burning taste. It is nonflammable and evaporates easily at room temperature. Background concentrations of TCE in the environment are usually less than 1 ppb. At this site, TCE is thought to be a natural breakdown chemical of the PCE used for drycleaning. Biological organisms break down PCE, forming TCE.

Breathing TCE may cause a variety of short-term health effects including headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing it for long periods may cause nerve, kidney, and liver damage.

TCE, is also “*reasonably anticipated to be a human carcinogen*” (IARC 1995, NTP 2001). Similar to PCE, the cancer and non-cancer risks posed by TCE have also been under evaluation. ATSDR does not have a chronic EMEG for TCE for chronic inhalation exposure. EPA has a provisional value of 7.4 ppb for protecting public health from inhalation exposures to TCE (EPA 2008).

Evaluation of Indoor Air Results

The indoor air results for the three suites were compared to ATSDR and EPA air health comparison values. What these results mean is discussed below for the former cleaner, the stamp and coin shop, and the ice cream store.

PCE was detected in the Kraus Model Cleaners site, the ice cream store, and the stamp and coin store. TCE was detected only in the Kraus Model Cleaners site. No other PCE solvent breakdown contaminants were detected in any of the air samples. Reporting limits for these chemicals are below levels of health concern.

Kraus Model Cleaners Suite

As stated previously, the potentially exposed population would be the workers who work in the same space as former cleaner suite and the customers of the cleaner. The customers would only have a brief and limited exposure.

In the February 2010 indoor air sampling event (Table 1), the 230 ppb PCE concentration in the former cleaner was nearly 6 times higher than the published chronic exposure ATSDR EMEG of 40 ppb and nearly 40 times greater than EPA’s 10^{-4} risk excess cancer risk level of 6 ppb.

The 0.55 ppb TCE concentration in the former cleaner was below the EPA provisional guidance value of 7.4 ppb for non-cancer effects. EPA's RSL for a one in million excess cancer risk is 0.22 ppb. TCE was measured at a concentration of 0.55 ppb or $3 \mu\text{g}/\text{m}^3$. The theoretical risk above background for chronic exposure for this concentration would be between 1 excess cancer in 1,000,000 and 1 excess cancer in 100,000 people. This theoretical risk is within EPA's acceptable range of excess cancer risk above background (EPA 1991).

The PCE breakdown chemical, cis-1,2-dichloroethylene (cis-1,2-DCE), does not have established comparison values for non-cancer health effects, although the trans isomer has an intermediate EMEG of 200 ppb. Both isomers are considered together for toxicity comparison purposes.

RSLs have been developed for a chronic, 24 hours per day, 7 days a week, 365 days per year, 70-year lifetime exposure. The theoretical risk for this chronic exposure scenario that workers would be subjected to can be calculated using the concentration of PCE in the cleaner space multiplied by the inhalation unit risk (IUR) derived for PCE. The concentration in the cleaner was 230 ppb ($1560 \mu\text{g}/\text{m}^3$) multiplied by the PCE inhalation unit risk of $5.9 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$. The theoretical risk would be 9.3×10^{-3} or about 9 extra cancers in 1,000 people. This theoretical risk is an unacceptable excess cancer risk above background to workers.

Residential values were used because of the involuntary exposure that would be experienced by people working in the building that housed the former cleaner (ATSDR 2006). These individuals are not like workers who work with chemicals in a work place and are told about the hazards of them (OSHA Right-To-Know laws). Workers that work with or in areas near chemicals willingly accept the risks by continuing to work with them or be in the same area as the chemicals. Workers who work in a work place with chemicals and are told about the hazards of them also have access to, and training on, the use of personal protective equipment (PPE) which they would wear working with these chemicals.

To be clear, the actual exposure at the former cleaner would be much less than the calculated theoretical risk. Workers are not in the cleaner suite 24 hours per day, 7 days a week, 365 days each year, for a 70-year lifetime. A worker in the former cleaner space would definitely have a shorter exposure because the worker is not in the cleaner 24 hours each day over a lifetime. For a customer of the cleaner, the limited amount of time they would breathe the indoor air containing PCE, while doing business, would not likely increase their cancer risk.

In an attempt to calculate a site-specific risk using time worked at the facility, the risk was modified for a worker working 10-hours per day, 6 days per week, 50 weeks per year, for 10 years. The inhalation unit risk for PCE of $5.9 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$ was multiplied by the measured concentration of 230 ppb ($1560 \mu\text{g}/\text{m}^3$). The resulting risk of 9.2×10^{-3} was then multiplied by 0.049 to adjust the exposure duration. Therefore, the adjusted calculated exposure risk was 4.5×10^{-4} or approximately 4 excess cancers in 10,000 people. This excess cancer risk is outside the 10^{-6} to 10^{-4} excess cancer risk considered acceptable by EPA. Therefore, there is a potential health concern from breathing air containing this level of PCE to workers of the former cleaner.

The exposure duration modifier was calculated as follows:

$$\frac{10 \text{ hours per day}}{24 \text{ hours per day}} \times \frac{6 \text{ days per week}}{7 \text{ days per week}} \times \frac{50 \text{ weeks per year}}{52 \text{ weeks per year}} \times \frac{10 \text{ years exposure}}{70 \text{ years exposure}} = 0.049$$

In summary, breathing indoor air in the cleaner suite would not likely lead to non-cancer health effects. However, there may be potential cancer health effects to those workers who work in the space of the former cleaner from breathing indoor air containing the levels of PCE measured, assuming long term endpoint/exposure. Only one air sampling event has occurred at the former cleaner suite. This one-time sampling event is not adequate to determine the potential long-term health effects from exposure to PCE. It is not known if the clothing awaiting pick up by customers is the origin of, or is contributing to, PCE levels in the indoor air. Additional focused sampling could lead to better understanding of the origin of the PCE levels in indoor air.

Stamp and Coin Suite

The drycleaner solvent chemical, PCE, was the only chemical detected in the stamp and coin store suite. The PCE concentration of 24 ppb in this suite was below its ATSDR non-cancer EMEG of 40 ppb.

For the measured PCE detection of 24 ppb or $163 \mu\text{g}/\text{m}^3$, the inhalation unit risk was used to determine the risk of excess cancer in the stamp and coin suite. EPA's IUR for PCE is $5.96 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$. The IUR was multiplied by the measured concentration. This yields a nearly 10 in 10,000 increased cancer risk for the stamp and coin suite. This risk is greater than EPA's accepted risk above background range of 1 in 10,000 to 1 in 1 million (EPA 1991). This risk is based on a 24 hour per day, 7 day per week, 365 days per year, 70-year lifetime exposure. Workers and customers of the stamp and coin store would not be in the suite for this period of time.

The exposure concentration was modified as discussed for the Kraus Model Cleaners Suite. The inhalation unit risk for PCE of $5.9 \times 10^{-6} (\mu\text{g}/\text{m}^3)^{-1}$ was multiplied by the concentration of 24 ppb or $163 \mu\text{g}/\text{m}^3$, resulting in a calculated risk of 9.6×10^{-4} . The resulting risk of 9.6×10^{-4} was then multiplied by the exposure duration modifier of 0.049 to adjust the exposure duration. Therefore, the adjusted calculated exposure risk was 4.7×10^{-5} or approximately 5 excess cancers in 100,000 people. This excess cancer risk is within the 10^{-6} to 10^{-4} excess cancer risk considered acceptable by EPA (1991). Therefore, the levels of PCE in the air should not be a health concern to workers or customers of the stamp and coin shop.

In summary, breathing indoor air in the stamp and coin suite would not likely lead to non-cancer health effects. Based on the levels of PCE in the suite, there would not likely be increased cancer risk above background to workers or customers from breathing indoor air containing the measured levels of PCE.

Ice Cream Store Suite

The ice cream store suite was once part of the cleaner suite. It was remodeled after the cleaner became a pick-up only store in 2004. The drycleaning machines and still were not located in what now is the ice cream store suite.

PCE was measured at 0.69 ppb or 4.7 $\mu\text{g}/\text{m}^3$ in the ice cream store, far below its ATSDR non-cancer EMEG of 40 ppb. This was the only detection of drycleaner-related chemicals in the suite.

For the measured PCE detection of 0.69 ppb or 4.7 $\mu\text{g}/\text{m}^3$, the inhalation unit risk was used to determine the theoretical increased cancer risk from breathing indoor air in the ice cream store. EPA's IUR for PCE is 5.9×10^{-6} ($\mu\text{g}/\text{m}^3$)⁻¹. The inhalation unit risk was multiplied by the measured concentration. This yields a 3 in 100,000 increased cancer risk for the ice cream store suite. This excess cancer risk is within EPA's accepted risk above background range of 1 in 10,000 to 1 in 1 million (EPA 1991). This risk is based on a 24 hour per day, 7 day per week, 365 days per year, 70-year lifetime exposure. Workers and customers of the ice cream store would not be in the suite for this period of time.

In summary, breathing indoor air in the ice cream store suite would not likely lead to non-cancer health effects. Based on the levels of PCE in the suite, there would not likely be increased potential cancer health effects to workers or customers from breathing indoor air containing the measured levels of PCE.

PCE and TCE Mixture

PCE and a minor amount of TCE were the only drycleaner-related chemicals found in the former Kraus Model Cleaners suite during the February 2010 sampling. In previous indoor air sampling events both PCE and TCE were present in the former cleaner. There are possible additive health effects from these chemicals to an exposed population (ATSDR 2004). There is no evidence to indicate that greater-than-additive interactions among TCE or PCE health effects might occur. This includes interactions for the most common liver and kidney or nervous system effects observed from PCE or TCE exposure.

Adding together the risks of PCE and TCE, the total excess cancer risk was still about 4 in 10,000 in the Kraus Model Cleaners suite. It is unlikely that the presence of both PCE and TCE in indoor air would create any increased health effects to those who breathe the indoor air by visiting or working in the suite.

Uncertainties and Limitations

There is not enough information or data to determine if vapor intrusion is or is not occurring in the former cleaner suite. PCE off-gassing from drycleaned clothing could be the origin of the PCE in indoor air of cleaners. DCERP has found this to be the case in studies of other former cleaners that have been converted to pick-up stores (James Gilbert TDEC DCERP, personal communication, January 2009). ATSDR (1997) has found studies that showed measured

concentrations of PCE in newly drycleaned garments stored in a residential closet ranged from 74 to 428 ppb PCE after 1 day of storage. A pick-up location storing drycleaned garments would likely, based on the number of garments, have at least a similar concentration of PCE in the indoor air. Therefore, the PCE concentration in the indoor air of the former Kraus Model Cleaner laundry would not be uncommon for a pick-up store.

Future Considerations

It is unknown if the concentrations of PCE measured are the result of off-gassing of PCE from drycleaned clothes, vapor intrusion from past releases, or a combination of both. Drycleaning is no longer conducted on the premises. Remedial actions have been conducted for soil and groundwater at the site. Additional sampling and testing can be done to further identify the source of the PCE.

The elevator shaft in the building housing the former Kraus Model Cleaners connects the lower floor of the building containing the former cleaner, the stamp and coin store, the ice cream store, and the former restaurant. The shaft could be a potential conduit for the migration of drycleaner solvent and drycleaner solvent breakdown chemicals upwards to the second floor commercial suites of the building. There is a door that may or may not lead to the elevator shaft or access to the shaft. Currently access is unknown. In conversations with DCERP, sample may be collected in the next round of site sampling if access to the elevator shaft is available through the door/closet.

The remaining ground floor suite south of the stamp and coin shop is the suite once occupied by a bistro restaurant. EnSafe (2010) reported that access to the bistro restaurant suite could not be gained for the sampling event. Based on the results of the planned next round of indoor air sampling, future sampling of the former restaurant suite may be considered by DCERP. Additionally, an outdoor air sample should be collected with future indoor air sampling. The outdoor air sample should be analyzed for the drycleaner solvent, PCE, and its breakdown chemicals to compare the indoor air concentrations to the concentrations of these same chemicals in outside ambient air.

Child Health Considerations

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 (ATSDR 1997, 1998). Children have lower body weights than adults. Although children's lungs are usually smaller than adults, children breathe a greater relative volume of air compared to adults. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage.

In preparation of this health document, the health of children was thoughtfully considered. The former cleaner is now a pick-up store. Drycleaning is no longer conducted on the premises. PCE and TCE affect the bodies of children in the same manner as those of adults. Given the types of businesses located in the strip mall, children could be present for part of a day in the business suites tested. Children could accompany their parent to work or meet their parent at

work after school. Children would likely spend less time than their parent in any of the three businesses. It is not expected that children who would be present in any of the three businesses would experience more than a minimal exposure to drycleaner-related chemicals.

Conclusions

The Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) reached five conclusions in this health consultation:

TDH EEP cannot currently conclude whether breathing indoor air in the cleaner with the measured tetrachloroethylene (PCE) concentrations could harm the health of the cleaner workers. Not all the information we need to make a decision is available. TDH EEP will work with TDEC DCERP to gather the additional information. The exposure for a worker of the cleaner would be much less than the cautious 24 hours per day, 7 day per week, lifetime exposure on which the acceptable risk values are based. PCE is no longer used as a drycleaner solvent chemical at the site. It is also not stored on-site. The source of the PCE in the cleaner is also unknown. It could be from vapor intrusion or it could be from off-gassing of PCE from clothing that is ready for pick up by customers. Members of the general public who are customers of the former cleaner would have a limited exposure to PCE because they would spend only a short amount of time in the cleaner.

EEP concludes that the concentration of the drycleaner breakdown chemical trichloroethylene (TCE), in the indoor air of the cleaner is not expected to harm the health of workers or customers. Indoor air in the former cleaner also contained minor measured amounts of TCE. Exposure to the measured TCE concentration is not likely to lead to long-term exposure to workers putting in many hours over many years at the pick-up store. The measured amounts of TCE will also not likely result in a higher than background cancer risk from breathing indoor air. Customers of the cleaner would have a short and very limited exposure to TCE. They should not experience health effects from breathing the indoor air containing TCE in the cleaner.

EEP concludes that the concentrations of the drycleaner solvent, PCE, measured in the stamp and coin store suite is not expected to harm the health of workers or customers. Indoor air in the stamp and coin store contained small amounts of PCE. The measured PCE concentration is not likely to lead to long-term exposure to workers putting in many hours over many years at the store. The measured amounts of PCE will also not likely result in a higher cancer risk from breathing indoor air. Customers of the stamp and coin store would have a short and very limited exposure to PCE. They should not experience increased health effects by breathing the indoor air in the stamp and coin shop. It is not known if the PCE measured in the stamp and coin store is from vapor intrusion or from migration of PCE off-gassing from clothing that is ready to be picked up by customers from the cleaner next door.

EEP concludes that the level of PCE measured in the ice cream store was below levels published by both ATSDR and EPA that would be expected to harm the health of adult workers or adult and children customers. There were very low measured amounts of PCE above the detection limits of the testing found to occur in the indoor air of the ice cream store. The measured amount

of PCE in indoor air would be acceptable and would not be expected to harm the health of the workers or adult and children customers of the ice cream store. Therefore, there should be no harm from PCE or PCE breakdown chemicals to the health of the workers or adult and children customers of the ice cream store.

EEP cannot currently conclude whether breathing the indoor air in other business suites of the strip mall could harm the health of the workers or customers of these businesses. Not all the information we need to make a decision is available. There may or may not be measureable concentrations of PCE and PCE breakdown chemicals in other suites of the strip mall. TDH EEP will work with TDEC DCERP to gather the additional information. It is unknown if the drycleaned clothing awaiting pick up by customers is off-gassing PCE or if there is a definite vapor intrusion issue at the site. TDH EEP and DCERP have agreed additional testing is necessary and DCERP's contractor will provide the testing. Other suites may be evaluated in the future depending on the results of the proposed testing.

Recommendations

The focus of this health consultation is to make sure the indoor air in the Kraus Model Cleaners will not lead to harmful health effects to workers or customers of the other business suites in the strip mall. With that in mind, the following recommendations are believed to be appropriate based on EEP's review of the indoor air sampling data.

- It is recommended that the TDEC, the TDH, and other appropriate parties continue to work together to continue to protect public health during cleanup of the site.
- It is recommended that another round of indoor sampling be done at the site. DCERP and EEP agreed that indoor air, outdoor air, and sub-slab soil-gas samples from beneath the cleaner be collected by the site's DCERP-approved drycleaner-approved contractor.

Public Health Action Plan

The public health action plan for the former Kraus Model Cleaners Site contains a list of actions that have been or will be taken by TDH EEP and other agencies. The purpose of the public health action plan is to ensure that this health consultation identifies public health concerns and offers a plan of action designed to mitigate and prevent harmful health effects that result from breathing, eating, drinking, or touching hazardous substances in the environment. Included is a commitment on the part of EEP to follow up on this plan to ensure that it is implemented.

Public health actions that have been taken by TDEC's DCERP include:

- Interfacing with the cleaner's owner regarding the DCERP process.
- Overseeing and monitoring the outcome of the phased investigations for the Kraus Model Cleaners Site

- Managing the technical aspects of the outcomes of the investigations.
- Beginning the remediation process for the Site.

Public health actions that have been taken by TDH's EEP include:

- Reviewing the indoor air data collected in the former cleaner suite and two adjacent retail suites.
- Preparing this health consultation.

Public health actions that will be taken include:

- TDH EEP will provide copies of this health consultation to state and federal government groups interested in the Kraus Model Cleaners Site.
- TDH EEP will maintain dialogue with ATSDR, TDEC, and EPA, to safeguard public health.
- TDH EEP will be available to review newly collected or additional environmental data, and provide interpretation of the data, as requested by TDEC

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References

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997. Toxicological profile for Tetrachloroethylene. U.S. Department of Health and Human Services. September 1997. Last accessed November 1, 2010. Available from: <http://www.atsdr.cdc.gov/toxprofiles/tp18.pdf>

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997. Toxicological profile for Trichloroethylene. U.S. Department of Health and Human Services. September 1997. Last accessed November 1, 2010. Available from: <http://www.atsdr.cdc.gov/toxprofiles/tp19.html>

[ATSDR] Agency for Toxic Substances and Disease Registry. 1998. Promoting children's health, progress report of the Child Health Workgroup, Board of Scientific Counselors. Atlanta, GA: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2001. Toxicological profile for 1,2-dichloroethane. Atlanta, GA. U.S. Department of Health and Human Services. Last accessed November 3, 2010. Available from: <http://www.atsdr.cdc.gov/toxprofiles/tp38.html>

[ATSDR] Agency for Toxic Substances and Disease Registry. 2004. Interaction profile for 1,1,1-trichloroethane, 1,1-dichloroethane, trichloroethylene, and tetrachloroethylene. Atlanta, GA, U.S. Department of Health and Human Services Public Health Service. May 2004. Last accessed November 3, 2010. Available from: <http://www.atsdr.cdc.gov/interactionprofiles/ip02.html>

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006. Evaluating "environmental health impacts to neighboring workplaces" in public health assessments and health consultations. Memorandum on Health Assessment Guidance from CAPT William Cibulas, Jr., Director, ATSDR/Division of Health Assessment and Consultation. Atlanta, GA. U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2007. Toxicological profile for vinyl chloride. Atlanta, GA. U.S. Department of Health and Human Services. Last accessed November 4, 2010. Available from: <http://www.atsdr.cdc.gov/toxprofiles/tp20.html>

[ATSDR] Agency for Toxic Substances and Disease Registry. 2010. Air comparison values. U.S. Department of Health and Human Services. March 2010.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2010. Minimal risk levels (MRLs) for hazardous substances. Atlanta, GA: U.S. Department of Health and Human Services. Last accessed: November 2010. Available from: <http://www.atsdr.cdc.gov/mrls.html>.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2011. Glossary of terms. Atlanta, GA: U.S. Department of Health and Human Services. Last accessed: January 20, 2011. Available from: <http://www.atsdr.cdc.gov/glossary.html>.

[EnSafe] EnSafe Inc. 2004. Prioritization investigation report, Kraus Model Cleaners, DCERP Facility ID No. D-79-137, 5007 Black Road, Memphis, Shelby County, TN 38117. Memphis, TN. September 16, 2004.

[EnSafe] EnSafe Inc. 2005. Solvent impact assessment Phase 1 report, Kraus Model Cleaners, DCERP Facility ID No. D-79-137, 5007 Black Road, Memphis, Shelby County, TN 38117. Memphis, TN. March 31, 2005.

[EnSafe] EnSafe Inc. 2009. Interim action monitoring report, Kraus Model Cleaners, DCERP Facility ID No. D-79-137, 5007 Black Road, Memphis, Shelby County, TN 38117. Memphis, TN. August 31, 2009.

[EnSafe] EnSafe Inc. 2010. Interim action phase 2 report, Kraus Model Cleaners, DCERP Facility ID No. D-79-137, 5007 Black Road, Memphis, Shelby County, TN 38117. Memphis, TN. July 12, 2010.

[EnSafe] EnSafe Inc. J. Broughton, personal communication, August 22, 2010 and October 21, 2010.

[EPA] U.S. Environmental Protection Agency. 1991. Role of the baseline risk assessment in superfund remedy selection determination. OSWER Directive 9355.0-30. Washington, D.C.

[EPA] U.S. Environmental Protection Agency. 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization (External Review Draft). Office of Research and Development, Washington, D.C., August 1, 2001.

[EPA] U.S. Environmental Protection Agency. 2010. Regional screening levels (RSL) for chemical contaminants at superfund sites. Oak Ridge, TN: Oak Ridge National Laboratory. Last accessed: August 25, 2010. Available from: <http://www.epa.gov/region09/superfund/prg>

[EPA] U.S. Environmental Protection Agency. 2011. Terms of environment: glossary, abbreviations and acronyms. Washington, D.C. Last accessed: January 20, 2011. Available from: <http://www.epa.gov/OCEPaterms/>

[IARC] 1995. Dry Cleaning, Some Chlorinated Solvents and Other Industrial Chemicals. IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Humans, vol. 63. Lyon, France: International Agency for Research on Cancer. 558 pp.

[NTP] 2001. Ninth report on carcinogens. Revised January 2001. U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program.

FIGURE 1 - Details of the Former Kraus Model Cleaners (before remodel) and surrounding properties. Drawing Credit: EnSafe Inc., Interim Action Phase II Report, July 12, 2010.

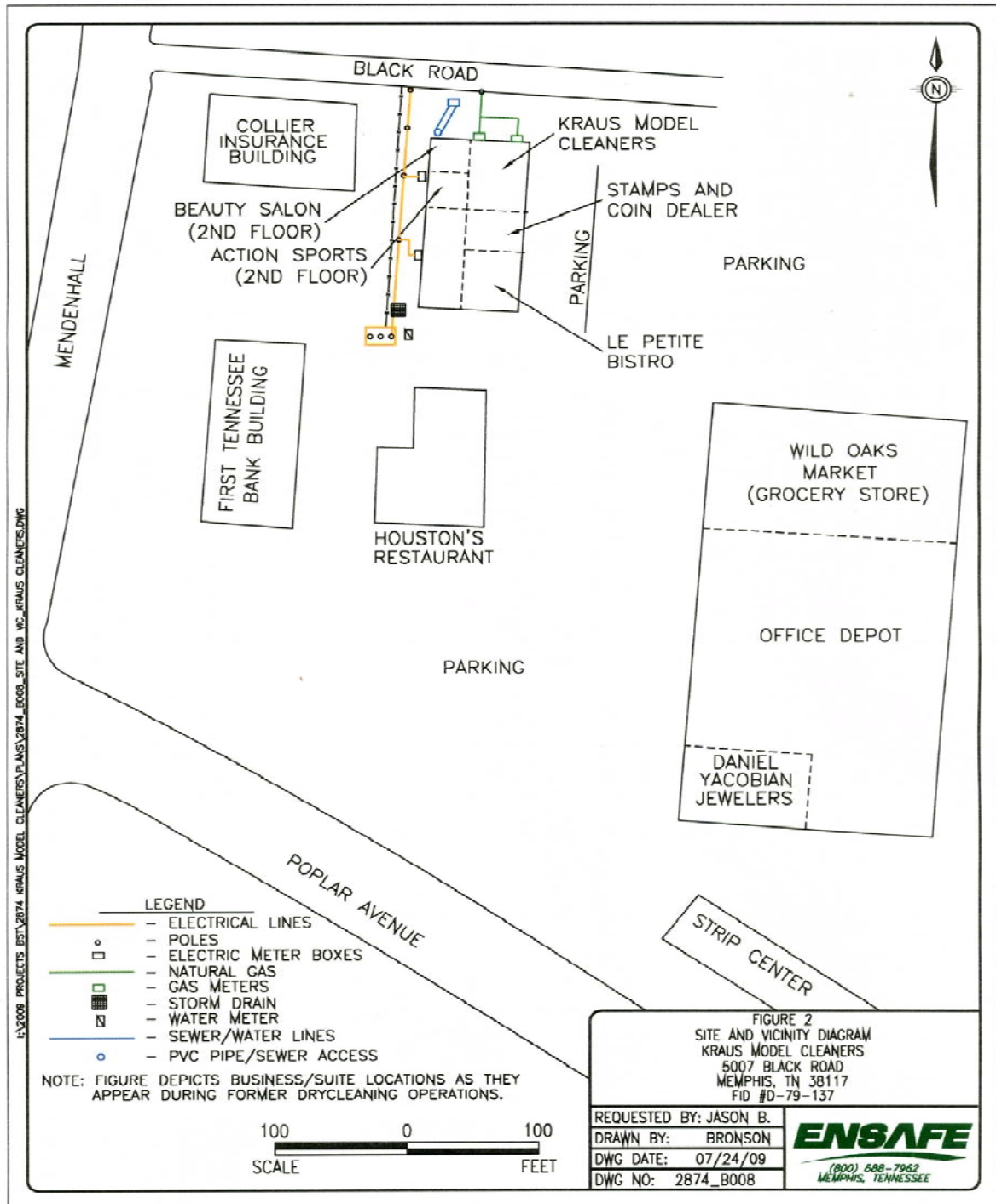


FIGURE 2 - Details of the Former Kraus Model Cleaners suite before its remodel.
 Drawing Credit: EnSafe Inc., Interim Action Phase II Report, July 12, 2010.

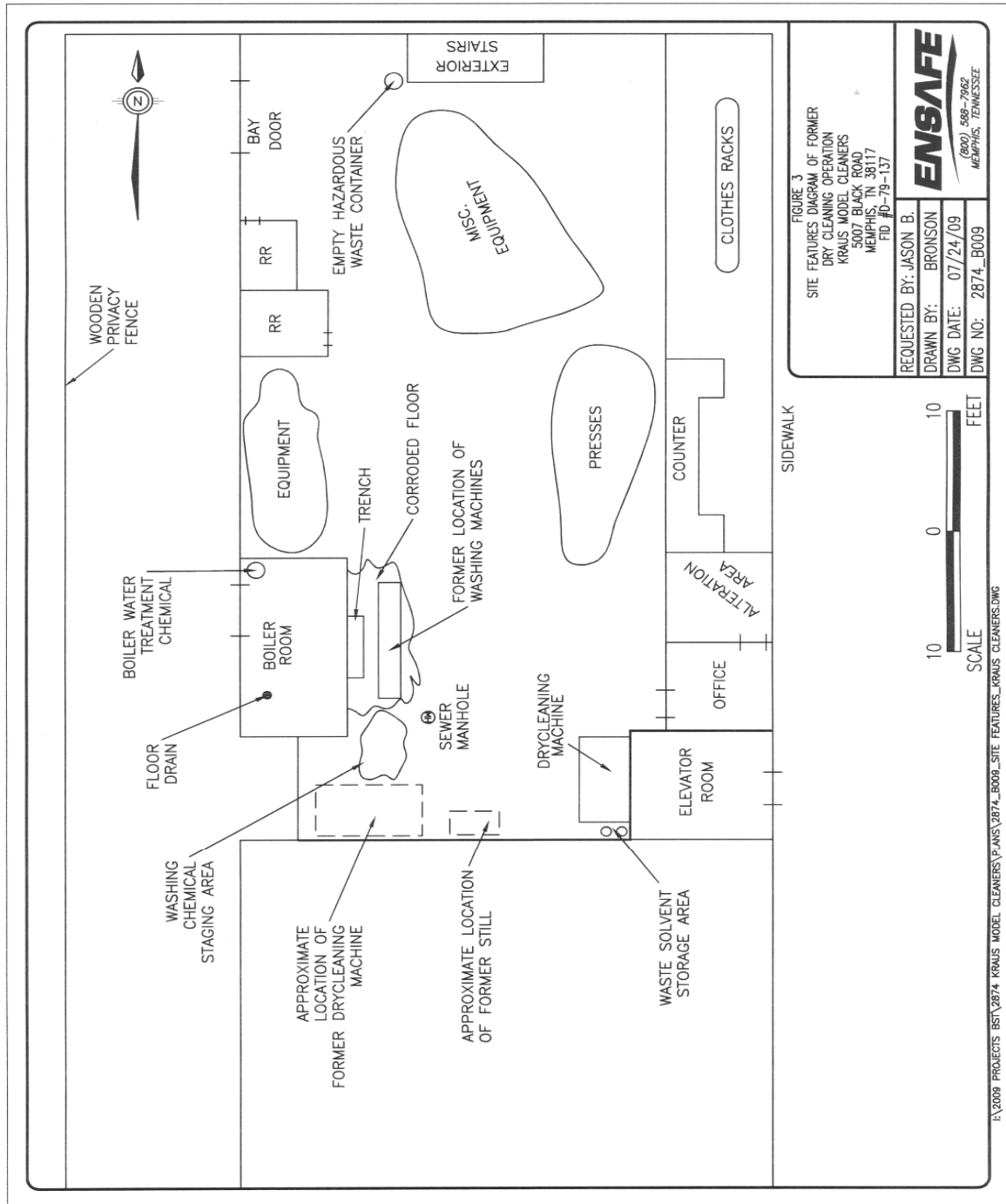
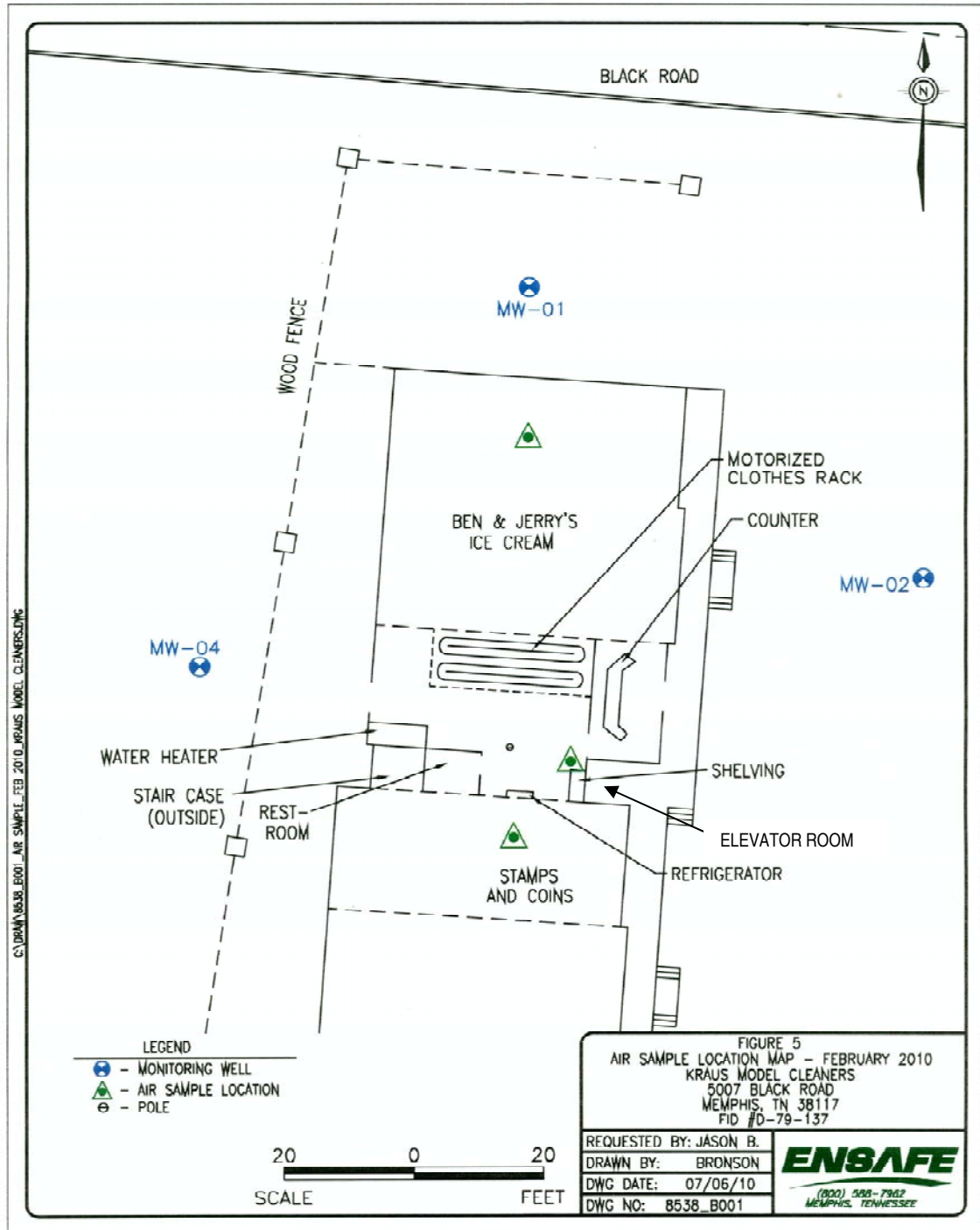


FIGURE 3 - Indoor air sample locations for the Former Kraus Model Cleaners site.
 Drawing Credit: EnSafe Inc., Interim Action Phase II Report, July 12, 2010.



Certification

This Public Health Consultation: *Kraus Model Cleaners Indoor Air Evaluation, Memphis, Shelby County, Tennessee*, was prepared by the Tennessee Department of Health's Environmental Epidemiology Program. It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun.



Director of EEP, CEDS, TDH