Health Consultation

AIR INVESTIGATION

BRUCE ROAD

DICKSON, DICKSON COUNTY, TENNESSEE

APRIL 9, 2012

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Foreword

This document summarizes an environmental public health investigation performed by the State of Tennessee Department of Health's Environmental Epidemiology Program. 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 could 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 action 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 and Acronyms

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).

ATSDR: Agency for Toxic Substances and Disease Registry.

background level: An average or expected amount of a substance 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: The theoretical excess risk for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower. The excess cancer risk is often expressed as $1x10^{-6}$ for one excess cancer in 1 million people.

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.

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: 1) a source of contamination (such as an abandoned business), 2) an environmental media and transport mechanism (such as movement through ground water), 3) a point of exposure (such as a private well), 4) a route of exposure (eating, drinking, breathing, or touching), and 5) a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

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.

migration: Chemical movement 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.

ppb: parts per billion.

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. An environmental sample, such as a small amount of soil or water, might be collected to measure contamination in the environment at a specific location.

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.

Introduction

It has been many years since chemicals were discovered to be leaking from the Dickson County Landfill (DCL) Site (Site No. SRS-0776). The Tennessee Department of Environment and Conservation (TDEC) has overseen numerous environmental investigations to understand the area affected by releases from the DCL. As another step in the investigation of the site, outdoor and indoor air were sampled at a home near Bruce Spring. The sampling was done to determine if chemical vapors were migrating into the home.

TDEC's Division of Solid and Hazardous Waste Management (DSWM), State Remediation Program (SRP), requested that the Tennessee Department of Health's (TDH), Environmental Epidemiology Program (EEP), review and evaluate the results of the air sampling. The air testing was done near and in a home located on Bruce Road, southwest and downgradient from the DCL, in western Dickson County, Tennessee. Environmental investigations and remedial actions at the DCL have been carried out since the 1980s. The groundwater has been found to migrate away from the DCL in a south-southwesterly direction.

Air samples were collected in October 2011 at Bruce Spring, along the stream that discharges from the spring, and outside and inside the Bruce Road home. Both the spring and the stream have been impacted by chemicals that were released from the DCL. The spring discharge stream passes close to the Bruce Road home. The single family home was of wood frame construction and had a crawlspace. The home was supplied with municipal water.

Chemicals, found in the groundwater that migrates from the DCL, included trichloroethylene (TCE) and the TCE breakdown product cis-1,2-dichloroethylene (cis-1,2-DCE). TCE chemicals are in a group of chemicals called chlorinated solvents. Chlorinated solvents were typically used as degreasers and cleaners by industries. These chemicals are also part of a larger group of chemicals called volatile organic compounds (VOCs). VOC vapors can off-gas from the groundwater, migrate up through the soil cover, and come into the indoor air of buildings above the contaminated groundwater. TDEC SRP and Dickson County representatives were concerned about the potential intrusion of these chemical vapors migrating from surface water bodies and groundwater into the nearby home.

The State of Tennessee does not have promulgated environmental regulatory guidance for conducting indoor vapor intrusion investigations at these types of sites. Therefore, the investigation was conducted using various procedures that are generally accepted by other state and federal regulatory agencies and outlined in various indoor air sampling guidance documents (NYSDOH 2006, ITRC 2007). This health consultation will present what was done as part of the indoor vapor intrusion sampling and will evaluate the results.

Background

The DCL was operated as a municipal landfill for many years before it stopped accepting waste. It was capped according to TDEC Division of Solid and Hazardous Waste Management rules and conditions of the landfill's operating permit in 2001.

Groundwater contamination was discovered in a private residential water well near the DCL in 1988 (Gadd 2011). Water at Bruce Spring was found to contain TCE circa 2004 (EnSafe 2011a). The presence of TCE at Bruce Spring approximately 2.5 miles southwest of the DCL was attributed to the landfill. The discovery of TCE in Bruce Spring and in other springs and private water wells some distance from the landfill prompted extending public water lines to the affected areas.

Data show that TCE measurements in Bruce Spring from late-2004 to mid-2011 ranged from 4 micrograms per liter (µg/L) to 17 µg/L (EnSafe 2011a). In 29 of the 31 measurements in this time period, the TCE concentration was above the U.S. Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for TCE of 5 µg/L. MCLs are set as public/municipal drinking water standards. Levels of cis-1,2-DCE during this same time frame have ranged from below detection limits to 2.6 µg/L. These cis-1,2-DCE measurements were below its MCL of 70 µg/L. MCLs are often used as screening levels for comparison of private drinking water results. The water from Bruce Spring discharges to a small stream that is located near the home (Figure 1). The water from the stream discharges into the West Piney River located on the west side of Bruce Road from the home. A sample of surface water collected from the small stream in April 2009 also had TCE, at a level of 6 µg/L. This level was above the TCE MCL (EnSafe 2011a).

In the past, the home used water from Bruce Spring as its water source. Municipal water is now provided to the Bruce Road home, removing any concern for TCE in the home's drinking water. Dickson County government remains responsible for addressing the groundwater contamination at and downgradient from the DCL.

TCE and cis-1,2-DCE can off-gas from groundwater and surface water. If contaminated groundwater moves beneath a building, vapors could enter the building through a variety of ways. The vapor migration concern is why air sampling was done at the home on Bruce Road. The air sampling was used to evaluate if any VOC vapors from chemicals in Bruce Spring and its discharge stream were entering the indoor air of the home.

Dickson County's environmental consultant, EnSafe, continues to investigate and monitor the groundwater downgradient from the DCL. TDEC DSWM SRP provides oversight for these investigations.

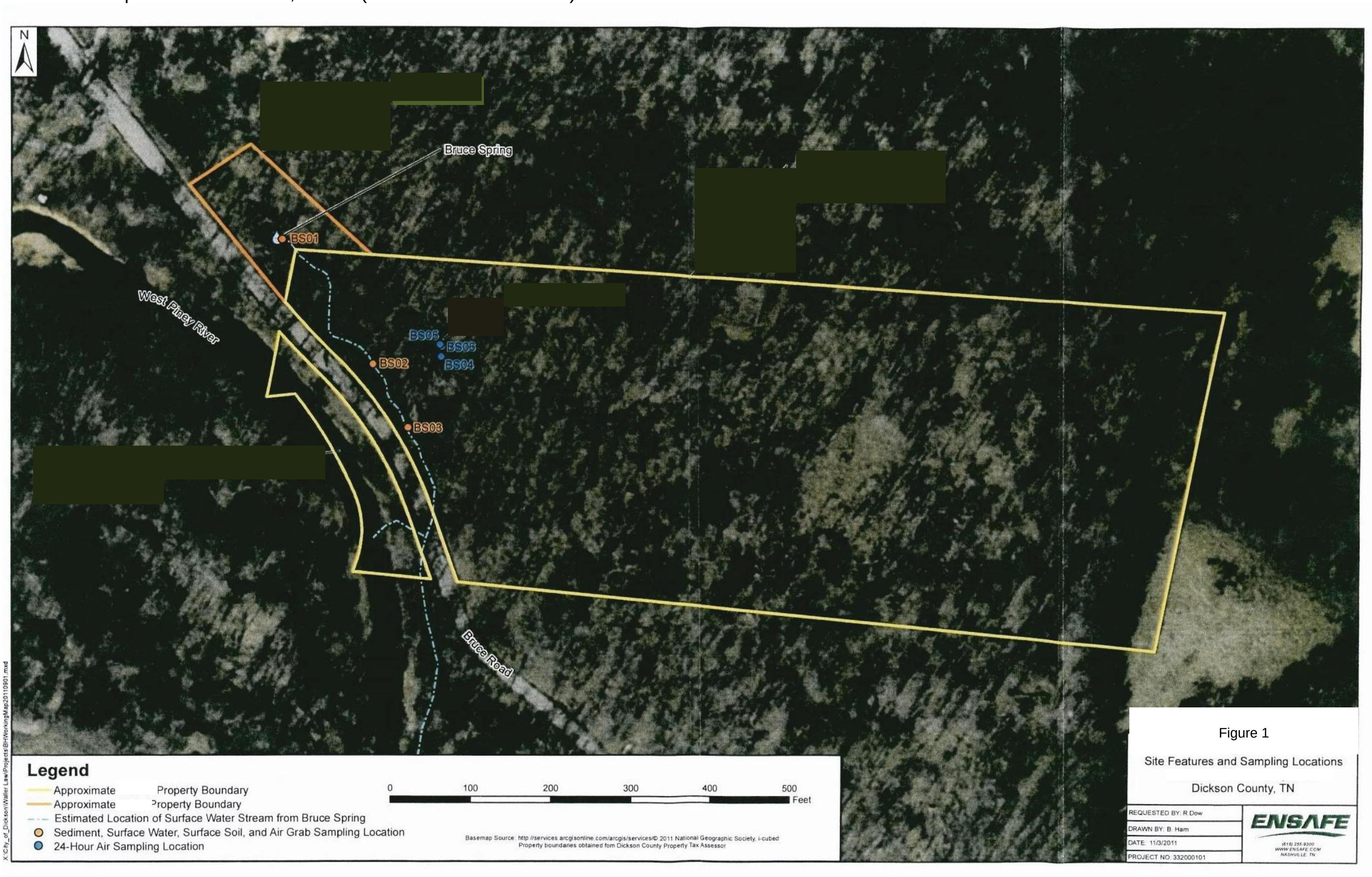
Discussion

Introduction to Chemical Exposure

To determine whether persons have been or are likely to be exposed to chemicals, TDH EEP evaluates ways that could lead to human exposure. Chemicals released into the environment have the potential to cause harmful health effects. 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.

Figure 1. Location of Bruce Spring and air sampling locations near Dickson, Dickson County, Tennessee. EnSafe Inc. personnel used Summa canisters to collect air samples on October 24, 2011. (Source: EnSafe 2011b).



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.

The source of contamination is the place where the chemical was released. For this site, the source would have been waste placed in the DCL. The environmental media transports the contaminants. Environmental media are groundwater, soils, surface water, or air. For this site, the chemicals were likely transported through the groundwater to the spring. A spring is a point at which groundwater comes to the surface and becomes surface water. The point of exposure is the place where people come into contact with the contaminated media. Air around the surface water bodies near the home and the indoor air of the home itself are the potential points of exposure at this site. The route of exposure is the way the contaminant enters the body. Ways a contaminant can enter the body are through ingestion, inhalation, or dermal contact. For this project, the route of exposure would be inhalation or breathing of air if the VOCs are migrating into the outdoor or indoor air.

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 health is controlled by a number of other factors, including:

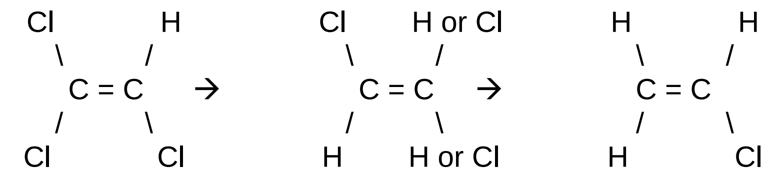
- the amount of the chemical that a person is exposed to (dose)
- the length of time that a person is exposed to the chemical (duration)
- the number of times a person is exposed to the chemical (frequency)
- the person's age and health status, and
- the person's diet and nutritional habits.

For this project, the potentially exposed populations would be the people that live in the home near Bruce Spring and anyone that would be near the spring or spring discharge stream.

Solvent Explanation

Trichloroethylene (TCE) is the most commonly used chemical solvent; it is used as a degreaser. It is a colorless liquid and has sweet smell (ATSDR 1997). TCE is a volatile organic compound. It will quickly evaporate into a gas at room temperature. As its name implies, trichloroethylene has three chlorine anions on a two-carbon molecule. They can break down into other chlorinated volatile organics. Each of these breakdown chemicals has different chemical properties and toxicities. The following diagram is an example of how one chemical can break down to form another.

In the example below, TCE can break down 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 solvent TCE and all of its breakdown chemicals were carefully considered in developing this report.



trichloroethylene | dichloroethylene cis & trans isomers | vinyl chloride

Comparison Values

To evaluate exposure to a hazardous substance, health assessors often use health 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 2012, EPA 2011a) for a particular chemical, then further evaluation is needed.

The Agency for Toxic Substances and Disease Registry (ATSDR) developes Minimal Risk Levels (MRLs) using conservative or “worst case” assumptions. MRLs are an estimate of the daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects during a set time of exposure. 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 represent concentrations of substances in water, soil, and air to which humans may be exposed during a specified period of time (acute, intermediate or chronic) without experiencing adverse health effects. EMEGs only consider non-cancer adverse health effects. These exposure durations are defined as acute (14 days or less), intermediate (15–364 days), or chronic (365 days or more). Chronic EMEGs are generally the more conservative and were calculated for an exposure of 24 hours per day, 7 days per week, 52 weeks a year, for 1 year or longer. Exposure to a level above the EMEG for a chemical does not necessarily mean that adverse health effects will occur (ATSDR 2007).

The measured indoor air levels of TCE and TCE breakdown chemicals were also compared to ATSDR Cancer Risk Evaluation Guides (CREGs). The levels of chemicals measured in the environment are compared to CREGs to understand the additional risk of cancer from exposure to the chemical (ATSDR 2012). Lifetime exposure to a chemical at an amount equal to its CREG comparison value could theoretically result in a one in a million (10^{-6}) risk of developing cancer in addition to the background risk of developing cancer. The background risk is the risk that all people have of developing cancer, which is currently 1 in 2 for men and 1 in 3 for women in the United States. Both ATSDR and EPA prefer to base health comparison values on 1 excess cancer in 1,000,000 people or a 1×10^{-6} risk. When making remedial action decisions, EPA uses an acceptable cumulative carcinogenic site risk "target range" of 1 in 10,000 to 1 in 1,000,000, or 10^{-4} to 10^{-6} (EPA 1991).

TCE is *“reasonably anticipated to be a human carcinogen”* (IARC 1995, NTP 2011). TCE is readily absorbed following inhalation. For this site, we were concerned with the inhalation of TCE from vapor intrusion into indoor air of the home.

The carcinogenic and non-carcinogenic toxicity of TCE has been under review for a number of years by a variety of state, federal, and other human health and environmental organizations. ATSDR recently revised its CREGs to reflect EPA's revised oral cancer slope factors to generate interim inhalation CREGs for TCE (ATSDR 2012). The TCE CREG is 0.045 parts per billion (ppb). The U. S. Environmental Protection Agency (EPA) has a residential setting PCE inhalation regional screening level (RSL) for one excess cancer in 1,000,000 people of 0.08 ppb (EPA 2011a).

Introduction to Vapor Intrusion

Volatile and semi-volatile chemicals evaporate from impacted subsurface soil and/or groundwater beneath a building and move toward areas of lower chemical levels such as the atmosphere, utility conduits, or basements. Subsurface vapors can enter a building due to two main factors: environmental effects and building effects. Some examples of these factors are barometric pressure changes, wind load, temperature currents, or depressurization from building exhaust fans. Chemicals can migrate up and enter indoor air through foundation slabs, crawl spaces, or basements. The chemical migration depends on the construction of the building, if there are any unsealed joints or cracks in the foundation, the building's heating and ventilation characteristics, and other factors. The rate of movement of the vapors into the building is difficult to measure and depends on soil type, chemical properties, building design and condition, and pressure differences between the outside and inside air (ITRC 2007). Upon entry into a structure, chemical vapors mix with the existing air through the natural or mechanical ventilation of the building.

Commonly found concentrations of chemicals in indoor and outdoor air are referred to as "background levels." These background levels are generally determined from the results of samples collected in homes, offices, and outdoor areas not thought to be affected by "outside" sources of volatile chemicals; for example, a home not known to be near a chemical spill, a hazardous waste site, a drycleaner, or a factory. Background levels of volatile chemicals are considered when conducting an investigation of the vapor intrusion pathway (NYSDOH 2006, EPA 2011b).

Air Sampling Methods

Indoor and outdoor air samples were collected using Summa canisters during the investigation. EnSafe staff collected 4 outdoor air samples and 2 indoor air samples. The outdoor air samples were collected at Bruce Spring, along the spring discharge stream near the home, at the spring discharge stream where the home's driveway crosses the stream, and immediately outside the home (Figure 1). The two indoor air samples were collected inside the home on the first floor in a room frequented by the residents. One sample was identified as an original indoor air sample. The second sample was identified as a duplicate sample. The outdoor air samples collected from the spring and the stream were collected from approximately 2 feet above the surface of the water and over a very short time period (EnSafe 2011b).

The outdoor air sample collected near the home was collected approximately 3 to 5 feet above the ground surface. The two indoor air samples were also collected approximately 3 to 5 feet above the floor in an area frequented by the residents on the first floor of the home. The outdoor sample near the home and the two indoor air samples had flow controllers calibrated to collect the samples over a 24-hour time period.

The Summa canisters used to collect the samples were certified by the subcontract laboratory, Environmental Science, Inc., in Mount Juliet, Tennessee, to ensure the cleanliness of the canisters when dealing with low reporting limits. The air samples collected were analyzed for many different chemicals, including those identified in Bruce Spring and in the spring's discharge stream, using the EPA Method TO-15 selective ion method (SIM) for VOCs (EnSafe 2011b).

The equipment used for testing air samples was sophisticated and could detect extremely small levels of chemicals in air. The U.S. Environmental Protection Agency (EPA) has compiled statistics on normal background levels of many chemicals in residential indoor air (EPA 2011b). Outdoor and indoor air can contain low background levels of many chemicals, such as those from vehicle exhaust, cleaning products, drycleaned clothing, paint, and chemicals from many other consumer products that are a part of normal daily activities.

Air Sampling Results

The air test results showed there were several chemicals in the outdoor and indoor air samples, although at very low levels. Air samples collected outside and inside the home contained benzene, carbon tetrachloride, chloroform, chloromethane, cis-1,2-DCE, ethylbenzene, PCE, and TCE. All levels were very low. Benzene and ethylbenzene are likely related to automobile exhaust. Chloroform and chloromethane are commonly used in the water disinfecting process and are likely off-gassing from the municipal water supplied to the home. PCE is used to dry clean clothing. Many of the other chemicals were likely from products such as paints, cleaners, adhesives, varnishes, sealers, and lubricants that are all used as part of everyday activities. Because TCE was found in both the spring and stream water, it is likely off-gassing from those locations by aeration of the water as it moves. For this report, we will concentrate on the chlorinated solvent TCE, and the TCE breakdown chemicals cis-1,2-DCE and vinyl chloride. Results of the air sampling are shown in Table 1.

TCE was measured in the outside air samples from Bruce Spring, the spring's discharge stream, and the outside air sample at the Bruce Road home. The amount of TCE measured in the air at Bruce Spring was 0.069 ppb. TCE was measured at 0.29 ppb and 0.39 ppb above the spring's discharge stream near the Bruce Road home. TCE was measured at 0.10 ppb in the air outside the home (EnSafe 2011b).

TCE was also measured at a very low level in the indoor air. The TCE measured in the indoor sample was the same as the TCE measured in the outdoor sample, 0.10 ppb. The TCE measurement in the duplicate indoor air sample was 0.098 ppb.

The TCE breakdown chemical, cis-1,2-DCE, was found in very low amounts in both outdoor and indoor air. Cis-1,2-DCE was not found at Bruce Spring but it was found in the two samples collected above the spring's discharge stream at 0.049 and 0.07 ppb. It was found in the outside air near the home at 0.051 ppb. Cis-1,2-DCE was found at 0.099 and 0.10 ppb inside the home. Another breakdown chemical, vinyl chloride, was not found in either of the outdoor or indoor air samples.

Table 1. Air Results for Bruce Spring, the spring discharge stream, and the home. Samples collected on October 24, 2011. The Bruce Spring and stream samples were collected over a short period of time, about one minute. The outdoor and indoor air samples at the home were collected over a 24-hour time period. All results are reported in parts per billion (ppb). Summarized from EnSafe 2011b.

Sample Location		Bruce Spring* (BS01)	Stream at Home* (BS02)	Stream at Home Driveway* (BS03)	Outside Air West of Home (BS04)	Indoor Air of Home (BS05)	Indoor Air of Home – Duplicate (BS06)	ATSDR EMEG (non-cancer) (ppb)	ATSDR CREG (10^{-6} excess cancer risk) (ppb)
Parameter	**Units**								
1,1-dichloroethylene	ppb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	20[i]	ns
cis-1,2-dichloroethylene	ppb	<0.02	0.049	0.07	0.051	0.099	0.10	ngv	nc
trans-1,2-dichloroethylene	ppb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	200[i]	nc
tetrachloroethylene	ppb	<0.02	<0.02	<0.02	<0.02	0.034	<0.02	40	0.57
trichloroethylene	ppb	0.069	0.29	0.39	0.10	0.10	0.098	0.37	0.045
vinyl chloride	ppb	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	30[i]	0.04

Notes:

0.069 = Measured concentration of chemical in air sample.

< 0.02 = Chemical not detected. Detection limit shown.

***** = Grab sample collected over an approximate 1 minute time frame.

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2012). Chronic non-cancer exposure comparison values for an exposure greater than 365 days used to determine if chemical concentrations warrant further health-based screening.

ATSDR CREG = Agency for Toxic Substances and Disease Registry Interim Cancer-Based Comparison Value Risk Evaluation Guide, (ATSDR 2012). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people.

EPA RSL = Environmental Protection Agency Regional Screening Level (EPA 2011). The screening levels were developed using risk assessment guidance from the EPA Superfund Program. RSLs are considered by EPA to be protective for humans, including sensitive groups, over a 70-year lifetime.

i = ATSDR comparison value for intermediate exposures of 15-365 days.

ns = Suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential.

nc = Not classified as to carcinogenicity and no guidance value is available.

ngv = No guidance value available.

One of the 2 indoor air samples collected inside the Bruce Road home also contained tetrachloroethylene (PCE) at a very low level. The PCE measurement was 0.034 ppb. It was not found in the duplicate indoor air sample. The average of the detected measurement and the duplicate non-detect would be the same as the detection level of the analysis.

Air Results Evaluation

Trichloroethylene (TCE)

Outside air near the home contained the DCL-related chemical TCE. The air samples collected at Bruce Spring and along the spring's discharge stream were collected approximately 2 feet above the water surface. One study conducted by the New York State Department of Health measured typical TCE background levels in outside air at 0.19 ppb or 1 $\mu g/m^3$ (NYSDOH 2006). Levels measured at Bruce Spring, were above this level.

For the evaluation of TCE in the outside air, EEP used standard comparison values for indoor air that are protective for an exposure lasting 24 hours each day for a 70-year lifetime. ATSDR has developed an environmental media evaluation guide (EMEG) that is protective for non-cancer health effects over a chronic, or greater than 364 day, exposure time period. The chronic EMEG is 0.37 ppb.

Considering this comparison value, no non-cancer adverse health effects are expected from exposure to TCE outdoors as the concentrations at the spring of 0.069 ppb and in the stream at 0.29 and 0.39 ppb were below or equal to the most conservative ATSDR EMEG of 0.4 ppb. Also, residents would not be at these locations 24 hours each day for a lifetime.

Levels of TCE found near the discharge stream and outside the home were also evaluated for cancer health effects. The highest measured amount of TCE in the outdoor air near the home was 0.39 ppb (2.1 $\mu g/m^3$). ATSDR's inhalation cancer risk comparison value for TCE for a 1 in 1,000,000 excess cancer risk is 0.045 ppb (ATSDR 2012). The highest measured TCE level was greater than the ATSDR cancer health effects comparison value. Therefore, further evaluation was necessary.

Further evaluation of the highest outside TCE level was done using EPA's TCE inhalation unit risk. This is a very conservative evaluation. The inhalation unit risk of a chemical is the highest additional lifetime cancer risk estimated to result from continuous exposure to the chemical at a concentration of 1 microgram per cubic meter of air ($\mu g/m^3$), or 0.19 ppb for TCE. The inhalation unit risk of 4.1×10^{-6} risk of TCE per microgram per cubic meter of air $(\mu g/m^3)^{-1}$, assumes a lifetime breathing exposure to TCE for 24 hours per day, every day. Even with these conservative exposure assumptions, the theoretical risk from breathing 0.39 ppb of TCE calculates to be 1.6×10^{-6} or about 2 excess cancers in 1 million people, in addition to the background cancer rate of 1 in 2 for men and 1 in 3 for women. This theoretical risk is considered very, very low. The TCE levels in the stream do not appear to be causing potential vapor intrusion issues in the Bruce Road home.

For the air inside the home, EEP compared the Chronic EMEG of 0.37 to the value of TCE found in the indoor air of the home. The TCE level was measured to be 0.10 ppb in the indoor air of the home. Compared to the 0.37 ppb chronic EMEG comparison value set by ATSDR, there should not be any non-cancer adverse health effects from breathing the air inside the home.

The measured amount of TCE in the home of 0.10 ppb was also compared to EPA's *Ranges of Summary Statistics for Background Indoor Air Concentrations of Common VOCs Measured in North American Residences between 1990 and 2005* (2011). This comparison was done in an effort to understand if the measured TCE level in the home was within the range measured in other homes throughout the country. The TCE measurements in the original and duplicate samples were within the range of values from 0.004 to 0.3 ppb for 50% of the homes tested, the most conservative range reported.

Levels of TCE found in the home were also evaluated for cancer health effects. ATSDR's cancer risk comparison value for TCE for a 1 in 1 million excess cancer risk is 0.045 ppb (ATSDR 2012). The measured TCE level of 0.10 ppb is greater than the ATSDR cancer health comparison values.

Further evaluation of the TCE level was done using EPA's conservative TCE inhalation unit risk. The inhalation unit risk of $4.1x10^{-6}$ $(\mu g/m^3)^{-1}$ assumes a lifetime breathing exposure to TCE for 24 hours per day, every day. Even with these exposure assumptions, the theoretical risk from breathing 0.10 ppb (0.54 $\mu g/m^3$) of TCE calculates to be $2.2x10^{-6}$ or 2 in 1 million, in addition to the background cancer rate of 1 in 2 for men and 1 in 3 for women. This additional theoretical risk is negligible. There is no additional hazard from TCE for the people in the home breathing the indoor air.

cis-1,2-Dichloroethylene (cis-1,2-DCE)

Levels of cis-1,2-DCE found outside at the discharge stream, outside the home, and inside the home were very low. Cis-1,2-DCE has not been determined to cause cancer. The levels of cis-1,2-DCE in the outside and indoor air are not a problem in the area of the home or inside the home.

tetrachloroethylene (PCE)

As mentioned previously, 1 of the 2 indoor air samples collected inside the Bruce Road home also contained PCE at a very low level, 0.034 ppb. It was not found in the duplicate indoor air sample. The average of the detected measurement and the duplicate non-detect would be the same as the detection level of the analysis, which was very low. PCE was not found in the Bruce Spring air sample, the spring discharge stream air sample, or in the outside air sample. PCE is not considered a problem in the area of the home nor inside the home.

Children's Health Considerations

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. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

In preparation of this health document, the health of children was thoughtfully considered. Children breathe a higher volume of air than adults. Low levels of TCE were measured in the outside air. Children may be more sensitive to the carcinogenic effects of TCE than adults (IRIS 2011). ATSDR considered this increased sensitivity when they developed their CREG value. The levels, based on EEP's evaluation, should not harm any children that breathe the air outside or inside the home.

Conclusions

EEP reached two conclusions in this health consultation:

Conclusion 1

EEP concludes that the low levels of trichloroethylene (TCE) in the indoor air of the Bruce Road home would not harm the residents living in the home.

TCE levels measured inside the home were very low and would not produce any increased health risk.

Conclusion 2

EEP concludes that the low levels of TCE in the outside air would not harm anyone breathing this air.

The measurements of TCE found in the outside air at Bruce Spring, the spring discharge stream, and outside the Bruce Road home were very low. Evaluation suggests that the TCE levels found would provide a calculated theoretical risk that is very low, a 2 in a million additional cancer risk. This is an extremely low risk.

Recommendations

The Tennessee Department of Health's Environmental Epidemiology Program (EEP) recommends the following actions at this site:

- Dickson County's environmental consultant should continue to sample the water in Bruce Spring for VOCs at the frequency and duration agreed upon with the Tennessee Department of Environment and Conservation's (TDEC) Division of Solid and Hazardous Waste. This sampling would provide data to determine if groundwater conditions at the spring have changed, and

- Dickson County's environmental consultant should sample outdoor and indoor air at the Bruce Road home during the upcoming winter season. This sampling could confirm the October 2011 results and would also allow TDEC and EEP to evaluate if site conditions have changed.

Public Health Action Plan

The public health action plan for the day care contains a list of actions that have been or will be taken by EEP and other agencies. The purpose of the public health action plan is to ensure that this health consultation identifies public health hazards and offers a plan of action designed to mitigate and prevent harmful health effects that result from breathing 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 TDH EEP has taken included:

- Preparation of this health consultation.

Public health actions that will be taken include:

- TDH EEP will provide copies, if asked, of this health consultation to state, federal, and local government, other community members, and community group members.

- TDH EEP will maintain dialogue with TDEC, ATSDR, other government agencies and interested stakeholders to safeguard public health.

- TDH EEP will be available to review additional environmental data, and provide interpretation of the data, as requested.

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Certification

This Public Health Consultation: *Air Investigation, Bruce Road, Dickson, Dickson 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.

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