Health Consultation

HARDEMAN COUNTY LANDFILL
(a/k/a VELSICOL CHEMICAL CORPORATION)
TOONE, HARDEMAN COUNTY, TENNESSEE

EPA FACILITY ID: TND980559033

APRIL 16, 2007

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

Health Consultation: A Note of Explanation

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

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

Tennessee Department of Health
under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Preface

This document summarizes an environmental public health investigation performed by Environmental Epidemiology 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 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 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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Introduction

In September 2005, the Tennessee Department of Environment and Conservation (TDEC), Division of Remediation (DOR) contacted the Tennessee Department of Health (TDH), Environmental Epidemiology (EEP) about chemical vapor intrusion concerns in a private residence located in the vicinity of the Velsicol Chemical Corporation Landfill (VCCL). EEP was asked to evaluate any potential public health hazard that could result from the exposure of the occupants of the residence to the chemical vapors.

The VCCL is a U.S. Environmental Protection Agency (EPA), Superfund, National Priorities List (NPL) site, located in Toone, Hardeman County, Tennessee. The site and the lands surrounding it have been the subject of several environmental investigations in the years subsequent to its placement on the NPL. Carbon tetrachloride and chloroform have been identified as contaminants of concern associated with the site.

During a 2005 investigation, carbon tetrachloride and chloroform vapors were detected in soil gas sampling locations along Old Toone Road. The soil sampling point with the highest carbon tetrachloride reading was located near a private residence approximately one mile north of the VCCL site (Figures 1 and 2). Air samples were obtained from the crawlspace and outside the home. Carbon tetrachloride and chloroform were detected in both air samples. Thus, this public health consultation will focus on residential exposure to carbon tetrachloride and chloroform present in indoor and outdoor air.

Background

Landfill

The Velsicol Chemical Corporation Landfill (VCCL) covers approximately 27 acres on a 242-acre parcel of land that was owned by the Velsicol Corporation at the time of the waste disposal. The landfill was used for disposal of pesticide manufacturing wastes and volatile organic compounds (VOCs) from 1964 to 1973. The Velsicol facility in Memphis, Tennessee generated the waste materials. Approximately 130,000 drums of chemical wastes were disposed of in the landfill (EPA 2006).

The landfill site was added to the EPA Superfund NPL listing of hazardous waste sites in urgent need of cleanup in September 1983 (EPA Facility ID# TND980559033). Investigations of the site found that an estimated 3.6 million cubic yards of soils underlying the wastes were contaminated. Soil contamination has been found at 60 to 70 feet below the base of the landfill. Private drinking water wells in the vicinity were impacted by groundwater contamination (EPA 2006). A municipal water supply connection was provided to residencies. Groundwater is not currently used as a residential well water supply.

Groundwater

As groundwater moves through the area, carbon tetrachloride and chloroform from the landfill are carried along with the water flow. The contaminated groundwater emanating from the VCCL flows to the northeast, north, and northwest, and then discharges (i.e., groundwater moves from a subsurface aquifer and begins flowing as surface water) as groundwater seeps and as stream flow in Pugh Creek to the east, the unnamed streams to the north and northwest, and Clover Creek to the north (EIC 2005a & 2005b).

Groundwater in the area moves through two aquifers, an upper and lower aquifer. Both aquifers are comprised of unconsolidated sandy material that contains varying amounts of silt and clay. Separating the two aquifers is a clay layer called an *aquitard* (i.e., a layer of earth material that inhibits groundwater movement). Beneath the lower aquifer lies another aquitard, known as the Porter's Creek Clay. In the vicinity of the landfill where the chemical wastes were disposed, the shallow aquitard is approximately 140 feet below the ground surface. However, in the vicinity of the residence, the shallow aquitard is approximately 80 feet below the ground surface. Environmental investigation data suggest that the carbon tetrachloride and chloroform are predominately contained in the upper aquifer (EIC 2005b). Groundwater is not currently used as a residential well water supply.

Soil Gas Investigation

Previous VCCL site investigations did not take into account the potential for human exposure to VOCs emanating from the landfill because the actual chemical disposal areas had been covered with a compacted clay cap in 1980 and the concept of a completed exposure pathway from vapor intrusion was not understood. The subsequent discovery of carbon tetrachloride in the surface streams to the northeast, northwest, and north of the landfill, and in the groundwater moving to the north from the landfill prompted EPA to request further investigation.

EPA directed the current ownership entity of the VCCL, the Custodial Trust, in an August 2004 letter to prepare and submit a site sampling work plan. One of the tasks outlined in the work plan was a Soil Gas Investigation (SGI). ENVIRON International Corporation (EIC), working on behalf of the Custodial Trust, prepared and submitted the work plan. EPA subsequently approved the plan, and EIC began the soil gas investigation at the VCCL site in February 2005 (EIC 2005c).

EIC presented the SGI findings to EPA and TDEC on April 19, 2005. EIC concluded that, based on the soil gas results from soil gas sampling location ESG-12 (Figure 2), the residential indoor air may pose a health risk to the occupants of the residence in the vicinity of the soil gas probe ESG-12 (EIC 2005c). Because of these findings, EPA directed the Custodial Trust to conduct a vapor intrusion investigation at the residence.

In response to the EPA directive, EIC conducted the Residential Crawlspace Air Investigation (RCAI) at the residence located adjacent to soil gas probe ESG-12. After obtaining permission from the property owner, EIC collected the air samples on May 19 and May 20, 2005 (EIC

2005c). The data from the SGI and the RCAI were utilized in the preparation of this public health consultation.

Residence

The residence where the RCAI was conducted is located in a rural area near the town of Toone, Tennessee. The house is located on Old Toone Road, approximately 1.1 miles north of the VCCL site (Figure 1). The structure is a one-story ranch style house with a crawlspace underneath the structure (EIC 2005c). It is situated on an elevated point of land bounded by the Pugh Creek flood plain to the east and north and by the Clover Creek flood plain to the northwest (Figure 2).

Discussion

Environmental Sampling

The Soil Gas Investigation (SGI) involved the placement of 14 soil gas probes, five to six feet deep, at various locations along Old Toone Road (Figure 1). Table 1 shows the carbon tetrachloride and chloroform concentrations detected at the SGI sample locations (EIC 2005c).

TABLE 1. Carbon Tetrachloride and Chloroform concentrations in the soil gas in the vicinity of the Velsicol Chemical Corporation Landfill from soil gas samples collected on February 15 and 16, 2005, by ENVIRON International Corporation (EIC). The EIC soil gas sampling point locations are shown in Figure 1, and the carbon tetrachloride and chloroform vapor concentration results are reported in parts per billion by volume (ppb).

Soil Gas Sampling Location	Carbon Tetrachloride concentration	Chloroform concentration	Soil Gas Sampling Location	Carbon Tetrachloride concentration	Chloroform concentration
ESG-1; BKG	U	U	ESG-9	56	U
ESG-2	U	U	ESG-10	U	U
ESG-3	43	9	ESG-11	24	U
ESG-4	U	U	**ESG-12**	**1500**	**460**
ESG-5	U	U	ESG-13	U	U
ESG-7	U	U	ESG-14	U	U
ESG-8	U	U	ESG-16	U	U

BKG = background sample; taken in an area not suspected to contain VCCL related contaminants.
U = Undetected (i.e., constituent was either not present or at levels below the analytical detection limit)
BOLD = sampling point and chemical concentration that prompted the RCAI at the residence.

The SGI results show that carbon tetrachloride and chloroform are both present in the soil gas in two locations. Soil gas sampling location ESG-3 is located at the northwestern corner of the VCCL property, adjacent to Old Toone Road. Proceeding north along Old Toone Road, sampling points ESG-9 and ESG-11 were positive for carbon tetrachloride, but not chloroform. The highest concentrations of both carbon tetrachloride and chloroform were detected at ESG-12. The carbon tetrachloride concentration was 1500 ppb, and the chloroform concentration was 460 ppb (EIC 2005c). The concentration of carbon tetrachloride and chloroform at ESG-12, were 25 and 51 times higher, respectively, than any of the other soil gas sampling locations. The close proximity between ESG-12 and a residence prompted the need for additional investigation.

EPA directed EIC to conduct the Residential Crawlspace Air Investigation (RCAI) at the residence located closest to soil gas probe ESG-12 (EIC 2005c). As a part of the RCAI, ambient air samples were also collected at four points around the VCCL site. The purpose of the ambient outdoor air sampling was to provide characterization of site-related VOC concentrations in the outdoor air during the SGI and RCAI sampling events. Ambient outdoor air samples were collected on the north, west, south, and east sides of the VCCL and the results of those samples are shown in Table 2. All air samples for the RCAI were collected with standard, six-liter SUMMA™ canisters.

TABLE 2. Carbon Tetrachloride and Chloroform concentrations in the ambient outdoor air around the perimeter of the Velsicol Chemical Corporation Landfill site from outdoor air samples collected on May 19 and 20, 2005, by ENVIRON International Corporation (EIC). The ambient outdoor air sampling point locations are shown in Figure 1. The carbon tetrachloride and chloroform vapor concentration results are reported in parts per billion by volume (ppb).

Outdoor Ambient Air Sampling Location	Carbon Tetrachloride concentration	Chloroform concentration
AMB-1 (south)	U	U
AMB-2 (west)	U	U
AMB-3 (north)	U	U
AMB-4 (east)	1.4	1.1

U = Undetected (i.e., constituent was either not present or at levels below the analytical detection limit)

In May 2005, three of the four ambient air samples from around the perimeter of the VCCL (Figure 1) site did not indicate the presence of carbon tetrachloride or chloroform above the laboratory analytical detection limits of 0.7 ppb (EIC 2005c). However, the ambient air sampling location AMB-4, located on the east side of the VCCL site, did detect the presence of carbon tetrachloride and chloroform. Carbon tetrachloride and chloroform were detected at concentrations of 1.4 ppb and 1.1 ppb, respectively, along a stretch of Pugh Creek where chemical odors have been previously noted (EIC 2005c).

The AMB-4 air sampling location is few hundred yards south-southeast of the VCCL groundwater treatment building, along Pugh Creek. This was the same general vicinity where

contaminated ground water seeps along the stream bank had been found in a previous investigation (EIC 2005a). Thus, there is evidence that carbon tetrachloride and chloroform vapors can be present in the ambient air in the vicinity of the VCCL site.

The Residential Crawlspace Air Investigation samples were also collected concurrently with the ambient outdoor air samples. The RCAI consisted of three sampling locations at the residence. Two air samples were collected from the crawlspace, one on the north side and one on the south side (Figure 3). The third sample was an outdoor air sample taken approximately 15 feet from the north side of the house (Figures 2 and 3). The results of those samples are shown in Table 3.

TABLE 3. Carbon Tetrachloride and Chloroform concentrations in the outdoor air and crawlspace air of the residence closest to SGI sampling point ESG-12 from the air samples collected on May 19 and 20, 2005, by ENVIRON International Corporation (EIC). The RCAI sampling point locations are shown in Figure 3. The carbon tetrachloride and chloroform vapor concentration results are reported in parts per billion by volume (ppb).

Residential Crawlspace Air Sampling Location	Carbon Tetrachloride concentration	Chloroform concentration
RES-08S (crawlspace - south side of house)	1.6	0.3
RES-08N (crawlspace - north side of house)	2.0	0.3
RES-08-AA (outside; north side of house)	0.7	0.5

U = Undetected (i.e., constituent was either not present or at levels below the analytical detection limit)

The results of the RCAI indicate the presence of carbon tetrachloride and chloroform vapors in the crawlspace of the residence. The highest concentration of carbon tetrachloride was 2.0 ppb with a corresponding concentration of chloroform of 0.3 ppb. The ambient air sample outside of the residence contained 0.7 ppb carbon tetrachloride and 0.5 ppb chloroform.

Introduction to Chemical Exposure

To determine whether persons are, have been, or are likely to be exposed to chemicals, Environmental Epidemiology of the Tennessee Department of Health evaluates mechanisms that could lead to human exposure. An exposure pathway contains five parts:

1. a source of contamination
2. contaminant transport through an environmental medium,
3. a point of exposure
4. a route of human exposure, and
5. a receptor population

An exposure pathway is considered complete if there is evidence that all five of these elements are, have been, or will be present at the site. The pathway is considered either a potential or an incomplete exposure pathway if there is no evidence that at least one of the five elements listed is, has been, or will be present at the site, or if there is a lower probability of exposure.

When a chemical is released from an area such an industrial plant or from a container such as a drum, it enters the environment. A chemical release does not, however, always lead to human exposure. Persons can be exposed to a chemical when contact is made by breathing, eating, drinking, or otherwise touching the chemical.

Furthermore, 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
- the person's diet and nutritional habits.

EEP evaluated human exposure scenarios to carbon tetrachloride and chloroform in the residence closest to SGI sampling location ESG-12 on Old Toone Road. There is a completed inhalation pathway for the occupants of the residence. We then compared the environmental levels of carbon tetrachloride and chloroform to health screening values established by the Agency for Toxic Substances and Disease Registry (ATSDR) to determine if further evaluation was needed.

Evaluating Exposure

The purpose of this public health consultation is to examine any potential health hazard from carbon tetrachloride and chloroform exposure to the occupants of the residence. To look more closely at the people who might be exposed to a hazardous substance, health assessors use health-screening levels determined for specific chemicals. To use these screening levels we must know how much of a chemical someone is exposed to, for how long that exposure has been or will be occurring, how frequent the exposure is or will be, and age of the exposed person.

If the chemical concentrations are below the screening level for a particular chemical, health assessors can be reasonably certain that no adverse health effects will occur in people who are exposed. If concentrations are above the screening levels for a particular chemical, then the public health implications need to be evaluated further.

When examining chemical exposure through inhalation, it is necessary to take into account the amount of the chemical that is already in the environment. This is often called the background level. Carbon tetrachloride is ubiquitous in ambient air. The average concentration reported in the National Ambient Volatile Organic Compounds Database was 0.17 ppb (ATSDR 2005b). Average values reported in four U.S. cities ranged from 0.14 to 0.29 ppb. Average concentrations reported from five coastal monitoring stations around the world were 0.10 to 0.13 ppb (ATSDR 2005b). For comparison, the carbon tetrachloride values at the residence ranged from 0.7 ppb in the air just outside the north side of the house to 2.0 ppb in the crawlspace air.

Chloroform, though detected in ambient air throughout the nation, it is generally found in concentrations that are lower than that of carbon tetrachloride. The average concentration of chloroform reported in the National Ambient Volatile Organic Compounds Database was 0.02 ppb (ATSDR 1997). As with many volatile organic chemicals, chloroform concentrations will generally be higher in urban settings as opposed to rural areas. The most recent estimate of the national background level of chloroform in ambient air is 0.04 ppb (ATSDR 1997). For comparison, the chloroform values at the residence ranged from 0.5 ppb in the air just outside the north side of the house to 0.3 ppb in the crawlspace air.

Evaluating Non-cancer Risk

For non-carcinogenic effects of hazardous chemicals, ATSDR derives a minimal risk level (MRL) for each chemical. From the MRLs, ATSDR has derived health-screening values, often called Environmental Media Evaluation Guides (EMEGs) for soil, air, and water.

Inhalation is the primary route of exposure for carbon tetrachloride (ATSDR 2005b). Chloroform can readily enter the body through inhalation, ingestion, and from dermal contact with water containing chloroform (ATSDR 1997). Because we are looking at data pertaining to indoor air concentrations of chloroform, the inhalation route of exposure will be examined for the purposes of this public health consultation.

The ATSDR EMEGs for air were used as a starting place in determining if health hazards may exist for any occupants of the residence. To examine the inhalation route of exposure, we used

the ATSDR EMEGs because they are based on the MRLs, and are conservative assumptions about chemical exposure. EMEGs apply to acute (14 days or less), intermediate (15–365 days) and chronic (365 days or more) exposures.

For carbon tetrachloride, the EMEG and MRL values (or concentrations) for the inhalation exposure are the same. The EMEG/MRL concentrations for carbon tetrachloride are 30 ppb for intermediate inhalation exposure, and 30 ppb for chronic inhalation exposure (ATSDR 2005a).

For chloroform, the EMEG and MRL values (or concentrations) for the inhalation exposure are the same. The EMEG/MRL concentrations for chloroform are 41 ppb for intermediate inhalation exposure, and 20 ppb for chronic inhalation exposure (ATSDR 2005a).

The RCAI data, shown in Table 3, report the concentration of carbon tetrachloride in the crawlspace, from sampling locations RES-08S and RES-08N (Figure 3), to be 1.6 ppb and 2.0 ppb, respectively. The chloroform concentration at both sampling locations was 0.3 ppb.

Due to the lack of an actual indoor air sample from inside the living space of the residence, we will use the crawlspace air sample data and assume that the carbon tetrachloride and chloroform concentration inside the living space of the residence is the same as in the crawlspace. Since we have two different values for carbon tetrachloride from the crawlspace air sampling, to be as protective of human health as possible, we will utilize the higher concentration of 2.0 ppb from air sample RES-08N, for the living space analysis. The chloroform value from both crawlspace air samples was 0.3 ppb, thus that value will be assumed for the living space.

The outdoor ambient air sample was collected 15 feet away from the north side of the house, at sample location RES-08-AA (Figure 3). It reported the concentration of carbon tetrachloride to be 0.7 ppb and the concentration of chloroform to be 0.5 ppb (EIC 2005c).

The assumed carbon tetrachloride concentration in the indoor air sample of 2.0 ppb is above the average national background level of 0.17 ppb. When that concentration is compared to the EMEG/MRL for carbon tetrachloride in air, the indoor air concentration is 15 times lower than the intermediate and chronic inhalation exposure level of 30 ppb. Additionally, the carbon tetrachloride concentration in the air immediately outside the home, though higher than the potential background levels, is lower than that of the indoor air. Thus, non-carcinogenic adverse health effects would not be anticipated for the occupants of the residence from current levels of carbon tetrachloride.

The assumed indoor chloroform concentration in the air sample of 0.3 ppb is above the average national background level of 0.04 ppb. When that concentration is compared to the EMEG/MRL for chloroform in air, the indoor air concentration is 100 times lower than the intermediate inhalation exposure level of 41 ppb, and 66 times lower than the chronic inhalation exposure level of 20 ppb. Thus, non-carcinogenic adverse health effects would not be anticipated for the occupants of the residence from the current concentration levels of chloroform.

Evaluating Cancer Risk

For evaluating potential carcinogenic effects of hazardous chemicals, ATSDR has derived a comparison value similar to the MRL and EMEG. This comparison value is called the Cancer Risk Evaluation Guide (CREG). The CREG is the estimated contaminant concentration that would be expected to cause no more than one excess cancer in one million (1×10^{-6}) persons exposed over a lifetime (70 years). CREG values are calculated using the EPA cancer slope factors. The CREG value for inhalation exposure to both carbon tetrachloride and chloroform is 0.01 ppb.

The carbon tetrachloride and chloroform concentrations found in the indoor and outdoor air samples from the residence are higher than the average ambient air (i.e., background) concentrations. The concentrations also exceed the CREG values established for both chemicals. Based on this finding, additional calculations were made utilizing the EPA Inhalation Unit Risk. These calculations are not a specific estimate of expected cancers. Rather, they are an estimate of the increase in the probability that a person may develop cancer sometime during his or her lifetime following exposure to a particular contaminant.

There are varying suggestions among the scientific community regarding an acceptable excess lifetime cancer risk, due to the uncertainties regarding the mechanism of cancer. The recommendations of many scientists and EPA have been in the risk range of 1 in 1,000,000 (1×10^{-6}) to 1 in 10,000 (1×10^{-4}) excess cancer cases. An increased lifetime cancer risk of 1 in 1,000,000 (or 1×10^{-6}) or less is generally considered an insignificant increase in cancer risk (ATSDR 2005b and ATSDR 1997).

The results of our calculations, based on the assumed indoor air concentrations and the measured outdoor concentrations of carbon tetrachloride and chloroform, are as follows:

- 1.9×10^{-4} cancer risk from carbon tetrachloride, indoor assumed value of 2.0 ppb.
- 6.5×10^{-5} cancer risk from carbon tetrachloride, outdoor measured value of 0.7 ppb.
- 3.4×10^{-5} cancer risk from chloroform, indoor assumed value of 0.3 ppb.
- 5.6×10^{-5} cancer risk from chloroform, outdoor measured value of 0.5 ppb.

Thus, whether indoors or outdoors, these calculations indicate a cancer risk greater than 1 in 1,000,000 due to the carbon tetrachloride or chloroform vapor intrusion.

The scientific literature reports that the liver and kidneys are both affected by exposure to carbon tetrachloride and chloroform (ATSDR 2005b, 1997). However, documentation on the health effects of multiple chemical exposures by oral, dermal, and inhalation routes associated with hazardous waste sites is limited. Mixtures of chemicals could have additive effects, greater than additive effects (synergism, potentiation), or less-than-additive-effects (antagonism, inhibition, masking) (ATSDR 2004). No definite information concerning the simultaneous exposure to carbon tetrachloride and chloroform was located. The chemicals may or may not act in an additive manner for non-cancer risk. The chemicals are not believed to be additive for cancer risk, as the mechanisms of each chemical to trigger a potential cancer risk are different.

Additional Site Data

Preliminary calculations indicate that the lifetime cancer risk for this site exceeds the benchmark level of 1 in 1,000,000 (or 1 x 10^{-6}). Thus, in order to fully characterize the potential for cancer risk to occupants of the Old Toone Road residence, there exists a need for additional air sampling. EEP believes that an indoor air sample from the living space inside the residence would provide critical data concerning the actual measured indoor air concentrations of carbon tetrachloride and chloroform in the occupant living space. This type of data is considered essential to completing a thorough public health consultation for this site.

Therefore, EEP recommends that a minimum of three additional air samples be collected from the site: one indoor air sample from the crawl space of the residence, one outdoor ambient air sample taken outside of the residence, and one outdoor ambient air sample in the vicinity of soil gas probe location ESG-11. Additionally, EEP recommends that the sampling event be planned for the winter months in order to provide a sample taken under differing environmental conditions from the initial RCAI sampling event.

Child Health Considerations

In communities faced with environmental contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances (ATSDR 1997, 1998). Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

Child occupants of this residence would be exposed to carbon tetrachloride and chloroform via the inhalation pathway. While children's lungs may be smaller than adults, they breathe a greater relative volume of air compared to adults. According to environmental literature, no adverse health effects have been directly linked to the exposure of children to carbon tetrachloride or chloroform. However, prudent public health practice dictates that any potential child exposure to carbon tetrachloride and chloroform should be eliminated.

Conclusions

1. An indeterminate public health hazard exists for carbon tetrachloride exposure to the occupants of the Old Toone Road residence at the Hardeman County Landfill site due an insufficient number of environmental air samples.

2. An indeterminate public health hazard exists for chloroform exposure to the occupants of the Old Toone Road residence at the Hardeman County Landfill site due an insufficient number of environmental air samples.

Recommendations

1. Conduct additional air sampling at the site. EEP recommends that a minimum of three additional air samples be collected from the site:
   - One indoor air sample from the crawl space of the residence,
   - One outdoor ambient air sample taken outside of the residence, and
   - One outdoor ambient air in the vicinity of soil gas probe location ESG-11.
2. EEP recommends that the sampling event be planned for the winter months in order to provide a sample taken under differing environmental conditions from the initial RCAI sampling event.

Public Health Action Plan

1. EEP will provide this public health consultation to the government agencies responsible for oversight of the VCCL to indicate the need for additional air sampling data.

2. EEP requests to review the additional air sampling data. Afterward, EEP will update this public health investigation with a follow-up report.

3. EEP and TDEC will provide this document and any needed health education to the affected property owner.

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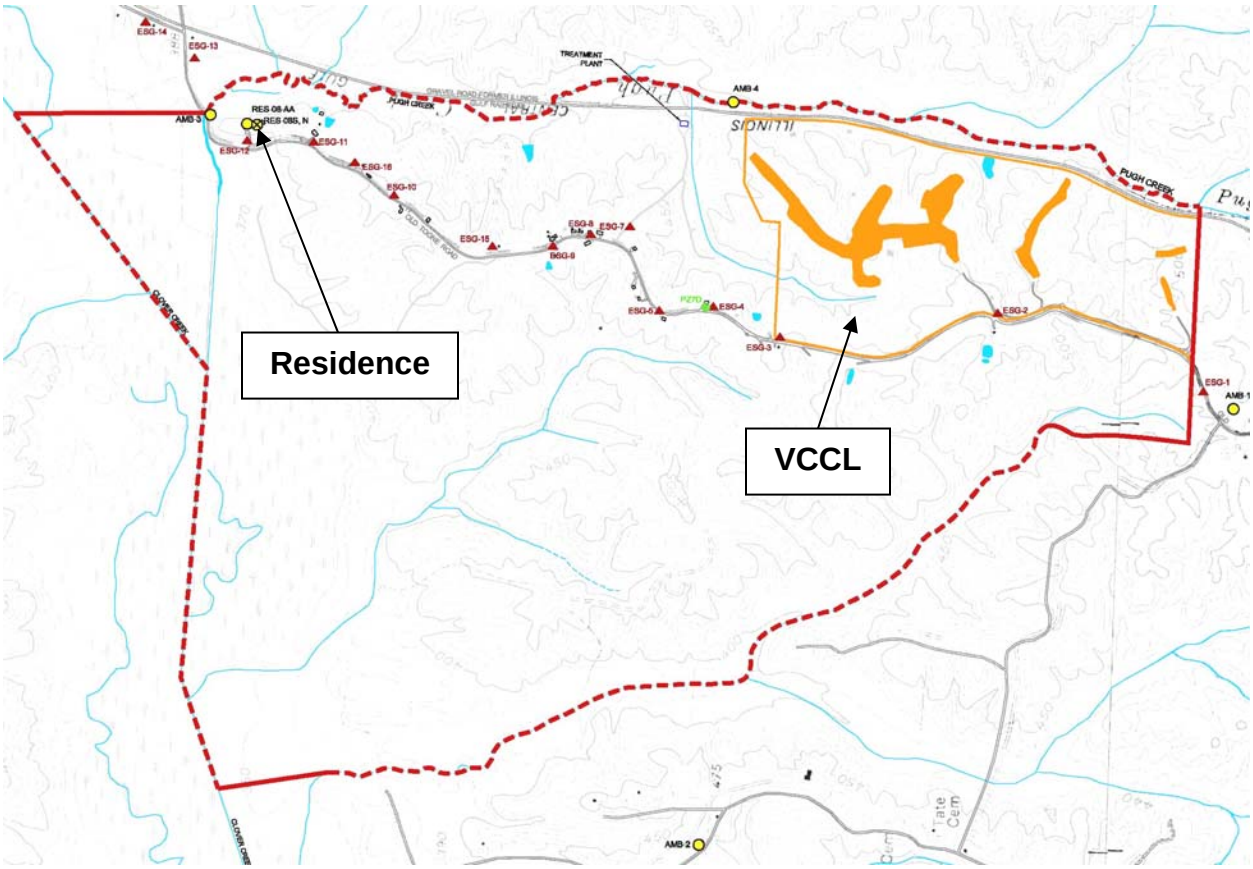
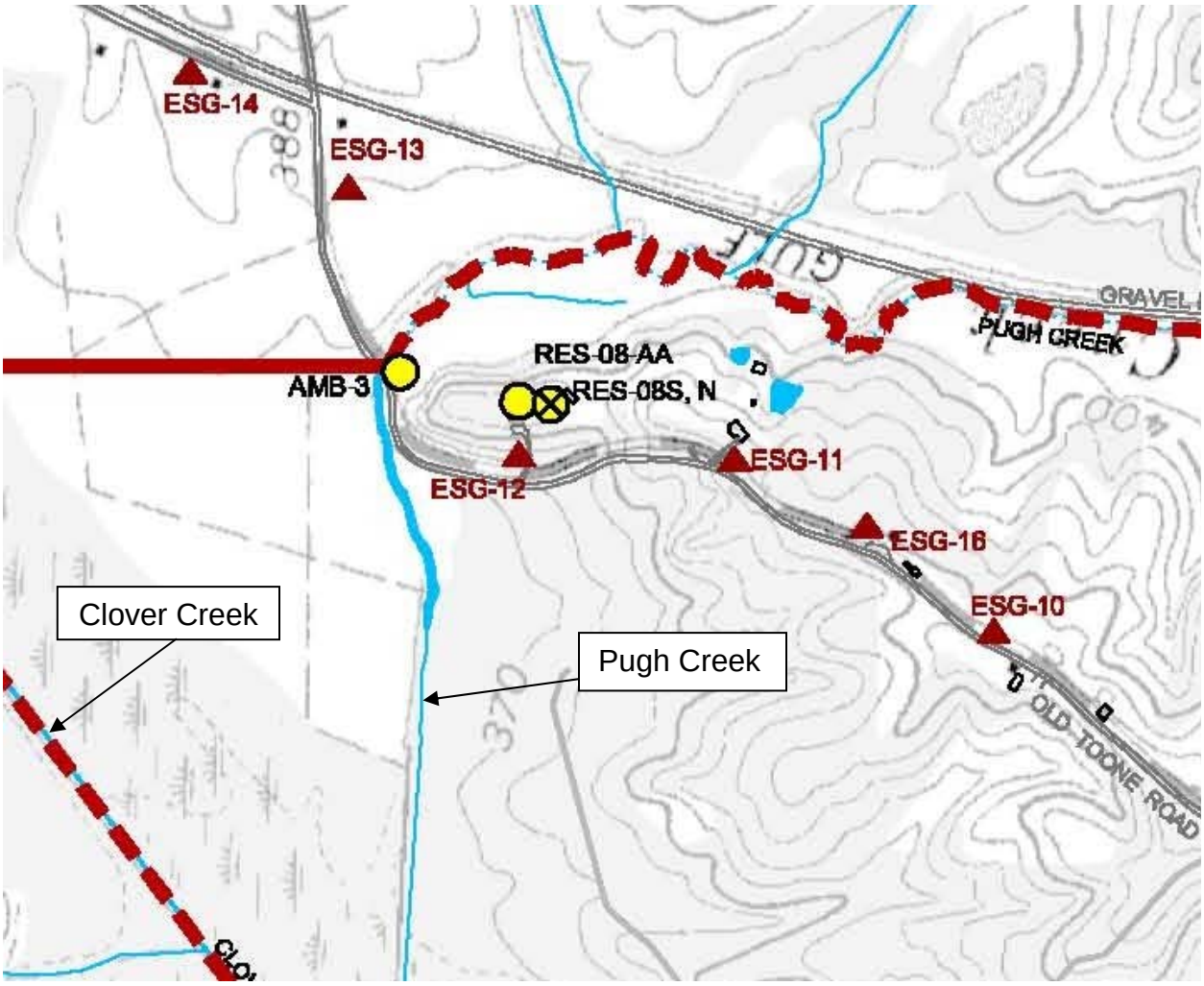
Figures

FIGURE 1 - Map showing the location of the Old Toone Road Residence in, Toone, Hardeman County, Tennessee. This map also shows the geographical relationship between the house and the Velsicol Chemical Corporation Landfill (VCCL) site. The house is approximately 1 mile north of the northern (orange line) boundary of the VCCL. (Note that the figure is oriented in a nonstandard manner, i.e. north is located to the left side of the page, not towards the top.)



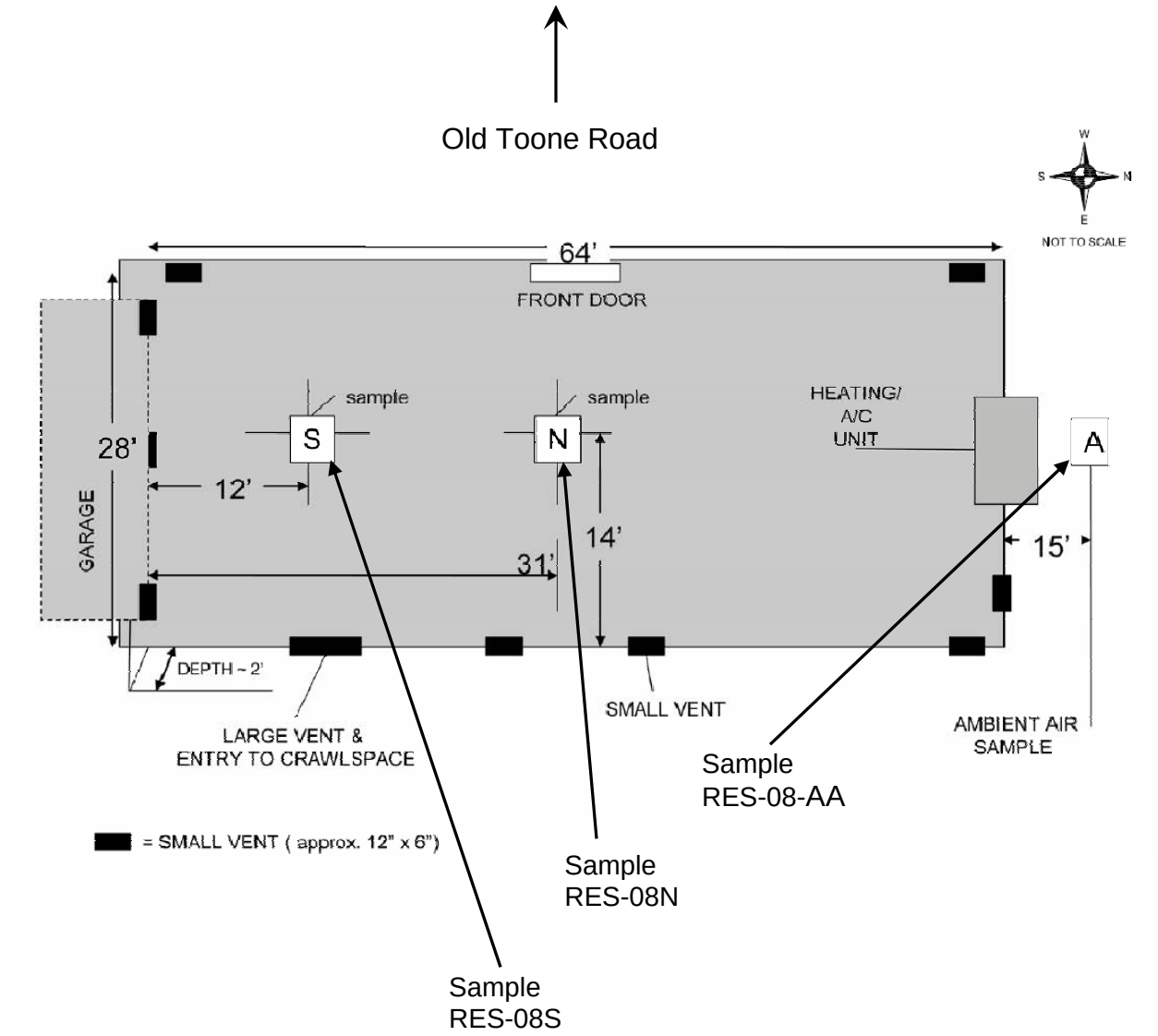
(Map credit: ENVIRON International Corporation)

FIGURE 2 - Map showing a close up view of the Old Toone Road Residence. (Note that the figure is oriented in a nonstandard manner, i.e. north is located to the left side of the page, not towards the top.)



(Map credit: ENVIRON International Corporation)

FIGURE 3 - Diagram showing the Residential Crawlspace Air Investigation sampling locations at the house located on Old Toone Road. (Note that the figure is oriented in a nonstandard manner, i.e. north is located to the right side of the page, not towards the top). The laboratory results from the RCAI are presented in Table 3.



(Map credit: ENVIRON International Corporation)

Appendix

Carbon Tetrachloride, CCl_4

Carbon tetrachloride is a clear, highly volatile liquid that evaporates very easily. Most carbon tetrachloride that escapes to the environment is therefore found as a gas. Carbon tetrachloride does not easily burn. Carbon tetrachloride has a sweet odor, and most people can begin to smell it in air when the concentration reaches 10,000 parts carbon tetrachloride per billion parts of air (ppb). It is not known whether people can taste it or, if they can, at what level.

Carbon tetrachloride does not occur naturally but has been produced in large quantities to make refrigeration fluid and propellants for aerosol cans. Since many refrigerants and aerosol propellants have been found to affect the earth's ozone layer, the production of these chemicals is being phased out.

Carbon tetrachloride concentrations in air, ranging from 0.1 to 0.16 parts per billion (ppb) is common in the United States (ATSDR 2005b). Once carbon tetrachloride is in the troposphere, it is a stable gaseous compound. Due to the lack of rapid tropospheric removal mechanisms, carbon tetrachloride accumulates in the lower atmosphere and has an estimated atmospheric lifetime of 50 years. Thus, the most common source of exposure to ambient carbon tetrachloride is from the background concentration.

Most information on the health effects of carbon tetrachloride in humans comes from cases where people have been exposed to relatively high levels of carbon tetrachloride, either only once or for a short period of time. Experiments have not been performed on the effects of long-term exposure of humans to low levels of carbon tetrachloride, so the human health effects of such exposures are not known.

The liver is especially sensitive to carbon tetrachloride. In mild cases, the liver becomes swollen and tender, and fat builds up inside the organ. In severe cases, liver cells may be damaged or destroyed, leading to a decrease in liver function. Such effects are usually reversible if exposure is not too high or too long. The kidney is also sensitive to carbon tetrachloride. Less urine may be formed, leading to a buildup of water in the body (especially in the lungs) and buildup of waste products in the blood. Kidney failure often was the main cause of death in people after very high exposure to carbon tetrachloride (ATSDR 2005b).

After exposure to high levels of carbon tetrachloride, the nervous system, including the brain, is affected. Such exposure can be fatal. The immediate effects are usually signs of intoxication, including headache, dizziness, and sleepiness perhaps accompanied by nausea and vomiting. These effects usually disappear within a day or two after exposure stops. In severe cases, stupor or even coma can result, and permanent damage to nerve cells can occur.

Many reported cases of carbon tetrachloride toxicity are associated with drinking alcohol. The frequent consumption of alcoholic beverages increases the danger from carbon tetrachloride exposure (ATSDR 2005b).

Studies in animals have shown that the ingestion of carbon tetrachloride can increase the frequency of liver tumors in some species. Studies have not been performed to determine if breathing carbon tetrachloride causes tumors in animals, or whether swallowing or breathing carbon tetrachloride causes tumors in humans, but it should be assumed that carbon tetrachloride could produce cancer. The Department of Health and Human Services (DHHS) has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has determined that carbon tetrachloride is possibly carcinogenic to humans. The EPA has determined that carbon tetrachloride is a probable human carcinogen. EPA has derived an Inhalation Unit Risk of an excess risk of cancer of 1.5×10^{-5}. This means that 1 excess cancer in one million people may occur if people are exposed to 0.01 ppb carbon tetrachloride over a lifetime.

It is important to note that there are no data on exposure of humans to low levels of carbon tetrachloride nor is there useful experimental data in animals on adverse effects from inhalation of carbon tetrachloride.

Chloroform, $CHCl_3$

Chloroform is also known as trichloromethane or methyltrichloride. It is a colorless liquid which evaporates very quickly but breaks down slowly once in the air. Most of the chloroform found in the environment comes from industry, such as chemical companies and paper mills**.** Chloroform can enter the air directly from factories that make or use chloroform and through evaporation from water and soil that contain it. It is also found in wastewater from sewage treatment plants and drinking water that is treated with chlorine. It may enter water and soil from spills and by leaks from storage containers and from waste disposal sites. There are many ways for chloroform to enter the environment, so small amounts of it are likely to be found almost everywhere. The chlorination of water produces chloroform as a by-product.

People may be exposed to small amounts of chloroform in drinking water and in beverages (such as soft drinks) made using water that contains chloroform. Chloroform can also enter the body by ingestion of food, breathing air, and by dermal (i.e. skin) contact with water that contains it. The most likely way to be exposed to chloroform is by drinking water and breathing indoor or outdoor air containing it. The amount of chloroform normally expected to be in the air ranges from 0.02 to 0.05 parts of chloroform per billion parts (ppb) of air (ATSDR 1997).

Chloroform affects the central nervous system (brain), liver, and kidneys after a person breathes air or drinks liquids that contain large amounts of chloroform. Breathing about 900 parts of chloroform in a million parts of air (900 ppm or 900,000 ppb) for a short time causes fatigue, dizziness, and headache. Should a person breathe air, eat food, or drink water containing elevated levels of chloroform, over a long period, the chloroform may damage the liver and kidneys.

Studies have shown that people who drink chlorinated water have shown a possible link between the chloroform in chlorinated water and the occurrence of colon and urinary bladder cancers. Animal studies have shown an association with liver and kidney cancer after long-term exposure to drinking or ingesting chloroform, but it is not known whether humans would develop the same cancers.

The Department of Health and Human Services (DHHS) has determined that chloroform may reasonably be anticipated to be a carcinogen (cancer-causing agent). The International Agency for Research on Cancer (IARC) has determined that chloroform is possibly carcinogenic to humans. The Environmental Protection Agency (EPA) classifies chloroform as likely to be carcinogenic to humans. Indoor air contaminants in residences could result in a higher increased cancer risk than outdoor air contaminants. EPA has derived an Inhalation Unit Risk of an excess risk of cancer of 2.3×10^{-5}.

Certification

This Public Health Consultation: *Hardeman County Landfill (Velsicol Chemical Corporation), Toone, Hardeman County, Tennessee,* was prepared by the Tennessee Department of Health Environmental Epidemiology under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun. Editorial review was completed by the Cooperative Agreement Partner.

Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

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

Team Leader, CAT, CAPEB, DHAC, ATSDR