Health Consultation

QUAD INDUSTRIES INDOOR AIR EVALUATION

BRADFORD, GIBSON COUNTY, TENNESSEE

APRIL 2, 2011

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

Please write to: Environmental Epidemiology
Tennessee Department of Health
1st Floor, Cordell Hull Building
425 5th Avenue North
Nashville TN 37243

Or call us at: 615-741-7247 or toll-free 1-800-404-3006 during normal business hours

Or e-mail us at: eep.health@tn.gov

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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 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 ground water); 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.

Ground water: 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 ground water.

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 ground water 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 Environmental Epidemiology Program.

EEP wrote this health consultation at the request of the Tennessee Department of Environment and Conservation (TDEC) Division of Solid and Hazardous Waste Management's (DSWM) State Remediation Program (SRP). This health consultation was prepared to evaluate the results of indoor air sampling conducted inside the Quad Industries manufacturing building in July 2010. TDEC SRP asked EEP to evaluate potential exposures to vapor intrusion at the site and any public health implications to the exposures. The purpose of this health consultation is to document our review of indoor air data collected and to evaluate the potential for vapor intrusion into the manufacturing building at the site, as requested by TDEC SRP.

All data supplied for this health consultation was compared to the Agency for Toxic Substances and Disease Registry's (ATSDR's) and the U.S. Environmental Protection Agency's (EPA's) residential indoor 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 that the potential health risk requires further investigation.

CONCLUSIONS

EEP reached one conclusion in this health consultation:

Conclusion 1

EEP concludes that there should be no harm from breathing indoor air at the site containing PCE and TCE, and their breakdown products, in concentrations up to their detection levels.

Basis for Conclusion

No PCE solvent vapor or PCE breakdown chemical vapors were measured above laboratory detection levels inside or outside of the building.

Next Steps

It is understood that TDEC SRP will continue to oversee the remediation of the site.

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 DSWM SRP at 615-532-0670 during normal business hours. For health related issues you may contact the TDH EEP at 615-741-7247, or toll free, 1-800-404-3006. You may also email the TDH EEP at eep.health@tn.gov.

Introduction

The Quad Industries site is located at 317 Alexander Street in Bradford, Gibson County, Tennessee. The Tennessee Department of Environment and Conservation (TDEC), Division of Solid and Hazardous Waste Management's (DSWM), State Remediation Program (SRP) has been overseeing the investigations and remedial activities being conducted at the site. The site has TDEC SRP number SRS-01067. Quad Industries operates as a manufacturer of sleeve bearings. The Quad Industries site is located south of downtown Bradford in an approximate 200 feet wide by 500 feet long L-shaped manufacturing building. The manufacturing building is located on a rectangular 5-acre parcel of land (GEI 2010).

Various environmental investigations have been conducted at the site. A limited soil removal was also completed. The main mass of impacted soil beneath the floor in the southern portion of the building was removed in 2008.

After the various investigations and soil removals were completed, TDEC SRP wanted further testing to determine whether there was potential for vapor intrusion into the indoor air from the soil and groundwater beneath the building. The testing was done to determine if workers and visitors to the site were being exposed to site-related chemicals. Testing was done by Genesis Environmental Incorporated (GEI) of Marietta, Georgia, in July 2010. TDEC SRP asked EEP to review results of this recent investigation. After the evaluation of the indoor air investigation data, EEP prepared this health consultation for the site.

Background

The Quad Industries site is located in Bradford, Tennessee, on a 5-acre parcel of land. The site is situated near the end of Alexander Road. Several homes are located across Alexander Road west of the site. Surrounding areas appear to be farmland (Google Earth 2010).

GEI performed a limited Phase 2 Environmental Site Investigation of the property in September 2007. Chlorinated solvent chemicals were identified in soil and groundwater samples collected as part of the Phase 2 investigation. The chemicals were used to clean parts in a parts cleaning machine in the south-central portion of the facility. Specifically, the common parts cleaning solvents, tetrachloroethylene (PCE) and trichloroethylene (TCE), were found. Elevated concentrations of PCE and TCE were found in soil samples during a subsequent Phase 2 investigation. PCE and TCE soil concentrations were limited to an area adjacent to the location of a former parts cleaning machine inside the southern portion of the manufacturing building. Results from the investigation also showed that groundwater flowed to the north-northeast and that groundwater was impacted by releases of PCE and TCE from the parts cleaning machine (GEI 2010).

A limited soil removal was done to take away the bulk of the on-site solvent contamination. The excavation was completed inside the Quad Industries building in the vicinity of the former parts cleaning machine location and involved removing part of the floor. Approximately 53 tons of soil were excavated from the source area and properly disposed of. The excavation was filled, a

new floor was installed over the area, and joints between the old floor and the new floor were sealed (GEI 2010).

Two years of semi-annual groundwater monitoring was conducted. PCE, TCE, and cis-1,2-dichloroethene (cis-1,2-DCE) were detected in the groundwater samples (GEI 2009). The presence of cis-1,2-DCE indicated that some biodegredation was occurring in the site groundwater (GEI 2009).

Based on the areal extent and depth to the PCE- and TCE-impacted groundwater and the distance to an intake depth of the City of Bradford water supply wells, no exposure pathways or potential receptors were identified as part of a risk evaluation performed by GEI (2009) that was submitted to and approved by TDEC SRP.

An initial soil-gas and indoor air investigation was completed by GEI (GEI 2009). This investigation was to determine if any PCE or TCE vapors were present inside the site building or in the soil above impacted groundwater beneath the building's floor slab. Both soil-gas and indoor air were tested.

For the September 2009 sampling, GEI measured a concentration of PCE at 18 $\mu g/m^3$), or 2.7 parts per billion (ppb) in 1 of 2 indoor air samples. TCE was also measured in the same indoor air sample at 2.3 $\mu g/m^3$ or 0.43 ppb. The second sample did not have any detections of PCE or TCE. Cis-1,2-DCE was detected in both indoor air samples collected, at 8.3 and 2.8 $\mu g/m^3$, which is equivalent to 2.1 and 0.70 ppb, respectively.

PCE, TCE, and cis-1,2-DCE were detected in all 6 sub-slab soil-gas samples collected. PCE sub-slab soil-gas concentrations ranged from 140 to 1,100 micrograms per cubic meter ($\mu g/m^3$) which is equivalent to 20.6 to 162 parts per billion (ppb). TCE sub-slab soil-gas concentrations ranged from 5.1 to 180 $\mu g/m^3$, which is equivalent to 0.95 to 34 ppb. Cis-1,2-DCE sub-slab soil-gas concentrations ranged from 4.0 to 290 $\mu g/m^3$, which is equivalent to 1.0 to 73 ppb. Only 1 of 6 sub-slab samples contained concentrations of another breakdown product, trans-1,2-DCE, at a concentration of 1.7 $\mu g/m^3$, equivalent to 0.43 ppb.

Vinyl chloride was not detected in either indoor air sampling event. The detection limit for vinyl chloride in both sampling events was 0.4 ppb.

Both the soil-gas and indoor air results are discussed more in a November 24, 2009, memorandum from Mr. Joe George, PG, TDH EEP to Mr. Dana Petway, PG, TDEC SRP (Appendix).

TDH EEP expressed reservations about the methods used to collect the soil-gas and indoor air data (TDH EEP 2009). Soil-gas and indoor air samples were both collected using the pump of a photoionization detector (PID) to fill a Tedlar bag. The sampling approach was unconventional compared to the usual methods used to collect a representative sub-slab soil-gas and indoor air samples. Usually, a syringe or a Summa canister is used. If using a PID to collect a soil-gas sample, the PID's internal pump and the tubing can cause cross-contamination. With this in mind, the reported concentrations of compounds could be more or less than the actual concentrations. If using a PID to collect an indoor air sample, losses can occur because of

adsorption of the chemicals onto the PID's internal pump or onto the tubing used to collect the sample. Following this line of reasoning, the reported concentrations of compounds could be biased low, resulting in lower reported concentrations than are actually present.

Another issue with the September 2009 sampling was that an evaluation of vapor intrusion into a work place typically mimics the amount of time of worker exposure. The September 2009 indoor air sampling was completed in just 30 minutes. Therefore EEP considered this data more qualitative and only a representation for a short period of time within a usual exposure time frame (Appendix).

GEI's September 2009 report provided a description of the air flow rate inside the manufacturing building. According to the report the air inside the building is turned over in less than 19 minutes during the work day, for a total of 31 times during a 10-hour work day (GEI 2009). GEI suggests this is more than sufficient to provide fresh air exchange during the work day (GEI 2009). It is also possible that this system would draw sub-slab soil gas vapors into the indoor air of the building if any cracks in the floor were present.

Because of the concerns TDH EEP had about the sampling technique used for the September 2009 soil-gas and indoor air sampling, TDEC asked Quad Industries to resample the indoor air. Sub-slab soil-gas was not requested by TDEC to be resampled. GEI resampled indoor air in two locations within the site building and sampled outdoor ambient air as a background sample on July 22, 1010. GEI reported results to TDEC on July 30, 2010 (GEI 2010). This health consultation assesses the indoor air quality in the Quad Industries building based on the July 2010 measurements.

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. 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 complete 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.

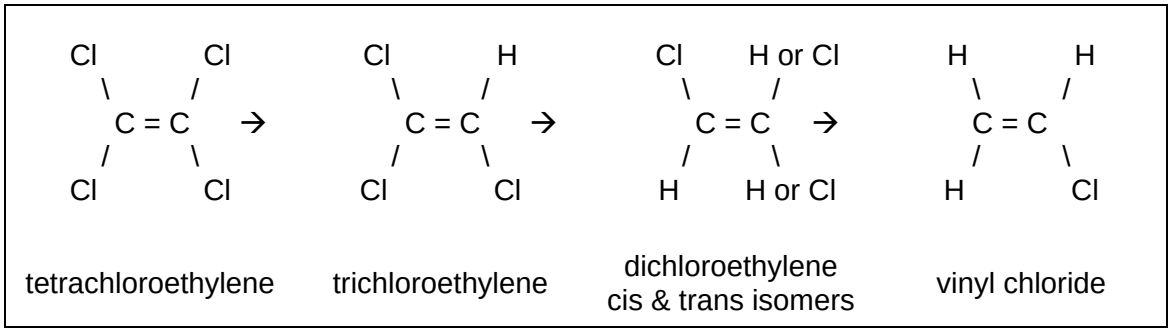
The purpose of this public health consultation is to assess the indoor air quality in the Quad Industries manufacturing building. This consultation will assess the impact from breathing air potentially containing the solvents PCE, TCE, cis-1,2-DCE, and vinyl chloride. These solvents are site-related chemicals and may have entered the indoor air of the building through a process called vapor intrusion. The potentially exposed population would be the manufacturing workers and office staff of Quad Industries who would work 8-hours per day, 5 days per week, for a 40-hour work week inside the manufacturing building.

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.

Solvent Explanation

The most commonly used solvent for parts cleaning at this site was tetrachloroethylene, more commonly referred to as PCE 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. PCE breaks down into other volatile organics with fewer chlorine atoms (see diagram below). Each of these breakdown products has slightly different chemical properties and toxicities.



TCE was also used as a solvent at this site. TCE can also be a chemical breakdown product of PCE. 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 products is to collect environmental samples. The solvent PCE, and all of its breakdown products plus their isomers, were carefully considered in developing this report.

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.

There is a difference between occupational "voluntary workplace exposure" and a "non-voluntary" type of exposure. Federal Occupational Safety and Health Administration (OSHA) standards or limits apply only if personnel in the facility are trained in the proper handling and the health effects of chemicals used. EEP assumed that all facility personnel are not trained in the handling or health effects of PCE and TCE and their breakdown chemicals because these chemicals are no longer used at the site (GEI 2010). Therefore, instead of evaluating the exposure and potential health effects based on federal OSHA standards, results will be evaluated based on the Agency for Toxic Substances and Disease Registry's (ATSDR) health comparison values and U.S. Environmental Protection Agency's (EPA's) residential inhalation Regional Screening Levels (RSLs).

The ATSDR environmental media evaluation guidelines (EMEGs) were developed using conservative assumptions. 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.

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

Two indoor air samples were collected as part of the July 2010 indoor air investigation. One outdoor background air sample was also collected. The two indoor air samples were both collected from work areas inside the former manufacturing building. The samples were labeled IA-1 and IA-2. The outdoor air sample was collected approximately 50 feet west of the building in a landscaped area between the building and Alexander Road. The outdoor air sample was labeled OA-1. Samples were collected over an 8-hour time frame during the active work period from approximately 8:30 am until approximately 5:00 pm on July 22, 2010. GEI personnel performed the sampling. Samples were analyzed by ESC Lab Sciences of Mount Juliet, Tennessee. SUMMA canisters were used to collect all three samples. Figure 1 shows the location of the indoor air samples for this investigation.

Observations made during the July 2010 indoor air sampling event show that a loading dock door was open during the sampling. The loading dock door was approximately 30 feet from the location of sample IA-2. The effect of the door being open during the testing is unknown.

Results

As noted previously, the September 2009 indoor air samples measured very low concentrations of the solvent PCE, TCE and their breakdown chemical cis-1,2-DCE inside the manufacturing building. PCE, TCE, and cis-1,2-DCE were not measured above their detection levels in the July 2010 sampling inside the building or in the outside ambient air. The detection level for each of these compounds was 0.40 ppb. Indoor air measurements for the two sampling events conducted at the Quad Industries site are presented in Table 1.

Because of the uncertainties in the sampling methods used during the September 2009 indoor air sampling, TDH EEP did not consider the results representative of the amounts of the solvents in the indoor air of the facility. EEP only evaluated the July 2010 indoor air sampling results as part of this health consultation. The earlier data were included in Table 1 for completeness.

Data Quality

The first round of site sub-slab soil-gas and indoor air data was collected during September 2009. Only minor detections of site-related chemicals were found in the indoor air samples. The loading dock door closest to one of the sampling locations was closed during this sampling event. However, the September 2009 sampling was not conducted according to generally accepted protocols and may have biased the sample results. Concentrations of chemicals found in the September 2009 sampling were below their respective comparison values for EPA's acceptable range of risk. Because of the collection techniques used, TDH EEP questioned the representativeness of the data. A second round of site indoor air data was collected during July 2010. This second round was also done after the joints between the old floor and new floor were sealed. While no site-related chemicals were detected in July 2010, there was potential sampling bias because an open loading dock door may have caused outside air to mix with the indoor air at one sampling location, IA-2.

TABLE 1. Indoor air data for the Quad Industries manufacturing building, Bradford, Gibson County, TN. Values reported in parts per billion (ppb). Health screening guidelines based on chronic exposure duration (ATSDR 2010) and EPA Risk-Based Concentrations (EPA 2010). Data provided by Genesis Environmental Inc., July 2010.

Chemical	Acronym	September 18, 2009*		July 22, 2010			ATSDR EMEG (non-cancer)	ATSDR CREG / EPA RSL (10^{-6} excess cancer risk)
		AS-1 Indoor air	AS-2 Indoor air	IA-1 Indoor air	IA-2 Indoor air	OA-1 Outdoor air		
		ppb	ppb	ppb	ppb	ppb	ppb	ppb
tetrachloroethylene	PCE	2.7	<0.4	<0.4	<0.4	<0.4	40	0.06[EPA]
trichloroethylene	TCE	0.42	<0.4	<0.4	<0.4	<0.4	7.4[EPA]	0.22[EPA]
cis-1,2-dichloroethene	cis-1,2-DCE	2.1	0.7	<0.4	<0.4	<0.4	nc	nc
vinyl chloride	VC	<0.4	<0.4	<0.4	<0.4	<0.4	30i	0.04

Notes:

<0.4 = not detected in the air sample (above the analytical detection limit of 0.4 ppb for compounds listed).

ATSDR EMEG = Agency for Toxic Substances and Disease Registry Environmental Media Evaluation Guide (ATSDR 2010). Chronic non-cancer exposure comparison values (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 Cancer Risk Evaluation Guide (ATSDR 2010). Cancer risk comparison values for cancer risk of 1 excess cancer in 1,000,000 people used to determine if chemical concentrations warrant further health-based screening.

* Due to indoor air sample collection techniques, indoor air results may not be representative of actual site conditions.

EPA* = There is not a published EMEG for TCE. The results were compared to the EPA's provisional comparison value for the potential health risks from exposure to TCE of 7.4 ppb (EPA 2008).

EPA = EPA Residential Indoor Air Regional Screening Levels (EPA 2010)

nc = not classified as to carcinogenity and no guidance value available

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

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)

As stated earlier, PCE is a clear, colorless liquid said to produce a sharp, sweet smell. PCE is a synthetic chemical and is often used as a starting point for the manufacture of other chemicals (ATSDR 1997). The 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 and, to a lesser extent, by direct exposure to the skin. Toxicity values for PCE are currently being re-evaluated by EPA.

At high concentrations PCE is known to produce loss of consciousness. When air concentrations are high, particularly in closed, poorly ventilated areas, single exposures can cause dizziness, headache, sleepiness, confusion, nausea, difficulty in speaking and walking, unconsciousness, and death. The health effects of breathing in air or drinking water with low levels of PCE are not definitely known.

Trichloroethylene (TCE)

TCE is also 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. If TCE is released to surface water or surface soil, like PCE, it will mostly evaporate into the air and disperse. The background concentration of TCE in the environment is usually less than 1 ppb. TCE is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers (ATSDR 1997).

Breathing small amounts of 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. Toxicity values for TCE are currently being re-evaluated by EPA.

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

Cis-1,2-DCE is an isomer, or form, of 1,2-dichloroethylene (1,2-DCE). The other isomer of 1,2-DCE is trans-1,2-dichloroethylene (trans-1,2-DCE). Isomers are molecules with the same chemical formula, but with different arrangements of their atomic structure. 1,2-DCE is a colorless liquid with a sharp, harsh odor. It is highly flammable and evaporates rapidly at room temperature. Cis-1,2-DCE is a synthetic chemical and is used in the manufacture of other chemicals (ATSDR 1996). Background concentrations of cis-1,2-DCE in ambient air are usually less than 1 ppb (ATSDR 1996).

Breathing high levels of cis-1,2-DCE can cause health effects such as nausea, drowsiness, or fatigue. The long-term (365 days or longer) human health effects after exposure to low concentrations of cis-1,2-DCE are unknown.

Vinyl Chloride (VC)

At room temperature, vinyl chloride is a colorless gas. It burns easily, and it is not stable at high temperatures. Vinyl chloride exists in liquid form if kept under high pressure or at low temperatures. Vinyl chloride has a mild, sweet odor. Vinyl chloride is a manufactured substance that does not occur naturally; however, it can be formed in the environment when other manufactured substances, such as TCE, trichloroethylene, and PCE, are broken down by certain microorganisms.

If you breathe high levels of vinyl chloride, you will feel dizzy or sleepy. The U.S. Department of Health and Human Services has determined that vinyl chloride is a known carcinogen. The International Agency for Research on Cancer has determined that vinyl chloride is carcinogenic to people, and EPA has determined that vinyl chloride is a human carcinogen (ATSDR 2006).

Exposure and Public Health Implications

The indoor air sampling results from the July 2010 indoor air testing in the manufacturing building were compared to ATSDR and EPA indoor air comparison values and discussed below. As mentioned previously, TDH EEP did not believe the September 2009 indoor air results were representative of site conditions because of the sampling techniques used. During the September sampling very low levels of site-related chemicals were found. These levels, if representative, were within the range of risk that is acceptable (EPA 1991).

Non-Cancer Evaluation

No chemicals were detected in the indoor air of the site's manufacturing building. The loading dock door was open during the July 2010 indoor air sampling. It is unknown what effect the open door had on the testing. Conservatively, the open door may have caused lower concentrations of chemicals detected at the closest sampling point, IA-2, due to mixing with outdoor air. To be cautious, the concentrations of chemicals were estimated to be 0.4 ppb, the detection limit, as a theoretical detection. The 0.4 ppb concentration was compared to each chemical's non-cancer health comparison value. All theoretical results fall well below any published comparison values (Table 1). Therefore, there would be no non-cancer health effects to workers breathing indoor air in the manufacturing building from facility-related chemicals.

Cancer Evaluation

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. Because of this long-term review, ATSDR does not have a published cancer risk evaluation guide (CREG) for PCE. Therefore, the theoretical PCE concentration of 0.4 ppb in the manufacturing building was compared to an EPA RSL calculated for PCE. The RSLs are health comparison values based on EPA evaluations and assumptions about hypothetical cancer risks at low levels of exposure. The EPA residential inhalation RSL for PCE for one excess

cancer in 1,000,000 people is 0.06 ppb and for one excess cancer in 10,000 people is 6 ppb. This is considered an acceptable level of risk (EPA 1991). Using the detection level of 0.4 ppb as the theoretical PCE concentration in the building, the concentration is within this acceptable risk range, roughly $1x10^{-5}$ or 1 in 100,000 excess cancer risk. The RSLs are conservative, having been developed for chronic exposure based on a 24-hour per day, 7 day a week, 365 day per year, 70-year lifetime. The real risk at the site would be less than the 1 in 100,000 excess cancer risk because workers are not in the building for the chronic lifetime exposure time frame.

In an attempt to calculate a site-specific unit risk using time worked at the facility, the risk was modified for a worker working 8-hours per day, 5 days per week, 50 weeks per year, for 10 years. The inhalation unit risk for PCE of $5.9x10^{-6}$ $(\mu g/m^3)^{-1}$ was used and was multiplied by the theoretical concentration of 0.4 ppb (2.71 $\mu g/m^3$) which was multiplied by a conversion factor of 0.03 (see the Appendix). The theoretical exposure risk was calculated to be $4.8x10^{-7}$ or approximately 5 excess cancers in 10,000,000 people. This excess cancer risk is lower than the range of excess cancer risk of 10^{-6} to 10^{-4} considered acceptable by EPA (1991). Therefore, there should not be a health concern from breathing air containing these levels of PCE to workers at Quad Industries.

The PCE breakdown product TCE is also "*reasonably anticipated to be a human carcinogen*" (IARC 1995, NTP 2001). Similar to PCE, the cancer risk posed by TCE has also been under evaluation. ATSDR does not have a published CREG for TCE. EPA does have a RSL for residential inhalation situations. The RSL is 0.22 ppb for one excess cancer occurrence in 1 million people. TCE was not detected at the site in July 2010. Similar to the PCE discussion above, if the 0.4 ppb detection limit is considered the actual concentration measured, the theoretical risk would be between 1 additional excess cancer in 100,000 to 1 additional excess cancer in 1,000,000 people. This is a very low, acceptable risk (EPA 1991).

Like that for PCE, a site-specific unit risk was calculated using time worked at the facility, the risk was modified for a worker working 8-hours per day, 5 days per week, 50 weeks per year, for 10 years. The inhalation unit risk for TCE of $2.0x10^{-6}$ $(\mu g/m^3)^{-1}$ was used and was multiplied by the theoretical concentration of 0.4 ppb (2.2 $\mu g/m^3$) which was again multiplied by a conversion factor of 0.03 (Appendix). The calculated exposure risk was $1.3x10^{-7}$ or approximately 1 excess cancer in 10,000,000 people. This theoretical cancer risk is lower than the 10^{-6} to 10^{-4} excess cancer risk considered acceptable by EPA. Therefore, there should be no increased risk of excess cancer from TCE from working and breathing indoor air in the Quad Industries building.

The PCE and TCE breakdown chemical cis-1,2-DCE, is not classified as to its carcinogenicity. It does not have established comparison values for non-cancer nor cancer health effects. Therefore, it is not considered a carcinogen for evaluation purposes and it will not be evaluated.

Vinyl chloride is a known human carcinogen. ATSDR has a CREG for vinyl chloride, of 0.04 ppb at a risk of 1 excess cancer in one million people. Vinyl chloride was also not detected at the site in either September 2009 or July 2010. Similar to the previous discussions, if the 0.4 ppb detection limit is considered the actual concentration measured, the theoretical risk would be 1 additional excess cancer in 100,000 people. This risk is very low and within EPA's acceptable range of risk (EPA 1991).

Using the theoretical assumption of the 0.4 ppb (1.02 $\mu g/m^3$) analytical detection limit for the chemical concentration and the vinyl chloride inhalation unit risk of $4.4x10^{-6}$ $(\mu g/m^3)^{-1}$, and a conversion factor of 0.03 (Appendix), the theoretical calculated risk from inhalation of vinyl chloride would again be about 2 additional excess cancers in 10,000,000 people, or $1.3x10^{-7}$ risk. This theoretical risk is for a worker working 8-hours per day, 5 days per week, 50 weeks per year, for 10 years.

Chemical Mixtures

No solvent or breakdown chemicals were measured in the July 2010 sampling of indoor air in the Quad Industries manufacturing building. In a previous indoor air sampling events PCE, TCE and cis-1,2-DCE were measured. However, these measurements may not have been representative of the actual concentrations in indoor air. 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 PCE or TCE 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 from the July 2010 indoor air sampling puts the total excess cancer risk at about one in 1,000,000. It is unlikely that the presence of both PCE and TCE in indoor air would affect those workers who breathe the indoor air in the Quad Industries manufacturing building. No chemical concentrations were measured in the indoor air of the manufacturing building in July 2010.

Child Health Considerations

Children are typically a sensitive, exposed population when it comes to evaluating exposure at hazardous materials sites. Since no children live or work in the Quad Industries manufacturing building, any effects that chemicals in the indoor air of the facility would have on children were not considered in this health consultation.

Conclusion

EEP reached one conclusion in this health consultation:

EEP concludes that there should be no harm from breathing indoor air at the site containing PCE and TCE, and their breakdown products, in concentrations up to their detection levels. This is because no PCE solvent vapor or PCE breakdown chemical vapors were measured above laboratory detection levels inside or outside of the building.

Recommendation

Based on the indoor air data and the previous soil-gas data presented and reviewed, there is one recommendation at this time. It would be prudent for Quad Industries to begin a maintenance program to inspect the floor of the building twice a year. The inspection program should also include a maintenance program to fill and seal cracks observed in the floor. This maintenance program would deter PCE, TCE, and cis-1,2-DCE vapors from migrating into indoor air of the Quad Industries building. TDH EEP and TDEC should continue to work together to see that the public health continues to be protected during cleanup of the site.

Public Health Action Plan

The public health action plan for the Quad Industries site 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 have been taken by TDH's EEP include:

- Reviewed the indoor air data collected at the site.
- Prepared this health consultation.

Public health actions that will be taken include:

- TDH EEP will provide copies of this health consultation to state, federal, and local government, environmental groups, community groups, and others interested in the Quad Industries site.
- TDH EEP will maintain dialogue with ATSDR, TDEC, EPA, and other interested stakeholders to safeguard public health and to prevent people from future exposure to chemicals related to the Quad Industries site.
- TDH EEP will be available to review newly collected or additional environmental data, and provide interpretation of the data, as requested by TDEC.

Preparer of Report

Joseph P. George, PG, MS
Environmental Epidemiologist

Tennessee Department of Health (TDH)
Communicable and Environmental Disease Services (CEDS)
Environmental Epidemiology (EEP)
1st Floor, Cordell Hull Building
425 5th Avenue North
Nashville TN 37243

Reviewers of Report

Bonnie S. Bashor, MS
Environmental Epidemiology Director

David M. Borowski, MS
Environmental Epidemiology Assistant Director

Tennessee Department of Health
Environmental Epidemiology Program

Dana Petway, BS
Environmental Specialist

Roy Crowder, PhD.
Environmental Specialist

Tennessee Department of Environment and Conservation
Division of Solid and Hazardous Waste Management, State Remediation Program

ATSDR Technical Project Officer

Trent LeCoultre, MSEH, REHS, CMDR US Public Health Service
Cooperative Agreement and Program Evaluation Branch (CAPEB)

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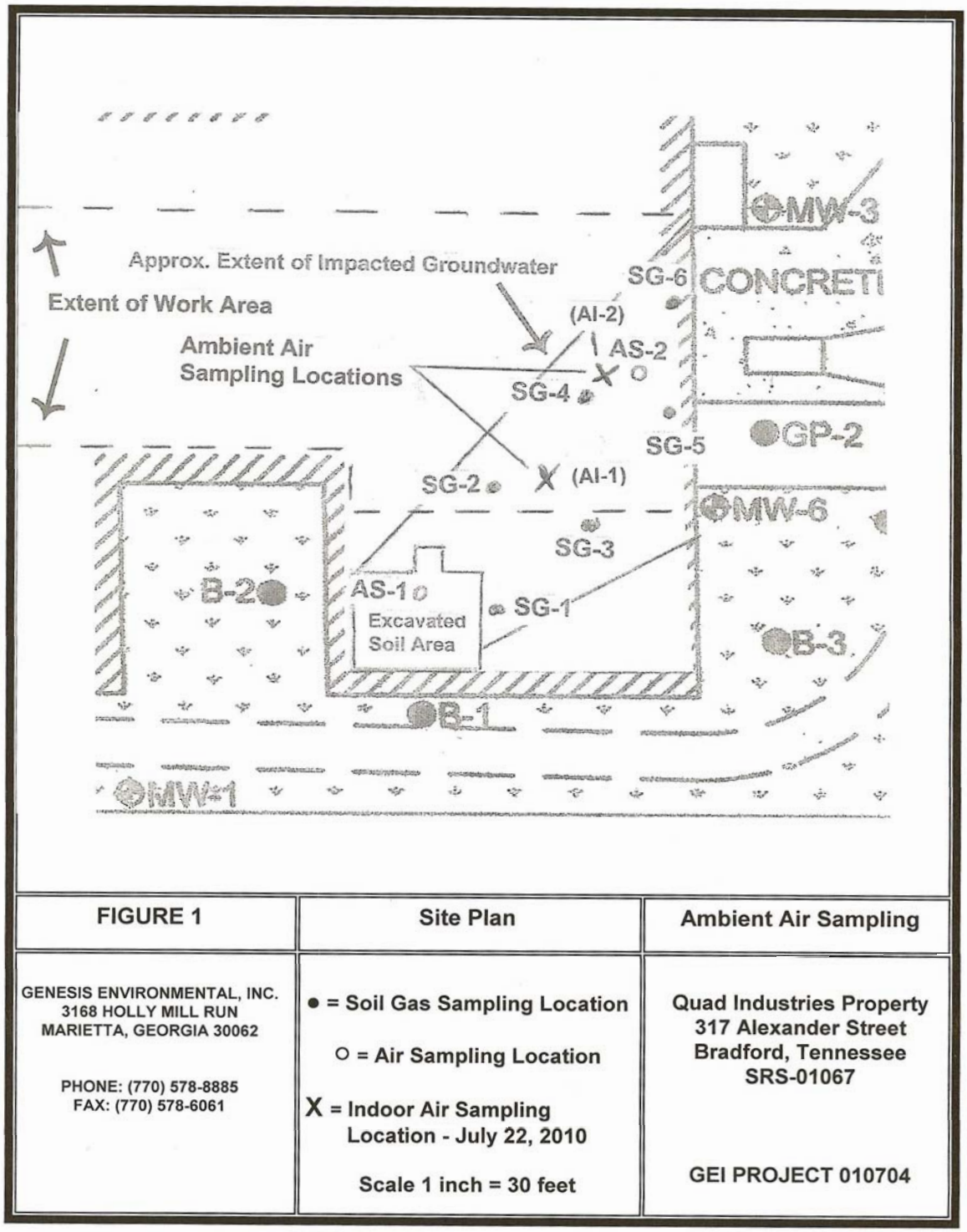
FIGURE 1 - Indoor air sampling locations (IA-1 and IA-2) for the Quad Industries site. Drawing Credit: GEI, Ambient Indoor Air Quality Sampling Report, July 30, 2010.



Appendix

Modified Risk Equation

$$\frac{8\ hours\ per\ day}{24\ hours\ per\ day} \times \frac{5\ days\ per\ week}{7\ days\ per\ week} \times \frac{50\ weeks\ per\ year}{52\ weeks\ per\ year} \times \frac{10\ years\ exposure}{70\ years\ exposure} = 0.03$$

November 24, 2009 Memorandum

Joe George, PG, TDH EEP to Dana Petway, PG, TDEC DSWM SRP

STATE OF TENNESSEE
DEPARTMENT OF HEALTH
COMMUNICABLE AND ENVIRONMENTAL DISEASE SERVICES
1ST FLOOR CORDELL HULL BUILDING
425 5TH AVENUE NORTH
NASHVILLE TN 37243

MEMORANDUM

DATE: November 24, 2009

TO: Dana Petway, PG, Environmental Specialist
Tennessee Department of Environment and Conservation
Division of Solid Waste Management, State Remediation Program

FROM: Joe George, MS, PG, Environmental Health Assessor
Tennessee Department of Health Environmental Epidemiology Program

RE: Quad Industries Property, 317 Alexander Street, Bradford, Tennessee
Soil Gas Survey and Ambient Air Sampling Report
TDEC SRS No. 01067

The Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) was asked by the Tennessee Department of Environment and Conservation (TDEC), Division of Solid Waste Management (DSWM), State Remediation Program (SRP) to provide comments on the Quad Industries Property Soil Gas Survey and Ambient Air Sampling Report (the report). Quad Industries is located at 317 Alexander Street in Bradford, Gibson County, Tennessee. The report was prepared by Genesis Environmental, Inc. (GEI) of Marietta, Georgia, and submitted to the TDEC SRP in September 2009.

Based on communication with TDEC SRP, EEP understands that the property is owned by the party responsible for a release to groundwater from a former parts cleaning machine. The former location of the parts cleaning machine was in the southern portion of the Quad Industries building. Quad Industries appears to be located south of downtown Bradford, Tennessee (Google Earth 2009). The building is oriented north to south. In the southern portion of the building is oriented in the general shape of an upside-down "U". The right side of the upside-down "U" appears to be the former location of the parts cleaning machine (GEI 2009). A limited Phase 2 Site Investigation conducted by GEI indicated that tetrachloroethylene (PCE) and trichloroethylene (TCE) had impacted site soil and groundwater. Degredation products of PCE including cis-1,2-dichloroethylene (cis-1,2-DCE), trans-1,2-dichloroethylene (trans-1,2-DCE), and vinyl chloride (VC) were also identified in site groundwater. The highest groundwater PCE concentration was 0.230 milligrams per liter (mg/L), located in a monitoring well approximately 140 feet downgradient from the former location of the parts cleaning machine. The City of Bradford operates a municipal supply well approximately 0.4 miles from the site of the release.

No other private potable drinking water wells were identified within the City of Bradford by GEI. Semi-annual groundwater monitoring is conducted at the Quad Industries site.

Surrounding land use appears to be residential and agricultural. Several houses are located along Alexander Street, west and north of the site. Agricultural land appears to be west and south of the site (Google Earth 2009).

The concentrations of PCE and TCE in soil beneath the location of the former parts cleaner warranted a limited source removal. This source removal occurred in the extreme southern portion of the building. Approximately 53 tons of soil contaminated with chlorinated solvents was excavated beneath the floor of the building and properly disposed at the Northwest Tennessee Disposal Corporation Landfill in Union City, Tennessee.

To protect the workers currently working in the building in the area of the release, TDEC SRP required the facility evaluate the potential for vapor intrusion into indoor air of the building. Thus, the soil-gas and indoor air investigation was one step in a process to make sure that the indoor air the workers breathe at this property is not a potentially harmful chemical exposure pathway.

Two indoor ambient air samples were collected. One sample was located in the former area of the parts cleaner location and the second sample was located near the loading dock area in the southeastern portion of the building. Indoor ambient air sampling detected a concentration of PCE at 18 micrograms per square meter ($\mu g/m^3$), or 2.7 parts per billion (ppb) in 1 of 2 samples. TCE was also measured in the same sample at 2.3 $\mu g/m^3$ (0.43 ppb). The second sample did not have any detections of TCE. Cis-1,2-DCE was detected in both ambient air samples collected, at 8.3 and 2.8 $\mu g/m^3$ (2.1 ppb and 0.70 ppb, respectively).

Several chlorinated solvent compounds were detected in sub-slab soil-gas samples. PCE, TCE, and cis-1,2-DCE were detected in all 6 sub-slab soil-gas samples collected. PCE sub-slab soil-gas concentrations ranged from 140 to 1,100 $\mu g/m^3$ (20.6 ppb to 162 ppb). TCE sub-slab soil-gas concentrations ranged from 5.1 to 180 $\mu g/m^3$ (0.95 ppb to 34 ppb). Cis-1,2-DCE sub-slab soil-gas concentrations ranged from 4.0 to 290 $\mu g/m^3$ (1.0 ppb to 73 ppb). Only 1 of 6 sub-slab samples contained concentrations of another breakdown product, trans-1,2-DCE, at a concentration of 1.7 $\mu g/m^3$ (0.43 ppb).

The following are our general and specific comments on the report.

General Comments:

EEP has two main concerns with the vapor intrusion investigation conducted at the site. The first concern is with methodology used to collect the soil-gas and ambient air samples for the investigation. The second concern is because of the sample collection methods employed, EEP is unsure that the sample results are wholly representative of concentrations at the sampling locations. EEP is used to interpreting indoor air and soil-gas results collected using standard

U.S. Environmental Protection Agency (EPA) guidelines or protocols. The method used to collect both indoor air and soil-gas at the Quad Industries site seems OK but unconventional. The unconventional method used could result in concentration reported at the sample locations that are biased low because of the potential losses due to adsorption on the pump or on the tubing used to connect to the Tedlar bag.

Soil-gas Sampling

- Using a photoionization detector (PID) to pull vapors into a Tedlar bag from the sample probe seems to be an unconventional method of sample collection. It is not an EPA guidance or protocol method. In the report it was stated that the Teflon sampling tubing ran to the Tedlar bag and was attached to the PID. If this were the case, the PID's internal pump and the tubing can cause cross-contamination. With this in mind, the reported concentrations of compounds could be more or less than the actual concentrations. Typical sampling methods for collecting soil-gas samples include some other type of pump that is just used to fill the Tedlar bag, a syringe, or a Summa canister.

- The duration of time these samples were collected was also unconventional. It is stated in the report that the samples were allowed to equilibrate from 5 minutes prior to sampling but it does not state in the report the duration of the sample collection. It is unknown if the sample collection period was just long enough to fill the Tedlar bag. It appears the sampling time was kept consistent at each sampling location. On the chain of custody form, each sample was listed as being collected over a 30 minute timeframe; no more and no less. EEP is concerned that this may not be the case. The laboratory uses this sampling time interval to calculate the concentrations and report the results. It is unordinary that sampling times are this consistent. The laboratory would have to have known the specific timeframe in order to calculate proper concentrations.

- It is also common practice to collect sub-slab soil-gas samples in tandem and over the same duration as the ambient air samples to get a more representative picture of the conditions in both environments. This is to enable comparisons of data from both media.

- An evaluation of vapor intrusion into a work place typically mimics the amount of time of worker exposure. Indoor air sampling and the tandem sub-slab sampling are therefore, usually conducted over a period of eight consecutive hours. This was not the case for this investigation. Unfortunately, the data collected as part of this investigation would be considered qualitative and only is a representation for a select period of time within a usual exposure time frame.

- The soil-gas probes installed were made out of 2-foot sections of one-half-inch diameter, steel conduit pipe with quarter-inch slots cut into the pipe. The pipe was crimped at one end and slots were cut within the pipe to allow the influx of vapors into Teflon tubing. This is an unconventional construction of a sampling probe. It is unknown if any solvents were used to clean the pipe prior to consumer purchase/use or if the pipe was decontaminated prior to use as a sampling probe. While the probe construction is

unconventional, if enough volume was purged from the "pipe" before sampling, this probe may have been adequate. Typically, an inert steel or brass probe connected to

Teflon tubing that is directly attached to the inert pump or sample collection device is used. The brass or steel probe is placed at the desired depth, glass beads are placed around the probe, and a bentonite seal is placed over the beads to prevent ambient air infiltration.

Ambient Air Sampling

- The report stated that the ambient air samples were collected in a similar manner as the soil-gas samples using a PID and Tedlar bag. Again, this approach is unconventional compared to the usual methods used to collect a representative indoor air. Usually, a syringe or a Summa canister is used. Losses can occur because of adsorption of the chemicals onto the pump or on the tubing used to collect the sample in the Tedlar bag. Following this line of reasoning, the reported concentrations of compounds could be biased low, resulting in lower reported concentrations than are actually present.

- Typically, low detection limits cannot be achieved with Tedlar bags. However, in this case the laboratory seems to have been able to do so.

- Common vapor intrusion sampling practice is to collect ambient air samples in tandem and over the same duration as the sub-slab soil-gas samples.

- Typically, an evaluation of vapor intrusion into a work place mimics the amount of time of worker exposure. Indoor air sampling and the tandem sub-slab sampling are therefore, usually conducted over a period of eight consecutive hours. This was not the case for this investigation. Therefore EEP considered this data more qualitative and only a representation for a select period of time within a usual exposure time frame.

Evaluation of Property Building Floor Slab and Ventilation System

- The evaluation of the property building floor slab and ventilation system is a very good synopsis of an investigation into the details of the building floor and ventilation system of the building. Remedial activities to seal the floor cracks inside the Quad Industries building where the old and new floor slabs meet was a proactive approach to minimizing a potential vapor intrusion pathway. EEP would be interested to know if there is an inspection of the building interior that is part of a building maintenance plan. This routine inspection could be done to identify any cracks or unsealed areas around piping, etc. that come up through the floor in the vicinity of the soil removal.

- The detailed information on the air exchange rate and operation of the HVAC system inside the Quad Industries building is good information.

Specific Comments:

A short discussion of the weather conditions at the time of sampling would be helpful.

Page 4, bottom
Ambient air sample AS-2 was reportedly collected near the door of the loading dock inside the building. Was the loading dock door closed when sampling was performed? Were there any drafts noted when sampling was conducted? Was the bottom and sides of the overhead door sealed to prevent ambient air from entering the building during the testing?

Page 7, Conclusions
When evaluating potential chemical exposure to workers from impacted indoor air, EEP uses screening values established by the Agency for Toxic Substances and Disease Registry (ATSDR) as the first tier of comparison. A second tier of comparison, if ATSDR does not have values for specific compounds, is EPA's April 2009 Regional Screening Levels (RSLs) for Industrial Air. This is the difference between occupational "voluntary workplace exposure" and a "non-voluntary" type of exposure. OSHA standards or limits only apply if all personnel in the facility are trained in the chemicals used. So EEP is assuming all facility personnel are not trained. Therefore, instead of evaluating the exposure and potential health effects based on OSHA standards, results should be evaluated based on ATSDR health comparison values and/or EPA RSLs.

EEP Conclusions

Based on the data presented by GEI (2009), it is difficult to develop conclusions. This due to the unconventional methods used to collect the samples and the possible influence of the PID on collection of samples. Results indicated very low concentrations of chlorinated solvent chemicals in the indoor ambient air of the Quad Industries building. There is no way of knowing if these concentrations are representative of actual concentrations in the building.

If these levels are representative, the detection limits used are below the Agency for Toxic Substances and Disease Registry (ATSDR) Environmental Media Evaluation Guide comparison value for PCE for non-cancer health effects. Levels detected in ambient air are also within EPA's acceptable range of risk for cancer health effects.

For the soil-gas results, the following discussion compares the results to soil-gas target concentrations established by EPA. These evaluations were done considering the data to be representative of site conditions. The data may or may not be. PCE and TCE concentrations in soil-gas in samples were compared to generic target shallow soil-gas to indoor air concentrations (attenuation factor of 0.1) in Table 2c: Question 4 of the Generic Screening Levels and Summary Sheet of the *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (EPA 2002). This target shallow soil-gas to indoor air concentration for PCE is 81 $\mu g/m^3$ (12 ppb) at a risk of one excess cancer in 100,000 people. Sub-slab samples of PCE at 2 of 6 locations exceeded this screening criteria. Specifically, sub-slab soil-gas PCE concentrations at locations SG-2 and SG-3 were above this risk value, typically cited for industrial use scenarios. The target shallow soil-gas to

indoor air concentration for TCE is 22 µg/m^3 (12 ppb) (1 excess cancer in 10,000 people). Sub-slab soil-gas measurements for TCE at 3 of 6 sampling locations exceed EPA's screening value. Specifically, samples collected from SG-1, SG-5, and SG-6 are above the screening concentration.

Sub-slab soil-gas results suggest the potential for vapor intrusion from soil-gas to ambient air at the site. Indoor air results for all chemicals were below ATSDR and EPA screening values. Unfortunately EEP is not sure that the method to collect samples for both the sub-slab soil-gas and ambient air obtained representatives samples of each media. Therefore, EEP cannot make a definite evaluation on the indoor air data and whether the chemicals are present in the concentrations reported. It is helpful that air inside the building is turned over in less than 19 minutes during the work day, for a total of 31 times during a 10-hour work day.

EEP Recommendations

As stated previously, EEP is unsure if the indoor air sampling results are representative. Resampling indoor air using Summa canisters with flow controllers calibrated for the standard length of the work day at the facility is recommended. The Summa canisters can be analyzed for only site-related compounds (if desired) using EPA method TO-15. Detection limits should be appropriately low (a minimum of 0.25 parts per billion) to evaluate PCE and TCE levels within the facility. With this re-sampling, the results could be compared to the indoor air testing done by GEI in September 2009. This sampling does not necessarily need to be conducted right away.

Sub-slab vapor results indicate site-related contaminant vapors are trapped beneath the concrete slab floor of the Quad Industries building. Given the relatively high concentrations detected in the sub-slab, this data is more useful. The sub-slab may not have to be resampled. If TDEC is potentially concerned about mitigating the sub-slab vapors then resampling would be necessary.

Because of sub-slab vapors being detected, it is recommended that the floor of the facility in the area of, and surrounding the known soil, vapor, and groundwater contaminant plumes be evaluated annually. This annual evaluation can be done as part of a facility maintenance plan. The evaluation should focus on any potential avenues for vapors to migrate from the sub-slab to the indoor air. If cracks or seams are noted during the inspection, they should be properly sealed using a non-VOC-containing sealant.

EEP appreciated the opportunity to evaluate the results from this vapor intrusion investigation. Should you have any further questions or concerns please contact me at 615-741-7247 or via email at joseph.george@tn.gov.

Regards,

Joseph P. George, MS, PG,
Environmental Health Assessor
Tennessee Department of Health
Environmental Epidemiology Program

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Certification

This Public Health Consultation: *Quad Industries Indoor Air Evaluation, Bradford, Gibson, Fayette 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