Health Consultation

HALIFAX RD/VIRGILINA RD DCE SITE

ROXBORO, PERSON COUNTY, NORTH CAROLINA

EPA FACILITY ID: NCN000410161

SEPTEMBER 30, 2008

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.

HEALTH CONSULTATION

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EPA FACILITY ID: NCN000410161

Prepared By:

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Division of Public Health
Occupational and Environmental Epidemiology Branch
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Acronyms

AEGL	Acute Exposure Guideline Level
AT	Averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
CF	Conversion factor
Cm	Centimeter
CREG	ATSDR Cancer Risk Evaluation Guide
CR	Contact rate
CV	Comparison Value
DAF	Dermal absorption efficiency
ED	Exposure duration
EF	Exposure frequency
EMEG	ATSDR Environmental Media Evaluation Guide
EPA	U.S. Environmental Protection Agency
EQRR	EQ Resource Recovery
HAZMAT	Hazardous Materials
IRi	Inhalation rate
IURF	Inhalation Unit Risk Factor
Kg	Kilogram
LOAEL	Lowest Observed Adverse Effect Level
MCLG	EPA Maximum Contaminant Level Goal
MCL	EPA Maximum Contaminant Level
M	Meter
mg	milligram
$\mu g/m^3$	micro-gram per cubic meter
µg	microgram
Ng	nano-gram
NA	Not applicable
NCDHHS	North Carolina Dept Health Human Services
NIOSH	National Institute for Occupational Safety and Health
NOAEL	No Observed Adverse Effect Level
PMCLG	EPA Proposed Maximum Contaminant Level Goal
ppm	Parts per million
ppb	Parts per billion
RfC	Reference Concentration
RfD	Reference Dose
SAd	Dermal surface area available for absorption
SAg	Dermal surface area available for ingestion
SVOC	Semi-volatile organic compound
VOC	Volatile organic compound

*** These acronyms may or may not be used in this report**

EXECUTIVE SUMMARY

The Halifax Road/Virgilina Road 1,1-dichloroethene (DCE) site was formerly used by GMH Electronics. Groundwater is the only source of drinking water for homes located within a one-mile radius of the former GMH facility. Currently the private drinking water wells that are contaminated are using a two-tank filter system to remove the contaminants.

The United States Environmental Protection Agency (USEPA) and the North Carolina Department of Environment and Natural Resources (NCDENR) Superfund Section are discussing options for connecting residents at the Halifax Road/Virgilina Road site to municipal water. The NC Superfund Section has submitted paperwork to the USEPA recommending that the site be proposed for the National Priorities List (NPL).

Wells that are contaminated have filter systems in place. The filter systems integrity is tested on a routine basis by NCDENR and Person County Health Department. The filter system placed on the drinking water wells is effective in reducing the contaminates below drinking water health standards. Residents should not drink or use unfiltered well water until further notice.

Based on sampling data, dose calculations, and information outlined in this report, the Halifax Road/Virgilina Road DCE site is considered to be **No Apparent Public Health Hazard.** The category of no apparent public health hazard is primarily contingent on the drinking well water filter systems. The filter systems need to be in-place and properly maintained for this category to apply.

If the filter systems are not in place or not properly maintained the Halifax Rd / Virgilina Rd DCE site would be considered a **Public Health Hazard**. Please see the recommendations section for more information.

PURPOSE AND HEALTH ISSUES

NCDENR requested a health consultation (PHC) for the Halifax Road/Virgilina Road DCE site after initial survey results determined there was potential for human exposure to 1,1-dichloroethene (DCE). This health consultation evaluates private well water samples and soil gas vapor surveys from homes in the vicinity of the Halifax Road and Virgilina Road intersection.

BACKGROUND

SITE DESCRIPTION AND HISTORY

The Halifax DCE site is located in Roxboro, Person County, North Carolina (Figure 1, Appendix A). The main site is specifically located at the intersection of Halifax Road and Virgilina Road (36.4168º north 78.7424º west). At the Halifax-Virgilina intersection there is a rectangular building, formerly used by GMH Electronics, and is approximately 8,000 square feet. On the northwest corner of the intersection is located a bar, which was formerly a gas station. Near the former GMH site are 10 residential homes. The study area is approximately 80 acres with a length of 2,500 feet and 1,300 feet wide. The elevation of the site is 750 feet above mean sea level (amsl). The upper-most aquifer is approximately 30 feet below ground surface at the site.

Person County is located in the Piedmont Physiographic Province of North Carolina, which consists of well-rounded hills and long rolling ridges (Expanded Site Inspection (ESI), 2008). Groundwater wells in the area are typically bored to depths ranging from 30-200 feet.

According to the ESI report, the city of Roxboro's drinking water is supplied by a surface lake called City Lake, located approximately 4 miles west of the site. The former GMH site and surrounding residential homes are not currently serviced by city water. The nearest water line to the Halifax Road/Virgilina Road area is approximately one mile west of the site.

GMH Electronics was in operation from 1972 to 2004. The former company employed approximately 16 people to produce electronic components, including but not limited to, printed circuit boards. The property had at one time been the location for an unmanned gasoline dispensary. In 1994, two 4,000-gallon underground gasoline tanks were removed from the site. According to the ESI report, in 1987 the NC DENR Groundwater Section received a complaint about GMH from a resident near the property. The complaint centered on the fact that gasoline was contaminating the well water at the private residence. Sampling of the well indicated the presence of 1,2-dichlorethane (DCA), benzene, toluene, 1,1,1-trichloroethane (TCA), ethyl benzene, ethyl dibromide, and 2-methoxy-2-methyl-propane. The contaminated well prompted the state to recommend avoiding drinking, cooking and prolonged bathing in the well water. Additional sampling near this well indicated the same types of contaminants present. Soil samples near the site of concern indicated the presence of toluene and xylene. The NC DENR Groundwater Section notified the owner of the former GMH property about well water contamination at the nearby residence in 1989. The response to the state from the former GMH property owner was that "the underground tanks were removed in 1984 and no gas had been dispensed from the tanks since 1974".

A carbon filter system was installed at the private residence where the contamination had been identified in the 1980s and near the former GMH facility. Monthly samples were collected at both the former GMH site private well and the residential well. In June 1990, additional sampling of residential drinking water wells in the area was conducted. According to the ESI report, the results of this sampling revealed the possibility of two plumes of contamination in the area. Officials speculated the plumes originated from the former GMH facility and the former gas station.

In 1992, the Person County Health Department conducted sampling of residential drinking water wells in the area. The house immediately west of the former gas station was found to be contaminated with 1,2-dichloroethane (DCA) and xylene. Sampling at the former GMH well revealed the presence of 1,1-dichloroethylene and 1,1,1-trichloroethane (TCA) in addition to petroleum products. Both locations were advised by NCDENR not to consume the water due to potential risk to health.

In November and December of 2007 NCDENR sampled several nearby private drinking wells and found several volatile organic compounds (VOC) including 1,1-dichloroethene (DCE). The USEPA distributed bottled water to 14 affected residences and 7 homes had filter systems installed in their wells.

In December 2008, the USEPA conducted sampling of more than 30 wells surrounding the former gas stations and GMH facilities, and as a consequence, bottled water was provided to a total of 17 homes.

In February 2008, an investigation with sampling was conducted by NCDENR Superfund Section, USEPA (ERRB) and their contractors, USEPA Environmental Response Team (ERT), and USEPA Region 4 Science and Ecosystem Support Division (SESD). The former GMH building was vacant except for a beauty salon which is operating from a small room in the center of the building. The former electronics company site history revealed gasoline USTs located on the north side of the property from gas stations that were no longer viable. During February 2008, the following tasks were completed by USEPA, NCDENR, and their contractors to define the extent of the contamination:

- Six groundwater samples collected and analyzed
- Seven surface water samples collected and analyzed
- Two samples collected and analyzed from a granulated activated carbon system
- Five temporary monitoring wells installed
- 25 soil samples collected and analyzed
- 19 soil borings and soil cores sampled and screened for VOCs
- 18 soil vapor borings for use
- Five sub-slab vapor points drilled
- Four sediment samples collected and analyzed
- GPS survey conducted

DEMOGRAPHICS

According to year 2000 Census data, approximately 8696 people lived in Roxboro North Carolina. A total of 57 residents and workers lived within ¼ of a mile of the former GMH property according to the Person County Health Department and the ESI report findings.

COMMUNITY HEALTH CONCERNS

The Person County Health Department held a community meeting to address community questions and concerns about the Halifax Road/Virgilina Road contamination on December 20, 2007. Person County, USEPA, ATSDR, NCDENR UST Section, and NCDHHS representatives were available for questions. The agenda of the public meeting included a site history, chronology of events, the federal response, and public health issues associated with the contamination at the site. Most of the local residents attending the public meeting were interested in and concerned about contamination in their drinking water wells. Some residents wanted to know if their well was “safe” and if there would be possible impact of the contaminants to their drinking water supply. Although health and environmental representatives would not address specific samples during the public meeting, the appropriate representative was available to speak with residents one on one after the meeting.

DISCUSSION

A Federal Maximum Contaminant Level (MCL) is the regulatory limit set by USEPA that establishes the maximum permissible level of a contaminant in water that is deliverable to the user of a public water system. MCLs are based on health data, also taking into account economic and technical feasibility to achieve that level.

Groundwater Sampling

From October through December of 2007 NCDENR and the Person County Health Department and USEPA sampled various private drinking water wells around the former GMH Electronics site. Water sampling revealed that several contaminants such as TCA, DCE, DCA, benzene and ethylene dibromide were present above the MCL drinking water standards. Tables A1-A4 in Appendix B lists 2007 groundwater samples with detected VOC compounds.

In February 2008 NCDENR, Person County and the USEPA with their contractors conducted additional sampling and a site assessment of the GMH facility and surrounding community. The purpose of the sampling was to further characterize the plume. Tables B1-B3 in Appendix B lists 2008 groundwater samples with detected VOC compounds.

Four 1-inch diameter soil borings were designated as temporary monitoring wells with depths ranging from 28 to 40 feet (Lockheed Martin, 2008). The background sample bore was located upgradient approximately 800 feet southeast of the intersection of Halifax and Virgilina Roads. Groundwater samples were taken from these temporary monitoring wells during the February sampling period (Figures 1-3, Appendix A).

Samples taken from 3 temporary monitoring wells contained DCE, DCA and TCA at concentrations above the MCL. The highest DCE concentration collected at a location on the southwestern corner of the site was 1,370 µg/L (Figure 1, Appendix A). Wells TW-3 and TW-5 had DCE concentrations of 275 µg/L and 33.1 µg/L, respectively. DCA was detected above the MCL at wells TW-3 (7.8 µg/L) and TW-7 (57 µg/L). TCA was detected above the MCL at well TW-7 (1,360 µg/L). No VOCs were detected in the upgradient background well located offsite.

Monitoring wells installed in the 1990s designated B1-B6 (B2 not being on the property) at the perimeter of the former underground storage tank site were still accessible. On February 11, 2008, samples were taken from wells B3, B4 and B6 and sent to the USEPA ERT's/REAC laboratory for analysis. Samples taken from monitoring well B6 had a DCE concentration of 11 µg/L, exceeding the MCL. Wells B6, B3, and B4 had elevated concentrations of gasoline related VOCs. DCA was also detected in well B6 at a concentration of 38.1 µg/L, which exceeds the MCL.

Additional groundwater sampling was completed for six residential drinking water wells in February 2008. The primary goal of the February 2008 sampling was to test the filter systems installed on the drinking wells. Samples were collected between, or after the twin filter system. None of the samples collected at this time were above the MCL.

Surface Water

Six surface water (SW) samples and one spring water sample (SP) were collected and analyzed for contaminants during the February 2008 sampling.

With the exception of the spring water sample (HVD-001-SP), no VOCs were detected in surface water samples. Sample HVD-001-SP contained DCE at 16.4 µg/L, which exceeds the MCL. The spring water sample may be an indication that the groundwater plume has migrated to this location, approximately 1800 feet from the intersection of Halifax and Virgilina Roads.

On-site Soil Sampling

Twenty-five sub-surface soil samples were collected in February of 2008 from the perimeter of the GMH facility to investigate additional sources of contamination. The samples were sent to the ERT/REAC lab for analysis.

The maximum concentration of 1,1-dichloroethene (DCE) was 31.8 µg/kg in sample SB-3(40) collected at a depth of 40ft below ground surface (bgs). The contaminant 1,1,1-Trichlorethane (TCA) was also detected at 3.2 µg/kg in SB-3. The maximum concentration of TCA was 26 µg/kg in soil sample SB-1(30). TCA was also detected at 6.2 µg/kg at SB-1(33). Human exposure does not readily occur with sub-surface samples. These samples were taken primarily to help the EPA and DENR characterize the extent of the site contamination.

On-site Soil Borings

Nineteen soil borings were taken for screening purposes during February 2008. The soil gas was taken using the Geoprobe® system at a depth of 5 feet below the soil surface from the perimeter of the former electronics site property and ten residential properties (two samples per property). Each sample core was then analyzed with a TVA-1000 flame ionizing detector (FID) which screened for VOCs. The highest FID reading was 20 parts per million (ppm) recorded for the 22 feet bgs horizon for soil SB7 located on the southern portion of the former GMH property. This area was noted as a possible septic leach field

Of the nineteen soil borings, only low levels of DCE and TCA were detected. The soil boring sampling did not indicate a “source” area as predicted.

Soil Gas, Interior sub-slab and Crawl Space Air Samples:

The February 2008 sampling activities included installation of sub-slab soil gas sample ports installed inside two nearby residential homes with basements. Three additional ports were drilled at the former GMH building. The sub-slab sample ports were installed using REAC standard operating procedure *(SOP) #2082 Construction and Installation of Permanent Sub-Slab Soil Gas Wells*. All sub-slab samples were collected over a 24-hour period using SUMMA® canisters .

Residential properties that did not have basements were evaluated for potential vapor intrusion using SUMMA® canisters placed within the crawl space under the homes.

Several volatile organic compounds (VOCs) were detected at significant levels in sub-slab samples. The highest concentration detected was at the former GMH facility. The results revealed 1,1,1-trichloroethane (TCA) at 880 µg/m^3 and 1,1-dichloroethene (DCE) at 120 µg/m^3. Samples collected from the residential sub-slab locations showed some elevated VOC levels. Based on contaminant properties and soil type, the VOC levels do not pose an elevated risk.

Because only one round of sampling was analyzed for soil vapor evaluation, it should be considered a "snapshot" of exposure to contamination at one point in time. Actual concentrations of contaminants may vary in homes based on seasonal changes, heating and ventilation system use, and other factors. Additional information on these factors and the possible impacts on the concentrations of contaminants present in the air are not provided from one round of sampling.

Sediments

Four sediment samples designated (SD) were collected from nearby streams and ponds. The samples were collected approximately 1,200 to 1,800 feet from the Halifax and Virgilina Road intersection.

With the exception of acetone at concentrations of 46.7 µg/kg and 33.0 µg/kg in samples (HVD-005-SD and HVD-105-SD) there were no other contaminants or VOCs found in the sediment samples. Samples HVD-005-SD and HVD-105-SD were duplicate samples taken from the same location. It is unclear why the acetone showed up in these samples. Lab error cannot be ruled out in situations where a contaminant is not detected in homogonous areas of predictable contamination. Sediment sampling accomplished in February 2008 did not indicate VOCs were present.

Exposure Pathways

According to the ATSDR, a completed exposure pathway is one that contains the following elements:

- Source of contamination
- Transport through a medium such as air, water, or soil.
- Point of exposure, such as a point in time when water is ingested.
- Route of exposure like drinking contaminated water.
- Exposed population who could come in contact with the contaminants.

An exposure pathway is complete if all elements currently exist, or existed in the past. If one of the elements listed above are not present, but could be at some point, the exposure would be considered to be a potential pathway. The amount of time exposed, area exposed, and type of exposure are factors used in defining the specific exposure event and must be considered when evaluating exposure routes. Furthermore, short (acute) or long (chronic) exposure events should be considered as factors in the completed pathway exposure.

A. Completed Exposure Pathway

The exposed population for the Halifax Road/Virgilina Road DCE site are the residents that live near the former GMH facility. The completed pathways for this site are ingestion (drinking the contaminated groundwater) and dermal (contact with contaminated drinking water). See Table 1, which illustrates completed exposure pathways. Residents living near the former GMH Electronics site located at the intersection of Halifax and Virgilina Roads are exposed to contaminants of concern if they drink, cook, shower, or bathe in *un-filtered* well water.

The affected drinking water wells are filtered in process. The filtered water removes the contaminants from the water making it safe for human use. The completed exposure pathway of ingestion and contact assumes that the water is unfiltered. By calculating doses and exposure assumptions for unfiltered water assures maximum protection of public health as we base our assumptions on contaminants entering the body without engineering controls such as well filtering systems. Using the logic stated above the exposure pathway will not be completed if the filters are used on the drinking water wells.

Table 1. Completed Exposure Pathway

Source	Medium	Exposure Point	Route of Exposure	Exposed Population
Contaminated groundwater	Groundwater	Private well water	Ingestion, dermal (contact)	Persons in the past and present with contaminated well water not treated to remove volatile organic compounds

B. Potential Exposure Pathway

It is possible for contaminants to volatilize from soil and groundwater, migrate through the air spaces, and enter buildings, collecting in a living space, and then inhaled by dwellers. It should be noted that many variables could influence the levels of volatile chemicals entering a home from the soil. Variables include contaminant chemical properties, soil characteristics, seasonal variations, and building construction. Confounding factors to consider when assessing indoor air in homes for VOCs are that many household cleaners and chemicals contain VOCs, as do some textile containing furnishings.

Exposure to air from a crawl space is assumed to be limited to occasional activities. ATSDR does not consider crawl space activities to be a full-time exposure source. However, crawl space air samples indicate VOCs have migrated to the soils and crawl spaces under the sampled homes.

The potential does exist for a completed exposure inhalation pathway for the contaminants at Halifax Rd /Virgilina Rd DCE site. A common approach for estimating the potential for vapor intrusion into the homes has been to use the Johnson and Ettinger model for vapor intrusion (Johnson and Ettinger, 1991). DHHS used a two-pronged approach in assessing vapor intrusion at this site. The Johnson and Ettinger computer vapor model was utilized inputing the February 2008 site assessment data from the sub-slab, crawl space, and soil core screening. In addition, calculated potential exposure risks were accomplished using guidance outlined in the USEPA's, *Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)*. Based on calculated risk factors and modeling it was determined that unacceptable health effects due to exposure to the contaminants of concern was unlikely. If exposure factors should change at this site, then the exposure risk for the vapor intrusion exposure pathway (inhalation) should be evaluated again.

PUBLIC HEALTH IMPLICATIONS

This section discusses the health effects that could plausibly result from exposures to contaminants at the Halifax Road/Virgilina Road DCE site. For a public health hazard to exist, people must contact contamination at levels high enough and for long enough time to adversely affect their health. Evaluation of potential public health hazards are based on ATSDR assessment procedures. The environmental data and conditions at the site revealed one major completed exposure pathway — use of private wells for potable purposes.

ATSDR prefers to use site-specific conditions whenever possible to evaluate whether people are being exposed to contaminants at levels of health concern. However, two important site-specific determinants are not known for this site: 1) when the contaminants from the site reached private drinking wells; and, 2) what levels of contamination residents might have been exposed to over time (the levels could have been higher or lower than those detailed in this study). Because of these unknowns, ATSDR must rely on reasonable assumptions rather than site-specific information in this instance.

Health Effects Information

ATSDR Comparison Values (CVs) are used to screen for chemicals that require further evaluation. A contaminant detected at levels lower than the CV are dropped from further analysis. A contaminant that exceeds a CV indicates a more detailed analysis is necessary for that chemical. Levels of contamination greater than comparison values do not necessarily mean that adverse health effects will occur. Important factors in determining the potential for adverse health effects also include the amount of the chemical, the duration of exposure, the route of exposure, and the health status of exposed people. Estimated site-specific exposure doses are calculated for chemicals that exceed the CVs. The estimated site-specific exposure doses are then compared to ATSDR Health Guidelines to determine if the potential for adverse health effects exists under the representative exposure conditions. Health guidelines represent daily human exposure to a substance that is likely to be without appreciable risk of adverse health effects during the specified exposure duration.

Several contaminants exceeded ATSDR comparison values. Table C in Appendix B lists CVs used for evaluation of the contaminants of concern on this site. Tables 2 and 3 summarize site data and comparison values. Table 4 lists the geometric mean values for detected VOCs for the combined 2007 and 2008 groundwater data.

Table 2. Halifax Rd 2007 Groundwater Data and Comparison Values

Contaminant	Range, µg/L	Screening (CV) Value, µg/L	CV Source	CA / non-CA
1,1,2-Trichloroethane (TCA)	0.6 – 3.40	0.6	CREG	CA
1,1-Dichloroethene (DCE)	130 – 6037	90 Child / 300 Adult	Chronic EMEG	non-Ca
1,2-Dichloroethane (DCA)	0.6 – 160	0.4	CREG	CA
Benzene	0.9 – 3700	5 Child / 20 Adult	Chronic EMEG	non-Ca
		0.6	CREG	CA
Carbon Tetrachloride	0.5 – 130	70 Child / 200 Adult	Int EMEG	non-Ca
		7 Child / 20 Adult	RMEG	non-Ca
		0.3	CREG	CA

- 1 ppb = 1 µg/L
- CA = Cancer effect / non-CA = non-cancer effect

Table 3. Halifax Rd 2008 Groundwater Data and Comparison Values

Contaminant	Range, µg/L	Screening (CV) Value, µg/L	CV Source	CA / non-CA
1,1,2-Trichloroethane (TCA)	0.6 – 24.50	0.6	CREG	CA
1,1-Dichloroethene (DCE)	33 – 5019	90 Child / 300 Adult	Chronic EMEG	non-Ca
1,2-Dichloroethane (DCA)	0.7 – 104	0.4	CREG	CA
Benzene	0.66 – 1.30	5 Child / 20 Adult	Chronic EMEG	non-Ca
		0.6	CREG	CA
Carbon Tetrachloride	0.6 – 4.5	70 Child / 200 Adult	Int EMEG	non-Ca
		7 Child / 20 Adult	RMEG	non-Ca
		0.3	CREG	CA

- 1 ppb = 1 µg/L
- CA = Cancer effect / non-CA = non-cancer effect

Table 4. Halifax Rd 2007 and 2008 Combined Groundwater Data

Contaminant	Range, µg/L	Geometric Mean µg/L	Screening (CV) Value µg/L	CA / non-CA
*1,1,2-Trichloroethane (TCA	0.6 – 24.50	1.638	0.6	CA
*1,1-Dichloroethene (DCE)	33 – 6037	691.88	90 Child / 300 Adult	non-Ca
*1,2-Dichloroethane (DCA)	0.6 – 160	13.965	0.4	CA
*Benzene	0.77 – 3700	235.20	5 Child / 20 Adult	non-Ca
			0.6	CA
*Carbon Tetrachloride	0.6 – 130	2.280	70 Child / 200 Adult	non-Ca
			7 Child / 20 Adult	non-Ca
			0.3	CA

* Data combined from 2007 and 2008 data
- 1 ppb = 1 µg/L
- CA = Cancer effect / non-CA = non-cancer effect

Using ATSDR's contaminant screening techniques and exposure dose calculations indicates there are three contaminants of concern at the Halifax Road/Virgilina Road site: **DCE**, **benzene,** and **carbon tetrachloride**.

Using the available site data and standard assumptions the NC DHHS calculated exposure doses for children and adults exposed to maximum concentrations resulting from ingestion, inhalation, and dermal contact in private wells using the data provided by the 2007 and 2008 sampling events. An exposure dose (generally expressed as milligrams of chemical per kilogram of body weight per day or "mg/kg/day") is an estimate of how much of a substance a person may contact based on their actions and habits (ATSDR, 2005). To calculate exposure dose, NCDHHS uses standard assumptions about body weight, ingestion or inhalation rates and duration of exposure. Exposures are based on the assumption a person is exposed to the maximum concentrations of the contaminant with a daily occurrence. The exposure levels were compared with ATSDR health guidelines to determine whether further toxicological evaluation is needed. A complete list of calculated doses for contaminants that exceeded the CV can be found in Appendix B. Table 5 lists the maximum estimated exposure doses that exceed Health Guidelines for children and adults.

Table 5. Adult and Child Maximum Exposure Dose Estimates Exceeding Health Guidelines

Contaminant	Max., µg/L	Calculated Dose (mg/kg/day)		ATSDR Minimal Risk Levels (MRLs) (mg/kg/day)
		Child	Adult	
1,1-Dichloroethene (DCE)	6037	0.377	0.172	0.009 Chronic Oral
Benzene	3700	0.231	0.106	0.0005 Chronic Oral
Carbon Tetrachloride	130	0.00813	0.00371	0.02 Acute Oral
				0.007 Intermediate

The exposure dose data was based on the following assumptions as outlined by the ATSDR (ATSDR, 2005):

- Children between the ages of 1 and 6 ingest an average of 1 liter of water per day.
- Children weigh an average of 15 kilograms.
- Adults ingest an average of 2 liters of water per day.
- Adults weigh an average of 70 kilograms

The ATSDR developed Minimal Risk Levels (MRLs) for contaminants commonly found in the environment. MRLs are estimates of daily human exposure to a contaminant below which non-cancerous, adverse health effects are unlikely to occur (ATSDR, 2005). MRLs can be developed for specific exposure routes such as ingestion or inhalation. Lastly, MRLs are developed for length of exposure. Length of exposure is acute (less than 14 days), intermediate (14-364 days), and chronic (equal to or greater than 365 days) (ATSDR, 2005).

Assessing the public health significance of contaminants exceeding their respective screening levels includes reviewing toxicological information. The magnitude of the public health issue may be estimated by comparing the estimated exposures to “no observed” (NOAELs) and “lowest observed” (LOAELs) adverse effect levels in animals and in humans, when available. We assess the public health significance of contaminants exceeding screening values by reviewing and adding relevant toxicological information with maximum exposure scenarios (ATSDR, 2001).

DCE

DCE can easily enter the body through absorption in the stomach or intestines if you eat or drink contaminated food or water. DCE can leave the body through the urine, usually within 1-2 days after exposure (USDHHS, 1994).

The maximum amount of DCE sampled at this site is 6037 μg/L (see Table 5). The DCE Oral Minimal Risk Level (MRL) of 0.009 mg/kg/day has been derived for chronic duration oral exposure (365 days or more). The maximum amount of DCE found at the Halifax Rd/ Virgilina Rd site translates to 0.377 mg/kg/day for children and 0.172 mg/kg/day for adults, which both exceed the ATSDR MRL.

<u>Non-cancer Health Effects</u>
There is no current information on the health effects to humans who ate or drank water contaminated with DCE. Animal studies have shown test subjects developed liver and kidney disease when DCE was placed directly in the stomach. It should be noted that the amounts of DCE used in the referenced studies were much higher than typical exposures in drinking water. No studies were located regarding death in humans after oral exposure to DCE (USDHHS, 1994).

USDHHS states that spilling DCE on your skin and in your eyes can cause irritation. There is little to no information on the long-term effects of dermal exposure to DCE.

The highest estimated DCE doses for adults and children are not likely to cause additional risk of non-cancer effects in humans. The highest measured DCE concentration in a private drinking water well of 6037 µg/L translates to an estimated ingestion dose of 0.377 mg/kg/day for a child (the most sensitive population) and 0.172 mg/kg/day for adults. The dose estimation for children of 0.377 mg/kg/day is more than 20 times lower than the lowest NOAEL (no observable adverse effect level) based on animal studies for non-cancerous effects associated with increased liver toxicity (9 mg/kg/day). The dose for adults (0.172 mg/kg/day) is fifty times lower than the lowest NOAEL.

Cancer Health Effects
It is not known if exposure to DCE increases the risk for cancer in humans. Evidence from epidemiology studies are inconclusive (USDHHS, 1994). With respect to carcinogenicity, the International Agency for Research on Cancer (IARC) has determined that DCE is not classifiable as to its carcinogenicity. The USEPA has classified DCE as a possible carcinogen (USDHHS, 1994). There is no cancer slope factor (CSF) for 1,1-Dichloroethene and cannot be calculated to show potential for cancer risk.

Benzene

Everyone is exposed to small amounts of benzene every day. Benzene can be found in tobacco smoke, at automobile service stations, in motor vehicle exhaust, and industrial emissions. Benzene in water and soil breaks down more slowly than benzene in the air. Benzene can readily pass from soil to groundwater.

The maximum amount of benzene sampled at this site is 3700 µg/L (see Table 5). The benzene Oral Minimum Risk Level (MRL) of 0.0005 mg/kg/day has been derived for chronic duration oral exposure (365 days or more). The maximum amount of benzene found at the Halifax Rd/ Virgilina Rd site translates to 0.231 mg/kg/day for children and 0.106 mg/kg/day for adults. which both exceed the ATSDR MRL for benzene.

Non-cancer Health Effects
Most of the benzene taken in through food or drink passes through the gastrointestinal tract and enters the bloodstream. Drinking liquids that contain benzene at very high levels can cause vomiting, stomach irritation, dizziness, sleepiness, convulsions, rapid heart rate, coma and, in extreme cases, death (USDHHS, 2007). Data suggests that humans exposed to benzene in occupational settings for acute and chronic durations via inhalation and oral routes are at risk of developing neurological effects (USDHHS, 2007).

If skin is exposed to benzene, redness and sores may develop.

The highest estimated benzene doses for adults and children are not likely to increase risk of non-cancer effects in humans. The highest measured benzene concentration in a private drinking water well of 3700 µg/L translates to an ingestion dose of 0.231 mg/kg/day for a child (the most sensitive population). This dose is more than five times lower than the lowest LOAEL (lowest observable adverse effect level) for non-cancerous effects in humans (1.2 mg/kg/day) based on

1996 animal study (EPA IRIS). The dose for adults (0.106 mg/kg/day) is more than 10 times lower than the lowest LOAEL.

Cancer Health Effects

Long term exposure to benzene can cause cancer of the blood forming organs, a condition called leukemia. Children can be affected by benzene in the same manner as adults (USDHHS, 2007). The strongest evidence for leukemia potential comes from a series of studies conducted on workers exposed to benzene in Ohio (Pliofilm Study) and China (NCI/CAPM Study).

USEPA, IARC, and the U.S. Department of Health and Human Services (USDHHS) have concluded that benzene is a human carcinogen.

The cancer slope factor is multiplied by the estimated dose of a contaminant. The product is the theoretical cancer risk. This information is useful in determining if there is increased risk for cancer due to exposure to the contaminant. Benzene has a CSF of 0.055 (mg/kg/d)-1. When calculated using the formula *Theoretical Cancer Risk = Dose * CSF* the theoretical cancer risk is 60×10^{-4}. The calculated theoretical cancer risk for benzene predicts the probability of 60 additional cancers over background for a population of 10,000 persons and is an increased potential risk for cancer over expected background number of cancers. If unfiltered water from the Halifax Rd / Virgilina Rd DCE site is used for human consumption there is potential for increased cancer risk in the community based on exposure to benzene.

Carbon Tetrachloride

Carbon tetrachloride has been produced in large quantities to make refrigeration fluid and propellants for aerosol cans (USDHHS, 2005). Carbon tetrachloride evaporates easily in air and may be found in surface water but may evaporate readily as it reaches the surface. Carbon tetrachloride can be more persistent in groundwater because it is underground and can not easily evaporate. Carbon tetrachloride can enter the body through the lungs if inhaled, or the stomach and intestines if liquids containing carbon tetrachloride are ingested. Most of the information on health effects to carbon tetrachloride in humans comes from cases where people have been exposed to high doses once or for short (acute) durations (USDHHS, 2005). It is uncertain whether children are affected by carbon tetrachloride the same as adults, but effects are likely.

The maximum amount of carbon tetrachloride sampled at this site is 130 µg/L (see Table 5). The carbon tetrachloride Oral Minimal Risk Level (MRL) of 0.02 mg/kg/day has been derived for acute duration oral exposure (14 days or less). The intermediate MRL of 0.07 mg/kg/day has been derived for 15-364 days a year. The maximum amount of carbon tetrachloride found at the Halifax Rd/ Virgilina Rd site translates to 0.00813 mg/kg/day for children and 0.00371 mg/kg/day for adults. The calculated dose for both children and adults is below the acute ATSDR MRL and should not pose an acute health risk. Childrens calculated dose for carbon tetrachloride exceeded the intermediate ATSDR MRL while the adults were below the intermediate level. The carbon tetrachloride MRL is based on non-carcinogenic effects only.

Non-cancer Health Effects

Humans who ingest 680–900 mg/kg of carbon tetrachloride may experience nausea, vomiting, and abdominal pain (USDHHS, 2005). Ingestion of carbon tetrachloride can lead to marked hepatotoxicity (adverse affects to the liver) and renal (kidney) effects, as well as depression of the central nervous system (USDHHS, 2005).

The highest estimated doses of carbon tetrachloride for adults and children are not likely to increase risk of liver lesions identified as the most sensitive non-cancer adverse human health effect. The highest measured concentration of carbon tetrachloride in a private drinking water well of 130 µg/L translates to an ingestion dose of 0.00813 mg/kg/day for a child (the most sensitive population). This dose is more than 100 times lower than the lowest NOAEL (no observable adverse effect level) for non-cancerous effects associated with increased liver lesions based on animal studies (1 mg/kg/day). The dose for adults (0.00371 mg/kg/day) is more than 260 times lower than the lowest NOAEL.

Cancer Health Effects

There are few reports of cancer in people who have been exposed to carbon tetrachloride, but the data alone is not sufficient to determine if carbon tetrachloride may cause cancer in humans (USDHHS, 2005). There are no studies regarding carcinogenic effects after oral exposure to carbon tetrachloride.

The USDHHS has determined that carbon tetrachloride may reasonably be anticipated to be a human carcinogen. The IARC has classified carbon tetrachloride as possibly carcinogenic to humans. The USEPA has determined that carbon tetrachloride is a probable human carcinogen.

Carbon tetrachloride has a CSF of 0.13 (mg/kg/d)-1. When calculated using the formula *Theoretical Cancer Risk = Dose * CSF* the theoretical cancer risk is 5×10^{-4}. The calculated theoretical cancer risk for carbon tetrachloride predicts the probability of 5 additional cancers over background for a population of 10,000 persons and is an increased potential risk for cancer over background number of expected cancers. If unfiltered water from the Halifax Rd / Virgilina Rd DCE site is used for human consumption there is potential for increased cancer risk in the community based on exposure to carbon tetrachloride.

C. Evaluating Health Effects from Exposure to Multiple Chemicals

This section evaluates whether exposure to a mixture of the highest concentrations of DCE, benzene, and carbon tetrachloride found in well water in this study is likely to result in adverse health effects.

The health impact of exposure to chemical mixtures can be of particular concern to public health officials. Evaluation of chemical mixtures must be considered for their potential toxic interactions at environmentally relevant doses. However, relatively few studies have assessed toxic interactions in these low dose ranges. These studies found no discernable toxic response until the dose levels of the individual chemicals approached or exceeded their individual health thresholds. However, when the chemicals were administered at doses approaching their individual Lowest Observed Adverse Effect Level (LOAEL), additive toxic effects clearly were evident. Furthermore, additive toxicity was observed even though the chemicals had different mechanisms of toxicity. Evaluating the potential for toxic effects from exposure to chemical mixtures at all sites is prudent (ATSDR *Guidance Manual for the Assessment of Joint Action of Chemical Mixtures*).

Based on chemical mixture calculations it is determined that residents located near the Halifax Road/Virgilina Road site are **not at increased risk** from chemical mixtures of DCE, benzene and carbon tetrachloride (see Tables 6 and 7, Appendix C).

CHILD HEALTH CONSIDERATIONS

The ATSDR recognizes there are unique exposure risks concerning children that do not apply to adults. Children engage in increased outdoor activities and hand to mouth actions, and have lower body weights and higher intake rate than adults, which result in a greater dose of hazardous substance per unit of body weight. Other reasons that can affect a child's exposure response include genetic makeup, age, health, nutritional status, and exposure to other environmental substances. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage (ATSDR, 1999). Because adults are in charge of the housing, medical care and risk identification of children they should have as much information about environmental contaminants in order to make informed decisions which can affect the child's health.

DCE, benzene, and carbon tetrachloride are of special concern for children's health because the calculated exposure doses exceeded the ATSDR MRLs.

Furthermore, it should be noted that the fetus may be particularly susceptible to the toxic effects of these chemicals. Laboratory animals in epidemiologic studies indicate that VOC exposure to the fetus and children may result in adverse health effects.

CONCLUSIONS

Based on sampling data, dose calculations, and properly maintained filter system placement this site should be considered **No Apparent Public Health Hazard.** Sampling data collected in 2008 demonstrated the filter systems placed on the drinking water wells sufficiently reduce contaminates at the Halifax and Virgilina Rd site.

Filter systems are an engineering control prone to mechanical or human error, which can cause the filters to fail. Filter systems should only be considered a temporary solution. This site will pose a **Public Health Hazard** in the future if a permanent solution is not found. Permanent solutions would include but are not limited to bypassing or remediating the contaminants in the drinking water.

It is unknown if benzene was also used in the production process at the former GMH facility or if it is from a different source. A groundwater VOC plume was not defined by the February 2008 sampling investigation.
The water treatment systems, if properly maintained, will remove the contaminants of concern to levels below drinking water health standards.

Sampling has shown that the Halifax Road/Virgilina Road DCE site **is a continuing source of contamination**. Residential wells contain elevated levels of VOCs, some above the MCL. In addition to contaminants exceeding the MCL, concentrations of DCE, benzene, and carbon tetrachloride were detected above the ATSDR CVs and MRLs. Mid and effluent samples collected on the filter units have not exceeded the MCLs or ATSDR CVs, indicating are they effectively removing site contaminants to concentrations below health levels.

People around the former GMH site have been drinking contaminated water for an indeterminate amount of time. DCE, benzene, and carbon tetrachloride put the exposed population at increased risk via the drinking water pathway. NCDHHS believes that any hazard associated with drinking the water is temporarily reduced by using bottled water for drinking, and/or a properly maintained filter treatment system on the well.

RECOMMENDATIONS

- Continue periodic sampling of well water, including monitoring filter systems performance.
- Remediate contaminated groundwater or install municipal drinking water lines to residents within one mile of the former GMH site.
- Homeowners should continue to use bottled water or filtered well water until remediation of the contaminants is complete or a municipal water supply can be made available to the residents living near the former GMH site.
- A health advisory issued from NCDHHS using the Person County Health Department as a conduit, outlining the exposed population groups and contaminants of concern.
- Fact sheets and educational material will be made available for residents living near the former GMH site. The fact sheets will be developed by NCDHHS for providers and disseminated to safety net providers such as Health Department, Rural Health Centers, Community Health Centers and School Health Programs.
- Annual public meetings will be held to address concerns of the residents, disseminate current information about contaminants, disseminate information about appropriate treatment options, and explain the viability of well filter treatment systems.

PUBLIC HEALTH ACTION PLAN

The purpose of the Public Health Action Plan (PHAP) is to ensure that this health consultation provides a plan of action designed to mitigate or prevent potential adverse health effects.

A. Public Health Actions Completed

- NCDENR UST, and the USEPA installed drinking water treatment systems on wells determined to have contaminant levels above applicable drinking water standards.
- NCDENR, Person County Health Department, and the USEPA are monitoring private wells to ensure filter systems are working adequately. Samples are collected at several locations along the filtration process which include influent (flow in), mid (middle), and effluent (after filter) samples.
- ATSDR held a public availability session on May 25, 2004, to gather health concerns from the community.
- NCDENR Superfund Section has submitted documentation to USEPA Region 4 for a March 2009 NPL proposal.

B. Public Health Actions Planned

- Educational outreach materials distributed through the Person County Health Department for residents that live near the former GMH site on Halifax and Virgilina Rd. The educational materials will detail information about the contaminants of concern in the form of fact sheets or other written materials designed to educate the public. NCDHHS will provide the educational materials to Person County Health Department by October 15, 2008. Accurate alternate sources of information can be obtained by the Person County Health Department if desired. The alternate sources will include printed material obtained from internet resources provided by organizations such as the USEPA or ATSDR.
- The NCDENR Superfund Section has submitted documentation to USEPA Region 4 for a March 2009 NPL proposal. This may change the status of the site enabling more support for possible mitigation of alternate drinking water sources.
- Sampling private drinking water wells is accomplished on a periodic basis. Sampling is used to determine the condition of the filter systems and characterize contaminants of concern.

If any citizen has questions or concerns about this report, please contact the NC DHHS Occupational and Environmental Epidemiology Branch at (919) 707-5900.

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CERTIFICATION

This Health Consultation for the Halifax Road/Virgilina Road DCE Site was prepared by the North Carolina Division of Public Health (NC DHHS) under a cooperative agreement with the Federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consult and update was initiated. Editorial review was completed by the cooperative agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation, and concurs with its findings.

Gail Godfrey for AY

Alan Yarbrough
Team Leader,
CAT, CAPEB, DHAC, ATSDR

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Appendix A

Site Layout and Location Map
Figures (1-3)

Figure 1. Former GMH Property and Gas Station

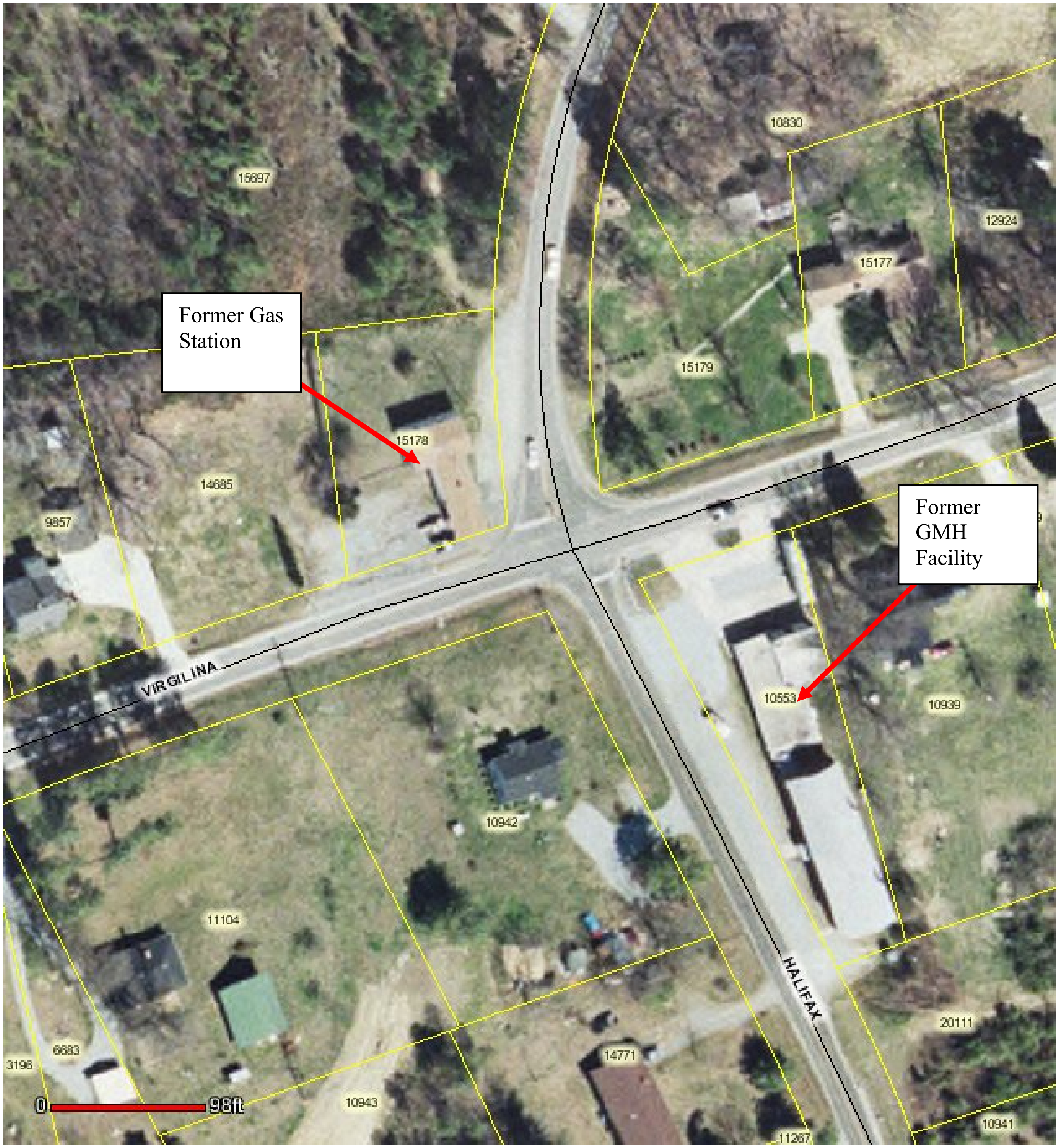


Figure 2. Halifax RD/ Virgil RD DCE Site Petroleum Sample Locations

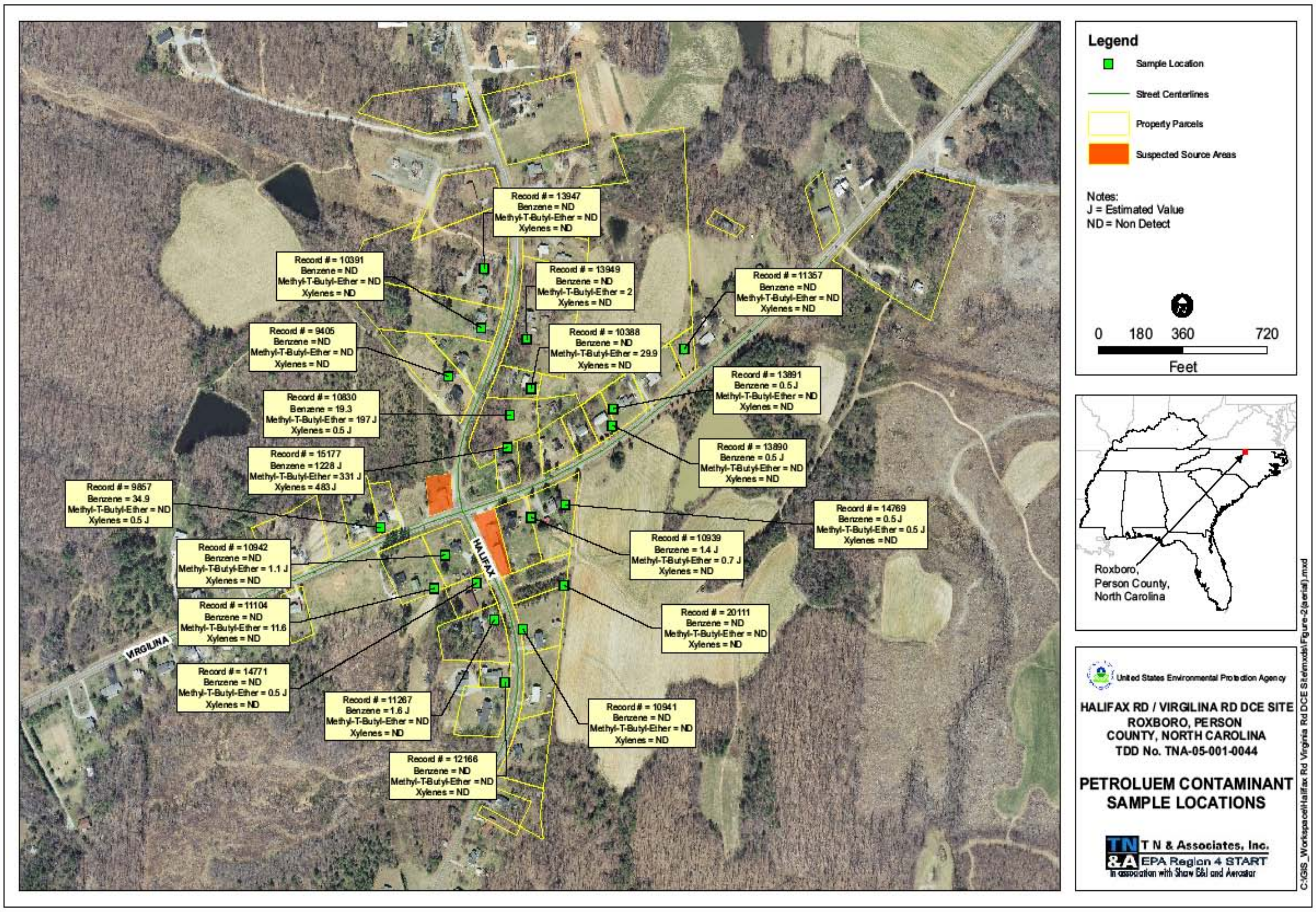
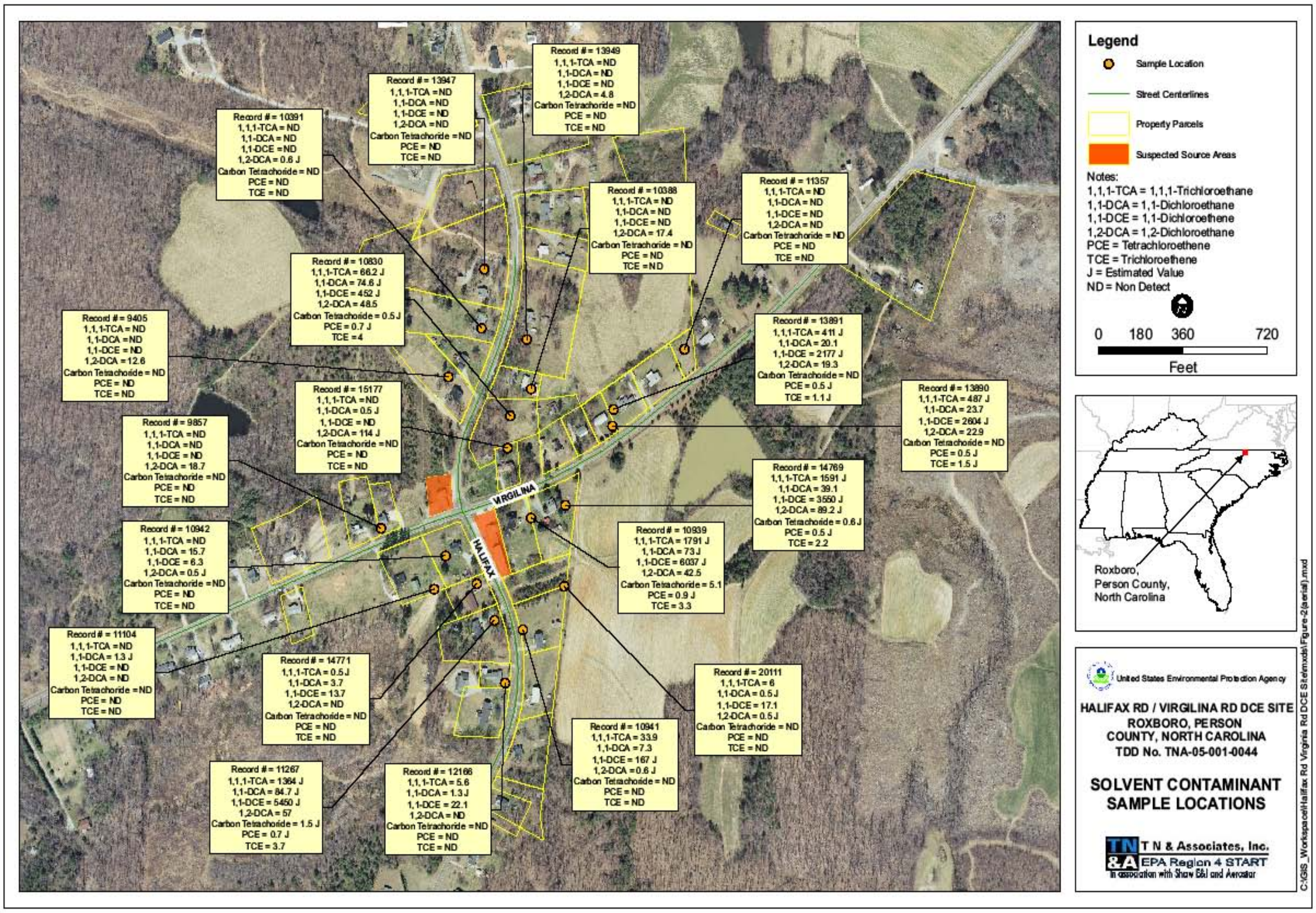


Figure 3. Halifax RD/ Virgil RD DCE Site Solvent Sample Locations



Appendix B

Private Well Water Data

Table A-1. 2007 Groundwater Samples Exceeding MCLs

Sample Id	Federal Drinking Water MCL	71480	71603	71734	71736	71738	71754	71756	71757	71758
Sample Date		10/3/2007	10/23/2007	11/14/2007	11/14/2007	11/14/2007	11/15/2007	11/15/2007	11/15/2007	11/15/2007
Record #		15177	10828	10388	13890	13891	14771	10939	9857	9405
Location:		Virgilina Rd	Virgilina Rd	Halifax Rd	Virgilina Rd	Virgilina Rd	Halifax Rd	Virgilina Rd	Virgilina Rd	Halifax Rd
VOC (ug/L)										
1,1,1-Trichloroethane	200	0.5 U	66.2 J	0.5 U	**487 J**	**411 J**	0.5 J	**1791 J**	0.5 U	0.5 U
1,1-Dichloroethene	7	0.5 U	**452 J**	0.5 U	**2604 J**	**2177 J**	**13.7**	**6037 J**	0.5 U	0.5 U
1,2-Dichloroethane	5	**114 J**	**48.5**	**17.4**	**22.9**	**19.3**	0.5 U	**42.5**	**18.7**	**12.6**
Benzene	5	**1228 J**	**19.3**	0.5 U	0.5 J	0.5 J	0.5 U	1.4 J	**34.9**	0.5 U
Ethylene Dibromide	0.05	**1.3 J**	**0.5 J**	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

Notes:

Bold and shaded - Value exceeds the Federal MCL

J - Estimated value.

MCL - Maximum Contaminant Level for Drinking Water

U - Analyte was analyzed for but not detected above the sample quantitation limit

ug/L - Micrograms per liter

VOC - Volatile Organic Compounds

MCL for DCE is 7 µg/L, MCL for DCA is 5 µg/L and **TCA is 200 µg/L**

Table A-2. 2007 Groundwater Samples Exceeding MCLs

Sample Id	Federal Drinking Water MCL	71760	71776	71877	71879	71881	71920	71922	72002	71992
Sample Date		11/15/2007	11/19/2007	12/3/2007	12/3/2007	12/3/2007	12/5/2007	12/5/2007	12/7/2007	12/10/2007
Record #		20111	11267	10941	12166	14769	14183	12056	14751	9510
Location:		Halifax Rd	Halifax Rd	Halifax Rd	Halifax Rd	Virgilina Rd	Virgilina Rd	Halifax Rd	Virgilina Rd	Halifax Rd
VOC (ug/L)										
1,1,1-Trichloroethane	200	6	**1364 J**	33.9	5.6	**1591 J**	7.4	4.4	5.4	2.8
1,1-Dichloroethene	7	**17.1**	**5450 J**	**167 J**	**22.1**	**3550 J**	**28.9**	**20.5**	**20.4**	**11.9**
1,2-Dichloroethane	5	0.5 J	**57**	0.6 J	0.5 U	**89.2 J**	0.8 J	0.5 U	0.5 U	0.5 U

Notes:

Bold and shaded - Value exceeds the Federal MCL
J - Estimated value.
MCL - Maximum Contaminant Level for Drinking Water
U - Analyte was analyzed for but not detected above the sample quantitation limit
ug/L - Micrograms per liter
VOC - Volatile Organic Compounds

MCL for DCE is 7 µg/L, MCL for DCA is 5 µg/L and **TCA is 200 µg/L**

Table A-3. 2007 Groundwater Samples Exceeding MCLs

Sample Id	Federal Drinking Water MCL	71996	HAL-DW-03	HAL-DW-39	HAL-DW-24	HAL-DW-13	HAL-DW-14	HAL-DW-27	HAL-DW-22-IN	HAL-DW-16-IN
Sample Date		12/10/2007	12/12/2007	12/12/2007	12/12/2007	12/12/2007	12/12/2007	12/12/2007	12/13/2007	12/13/2007
Record #		11853	10388	10553	10828	11104	10942	14183	10939	11267
Location:		Halifax Rd	Halifax Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Halifax Rd
VOC (ug/L)										
1,1,1-Trichloroethane	200	3.1	0.16 U	7.8	20	38	0.16 U	6.7	**1000**	**580**
1,1-Dichloroethene	7	**13.7**	0.24 U	**19**	**130**	**150**	0.24 U	**27**	**3500**	**2100**
1,2-Dichloroethane	5	0.5 U	**6.3**	0.19 U	**23**	0.38 J	**5.9**	0.41 J	**40**	**28**

Notes:

Bold and shaded - Value exceeds the Federal MCL
J - Estimated value.
MCL - Maximum Contaminant Level for Drinking Water
U - Analyte was analyzed for but not detected above the sample quantitation limit
ug/L - Micrograms per liter
VOC - Volatile Organic Compounds

MCL for DCE is 7 µg/L, MCL for DCA is 5 µg/L and **TCA is 200 µg/L**

Table A-4. 2008 Groundwater Samples Exceeding MCLs

Sample Id	Federal Drinking Water MCL	HAL-DW-25-IN	HAL-DW-41	HAL-DW-26-IN	HAL-DW-26-IN	HAL-DW-23-IN	HAL-DW-43	HAL-DW-41
Sample Date		12/13/2007	12/13/2007	12/13/2007	12/13/2007	12/13/2007	12/13/2007	12/13/2007
Record #		13890	9857	13891	13891	14769	15177	9857
Location:		Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd
VOC (ug/L)								
1,1,1-Trichloroethane	200	**210**	0.16 U	**220**	**220**	**1000 J**	0.16 U	0.16 U
1,1-Dichloroethene	7	**1000**	0.24 U	**990**	**990**	**2300 J**	1.1	0.24 U
1,2-Dichloroethane	5	**14**	**8**	**17**	**17**	**41**	**160**	**8**
Benzene	5	0.21 J	0.34 J	0.24 J	0.24 J	0.23 J	**3700**	0.34 J

Notes:

Bold and shaded - Value exceeds the Federal MCL
J - Estimated value.
MCL - Maximum Contaminant Level for Drinking Water
U - Analyte was analyzed for but not detected above the sample quantitation limit
ug/L - Micrograms per liter
VOC - Volatile Organic Compounds

MCL for DCE is 7 µg/L, MCL for DCA is 5 µg/L and **TCA is 200 µg/L**

Table B-1. 2008 Groundwater Samples Exceeding MCLs

Sample Id	Federal Drinking Water MCL	HAL-DW3-01	81133	81098	81085	81087	81123	81125	81115	81117
Sample Date		1/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008
Record #		10941	10388	10828	10939	10939	10941	11267	11853	12056
Location:		Halifax Rd	Halifax Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Halifax Rd	Halifax Rd	Halifax Rd	Halifax Rd
VOC (ug/L)										
1,1,1-Trichloroethane	200	29	0.5 U	43.2	**937 J**	**1485 J**	24.2	**483 J**	2.6	2.6
1,1-Dichloroethene	7	**120**	0.5 U	**329 J**	**3167 J**	**5019 J**	**146 J**	**2109 J**	**10.4**	**13.5**
1,2-Dichloroethane	5	0.32 J	**37.2**	**49.2**	**67 J**	**104 J**	0.5 U	**32.6**	0.5 U	0.5 U

Notes:

Bold and shaded - Value exceeds the Federal MCL
J - Estimated value.
MCL - Maximum Contaminant Level for Drinking Water
U - Analyte was analyzed for but not detected above the sample quantitation limit
ug/L - Micrograms per liter
VOC - Volatile Organic Compounds

EF - Effluent
FIL - Filtration system
HAL - Halifax Rd./Virgilina Rd. DCE site
IN - Influent
MID - Mid-port

MCL for DCE is 7 µg/L, MCL for DCA is 5 µg/L and **TCA is 200 µg/L**

Table B-2. 2008 Groundwater Samples Exceeding MCLs

Sample Id	Federal Drinking Water MCL	81095	81097	81137	81099	81103	81105	81091	81127	81089
Sample Date		6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008	6/10/2008
Record #		13890	13891	13949	14183	14751	14751	14769	14771	15177
Location:		Virgilina Rd	Virgilina Rd	Halifax Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Rd	Halifax Rd	Virgilina Rd
Notes										
VOC (ug/L)										
1,1,1-Trichloroethane	200	198 J	**370 J**	0.5 U	10.3	4.7	3.9	**1126 J**	0.7 J	0.5 U
1,1-Dichloroethene	7	**1014**	**1824 J**	0.5 U	**46.5**	**24.2**	**19.7**	**3037 J**	**15.3**	2.8 J
1,2-Dichloroethane	5	**24.4**	**48.4**	**17.7**	1.6 J	0.9 J	0.7 J	**89 J**	0.5 J	**9.2**

Notes:

Bold and shaded - Value exceeds the Federal MCL
J - Estimated value.
MCL - Maximum Contaminant Level for Drinking Water
U - Analyte was analyzed for but not detected above the sample quantitation limit
ug/L - Micrograms per liter
VOC - Volatile Organic Compounds

EF - Effluent
FIL - Filtration system
HAL - Halifax Rd./Virgilina Rd. DCE site
IN - Influent
MID - Mid-port

MCL for DCE is 7 µg/L, MCL for DCA is 5 µg/L and **TCA is 200 µg/L**

Table B-3. 2008 Groundwater Samples Exceeding MCL s

Sample Id	Federal Drinking Water MCL	81129	81111	81141	HAL-FIL4-01-IN	HAL-FIL5-01-IN	HAL-FIL5-02-EF[a]	HAL-FIL5-03-IN	HAL-FIL5-03-MID	HAL-FIL5-04-IN	HAL-FIL5-05-IN
Sample Date		6/10/2008	6/10/2008	6/10/2008	3/14/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008	5/6/2008
Record #		9405	9510	9774		13890	14769	10939	10939	13891	11267
Location:		Halifax Rd	Halifax Rd	Halifax Rd		Virgilina Rd	Virgilina Rd	Virgilina Rd	Virgilina Road	Virgilina Road	Halifax Road
VOC (ug/L)											
1,1,1-Trichloroethane	200	0.5 U	2.6	0.5 U	**590**	65	270	**260**	0.16 U	79	130
1,1-Dichloroethene	7	0.5 U	**9.5**	0.5 U	**2100**	**320**	**720**	**790**	**33**	**380**	**530**
1,2-Dichloroethane	5	**16.7**	0.5 U	**6.1**	0.19 U	**11**	**26**	**18**	**9.1**	**12**	**14**

Notes:

Bold and shaded - Value exceeds the Federal MCL
J - Estimated value.
MCL - Maximum Contaminant Level for Drinking Water
U - Analyte was analyzed for but not detected above the sample quantitation limit
ug/L - Micrograms per liter
VOC - Volatile Organic Compounds

EF - Effluent
FIL - Filtration system
HAL - Halifax Rd./Virgilina Rd. DCE site
IN - Influent
MID - Mid-port

MCL for DCE is 7 µg/L, MCL for DCA is 5 µg/L and **TCA is 200 µg/L**

Table C. Summary of Site Contaminants Exceeding ATSDR Comparison Values

Comparison Values parts per billion (ppb)							
Chemical Name	**EMEG**		**Cancer Risk**	**Int EMEG**		**Chronic RMEG**	
	Child	**Adult**	**CREG**	**Child**	**Adult**	**Child**	**Adult**
1,1,2-Trichloroethane			0.6	400	1000	40	100
1,1-Dichloroethene	90	300				500	2000
1,2-Dichloroethane			0.4	2000	7000		
Benzene	5	20	0.6			40	100
Carbon Tetrachloride			0.3	70	200	7	20

Table D-1. Estimated Exposure Dose Calculations, 2007 Groundwater Data

	MRL mg/kg/day		Max MCL	Max NC	Max C	Avg MCL	Avg NC	Avg C
			Dose mg/kg/day					
1,1,1-Trichloroethane	20 int.	Child	1.12E-01	-	-	5.04E-02	-	-
		Adult	5.12E-02	-	-	2.31E-02	-	-
1,1,2-Trichloroethane	0.3 acute	Child	-	-	2.12E-04	-	-	8.06E-05
	0.04 int	Adult	-	-	9.71E-05	-	-	3.69E-05
1,1-Dichloroethene	0.009 Chr	Child	3.77E-01	3.77E-01	-	1.42E-02	7.52E-02	-
		Adult	1.72E-01	1.72E-01	-	6.49E-03	3.44E-02	-
1,2-Dichloroethane	0.2 int	Child	1.00E-02	-	1.00E-02	1.56E-03	-	8.36E-04
		Adult	4.57E-03	-	4.57E-03	7.11E-04	-	3.82E-04
Benzene	0.0005 chr	Child	2.31E-01	2.31E-01	2.31E-01	1.47E-02	1.47E-02	1.01E-03
		Adult	1.06E-01	1.06E-01	1.06E-01	6.72E-03	6.72E-03	4.63E-04
Carbon Tetrachloride	0.02 Acute	Child	8.13E-03	8.13E-03	8.13E-03	1.61E-03	-	2.35E-04
	0.007 int	Adult	3.71E-03	3.71E-03	3.71E-03	7.63E-04	-	1.07E-04
Ethylene Dibromide		Child	8.13E-04	-	-	1.59E-04	-	-
		Adult	3.71E-04	-	-	7.29E-05	-	-
Tetrachloroethene		Child	5.63E-05	-	-	4.75E-05	-	-
NOAEL : 14 mg/kg-day 1000 1 1 x10-2		Adult	2.57E-05	-	-	2.17E-05	-	-

Table D-2. Estimated Exposure Dose Calculations, 2008 Groundwater Data

	MRL mg/kg/day		Max MCL	Max NC	Max Ca	Avg MCL	Avg NC	Avg C
			Dose mg/kg/day					
1,1,1-Trichloroethane	20 int.	Child	9.28E-02	-	-	4.85E-02	-	-
		Adult	4.24E-02	-	-	2.21E-02	-	-
1,1,2-Trichloroethane	0.3 acute	Child	-	-	1.53E-03	-	-	1.34E-04
	0.04 int	Adult	-	-	7.00E-04	-	-	6.11E-05
1,1-Dichloroethene	0.009 Chr	Child	3.14E-01	3.14E-01	-	9.13E-03	6.31E-02	-
		Adult	1.43E-01	1.43E-01	-	4.17E-03	2.88E-02	-
1,2-Dichloroethane	0.2 int	Child	6.50E-03	-	6.50E-03	1.92E-03	-	8.96E-04
		Adult	2.97E-03	-	2.97E-03	8.80E-04	-	3.97E-04
Benzene	0.0005 chr	Child	-	-	8.13E-05	-	-	6.12E-05
Carbon Tetrachloride	0.02 Acute	Child	-	-	2.50E-04	-	-	1.25E-04
	0.007 int	Adult	-	-	1.14E-04	-	-	5.71E-05
Tetrachloroethene		Child	5.00E-06					
NOAEL : 14 mg/kg-day 1000 1 1		Adult	2.29E-06					

Exceeds MRL

Table D-3. Estimated Exposure Dose Calculations, 2008 Groundwater Data

	MRL mg/kg/day		Dose mg/kg/day: Max MCL	Max NC	Max C	Avg MCL	Avg NC	Avg C
1,1,1-Trichloroethane	20 int.	Child	3.96E-02	-	-	-	-	-
		Adult	1.69E-02	-	-	-	-	-
1,1,2-Trichloroethane	0.3 acute	Child	-	-	1.00E-04	-	-	-
	0.04 int	Adult	-	-	4.57E-05	-	-	-
1,1-Dichloroethene	0.009 Chr	Child	1.31E-01	1.31E-01	-	-	-	-
		Adult	6.00E-02	6.00E-02	-	-	-	-
Carbon Tetrachloride	0.02 Acute	Child	-	-	2.81E-04	-	-	-
	0.007 int	Adult	-	-	1.29E-04	-	-	-
Tetrachloroethene		Child	2.31E-05	-	-	-	-	-
NOAEL : 14 mg/kg-day 1000 1 1		Adult	1.06E-05	-	-	-	-	-

Exceeds MRL

Table D-4. Estimated Exposure Dose Calculations, 2008 Groundwater Data

	MRL mg/kg/day		Dose mg/kg/day: Max MCL	Max NC	Max C	Avg MCL	Avg NC	Avg C
1,1,1-Trichloroethane	20 int.	Child	1.63E-02	-	-	-	-	-
		Adult	7.43E-03	-	-	-	-	-
1,1,2-Trichloroethane	0.3 acute	Child	-	-	8.75E-03	-	-	6.50E-05
	0.04 int	Adult	-	-	4.00E-03	-	-	2.97E-05
1,1-Dichloroethene	0.009 Chr	Child	4.94E-02	4.94E-02	-	2.04E-02	2.04E-02	-
		Adult	2.26E-02	2.26E-02	-	9.23E-03	9.23E-03	-
1,2-Dichloroethane	0.2 int	Child	1.63E-03	-	1.63E-03	8.81E-04	-	8.81E-04
		Adult	7.43E-04	-	7.43E-04	4.03E-04	-	4.03E-04
Benzene	0.0005 chr	Child	-	-	4.13E-05	-	-	-
		Adult	-	-	1.89E-05	-	-	-
Tetrachloroethene		Child	2.06E-05	-	-	-	-	-
NOAEL : 14 mg/kg-day 1000 1 1		Adult	-	-	-	-	-	-

Exceeds MRL

Appendix C

ATSDR Evaluation Process

Comparison Values and the Screening Process

In evaluating data, ATSDR uses comparison values (CVs) to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific medium (soil or water) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water and soil that someone may inhale or ingest each day.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on validated toxicologic studies for a chemical, with appropriate safety factors included, and the assumption that small children (22 pounds) and adults are exposed every day. Cancer levels are the media concentrations at which there could be a one additional cancer in a one million person population (one in a million excess cancer risk for an adult) eating contaminated soil or drinking contaminated water every day for 70 years. For chemicals for which both cancer and non-cancer CVs exist, the lower level is used to be protective. Exceeding a CV does not mean that health effects will occur, just that more evaluation is needed.

CVs used to select contaminants for further evaluation:

Environmental Media Evaluation Guides (EMEGs) represent concentrations of substances in water, soil, and air to which humans may be exposed over specified time periods without experiencing non-cancer adverse health effects. The EMEG is derived from the Agency for Toxic Substances and Disease Registry’s (ATSDR) minimal risk level (MRL).

Reference Dose Media Evaluation Guides (RMEGs) represent concentrations of substances in water and soil to which humans may be exposed over specified time periods without experiencing non-cancer adverse health effects. The RMEG is derived from the Environmental Protection Agency’s (EPA’s) oral reference dose (RfD).

Cancer Risk Evaluation Guides (CREGs) are estimated media-specific contaminant concentrations that would be expected to cause no more than one additional excess cancer in one million persons exposed over a lifetime. CREGs are calculated from EPA’s cancer slope factors (CSFs) or inhalation unit risk (IUR) values.

Risk-Based Concentrations (RBCs) are the estimated contaminant concentrations in media where non-carcinogenic health effects are unlikely. The RBCs used in this PHA were derived by EPA’s Region 3 toxicologists.

EPA Soil Screening Levels (SSLs) are estimated contaminant concentrations in soil at which additional evaluation is needed to determine if action is required to eliminate or reduce exposure.

Estimation of Exposure Dose

The next step is to consider those contaminants that are present at levels above the CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using our assumptions of who goes on the site and how often they contact the site contaminants. The exposure dose is the estimated amount of a contaminant that gets into a person's body.

Non-Cancer Health Effects

The doses calculated for exposure to each individual chemical are then compared to an established health guideline, such as a MRL or RfD, in order to assess whether adverse health impacts from exposure are expected. These health guidelines, developed by ATSDR and EPA, are chemical-specific values that are based on the available scientific literature and are considered protective of human health. Non-carcinogenic effects, unlike carcinogenic effects, are believed to have a threshold, that is, a dose below which adverse health effects will not occur. As a result, the current practice for deriving health guidelines is to identify, usually from animal toxicology experiments, a No Observed Adverse Effect Level (or NOAEL), which indicates that no effects are observed at a particular exposure level. This is the experimental exposure level in animals (and sometimes humans) at which no adverse toxic effect is observed. The NOAEL is then modified with an uncertainty (or safety) factor, which reflects the degree of uncertainty that exists when experimental animal data are extrapolated to the general human population. The magnitude of the uncertainty factor considers various factors such as sensitive subpopulations (for example; children, pregnant women, and the elderly), extrapolation from animals to humans, and the completeness of available data. Thus, exposure doses at or below the established health guideline are not expected to result in adverse health effects because these values are much lower (and more human health protective) than doses that do not cause adverse health effects in laboratory animal studies. For non-cancer health effects, the following health guidelines are described below in more detail. It is important to consider that the methodology used to develop these health guidelines does not provide any information on the presence, absence, or level of cancer risk. Therefore, a separate cancer evaluation is necessary for potentially cancer-causing chemicals detected in samples at this site. A more detailed discussion of the evaluation of cancer risks is presented in the following section.

Minimal Risk Levels (MRLs) – developed by ATSDR

ATSDR has developed MRLs for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily exposure to a contaminant below which non-cancer, adverse health effects are unlikely to occur. MRLs are developed for different routes of exposure, such as inhalation and ingestion, and for lengths of exposure, such as acute (less than 14 days), intermediate (15-364 days), and chronic (365 days or greater). At this time, ATSDR has not developed MRLs for dermal exposure. A complete list of the available MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

References Doses (RfDs) – developed by EPA

The RfDs are an estimate of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause non-cancerous health effects. RfDs consider exposures to sensitive sub-populations, such as the elderly, children, and the developing fetus. EPA RfDs have been developed using information from the available scientific literature and have been calculated for oral and inhalation exposures. A complete list of the available RfDs can be found at http://www.epa.gov/iris.

If the estimated exposure dose for a chemical is less than the health guideline value, the exposure is unlikely to result in non-cancer health effects. If the calculated exposure dose is greater than the health guideline, the exposure dose is compared to known toxicological values for the particular chemical and is discussed in more detail in the text of the assessment. The known toxicological values are doses derived from human and animal studies that are presented in the ATSDR Toxicological Profiles and EPA's Integrated Risk Information System (IRIS). A direct comparison of site-specific exposure doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely to occur. This in-depth evaluation is performed by comparing calculated exposure doses with known toxicological values, such as the no-observed adverse-effect-level (NOAEL) and the lowest-observed-adverse-effect-level (LOAEL) from studies used to derive the MRL or RfD for a chemical.

Cancer Risks

Exposure to a cancer-causing compound, even at low concentrations, is assumed to be associated with some increased risk for evaluation purposes. The estimated excess risk of developing cancer from exposure to contaminants associated with the site was calculated by multiplying the site-specific adult exposure doses, with a slight modification, by EPA's chemical-specific cancer slope factors (CSFs or cancer potency estimates), which are available at http://www.epa.gov/iris. Calculated dermal doses were compared with the oral CSFs.

Because of the uncertainties involved with estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data. Therefore, the carcinogenic risk is also described in words (qualitatively) rather than giving a numerical risk estimate only.

Exposure Dose Calculations and Results for the Halifax / Virgilina Rd Site

When contaminant concentrations at the site exceed established CVs, the chemical needs additional evaluation. To evaluate the potential for human exposure to contaminants present at the site and potential health effects from site-specific activities, ATSDR estimates human exposure to the site contaminant from different environmental media by calculating exposure doses. A brief discussion of the calculations and assumptions is presented below.

Well Water Pathway (Ingestion, Inhalation, Dermal Contact)

The ATSDR exposure dose formula used for the well water pathway is:

$$ED = C \times IR \times EF / 1000 \times BW$$

where:

ED = exposure dose in milligrams per kilogram per day (mg/kg/day)
C = concentration of contaminant in water in parts per billion (ppb or µg/L)
IR = ingestion rate in liters per day (L/day)
EF = exposure factor, days of exposure divided by 365 (unitless) 1000 = conversion factor in micrograms per milligram (µg/mg)
BW = body weight in kilogram (kg) Assumptions used were based on default values and/or professional judgment.

The drinking water ingestion rate for adults was assumed to be 2 L/day and 1 L/day for children. For average body weight, 70 kg and 11 kg were used for adults and children, respectively. The exposure factor was 1 for highly exposed persons because they were assumed to be exposed for 365 days per year (365/365). The exposure factor was 0.96 for reasonably exposed persons because they were assumed to be exposed to 350 days per year (350/365). The exposure dose for each group was multiplied by 2 to account for dermal and inhalation exposure during showering or bathing.

Assessment of Chemical Interactions

To evaluate the risk for noncancerous effects in a mixture, ATSDR's guidance manual (*Guidance Manual for the Assessment of Joint Toxic Action of Chemical Mixtures*, 2004) prescribes the calculation of a hazard quotient (HQ) for each chemical. The HQ is calculated using the following formula:

HQ = estimated dose ÷ applicable health guideline

Generally, whenever the HQ for a chemical exceeds 1, concern for the potential hazard of the chemical increases. Individual chemicals that have HQs less than 0.1 are considered unlikely to pose a health hazard from interactions and are eliminated from further evaluation. If all of the chemicals have HQs less than 0.1, harmful health effects are unlikely, and no further assessment of the mixture is necessary. If two or more chemicals have HQs greater than 0.1, then these chemicals are to be evaluated further as outlined below.

Table 6. Hazard Quotient Calculation for Chemical Mixtures

Exposed Population	Media	Route	Contaminant	Dose mg/kg/day	MRL mg/kg/day	Hazard Quotient
Child	Potable Water	Ingestion / Dermal	DCE	0.377	0.009 Chr	41.88
			Benzene	0.231	0.0005 Chr	462
			Carbon Tetrachloride	0.00813	0.02 Acute	.40
					0.007 Int	1.16
Adult	Potable Water	Ingestion / Dermal	DCE	0.172	0.009 Chr	19
			Benzene	0.106	0.0005 Chr	212
			Carbon Tetrachloride	0.00371	0.02 Acute	.185
					0.007 Int	0.53

Since the HQ is greater than 1 for both adults and children the hazard index (HI) will be calculated. The HQ for each chemical then is used to determine the (HI) for the mixture of chemicals. An HI is the sum of the HQs and is calculated as follows:

$$HI = HQ_1 + \ldots + HQ_n$$

The HI is used as a screening tool to indicate whether further evaluation is needed. If the HI is less than 1.0, significant additive or toxic interactions are highly unlikely, so no further evaluation is necessary. If the HI is greater than 1.0, then further evaluation is necessary, as described below.

Halifax Rd data reveals an HI = > 1

For chemical mixtures with an HI greater than 1.0, the estimated doses of the individual chemicals are compared with their NOAELs or comparable values. IF the dose of one or more of the individual chemicals is within one order of magnitude of its respective NOAEL (0.1 x NOAEL), then potential exists for additive or interactive effects. Under such circumstances, an in-depth mixtures evaluation should proceed as described in ATSDR's *Guidance Manual for the Assessment of Joint Action of Chemical Mixtures*.

Table 7. Comparison Value / Dose Calculation for Chemical Mixtures

Exposed Population	Media	Contaminant	Dose mg/kg/day	NOAEL mg/kg/day	Dose/NOAEL
Child	Potable Water	DCE	0.377	28.5	.013
		Benzene	0.231	18.0	.012
		Carbon Tetrachloride	0.00813	0.71 Int	.011
Adult	Potable Water	DCE	0.172	28.5	.006
		Benzene	0.106	18.0	.005
		Carbon Tetrachloride	0.00371	0.71 Int	.005

Mixture dose for children are 0.036 and 0.016 for adults. Both are below 0.1 for their respective NOAEL's.
If the estimated doses of the individual chemicals are less than 1/10 of their respective NOAELs, then significant additive or interactive effects are unlikely, and no further evaluation is necessary.

Appendix D

ATSDR ToxFAQs

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

1,1-DICHLOROETHENE

CAS # 75-35-4

Agency for Toxic Substances and Disease Registry ToxFAQs **September 1995**

This fact sheet answers the most frequently asked health questions (FAQs) about 1,1-dichloroethene. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It's important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

SUMMARY: Exposure to 1,1-dichloroethene occurs mainly in the workplace. Breathing high levels of 1,1-dichloroethene can affect the liver, kidney, and central nervous system. This chemical has been found in at least 515 of 1,416 National Priorities List sites identified by the Environmental Protection Agency.

What is 1,1-dichloroethene?

(Pronounced 1,1-dī′klôr′ō ĕth′ēn)

1,1-Dichloroethene is an industrial chemical that is not found naturally in the environment. It is a colorless liquid with a mild, sweet smell. It is also called vinylidene chloride.

1,1-Dichloroethene is used to make certain plastics, such as flexible films like food wrap, and in packaging materials. It is also used to make flame retardant coatings for fiber and carpet backings, and in piping, coating for steel pipes, and in adhesive applications.

What happens to 1,1-dichloroethene when it enters the environment?

- 1,1-Dichloroethene enters the environment from industries that make or use it.
- 1,1-Dichloroethene evaporates very quickly from water and soil to the air.
- In the air, it takes about 4 days for it to break down.
- 1,1-Dichloroethene breaks down very slowly in water.
- It does not accumulate very much in fish or birds.
- In soil, 1,1-dichloroethene is slowly transformed to other less harmful chemicals.

How might I be exposed to 1,1-dichloroethene?

- Workers may be exposed in industries that make or use 1,1-dichloroethene (these industries are mainly in Texas and Louisiana).
- Food that is wrapped in plastic wrap may contain very low levels of 1,1-dichloroethene. The government controls these levels to prevent harm to your health.
- A small percentage (3%) of the drinking water supplies may contain very low levels of 1,1-dichloroethene.
- Air near factories that make or use 1,1-dichloroethene and air near hazardous waste sites may contain low levels of it.

How can 1,1-dichloroethene affect my health?

The main effect from breathing high levels of 1,1-dichloroethene is on the central nervous system. Some people lost their breath and fainted after breathing high levels of the chemical.

Breathing lower levels of 1,1-dichloroethene in air for a long time may damage your nervous system, liver, and lungs. Workers exposed to 1,1-dichloroethene have reported a loss in liver function, but other chemicals were present.

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Animals that breathed high levels of 1,1-dichloroethene had damaged livers, kidneys, and lungs. The offspring of some of the animals had a higher number of birth defects. We do not know if birth defects occur when people are exposed to 1,1-dichloroethene.

Animals that ingested high levels of 1,1-dichloroethene had damaged livers, kidneys, and lungs. There were no birth defects in animals that ingested the chemical.

Spilling 1,1-dichloroethene on your skin or in your eyes can cause irritation.

How likely is 1,1-dichloroethene to cause cancer?

The Environmental Protection Agency (EPA) has determined that 1,1-dichloroethene is a possible human carcinogen.

Studies on workers who breathed 1,1-dichloroethene have not shown an increase in cancer. These studies, however, are not conclusive because of the small numbers of workers and the short time studied.

Animal studies have shown mixed results. Several studies reported an increase in tumors in rats and mice, and other studies reported no such effects.

Is there a medical test to show whether I've been exposed to 1,1-dichloroethene?

Tests are available to measure levels of 1,1-dichloroethene in breath, urine, and body tissues. These tests are not usually available in your doctor's office. However, a sample taken in your doctor's office can be sent to a special laboratory if necessary.

Because 1,1-dichloroethene leaves the body fairly quickly, these methods are useful only for finding exposures that have occurred within the last few days. These tests can't tell you if adverse health effects will occur from exposure to 1,1-dichloroethene.

Has the federal government made recommendations to protect human health?

The EPA has set a limit in drinking water of 0.007 parts of 1,1-dichloroethene per million parts of drinking water (0.007 ppm). EPA requires that discharges or spills into the environment of 5,000 pounds or more of 1,1-dichloroethene be reported.

The Occupational Safety and Health Administration (OSHA) has set an occupational exposure limit of 1 ppm of 1,1-dichloroethene in workplace air for an 8-hour workday, 40-hour workweek.

The National Institute for Occupational Safety and Health (NIOSH) currently recommends that workers breathe as little 1,1-dichloroethene as possible.

Glossary

Carcinogen: A substance that can cause cancer.
CAS: Chemical Abstracts Service.
Ingesting: Taking food or drink into your body.
ppm: Parts per million.
Tumor: An abnormal mass of tissue.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 1994. Toxicological profile for 1,1-dichloroethene. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop E-29, Atlanta, GA 30333. Phone:1-888-422-8737, FAX: 404-498-0093. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

(Link to Public Health Statement)

ATSDR

AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

BENZENE

CAS # 71-43-2

Division of Toxicology and Environmental Medicine ToxFAQs™ **August 2007**

This fact sheet answers the most frequently asked health questions (FAQs) about benzene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Benzene is a widely used chemical formed from both natural processes and human activities. Breathing benzene can cause drowsiness, dizziness, and unconsciousness; long-term benzene exposure causes effects on the bone marrow and can cause anemia and leukemia. Benzene has been found in at least 1,000 of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is benzene?

Benzene is a colorless liquid with a sweet odor. It evaporates into the air very quickly and dissolves slightly in water. It is highly flammable and is formed from both natural processes and human activities.

Benzene is widely used in the United States; it ranks in the top 20 chemicals for production volume. Some industries use benzene to make other chemicals which are used to make plastics, resins, and nylon and other synthetic fibers. Benzene is also used to make some types of rubbers, lubricants, dyes, detergents, drugs, and pesticides. Natural sources of benzene include emissions from volcanoes and forest fires. Benzene is also a natural part of crude oil, gasoline, and cigarette smoke.

What happens to benzene when it enters the environment?

- Industrial processes are the main source of benzene in the environment.
- Benzene can pass into the air from water and soil.
- It reacts with other chemicals in the air and breaks down within a few days.
- Benzene in the air can attach to rain or snow and be carried back down to the ground.
- It breaks down more slowly in water and soil, and can pass through the soil into underground water.
- Benzene does not build up in plants or animals.

How might I be exposed to benzene?

- Outdoor air contains low levels of benzene from tobacco smoke, automobile service stations, exhaust from motor vehicles, and industrial emissions.
- Vapors (or gases) from products that contain benzene, such as glues, paints, furniture wax, and detergents, can also be a source of exposure.
- Air around hazardous waste sites or gas stations will contain higher levels of benzene.
- Working in industries that make or use benzene.

How can benzene affect my health?

Breathing very high levels of benzene can result in death, while high levels can cause drowsiness, dizziness, rapid heart rate, headaches, tremors, confusion, and unconsciousness. Eating or drinking foods containing high levels of benzene can cause vomiting, irritation of the stomach, dizziness, sleepiness, convulsions, rapid heart rate, and death.

The major effect of benzene from long-term exposure is on the blood. Benzene causes harmful effects on the bone

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BENZENE
CAS # 71-43-2

marrow and can cause a decrease in red blood cells leading to anemia. It can also cause excessive bleeding and can affect the immune system, increasing the chance for infection.

Some women who breathed high levels of benzene for many months had irregular menstrual periods and a decrease in the size of their ovaries, but we do not know for certain that benzene caused the effects. It is not known whether benzene will affect fertility in men.

How likely is benzene to cause cancer?

Long-term exposure to high levels of benzene in the air can cause leukemia, particularly acute myelogenous leukemia, often referred to as AML. This is a cancer of the blood-forming organs. The Department of Health and Human Services (DHHS) has determined that benzene is a known carcinogen. The International Agency for Research on Cancer (IARC) and the EPA have determined that benzene is carcinogenic to humans.

How can benzene affect children?

Children can be affected by benzene exposure in the same ways as adults. It is not known if children are more susceptible to benzene poisoning than adults.

Benzene can pass from the mother's blood to a fetus. Animal studies have shown low birth weights, delayed bone formation, and bone marrow damage when pregnant animals breathed benzene.

How can families reduce the risks of exposure to benzene?

Benzene exposure can be reduced by limiting contact with gasoline and cigarette smoke. Families are encouraged not to smoke in their house, in enclosed environments, or near their children.

Is there a medical test to determine whether I've been exposed to benzene?

Several tests can show if you have been exposed to benzene. There is a test for measuring benzene in the breath; this test must be done shortly after exposure. Benzene can also be measured in the blood; however, since benzene disappears rapidly from the blood, this test is only useful for recent exposures.

In the body, benzene is converted to products called metabolites. Certain metabolites can be measured in the urine. The metabolite S-phenylmercapturic acid in urine is a sensitive indicator of benzene exposure. However, this test must be done shortly after exposure and is not a reliable indicator of how much benzene you have been exposed to, since the metabolites may be present in urine from other sources.

Has the federal government made recommendations to protect human health?

The EPA has set the maximum permissible level of benzene in drinking water at 5 parts benzene per billion parts of water (5 ppb).

The Occupational Safety and Health Administration (OSHA) has set limits of 1 part benzene per million parts of workplace air (1 ppm) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Benzene (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

CARBON TETRACHLORIDE

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

CAS # 56-23-5

Division of Toxicology ToxFAQs™ **August 2005**

This fact sheet answers the most frequently asked health questions (FAQs) about carbon tetrachloride. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Carbon tetrachloride does not occur naturally. Exposure to this substance results mostly from breathing air, drinking water, or coming in contact with soil that is contaminated with it. Exposure to very high amounts of carbon tetrachloride can damage the liver, kidneys, and nervous system. Carbon tetrachloride can cause cancer in animals. Carbon tetrachloride has been found in at least 425 of the 1,662 National Priority List sites identified by the Environmental Protection Agency (EPA).

What is carbon tetrachloride?

Carbon tetrachloride is a manufactured chemical that does not occur naturally. It is a clear liquid with a sweet smell that can be detected at low levels. It is also called carbon chloride, methane tetrachloride, perchloromethane, tetrachloroethane, or benziform.

Carbon tetrachloride is most often found in the air as a colorless gas. It is not flammable and does not dissolve in water very easily. It was used in the production of refrigeration fluid and propellants for aerosol cans, as a pesticide, as a cleaning fluid and degreasing agent, in fire extinguishers, and in spot removers. Because of its harmful effects, these uses are now banned and it is only used in some industrial applications.

What happens to carbon tetrachloride when it enters the environment?

- It moves very quickly into the air upon release, so most of it is in the air.
- It evaporates quickly surface water.
- Only a small amount sticks to soil particles; the rest evaporates or moves into the groundwater.
- It is very stable in air (lifetime 30-100 years).
- It can be broken down or transformed in soil and water within several days.
- When it does break down, it forms chemicals that can destroy ozone in the upper atmosphere.
- It does not build up in animals. We do not know if it build up in plants.

How might I be exposed to carbon tetrachloride?

- Breathing contaminated air near manufacturing plants or waste sites.
- Breathing workplace air when it is used.
- Drinking contaminated water near manufacturing plants and waste sites.
- Breathing contaminated air and skin contact with water while showering or cooking with contaminated water.
- Swimming or bathing in contaminated water.
- Contact with or eating contaminated soil (pica child) at waste sites.

How can carbon tetrachloride affect my health?

High exposure to carbon tetrachloride can cause liver, kidney, and central nervous system damage. These effects can occur after ingestion or breathing carbon tetrachloride, and possibly from exposure to the skin. The liver is especially sensitive to carbon tetrachloride because it enlarges and cells are damaged or destroyed. Kidneys also are damaged, causing a build up of wastes in the blood. If exposure is low and brief, the liver and kidneys can repair the damaged cells and function normally again. Effects of carbon tetrachloride are more severe in persons who drink large amounts of alcohol.

If exposure is very high, the nervous system, including the brain, is affected. People may feel intoxicated and experience headaches, dizziness, sleepiness, and nausea and vomiting. These effects may subside if exposure is stopped, but in severe cases, coma and even death may occur.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service
Agency for Toxic Substances and Disease Registry

CARBON TETRACHLORIDE

CAS # 56-23-5

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html

There have been no studies of the effects of carbon tetrachloride on reproduction in humans, but studies in rats showed that long-term inhalation may cause decreased fertility.

How likely is carbon tetrachloride to cause cancer?

Studies in humans have not been able to determine whether or not carbon tetrachloride can cause cancer because usually there has been exposure to other chemicals at the same time. Swallowing or breathing carbon tetrachloride for years caused liver tumors in animals. Mice that breathed carbon tetrachloride also developed tumors of the adrenal gland.

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, whereas the EPA determined that carbon tetrachloride is a probable human carcinogen.

How can carbon tetrachloride affect children?

The health effects of carbon tetrachloride have not been studied in children, but they are likely to be similar to those seen in adults exposed to the chemical. We do not know whether children differ from adults in their susceptibility to carbon tetrachloride.

A few survey-type studies suggest that maternal drinking water exposure to carbon tetrachloride might possibly be related to certain birth defects. Studies in animals showed that carbon tetrachloride can cause early fetal deaths, but did not cause birth defects. A study with human breast milk in a test tube suggested that it would be possible for carbon tetrachloride to pass from the maternal circulation to breast milk, but there is no direct demonstration of this occurring.

How can families reduce the risks of exposure to carbon tetrachloride?

❏ Discard any product that contains carbon tetrachloride that you may have at home and may have used in the past.

❏ Household chemicals should be stored out of the reach of children in their original containers.

❏ Sometimes older children sniff household chemical products to get high. Talk to your children about the dangers of sniffing chemicals.

Is there a medical test to determine whether I've been exposed to carbon tetrachloride?

Several sensitive and specific tests are available to measure carbon tetrachloride in exposed persons. The most convenient way is simply to measure carbon tetrachloride in the exhaled air. Carbon tetrachloride also can be measured in blood, fat, or other tissues. These tests are not usually done in the doctor's office because they require special equipment. Although these tests can show that a person has been exposed to carbon tetrachloride, the results cannot be used to reliably predict whether any adverse health effect might result. Because carbon tetrachloride leaves the body fairly quickly, these methods are best suited to detecting exposures that have occurred within the last several days.

Has the federal government made recommendations to protect human health?

The EPA has set a limit for carbon tetrachloride in drinking water of 5 parts of carbon tetrachloride per billion parts of water (5 ppb). The EPA has also set limits on how much carbon tetrachloride can be released from an industrial plant into waste water and is preparing to set limits on how much carbon tetrachloride can escape from an industrial plant into outside air.

The Occupational Safety and Health Administration (OSHA) set a limit of 10 ppm for carbon tetrachloride in workplace air for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological Profile for Carbon Tetrachloride (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-0093. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

(Link to Public Health Statement)

Appendix E

ATSDR Public Health Hazard Levels

ATSDR categories for exposure pathways at hazardous waste sites are as follows:

Urgent Public Health Hazard:	This category applies to exposure pathways and sites that have certain physical features or evidence of short-term (less than 1 year), site- related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed
Public Health Hazard:	The category applies to exposure pathways and sites that have certain physical features or evidence of chronic (long-term), site-related chemical exposure that could result in adverse health effects.
Indeterminate Public Health Hazard:	The category applies to exposure pathways and sites where important information is lacking about chemical exposures, and a health determination cannot be made.
No Apparent Public Health Hazard:	The category applies to pathways and sites where exposure to site- related chemicals may have occurred in the past or is still occurring, however, the exposure is not at levels expected to cause adverse health effects.
No Public Health Hazard:	The category applies to pathways and sites where there is evidence of an absence of exposure to site-related chemicals.

Appendix F

ATSDR Glossary

Appendix E - ATSDR Glossary

Absorption
The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

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 [compare with antagonistic effect and synergistic effect].

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

Aerobic
Requiring oxygen [compare with anaerobic].

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

Anaerobic
Requiring the absence of oxygen [compare with aerobic].

Analyte
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

Analytic epidemiologic study
A study that evaluates the association between exposure to hazardous substances and disease by testing scientific hypotheses.

Antagonistic effect
A biologic response to exposure to multiple substances that is less than would be expected if the known effects of the individual substances were added together [compare with additive effect and synergistic effect].

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

Biodegradation
Decomposition or breakdown of a substance through the action of microorganisms (such as bacteria or fungi) or other natural physical processes (such as sunlight).

Biologic indicators of exposure study
A study that uses (a) biomedical testing or (b) the measurement of a substance [an analyte], its metabolite, or another marker of exposure in human body fluids or tissues to confirm human exposure to a hazardous substance [also see exposure investigation].

Biologic monitoring
Measuring hazardous substances in biologic materials (such as blood, hair, urine, or breath) to determine whether exposure has occurred. A blood test for lead is an example of biologic monitoring.

Biologic uptake
The transfer of substances from the environment to plants, animals, and humans.

Biomedical testing
Testing of persons to find out whether a change in a body function might have occurred because of exposure to a hazardous substance.

Biota
Plants and animals in an environment. Some of these plants and animals might be sources of food, clothing, or medicines for people.

Body burden
The total amount of a substance in the body. Some substances build up in the body because they are stored in fat or bone or because they leave the body very slowly.

CAP See Community Assistance Panel.

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

Cancer risk
A theoretical risk of 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.

Case study
A medical or epidemiologic evaluation of one person or a small group of people to gather information about specific health conditions and past exposures.

Case-control study
A study that compares exposures of people who have a disease or condition (cases) with people who do not have the disease or condition (controls). Exposures that are more common among the cases may be considered as possible risk factors for the disease.

CAS registry number
A unique number assigned to a substance or mixture by the American Chemical Society Abstracts Service.

Central nervous system
The part of the nervous system that consists of the brain and the spinal cord.

CERCLA [see Comprehensive Environmental Response, Compensation, and Liability Act of 1980]

Chronic
Occurring over a long time (more than 1 year) [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure].

Cluster investigation
A review of an unusual number, real or perceived, of health events (for example, reports of cancer) grouped together in time and location. Cluster investigations are designed to confirm case reports; determine whether they represent an unusual disease occurrence; and, if possible, explore possible causes and contributing environmental factors.

Community Assistance Panel (CAP)
A group of people, from a community and from health and environmental agencies, who work with ATSDR to resolve issues and problems related to hazardous substances in the community. CAP members work with ATSDR to gather and review community health concerns, provide information on how people might have been or might now be exposed to hazardous substances, and inform ATSDR on ways to involve the community in its activities.

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.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response,
Compensation, and Liability Act of 1980 (CERCLA) CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

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.

Delayed health effect
A disease or injury that happens as a result of exposures that might have occurred in the past.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Descriptive epidemiology
The study of the amount and distribution of a disease in a specified population by person, place, and time.

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

Disease prevention
Measures used to prevent a disease or reduce its severity.

Disease registry
A system of ongoing registration of all cases of a particular disease or health condition in a defined population.

DOD
United States Department of Defense.

DOE
United States Department of Energy.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An "exposure dose" is how much of a substance is encountered in the environment. An "absorbed dose" is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose (for radioactive chemicals)
The radiation dose is the amount of energy from radiation that is actually absorbed by the body. This is not the same as measurements of the amount of radiation in the environment.

Dose-response relationship
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

Environmental media
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Environmental media and transport mechanism
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur.

EPA
United States Environmental Protection Agency.

Epidemiologic surveillance
The ongoing, systematic collection, analysis, and interpretation of health data. This activity also involves timely dissemination of the data and use for public health programs.

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 assessment
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

Exposure-dose reconstruction
A method of estimating the amount of people's past exposure to hazardous substances. Computer and approximation methods are used when past information is limited, not available, or missing.

Exposure investigation
The collection and analysis of site-specific information and biologic tests (when appropriate) to determine whether people have been exposed to hazardous substances.

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

Exposure registry
A system of ongoing followup of people who have had documented environmental exposures.

Feasibility study
A study by EPA to determine the best way to clean up environmental contamination. A number of factors are considered, including health risk, costs, and what methods will work well.

Geographic information system (GIS)
A mapping system that uses computers to collect, store, manipulate, analyze, and display data. For example, GIS can show the concentration of a contaminant within a community in relation to points of reference such as streets and homes.

Grand rounds
Training sessions for physicians and other health care providers about health topics.

Groundwater
Water beneath the earth's surface in the spaces between soil particles and between rock surfaces [compare with surface water].

Half-life ($t_{1/2}$)
The time it takes for half the original amount of a substance to disappear. In the environment, the half-life is the time it takes for half the original amount of a substance to disappear when it is changed to another chemical by bacteria, fungi, sunlight, or other chemical processes. In the

human body, the half-life is the time it takes for half the original amount of the substance to disappear, either by being changed to another substance or by leaving the body. In the case of radioactive material, the half life is the amount of time necessary for one half the initial number of radioactive atoms to change or transform into another atom (that is normally not radioactive). After two half lives, 25% of the original number of radioactive atoms remain.

Hazard
A source of potential harm from past, current, or future exposures.

Hazardous Substance Release and Health Effects Database (HazDat)
The scientific and administrative database system developed by ATSDR to manage data collection, retrieval, and analysis of site-specific information on hazardous substances, community health concerns, and public health activities.

Hazardous waste
Potentially harmful substances that have been released or discarded into the environment.

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 [compare with public health assessment].

Health education
Programs designed with a community to help it know about health risks and how to reduce these risks.

Health investigation
The collection and evaluation of information about the health of community residents. This information is used to describe or count the occurrence of a disease, symptom, or clinical measure and to estimate the possible association between the occurrence and exposure to hazardous substances.

Health promotion
The process of enabling people to increase control over, and to improve, their health.

Health statistics review
The analysis of existing health information (i.e., from death certificates, birth defects registries, and cancer registries) to determine if there is excess disease in a specific population, geographic area, and time period. A health statistics review is a descriptive epidemiologic study.

Indeterminate public health hazard
The category used in ATSDR's public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

Incidence
The number of new cases of disease in a defined population over a specific time period [contrast with prevalence].
Ingestion
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

Inhalation
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

Intermediate duration exposure
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

In vitro
In an artificial environment outside a living organism or body. For example, some toxicity testing is done on cell cultures or slices of tissue grown in the laboratory, rather than on a living animal [compare with in vivo].

In vivo
Within a living organism or body. For example, some toxicity testing is done on whole animals, such as rats or mice [compare with in vitro].

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.

Maximum Contaminant Level (MCL)
The highest level of a contaminant that EPA allows in drinking water. MCLs ensure that drinking water does not pose either a short-term or long-term health risk. EPA sets MCLs at levels that are economically and technologically feasible. Some states set MCLs which are more strict than EPA's.

Medical monitoring
A set of medical tests and physical exams specifically designed to evaluate whether an individual’s exposure could negatively affect that person’s health.

Metabolism
The conversion or breakdown of a substance from one form to another by a living organism.

Metabolite
Any product of metabolism.

mg/kg
Milligram per kilogram.

mg/cm^2
Milligram per square centimeter (of a surface).

mg/m^3
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

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 [see reference dose].

Morbidity
State of being ill or diseased. Morbidity is the occurrence of a disease or condition that alters health and quality of life.

Mortality
Death. Usually the cause (a specific disease, condition, or injury) is stated.

Mutagen
A substance that causes mutations (genetic damage).

Mutation
A change (damage) to the DNA, genes, or chromosomes of living organisms.

National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR's public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful 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.

No public health hazard
A category used in ATSDR's public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Physiologically based pharmacokinetic model (PBPK model)
A computer model that describes what happens to a chemical in the body. This model describes how the chemical gets into the body, where it goes in the body, how it is changed by the body, and how it leaves the body.

Pica
A craving to eat nonfood items, such as dirt, paint chips, and clay. Some children exhibit pica-related behavior.

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

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Prevalence
The number of existing disease cases in a defined population during a specific time period [contrast with incidence].

Prevalence survey
The measure of the current level of disease(s) or symptoms and exposures through a questionnaire that collects self-reported information from a defined population.

Prevention
Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.

Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR's public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting
A public forum with community members for communication about a site.

Radioisotope
An unstable or radioactive isotope (form) of an element that can change into another element by giving off radiation.
Radionuclide
Any radioactive isotope (form) of any element.

RCRA [See Resource Conservation and Recovery Act (1976, 1984)]

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

Registry
A systematic collection of information on persons exposed to a specific substance or having specific diseases [see exposure registry and disease registry].

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

Resource Conservation and Recovery Act (1976, 1984) (RCRA)
This Act regulates management and disposal of hazardous wastes currently generated, treated, stored, disposed of, or distributed.

RFA
RCRA Facility Assessment. An assessment required by RCRA to identify potential and actual releases of hazardous chemicals.

RfD See reference dose

Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

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].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

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.

Sample size
The number of units chosen from a population or environment.

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

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.

Substance
A chemical.

Substance-specific applied research
A program of research designed to fill important data needs for specific hazardous substances identified in ATSDR's toxicological profiles. Filling these data needs would allow more accurate assessment of human risks from specific substances contaminating the environment. This research might include human studies or laboratory experiments to determine health effects resulting from exposure to a given hazardous substance.

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Surveillance [see epidemiologic surveillance]

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Synergistic effect
A biologic response to multiple substances where one substance worsens the effect of another substance. The combined effect of the substances acting together is greater than the sum of the effects of the substances acting by themselves [see additive effect and antagonistic effect].

Teratogen
A substance that causes defects in development between conception and birth. A teratogen is a substance that causes a structural or functional birth defect.

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents which, under certain circumstances of exposure, can cause harmful effects to living organisms.

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.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

Urgent public health hazard
A category used in ATSDR's public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.

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