Public Health Assessment

Final Release

CTS/MILLS GAP ROAD SITE
ASHEVILLE, BUNCOMBE COUNTY, NORTH CAROLINA

EPA FACILITY ID: NCSFN0406988

Prepared by the
North Carolina Department of Health and Human Services

JANUARY 20, 2011

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR's Cooperative Agreement Partner pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR's Cooperative Agreement Partner has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR's Cooperative Agreement Partner addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR's Cooperative Agreement Partner which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared by:

North Carolina Department of Health and Human Services
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

AF	Attenuation factor
AT	Averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Center for Disease Control and Prevention
CF	Conversion factor
cm	Centimeter
CREG	ATSDR Cancer Risk Evaluation Guide
CR	Contact rate
CV	Comparison Value
DAF	Dermal absorption efficiency
DWM	N.C. DENR Davison of Waste Management
DWQ	N.C. DENR Davison of Water Quality
ED	Exposure duration
EF	Exposure frequency
EMEG	ATSDR Environmental Media Evaluation Guide
EQRR	EQ Resource Recovery
IRi	Inhalation rate
IUR	Inhalation Unit Risk factor
Kg	Kilogram
L	Liter
LOAEL	Lowest Observed Adverse Effect Level
MCLG	EPA Maximum Contaminant Level Goal
MCL	EPUSA Maximum Contaminant Level
M	Meter
mg	milligram
µg/dL	micro-gram per deci-liter
µg/m^3	micro-gram per cubic meter
µg	microgram
ng	nano-gram
NA	Not applicable
N.C. DENR	North Carolina Department of the Environment and Natural Resources
N.C. DHHS	North Carolina Department of Health and Human Services
NIOSH	National Institute for Occupational Safety and Health
NOAEL	No Observed Adverse Effect Level
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
EPA	U.S. Environmental Protection Agency
VOC	Volatile organic compound

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

SUMMARY

INTRODUCTION

The N.C. Division of Public Health (DPH) understands the community's concerns about contact with chemicals from the CTS/Mills Gap Road ("CTS") site. The N.C. DPH's top priority is to make sure the community near the site has the best science information available to safeguard its health.

The DPH performed a comprehensive evaluation of available environmental analytical data associated with the CTS site. This public health assessment evaluates potential public health hazards related to exposures to contaminated groundwater, drinking water, soil, surface water, and outdoor and indoor air on and near the CTS/Mills Gap Road site near Asheville, NC (EPA site ID: NCSFN0406988). This report discusses environmental samples associated with the site collected from 1990 through August 2008. It also discusses private well samples collected through January 2008. Discussions of subsequent private well samples are provided in a separate Health Consultation.

CTS and other operators manufactured electronic components on the site from 1952 until 1986 and related operations are believed to be the source of the chemical contamination. Contaminated soils and groundwater were identified on the CTS property and in surface waters leaving the property in 1991. Groundwater contamination associated with the CTS site was identified in July 1999 on a nearby property east of CTS. Also in 1999, chemical contamination (trichloroethylene [TCE]) was found in drinking water wells near the site, at which time residences in the area were connected to municipal drinking water supplies.

CONCLUSIONS

The N.C. DPH reached five conclusions in the public health assessment:

Conclusion 1

The DPH concludes that the residents using a private well identified in 1999 as contaminated with trichloroethylene (TCE), for possibly as long as 11 years, could have been harmed by drinking the water or breathing TCE escaping from the water to the household air.

Persons using two spring private wells serving one home until approximately 1994, and serving two other homes until 1999, could have been harmed by drinking the water or breathing TCE escaping from the water to the household air.

Basis for decision

TCE contamination was identified in three private wells serving three homes in July 1999 and the wells were disconnected. It is not known when the contamination first appeared in the well water, or what the range of TCE concentrations were over the time the well was being used. Some of the health issues reported by family members include those that have been associated with TCE contact. An increased cancer risk is indicated if the long-term occupants of the residence were in contact with TCE concentrations similar to those in the single well water sample collected in

	1999. Drinking water contaminated with TCE and breathing TCE volatilized from the drinking water supply over many years in large amounts may cause adverse health effects. These effects include increased risk of kidney or liver cancer; dizziness, lung irritation, impaired heart function; and nerve, kidney or liver damage. Reproductive effects such as impaired fetal growth or decreased fertility may also result. There may be an increased risk of birth defects or leukemia to children of women exposed during pregnancy.
Next steps	The DPH makes the following recommendations: Persons who lived at these locations and were in contact with TCE contaminated well water should have their health periodically evaluated by a physician. They should make their physician aware that they have been in contact with TCE. The medical evaluation should include routine testing of liver and kidney function, with urinalysis.
Conclusion 2	**The DPH concludes that other groundwater contaminants, including the volatile organic compound (VOC) trichloroethylene (TCE) and vinyl chloride, are not expected to harm people's health.**
Basis for decision	There is no indication that people have been drinking water that contains VOC contaminants observed in the groundwater samples. The concentrations of TCE and other contaminants related to the CTS site and detected in groundwater beyond the property (off-site) were lower than the levels expected to harm people's health. Vinyl chloride was found in groundwater on the CTS property, but not off-site. Long-term ingestion of vinyl chloride at the concentration observed in the on-site groundwater could result in both non-cancer harm to people's health and a moderate cancer risk. There is no potential for health effects if the vinyl chloride does not travel off-site and people are not exposed.
Next steps	The DPH makes the following recommendations: ▪ Monitor the concentration of contaminants in the groundwater moving off the CTS property, particularly vinyl chloride. ▪ Identify all users of private drinking water wells within the flow-path and at the leading edge of detected groundwater contamination. Periodically monitor their well water for volatile organic compounds (VOCs). Provide an alternative drinking water source if concentrations exceed regulatory or health-based guidelines.
Conclusion 3	**The DPH concludes that chemicals identified in the past and current samples of private well waters (other than those discussed in Conclusion 1), surface waters, sub-surface soils, crawl-space air, sub-**

surface soil gas and outdoor air are not expected to harm people's health.

Basis for decision

The concentrations of chemicals detected in the private well waters other than those collected in 1999 and discussed in Conclusion 1, surface waters, sub-surface soils, crawl-space air, sub-surface soil gas and outdoor air were compared to health effect studies of people and animals coming into contact with the chemicals. The levels measured in these samples were lower than the levels expected to harm health or to cause an increase in cancer rates.

Next steps

The DPH makes the following recommendations:

- Continue to limit access to contaminated stream and spring ("seep") surface waters near the east side of the CTS property.
- Continue monitoring of the potential for sub-surface volatile organic compounds to move into dwellings near the site and present an inhalation hazard.

Conclusion 4

The DPH cannot currently conclude whether groundwater with elevated concentrations of the metals chromium and lead could harm people's health. There is not adequate information to determine whether groundwater with elevated lead and chromium has been, or is, a source for private drinking water wells.

Basis for decision

There is no indication that people have been in contact with concentrations of lead or a toxic form of chromium (hexavalent chromium) in their private drinking water wells. Many people in the area have in the past and currently get their drinking water from private wells. Studies of groundwater flow in the area of the CTS site indicate that groundwater located at different depths are inter-connected and have been used as regional drinking water sources. The chromium and lead may not be related to the CTS site.

Lead in groundwater was found at concentrations greater than the health guideline value referenced by the N.C. Department of Health and Human Services (DHHS) for private well water supplies. It has not been confirmed that the groundwater with the elevated lead has been used, or will be used, as a drinking water source.

Elevated levels of chromium have been identified in groundwater in the area of the CTS property. If the chromium is present as substantial concentrations of hexavalent chromium, and the waters have been, or maybe used as a drinking water source, adverse non-cancer and cancer health effects could result from long-term ingestion.

Next steps

- The DPH makes the following recommendations:
- Determine if the groundwater supply with the elevated lead or chromium was or is being used as a drinking water source for private

wells.

- If the groundwater was used as a drinking water source, or may be used as a drinking water source in the future, gather current analytical data on lead, total chromium, and hexavalent chromium concentrations.
- Prevent the use of the groundwater supply as a drinking water source if lead or chromium is elevated to levels exceeding health or regulatory guidelines.
- Include lead and chromium analysis of private well water supplies monitored in the area of the CTS site.

Conclusion 5

The DPH N.C. Central Cancer Registry (CCR) determined that cancer rates for the population living in a 1-mile radius around the CTS property were not elevated.

Basis for decision

The CCR studied the number of cancers reported by health care providers in the area surrounding the CTS site to the expected number of cases in the same time period. The study focused on the types of cancers linked with TCE contact: liver cancer, renal cancer, and non-Hodgkin lymphoma. The results of the investigation indicate that the observed numbers of cases of these cancers fall within the expected range, and there is no evidence of a clustering of cancer cases in the study area.

The cancer evaluation is limited by the small population size of the study area and the availability of cancer records only since 1990. Because of the long latency period of most cancers the evaluation is also limited by the use of a person’s address at the time of diagnosis rather than the ability to identify if and where the critical exposure that led to cancer development took place.

Next steps

The DPH makes the following recommendations:

- Continued monitoring of cancer rates in the area around the CTS site.

For more information

If you have concerns about your health, you should contact your health care provider. Please call the N.C. Division of Public Health at (919) 707-5900, or send an e-mail to nchace@ncmail.net and ask for information on the CTS/Mills Gap Road Site Public Health Assessment.

PURPOSE AND HEALTH ISSUES

The North Carolina Department of Health and Human Services (N.C. DHHS) Division of Public Health (DPH) Epidemiology Branch, which is a cooperative partner of the Agency for Toxic Substances and Disease Registry (ATSDR), was asked to conduct a public health assessment (PHA) on the CTS/Mills Gap Road (CTS) site by the North Carolina Department of the Environment and Natural Resources (N.C. DENR). The local community has expressed concern regarding concentrations of the volatile organic compound trichloroethylene (TCE) found in groundwater and private drinking water wells on and around the CTS site. Historical electroplating and associated operations on the CTS property are believed to be the source of the contamination. The U.S. Environmental Protection Agency (EPA) and the N.C. DENR have on-going investigation and remediation efforts associated with the TCE contamination. The CTS PHA evaluates past and current environmental sampling data and the public health significance of human exposures to contaminants found in environmental media on the site and surrounding properties. Groundwater, private well water, sub-surface soils and soil vapors, outdoor air, and residential crawl-space air surveys from homes in the vicinity of the CTS site were evaluated. This report discusses environmental samples associated with the site collected from 1990 through August 2008. It also discusses private well samples collected through January 2008. Discussions of subsequent private well samples are provided in a separate Health Consultation. This document discusses the potential public health impacts related to chemicals found at the CTS site and provides recommendations for actions to prevent, reduce, and further identify the possibility of site-related exposures that could result in adverse health effects.

BACKGROUND

SITE DESCRIPTION AND HISTORY

The former CTS Site is located off Mills Gap Road, approximately one mile east of Skyland, near Asheville, in Buncombe County, North Carolina (Appendix A, Figure 1). The site consists of approximately nine acres of maintained grounds containing a large single-story building. The nine-acre fenced property represents the core industrial portion of the original 54 acre CTS holding. The remaining 46 acres were parceled and sold to developers for residential development. The area surrounding the Mills Gap Road facility is a mix of residential and industrial properties. The closest residence is approximately 70 feet from the fence line surrounding the 9-acre CTS site.

The former CTS site operated as an electroplating facility for approximately thirty-four years. Electroplating operations began on the site in 1952 by IRC, Inc. when the land was purchased and the building constructed. CTS, Inc. bought the site in 1959. CTS operated an electroplating facility on the site from 1959 until 1986. Both IRC and CTS employed the chlorinated organic compound trichloroethylene (also known as TCE) to clean or degrease metal objects in the electroplating process. Mills Gap Road Associates (MGRA) purchased the property in 1987 and is the current owner (OSC 2009).

A screening site inspection (SSI) was completed in February 1991 by the NUS Corporation, an EPA contractor. The objective of the SSI was to characterize site contaminants and determine if a release had or may occur, and to identify possible migration pathways and potentially exposed populations. Concentrations of metals and organics were identified in soil, sediments and surface water samples collected on the CTS property at concentrations greater than typical background levels, and in some cases regulatory levels. The detected contaminants were consistent with those associated with electroplating operations. No site-related contamination was found in a ground water sample collected from what was identified by the EPA contractor as the nearest private well, located 4,000 feet northwest of the site. The study recommended no further remedial action for the site (NUS 1991). [Subsequent environmental studies at the site indicated that the private well sample collected in 1991 was not in the direction of groundwater flow from the site.]

The site was identified during follow-up on a citizen complaint in July 1999 by the North Carolina Department of Environment and Natural Resources (N.C. DENR). A taste and odor complaint was registered for a potable supply spring southeast of the plant. High concentrations of chlorinated solvents were identified in two springs and one domestic well, located topographically down-gradient from the site.

In August 1999, the N.C. DENR referred the Site to the EPA's Emergency Response and Removal Branch (ERRB) for removal eligibility consideration. ERRB evaluations initiated in 1999 identified contamination of potable drinking water supplies with chlorinated organic compounds. High concentrations were found in two springs and one domestic well located down-gradient of the site. ERRB determined contamination of potable drinking water supplies with chlorinated organic compounds posed a threat to public health or welfare or the environment. Bottled water was provided to four households that had been using the contaminated drinking water sources, and they were ultimately connected to the Asheville-Buncombe municipal supply.

Samples collected in 2001 from beneath the former CTS plant revealed elevated concentrations of volatile organic compounds (VOCs, including TCE and benzene), semi-volatile organic compounds (SVOCs, including 2-methylnaphthalene and phenanthrene), and total petroleum hydrocarbons (TPH, as no. 2 fuel oil or diesel fuel). TCE was detected in all the samples and was typically the contaminant present at the highest concentration. Surface waters traveling off-site were also contaminated with VOCs and TPH. A soil vapor extraction (SVE) system was brought on-line in July 2007 for removal of VOCs from the subsurface (OSC 2009). The SVE system is still in operation.

Following mitigation of the immediate threat posed by the contaminated springs and water well, EPA entered into negotiations with the identified Potentially Responsible Parties and executed an Administrative Order on Consent (AOC) with CTS Corporation and Mills Gap Road Associates in January 2004. On-site removal activities began in June 2004 (EPA, 2007).

Currently, the NC Division of Waste Management (DWM) is working in its role as a support agency to EPA as they work with the responsible parties to remove imminent threats to public health and the environment at the CTS site.

DEMOGRAPHICS

According to Census 2000 data, approximately 2,979 people live within one mile of the CTS site. Census figures show a predominantly White population (94% compared to 72% in the state and 75% in the U.S.). Other ethnic groups include 2% African-Americans, 0.7% Hispanics, 3% Asians, and 0.5% American Indians (see Appendix C, Table 1).

The education level of the population in this area is higher than the rest of the state with 92% of the population having earned a high school diploma or above, compared to 77% for the rest of the state and 80% for the total U.S. population. The percentage of individuals living below the poverty level in this area is also lower than the rest of the population, with a 3% compared to 12% in the rest of the state and in the rest of the U.S. There are 1,288 housing units occupied, with 74% occupied by the owner, and 26% occupied by renters.

SITE GEOLOGY AND HYDROGEOLOGY

The CTS site is underlain by saprolite materials, described as reddish brown silty or clayey soils near the surface and underlain by sandy silt and silty sand, developed by weathering of crystalline rock. The saprolite material ranges from approximately 28 to 81 feet thick beneath the site and in adjacent areas. Saprolite materials have the capacity to act as reservoirs, storing water that infiltrates the soil, including precipitation, surface water that runs onto the site, and water disposed on the site. The saprolite materials under the site consist of dry materials nearer the surface with underlying moist and wet materials of varying thickness underneath, all perched above garnet-mica bedrock. Bedrock beneath the saprolite materials are metasedimentary and metavolcanic rocks. Contaminants from the site migrate downward through the porous saprolite material to the impervious bedrock, where they tend to pool up, and also to move into fractures in the bedrock. Some of the contamination then migrates laterally in groundwater, both through bedrock fractures and along the top of the bedrock, until it discharges at springs (“seeps”), or into streams downhill from the site (TNA 2008). A 2009 study indicated a groundwater divide is present in the north central portion of the site, with the position of the divide changing in response to precipitation. In the southern portion of the site the groundwater flows to the north and east. Groundwater in the central portion of the site flows to the northwest and east/southeast. Springs are located east and west of the site (MACTEC 2009).

SITE VISIT

The N.C. DPH conducted a site visit of the CTS site in April 2009. The site included a chain-linked fenced area enclosing a large area that included a single large building and a small guard shack located at the entrance gate to the fenced area. The majority of the site is currently covered with over-grown grass, with small areas covered by asphalt. A group of 55-gallon drums was observed located near the guard shack. Multiple “no trespassing” signs were observed on the Mills Gap Road side of the fence, including a large “warning - no trespassing” sign that included the U.S. EPA and N.C. DENR logos. The area surrounding the site includes primarily single family residences and a few small business/industrial facilities. A fenced area was observed east of the CTS property that presumably encloses the springs adjacent to the site.

COMMUNITY HEALTH CONCERNS

The Buncombe County Health Department held several community meetings (the most recent on October 29, 2008 and April 21, 2009) to address community questions and concerns about the former CTS site, including groundwater and soil vapor contamination. Buncombe County, EPA, ATSDR, N.C. DENR and N.C. DHHS representatives were available for questions during these meetings. The agenda of the public meetings included a site history, chronology of events, the federal and state response, and public health issues associated with the contamination at the site. Most of the local residents attending the public meeting were concerned about contamination in their drinking water wells. Some residents wanted to know if their wells were "safe" and if there was the potential for the contaminants to impact their drinking water supply. Citizens also were concerned with outdoor exposures to vapors, such as children playing outdoors or waiting at a bus stop. Concerns were also expressed regarding property values in association with contaminated well waters. Although health and environmental representatives would not address specific well water sampling results for individual residents during the public meetings, the appropriate representative was available to speak with residents one-on-one after the meetings. N.C. DPH prepared two documents in October 2007 to address community health concerns; *Frequently Asked Questions (FAQs), Mills Gap (former CTS Plant) Site, Asheville, NC* and *Trichloroethylene (TCE) Fact Sheet and FAQs*. A list of community concerns gathered during public meetings and the documents referenced above are included in Appendix G.

The N.C. DPH performed a comprehensive evaluation of past and current environmental analytical data associated with the CTS site. The intent was to evaluate the potential health risks associated with the contaminants identified in the data across all potential exposure scenarios and address the concerns voiced by the community. The DPH's evaluation incorporated highly protective health effect assumptions of the potential for exposure and exposure concentrations. The objective is to protect public health and to provide the community with a public health assessment that evaluates the "worst-case" exposures and minimizes uncertainties related to identifying potential health effects. While the "contaminant of concern" for the CTS site was identified as TCE, DPH's health evaluation included all chemicals detected in the drinking water, ground water, surface water, soil, and air samples. Concerns expressed by the community included those associated with soil, indoor and outdoor air, drinking water, and surface water contamination. The DPH addressed these concerns as is reflected in the discussions and recommendations provided in this report.

Community members were also concerned with the potential for increased cancer rates in the area around the former CTS facility. This concern was addressed by the N.C. DHHS Central Cancer Registry Center for Health Statistics in a report dated August 1, 2008 (see Appendix H). Cancer rates for Buncombe County and a 1-mile radius around the CTS site were found to be typical of the numbers and types of cancers expected in North Carolina.

DISCUSSION

The ATSDR Health Effects Evaluation Process

This section provides a summary of the ATSDR health effects evaluation process. A more detailed discussion is provided in Appendix D.

The ATSDR health effects evaluation process consists of two steps: a screening analysis, and at some sites, based on the results of the screening analysis and community health concerns, a more in-depth analysis to determine possible public health implications of site-specific exposure estimates.

The two step screening analysis process provides a consistent means to identify site contaminants that need to be evaluated more closely through the use of "comparison values" (CVs). The first step of the screening analysis is the "environmental guideline comparison" which involves comparing site contaminant concentrations to water, soil, air, or food chain comparison values derived by ATSDR from standard exposure default values. The highest concentration of a chemical found for each sample set is compared to CVs to provide a "worst-case" exposure estimate. The average concentration for chemicals found in multiple samples is also compared to CVs to provide an "average" exposure estimate. The second step is the "health guideline comparison" and involves looking more closely at site-specific exposure conditions, estimating exposure doses, and comparing the dose estimate to dose-based health-effect comparison values.

ATSDR comparison values are set at levels that are highly health protective, well below levels known or anticipated to result in adverse health effects. When chemicals are found on a site at concentrations greater than the screening values (CVs) it does not mean that adverse health effects would be expected. CVs are set at levels well below concentrations of known health effects to serve as a highly health protective initial screen of human exposure to chemicals. Contaminant concentrations at or below the CV may reasonably be considered safe. Those chemicals that are greater than the CV undergo further evaluation.

After completing a screening analysis, site contaminants are divided into two categories. Those not exceeding CVs do not require further analysis. Contaminants exceeding CVs are selected for a more in-depth site-specific analysis to evaluate the likelihood of possible harmful health effects. Contaminant concentrations exceeding the appropriate CVs are further evaluated against ATSDR health guidelines (HGs). 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. N.C. DPH also retained for further assessment contaminants that are known or suspected to be cancer-causing agents. To determine exposure dose, N.C. DPH uses standard assumptions about body weight, ingestion or inhalation rates, and duration of exposure. Important factors in determining the potential for adverse health effects include the concentration of the chemical, the duration of exposure, the route of exposure, and the health status of those exposed. Site contaminant concentrations and site-specific exposure conditions are used to make greatly health protective estimates of site-specific exposure doses for children and adults that are compared to ATSDR health guidelines. An exposure dose is an estimate of how much of a substance a person may come into contact with based on their actions and habits.

Increased numbers of cancers over the number that would be expected in a population are estimated for chemicals suspected or known to cause cancer. Estimates of increased numbers of cancers are calculated using the estimated site-specific exposure dose and a chemical's cancer slope factor (CSF) provided in ATSDR health guideline documents. This calculation is based on the highly health protective assumption that there is no safe level of exposure to a chemical that causes cancer. However, the calculated risk is not exact and tends to overestimate the actual risk, if any, associated with conditions of the site-specific exposure that may have occurred. This increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in the exposed population, but estimates an additional cancer risk for the exposed population. The cancer risk is expressed as the number of additional cancers over the number of cancers that occur in a population without these exposures. The N.C. Central Cancer Registry states that one out of every two men and one out of every three women will develop a cancer of some type during his or her lifetime.

Exposure dose estimates are also compared to data collected in animal and human health effect studies for the chemical of concern on the site. The health effects data are generally taken from ATSDR or EPA references that summarize data from studies that have undergone extensive validation review. Comparisons are made for non-cancer and cancer health effects, where applicable. Comparisons are made on the basis of the exposure route (ingestion/eating, inhalation/breathing, or skin contact) and the length of the exposure. Preference is given to human study data and chemical doses or concentrations where no adverse health effects were observed, when available. Alternatively, animal data and the lowest chemical dose or concentration where adverse health effects were observed is used for comparison. More detailed discussion of the process used to determine potential adverse health effects is provided in Appendix D.

There are limitations inherent to the public health assessment process. These include the limitations of the analytical data available for a site, the health effect study information, and the risk estimation process. To overcome some of these limitations, highly health protective (or "worst-case") assumptions are used to evaluate site data and interpret the potential for adverse health effects. ATSDR screening values (CVs) and health guideline values (HGs) incorporate large margins of safety to be highly health protective and protect groups of the exposed population that may be particularly sensitive, such as children and the elderly. Exposure concentrations are calculated using the highest concentration of a chemical found in the water, soil or air on the site. Large margins of safety are again used when comparing exposure concentrations to the health effect study data. The assumptions, interpretations, and recommendations made throughout this public health assessment err in the direction of protecting public health.

Site-Specific Exposures

Groundwater was evaluated for ingestion exposures related to drinking water supplies using standard ATSDR exposure assumptions. Surface water samples were evaluated for incidental (unintended) ingestion by children during recreational swimming, using highly health protective exposure parameters (1 hour of swimming activity per week for 26 weeks a year for 10 years, and ingestion of 50 ml of surface water [1.7 oz.] per event). Soils were also evaluated for incidental ingestion by children and adults, as well as pica-behavior child ingestion rates. Soil ingestion can occur by the unintentional intake of soil on hands or food items and the mouthing of objects. Pica-behavior soil ingestion involves ingesting unusually high amounts of soil. ATSDR uses a conservative value for child pica ingestion rates, 5,000 mg/day (ATSDR 2005).

Residential crawl-space, sub-slab soil gas, outdoor (ambient) air, and sub-surface soil gas samples were evaluated for inhalation exposures. A 30-year exposure period was used as a highly health protective maximum exposure period to account for the lack of information on the time of subsurface contaminant transport on and off-site of the CTS property. A 30-year exposure period also represents the average maximum length of residence at a single location as determined for EPA risk assessment studies. Sub-slab and soil gas exposure estimates for volatile organic compounds (VOCs) were calculated by applying standard highly health protective “attenuation factors” to the analytical data. An attenuation factor represents the decrease in amount of vapor (gas) as it travels through the soil up into a building where it may be inhaled. Attenuation factors were taken from EPA guidance (EPA 2001a). Highly health protective factors were applied to the analytical data to provide a “worst-case” exposure estimate that represents the highest expected exposure concentration. A 0.1 attenuation factor was applied to sub-slab soil gas and sub-surface soil gas concentrations as indicated in the calculation below. The adjusted gas concentration was used for subsequent site-specific exposure estimates and health effects evaluations.

Adjusted vapor concentration = (Detected soil gas or sub-slab gas concentration) x 0.1

Trichloroethylene (TCE) is the primary contaminant of concern for the CTS Site. ATSDR’s current TCE comparison and health guideline levels, which include only non-cancer values, were used for this evaluation. In addition, more conservative (health protective) proposed EPA non-cancer and cancer health-effect evaluation values for TCE were used in this assessment. More information regarding recent toxicological reviews of TCE effects and the current ATSDR and EPA proposed comparison values are included in Appendix F.

Exposure Pathway Analysis

Chemical contaminants in the environment can harm people’s health, but only if people have contact with those contaminants at a high enough concentration (dose), for a long enough time (exposure period) to cause a health effect. The concentration of a chemical that causes an adverse health effect will vary with the way a person is exposed (by eating or drinking the chemical, by breathing the chemical, or by skin contact with the chemical). Other factors, such as a person’s age, gender or their health status, may also affect whether they are harmed by contact with a chemical at a given concentration. Knowing or estimating the frequency with which people have contact with hazardous substances is essential to assessing the public health importance of these contaminants. The exposure pathway is evaluated to determine if people can come into contact with site contaminants.

A completed exposure pathway is one that contains the following elements:

- a source of contamination, such as a hazardous waste site or contaminated industrial site,
- travel of the contaminant through an environmental medium such as air, water, or soil,
- a point where people come in contact with a contaminated medium, such as drinking water, soil in a garden, or in the air,
- an exposure route, such as drinking contaminated well water or eating contaminated soil on homegrown vegetables, or inhaling contaminated air, and
- a population that can come into contact with the contaminants (be exposed)

A completed pathways is one in which all five pathway components exist and exposure to a contaminant has occurred, is occurring, or will occur. If one of the five elements is not present, but could be at some point, the exposure is considered a potential pathway. An exposure pathway is eliminated from further assessment if one of the five parts is missing and will not occur in the future. The length of the exposure period, the concentration of the contaminants at the time of exposure, and the route of exposure (skin contact, ingestion, and inhalation) are all critical elements considered in defining a particular exposure event.

A. Completed Exposure Pathways

The population of concern for this study is residents living near the CTS property. A completed pathway for this site is past ingestion (drinking) and dermal (skin contact) of contaminated groundwater before their contaminated private wells were disconnected. Soils on the CTS property were contaminated with volatile organic compounds (VOCs) used during industrial activities on the site. Contaminants were carried downward to the groundwater flowing beneath the site, resulting in contaminated groundwater flowing off the site. Contaminated groundwater being supplied to a household or commercial facility may provide an exposure pathway through ingestion (by drinking the water), inhalation (breathing chemicals dissolved in water that can escape to the air, such as during a shower), and dermal contact (when taking a shower or bath). During investigations of the CTS site, private drinking water wells and springs used for drinking water sources were disconnected. Users of the contaminated private drinking water were provided access to municipal drinking water supplies when contamination was identified. This eliminated ingestion, inhalation and dermal pathways for exposure to contaminated groundwater for persons connected to municipal water supplies.

Contaminants of concern for the CTS site have been observed in surface waters in the area. The CTS site may be the source of these chemicals, likely by surface run-off over contaminated soils associated with the CTS facility and discharge of contaminated groundwater passing through the site and up to the surface. Persons coming into contact with these surface waters during recreational activities such as wading or swimming present an exposure pathway. Completed exposure pathways exist for persons that may have had or currently have contact with the contaminated water from the springs (“seeps”) east of the site. A fence was placed around the springs in December 2007, preventing access. The fence was taken down temporarily in several locations during construction of the soil vapor extraction (SVE) system, allowing temporary access to the springs. The fence was replaced after construction of the SVE was completed.

The small stream formed by the combined flow from the springs east of the site travels beyond the fence around the springs, providing a past, current, and future exposure point as long as the waters are contaminated. The stream is typically small (estimated at 2 inches deep and 1 foot wide, personal communication with N.C. DENR) and so provides limited exposure potential. In addition, the SVE system when operational will likely reduce exposure potential from the springs and streams as the concentration of TCE and other volatile chemicals is reduced.

Volatile contaminants may volatilize (out-gas) from soil and groundwater, migrate through sub-surface air spaces and enter buildings, collecting in a living space where they may be inhaled by occupants. Many variables influence the levels of volatile chemicals entering a home from a water supply, including the chemical’s physical and chemical properties, seasonal variations, and building construction. Factors to consider when evaluating indoor exposures to volatile chemicals in supplied waters is that some of these chemicals are also common components of materials routinely used or present in the home or commercial and industrial operations, such as cleaning chemicals, textiles, or building materials. 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 collected from near-by residences indicate VOCs have migrated to the soils and crawl-spaces under the sampled homes. Volatile gases in the soil under residences with basements or concrete slabs were also measured to provide an estimation of exposure potential in these homes.

Volatile chemicals in soil and groundwater may also volatilize to the outdoor air where people may breathe them. Groundwater may be discharged at the surface from springs, or into streams or rivers, providing an exposure point for breathing volatile chemicals moving from groundwater into the air. VOCs were found in air samples taken near the springs where persons in the immediate vicinity of the springs may be exposed. VOCs were also found in air samples collected during mobile monitoring events along roadways west of the CTS property. Persons may breathe VOCs while traveling in these areas. Table 2 illustrates the completed exposure pathways for the CTS site.

Table 2. Completed exposure pathways for the CTS site.

Source of Contamination	Contaminant Travel Pathway	Exposure Point	Route of Exposure	Exposed Population
Contaminated groundwater	Groundwater, Springs	Private well water	Ingestion, dermal (contact), inhalation	Persons in the past with contaminated well water
Contaminated surface water east of the site	Surface water	Springs and streams	Ingestion, dermal (contact)	Persons in the past and currently with access to the contaminated surface water
Crawl-space air containing volatile organics coming from contaminated soil or groundwater	Air	Crawl-space	Inhalation	Persons in the past and currently breathing air in a contaminated crawl-space
Outdoor air containing volatile organics coming from contaminated surface water and soil	Air	Outdoor air in vicinity of site	Inhalation	Persons in the past and currently breathing in areas of site volatile organic chemicals

Note: For a completed exposure pathway all 5 components must be present at a site.

B. Potential Exposure Pathways

A current and future potential exposure pathway exists should unidentified private wells in the groundwater flow path from the CTS site be identified and are found to contain contaminants identified as emanating from the CTS site. Continued efforts to identify private well users in the path of the TCE contaminated groundwater plume traveling through the CTS site, test their water, and disconnect their wells if contaminated would eliminate this potential exposure pathway. Control of the transport of the TCE groundwater plume and/or remediation of the TCE plume would eliminate this potential exposure pathway.

A potential exposure pathway is identified for possible future exposures to the stream formed by the combined flow of the springs east of the site and passing through the fenced area. Elevated contaminant concentrations have been identified in the springs and stream water, should they continue, may present an exposure hazard.

Sub-surface soil samples collected on and off-site of the CTS property were evaluated to provide a comprehensive, highly protective evaluation of potential health effects associated with all site-related media. Subsurface soils can present an exposure point to persons that have direct access to the contaminated sub-surface soils through activities such as digging or construction activities. A low potential for exposure was determined for contaminated sub-surface soils since they were located within the fenced CTS property. Levels of substances found in off-site sub-surface soils were found to be within typical North Carolina soil background levels, or were at concentrations below ATSDR's health screening levels. Table 3 lists potential exposure pathways identified for the CTS site.

Table 3. Potential exposure pathways for the CTS site.

Source of Contamination	Contaminant Travel Pathway	Exposure Point	Route of Exposure	Potentially Exposed Population
Contaminated groundwater	Groundwater	Private well water	Ingestion, dermal (contact), inhalation	Persons currently with, or in the future with, contaminated well water
Contaminated surface water from springs east of the site	Surface water	Springs	Ingestion, dermal (contact)	Persons in the future with access to the contaminated surface water
Contaminated sub-surface soil	Soil	Sub-surface soil	Ingestion	Persons in the past, present or future with access to contaminated sub-surface soils

Note: For a potential exposure pathway one or more components at the site are missing or uncertain to exist.

Site-Specific Exposure Conditions Considered for the CTS Site

The CTS facility was in operation from 1953 until 1985 under various operators. Soil, surface water and sediment contamination was identified on the CTS property in 1991. The well nearest the site was identified and tested for TCE contamination in the 1991 study. The tested well was located 4,000 feet northwest of the site. No contamination was detected in the well water sample. Later studies indicated that this well was generally up-gradient of the direction of groundwater flow from off the CTS property. Future studies indicated groundwater flows under the CTS property from west to east. Building of the first phase of the Southside Village subdivision began in 1998.

TCE was detected in two springs east of the CTS facility and one residential supply well approximately 2,000 feet to the east, providing in 1999 the first indication of contaminated groundwater. Four households using the springs and the well as drinking water sources were supplied with bottled water and were ultimately connected to a municipal water supply in 1999. In 2000, TCE was again found in springs to the east of the site and in one of nine wells, the same well that was found to have TCE contamination in 1999 and had been disconnected. No contamination was found in springs to the west in 2000. It was recorded that no potable waters in the area were contaminated in 2001. Five residential wells with the potential to be impacted by the contaminated groundwater flow all showed no contamination in 2006. During the 2006 sampling, one resident chose not to have their water tested, and three wells were either not in service or were not used as a drinking water source. A soil vapor extraction system (SVE) was put into operation to remove TCE vapor from the subsurface in 2006. Higher concentrations of contaminants were seen in streams and springs both east and west of the site in late 2007 (TNA 2008, N.C. DENR Timeline). Sixty-six private wells within a 1-mile radius of the site (most to the north and east of the site) were sampled in 2007. Contamination was found in one well ¾ miles to the northeast. Eight active wells within ¾ mile north of the site were sampled in 2008 and the same well that was contaminated in 2007 again showed contamination. Residences on two streets were connected to the municipal water supply after the 2008 collections. Site documents note that the contamination observed in these wells may not be associated with the CTS site, since the area is not believed to be down-gradient of groundwater flow from the site.

On the basis of the above information a 10-year exposure period was used for possible groundwater and drinking water exposures The time period coincides with the time-frame contamination was initially identified in a private well and the springs down-gradient and adjacent to the site. This is also when private wells in the area of the identified contaminated private well were disconnected and the properties were provided a municipal water supply. A more health protective 30-year exposure period was also used for drinking water evaluations. A 30-year exposure period was used for soil, ambient (outdoor) air, and indoor air contamination evaluations. This exposure period was based on the time of initiation of residential construction in the area and the likelihood that soil contamination was evident before groundwater contamination was detected. The 30-year time period also represents the typical length of residential occupation at a given location.

Environmental Sampling Data

The following information outlines field-sampling activities conducted by the N.C. DENR, EPA, and EPA contractors from September 2007 through August 2008. Discussions include only compounds found in each environmental medium at concentrations equal to or greater than the analytical method minimum reporting concentration. Figures taken from EPA and DENR reports are provided to identify locations of collected samples and do not necessarily provide results for all data that was evaluated in this Public Health Assessment.

Groundwater Samples

Although there is no indication that persons are being directly exposed to the contaminants identified below in the groundwater, there may be unidentified private wells in the area that access these waters. To provide a complete evaluation of the potential hazards associated with the CTS site, NCDPH chose to include an evaluation of the groundwater data in this assessment.

This information may also serve to inform persons and agencies that are considering future activities on the site and in the area surrounding the site.

Groundwater samples were collected by the EPA in December 2007 and January 2008 from six temporary monitoring wells installed on-site and off-site to the east of the CTS property. One well was on the northwest side of the CTS property and the others were off-site, within approximately 1,200 feet east of the property. Analytical results indicated the metals total chromium and lead, the semi-volatile organics n-nitroso di-n-propylamine and pentachlorophenol, and the volatile organic compounds cis-1,2-dichloroethylene (cis-1,2-DCE), trichloroethylene, and vinyl chloride were present at concentrations greater than ATSDR CV values. All were carried through health-effect evaluations. The volatile organic compound (VOC) benzene was also detected at a concentration less than CV values but was carried through a health-effects evaluation because it is identified as a human carcinogen. See Appendix A, Figure 2 for groundwater sample locations. EPA believes a former junk yard may be the source of the lead and chromium (EPA 2010).

Trichloroethylene (TCE) was detected in three of six groundwater monitoring wells at concentrations ranging from 13 to 1,500 µg/L, all exceeding the EPA Federal Maximum Contaminant Level (MCL) of 5 µg/L. The EPA MCL value was used for screening site water levels since ATSDR has not published a CV for TCE. A MCL is the regulatory limit set by EPA that establishes the maximum permissible level of a contaminant in water that is deliverable to the user of a public water system. The highest TCE concentration (1,500 µg/L) was detected on the northwest side of the CTS property. TCE was not detected in the two off-site samples collected the furthest to the east (down-gradient). Lower concentrations of TCE were detected in the two off-site samples directly east of the CTS property (22 and 14 µg/L). The pentachlorophenol was detected at the sample location furthest to the east of the site. Vinyl chloride and cis-1,2-DCE are breakdown products of TCE, indicating some natural attenuation of the subsurface TCE plume. The other TCE detections were at the two sample locations closest to the east side of the property (22 and 14 µg/L) (TN&A 2008).

Lead was found in two of five monitoring wells at concentrations exceeding the 15 µg/L Federal Action Level (AL). The lead detections (71 and 35 µg/L) were from the two off-site sample locations furthest to the east off site. The lead value quantified for a third groundwater sample was less than the AL (2.2 µg/L), but the result was not considered valid due to quality control issues (TN&A 2008). ATSDR's lead CV is the EPA action level of 15 µg/L. Under the Lead and Copper Rule (LCR) EPA requires the testing of public water systems and states that actions be taken to lower lead levels if more than 10% of the samples collected at residences have lead levels greater than 15 µg/L (ATSDR 2007d). The EPA lists 0 µg/L as the goal for lead in drinking water. The Centers for Disease Control and Prevention (CDC) considers children to have an elevated blood lead level at 10 micro-grams per deci-liter (µg/dL) or greater (ATSDR 2007d). However, CDC identifies that blood lead levels in children less than 10 µg/dL can result in decreased cognitive function, developmental delays, and behavior problems (CDC 2009).

Private Drinking Water Wells

DENR collected nine samples from drinking water wells in July 1999 following a citizen complaint. TCE was found in one well approximately 1,000 feet east of the CTS property at 270 µg/L. TCE and other VOCs were also detected in water from two springs that had been used as drinking water sources. One spring was serving two homes. The second spring had served a third home until approximately 1994, at which time that home was connected to the city water supply. TCE at 21,000 µg/L, 49 µg/L 1,1,1-trichloroethane (1,1,1-TCA) and 31 µg/L 1,1-dichlorethene (1,1-DCE) was detected in the spring sample serving the two homes at the time. TCE at 15,000 µg/L, 570 µg/L 1,1,1-TCA, and 370 µg/L cis-1,2-DCE was detected in the spring sample that was no longer in use (N.C. DENR 1999). The spring samples were collected at the springs, not at the tap in the homes. No samples were collected at the tap. For use in the homes the spring water was collected in an above ground container and piped from the collection vessel to the homes, likely reducing the concentration of VOCs to which persons may have been ultimately exposed.

The TCE concentrations are greater than the EPA Maximum Contaminant Level of 5 µg/L. A Federal Maximum Contaminant Level (MCL) is the regulatory limit set by EPA that establishes the maximum permissible level of a contaminant in water that is deliverable to the user of a public water system. The 1,1,1-TCA and cis-1,2-DCE in the spring used until 1994 both exceed the MCL values (200 and 70 µg/L, respectively). The MCL (7 µg/L) for the 1,1-DCE detected in the spring used until 1999 was also exceeded.

The N.C. DENR collected drinking water samples from 66 residential wells within a 1-mile radius of the CTS property in November and December 2007. Most of the locations were northeast, east and southeast of the CTS property. Samples were analyzed for volatile organic compounds (VOCs) including TCE. A total of six different VOCs were found in seven samples. Detected VOCs included TCE, cis-1,2-DCE, chloroform, bromodichloromethane, toluene and chloromethane. Only TCE and bromodichloromethane concentrations were greater than ATSDR CVs and were carried through health-effect evaluations. The TCE detection was 57 µg/L, detected at a residence ¾ mile northeast of the CTS property. Bromodichloromethane (BDCM) was detected in two samples, both exceeding the ATSDR cancer CV. BDCM is identified as a "probable" human carcinogen.

The N.C. DENR collected water samples in January 2008 from eight active private residential wells located in the immediate vicinity of the highest TCE concentration detected in the residential wells sampled in 2007. The locations are north of the CTS site. TCE and cis-1,2-DCE were detected at a single location at concentrations less than CVs (4.32 µg/L TCE and 1.35 µg/L cis-1,2-DCE) (N.C.DENR data). The TCE concentration was carried through a health-effect evaluation because EPA's proposed revised health guideline information identifies it as a human carcinogen. The residences were connected to a municipal supply after the samples were collected. Because of their location relative to the CTS property, and what is known about the direction of groundwater flow under the CTS site, the contamination observed in these wells might not be related to the CTS property (personal communication N.C. DENR 2009). The source of the drinking water contamination in this area is currently under investigation by EPA and DENR. The location of the private well samples is identified in Appendix A, Figure 3.

Surface Water

Water from three springs on the near east side of the site (approximately 400 feet east of the CTS property) was sampled in July 1999. TCE, 1,1,1-trichloroethane (1,1,1-TCA), cis-1,2-DCE and 1,1-dichloroethene were detected. TCE (21,000 µg/L) and 1,1,1-TCA (570 µg/L) concentrations were greater than CVs and were carried through health effect evaluations.

Four stream and three spring surface water samples were collected within approximately 400 feet east and 800 feet west of the CTS property in September 2007. The spring samples were at the same location as the samples collected in 1999. TCE, cis-1,2-DCE and 1,1,1-TCA were detected, with the highest concentrations detected in samples collected to the east. The highest concentrations were 19,700 µg/L TCE, 1,190 µg/L cis-1,2-DCE, and 856 µg/L 1,1,1-TCA. The high TCE and 1,1,1-TCA detections were from the same spring and the high cis-1,2-DCE detection was from a stream. See Appendix A, Figure 4 for sample collection locations and analytical data.

An additional 14 surface water samples were collected in November and December 2007 within approximately ¾ mile to the west and east of the site (Appendix A, Figure 5). Sample locations included eight streams and six springs. TCE was found in all samples except for two springs ¾ mile to the southwest and one stream ¾ mile to the southeast. TCE concentrations were highest on the east side of the CTS property and decreased with distance away from the site to the east. The highest TCE concentration (18,000 µg/L) was detected at the location nearest the east side of the CTS property, and other samples collected in the same immediate area ranged from 998 to 11,600 µg/L). TCE concentrations were lower on the west side of the property in two spring samples next to the site. The VOC cis-1,2-DCE was found intermittently in decreasing concentrations moving away from the site to the east, all in stream samples. One stream near the east side was contaminated with 1,1,1-TCA. The chemicals naphthalene, vinyl chloride and bis-2-ethylhexyl phthalate (BEHP) were each detected in one sample location on the east and west sides nearest the site. See Appendix A, Figure 5 for sample collection locations and analytical data.

TCE, cis-1,2-DCE, 1,1,1-TCA, bis-2-ethylhexyl phthalate (BEHP), and vinyl chloride concentrations exceeded CVs in the surface water samples collected in September through December 2007. Each was carried through a health-effects evaluation.

Sub-Surface Soil Samples

In December 2007 and January 2008 EPA collected sub-surface soil samples at five locations on the CTS property and 10 locations to the west, north and east off-site of the property. Soils for analyses were collected from depths ranging from 2 to 30 feet below the surface. Typically, ATSDR does not evaluate sub-surface soils for potential health-effects due to the limited potential for human access and exposure. Sub-surface soil data was evaluated for this site to provide additional assurance that adverse health effects were not indicated in response to public concerns associated with this site. All soils were analyzed for VOCs, semi-volatile organic chemicals (SVOCs), cyanide and metals. Analytical results indicated that eight SVOCs (all polycyclic aromatic hydrocarbons [“PAHs”]), the metals arsenic, barium, chromium, lead, selenium, and silver, and cyanide and the VOC acetone were detected in the soils. See Appendix A, Figure 6 for sample locations and analytical results.

The metal arsenic was the only detected substance with a concentration exceeding an ATSDR CV. Arsenic was detected in six of the 15 samples, with all detections less than the non-cancer CV, and all exceeding the cancer-effect CV, and was thus carried through a health-effects evaluation. Detected arsenic concentrations ranged from 2.1 to 6.1 mg/kg, with all detections identified as estimated values.

Polynuclear aromatic hydrocarbons (PAHs) were detected in a single soil sample located on the northwest corner of the CTS property. Eight PAH compounds were detected at concentrations from 42 to 70 micrograms per kilogram (µg/kg or "parts per billion"), with all concentrations identified as "estimated" values due to quality control issues. ATSDR does not have CVs for the individual chemicals making up the group of chemicals referred to as "PAHs", other than a CREG for benzo(a)pyrene (BaP). PAHs are a group of chemicals formed during the incomplete burning of gas, wood, coal and other organic materials. They can also be found in substances such as crude oil, coal, creosote, and asphalt. They are found throughout the environment in air, water, and soil. No data was available for background concentrations of PAHs in area soils. Detected PAHs were carried through a health-effects evaluation.

Residential Crawl-Space Air Samples

EPA collected crawl-space air samples in December 2007 to evaluate the potential for volatile contaminants in the groundwater or soil to move from the subsurface into off-site residential living spaces where inhalation exposures might occur. A passive air sampling technique ("SUMMA" canisters) was used to collect 24-hour air samples on 12 properties with dirt crawl-space foundations. Residential properties within approximately 800 feet of the west, south and east sides of the CTS property were sampled. The air samples were analyzed for VOCs. TCE, carbon tetrachloride, chloroethane, chloroform, chloromethane, cis-1,2-DCE, methylene chloride, tetrachloroethylene (PCE), 1,1,1-TCA and trichlorofluoromethane were detected. See Appendix A, Figure 7 for sample locations and analytical results. Three of the 10 detected VOCs in the December 2007 24-hour passive crawl-space air samples were detected at concentrations greater than ATSDR cancer effect CVs for inhalation exposures (carbon tetrachloride, chloroform and methylene chloride) and were carried through health-effect evaluations. TCE was detected above the analytical method reporting limit in six of 12 samples (0.161 to 3.78 parts per billion by volume, "ppbv") with the highest detection located off-site near the groundwater seeps (springs) to the southeast of the CTS property. All TCE detections were less than CVs, but TCE was carried through a health-effects evaluation using the EPA proposed health-effect values. The highest carbon tetrachloride and chloroform detections (0.0875 and 0.124 ppbv, respectively) were at the same sample location, adjacent to the southwest corner of the CTS property. The highest methylene chloride detection (2.45 ppbv) was from the sample location furthest to the west of the property.

Four additional crawl-space air samples were collected in residences southeast of the site in December 2007. These samples were analyzed for TCE and PCE on site using EPA's Trace Atmospheric Gas Analyzer ("TAGA"). TCE was detected at one location at 0.23 ppbv (a concentration less than the CV) and was reported at two other locations as "estimated" concentrations less than the analytical method minimum reporting concentration (the lowest concentration of precise quantitation of the chemical). PCE was detected in a single sample at an estimated concentration less than the reporting limit. The TAGA crawl-space sample locations and analytical results are provided in Appendix A, Figure 8. The four TAGA crawl-space samples collected in December 2007 for on-site TCE and PCE analysis had lower concentrations than the passive air samples and no additional health effect evaluations were performed for these samples.

EPA collected five additional crawl-space air samples in August 2008 on the west and east sides of the CTS property. TCE was found in all five samples. The highest TCE concentration was

1.38 ppbv (less than the CV), found at the sample location nearest the east side of the property. The location and analytical results for the August 2008 samples are provided in Appendix A, Figure 9. TCE concentrations found in the five crawl-space samples collected in August 2008 were lower than those observed in December 2007 and no additional analysis of the August 2008 data was performed.

The highest crawl-space air concentrations were used to calculate estimated exposure doses for cancer health-effect evaluations.

Residential Sub-Slab Soil Vapor Samples

EPA conducted sub-slab soil vapor studies in December 2007 to evaluate the potential for inhalation exposure to volatile contaminants in groundwater or soil rising from the subsurface into off-site residential living spaces. Ten properties on a basement or concrete slab foundation were sampled using a sub-slab air sampling technique (“slam-bar”). Sampling ports were installed through the slab and collected samples were submitted for laboratory analysis for TCE and tetrachloroethylene (PCE). Residential properties near the west and east sides of the CTS property were sampled. TCE and PCE were each found in a single different location (see Appendix A, Figure 8). Neither TCE nor PCE were present at a concentration greater than inhalation CVs. Both TCE and PCE are identified as “probable” human carcinogens and were carried through cancer-effect evaluations to further address community concerns.

Other Soil Gas Samples

Eighteen soil gas samples were collected in December 2007 by EPA. Samples were collected at a depth of approximately four feet below the surface and the soil gas analyzed on site for TCE and PCE. The samples were collected along three lines running from approximately 200 to 1,300 feet east of the site, down-gradient of the groundwater flow direction from the site. Each of the three lines of samples ran in a path from the southwest to northeast. Four additional samples were collected adjacent to the north side of the property. TCE was found in three of four samples in the line of samples collected closest to the east side of the site and included the highest concentration (460 ppbv). PCE was the only detection in the next line of samples to the east (1.2 ppbv PCE). There were no detections in the line of samples furthest to the east, or the four locations adjacent to the north side of the property. Sample locations and analytical results are provided in Appendix A, Figure 8. Only the highest detected TCE concentration exceeded the CV, but since both TCE and PCE are identified as “probable” human carcinogens they were carried through cancer-effect evaluations.

Outdoor Air Samples

Outdoor air samples were collected in close-by areas east and west of the CTS property to determine if volatile site contaminants were escaping from contaminated soil or water and were present in the air where they could be inhaled. EPA collected ambient air (outdoor air) samples in December 2007 using a bus-mounted mobile TAGA system. Samples were collected along the same route on local roadways in the vicinity of the CTS site during two mobile monitoring events. Air samples were analyzed for TCE and PCE. The highest TCE concentration detected was 21 ppbv, detected at Surrey Run near the entrance to Hidden Valley, on December 10, 2007. TCE was also detected at 4 ppbv along the South Side Village Drive west of the site. The highest TCE concentration detected during the December 12, 2007 sampling was 0.49 ppbv, also observed at the entrance to Hidden Valley. No PCE was detected during either sampling event.

The route and results of the two mobile air sampling events are provided in Appendix A, Figures 10 and 11. The 21 ppbv concentratiuon does not exceed the current ATSDR inhalation CV for TCE but does exceed the EPA proposed inhalation reference concentration (RfC = 7.1 ppbv).

TAGA ambient air sampling was also performed in December 2007 along a slope adjacent to the east side of the CTS property and at four "seeps" (springs) located to the east in the direction of groundwater flow away from the site. These samples were analyzed for TCE and PCE. Ambient air concentrations at the seeps ranged from 3.2 to 70 ppbv TCE (see Appendix A, Figure 8). No PCE was detected.

Additional ambient (outdoor) air samples were collected at 11 locations in August 2008 adjacent to the site and down-gradient to the east. TCE was found in seven of the locations, with the highest concentration at 277 ppbv, located adjacent to the property on the east side, at the groundwater seeps. The remaining detections ranged from 0.078 to 1.6 ppbv TCE. Lower ambient TCE concentrations were observed in the same area in the December 2007 (3.2 to 70 ppbv). No PCE was detected at either time. All outdoor TCE concentrations, except the single 277 ppbv, are less than ATSDR inhalation CVs for exposure periods up to one year. All TCE detections are less than the ATSDR acute CV (2,000 ppbv for exposures up to 14 days). Sample locations and analytical results are noted in Appendix A, Figure 9. The 277 ppbv TCE concentration was used for health-effect evaluations since it exceeds the current ATSDR and EPA proposed inhalation CVs.

Public Health Implications

This section discusses the health effects that could plausibly result from exposures to contaminants at the CTS site. For a public health hazard to exist, people must contact contamination at levels high enough and for a long enough time to adversely affect their health. Evaluation of potential public health hazards are based on ATSDR assessment procedures. The conditions at the site revealed four completed exposure pathways (Table 2).

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, N.C. DPH must rely on reasonable assumptions rather than site-specific information in this instance.

Substances detected in the environmental samples discussed below are summarized in tables in Appendix E. Tables include the range of detections, environmental media comparison values used for the screening analysis, exposure dose estimates for each substance, and health-effect comparison values. Table 23 following summarizes the health effect information discussed in the following section into a single table. More detail is provided in the tables in Appendix E.

Groundwater Data

Groundwater data was evaluated for potential adverse health effects related to drinking contaminated waters (Appendix E, Tables 4 and 5). There is no information to indicate that people have been exposed to the substances and concentrations discussed below in the groundwater samples. Despite this, DPH completed a health evaluation of the groundwater data since private wells have been used in the past in the area.

Pentachlorophenol and n-nitroso di-n-propylamine are identified as probable human carcinogens and both were carried through cancer health-effect evaluations. An estimate of the number of cancers related to pentachlorophenol ingestion indicated less than one additional cancer in population of 100,000 persons exposed. Estimated site-specific exposure doses were 200,000 times less than the lowest health study value causing cancer in animals. Estimated increases in cancer cases due to the observed concentration of n-nitroso di-n-propylamine indicated two additional cases in a population of 100,000, and an estimated exposure dose 40,000 times less than the lowest health study value causing cancer in animals. No health study data was available for human exposures. The estimated increased cancer risk for the benzene concentration was less than one per 100,000 (actual estimate was less than 1 in a million). As a result of these evaluations, no adverse health effects would be expected with long-term exposure to pentachlorophenol, n-nitroso di-n-propylamine, or benzene at the concentrations observed in these groundwater samples.

Lead was found in groundwater at concentrations exceeding the 15 µg/L AL, which is also the N.C. DPH health guideline level for private well water supplies. If the groundwater has been or may be used as a drinking water supply source the N.C. DPH recommends further testing to characterize the extent of the elevated lead levels. The N.C. DPH also recommends including lead testing in all subsequent analyses of groundwater private well drinking water sources in the area. Private wells with lead concentrations greater than 15 µg/L exceeds N.C. DPH's health guideline value for drinking water and alternative drinking water sources should be provided, or measures immediately undertaken to reduce the lead concentration to less than 15 µg/L. The source of the lead may be a former junkyard (EPA 2010).

Chromium data was reported as total chromium, and did not determine what proportion of that concentration, if any, was made-up of the more toxic hexavalent chromium, or the less toxic trivalent chromium. To provide the most health-protective evaluation, the groundwater detections of total chromium were evaluated against hexavalent chromium health values. Two of the four total chromium detections were greater than the lowest hexavalent chromium CV (none exceeded the trivalent chromium CVs). These two samples were collected the farthest to the east off-site of the CTS property. Estimated site-specific exposure doses for children and adults were calculated and health effects comparisons indicate potential adverse non-cancer health effects if hexavalent chromium concentrations make up a significant portion of the total chromium. If hexavalent chromium concentrations make-up less than approximately 9 µg/L of the total chromium concentration then no adverse health effects are indicated for the selected exposure parameters. The source of the chromium may be a former junkyard (EPA 2010).

Although the groundwater data is not adequate to fully access the nature of the observed chromium, at the acidic groundwater pH levels observed (pH 4.5 to 5.0, TNA 2008) the less toxic trivalent chromium species may predominate. Typical conditions existing in groundwater, would also contribute to a prevalence of trivalent versus hexavalent chromium, further reducing the potential for health effects. Hexavalent chromium in groundwater rarely occurs naturally. Therefore, unless there is a contamination source contributing to the elevated chromium levels, trivalent forms may be more likely. Additional investigation of the groundwater chromium is recommended. N.C. DPH recommends determining if the chromium is trivalent or hexavalent, whether the elevated concentrations are naturally occurring or due to a contamination source, and if due to contamination, the extent of the contamination. Providing alternative supplies of water is recommended if groundwater with chromium concentrations exceeding regulatory or health guidelines are being used for drinking.

ATSDR recommends assessing the combined effects of select metals that have a wide range of effects on common target organs. These metals include lead and chromium, which have differing sensitive effects. The critical sensitive effect for lead is identified as neurological effects, particularly in infants and children. The critical effect for hexavalent chromium is uncertain. Potential combined adverse health effects are assessed by summing the estimated dose levels relative to health effect guideline values when the metals are detected at concentrations greater than one tenth their health-guideline values. Groundwater lead levels in this study did not exceed health-effect guideline values. Health-effect guideline values for groundwater chromium were exceeded if the detected levels are assumed to be predominantly the more toxic hexavalent chromium, rather than predominantly the less toxic trivalent chromium. There is only one study with information on the potential interaction of chromium and lead. As a result of this information, there is limited evidence for potential increased effects related to the combined exposures to lead and chromium in the groundwater in this study (ATSDR 2004).

Vinyl chloride (VC) was detected in the groundwater sample collected on the northwest side of the CTS property and the concentration (48 µg/L) exceeds both ATSDR non-cancer and cancer CVs, as well as the EPA MCL (2 µg/L). ATSDR identifies vinyl chloride as a “known” human carcinogen. Health-effects evaluation using site-specific estimated exposure doses for ingestion indicates there is potential for adverse non-cancer and cancer effects related to long-term ingestion. No VC was detected in the down-gradient samples collected off site, indicating there is no apparent exposure source. Without an exposure source there is no health hazard. Regardless, N.C. DPH recommends the VC concentration in the groundwater be closely monitored. Vinyl chloride is a break-down product of TCE and cis-1,2-DCE and may occur in other subsurface locations that have conditions conducive to the natural break-down of these contaminants.

TCE health-effect evaluations using site-specific estimated exposure doses based on the highest detected TCE concentration indicate the potential for adverse health effects. Exposure dose estimates were greater than the proposed EPA reference concentration (RfC), an estimate of a daily exposure that is likely to be without a risk of adverse effects to the general population and sensitive subgroups during a lifetime of exposure (ATSDR 2005).

Private Drinking Water Well Samples

Well water samples were evaluated for adverse health effects due to drinking (ingesting) the water. Calculations of estimated increased number of cancer cases for the 270 µg/L TCE indicated “low” to “moderate” numbers (2 to 40 per 100,000 population) for a 10-year exposure period using the range of proposed EPA cancer risk values. Calculations for TCE exposures related to the spring source drinking water were based on the available data which reflects concentrations found at the spring and would not likely represent what persons would have been exposed to at the tap. Concentrations of VOCs at the tap would likely have been reduced due to the storage of the water at the spring and piping to the homes. The estimated exposure dose for

TCE was greater than current and proposed health guideline values, indicating the potential for non-cancer adverse health effects. Calculations of estimated increased number of cancer cases for the 21,000 µg/L TCE indicated “high” to “very high” numbers (200 to 3,000 per 100,000 population) for a 10-year exposure period using the range of proposed EPA cancer risk values. A shorter exposure period would result in a proportional reduced risk of increased cancers. Because the time frame of contamination of the drinking water can not be conclusively identified for the 270 µg/L detection, the potential for adverse health effects with a longer exposure period were evaluated. If a more health protective 30-year exposure period is used for the TCE detection identified in this well, the number of increased cancers ranges from “low” to a “high” increase in the number of cancers (estimated at 7 to 100 increased cancer cases per 100,000 population). The July 1999 data and health-effect values are listed in Appendix E, Table 6 and 7. Uncertainty exists in the evaluation of the potential health effects associated with the TCE concentrations in these private well locations. A single analysis was done on the well waters prior to the wells being disconnected and the homes supplied with a municipal water supply. Prior TCE concentrations in the well water could have been higher or lower. Additionally, based on information provided by persons living at these locations, they used the well for approximately 10 to 12 years, but when TCE may have first appeared in the water, and at what concentration, is not known. Family members living at the location with the 270 µg/L TCE detection have identified health effects that may be associated with TCE exposure, but these same health effects may also be associated with other causes. While exposure to TCE is likely based on the single well sample, DPH cannot currently conclude that the health issues the family members have identified are a result of their TCE exposure. Cancer risk estimates greater than 10 additional cases per population of 100,000 indicate an unacceptable level of cancer risk. In addition to the ingestion risks, there may have been additional risks due to inhalation (breathing) of TCE that escaped from the water to the air during activities such as showering or bathing. No indoor air data exists to quantify the potential risk related to TCE inhalation exposure at this residence. The potential for harmful health effects may be increased if the persons using the contaminated well water were exposed to both drinking and breathing high levels of TCE. It is not know if the 21,000 and 15,000 µg/L detections at the springs are representative of actual exposures from the drinking water available within the homes. The spring water was collected in external concrete structures and pumped to the homes. There may have been some reduction of TCE concentrations resulting from volatilization (out-gassing) where it was exposed to headspace. The DPH concluded that the single TCE concentration for these wells may have been adequate to cause harmful health effects if the household occupants were exposed for as long as 10 years. Because of the lack of knowledge of the length of time the well was contaminated, and at what concentrations over the contamination period, a great deal of uncertainty exists in identifying potential health risks.

TCE and bromodichloromethane concentrations found in the private well samples collected by N.C. DENR in November and December 2007 were evaluated for potential health-effects. No adverse non-cancer health effects were indicated. Calculations of estimated increases of cancer cases indicated “low” numbers of increased cancers (1 additional cancer in a population of 100,000). No adverse health effects related to TCE ingestion exposures are indicated at these concentrations for the selected exposure parameters. The data and health-effect values for the private well samples are listed in Appendix E, Tables 8 and 9.

Bromodichloromethane (BDCM) cancer-effect calculations indicate the estimated site-specific exposure dose using the maximum detected concentration is 790,000 times lower than the lowest cancer-effect level identified in animal studies. No apparent increased numbers of cancer cases were indicated (less than 1 per 100,000 population). No adverse health effects are indicated related to BDCM exposures at these concentrations.

Although lower than CVs the TCE concentration detected in the January 2008 private well samples collected by N.C. DENR was carried through a cancer-effect evaluation. Cancer-effect evaluation of the TCE concentration estimates "low" numbers of increased cancers (2 additional cases of cancer per 100,000 population). The estimated exposure dose for TCE was 140,000 times lower than the lowest animal cancer health-effect level. No adverse health effects are indicated for the TCE and cis-1,2-DCE exposures in this well. The N.C. DPH recommends continued efforts to identify private wells that are used as drinking water sources in areas of observed contamination or in the flow-path of known contaminated groundwater. Periodic monitoring of identified private wells for VOC contamination and connection to alternative drinking water supplies is recommended if contamination is found that exceeds regulatory or health-based guidelines.

Some of the contaminants in the well water samples are identified as "volatile" and could volatilize ("out-gas" or move from being dissolved in the water into air) from waters during activities such as showering, bathing, car washing or watering the lawn. The magnitude of these exposures varies depending on the frequency of showering and bathing, time spent indoors, air exchange rates in the bathroom and house, and other factors. ATSDR states that non-ingestion exposures may yield a contaminant dose that is comparable to the ingestion dose (ATSDR 2005a). Concentrations of volatile compounds in the drinking water samples discussed in this section (TCE and cis-1,2-DCE) are not likely at concentrations high enough to cause adverse health effects due to inhalation exposures. Bathroom air concentrations during showering were calculated using the maximum concentration of each VOC in the well water. All values were less than inhalation screening values.

Table 23. Summary of the health effects evaluation information for chemical concentrations for all sample types exceeding comparison values at the CTS site. (Table continued on next page.)

Contaminant	Exposure Pathway	Detected at Concentration Above Screening Values?	Site Exposures Above Health Guideline Screening Values?	Site Exposures Above Health Study Values?	Are Health Risks Indicated?	Are Cancer Risks Indicated?
Private Well Water, collected Jan. 2008						
Trichloroethylene (TCE)	Drinking	No	No			
Private Well Water, collected Nov. to Dec. 2007						
Trichloroethylene (TCE)	Drinking	Yes	Yes	No	No	No
Bromodichloromethane	Drinking	Yes	No			No
Private Well Water, collected Jul. 1999						
Trichloroethylene (TCE), Groundwater well	Drinking	Yes	Yes	No	No	Yes
Trichloroethylene (TCE), Spring wells	Drinking	Yes	Yes	Yes	No Yes	Yes
1,1,1-Trichlrorethane (TCA), Spring wells	Drinking	Yes	No			
cis-1,2-Dichloroethane (c-1,2-DCE), Spring wells	Drinking	Yes	No			
1,1-Dichloroethene (1,1-DCE), Spring wells	Drinking	Yes	No			
Groundwater, collected Dec. 2007 to Jan. 2008 (not confirmed as a drinking water source)						
Trichloroethylene (TCE)	Drinking	Yes	Yes	No	No	No
cis-1,2-Dichloroethane (c-1,2-DCE)	Drinking	Yes	No			
Lead	Drinking	Yes	No	Yes	Possible - If a drinking water source	
Pentachlorophenol	Drinking	Yes	No			
n-Nitroso di-n-propylamine	Drinking	Yes	No			
Chromium	Drinking	No for Total Chromium, Yes for Hexavalent Chromium	No for Total Chromium, Yes for Hexavalent Chromium	No for Total Chromium, Unknown for Hexavalent Chromium	No for Total Chromium, Unknown for Hexavalent Chromium	
Vinyl Chloride	Drinking	Yes	Yes	Yes	No – Not detected off site	No – Not detected off site

No

No

Table 23, continued. Summary of the health effects evaluation information for chemical concentrations for all sample types exceeding comparison values at the CTS site.

Contaminant	Exposure Pathway	Detected at Concentration Above Screening Values?	Site Exposures Above Health Guideline Screening Values?	Site Exposures Above Health Study Values?	Are Health Risks Indicated?	Are Cancer Risks Indicated?
Surface Water, collected Sept., Nov. and Dec. 2007						
Trichloroethylene (TCE)	Drinking/ Swimming[1]	Yes	Yes	No	No	No
cis-1,2-Dichloroethane (c-1,2-DCE)	Drinking/ Swimming[1]	Yes	No			
1,1,1-Trichlrorethane (TCA)	Drinking/ Swimming[1]	Yes	No			
Bis(2-ethyl hexyl)phthalate	Drinking/ Swimming[1]	Yes	No			No
Vinyl Chloride	Drinking/ Swimming[1]	Yes	No			No
Surface Water (Springs), collected Jul. 1999						
Trichloroethylene (TCE)	Drinking/ Swimming[1]	Yes	Yes	No	No	No
1,1,1-Trichlororethane (TCA)	Drinking/ Swimming[1]	Yes	No			
Sub-surface Soil, collected Dec. 2007 to Jan. 2008						
Arsenic	Eating	Yes	Yes	Yes	No	No, Buried Soils & at Background Levels
Polynuclear Aromatic Hydrocarbons (PAHs)	Eating	Yes	No	No	No	No
Crawl-space Air, collected Dec. 2007						
Carbon Tetrachloride	Breathing	Yes			No	No
Chloroform	Breathing	Yes				
Methylene Chloride	Breathing	Yes		No	No	No
Trichloroethylene (TCE)	Breathing	No			No	No
Sub-slab Soil Gas, collected Dec. 2007						
Trichloroethylene (TCE)	Breathing	Yes		No	No	No
Soil Gas, collected Dec. 2007			No			
Trichloroethylene (TCE)	Breathing	Yes		No	No	No
Ambient Air, collected Aug. 2008					No	
Trichloroethylene (TCE)	Breathing	Yes	No		No	No

[1] Evaluated as accidental drinking of water by children while swimming

Surface Water Samples

Spring samples collected in 1999 were evaluated for potential health effects associated with intermittent incidental ingestion of water as might be anticipated for children while swimming or playing in the springs (Appendix E, Tables 10 and 11). Long-term exposures such as those associated with a residential drinking water source were not included in surface water evaluations. The swimming incidental ingestion exposures were calculated as one hour per week of swimming, for six months a year, for 10 years. The estimated exposure dose for the highest 1,1,1-TCA concentration was less than the ATSDR non-cancer health guideline. No adverse health effects associated with incidental ingestion is indicated.

Surface water samples collected in September, November and December 2007 were treated as a single sample set for health-effect evaluations associated with incidental ingestion of water by children while swimming (Appendix E, Tables 12 and 13). Estimated site-specific exposure doses calculated with maximum detected concentrations for cis-1,2-DCE, 1,1,1-TCA, naphthalene, bis(2-ethylhexyl)phthalate (BEHP) and vinyl chloride indicate no expected adverse health effects. ATSDR identifies BEHP as a “probable” human carcinogen. Cancer health-effect calculations estimate less than one excess cancer per one million persons at the estimated BEHP exposure dose, indicating cancer-effects would not be anticipated.

No dermal effects were evaluated since no ATSDR or EPA dermal CVs were available for any of the chemicals detected in surface waters. While the lack of dermal CVs does not allow evaluation, the ability to come into contact with the surface waters, and the typical intermittent nature of contact with the surface waters, would reduce the potential for adverse effects. For most exposure situations, ATSDR generally considers dermal exposure to be a minor contributor to the overall exposure dose as compared to those from ingestion and inhalation (ATDSR 2005a).

The incidental ingestion exposure estimate for children at the maximum TCE concentration (19,700 µg/L) for all samples exceeds the EPA proposed health guideline value (0.0003 mg/kg/d RfC). The estimated exposure dose calculated for the geometric mean concentration (386 µg/L) is less than the EPA RfC. No ATSDR dermal or inhalation comparison values are available for TCE. Although the evaluation does not indicate adverse health-effects would be expected for incidental ingestion by children while swimming, caution is recommended for incidental ingestion or direct contact exposures for sensitive populations to waters with TCE concentrations at these concentrations. The springs sampled to the east of the CTS site were isolated by a fence which was constructed in December 2007. Warning signs were also placed on the fence. During construction of the soil vapor extraction (SVE) system sections of the fence were temporarily removed. The fence, when intact, serves to limit, if not eliminate access to the springs which are located on private property.

Sub-Surface Soil Samples

Typically, ATSDR does not evaluate sub-surface soils for potential health-effects due to the limited potential for human access and exposure. Sub-surface soil data was evaluated for this site to provide additional assurance that adverse health effects were not indicated in response to public concerns associated with this site.

Cancer-effect evaluations for arsenic incidental soil ingestion estimate no increase in the number of cancer cases for adults (less than one additional cancer per 100,000 population). Human cancer-effect health study data estimates child exposure doses for the highest arsenic concentration was 1,100 to 2,300 times lower than the lowest study dose level for exposure periods of 16 and 12 years respectively. Child pica-behavior dose estimates were 46 times lower than the lowest study dose resulting in a cancer-effect over a 12-year exposure (Appendix E, Table 17). Three of the five arsenic detections, including the highest detection, were located on the CTS property. The other two detections were at the closest sample locations to the west and southeast of the property. The soils with arsenic detections were all collected at least 10 feet below the surface. Limited exposure potential would be expected for sub-surface soils located on the property, such as digging to the depth of the sample collection. No site-specific background metal data for comparison was indicated for this study. As a result, other data resources were sought. In their 2008 revision of average natural background concentrations of metals in North Carolina soils, the NC Department of Agriculture listed a value of 4.5 mg/kg arsenic (NCDA 2008). Detections less than twice the average background concentration are typically considered in the normal range in risk assessment. As a result of the comparison to typical background concentrations of arsenic in North Carolina soils, the limited exposure potential to the detected arsenic in sub-surface soils, and the potential for adverse cancer effects only for pica behavior, no adverse health effects are indicated for the arsenic levels observed in soils on and around the CTS property.

Polynuclear aromatic hydrocarbons (PAHs) were detected in a single soil sample located on the northwest corner of the CTS property (Appendix E, Tables 15 and 17). ATSDR does not provide CVs for individual PAHs other than a CREG for benzo(a)pyrene (BaP). BaP is the most studied of the individual chemicals of the PAH group, and has shown to be the most toxic. Seven of the eight detected PAHs, including BaP, are identified as “probable” human carcinogens by ATSDR. To evaluate potential adverse health effects associated with incidental ingestion of soil PAH concentrations, the other eight PAH chemicals were converted to an equivalent BaP concentration and summed to provide a “BaP-equivalent” concentration for all detected PAHs. An estimated incidental soil ingestion BaP-equivalent exposure dose was calculated for pica-behavior children, and children and adults using typical soil exposure rates. Estimated numbers of increased cancers were less than one per 100,000 population. Based on the limited exposure potential related to the location of the single PAH sub-surface soil detection on the CTS property, and the low exposure dose estimates relative to known health-effect study data, no adverse health effects are indicated for PAHs.

Appendix A, Tables 14 through 16 lists the detected chemicals in the sub-surface soils and those that exceeded comparison values.

Residential Crawl-Space Air Samples

The highest crawl-space air concentrations were used to calculate estimated exposure doses for cancer health-effect evaluations (Appendix E, Table 18). A 30-year period was used to represent a conservative (highly health protective) exposure period estimate for the typical maximum length of time a person lives at a single residence and to accommodate for a lack of information on the length of time soils have been contaminated with TCE and other VOCs. When evaluating crawl-space inhalation exposures ATSDR utilizes a 20 to 50% reduction of the measured VOC concentration for calculation of the estimated exposure concentration. For this study, to provide a worst-case exposure estimate to crawl-space VOCs, the measured crawl-space concentration was used for exposure estimates. This would serve to overestimate exposure concentrations and potential health risks. There is no data to indicate that persons were exposed to the concentrations of chemicals detected in the crawl-space air samples. Actual exposure concentrations in the living areas of the tested residences would likely be less. Testing of the indoor air is the most appropriate means to identify if exposures are present.

ATSDR identifies carbon tetrachloride as a “probable” human carcinogen. Exposure dose estimates for the carbon tetrachloride indicate “no apparent increased cancers” (less than one additional cancer for a population of 100,000 exposed). Chloroform is identified as a “likely” human carcinogen by ATSDR. Chloroform exposure dose estimates indicate “no apparent increased cancers” (less than one additional cancer per 100,000 exposed persons). There is no chloroform ATSDR or EPA human or animal cancer-effect study data for comparison. Methylene chloride is identified as a “likely” human carcinogen by ATSDR. Methylene chloride exposure dose estimates indicate “no apparent increased cancers” (less than one increased cancer per 100,000 exposed persons. The TCE cancer-effect evaluation estimates “low” to “moderate” numbers of increased cancers (2 to 10 per 100,000 population) using current and proposed health guidelines. Based on these evaluations, no cancer or non-cancer adverse health-effects are indicated for 30-year inhalation exposures to these VOCs at the concentrations in the December 2007 crawl-space samples.

Due to the nature of soil sampling and vapor transport studies, the crawl-space sampling 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. Yet, the highly health protective assumptions made in the crawl-space evaluation reduce the uncertainty associated with the sampling data.

Residential Sub-Slab Soil Gas Samples
A 0.1 “attenuation factor” was applied to soil gas TCE and PCE concentrations to represent conservative estimates of indoor air concentrations available to occupants for inhalation (Appendix E, Table 19). Estimates of increased numbers of cancers due to TCE inhalation at the concentration detected in the single sample (0.80 ppbv, located west of the CTS property) ranged from less than one to two per 100,000 population for the current and proposed range of cancer risk factors. The inhalation exposure dose estimate was 1.2 million times lower than the lowest animal cancer-effect study value. No human values were available for comparison. The PCE evaluation estimates “low” numbers of increased cancers (three additional cancers per 100,000). No human values were available for comparison. No adverse health effects are indicated from breathing air with TCE or PCE at the concentrations detected in the December 2007 sub-slab soil gas samples.

Other Soil Gas Samples
A 0.1 attenuation factor was applied to soil gas concentrations to represent conservative estimates of indoor air concentrations available for inhalation (Appendix E, Table 20).

TCE: The adjusted maximum TCE soil gas concentration is 2,000 times lower than lowest no-effect human study value for a 4-hour exposure, and 4,300 times lower than the lowest-effect human study value for a 7-hour per day for 5 days exposure. The adjusted maximum TCE concentration was used to estimate cancer-effects for 30-year residential exposures. Estimates of increased numbers of cancer ranged from “moderate” to “high” (20 to 1,000 per population of 100,000). The two other TCE detections in this line of samples were much lower and cancer-effect evaluations of the mean concentration were calculated. The mean calculation estimates “low” to “high” increased numbers of cancers (4 to 210 per 100,000).

PCE: The attenuation factor adjusted PCE concentration was 1,700 times less than the lowest no-effect human study values for long-term exposures, and 83,000 times lower than the lowest human study for a 14-year intermittent exposure. There was “no apparent” risk of additional cancers (less than one additional cancer per 100,000 population.

The soil gas data evaluated in this sample set represents TCE and PCE concentrations in the sub-surface soil environment and not concentrations found in residential breathing zones. There is no indication that persons have been or are being exposed at the concentrations observed in the soil gas samples. The soil gas concentrations were adjusted with highly health protective attenuation factors to represent “worst-case” changes in TCE and PCE concentrations as they move through the soil to the area under a building, where they may ultimately gain access to indoor air. A less health protective attenuation factor referenced in guidance documents (0.01) results in adjusted concentrations 10 times less than those used for this evaluation, with an associated 10 times decrease in health-effect estimates. The highly health protective adjustment used in this study results in the maximum expected indoor concentrations, the highest expected exposure concentrations, and estimates of the maximum expected (“worst-case”) adverse health risks. Crawl-space samples collected in the vicinity of the sub-surface soil vapor samples do not indicate that TCE or PCE concentrations in the range estimated with the conservative attenuation factors have been found in residences. Soil gas concentrations are variable and decreased to below detection limits a short distance to the east of the CTS site. Health effect evaluations included a highly protective estimate of cancer effects for both TCE and PCE assuming long-term exposures at the adjusted soil gas concentrations. Because of the lack of exposure potential and the highly protective assumptions used, adverse health effects are not indicated for the TCE and PCE soil gas concentrations.

To be protective of the community’s health, N.C. DPH recommends TCE and other volatile gases in the sub-surface be closely monitored for potential exposures in indoor and outdoor living environments. Continued monitoring of soil gas and crawl-space concentrations, or indoor air environments, are recommended if there is evidence of the potential for soil gas concentrations to increase over those in this health assessment, or to be transported to areas where human exposures are likely to take place, such as residential dwellings.

Outdoor Air Samples

The highest detected TCE concentration collected along the roadway (21 ppbv) is 95 times less than the ATSDR CV for short-term exposure periods (less than 15 days) (Appendix E, Table 21). The 21 ppbv concentration is 4,500 times less than the no adverse health-effect study level for a 4-hour exposure, and 9,500 times less than the lowest adverse effect level for a second human study using a 7-hour per day exposure for 5 days. No short-term effects are indicated for inhalation exposures at the TCE concentrations seen in the roadway monitoring, such as persons travelling along the roadway or waiting for a bus.

The highest TCE concentration detected in the other ambient air samples (not collected along the roadways) was 277 ppbv at the seeps (springs) to the east of the CTS property, observed in August 2008 (Appendix E, Table 22). Exposures were calculated to evaluate potential health effects associated with short-term intermitent recreational exposures near the seeps. The 277 ppbv detectection is 340 times lower than the lowest no adverse health effect level from human studies with a 4-hour inhalation exposure, and 2,200 times lower than the non-cancer long-term (chronic) exposure in an animal study. The geometric mean concentration for the December 2007 samples (0.945 ppbv) is 100,000 times lower than the health-effect level. The lowest adverse effect level for a second human health study using a 7-hour per day for 5 days exposure period was 720 times higher than the highest outdoor air sample, and 760,000 times higher than the geometric mean TCE concentration. Based on the health effect evaluations, the variability in the detected TCE concentrations at the seeps, and the likley short-term exposure scenarios expected in the immediate vicinity of the seeps, no adverse health effects would be expected to persons intermittently exposed to the TCE concentrations measured in this area. The security fence that has been placed around the seeps will prevent access to the immediate vicinity of the springs, preventing persons from breathing any released volatile chemicals at their highest concentration.

Selected Site Contaminant Toxicological Information

The following information is provided for TCE, chromium and lead. Additional information is included in materials in Appendix F and H and in documents listed in the References.

Trichloroethylene (TCE)

Trichloroethylene is a colorless liquid which is used as a solvent for cleaning metal parts and as a solvent to make other chemicals. Trichloroethylene can be found in some household products, including, paint removers, adhesives, and spot removers.

It is not known if drinking water contaminated with trichloroethylene (TCE) causes non-cancer illness in humans. Childhood leukemia has been observed after maternal exposure to TCE-contaminated drinking water during the prenatal period. Breathing small amounts may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing large amounts of TCE may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage. Evidence from animal and epidemiological studies also suggest that exposure to TCE might be associated with congenital heart defects and poor intrauterine growth. Studies in rats and mice show that TCE can effect fertility, but the relevance to humans is not clear (NRC 2006). Human epidemiological studies have been limited by difficulties in estimating exposure levels and by the presence of other solvents with similar toxic effects. In rats and mice, TCE begins affecting the liver, kidney, and developing fetus at doses as low as 1 mg/kg/day. These studies are limited, however, by inadequate characterization of exposure, inadequate quantification of results, or lack of endpoints suitable for deriving chronic endpoints. The current ASTDR cancer classifications listed for TCE are “under review” (EPA), “reasonably anticipated to be a carcinogen” (NTP), and “probably carcinogenic to humans" (ATSDR 1997e, ATSDR 2003, EPA 2001b, NJDHSS 2003). In recent years evidence supporting TCE's ability to cause cancer has been strengthened.

Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, and soil. It can exist in several different forms, including trivalent and hexavalent chromium. Hexavalent chromium is more toxic than trivalent. Small amounts of trivalent chromium are considered to be a necessity for human health. Chromium can easily change from one form to another in water and soil, depending on the conditions present. Chromium is widely used in manufacturing and is found in products such as treated wood, tanned leather and stainless steel cookware.

The main health problems seen in animals following ingestion of hexavalent chromium compounds are irritation and ulcers in the stomach and small intestine, and anemia. Trivalent chromium compounds are much less toxic and do not appear to cause these problems. Sperm damage and damage to the male reproductive system have also been seen in laboratory animals exposed to hexavalent chromium. Skin contact with certain hexavalent chromium compounds can cause skin ulcers. Some people are extremely sensitive to hexavalent chromium or trivalent chromium. Allergic reactions consisting of severe redness and swelling of the skin have been noted.

The U.S. Department of Health and Human Services (U.S. DHHS), the International Agency for Research on Cancer (IARC), and the EPA have determined that hexavalent chromium compounds are "known" human carcinogens. In workers, inhalation of hexavalent chromium has been shown to cause lung cancer. Hexavalent chromium also causes lung cancer in animals. An increase in stomach tumors was observed in humans and animals exposed to hexavalent chromium in drinking water.

It is likely that health effects seen in children exposed to high amounts of chromium will be similar to the effects seen in adults. It is not known whether children would be more sensitive than adults to the effects of chromium. It is not known if exposure to chromium will result in birth defects or other developmental effects in people. Some developmental effects have been observed in animals exposed to hexavalent chromium. In animals, some studies show that exposure to high doses during pregnancy may cause miscarriage, low birth weight, and some changes in development of the skeleton and reproductive system. Birth defects in animals may be related, in part, to chromium toxicity in the mothers (ATSDR 2008a, ATSDR 2008b).

Lead

Lead is a naturally occurring toxic metal. It may be found in its pure form or in combination with other minerals. Lead has no nutritional value, but is very valuable in manufacturing. In industry, lead is used in the production of batteries, solder, paints, ammunition, sheet metal, and other metal alloys. Lead was found in house paint sold before 1978. Since 1978, paint sold for residential use can contain no more than 600 parts per million lead. Most lead is now used to manufacture car batteries. Other lead sources include bullets, fishing weights, curtain weights, some glazed ceramics, and plumbing solders made before 1986.

Lead is a well known developmental neurotoxin, and also affects the kidneys, blood formation, reproduction, humoral immunity, and the peripheral nervous system (ATSDR 2007d). Long-term lead exposure for working adults is associated with decreased performance in some tests that measure functions of the nervous system. Lead exposure may also cause weakness in fingers, wrists, or ankles. Lead may also cause anemia. In pregnant women, high levels of exposure to lead may cause miscarriage. According to the ATSDR there is no conclusive proof that lead causes cancer, however both the U.S. Department of Heath and Human Services and EPA have determined that lead is a probable human carcinogen. Children are more sensitive to the effects of lead than adults, and studies show that even low lead levels that do not affect adults can be detrimental to a child's cognitive development.

Additional Contaminant and Health Information

Additional contaminant and health hazard information is provided in Appendix H for TCE, chromium and lead. The information is provided in the form of fact sheets prepared by ATSDR and N.C. DPH. These fact sheets provide information on the occurrence of these chemicals in the environment and adverse health effects that may occur with exposures exceeding health-effect levels through different routes of exposure. Additional information on these and the other chemicals identified in the environmental matrices associated with the CTS site is available on ATSDR's web site through the "Toxic Substances Portal" (http://www.atsdr.cdc.gov/substances/index.asp). Additional discussion of recent findings on the toxicity of TCE and the EPA proposed CVs and health guidelines is provided in Appendix F.

HEALTH OUTCOME DATA

In addition to studying exposure and chemical-specific toxicity data as part of the public health assessment process, N.C. DPH also considers health outcome data, such as mortality and morbidity data. The following criteria are evaluated when determining if a study of health outcome data is reasonable: (1) presence of a completed human exposure pathway, (2) high enough concentrations of contaminant to result in measureable adverse health effects, (3) sufficient numbers of exposed people in the pathway for effects to be measured, and (4) a health outcome database where disease rates for the population of concern can be identified.

N.C. DPH identified groundwater, private drinking water well, surface water and air completed exposures pathway for the CTS site. The limited number of potentially exposed persons, the length of the potential exposure periods, the concentrations of contaminants of potential exposure, and the potential long-term health effects associated with the site contaminants limit the study of health outcome data related to this site. Non-cancer health statistics are not available at the level necessary for evaluation. A cancer rate study was done for Buncombe County and for a 1-mile radius around the CTS property. The study compared the numbers and types of cancers in the study area to typical data observed in other areas of North Carolina. The cancer rate study did not identify elevated numbers of cancers over what is expected for the number of persons studied. The types of cancers observed in the study population reflected the types and numbers expected in the community. The cancer study report is included in Appendix G. The ability to associate chemicals from a specific site to resulting cancers in a population is complicated by a number of factors. It is estimated that one out of every two men and one out of every three women will develop a cancer of some type during his or her lifetime. As a result, it is common to find what appear to be cancer cases clustering in neighborhoods over a period of years. This will occur in any neighborhood. As people age, their chance of getting cancer increases, and so as we look at a community, it is common to see increasing numbers of cancer cases as the people in the community age. Different types of chemicals cause different types of cancers (such as liver, lung, or colon). Cancer rate studies look for excess cancers related to exposures to specific chemicals over the 30% expected in a population. We are all exposed to hundreds of natural and man-made chemicals on a daily basis. Although not all chemicals can cause cancer, separating the health-effects of these chemicals from those in a particular cancer study is statistically difficult. An added complication is that cancers are typically developed long after the initial exposure to the causative chemical, in many cases years to decades afterward.

CHILD HEALTH CONSIDERATIONS

The ATSDR recognizes there are unique exposure risks concerning children that do not apply to adults. Children are at a greater risk than are adults to certain kinds of exposures to hazardous substances. Because they play outdoors and because they often carry food into contaminated areas, children are more likely to be exposed to contaminants in the environment. Children are shorter than an adult, which means they breathe dust, soil, and heavy vapors closer to the ground. They are also smaller, resulting in higher doses of chemical exposure per body weight. If toxic exposures occur during critical growth stages, the developing body systems of children can sustain permanent damage. Probably most important, however, is that children depend on adults for risk identification and risk management, housing, and access to medical care. Thus, adults should be aware of public health risks in their community, so they can guide their children accordingly. Other susceptible populations may have different or enhanced responses to toxic chemicals than will most persons exposed at the same concentration of a particular chemical in the environment. Reasons for these differences may include: genetic makeup, age, health, nutritional status, and exposure to other toxic substances (like cigarette smoke or alcohol). These factors may limit that persons' ability to detoxify or eliminate the harmful chemicals from their body, or may increase the effects of damage to their organs or physiological systems. Child-specific exposure scenarios, including incidental ingestion of surface waters during swimming, and exposure parameters, were considered in this assessment.

Children are particularly sensitive to lead as compared to adults. No safe blood lead level in children has been determined. Lead affects children in different ways depending on the level of exposure. High levels of lead exposure may increase the risk of children developing anemia, kidney damage, colic, muscle weakness, and brain damage. Lower levels of lead exposure may affect development and behavior. Even lower levels of lead exposure can affect a child's cognitive abilities and physical growth. Fetal exposure to lead is associated with premature birth and low birth weight. Fetal and early childhood exposure to lead has also been linked to decreased cognitive development and reduced intelligence in early childhood, and evidence suggests that these effects may persist into adulthood (see Appendix 2, for a child-specific public health statement). There is the potential that children were exposed to groundwater drinking sources containing lead at concentrations exceeding ATSDR comparison values. Calculated blood lead levels for children using the maximum and geometric mean concentration for the groundwater samples collected in 2007 and 2008 indicate estimated blood lead levels less than the Center for Disease Control and Prevention (CDC) health-effects action level of 10 µg/dL.

The number of children possibly exposed, if any, the length of the exposure, and actual exposure concentrations over time are unknown.

The TCE concentration in the groundwater monitoring well samples collected on the CTS property was high enough to potentially cause adverse health effects to children. TCE concentrations found off-site down-gradient were lower and adverse effects would not be expected. Vinyl chloride was also detected on the site in groundwater at concentrations that could potentially cause health effects to children. No vinyl chloride was detected off-site. Elevated total chromium was found in groundwater east of the site. If the concentration of chromium detected in the groundwater is made up of elevated hexavalent chromium concentrations, then children may be at risk of health effects. There is no indication that children have been or are being exposed to groundwater in the area of these sample locations. However, monitoring of the exposure potential and verification of a lack of exposure is recommended.

High concentrations of TCE were observed in surface waters and seeps near the east side of the CTS property. Although the health effect evaluation did not indicate the potential for adverse health effects, N.C. DPH recommends limiting access of children to these waters to protect them from inhalation, direct contact, and incidental ingestion exposures that might occur during swimming or wading.

COMMUNITY HEALTH CONCERNS EVALUATION

The community living around the CTS/Mills Gap site has expressed concerns regarding the potential for adverse health effects, including cancer, to persons drinking contaminated well water, using contaminated well water for bathing or other household uses, and breathing air containing volatile contaminants associated with the site.

Family members at the residences to the east of the CTS property where TCE was observed in 1999 in their private well waters have expressed concerns that their health issues may be related to TCE exposure. Persons using the groundwater well have identified health concerns including liver abnormalities, immune system deficiencies, possible kidney effects, and liver cancer. Persons using the spring water drinking water source have identified health issues. DPH can not confirm that these health effects are related to TCE exposure because of limited medical and occupational data, limited historical well water data, and the length of time since the exposure has ended.

The N.C. DPH was not able to conclude whether chromium and lead concentrations detected in groundwater collected down-gradient of the CTS property in 2007 present a public health hazard. There is no indication that people have been exposed to the elevated chromium or lead. Whether these particular waters have been used as a drinking water source is unknown. All other evaluations of potential exposure pathways and identified contaminants concentrations do not indicate the potential for adverse health effects, including exposures to children.

PUBLIC COMMENT PERIOD

The Public Health Assessment was published as a draft document on January 19, 2010. N.C. DPH staff met with the community in Asheville, N.C. on January 21, 2010 to present the results of the PHA, hear the community's comments and answer their questions. A 60-day comment period was provided from January 19 through March 19, 2010. During the comment period DPH collected comments from the community, agencies and organizations. A summary of the comments submitted and DPH's responses are included in Appendix J.

CONCLUSIONS

N.C. DPH has reviewed sampling and analytical data from a variety of environmental samples collected by the EPA and N.C. DENR on, and in the area near, the CTS/Mills Gap site. Contaminant concentrations in groundwater, surface water, sub-surface soil, sub-surface soil gas, crawl-space gases and outdoor air were all evaluated. The DPH reached five conclusions in this health assessment:

The DPH concluded that the residents using a private groundwater and spring wells identified in 1999 as contaminated with TCE could have been harmed by drinking their well water or breathing TCE that escaped from the well water to the air (volatilized) during activities such as showering or bathing. The length of time they used contaminated well water is not known. The concentrations of TCE that they may have been exposed to in the air or drinking water over the period of contamination are also not known, other than the single 1999 sample concentrations of TCE in the waters. The DPH cannot currently conclude whether the health effects identified by the families living at the residences east of the CTS site where TCE was detected in 1999 are a result of TCE exposure. A single well water sample was collected at each of the residences before the wells were closed. No samples were collected in the homes for the samples served by the spring source. The potential for adverse health effects are indicated on the basis of the single sample concentrations and assuming a long-term exposure period (10 years or more). During an interview with the DPH Public Health Physician a family member that had used the groundwater well reported health effects that may be linked to TCE exposure, however these same health effects may also be the result of other circumstances (smoking, occupational exposures, infectious diseases, and genetic predispositions). Because of the length of time that has passed since the exposures were stopped, the limited data available for the well water, and limited data on occupational and medical history, we do not have the ability to directly link the reported health effects to the well water exposures. These findings are relevant only for persons that were long-term users (more than 10 years) of the private well water at this location before the well was disconnected. Drinking or breathing TCE over many years in large amounts may cause adverse health effects. These effects include increased risk of kidney or liver cancer; dizziness, lung irritation, impaired heart function; and nerve, kidney or liver damage. Reproductive effects such as impaired fetal growth or decreased fertility may also result.

The DPH cannot currently conclude whether groundwater with the metal chromium has or may present a drinking water hazard. There are no indications that drinking water supplies contained elevated concentrations of chromium, but the available analytical data does not adequately identify the type of chromium in the groundwater to determine if a health hazard would exist if the groundwater was used as a drinking water supply.

The DPH concludes that other groundwater contaminants, including trichloroethylene (TCE), are not expected to harm people's health. There is no indication that private drinking water well analyses included in this PHA, other than the groundwater well and two spring wells identified in 1999 and discussed above, contain concentrations of TCE that may present a health hazard.

The DPH concludes that levels of chemicals identified in the surface waters, sub-surface soils, crawl-space air, sub-surface soil gas and outdoor air will not harm people's health.

The DPH cannot currently conclude whether groundwater with elevated concentrations of the metal lead has been or may present a drinking water hazard. While there are no indications that private drinking water supplies contain elevated concentrations of lead, more information is needed to determine if people may be using private drinking water supplies with elevated lead.

The DPH N.C. Central Cancer Registry (CCR) determined that cancer rates for a 1-mile radius around the CTS property were not elevated. Cancer cluster investigations such as this are subject to a typical set of limitations as expressed in the CCR report provided in Appendix G. The cancer evaluation for this site is limited by the small population size of the study area and the availability of cancer records only since 1990. The cancer study included cancers reported to the Registry through 2005. Because of the long latency period of most cancers the evaluation is also limited by the use of a person's address at the time of diagnosis rather than the ability to identify if and where the critical exposure that led to cancer development took place.

RECOMMENDATIONS

The N.C. DPH makes the following recommendations:

- Encourage persons that lived at the residences identified in 1999 as having elevated TCE in their private well waters and spring water drinking sources to undergo periodic medical evaluations, making their health-care providers aware of the circumstances of their exposure to TCE. The medical evaluation should include routine testing of liver and kidney function, with urinalysis.
- Identify if there are private wells currently being used as drinking water sources in the path of the contaminated groundwater flow emanating from the CTS property. Periodic VOC monitoring of these private wells, if they exist, is recommended. If contaminants are identified at concentrations exceeding regulatory or health-based drinking water guidelines, alternative drinking water sources should be provided.
- Determine if additional drinking water sources may be impacted in the area of the contaminated wells in the residences north of the CTS site. (On the basis of the described groundwater flow through and away from the CTS site the contamination observed in these wells may not be related to the CTS site.)
- Monitor groundwater moving off the CTS property for vinyl chloride, a known human carcinogen that is a breakdown product of contaminants found associated with this site. If vinyl chloride is identified in drinking water sources exceeding regulatory or health-

protective guideline values it is recommended that alternative drinking water supplies be provided.

- Monitor groundwater in the flow path from the CTS site that are being used or may be used as drinking water sources for TCE and other contaminants. Provide an alternative drinking water source if contaminant concentrations exceed regulatory or health-guideline values.
- Prevent children from wading or swimming in surface waters and springs near the east side of the property where elevated concentrations of TCE were detected.
- Determine the hexavalent chromium component of the groundwater where elevated total chromium was reported if these waters are being, or may be used as a drinking water source.
- Determine the lead concentration of the groundwater where elevated lead was reported if these waters are being, or may be used as a drinking water source.
- Monitor lead levels in private well supplies in the areas where groundwater concentrations of lead exceeded the regulatory level.
- Continued monitoring of out-gassing of VOCs from elevated concentrations in the sub-surface into dwellings where they may present an inhalation hazard.
- Control potential inhalation exposures in the area of the seeps (springs) adjacent to the east side of the CTS property, either by controlling discharges or controlling access.

PUBLIC HEALTH ACTION PLAN

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

A. Public Health Actions Completed

- Residences known to have contaminated groundwater as their private drinking water wells have been connected to alternative drinking water sources.
- Public meetings have been held to provide the community an opportunity to voice their concerns to EPA and N.C. DENR.
- EPA and N.C. DENR have provided periodic updates on site activities to the public, as well as local and state government officials.
- N.C. DPH distributed two Health Education documents in October 2007: *Frequently Asked Questions (FAQs), Mills Gap (former CTS Plant) Site, Asheville, NC* and *Trichloroethylene (TCE) Fact Sheet and FAQs*.
- An "Initial/Public Comment Release" draft version of the Public Health Assessment (PHA) was published on January 12, 2010 and made available to the community, government officials, and environmental agencies. A 60-day period was provided for comments to be submitted to ATSDR or HACE. Comments received and HACE's responses were included in this "Final PHA" version in an Appendix.
- A press release issued by N.C. DHHS announced the release of the "Initial/Public Comment Release" draft version of the PHA and where copies could be located. Locations of availability included the Buncombe County Health Department, 6

community libraries, and the ATSDR and HACE web sites.

- A 2-page factsheet dated January 13, 2010 was made available to summarize the findings of the PHA. It is available on N.C. DPH's Health Assessment and Consultation (HACE) Program website (http://www.epi.state.nc.us/epi/oee/hace/ncmap/CountyInfo.html#Buncombe).
- N.C. DPH presented our findings and recommendations included in the Public Health Assessment at a public meeting on January 21, 2010. The meeting took place at Roberson High School near the site.
- A link to U.S. EPA's web page for the site is provided from the HACE web site.
- N.C. DPH published the *Private Well Waters from the Mills Gap Road Area Health Consultation, Skyland, NC, EPA Facility: NCSFN0406988* document on July 8, 2010. In this document HACE evaluated private well water samples collected near the site from June 2008 through January 2010 that were not included in the PHA. This report is available on the ATSDR and HACE websites.

B. Public Health Actions Planned

- N.C. DPH will continue to review of additional environmental or health data generated on or around the site as requested by the community, local health departments, N.C. DENR or EPA.
- N.C. DPH will continue to assist community members with interpretation of environmental and health information generated in association with site investigations.
- N.C. DPH will provide assistance to community members concerned with their exposure to site contaminants and their health, including N.C. DPH Public Health Physicians interfacing with community member's primary care physicians to explain the potential health effects related to identified exposures.

REPORT PREPARATION

Author:

Sandy Mort, MS
Public Health Assessor
North Carolina Department of Health and Human Services
Division of Public Health
Occupational and Environmental Epidemiology Branch

Reviewers:

Mina Shehee, PhD, N.C. DHHS/DPH/OEEB
Ken Rudo, PhD, N.C. DHHS/DPH/OEEB
Mercedes Hernandez-Pelletier, MPH, N.C. DHHS/DPH/OEEB

ATSDR Technical Project Officer:

Jennifer Freed, MPH
ATSDR/DHAC

CERTIFICATION

This Public Health Assessment for the Mills Gap Road/CTS Site was prepared by the North Carolina Division of Public Health (N.C. 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 assessment was initiated. Editorial review was completed by the cooperative agreement partner.

Jennifer aFreed

Jennifer A. Freed
Technical Project Officer
Division of Health Assessment and Consultation (DHAC)
ATSDR

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

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

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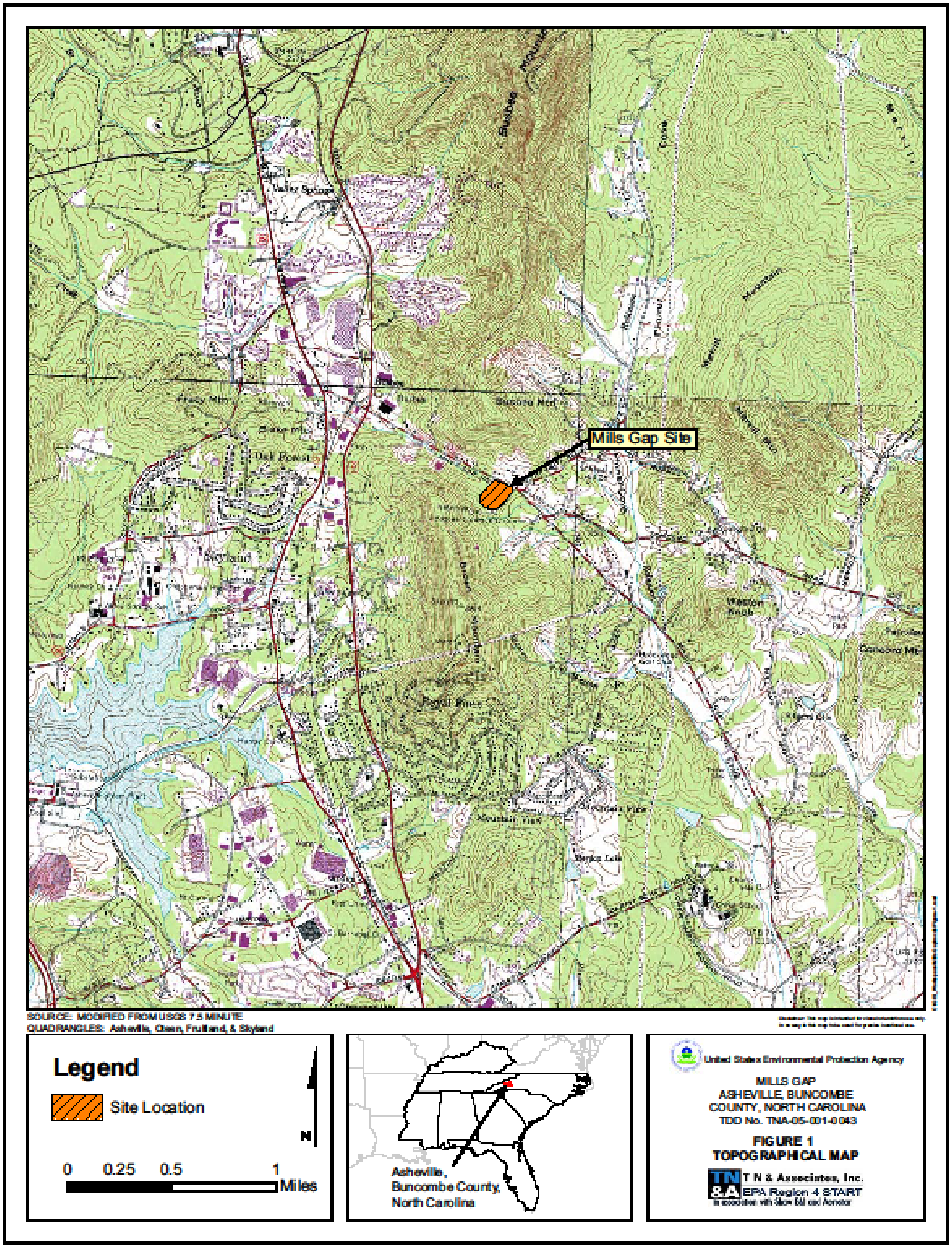
Appendix A

Figures

Figure 1. CTS/Mills Gap Site, Ashville, Buncombe County, NC Topographical Map



SOURCE: MODIFIED FROM USGS 7.5 MINUTE
QUADRANGLES: Asheville, Oteen, Fruitland, & Skyland

Figure 2. Groundwater Sample Locations Collected In December 2007 And January 2008 At The CTS/Mills Gap Site.

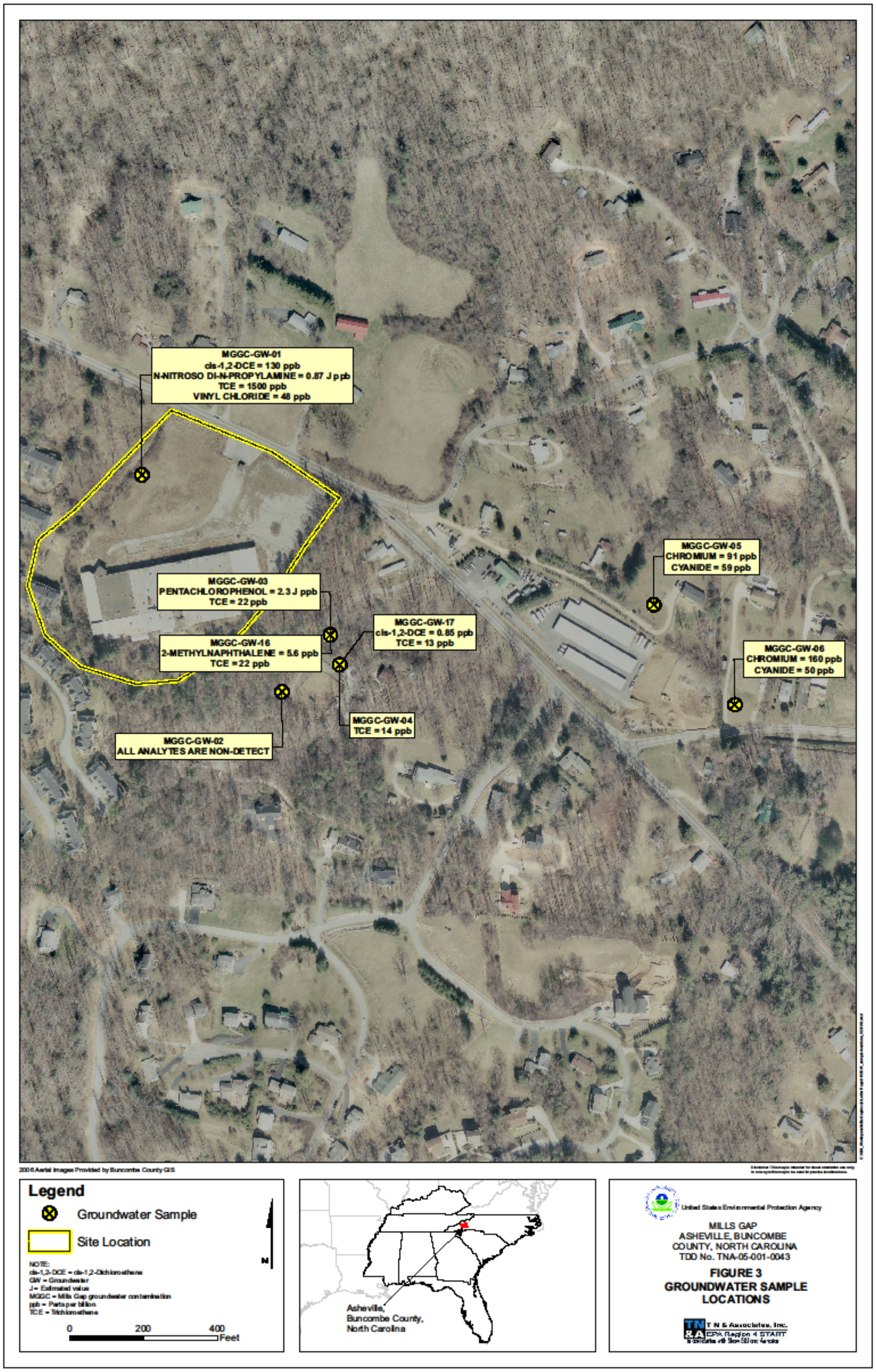


Figure 3. Location Of The Private Well Samples Collected By N.C. DENR In 2007.

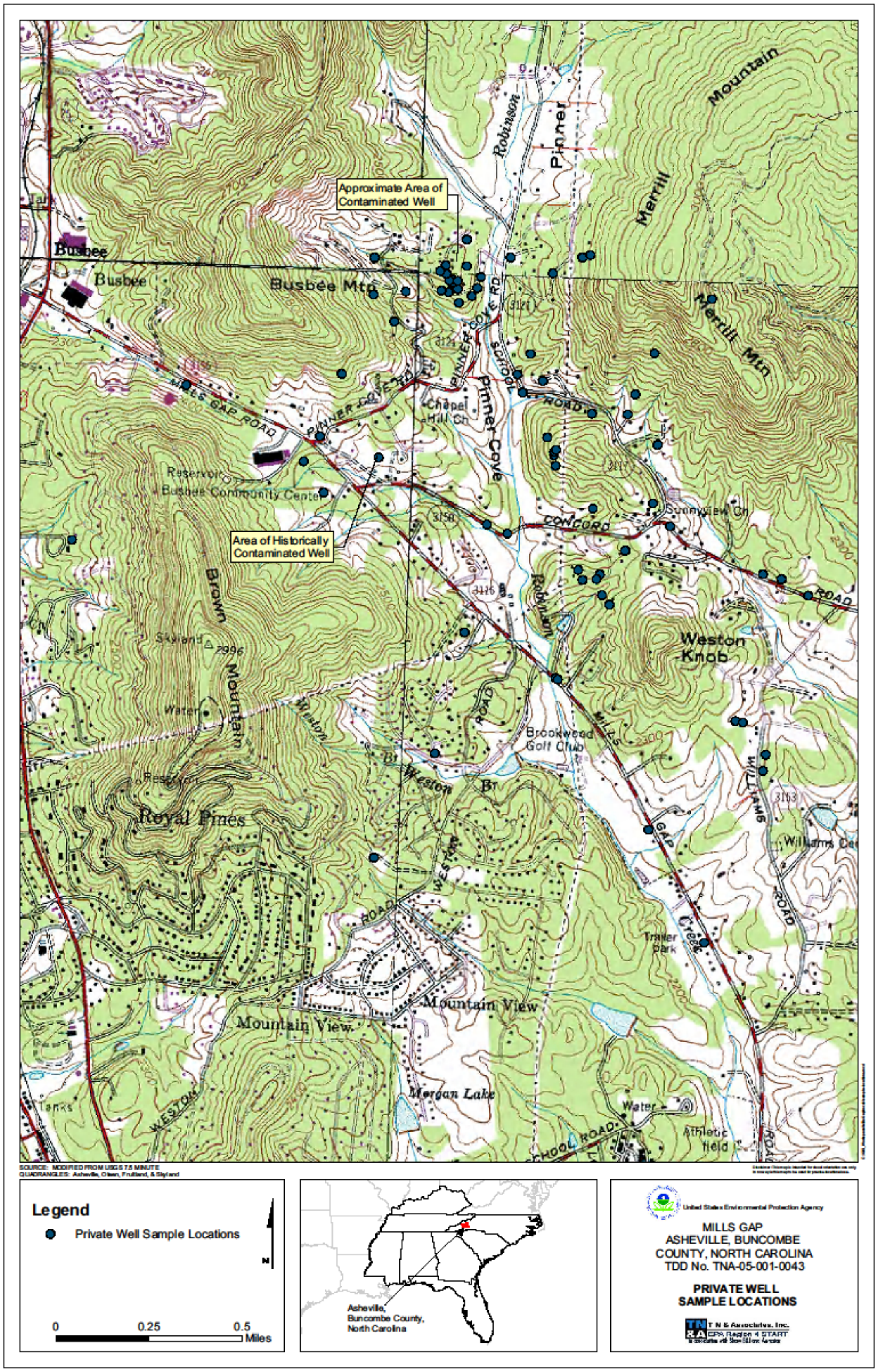


Figure 4. Surface Water Sample Locations Collected In September 2007 At The CTS/Mills Gap Road Site. Locations 1A, 3A and 4A are springs, all other locations are streams.

Figure 5. Surface Water Sample Locations Collected In November And December 2007 At The CTS/Mills Gap Road Site.

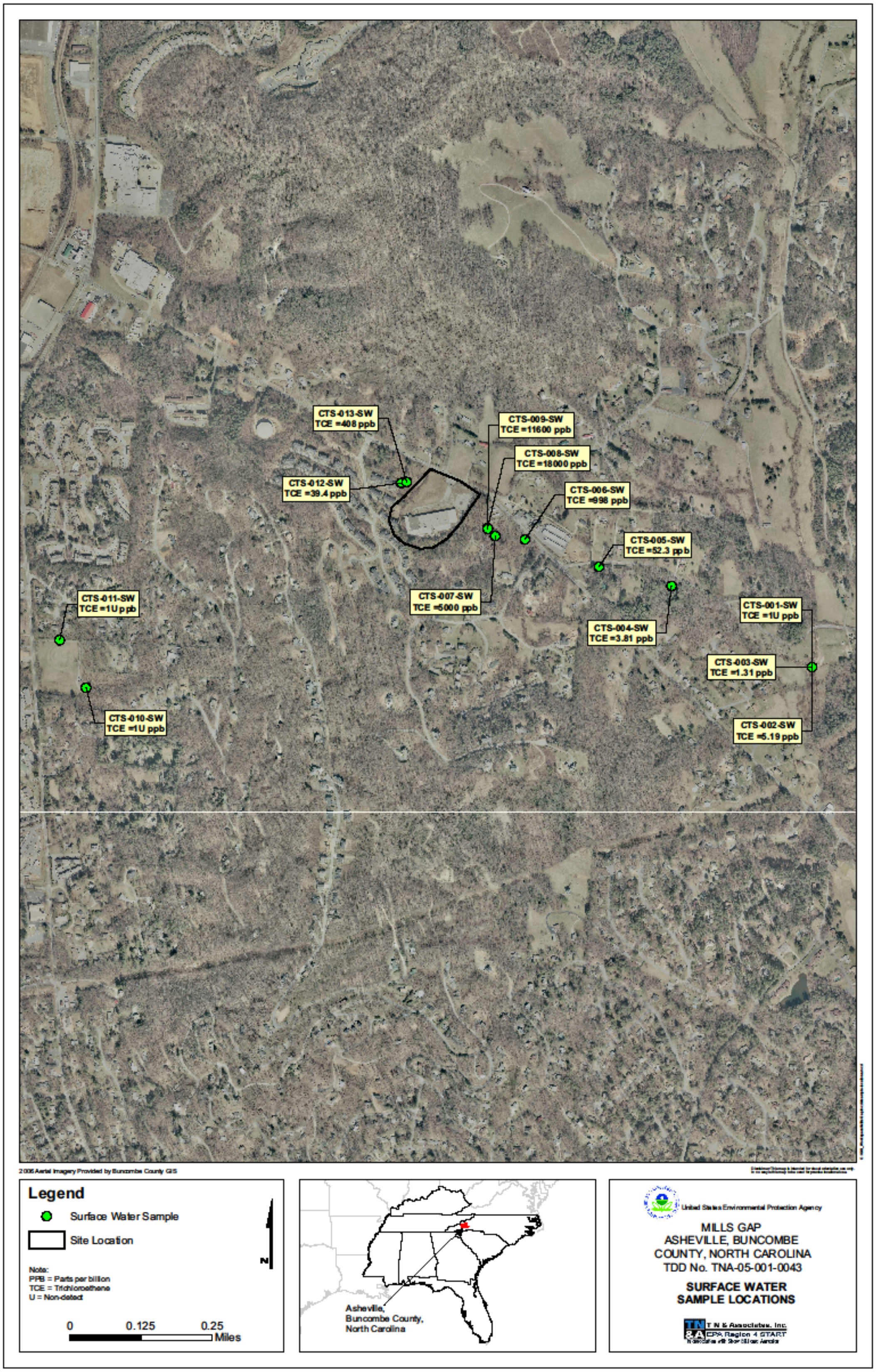


Figure 6. Sub-Surface Soil Sample Collection Locations Collected In December 2007 And January 2008 At The CTS/Mills Gap Road Site.

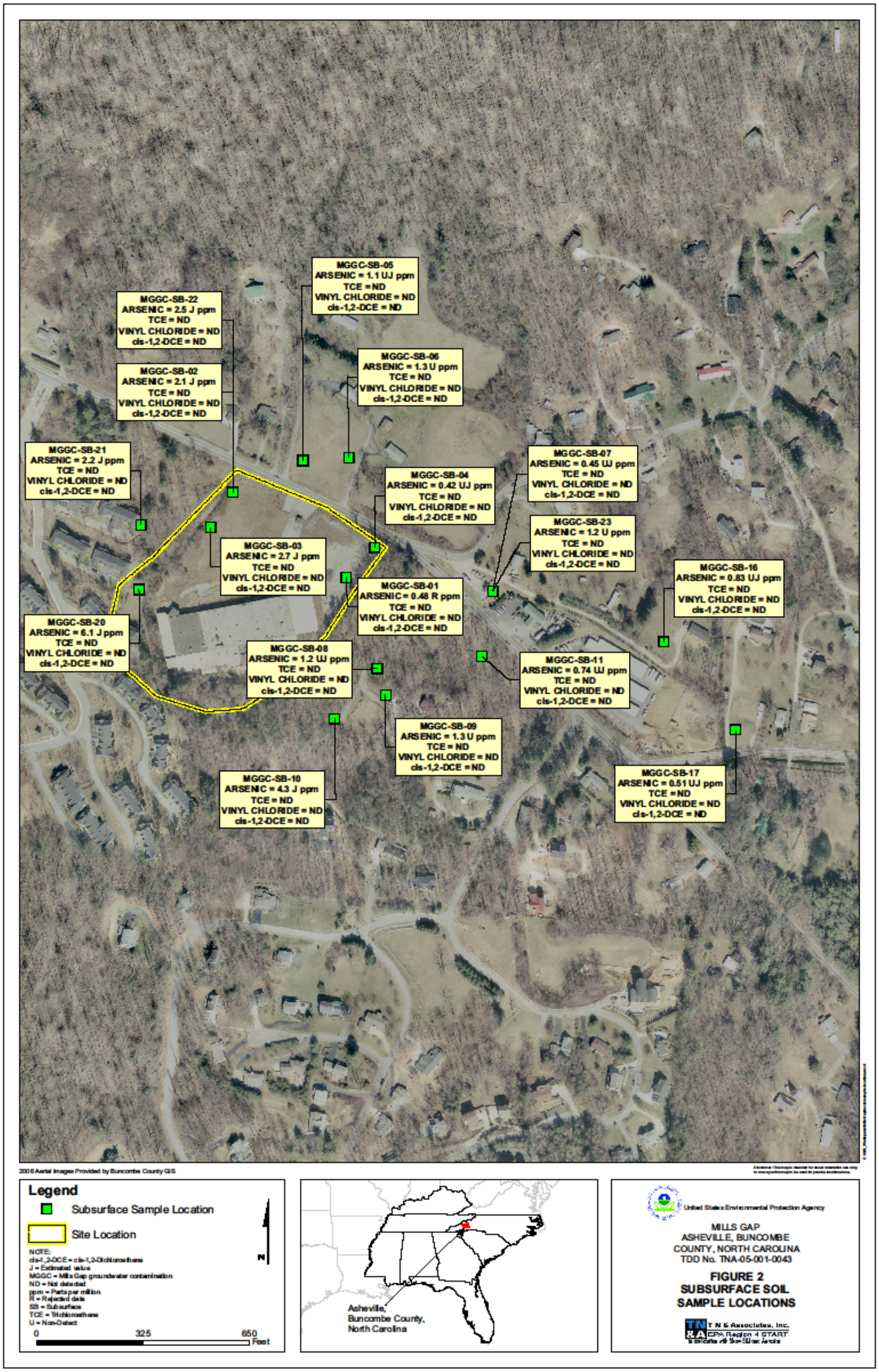


Figure 7. Dirt Crawl-Space Passive Air Samples Collected In December 2007 At The CTS Mills/Gap Road Site.

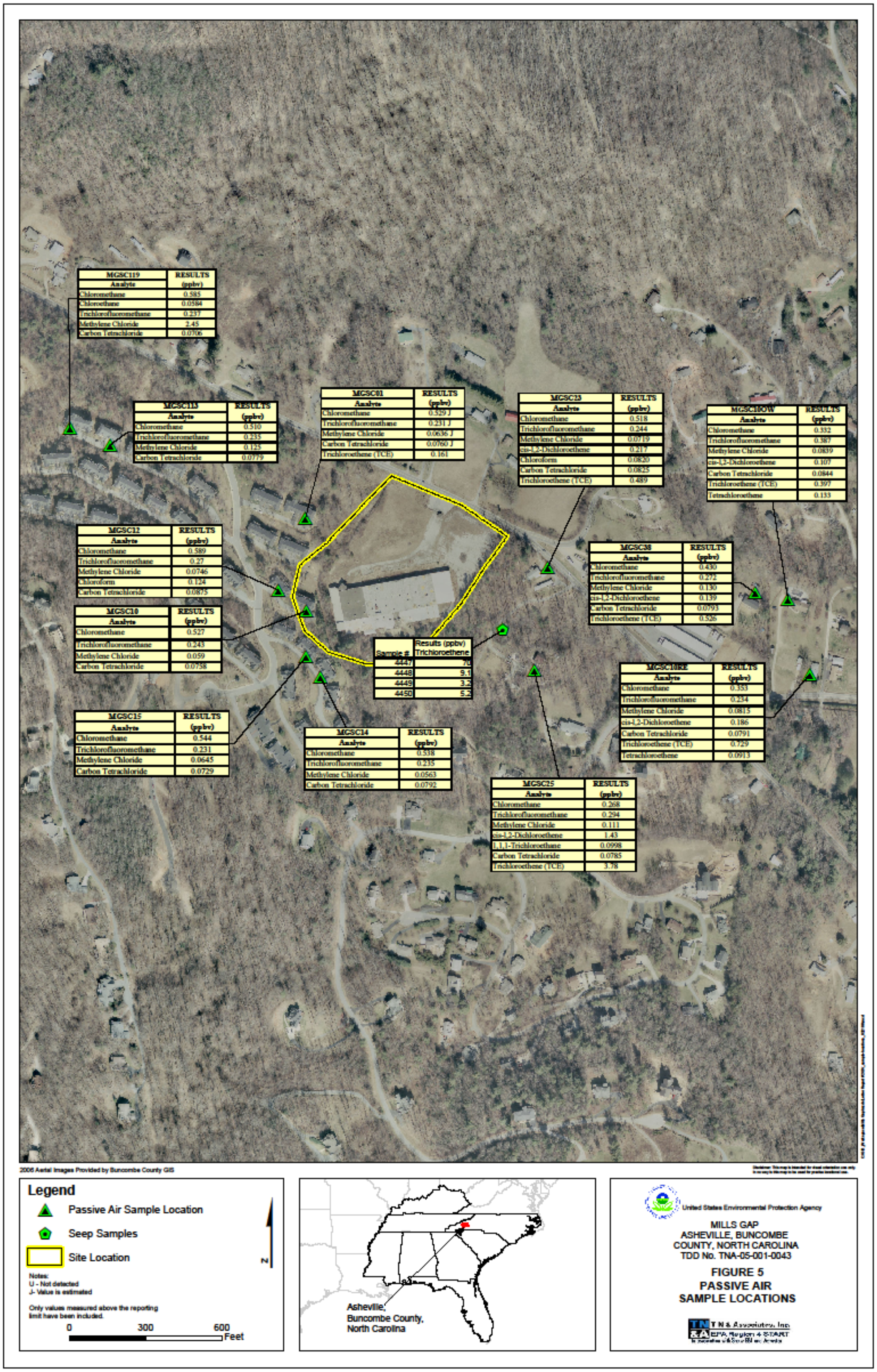


Figure 8. TAGA Soil Gas And Sub-Slab Soil Gas Samples Collected In December 2007 At The CTS/Mills Gap Road Site.

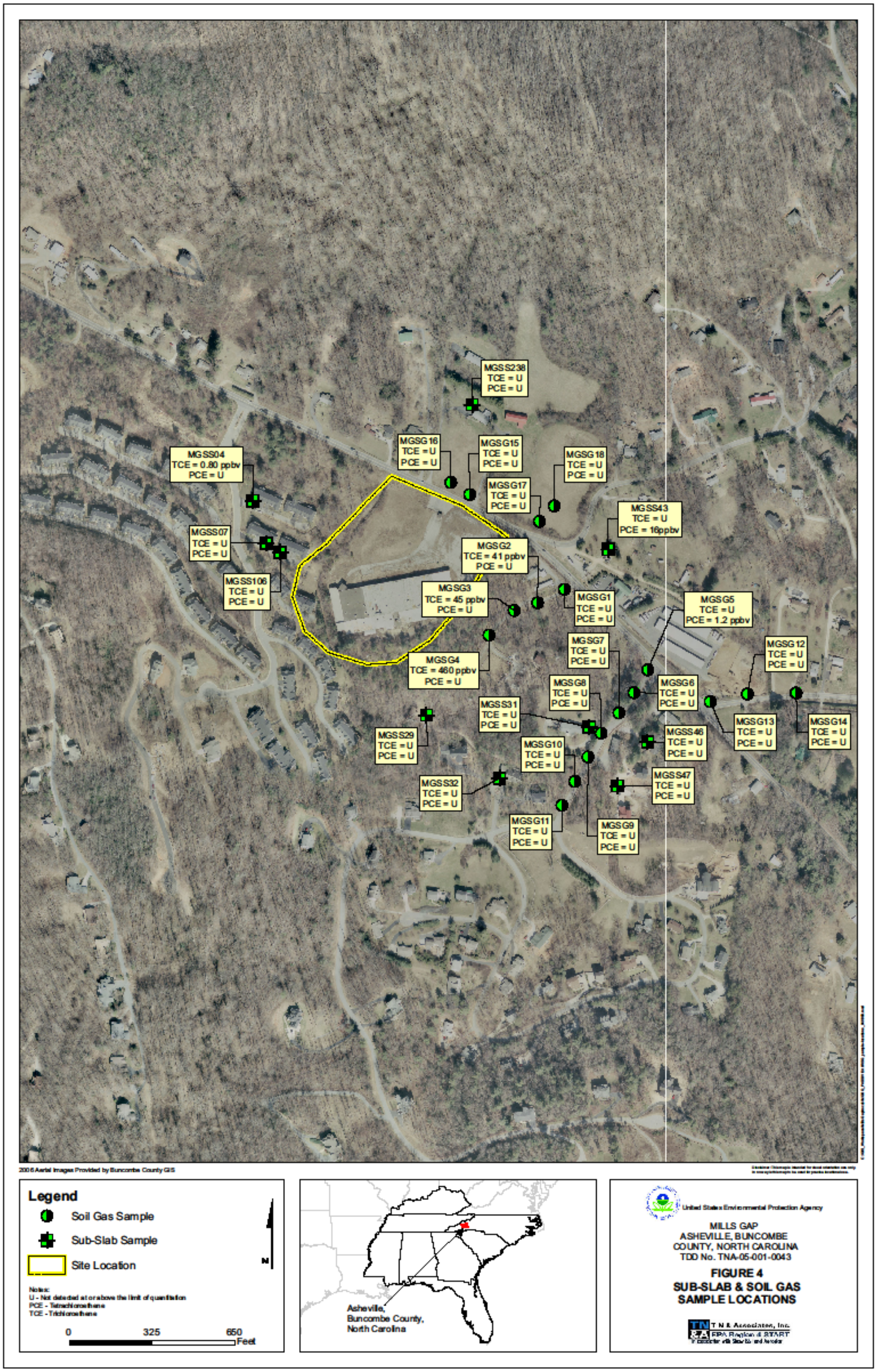


Figure 9. Crawl-Space Air, Ambient (Outdoor) Air, and Sub-Surface Soil Gas Samples Collected in August 2008 At The CTS/Mills Gap Road Site.

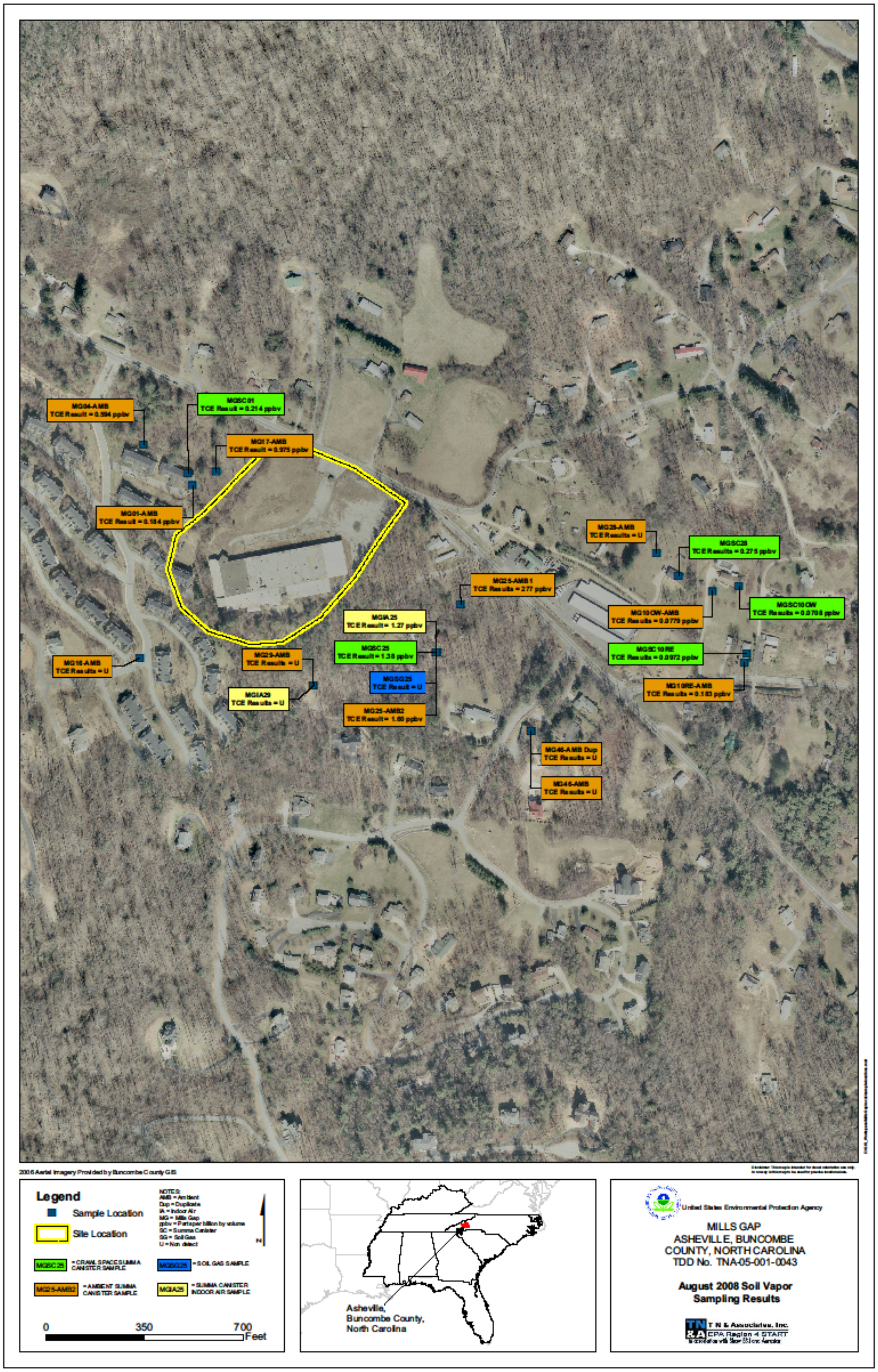


Figure 10. TAGA Bus-Mounted Mobile Air Monitoring Collected Along Roadways In The Vicinity Of The CTS/Mills Gap Road Site On December 10, 2007.

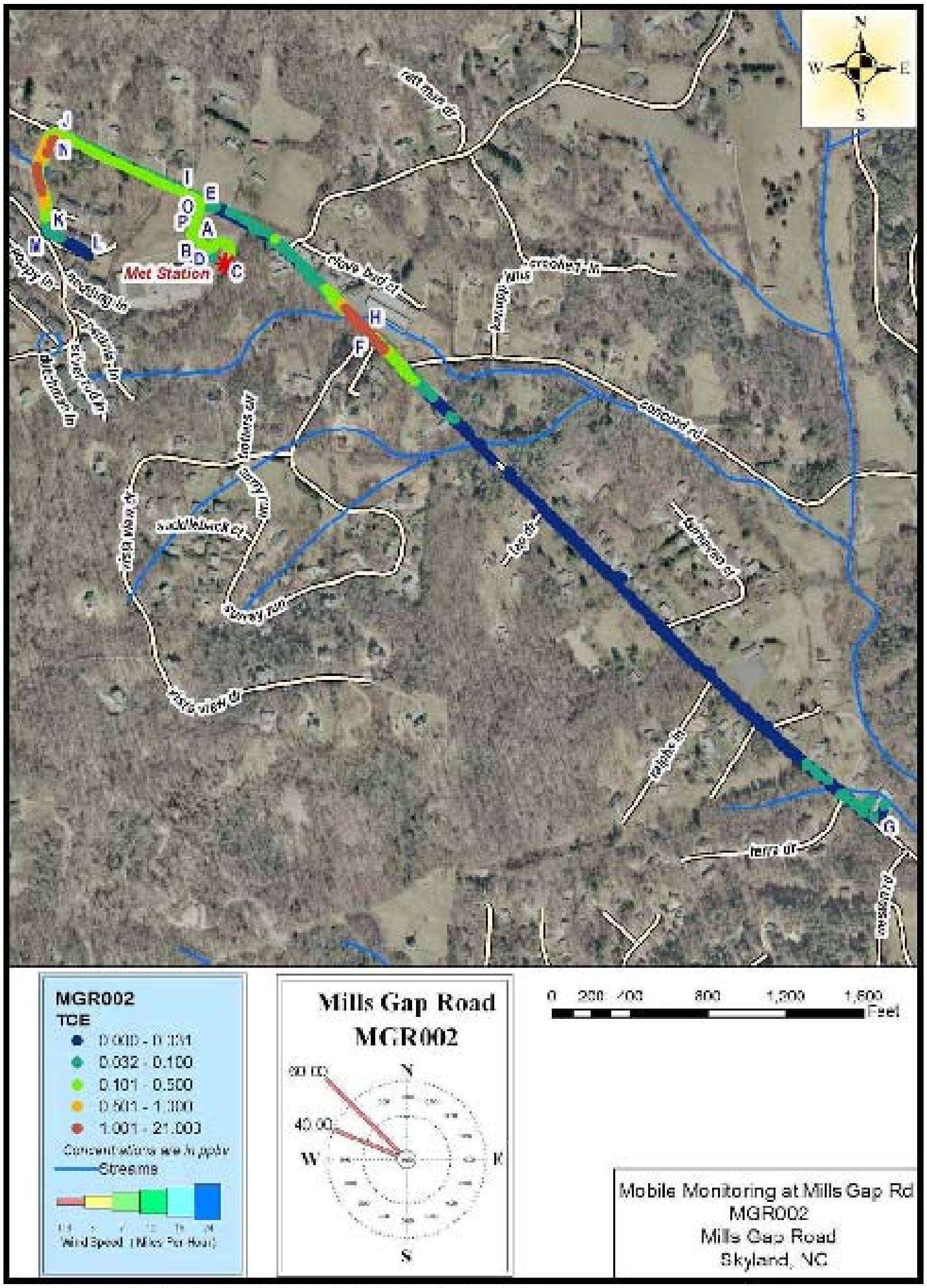


Figure 1a Mobile Monitoring Path at Mills Gap Road, MGR002

0296-DFA-011808

Figure 11. TAGA Bus-Mounted Mobile Air Monitoring Collected Along Roadways In The Vicinity Of The CTS/Mills Gap Road Site On December 12, 2007.

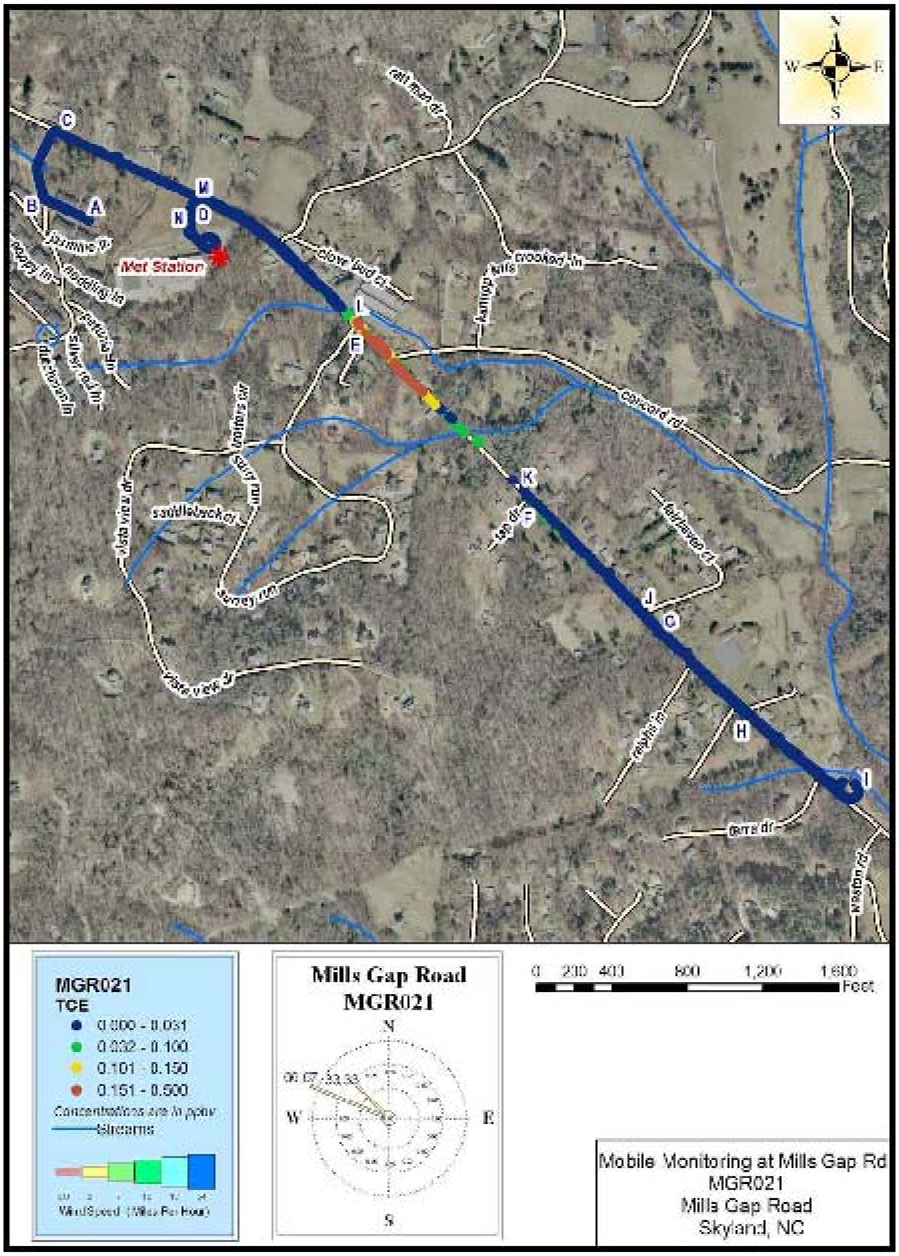


Figure 7a Mobile Monitoring at Mills Gap Road, MGR021

0296-DFA-011808

Appendix B

Time-Line of U.S. EPA and N.C. DENR Activities at the CTS/Mills Gap Road Site

The following is a timeline of activities at the Mills Gap Road (CTS) site:

A Preliminary Assessment (PA) Report was submitted to Region 4 EPA Superfund by NC Dept of Human Resources, Div. of Health Services on October 30, 1985. This was the first of four efforts by the State and EPA to qualify the site for listing on the National Priorities List (NPL) for cleanup under the Federal Superfund Remedial process. A PA is the first step in the Remedial Site Assessment process. At that time, PA reports contained only operational history and site characteristics, and not collection of samples. A Site Inspection (SI), which involves sampling, could only be tasked on the basis of a PA that found indications of a release of contaminants. No release was identified at this time, so the PA report recommended “no further remedial action planned” under Superfund (NFRAP).

A report of Site Assessment Services by Law Environmental, Inc. was issued on behalf of CTS on August 31, 1987. This report was requested by CTS due to pending sale of the property. The report identified several areas outside of the building that were used in handling of hazardous substances. A single above ground storage tank containing TCE was identified as being located on the west side of the building. A hazardous waste treatment pit was also identified in the report as being located inside the building. Additionally, several small chemical storage areas including a TCE sump pit, a sulfuric acid tank and a sodium hydroxide tank, were located inside the building at the CTS site.

Several samples were collected during the site assessment conducted by Law Environmental in August 1987. Sub-surface soil samples were collected outside the building and indicated low to non-detect concentrations of metals and volatile organic compounds (VOCs). TCE was detected in all the soil samples. The Recommendations listed removal of hazardous materials and evaluation of the groundwater.

In February 1989 the NC Inactive Hazardous Sites Branch (IHSB) becomes operational pursuant to 1987-1989 legislation, rulemaking, and funding authorization. IHSB begins hiring staff and establishment of prioritization system for State Priority List (SPL) is conducted. Also in 1989, the EPA Field Investigation Team (FIT) contractor, NUS Corporation, conducted a Screening Site Inspection (SSI), Phase I for EPA Region 4. Based on the target population, FIT recommended that a high priority Phase II Screening Site Inspection of the property be conducted (TNA 2008).

A Site Screening Inspection for Phase II was conducted by the EPA Field Investigation Team (FIT). The EPA contractor NUS Corporation submitted the activity report dated February 22, 1991 (NUS 1991). Samples were collected for the study in June 1990. Soil, sediment and surface water samples were collected on the property. A ground water sample was also collected from the private well nearest the site. The survey inspection was the second effort to qualify the site for listing on the NPL. The Site Screening Inspection (SSI), at that time the equivalent of an SI, was tasked by EPA due to the results of the August 1987 assessment done on behalf of CTS. The SSI found contamination in soils and sediments on the site, and in surface water. Contaminants included metals (cadmium, magnesium, manganese, vanadium, beryllium, barium, and nickel) and volatile organic compounds (1,2-dichloroethene and vinyl chloride). The nearest private well identified in the report was 4,000 feet to the northwest. A sample from that well contained only lead caused by the well construction. Because of a lack of known impacted receptors, the site did not score high enough on the Superfund Hazard Ranking System (HRS) to qualify for NPL listing, and the recommendation was for no further remedial action planned under Superfund. The site was referred to the IHSB for further action.

The NC Div. of Waste Management (DWM) State Inactive Hazardous Sites Branch (IHSB) conducted a Site Evaluation on November 30, 1993. The CTS site was evaluated and entered on the IHSB list. The evaluation was based on available data from previous investigations. Because no impacts to receptors were known at that time, the State Priority List (SPL) score is low.

The IHSB issued an Order to Submit Notice of and to Record an Inactive Hazardous Substance or Waste Disposal Site on December 15, 1997. CTS had 180 days to submit a survey plat of the property.

Phase 1 of the Southside Village subdivision development began on May 1, 1998. (Information supplied by Mr. Durand.)

The IHSB contracts ENSCI to prepare Notice of and to Record an Inactive Hazardous Substance or Waste Disposal Site on July 8, 1998 and recorded on a plat for 8.69 acre fenced plant area.

Springs from a property near the former CTS plant were sampled by the NC Division of Water Quality (DWQ) on July 12, 1999. According to DENR, this is the first indication of contaminated groundwater at the site. A potable supply spring southeast of the plant site is also sampled, in response to citizen complaint. No taste or odor issues were reported prior to this date. On July 28, 1999 potable wells were sampled by the NC DWQ. Nearby wells were sampled as a follow-up to the identification of contaminated springs. Contamination was found in the springs and in one residential supply well sampled during this time.

On August 16, 1999, North Carolina Department of Environmental Natural Resources (N.C. DENR) Superfund Section requested that the EPA Region 4 Emergency Response and Removal Branch (ERRB) evaluate the site for removal action. The request followed N.C. DENR sampling of contaminated springs in close proximity to the former CTS site. This request was based on the sampling results from several contaminated springs and one well close to the property. High concentrations of chlorinated solvents were found in two springs and one domestic well, located topographically down-gradient from the site. Under this authority, EPA Superfund ERRB can act at sites to remove imminent threats to human health and the environment.

The ERRB conducted a removal site evaluation on August 20, 1999 in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) §300.410. Conditions at the site, specifically contamination of potable drinking water supplies with chlorinated solvents, were found to pose a threat to public health or welfare or the environment. Consequently, bottled water was provided to the four households by August 23, 1999 that had used the contaminated sources for potable water. These residences were subsequently connected to the Asheville-Buncombe municipal water supply

Analytical results for soil samples collected in August 1999 from beneath the former CTS plant indicated elevated concentrations of Volatile Organic Compounds (VOCs) (e.g. 830,000 g/kg

TCE), base neutral and acid extractable compounds (BNAs), and petroleum hydrocarbons, most likely #2 fuel oil. TCE was detected in all samples and was typically present at the highest concentrations relative to other chemical compounds identified. Toxic Characteristic Leaching Procedure (TCLP) analysis of a selected sample collected from 32-34 feet below ground surface, near the water table, had TCE at 7.00 milligrams/liter (mg/L) compared to the regulatory level of 0.5 mg/L (EPA 2007). Buncombe Water Authority supply is authorized by EPA ERRB. Subsequently, the affected the residences were connected to the municipal water system (EPA 2007).

On September 14, 1999 additional sampling was conducted by NC DWM on surrounding wells and property. One additional well and two garden plots were sampled. No contamination was found.

The EPA ERRB Start Contractor (Tetra Tech) conducted soil sampling on-site and sediment samples from neighboring properties on November 8, 1999. This Removal Assessment was conducted under the CERCLA Removal authority. Contamination was detected in the soils and sediments.

The NC DWM sampled potable wells and surface water pathways as part of a CERCLA Expanded Site Inspection (ESI) on May 23, 2000. The ESI is the third effort to qualify the site for listing on the NPL. Nine wells previously identified by NC DWQ were re-sampled and surface water and sediment samples were collected from the surface water pathways flowing east and west from the site. Springs to the east were impacted by TCE, while nothing was detected in the springs flowing west. Contaminants were detected only the well previously identified as impacted.

An EPA REAC Contractor performed a geophysical survey for buried contaminant sources on August 1, 2000. Re-sampling of springs was also done at this time. Magnetic and electromagnetic surveys identified anomalies on-site. High levels of contamination were still present in the springs. An EPA REAC Contractor installed trenches on September 1, 2000 to investigate the anomalous areas and other areas identified by surface debris. Nothing notable was found, other than a few pieces of piping.

The EPA conducted more extensive soil sampling on May 1, 2001 in an effort to better characterize the site for a soil cleanup as an EPA Time Critical Removal. The EPA REAC Contractor used a truck-mounted Geo-probe unit to characterize soils near and beneath the building at the CTS site. Analytical results from the soil samples revealed elevated concentrations of VOCs at 830,000 micrograms per kilogram (µg/kg). TCE was detected in all the samples. Toxicity Characteristic Leaching Procedure (TCLP) analyses of soils collected near the water table contaminated with TCE were as high as 7 milligrams per liter mg/L, compared to the regulatory level of 0.5 mg/L (TNA 2008). The EPA Emergency Response and Removal Action did not have the authority to conduct or compel a groundwater cleanup based on this information. The report dated July 12, 2001 indicated several areas of high concentrations of contaminants located underneath the building.

The NC DWM submitted an ESI report to the EPA Region 4 Superfund on May 8, 2001. The ESI is the third effort to qualify the site for listing on the NPL. Contamination of groundwater/ surface water is documented, however, due to no contaminated water in potable use, the site was recommended for “No Further Remedial Action” under Superfund. The limited number of impacted targets (impacted drinking water originally discovered in four households) resulted in an HRS score too low to qualify the site for NPL listing and cleanup under the CERCLA Remedial program. EPA and NC DWM focus on enforcement through EPA Removal Authority.

On February 1, 2002 the EPA conducts a Potentially Responsible Party search. This search identifies PRPs for inclusion in any enforcement action, in this case an Administrative Order on Consent (AOC).

The EPA submits a Request for a Responsible Party-Lead Removal Action by CTS and Mills Gap Road Associates on April 4, 2002. A Removal Action allows EPA to begin to investigate ways to contain and control the contaminant source beneath the building.

The CTS Corporation and Mills Gap Road Associates sign an Administrative Order on Consent with EPA on January 22, 2004. An AOC Statement of Work (SOW) requires CTS and Mills Gap Associates to evaluate the potential impact to wells within a 1-mile radius of site, to evaluate the removal and/or treatment of contaminants in the unsaturated zone beneath the building, and to evaluate the feasibility of removal/containment of surface waters discharging from the springs.

On September 17, 2004 a Report of Removal Action Pilot Study is submitted by the PRP Contractor (Mactec) to EPA. Samples document a continuing impact to the springs on the east side of the site property. A Pilot Study of the effectiveness of Soil Vapor Extraction (SVE) system was run using one extraction well and four observation wells. The study concluded that SVE is a viable technique for the removal of VOCs from the unsaturated soils beneath the building. Additional soil samples better defined the suspected areas of higher contamination beneath the building. Six additional wells were identified in the report as having a potential to be impacted by the contaminated groundwater plume.

A Site Reassessment Report (SRR) was submitted to EPA Region 4 by NC DWM on June 30, 2006. This SRR was the fourth effort to qualify the site for listing on the NPL. The report was based on the most recent sampling data. Due to the lack of contaminated groundwater being used for potable uses and the distance to the nearest fisheries, the site was recommended for “No Further Remedial Action Planned” under Superfund.

In July 2006, the Soil Vapor Extraction System becomes operational on the CTS site. Through the fall of 2008 more than 2,900 pounds of TCE have been removed from the soil.

On September 26, 2007 samples were collected from springs by NC DWM. Analysis indicated continuing impact. Higher levels than previously recorded were encountered in the small streams east and west of the site.

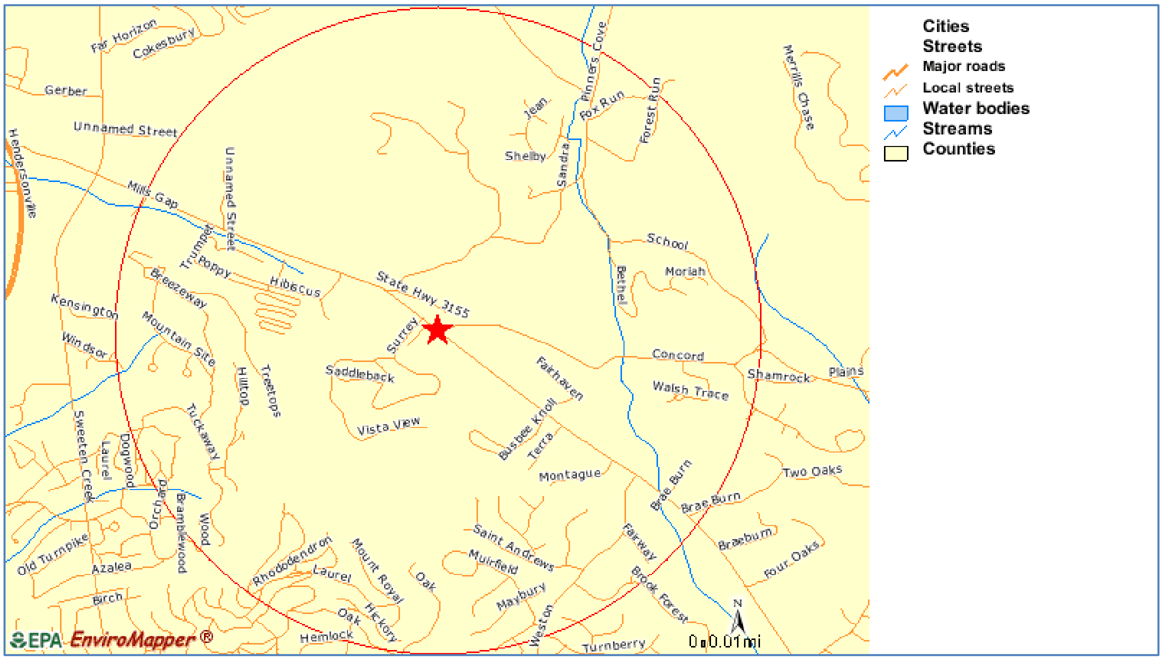
From November 27 to December 7, 2007 N.C. DENR sampled 66 residential wells within a 1-mile radius of the site as part of the expanded site risk assessment. One well located approximately ¾ miles northeast of the site contained 57 µg/L of TCE, exceeding the National Drinking Water Regulations Maximum Contaminant Level (MCL) of 5 µg/L. Trace quantities of cis-1,2-dichloroethylene (cis-1,2-DCE), a breakdown of TCE, was also detected. Confirmation samples were taken by N.C. DENR on December 14, 2008 to confirm results from previous samples collected in 2007. TCE was found at 54.1 µg/L and cis-1,2-DCE at 9.5 µg/L. The EPA also conducted a field investigation around this time. The EPA funded field investigation took place from December 12, to December 14, 2007, and again from January 14, to January 16, 2008. The results of the EPA field activities are described in greater detail in the "Discussion" section of this report.

In December 2007 and August 2008 EPA collected crawl-space air samples at residences with-in approximately 800 feet of the CTS site to evaluate sub-surface transport of VOCs off-site. EPA also conducted sub-slab soil vapor studies in December 2007 to evaluate the potential for inhalation exposure to volatile contaminants in groundwater or soil rising from the subsurface into off-site residential living spaces. Properties on a basement or concrete slab foundation were sampled. Soil gas samples were also collected in December 2007 by EPA. The samples were collected along three lines running from approximately 200 to 1,300 feet east of the site, down-gradient of the groundwater flow direction from the site. Additional samples were collected adjacent to the north side of the property. Outdoor air samples were collected in close-by areas east and west of the CTS property to determine if volatile site contaminants were escaping from contaminated soil or water and were present in the air where they could be inhaled. EPA collected ambient air (outdoor air) samples in December 2007 using a bus-mounted mobile TAGA system. Samples were collected along the same route on local roadways in the vicinity of the CTS site during two mobile monitoring events. Additional ambient (outdoor) air samples were collected in August 2008 adjacent to the site and down-gradient to the east.

On January 8, 2008 N.C. DENR tested eight residential wells in the area of the previously identified contaminated well. One well located ¾ mile northeast of the site also contained TCE at a concentration of 4.32 µg/L and DCE at 1.35 µg/L. No VOCs or SVOCs were detected in the other seven wells (TNA 2008).

Appendix C

Demographics Data



	CTS Site	**North Carolina**	**U.S.**
Total population	2,979	8,049,313	281,421,906
Ethnicity			
White	94% (2,799)	72.1%	75.1%
African-American	2.3% (67)	21.5%	12.3%
Hispanics	0.7% (22)	4.6%	12.5%
Asians	2.6% (78)	1.4%	3.6%
American Indians	0.5% (15)	1.3%	0.9%
Poverty Level	2.7%	11.9%	12.4%
High school diploma or higher	92.4%	76.5%	80.4%

Table 1. State and National Demographic Comparison Figures for CTS/Mills Gap Site, Buncombe County, NC. Based on 2000 Census Data.

Appendix D

The ATSDR Health Effects Evaluation Process

The ATSDR Health Effects Evaluation Process

The ATSDR health effects evaluation process consists of two steps: a screening analysis, and at some sites, based on the results of the screening analysis and community health concerns, a more in-depth analysis to determine possible public health implications of site-specific exposure estimates.

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, water, or air) 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.

The two step screening analysis process provides a consistent means to identify site contaminants that need to be evaluated more closely through the use of "comparison values" (CVs). The first step of the screening analysis is the "environmental guideline comparison" which involves comparing site contaminant concentrations to medium-specific comparison values derived by ATSDR from standard exposure default values. The second step is the "health guideline comparison" and involves looking more closely at site-specific exposure conditions, estimating exposure doses, and comparing them to dose-based health-effect comparison values.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. CVs are not thresholds of toxicity and do not predict adverse health effects. CVs serve only as guidelines to provide an initial screen of human exposure to substances. Contaminant concentrations at or below the relevant CV may reasonably be considered safe, but it does not automatically follow that any environmental concentration that exceeds a CV would be expected to produce adverse health effects. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on validated toxicological 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.

After completing a screening analysis, site contaminants are divided into two categories. Those not exceeding CVs usually require no further analysis, and those exceeding CVs are selected for a more in-depth analysis to evaluate the likelihood of possible harmful effects.

The North Carolina Department of Public Health (N.C. DPH) uses the following screening values for public health assessments:

1. **Environmental Media Evaluation Guide (EMEG):** EMEGs are estimated contaminant concentrations in water, soil or air to which humans may be exposed over specified time periods and are not expected to result in adverse non-cancer health effects. EMEGs are based on ATSDR "minimum risk levels" (MRLs) and conservative (highly health protective)

assumptions about exposure, such as intake rate, exposure frequency and duration, and body weight.

2. **Reference Dose Media Evaluation Guides (RMEGs):** 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 U.S. Environmental Protection Agency's (EPA's) oral reference dose (RfD).

3. **Cancer Risk Evaluation Guide (CREG**): 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 70-year lifetime. CREGs are calculated from EPA's cancer slope factors (CSFs) or inhalation unit risk (IUR) values.

4. **Maximum Contaminant Levels (MCL):** A Federal Maximum Contaminant Level (MCL) is the regulatory limit set by EPA 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. (ATSDR 2005a)

5. **EPA Regional Screening Levels (RSL):** "Regional Screening Levels for Chemical Contaminants at Superfund Sites" are tables of risk-based screening levels, calculated using the latest toxicity values, default exposure assumptions and physical and chemical properties. The Regional Screening table was developed with input from EPA Regions III, VI, and IX in an effort to improve consistency and incorporate updated guidance. (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm)

Contaminant concentrations exceeding the appropriate CVs are further evaluated against ATSDR health guidelines. N.C. DPH also retains for further assessment contaminants that are known or suspected to be cancer-causing agents. To determine exposure dose, N.C. DHHS uses standard assumptions about body weight, ingestion or inhalation rates, and duration of exposure. Important factors in determining the potential for adverse health effects also include the concentration of the chemical, the duration of exposure, the route of exposure, and the health status of those exposed. Site contaminant concentrations and site-specific exposure conditions are used to make conservative estimates of site-specific exposure doses for children and adults that are compared to ATSDR health guidelines (HGs), generally expressed as Minimal Risk Levels (MRLs). 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 come into contact based on their actions and habits. Exposure dose calculations are based on the following assumptions as outlined by the ATSDR (ATSDR 2005a):

- 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
- Infants weigh an average of 10 kilograms
- Adults ingest an average of 2 liters of water per day
- Adults weigh an average of 70 kilograms

Ingestion of contaminants present in drinking water

Exposure doses for ingestion of contaminants present in groundwater are calculated using the maximum and average detected concentrations of contaminants in milligrams per liter (mg/kg [mg/kg = ppm]). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated groundwater:

$$ED_w = \frac{C \text{ x } IR \text{ x } AF \text{ x } EF}{BW}$$

Where:

ED_w = exposure dose water (mg/kg/day)
C = contaminant concentration (mg/L)
IR = intake rate of contaminated medium (liters/day)
AF = bioavailability factor (unitless)
EF = exposure factor
BW = body weight (kilograms)

Ingestion of contaminants present in soil

Exposure doses for ingestion of contaminants present in soil are calculated using the maximum and average detected concentrations of contaminants in milligrams per kilogram (mg/kg [mg/kg = ppm]). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated soil:

$$ED_s = \frac{C \text{ x } IR \text{ x } AF \text{ x } EF}{BW}$$

Where:

ED_s = exposure dose soil (mg/kg/day)
C = contaminant concentration (mg/kg)
IR = intake rate of contaminated medium (kilograms/day)
EF = exposure factor (unitless)
BW = body weight (kilograms)

The exposure factor is an expression of how often and how long a person may contact a substance in the environment. The exposure factor is calculated with the following general equation:

$$EF = \frac{F \text{ x } ED}{AT}$$

Where:

F = frequency of exposure (days/year)
ED = exposure duration (years)
AT = averaging time (ED x 365 days/year)

Inhalation (breathing) of contaminants present in air

Inhalation is an important pathway for human exposure to contaminants that exist as atmospheric gases or are adsorbed to airborne particles or fibers. Exposure doses for breathing contaminants in air were calculated using the maximum or average detected concentrations in milligrams per cubic meter (mg/m^3) or parts per billion by volume (ppbv). The following equation is used to estimate the exposure doses resulting from inhalation of contaminated air.

$$D = (C \times IR \times EF) / BW$$

Where:

D = exposure dose (mg/kg/day)
C = contaminant concentration (mg/m^3)
IR = intake rate (m^3/day)
EF = exposure factor (unitless)
BW = body weight (kg)

Calculations of Contaminant Exposures During Showering

When showering in contaminated water a person may be exposed to the chemicals in the water by breathing a portion of the chemical that comes out of the water into the air (inhalation exposure), or by absorbing the chemical from the water through their skin (dermal exposure). Inhalation and dermal exposures to volatile organic compounds (VOCs) in the shower or bath may be equal to or greater than exposures from drinking the contaminated water. ATSDR uses conservative assumptions to estimate "worst case" exposures to VOCs during showering with contaminated water. The maximum concentration of VOC in the bathroom air is estimated with the following equation (Andelman 1990).

$$C_a = (C_w \times f \times F_w \times t)/V_a$$

Where:

C_a = bathroom air concentration (mg/m^3)
C_w = tap water concentration (mg/L)
f = fractional volatilization rate (unitless)
F_w = shower water flow rate (L/min)
t = exposure time (min)
V_a = bathroom volume (m^3)

Conservative calculation parameters are assumed, including a fractional volatilization of 0.9 for chlorinated VOCs, a flow rate of 8 L/min, and a small bathroom volume of 10 m^3. Conservative calculations are also made by using the maximum concentration found for each VOC in the tap water. Calculated bathroom air concentrations of VOCs can then be compared to ATSDR inhalation comparison values. Inhalation exposure dose estimates can be made using ATSDR's inhalation dose calculations.

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. The potential for adverse health effects exists under the representative exposure conditions if the estimated site-specific exposure doses exceed the health guidelines and they are retained for further evaluation. A MRL is an estimate of daily human exposure to a substance (in milligrams per kilogram per day [mg/kg/day] for oral exposures) that is likely to be without non-cancer health effects during a specified duration of exposure. Exposures are based on the assumption a person is exposed to the maximum concentration of the contaminant with a daily occurrence.

Generally, site-specific exposure doses that do not exceed screening values are dropped from further assessment. Exposure doses that exceed MRLs, or are known or suspected cancer-causing agents, are carried through to the health-effects evaluation. The health-effects evaluation includes an in-depth analysis examining and interpreting reliable substance-specific health effects data (toxicological, epidemiologic, medical, and health outcome data) related to dose-response relationships for the substance and pathways of interest. 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.

ATSDR's toxicological profiles serve as the primary source of the health-effects data. Other sources of toxicological data include EPA's Integrated Risk Information System (IRIS) database, International Agency for Research on Cancer (IARC) Monographs, and the National Toxicology Program (NTP). Standard toxicology textbooks and peer-reviewed scientific journals of environmental toxicology or environmental health can also be consulted.

Polynuclear Aromatic Hydrocarbons (PAHs)

ATSDR does not provide individual comparison values (CVs) for the group of structurally related multi-carbon ring compounds known as polynuclear aromatic hydrocarbons or PAHs (PAHs my also be called "polycyclic aromatic hydrocarbons"). ATSDR does provide a CREG the PAH compound benzo(a)pyrene (BaP). BaP is the most studied of the individual chemicals of the PAH group, and is thought to be the most toxic. To evaluate potential adverse health effects associated with incidental ingestion of soil PAH concentrations, the concentrations of individual detected PAH compounds are converted to an equivalent BaP concentration and summed to provide a "BaP-equivalent" concentration for all detected PAHs. BaP-equivalent exposure dose are calculated by multiplying the concentration of individual detected PAH compounds by their "toxicity equivalency factor" (TEF), a value that relates the relative toxicity of the individual PAH compounds to the toxicity of BaP. Below is a table of TEF values used by N.C. DPH to calculated BaP-equivalent concentrations. An estimated soil ingestion BaP-equivalent exposure dose is calculated using soil exposure rates. Estimated numbers of increased cancers for the combined PAH exposure is calculated by multiplying the CREG value by the BaP-equivalent exposure dose.

$$\mathrm{PAH}_{\mathrm{BaP\text{-}eq}} = \mathrm{PAH}_{\mathrm{conc}} \times \mathrm{TEF}$$

$$\text{Combined Cancer Risk}_{\mathrm{PAHs}} = \sum \mathrm{PAH}_{\mathrm{adj}} \times \mathrm{CSF}$$

Where:

$\mathrm{PAH}_{\mathrm{BaP\text{-}eq}}$ = Benzo(a)pyrene equivalent TEF adjusted PAH compound concentration, mg/kg

$\mathrm{PAH}_{\mathrm{conc}}$ = concentration of PAH compound, mg/kg

TEF = = Toxicity Equivalency Factor for PAH compound, unitless

Combined Cancer Risk$_{PAHs}$
= Summed cancer risk of all detected PAH compounds
$\sum PAH_{adj}$ = summed TEF-adjusted concentrations of all detected PAH compounds, mg/kg
CSF = Cancer Slope Factor, mg/kg-d

PAH Toxicity Equivalency Factors ("TEFs")

PAH compounds	TEF value
acenaphthene	0.001
acenaphthylene	0.001
anthracene	0.01
benzo(a)anthracene	0.1
benzo(a)pyrene	1.00
benzo(b,k)fluoranthene	na
benzo(g,h,i)perylene	0.01
benzo(b)fluoranthene	0.1
benzo(k)fluoranthene	0.01
chrysene	0.001
dibenzo(a,h)anthracene	1.00
fluoranthene	0.001
fluorene	0.001
indeno(1,2,3-cd)pyrene	0.1
2-methylnaphthalene	0.001
naphthalene	0.001
phenanthrene	0.001
pyrene	0.001

Source: *Toxicity equivalency factors for PAH and their applicability in shellfish pollution monitoring studies.* J Environ Monit, 2002, **4**, 383-388
na = not available

Cancer Health Effect Evaluations

Theoretical increased numbers of cancers are calculated for known or suspected cancer-causing contaminants using the estimated site-specific exposure dose and cancer slope factor (CSF) provided in ATSDR health guideline documents. This theoretical calculation is based on the assumption that there is no safe level of exposure to a chemical that causes cancer. However, the theoretical calculated risk is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This theoretical increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in the exposed population, but estimates a theoretical excess cancer risk expressed as the proportion of a population that may be affected by a carcinogen during a lifetime or other selected period of exposure. For example, an estimated cancer risk of 1×10^{-4} predicts the probability of one additional cancer over the background number of cancers in a population of 10,000. Qualitative assessment of the predicted increased numbers of cancers is also used and represents terminology suggested by ATSDR and N.C. DPH.

The theoretical cancer risk calculation is:

$$\text{Theoretical Cancer Risk} = \text{Dose} \times \text{CSF}$$

or

$$\text{Theoretical Cancer Risk} = \text{Air Concentration} \times \text{IUR}$$

Where:

Theoretical Cancer Risk = Expression of the cancer risk (unitless)
Dose = Site-specific cancer dose (mg/kg/d)
Air Concentration = Site-specific air concentration ($\mu g/m^3$)
CSF = Cancer Slope Factor ($[mg/kg/d]^{-1}$)
IUR = Inhalation Unit Risk ($[\mu g/m^3]^{-1}$)

The N.C. Central Cancer Registry states:

“*Although much has been learned about cancer over the past couple of decades, there is still much that is not known about the causes of cancer. What we do know is that cancer is not one disease, but a group of diseases that behave similarly. We know that different types of cancers are caused by different things. For example, cigarette smoking has been implicated in causing lung cancer, some chemical exposures are associated with leukemia, and prolonged exposure to sunlight causes some types of skin cancer. Genetic research has shown that defects in certain genes result in a much higher likelihood that a person will get cancer. What is not known is how genetic factors and exposures to cancer causing agents interact.*

Many people do not realize how common cancers are. It is estimated that one out of every two men and one out of every three women will develop a cancer of some type during his or her lifetime. As a result, it is common to find what appear to be cancer cases clustering in neighborhoods over a period of years. This will occur in any neighborhood. As people age, their chance of getting cancer increases, and so as we look at a community, it is common to see increasing numbers of cancer cases as the people in the community age.

Cancers are diseases that develop over many years. As a result, it is difficult to know when any specific cancer began to develop, and consequently, what the specific factor was which caused the cancer. Because people in our society move several times during their lives, the evaluation of clusters of cancer cases is quite challenging. One can never be certain that a specific cancer was caused by something in the community in which the person currently resides. When we investigate clusters of cancer cases, we look for several things that are clues to likely associations with exposures in the community. These are:

1. *Groups of cases of all the same type of cancer (such as brain cancer or leukemia). Because different types of cancer are caused by different things, cases of many different types of cancer do not constitute a cluster of cases.*
2. *Groups of cases among children, or ones with an unusual age distribution.*
3. *Cases diagnosed during a relatively short time interval. Cases diagnosed over a span of years do not constitute a cluster of cases unless there is consistency in the type of cancer.*
4. *Clusters of rare cancers. Because lung, breast, colon, and prostate cancers are so common, it is very difficult to find any association between them and exposures in a community."*

N.C. DPH evaluates cancer health effects in terms of possible increased cancer risk. In North Carolina, approximately 30% of women and 50% of men (about 40% combined), will be diagnosed with cancer in their life-time from a variety of causes. This is referred to as the "background cancer risk". The term "excess cancer risk" represents the risk on top of the background cancer risk. A "one-in-a-million" excess cancer risk (1/1,000,000 or 10^{-6} cancer risk) means that if 1,000,000 people are exposed to the cancer-causing substance at a certain level every day of their life-time (considered 70 years), then one cancer above the background number of cancers may develop in those 1 million people. In numerical terms, the background number of cancers expected in 1 million people over their life-time in 400,000. If they are all exposed to the cancer-causing substance daily throughout their life-time, then 400,001 people may get cancer, instead of the expected 400,000. The expression of the estimated cancer risk is not a prediction that cancer will occur, it represents the upper bound estimate of the probability of additional cancers, and merely suggests that there is a possibility. The actual risk may be much lower, or even no risk. For specific exposure situations N.C. DPH may use exposure periods of less than a life-time to provide a more realistic estimation of the risks that are known or predicted to have occurred for a particular area. If information on the specifics of the exposure situations at a particular site is not known, then N.C. DPH will always use health protective values to estimate the maximum level of risk that we believe to be realistic.

Estimates of Increased Number of Cancers Qualitative Assessment Categories Utilized by N.C. DPH

Estimated Number of Increased Cancers [a]	Qualitative Increased Risk Term
< 1/1,000,000	**No Increase**
< 1/100,000	**Very Low or No Apparent**
< 1/10,000	**Low**
< 1/1,000	**Moderate**
< 1/100	**High**
> 1/100	**Very High**

[a] As number of increased cancers above typical background numbers of cancers in the stated population size. "<1/1,000,000" = less than one additional cancer in a population of 1 million persons.

Limitations of the Health Evaluation Process

Uncertainties are inherent in the public health assessment process. These uncertainties fall into the following categories: 1) the imprecision of the risk assessment process, 2) the incompleteness of the information collected and used in the assessment, and 3) the differences in opinion as to the implications of the information. These uncertainties are addressed in public health assessments by using worst-case assumptions when estimating or interpreting health risks. The health assessment calculations and screening values also incorporate safety margins. The assumptions, interpretations, and recommendations made throughout this public health assessment err in the direction of protecting public health.

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:

$$\text{HQ} = \text{estimated dose} \div \text{applicable health guideline}$$

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.

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:

$$\text{HI} = \text{HQ}_1 + \text{HQ}_2 + \text{HQ}_3 + \dots \text{HQ}_n$$

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.

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*.

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.

Reference:
(Andelman 1990). *Total Exposure of Volatile Organic Compounds in Potable Water*. In: Significance and Treatment of Volatile Organic Compounds in Water Supplies, Chapter 20. Lewis Publishers, Chelsea, MI.

Appendix E

Tables

Table 4. Data Summary and Screening Value Analysis for Groundwater Samples Collected in December 2007 and January 2008 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (µg/L)	Number of Detections Greater Than CV	Geometric Mean Concentration (µg/L)	ATSDR Health-Based CV (µg/L)	Type of CV
Trichloro-ethylene (TCE)	3/6	13 -1,500	3	42.1	5	MCL
cis-1,2-Dichloro-ethane (cis-1,2-DCE)	2/6	0.85 – 130	1	11.2	3,000 child 10,000 adult	Intermediate EMEG
					70	MCL
Lead	2/5	35 – 71	2	49.8	15	EPA AL
Barium	6/6	34 J – 1300 J	0	116	2,000 child 7,000 adult	Chronic EMEG
Cyanide	3/6	8.5 J - 59	0	29.3	200 child 700 adult	RMEG
Pentachloro-phenol	1/6	2.3	1	----	10 child 40 adult	Chronic EMEG
					0.3	CREG
n-Nitroso di-n-propylamine	1/6	0.87	1	----	0.005	CREG
Chromium	4/6	1.9 J - 160	2 (as Hexavalent)	121	Hexavalent: 30 child 100 adult	RMEG
			0 (as Trivalent)		Trivalent: 20,000 child 50,000 adult	RMEG

Continued-

Table 4, continued. Data Summary and Screening Value Analysis for Groundwater Samples Collected in December 2007 and January 2008 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (µg/L)	Number of Detections Greater Than CV	Geometric Mean Concentration (µg/L)	ATSDR Health-Based CV (µg/L)	Type of CV
Vinyl Chloride	1/6	48	1	----	30 child 100 adult	Chronic EMEG
					0.03	CREG
(3- and /or 4-) Methylphenol	1/6	0.66 J	0	----	As Cresol mixture: 1,000 child 4,000 adult	Intermediate EMEG
2-Methyl-naphthalene	1/6	7 J	0	----	40 child 100 adult	RMEG
Phenol	1/6	0.59 J	0	----	2,000	LTHA
Benzene	1/6	0.06 J	0	----	5 child 20 adult	Chronic EMEG
					0.6	CREG
Toluene	1/6	0.09 J	0	----	200 child 700 adult	Intermediate EMEG

Notes:
CV = Comparison value (ATSDR established screening values)
AL = Action Level
J = estimated value
RMEG = Reference Dose Media Evaluation Guide
EMEG = Environmental Media Evaluation Guide
CREG = Cancer Risk Evaluation Guide
LTHA = Lifetime Health Advisory for Drinking Water (EPA)
µg/L = micrograms per liter, parts per billion (ppb)

Table 5. Site-Specific Exposure Dose Estimates and Health Guideline Comparison for Groundwater Samples Collected in December 2007 and January 2008 at the CTS/Mills Gap Site.

Contaminant	Calculated Maximum Exposure Dose (mg/kg/d)$^{(1)}$	Calculated Geometric Mean Exposure Dose (mg/kg/d)$^{(1)}$	ATSDR MRL (non-cancer) (mg/kg/d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult)	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult)
Trichloro-ethylene (TCE)	Child 0.094 Adult 0.043	Child 0.0026 Adult 0.0012	0.2 acute oral; Proposed changes: RfD = 0.0003 mg/kg/d	<u>Current HG:</u> Child NO Adult NO <u>Proposed HG:</u> Child YES Adult YES	<u>Current HG:</u> Child NO Adult NO <u>Proposed HG:</u> Child YES Adult YES
cis-1,2-Dichloro-ethane (cis-1,2-DCE)	Child 0.0081 Adult 0.0037	----	0.3	Child NO Adult NO	----
Lead	Child 0.0044 Adult 0.0020	Child 0.0031 Adult 0.0014	Not Available	----	----
Pentachloro-phenol	Child 0.00014 Adult 0.000068	----	0.001	Child NO Adult NO	----
n-Nitroso di-n-propylamine	Child 0.000054 Adult 0.000025	----	0.1	Child NO Adult NO	----
Chromium	Child 0.01 Adult 0.0046	Child 0.0076 Adult 0.0035	0.003 (as Hexavalent) 1.5 (as Trivalent)	Child YES Adult YES	Child YES Adult YES
Vinyl Chloride	Child 0.003 Adult 0.0014	----	0.003	Child YES Adult NO	----
Benzene	Child 0.0000038 Adult 0.0000017	----	0.0005	Child NO Adult NO	----

Notes:
MRL = minimum Risk Level
RfD = Reference Dose
HG = Health Guideline
Non-CA = non-cancer

Table 6. Data Summary and Screening Value Analysis for Private Well and Spring Drinking Water Samples Collected in July 1999 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (µg/L)	Number of Detections Greater Than CV	Geometric Mean Concentration (µg/L)	ATSDR Health-Based CV (µg/L)	Type of CV
Trichloro-ethylene (TCE)	3/11	270 – 21,000	3	----	5	MCL
1,1,1-Trichloro-ethane	2/2	49 – 570	1	310	200	MCL
cis-1.2-Dichloro-ethene	1/2	370	1	----	70	MCL
1,1-Dichloro-ethane	1/2	31	1	----	7	MCL

Table 7. Site-Specific Exposure Dose Estimates and Health Guideline Comparison for Private Well and Spring Drinking Water Samples Collected in July 1999 at the CTS/Mills Gap Site.

Contaminant	Calculated Maximum Exposure Dose (mg/kg/d)(1)	ATSDR MRL (non-cancer) (mg/kg/d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult)
Trichloroethylene (TCE) at 270 µg/L	Child 0.0169 Adult 0.00771	0.2 acute oral; Proposed changes: RfD = 0.0003 mg/kg/d	Current HG: Child NO Adult NO Proposed HG: Child YES Adult YES
Trichloroethylene (TCE) at 21,000 µg/L	Child 1.31 Adult 0.60		Current HG: Child YES Adult YES Proposed HG: Child YES Adult YES
1,1,1-Trichloro-ethane	Child 0.0356 Adult 0.0163	2 EPA chronic RfD	Child NO Adult NO
cis-1.2-Dichloro-ethene	Child 0.0231 Adult 0.0106	0.3	Child NO Adult NO
1,1-Dichloro-ethane	Child 0.0019 Adult 0.00089	0.009	Child NO Adult NO

Table 8. Data Summary and Screening Value Analysis for Private Well Water Samples Collected in November and December 2007 and January 2008 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (μg/L)	Number of Detections Greater Than CV	Geometric Mean Concentration (μg/L)	ATSDR Health-Based CV (μg/L)	Type of CV
Trichloro-ethylene (TCE)	2/74	4.32 – 57	1	----	5	MCL
cis-1,2-Dichloro-ethane (cis-1,2-DCE)	2/74	1.35 – 10.2	0	----	3,000 child 10,000 adult	Intermediate EMEG
					70	MCL
Chloroform	4/74	1.9 – 5.36	0	3.36	100 child 400 adult	Chronic EMEG
					80	MCL
Bromodichloro-methane	2/74	2.15 – 2.2	1	2.17	200 child 700 adult	Chronic EMEG
					80	MCL
					0.6	CREG
Toluene	1/76	40.0	0	----	200 child 700 adult	Intermediate EMEG
Chloromethane	1/76	1.26	0	----	30	LTHA

Table 9. Site-Specific Exposure Dose Estimates and Health Guideline Comparison for Private Waters Samples Collected in November and December 2007 and January 2008 at the CTS/Mills Gap Site.

Contaminant	Calculated Maximum Exposure Dose (mg/kg/d)[(1)]	ATSDR MRL (non-cancer) (mg/kg/d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult)
Trichloroethylene (TCE)	Child 0.0036 Adult 0.0016	0.2 acute oral; Proposed changes: RfD = 0.0003 mg/kg/d	Current HG: Child NO Adult NO Proposed HG: Child YES Adult YES
Bromodichloro-methane	Child 0.00014 Adult 0.000063	0.02	Child NO Adult NO

Table 10. Data Summary and Screening Value Analysis for Spring Samples Collected in July 1999 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (µg/L)	Number of Detections Greater Than CV	Geometric Mean Concentration (µg/L)	ATSDR Health-Based CV (µg/L)	Type of CV
Trichloro-ethylene (TCE)	3/3	8.7 – 21,000	3	1,400	5	MCL
1,1,1-Trichloro-ethane (1,1,1-TCA)	3/3	4.2 – 570	1	105	20,000 child 70,000 adult	RMEG
					200	MCL, LTHA
cis-1,2-Dichloro-ethane (cis-1,2-DCE)	2/3	67 – 370	0	----	3,000 child 10,000 adult	Intermediate EMEG
1,1-Dichloroethene (1,1-DCE)	2/3	2.2 – 31	0	----	90 child 300 adult	Chronic EMEG

Table 11. Site-Specific Exposure Dose Estimates for Incidental Ingestion While Swimming and Health Guideline Comparison for Spring Samples Collected in July 1999 at the CTS/Mills Gap Site.

Contaminant	Calculated Maximum Exposure Dose (mg/kg/d)(1)	Calculated Geometric Mean Exposure Dose (mg/kg/d)(1)	ATSDR MRL (non-cancer) (mg/kg/d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult)	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult)
Trichloro-ethylene (TCE)	Child 0.0047	----	0.2 acute oral; Proposed changes: RfD = 0.0003 mg/kg/d	Current HG: Child NO Proposed HG: Child YES	----
1,1,1-Trichloro-ethane (1,1,1-TCA)	Child 0.00013	----	20 Intermediate	Child NO	Child NO

Table 12. Data Summary and Screening Value Analysis for Surface Water Samples Collected in September, November and December 2007 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (µg/L)	Number of Detections Greater Than CV	Geometric Mean Concentration (µg/L)	ATSDR Health-Based CV (µg/L)	Type of CV
Trichloro-ethylene (TCE)	15/21	1.31 – 19,700	13	386	5	MCL
cis-1,2-Dichloro-ethane (cis-1,2-DCE)	10/21	3.44 – 3,280	1	127	3,000 child 10,000 adult	Intermediate EMEG
1,1,1-Trichloro-ethane (1,1,1-TCA)	2/21	109 – 856	1	297	20,000 child 70,000 adult	RMEG
					200	MCL, LTHA
Naphthalene	1/14	16.2	0	----	200 child 700 adult	RMEG
					100	LTHA
Bis(2-ethyl hexyl)phthalate	1/14	850	1	----	200 child 700 adult	RMEG
					6	MCL
					3	CREG
Vinyl Chloride	1/14	2.8	1	----	30 child 100 adult	Chronic EMEG
					0.03	CREG

Table 13. Site-Specific Exposure Dose Estimates for Incidental Ingestion While Swimming and Health Guideline Comparison for Surface Water Samples Collected in September, November and December 2007 at the CTS/Mills Gap Site.

Contaminant	Calculated Maximum Exposure Dose (mg/kg/d)(1)	Calculated Geometric Mean Exposure Dose (mg/kg/d)(1)	ATSDR MRL (non-cancer) (mg/kg/d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult)	Does Calculated Geometric Mean Exposure Dose Exceed non-CA HG (child/adult)
Trichloro-ethylene (TCE)	Child 0.0044	Child 0.000086	0.2 acute oral; Proposed changes: RfD = 0.0003 mg/kg/d	Current HG: Child NO Proposed HG: Child YES	Current HG: Child NO Proposed HG: Child NO
cis-1,2-Dichloro-ethane (cis-1,2-DCE)	Child 0.00073	Child 0.000028	0.3	Child NO	----
1,1,1-Trichloro-ethane (1,1,1-TCA)	Child 0.00019	Child 0.000066	20 Intermediate	Child NO	Child NO
Bis(2-ethyl hexyl)phthalate	Child 0.00019	----	0.1	Child NO	----
Vinyl Chloride	Child 0.00000062	----	0.003	Child NO	----

Table 14. Metals Data Summary and Screening Value Analysis for Sub-Surface Soil Samples Collected in December 2007 and January 2008 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (mg/kg)	Number of Detections Greater Than CV	ATSDR Health-Based CV (mg/kg)	Type of CV
Cyanide	7/15	0.3 J – 3.9	0	1,000 child 10,000 adult	RMEG
Arsenic	6/15	2.1 – 6.1	1	20 child 200 adult	Chronic EMEG
				0.5	CREG
Barium	15/15	15 J – 210	0	10,000 child 100,000 adult	Chronic EMEG
Chromium	15/15	3.1 J – 55	0	200 child 2,000 adult	RMEG
Lead	14/14	4.1 – 17 J	0	400	EPA, Residential
Selenium	8/10	0.68 J – 3.4 J	0	300 child 4,000 adult	Chronic EMEG
Silver	8/15	0.14 J – 0.82 J	0	300 child 4,000 adult	RMEG

Table 15. Polynuclear Aromatic Hydrocarbon (PAH) Data Summary and Screening Value Analysis for Sub-Surface Soil Samples Collected in December 2007 and January 2008 at the CTS/Mills Gap Site.

PAH Contaminant	Frequency of Detection	Concentration (µg/kg)	Cancer Slope Factor $(mg/kg/d)^{-1}$	TEF Value	TEF Adjusted Concentration (µg/kg)
Benzo(a)anthracene	1/15	61 J	0.73	0.1	6.1
Benzo(a)pyrene	1/15	48 J	7.3	1	48
Benzo(b)fluoranthene	1/15	69 J	0.73	0.1	6.9
Benzo(g,h,i)perylene	1/15	51 J	----	0.01	0.51
Benzo(k)fluoranthene	1/15	56 J	0.073	0.1	5.6
Chrysene	1/15	70 J	0.0073	0.01	0.7
Dibenzo(a,h)anthracene	1/15	42 J	7.3	5	210
Indeno(1,2,3-cd)pyrene	1/15	61 J	0.73	0.1	6.1

Table 16. Organic Chemical Data Summary and Screening Value Analysis for Sub-Surface Soil Samples Collected in December 2007 and January 2008 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (µg/kg)	Number of Detections Greater Than CV	ATSDR Health-Based CV (µg/kg)	Type of CV
Acetone	1/15	27	0	50,000,000 child 600,000,000 adult	RMEG

Table 17. Site-Specific Exposure Dose Estimates and Health Guideline Comparison for Sub-Surface Soil Samples Collected in September, November and December 2007 at the CTS/Mills Gap Site.

Contaminant	Calculated Maximum Exposure Dose (mg/kg/d)(1)	ATSDR MRL (non-cancer) (mg/kg/d)	Does Calculated Maximum Exposure Dose Exceed non-CA HG (child/adult)
Arsenic	Child 0.000076 Pica Child 0.0019 Adult 0.0000087	0.0003 Chronic 0.005 Acute	Child NO Pica Child YES Adult NO
Total PAHs	Child 0.0000036 Pica Child 0.000089 Adult 0.00000040	-----	-----

Table 18. Data Summary and Screening Value Analysis for Crawl-Space Passive Air Samples Collected in December 2007 at the CTS/Mills Gap Site.

Contaminant	Frequency of Detection	Range of Concentrations (ppbv)	Number of Detections Greater Than CV	Geometric Mean Concentration (ppbv)	ATSDR Health-Based CV (ppbv)	Type of CV
Carbon Tetrachloride	12/12	0.0706 - 0.0875	12	0.0785	30	Chronic EMEG
					0.01	CREG
Chloroethane	1/12	0.0584	0	----	4,000	Acute EMEG, RfC
					3,800	IRIS
Chloroform	2/12	0.0820 – 0.124	2	0.101	50	Intermediate EMEG
					20	Chronic EMEG
					0.009	CREG
Chloromethane	12/12	0.268 – 0.589	0	0.464	50	Chronic EMEG
					44	IRIS RfCi
cis-1,2-DCE	5/12	0.107 – 1.43	0	0.244	200	Intermediate ENEG
Methylene Chloride	12/12	0.0563 – 2.45	1	0.107	300	Chronic EMEG
					0.6	CREG
Tetrachloroethene (PCE)	2/12	0.0913 – 0.133	0	0.110	40	Chronic EMEG
1,1,1-TCA	0/12	0.0998	0	----	700	Intermediate EMEG
TCE	6/12	0.161 – 3.78	0	0.597	100	Intermediate EMEG
					7.1	EPA proposed RfC
Trichlorofluoromethane	12/12	0.231 – 0.387	0	0.256	125	EPA HEAST RfCi

Table 19. Data Summary and Screening Value Analysis for Sub-Slab Gas Vapor Samples Collected in December 2007 at the CTS/Mills Gap Site. 0.1 Attenuation Factor (AF) Applied to Measured Concentrations.

Contaminant	Frequency of Detection	Range of Concentrations (ppbv), AF adjusted	Number of Detections Greater Than CV	ATSDR Health-Based CV (ppbv)	Type of CV
Tetrachloro-ethene (PCE)	1/10	1.6	0	40	Chronic EMEG
Trichloro-ethylene (TCE)	1/10	0.08	0	100	Intermediate EMEG
				7.1	EPA proposed RfC

Table 20. Data Summary and Screening Value Analysis for Soil Gas Samples Collected in December 2007 at the CTS/Mills Gap Site. 0.1 Attenuation Factor (AF) Applied to Measured Concentrations.

Contaminant	Frequency of Detection	Range of Concentrations (ppbv), AF adjusted	Number of Detections Greater Than CV	Geometric Mean Concentration (ppbv)	ATSDR Health-Based CV (ppbv)	Type of CV
Tetrachloro-ethene (PCE)	1/18	0.12	0	----	40	Chronic EMEG
Trichloro-ethylene (TCE)	3/18	4.1 - 46	1	9.47	100	Intermediate EMEG
					7.1	EPA proposed RfC

Table 21. Data Summary and Screening Value Analysis for Outdoor (Ambient) Air Samples Collected During Roadway Mobile Monitoring in December 2007 at the CTS/Mills Gap Site.

Contaminant	Maximum Concentrations (ppbv)	ATSDR Health-Based CV (ppbv)	Type of CV
Trichloro-ethylene (TCE)	21	100	Intermediate EMEG
		7.1	EPA proposed RfC

Table 22. Data Summary and Screening Value Analysis for Outdoor (Ambient) Air Samples Collected in August 2008 at the CTS/Mills Gap Site.

Contaminant	Range of Concentrations (ppbv), AF adjusted	Number of Detections Greater Than CV	Geometric Mean Concentration (ppbv)	ATSDR Health-Based CV (ppbv)	Type of CV
Trichloro-ethylene (TCE)	0.0779 – 277	1	0.945	100	Intermediate EMEG
				7.1	EPA proposed RfC
				7.1	EPA proposed RfC

Appendix F

Current and Proposed Trichloroethene Environmental Screening and Health Effects Values

The current ATSDR drinking water CV for trichloroethene (TCE) is 5 µg/L MCL. Current ASTDR CV cancer classifications are listed as "under review" (EPA), "reasonably anticipated to be a carcinogen" (NTP), and "probably carcinogenic to humans" (IARC) (ATSDR 2008 HG). The current ATSDR health guideline is an acute oral MRL (non-cancer effect) of 0.2 $(mg/kg/d)^{-1}$ (ATSDR 2008 HG). The ATSDR health guideline includes a reference to an EPA draft study that proposes changing the TCE oral reference dose (RfD) to 0.0003 mg/kg/d and setting a cancer slope factor (CSF) of 0.02 to 0.4 $(mg/kg/d)^{-1}$ (EPA 2001). The table at the end of this appendix summarizes current and proposed TCE screening values.

It is not known if drinking water contaminated with TCE causes non-cancer illness in humans. Childhood leukemia has been observed after maternal exposure to TCE-contaminated drinking water during the prenatal period. Evidence from animal and epidemiological studies also suggest that exposure to TCE might be associated with congenital heart defects and poor intrauterine growth. Studies in rats and mice show that trichloroethylene can affect fertility, but the relevance to humans is not clear. Human epidemiological studies have been limited by difficulties in estimating exposure levels and by the presence of other solvents with similar toxic effects. In rats and mice, TCE begins affecting the liver, kidney, and developing fetus at doses as low as 1 mg/kg/day. These studies are limited, however, by inadequate characterization of exposure, inadequate quantification of results, or lack of endpoints suitable for deriving chronic endpoints (EPA 2001).

The National Toxicology Program reviewed the carcinogenicity of TCE and concluded:

> "Trichloroethylene (TCE) is reasonably anticipated to be a human carcinogen based on limited evidence of carcinogenicity from studies in humans, sufficient evidence of carcinogenicity from studies in experimental animals, which indicates there is an increase incidence of malignant and/or a combination of malignant and benign tumors at multiple tissue sites in multiple species of experimental animals and information suggesting TCE acts through mechanisms that indicate it would likely cause cancer in humans." (NTP 2005)

In their 2001 draft assessment, EPA also reviewed the risk of cancer from exposure to TCE and concluded:

> "Epidemiological studies, considered as a whole, have associated TCE exposures with excess risk of kidney cancer, liver cancer, lympho-hematopoietic cancer, cervical cancer, and prostate cancer. TCE has been extensively tested in animals, with mice developing liver tumors, lung tumors, and lymphomas, and rats developing kidney tumors and testicular tumors. The epidemiologic evidence is strongest at sites where the animals develop cancer, with site concordance for kidney cancer (in rats and humans), liver cancer (in mice and humans), and lympho-hematopoietic cancer (in mice and humans). TCE is also associated with cervical cancer and prostate cancer in humans, sites for which there are no corresponding animal models." (EPA 2001)

In 2006, the National Research Council (NRC) found that the evidence on carcinogenic risk and other health hazards from exposure to TCE has strengthened since 2001. The NRC found that enough credible human health information exists and recommended finalizing EPA's 2001 draft risk assessment (NRC 2006).

In keeping with N.C. DPH's and ATSDR's conservative approach to public health assessments, the uncertainties of levels of TCE health effects, and the significant decrease in proposed TCE screening values, in this assessment N.C. DPH included evaluation of site TCE concentrations to the proposed lower screening values and applied the range of proposed cancer slope factors to calculate theoretical increased cancer risks.

Current and Proposed Drinking Water Screening Values for Trichloroethene (TCE).

Current ATSDR SV, Type	Current ATSDR Oral MRL, Exposure Scenario	Current ATSDR Cancer Classification(s)	Proposed USEPA SV	Proposed Cancer Slope Factor
5 µg/L MCL	0.2 mg/kg/d Acute	"Under Review" (USEPA); "Reasonably Anticipated to be a Carcinogen: (NTP); "Probably carcinogenic to humans (limited human evidence; sufficient evidence in animals)" (IARC)	0.0003 mg/kg/d RfD (chronic)	0.02 to 0.4 $(mg/kg/d)^{-1}$

Notes:
SV = screening value
MRL = minimum risk level
MCL = Minimum Concentration Limit, USEPA Federal Drinking Water Standard
RfD = Reference Dose

Appendix G

NC Central Cancer Registry Findings

North Carolina Department of Health and Human Services
Division of Public Health • Office of the State Health Director
1915 Mail Service Center • Raleigh, North Carolina 27699-1915

Michael F. Easley, Governor
Dempsey Benton, Secretary

Leah Devlin, DDS, MPH
State Health Director

August 1, 2008

Cluster Investigation for Buncombe County

Background

The Occupational and Environmental Epidemiology Branch (OEE) of the Division of Public Health contacted the North Carolina Central Cancer Registry (CCR) to investigate cancer incidence in the area surrounding the EPA Superfund Site at 273 Mills Gap Road, Asheville, NC 28803. A previous report (see Appendix) focused on all cancers in Buncombe County. This report focuses on liver cancer, renal cancer, and non-Hodgkin lymphoma in a one-mile radius around the area of concern and provides the methods and results of the investigation. These cancers were chosen, based on prior studies that indicate a link between these cancers and trichloroethylene.[1]

Methods

In order to be certain that all non-Hodgkin lymphoma, liver cancer, and renal cancer cases were identified, the CCR used several sources of data. Reporting of cancer cases to the CCR is required of all health care providers. Most reports are received from hospitals, but physicians whose practices include cancer patients who are diagnosed and treated in their outpatient clinics also report cases. In addition, the CCR links its data with death certificate files to be sure that all cancers identified on death certificates are in the CCR database.

The CCR was established in 1986 and the first year of data collected was in 1987. These data came from 14 hospitals in the state and represented less than 50 percent of the cancer cases diagnosed in the state. Between 1987 and 1989, the CCR worked with hospitals across the state to establish reporting procedures and to train hospital staff in the collection of data. In 1990 the CCR became a statewide, population-based registry with all hospitals reporting cases. Since 1990, over 90 percent of the state's cases have been reported to the CCR, and in recent years, that percentage is over 98 percent. Most of the cases that are missed are those that are easily diagnosed and treated as outpatient cases, such as cases of skin and prostate cancer. The CCR has relatively complete data only since 1990. Hence this study is based on all liver, renal and non-Hodgkin lymphoma cases reported since 1990.

To evaluate whether there has been greater than expected cancer incidence in the area surrounding the site, we compared the number of cases in the study area with the expected number of cases in the same time period. The procedure used for calculating the expected number of cases for each block group was to apply the age and gender-specific cancer incidence rates for the state to the age and gender-specific populations of the census block groups. This gives an expected number of cases for each age and gender group. These were added to arrive at an expected number for the entire census block group; the sums for the census block groups were then added to obtain the overall expected number for the study area.

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[1] Siemiatycki J, et al. *Listing Occupational Carcinogens*. Environmental Health Perspectives, Vol. 112, Nov 2004.

EveryWhere. EveryDay. EveryBody.   Location: *222 N. Dawson Street • Raleigh, N.C. 27603*

Record Selection

A total of 663 records with non-Hodgkin lymphoma, liver cancer, and renal cancer in zip code 28803, for 1990-2005, were identified and downloaded for analysis and geocoding. An attempt has been made to either batch or manually geocode each of these records.

Some error has been shown to exist in the County of Diagnosis field. To account for this, an attempt was made to correct possible ZIP code errors based on Address of Diagnosis and City of Diagnosis fields. After removing duplicates from both sets of records and limiting the cases to those within a one-mile radius of the site, 59 records remained and formed the basis of the investigation.

Study Area

The study area (Figure 1) was determined to be all Census 2000 Block Groups that intersect a one mile radius of 273 Mills Gap Road, Asheville, North Carolina. This study area was determined with the assistance of the Occupational and Environmental Epidemiology Branch of NC Division of Public Health, based on the areas that were tested for contamination.

The CCR is obligated by law to protect the confidentiality of the data, including protecting the identity of cancer cases. To publish information for areas smaller than a one-mile radius area would make it possible to identify individual cancer cases. The analyses in this report use a study area defined by the census block groups that intersect a one mile radius of the site.

Geocoding Results

Of the 663 records that were analyzed for this investigation, 98 did not have street addresses. Street addresses were researched for these records, and were assigned to 10 records for subsequent geocoding. The remaining 88 were not geocoded. For records with street addresses, 559 were successfully geocoded to street level; in other words, they were only geocoded if they matched a street address. Addresses not meeting these criteria were not geocoded. Of the successfully geocoded records, a total of 59 records were successfully geocoded to within the study area.

Results

Table 1 presents observed and expected incidence in the one-mile study area:

Observed and Expected Cases in Study Area, 1990-2005

Type of Cancer	Observed	Expected	Observed/ Expected	95% Confidence Interval[2] (Lower, Upper)
NH Lymphoma	49	43.78	1.12	(0.81, 1.43)
Liver	6	9.49	0.63	(0.13, 1.14)
Renal	4	2.71	1.48	(0.03, 2.92)

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[2] 95% confidence intervals were calculated for the rate ratios using the method described by Breslow and Day in: Breslow NE and Day NE. *Statistical Methods in Cancer Research, Volume II,* Lyon, France: International Agency for Research on Cancer, IARC Scientific Publications No. 32, 1987, p. 70-71.

As shown in Table 1, there were 1.12 times as many observed non-Hodgkin lymphoma cases, 0.63 times as many liver cancer cases, and 1.48 times as many renal cancer cases observed in the study area as expected. In both analyses, the 95 percent confidence intervals for the ratios of observed to expected include 1.0, which indicates that the difference between the observed and expected cases is not statistically significant. Please note that the statistics for liver and renal cancers are based on a small number of observed cases, which can lead to unstable results. Statistical significance does not imply causation, nor does a lack of statistical significance address the issue of biological relevance.

Limitations

The CCR has no residential, occupational, or medical histories about cases except as they may pertain to an earlier diagnosis of cancer. The CCR uses the county at the time of diagnosis as provided by the diagnosing facility to analyze cases by residence. It is recognized that this may not be the relevant address in terms of etiology for a disease with a long latent period, especially given the mobility of many populations. However, since we do not know at what point the disease process that was later diagnosed as a malignant tumor actually began, it is not possible to know what the relevant address is. The focus of the CCR is on cancer surveillance, and hence, we use the address at diagnosis. This approach is consistent with procedures used by all other cancer registries in the United States including the National Cancer Institute's Surveillance Epidemiology and End Results (SEER) program, the North American Association of Central Cancer Registries, and the Centers for Disease Control and Prevention. Incidence rates for a chronic disease with a long latent period are useful for disease surveillance, but they may not be good indicators for investigating the etiology of a disease. The CCR also uses the date of diagnosis as provided by the reporting facility to determine in which year to classify each case.

Summary

The results of the investigation indicate that the observed number of non-Hodgkin lymphoma, liver cancer, and renal cancer cases all fall within the normal range. At this time, there is no evidence of a clustering of cancer cases. Of the cancers we examined that may have a link to exposure to Trichloroethylene, none appear to be present in elevated numbers.

Appendix

May 19, 2008

Ms ———

Thank you for your concern regarding occurrence of cancer cases in Buncombe County. We receive many requests such as yours for information about cancers in local areas throughout the state. The Central Cancer Registry compiles information on cancers across North Carolina and we monitor cancer rates for many types of cancer for each county annually to see if there appear to be areas of the state that need special attention.

When clusters of cancer cases are investigated, we look for several things that are clues to likely associations with exposures in the community. These are:

- Groups of cases of all the same type of cancer (such as brain cancer or leukemia). Because different things cause different types of cancer, cases of many different types of cancer do not constitute a cluster of cases.
- Groups of cases among children, or ones with an unusual age distribution.
- Cases diagnosed during a relatively short time interval. Cases diagnosed over a span of years do not constitute a cluster of cases unless there is consistency in the type of cancer.
- Clusters of rare cancers. Because lung, breast, colon, and prostate cancers are so common, it is very difficult to find any association between them and exposures in a community.

In order to evaluate the cancer risk in the area of concern, all of the cancer cases in our database that were diagnosed in Buncombe County between 1990 and 2006 were identified. During this time, a total of 17,957 cancer cases were diagnosed in Buncombe County. The four major cancers – female breast, colon/rectum, prostate, and lung – comprised 58.1% of the 17,957 cases. Pediatric cancers comprised 0.7% of these cases and 86.9% of the patients were age 50 or older, an age group in which cancer diagnoses are quite common. The number of cases was spread out over the seventeen years, not concentrated in a short time period. Further, we looked at the age-adjusted incidence rates for 2001-2005 in Buncombe County and found that, in general, the cancer rates are within the normal range.

You expressed particular concern over cancer incidence in the area surrounding the 235 Mills Gap Rd, Asheville, NC 28803. In order to evaluate the risk in this area, all of the cancer cases in the concerned area that were diagnosed between 1995 and 2006 were identified. During this time, a total of 1,784 cancer cases were diagnosed with cancer within the boundaries of zip code 28803. The four major cancers – female breast, colon/rectum, prostate, and lung – comprised 56.2% of the 1,784 cases. Pediatric cancers comprised 0.7% of these cases and 88.8% of the patients were age 50 or older. The number of cases was spread out over the eleven years, not concentrated in a short time period.

We are now looking at the 2 mile radius around the specific site. This analysis will take approximately two weeks to complete. The findings of our investigation will be reported to you as soon as possible.

If you have questions regarding any of this information, please do not hesitate to contact me at (919) 715-7474 or Seth.Tyree@ncmail.net. Please let me know how I may be of further assistance regarding this matter.

Seth Tyree, Statistician
NC Central Cancer Registry
State Center for Health Statistics
Phone: (919) 715-7474
Seth.Tyree @ncmail.net

Appendix H

Community Concerns

Based on comments gathered from community meetings, conference calls and individual conversations, the following is a summary of the community's concerns.

Health Concerns

- Are people at risk from breathing the air near the CTS facility?
- Are people at risk from breathing the air inside of their home?
- Is the water safe for bathing, drinking, and washing clothes?
- Is there a higher incidence of cancer in the area as a result of the contamination?
- How often they should test their well for contamination? Is once a year enough?

Children's Health Concerns

- Is the indoor and outdoor air safe for children?
- Are children safe breathing the air while they wait for the bus or play outside?

Environmental Concerns

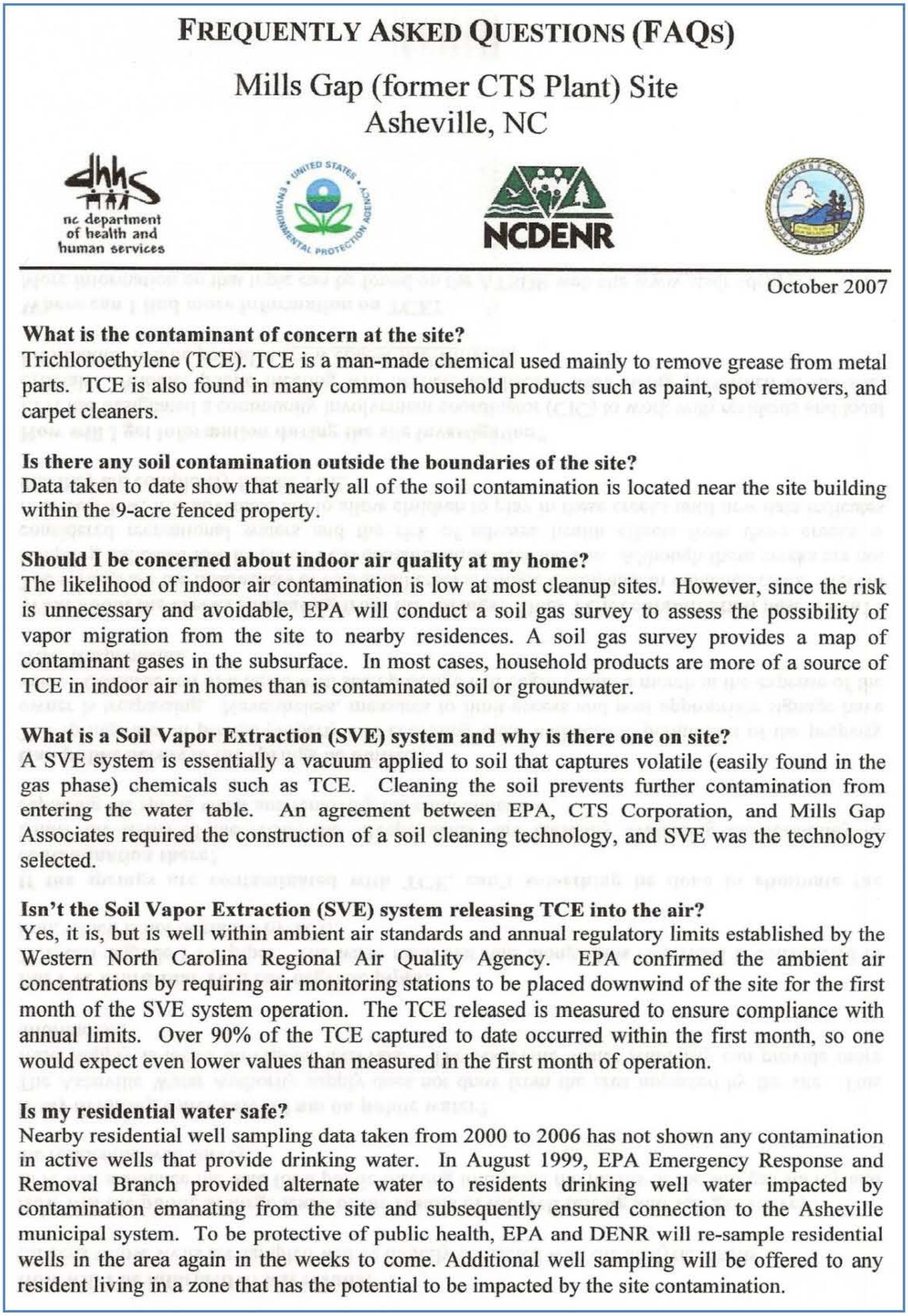
- Is there any soil contamination outside of the boundaries of the site?

How information will be communicated

- How will results of the health assessment be communicated with the community?
- What records are available to the public?
- Some people fear that they are not getting all the information from government agencies.

Other concerns

- How property values will be affected by the current studies?
- Why was property built in a contaminated site?
- Why has this investigation taken so long?



FREQUENTLY ASKED QUESTIONS (FAQS)

Mills Gap (former CTS Plant) Site
Asheville, NC

October 2007

What is the contaminant of concern at the site?
Trichloroethylene (TCE). TCE is a man-made chemical used mainly to remove grease from metal parts. TCE is also found in many common household products such as paint, spot removers, and carpet cleaners.

Is there any soil contamination outside the boundaries of the site?
Data taken to date show that nearly all of the soil contamination is located near the site building within the 9-acre fenced property.

Should I be concerned about indoor air quality at my home?
The likelihood of indoor air contamination is low at most cleanup sites. However, since the risk is unnecessary and avoidable, EPA will conduct a soil gas survey to assess the possibility of vapor migration from the site to nearby residences. A soil gas survey provides a map of contaminant gases in the subsurface. In most cases, household products are more of a source of TCE in indoor air in homes than is contaminated soil or groundwater.

What is a Soil Vapor Extraction (SVE) system and why is there one on site?
A SVE system is essentially a vacuum applied to soil that captures volatile (easily found in the gas phase) chemicals such as TCE. Cleaning the soil prevents further contamination from entering the water table. An agreement between EPA, CTS Corporation, and Mills Gap Associates required the construction of a soil cleaning technology, and SVE was the technology selected.

Isn't the Soil Vapor Extraction (SVE) system releasing TCE into the air?
Yes, it is, but is well within ambient air standards and annual regulatory limits established by the Western North Carolina Regional Air Quality Agency. EPA confirmed the ambient air concentrations by requiring air monitoring stations to be placed downwind of the site for the first month of the SVE system operation. The TCE released is measured to ensure compliance with annual limits. Over 90% of the TCE captured to date occurred within the first month, so one would expect even lower values than measured in the first month of operation.

Is my residential water safe?
Nearby residential well sampling data taken from 2000 to 2006 has not shown any contamination in active wells that provide drinking water. In August 1999, EPA Emergency Response and Removal Branch provided alternate water to residents drinking well water impacted by contamination emanating from the site and subsequently ensured connection to the Asheville municipal system. To be protective of public health, EPA and DENR will re-sample residential wells in the area again in the weeks to come. Additional well sampling will be offered to any resident living in a zone that has the potential to be impacted by the site contamination.

How will I be informed of test results?
Citizens whose wells are sampled will be directly contacted with the analytic results.

How will the public at large learn of the results of the well testing and soil gas survey?
EPA will announce the date for a public meeting to discuss the results of the soil gas survey and the residential well survey.

Is my drinking water safe if I am on public water?
The Asheville Water Authority supply does not draw from the area impacted by the site. This water supply is tested on regular intervals. The Asheville Water Authority can provide more information.

But I've heard that TCE can degrade pipes?
TCE can degrade PVC pipes. The water main that runs along Mills Gap Road is constructed of iron, which is not degraded by TCE.

If the springs are contaminated with TCE, can't something be done to eliminate the contamination there?
Under the terms of the AOC, the "Respondents" are currently evaluating the feasibility of capturing the spring water and removing the contamination.

Can public access to the springs be limited?
The springs are on private property and accessing them without the permission of the property owner is trespassing. Nevertheless, measures to limit access and post appropriate signage have value. Construction of a fence with such postings will begin within a month at the expense of the AOC Respondents.

What about the creeks emanating from the springs? Does TCE contamination pose a risk?
The springs are the headwaters of two small creeks, Dingle Creek and an unnamed creek. Recent sampling indicated low levels of TCE contamination near the site. Although these creeks are not considered recreational waters and the risk of adverse health effects from these creeks is relatively low, it is advisable not to allow children to play in these creeks until new data indicates that they are completely free of TCE.

How will I get information during the site investigation?
EPA has designated a community involvement coordinator (CIC) to work with residents and local officials. Another public meeting will be held to discuss work being performed at the site. Information will be posted at www.epaosc.net/MillsGap.

Where can I find more information on TCE?
More information on that topic can be found on the ATSDR web site www.atsdr.cdc.gov.

Trichloroethylene (TCE)

Fact Sheet and FAQs

October 2007

North Carolina
Public Health

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. This information is important because TCE has the potential to cause negative health effects. The effects of exposure to any hazardous substance depend on the dose, duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

What is trichloroethylene?

Trichloroethylene (TCE) is a nonflammable, colorless liquid with a somewhat sweet odor and a sweet, burning taste. It is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers.

Trichloroethylene is not thought to occur naturally in the environment. However, it has been found in underground water sources and many surface waters as a result of the manufacture, use, and disposal of the chemical.

What happens to TCE when it enters the environment?

- Trichloroethylene dissolves a little in water, but it can remain in ground water for a long time.
- Trichloroethylene quickly evaporates from surface water, so it is commonly found as a vapor in the air.
- Trichloroethylene evaporates less easily from the soil than from surface water. It may stick to particles and remain for a long time.
- Trichloroethylene may stick to particles in water, which will cause it to eventually settle to the bottom sediment.
- Trichloroethylene does not build up significantly in plants and animals.

How might I be exposed to trichloroethylene?

- Breathing air in and around the home that has been contaminated with trichloroethylene vapors from shower water or household products such as spot removers and typewriter correction fluid.
- Drinking, swimming, or showering in water that has been contaminated with trichloroethylene.
- Contact with soil contaminated with trichloroethylene, such as near a hazardous waste site.
- Contact with the skin or breathing contaminated air while manufacturing trichloroethylene or using it at work to wash paint or grease from skin or equipment.

How can trichloroethylene affect my health?

Breathing small amounts may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating. Breathing large amounts of trichloroethylene may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage.

Drinking large amounts of trichloroethylene may cause nausea, liver damage, unconsciousness, impaired heart function, or death. Drinking small amounts of trichloroethylene for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear.

Skin contact with trichloroethylene for short periods may cause skin rashes.

What guidelines have been set to protect human health?
The US EPA has set a maximum contaminant level for trichloroethylene in drinking water at 0.005 milligrams per liter (0.005 mg/L) or 5 parts of TCE per billion parts water (5 ppb). The US EPA has also developed regulations for the handling and disposal of trichloroethylene. The Occupational Safety and Health Administration (OSHA) has set an exposure limit of 100 parts of trichloroethylene per million parts of air (100 ppm) for an 8-hour workday, 40-hour workweek.

How can I limit my exposure to TCE?
TCE can get into indoor air through household sources (for example, commercial products that contain TCE), from contaminated drinking water, or by vapor intrusion. As with any indoor air contaminant, removing household sources of TCE will help reduce indoor air levels of the chemical. Maintaining adequate ventilation will also help reduce the indoor air levels of TCE.

If TCE is in the indoor air as a result of vapor intrusion, a sub-slab depressurization system, much like a radon mitigation system, will reduce exposures by minimizing the movement of vapors that are beneath a slab into a building. If TCE is in the water supply of a house, a carbon filter on the water supply to remove the TCE will minimize ingestion and inhalation exposures.

Is there a medical test that can tell me whether I have been exposed to TCE?
If you have recently been exposed to trichloroethylene, it can be detected in your breath, blood, or urine. The breath test, if it is performed soon after exposure, can tell if you have been exposed to even a small amount of trichloroethylene.

Exposure to larger amounts is assessed by blood and urine tests, which can detect trichloroethylene and many of its breakdown products for up to a week after exposure. However, exposure to other similar chemicals can produce the same breakdown products, so their detection is not absolute proof of exposure to trichloroethylene. This test isn't available at most doctors' offices, but can be done at special laboratories that have the right equipment.

When should my children or I see a physician?
If you believe you or your children have symptoms that you think are caused by TCE exposure, you or your children should see a physician. You should tell the physician about the symptoms and about when, how and for how long you think you and/or your children were exposed to TCE.

Where can I get more information?
If you have any questions about the information in this fact sheet or would like to know more about TCE and/or the public health consultation process please call the NC Department of Health and Human Services, Health Assessment, Consultation and Education program at (919) 707-5900 or visit the web site at http://www.epi.state.nc.us/epi/oee/hace/hc.html.

Additional information on TCE can be found on the following web sites:

http://www.atsdr.cdc.gov/tfacts19.html

http://www.atsdr.cdc.gov/toxprofiles/tp19.html

http://www.epa.gov/safewater/contaminants/dw_contamfs/trichlor.html

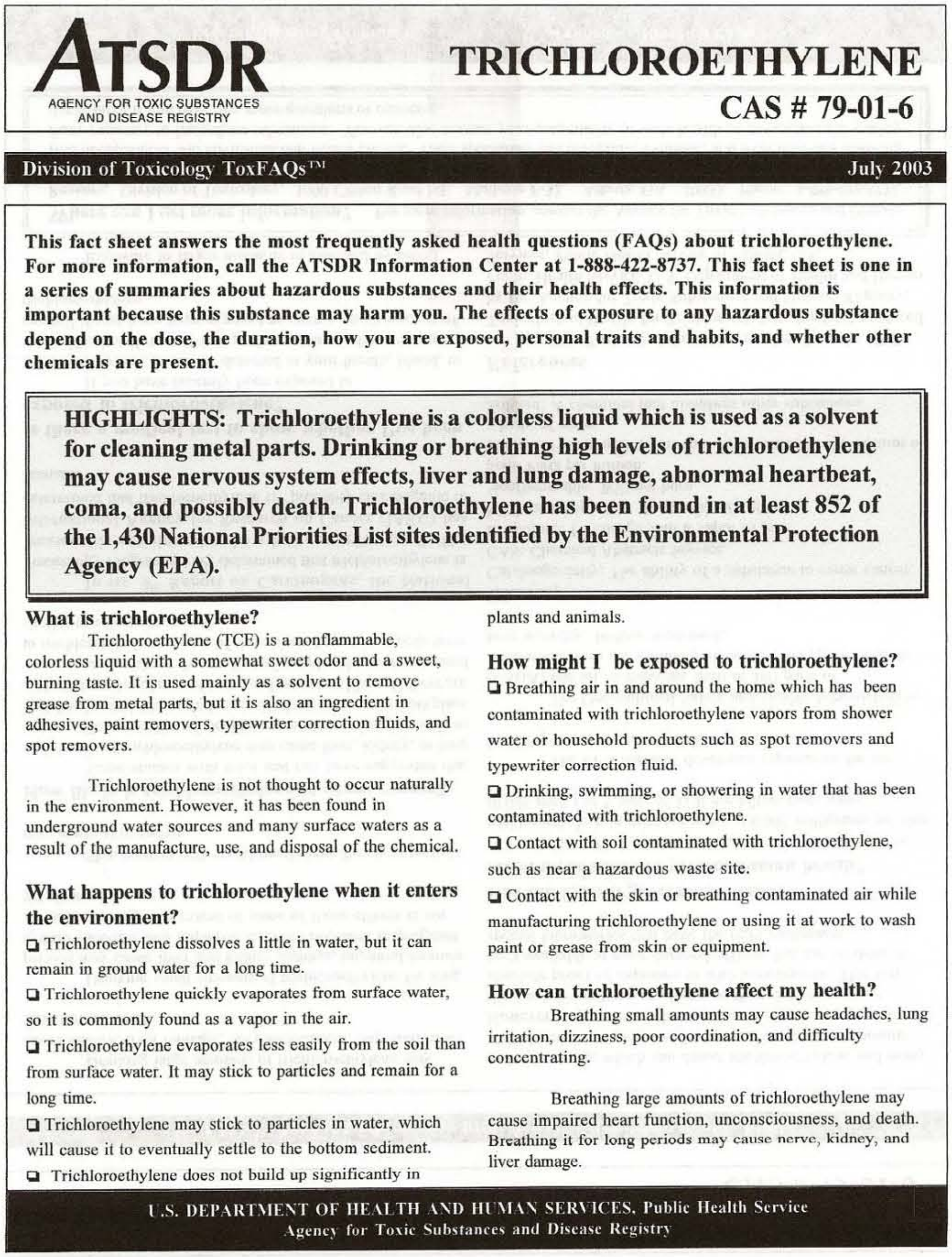
References

U.S. Environmental Protection Agency. *Trichloroethylene*. Technology Transfer Network, Air Toxics Web Site. Accessed on October 22nd, 2007 from http://www.epa.gov/ttn/atw/hlthef/tri-ethy.html#ref4

Agency for Toxic Substances and Disease Registry (ATSDR). *ToxFAQs for Trichloroethylene (TCE)*. Accessed on October 22nd, 2007 from http://www.atsdr.cdc.gov/tfacts19.html

Appendix I

Contaminant Information



ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

TRICHLOROETHYLENE

CAS # 79-01-6

Division of Toxicology ToxFAQs™ July 2003

This fact sheet answers the most frequently asked health questions (FAQs) about trichloroethylene. 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. This information is important 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: Trichloroethylene is a colorless liquid which is used as a solvent for cleaning metal parts. Drinking or breathing high levels of trichloroethylene may cause nervous system effects, liver and lung damage, abnormal heartbeat, coma, and possibly death. Trichloroethylene has been found in at least 852 of the 1,430 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is trichloroethylene?

Trichloroethylene (TCE) is a nonflammable, colorless liquid with a somewhat sweet odor and a sweet, burning taste. It is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers.

Trichloroethylene is not thought to occur naturally in the environment. However, it has been found in underground water sources and many surface waters as a result of the manufacture, use, and disposal of the chemical.

What happens to trichloroethylene when it enters the environment?

- ☐ Trichloroethylene dissolves a little in water, but it can remain in ground water for a long time.
- ☐ Trichloroethylene quickly evaporates from surface water, so it is commonly found as a vapor in the air.
- ☐ Trichloroethylene evaporates less easily from the soil than from surface water. It may stick to particles and remain for a long time.
- ☐ Trichloroethylene may stick to particles in water, which will cause it to eventually settle to the bottom sediment.
- ☐ Trichloroethylene does not build up significantly in plants and animals.

How might I be exposed to trichloroethylene?

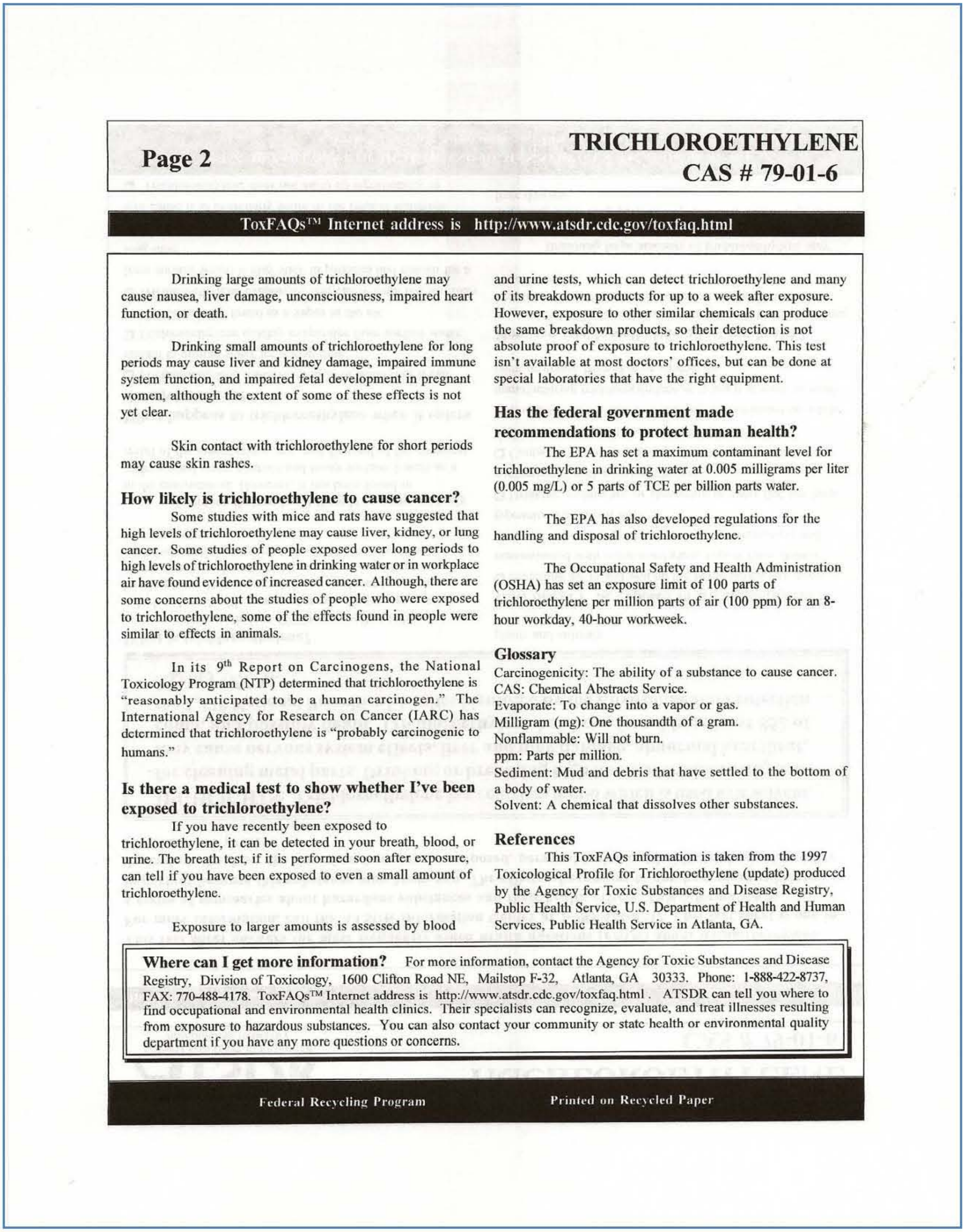
- ☐ Breathing air in and around the home which has been contaminated with trichloroethylene vapors from shower water or household products such as spot removers and typewriter correction fluid.
- ☐ Drinking, swimming, or showering in water that has been contaminated with trichloroethylene.
- ☐ Contact with soil contaminated with trichloroethylene, such as near a hazardous waste site.
- ☐ Contact with the skin or breathing contaminated air while manufacturing trichloroethylene or using it at work to wash paint or grease from skin or equipment.

How can trichloroethylene affect my health?

Breathing small amounts may cause headaches, lung irritation, dizziness, poor coordination, and difficulty concentrating.

Breathing large amounts of trichloroethylene may cause impaired heart function, unconsciousness, and death. Breathing it for long periods may cause nerve, kidney, and liver damage.

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



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

Drinking large amounts of trichloroethylene may cause nausea, liver damage, unconsciousness, impaired heart function, or death.

Drinking small amounts of trichloroethylene for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear.

Skin contact with trichloroethylene for short periods may cause skin rashes.

How likely is trichloroethylene to cause cancer?

Some studies with mice and rats have suggested that high levels of trichloroethylene may cause liver, kidney, or lung cancer. Some studies of people exposed over long periods to high levels of trichloroethylene in drinking water or in workplace air have found evidence of increased cancer. Although, there are some concerns about the studies of people who were exposed to trichloroethylene, some of the effects found in people were similar to effects in animals.

In its 9th Report on Carcinogens, the National Toxicology Program (NTP) determined that trichloroethylene is "reasonably anticipated to be a human carcinogen." The International Agency for Research on Cancer (IARC) has determined that trichloroethylene is "probably carcinogenic to humans."

Is there a medical test to show whether I've been exposed to trichloroethylene?

If you have recently been exposed to trichloroethylene, it can be detected in your breath, blood, or urine. The breath test, if it is performed soon after exposure, can tell if you have been exposed to even a small amount of trichloroethylene.

Exposure to larger amounts is assessed by blood and urine tests, which can detect trichloroethylene and many of its breakdown products for up to a week after exposure. However, exposure to other similar chemicals can produce the same breakdown products, so their detection is not absolute proof of exposure to trichloroethylene. This test isn't available at most doctors' offices, but can be done at special laboratories that have the right equipment.

Has the federal government made recommendations to protect human health?

The EPA has set a maximum contaminant level for trichloroethylene in drinking water at 0.005 milligrams per liter (0.005 mg/L) or 5 parts of TCE per billion parts water.

The EPA has also developed regulations for the handling and disposal of trichloroethylene.

The Occupational Safety and Health Administration (OSHA) has set an exposure limit of 100 parts of trichloroethylene per million parts of air (100 ppm) for an 8-hour workday, 40-hour workweek.

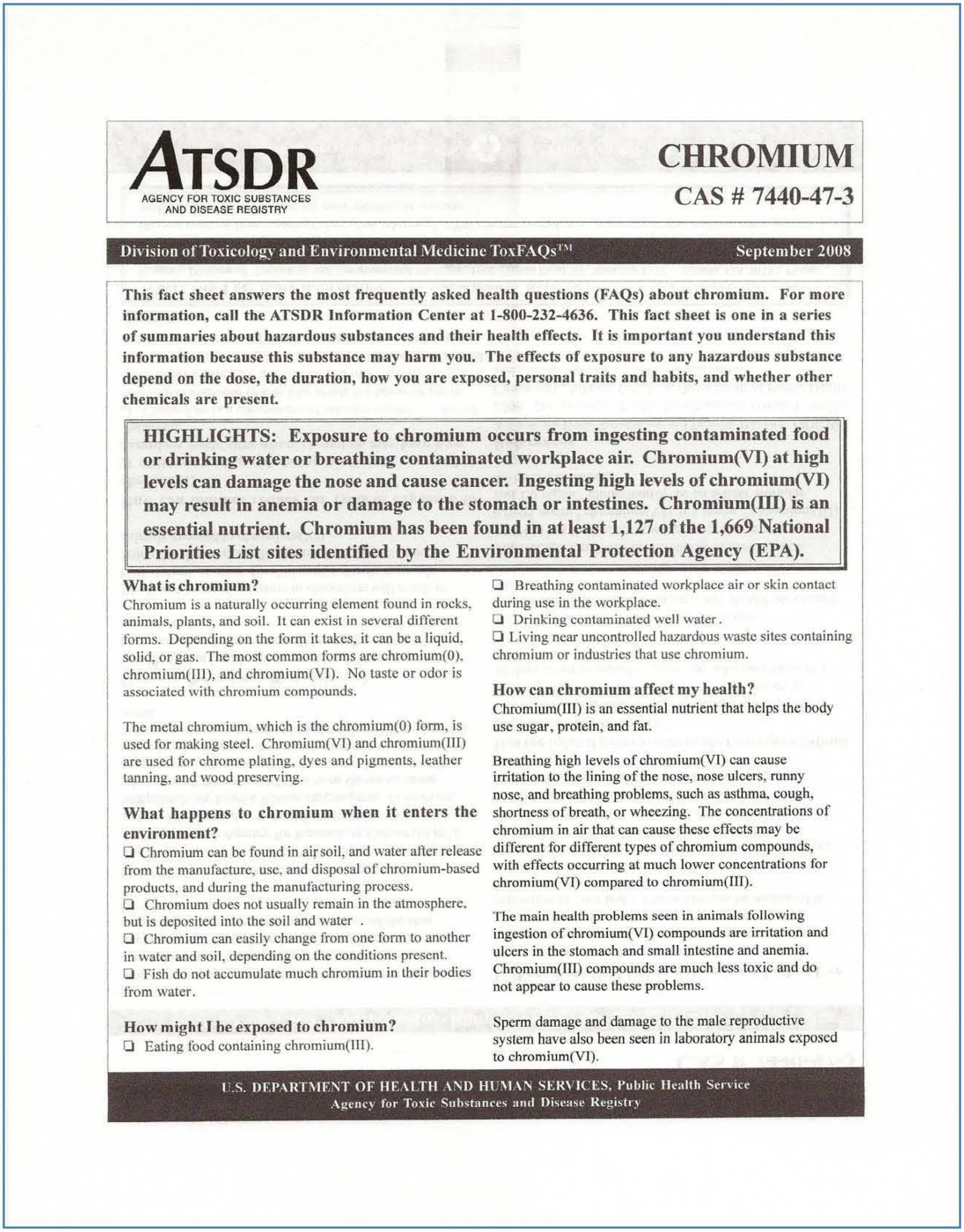
Glossary

Carcinogenicity: The ability of a substance to cause cancer.
CAS: Chemical Abstracts Service.
Evaporate: To change into a vapor or gas.
Milligram (mg): One thousandth of a gram.
Nonflammable: Will not burn.
ppm: Parts per million.
Sediment: Mud and debris that have settled to the bottom of a body of water.
Solvent: A chemical that dissolves other substances.

References

This ToxFAQs information is taken from the 1997 Toxicological Profile for Trichloroethylene (update) produced by the Agency for Toxic Substances and Disease Registry, Public Health Service, U.S. Department of Health and Human Services, Public Health Service in Atlanta, GA.

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: 770-488-4178. ToxFAQs™ Internet address 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.



ATSDR
AGENCY FOR TOXIC SUBSTANCES
AND DISEASE REGISTRY

CHROMIUM
CAS # 7440-47-3

Division of Toxicology and Environmental Medicine ToxFAQs™ **September 2008**

This fact sheet answers the most frequently asked health questions (FAQs) about chromium. 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: Exposure to chromium occurs from ingesting contaminated food or drinking water or breathing contaminated workplace air. Chromium(VI) at high levels can damage the nose and cause cancer. Ingesting high levels of chromium(VI) may result in anemia or damage to the stomach or intestines. Chromium(III) is an essential nutrient. Chromium has been found in at least 1,127 of the 1,669 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is chromium?

Chromium is a naturally occurring element found in rocks, animals, plants, and soil. It can exist in several different forms. Depending on the form it takes, it can be a liquid, solid, or gas. The most common forms are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds.

The metal chromium, which is the chromium(0) form, is used for making steel. Chromium(VI) and chromium(III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving.

What happens to chromium when it enters the environment?

☐ Chromium can be found in air,soil, and water after release from the manufacture, use, and disposal of chromium-based products, and during the manufacturing process.
☐ Chromium does not usually remain in the atmosphere, but is deposited into the soil and water .
☐ Chromium can easily change from one form to another in water and soil, depending on the conditions present.
☐ Fish do not accumulate much chromium in their bodies from water.

How might I be exposed to chromium?

☐ Eating food containing chromium(III).
☐ Breathing contaminated workplace air or skin contact during use in the workplace.
☐ Drinking contaminated well water .
☐ Living near uncontrolled hazardous waste sites containing chromium or industries that use chromium.

How can chromium affect my health?

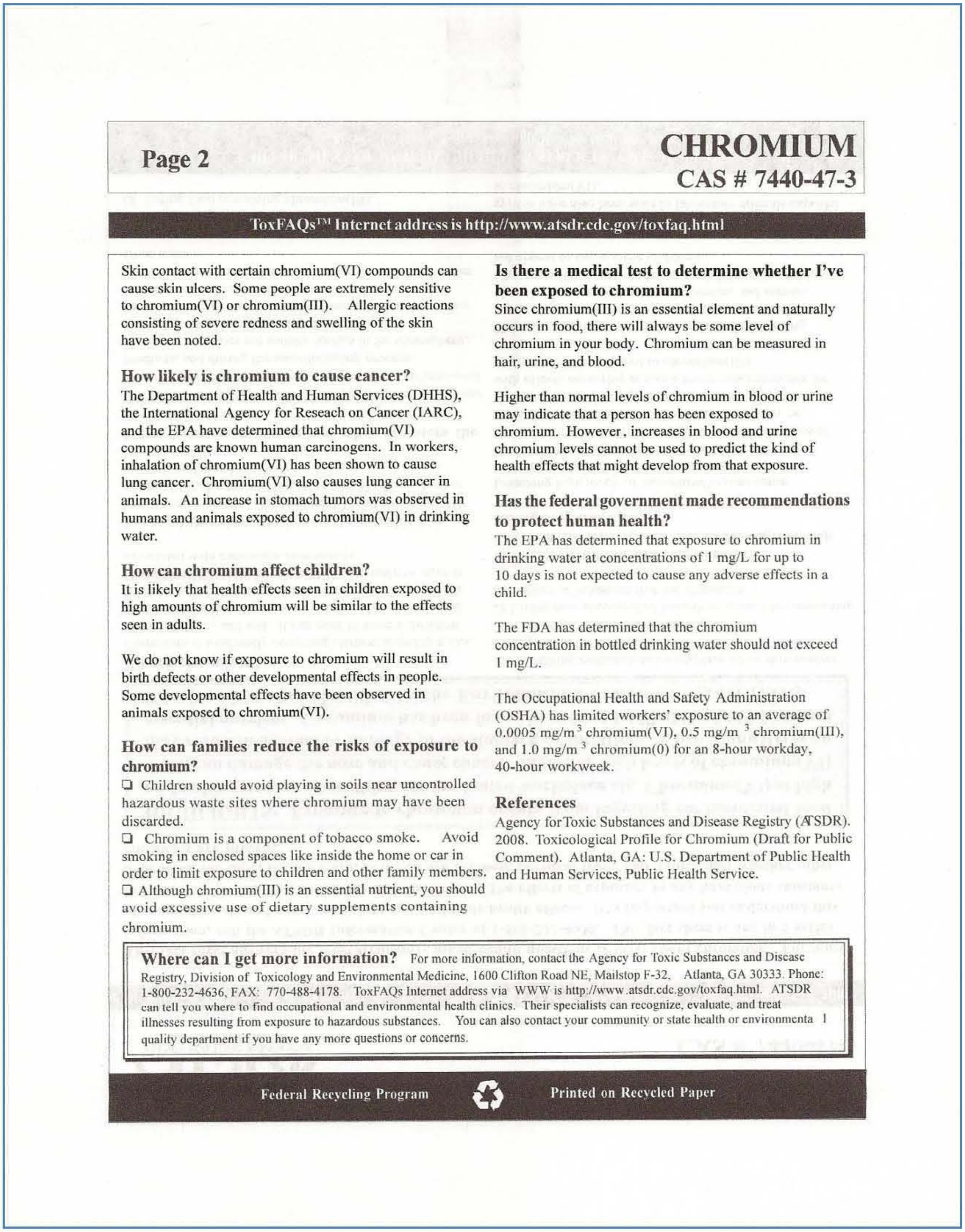
Chromium(III) is an essential nutrient that helps the body use sugar, protein, and fat.

Breathing high levels of chromium(VI) can cause irritation to the lining of the nose, nose ulcers, runny nose, and breathing problems, such as asthma, cough, shortness of breath, or wheezing. The concentrations of chromium in air that can cause these effects may be different for different types of chromium compounds, with effects occurring at much lower concentrations for chromium(VI) compared to chromium(III).

The main health problems seen in animals following ingestion of chromium(VI) compounds are irritation and ulcers in the stomach and small intestine and anemia. Chromium(III) compounds are much less toxic and do not appear to cause these problems.

Sperm damage and damage to the male reproductive system have also been seen in laboratory animals exposed to chromium(VI).

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



CHROMIUM
CAS # 7440-47-3

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

Skin contact with certain chromium(VI) compounds can cause skin ulcers. Some people are extremely sensitive to chromium(VI) or chromium(III). Allergic reactions consisting of severe redness and swelling of the skin have been noted.

How likely is chromium to cause cancer?

The Department of Health and Human Services (DHHS), the International Agency for Reseach on Cancer (IARC), and the EPA have determined that chromium(VI) compounds are known human carcinogens. In workers, inhalation of chromium(VI) has been shown to cause lung cancer. Chromium(VI) also causes lung cancer in animals. An increase in stomach tumors was observed in humans and animals exposed to chromium(VI) in drinking water.

How can chromium affect children?

It is likely that health effects seen in children exposed to high amounts of chromium will be similar to the effects seen in adults.

We do not know if exposure to chromium will result in birth defects or other developmental effects in people. Some developmental effects have been observed in animals exposed to chromium(VI).

How can families reduce the risks of exposure to chromium?

☐ Children should avoid playing in soils near uncontrolled hazardous waste sites where chromium may have been discarded.

☐ Chromium is a component of tobacco smoke. Avoid smoking in enclosed spaces like inside the home or car in order to limit exposure to children and other family members.

☐ Although chromium(III) is an essential nutrient, you should avoid excessive use of dietary supplements containing chromium.

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

Since chromium(III) is an essential element and naturally occurs in food, there will always be some level of chromium in your body. Chromium can be measured in hair, urine, and blood.

Higher than normal levels of chromium in blood or urine may indicate that a person has been exposed to chromium. However, increases in blood and urine chromium levels cannot be used to predict the kind of health effects that might develop from that exposure.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to chromium in drinking water at concentrations of 1 mg/L for up to 10 days is not expected to cause any adverse effects in a child.

The FDA has determined that the chromium concentration in bottled drinking water should not exceed 1 mg/L.

The Occupational Health and Safety Administration (OSHA) has limited workers' exposure to an average of 0.0005 mg/m^3 chromium(VI), 0.5 mg/m^3 chromium(III), and 1.0 mg/m^3 chromium(0) for an 8-hour workday, 40-hour workweek.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Toxicological Profile for Chromium (Draft for Public Comment). 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.

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Appendix J

Summary of Public Comments and Responses

Summary of PHA Comments and Responses

Community concerns for this site were gathered through 4 community meetings, mail and e-mail correspondence, and telephone conversations. This Public Health Assessment was distributed for public comment from January 12, 2010 to March 19, 2010. A public meeting was conducted on January 21, 2010 to present findings and to give an opportunity for community members to ask questions. The meeting lasted 4 hours and was attended by approximately 70 individuals. Twelve (12) participants completed a meeting evaluation and provided additional comments. During the public comment period, 9 individuals, 2 community organizations, and 2 government agencies provided written comments.

We summarized all comments provided during the meeting, the comment period and telephone conversations, and provided responses in this document. We also developed a shorter Frequently Asked Questions document that lists the most common questions.

Incomplete Site Evaluation

1. **Comment:** *Residents expressed concerns with the delay of the report as well as with the exclusion of the well water data collected after August 2008 near the CTS site.*

   Response: The Public Health Assessment included all finalized data collected in association with investigations of the CTS site through August 2008. Because of the large amount of current and historical environmental data evaluated for this document, the evaluation process required a longer time period than originally projected. Quarterly private well water sampling began well into the time period when site data was being evaluated by DPH. Rather than continue to delay the Public Health Assessment, and because several agencies are reviewing the private well data as it was reported, DPH chose to proceed with the Public Health Assessment and address recent private well data in a separate document. DPH believed that this was the best alternative to provide the community with the health evaluations as quickly as possible. A Health Consultation has been written for the private well data collected through January 2010. This document was finalized on July 8, 2010 (available at: *http://www.epi.state.nc.us/epi/oee/hace/ncmap/CountyInfo.html#Buncombe*). Additional private well samples collected after February 2010 are currently being reviewed and will be addressed in future documents.

2. **Comment:** *Community members identified that some site history items were not included in the PHA. There was also a request that all analytical data be included in the Public Health Assessment.*

   Response: Not all site history facts were included in the Public Health Assessment. The information included in the Public Health Assessment is not meant to provide a comprehensive history of the site, nor will it include a copy of all the environmental analytical data DPH reviewed for the assessment. The Public Health Assessment is a summary of the information relevant to assessing whether the community's health has been or may be negatively impacted. All environmental data available at the time (other than the most recent private well samples) was reviewed for the Public Health Assessment.

Groundwater contamination (plume) movement

3. **Comment:** *Residents want to understand how contamination is moving underground in order to evaluate if they may be at risk of drinking contaminated water in the future. They want a well survey and the testing of the well water to be conducted immediately. They were also wondering why certain homes were getting alternative water while others in close proximity were not getting alternative water. They wanted to know for how long people have been drinking the water.*

   Response: It is very difficult to assess how groundwater moves in mountain regions. It has also been difficult to determine which private wells are still in use and if there is contamination in some of these wells. In addition, it has been difficult to determine which wells are still in use. In some instances residents were not allowing agencies entry to their properties to test their water, which was later found to be contaminated. There is no data available to determine for how long people might have used contaminated water.

   A groundwater flow study ("attribution study") is EPA and DENR's effort to describe how contamination is moving underground. DPH is not involved in the groundwater flow study. Multiple agencies are involved in this sophisticated study to define the direction of groundwater flow in the area.

   Quarterly private well samples collected in the radius around the CTS site cover all possible directions of groundwater flow. It is not known if all the TCE observed in the private well samples collected since 2008 are due to contamination from the CTS site. The purpose of EPA's "attribution study" is to identify the source of the trichloroethylene (TCE) and some of the other contaminants observed in the private well samples taken since 2008. Private well users in the 1-mile radius that have not had their well tested should contact the County Health Department.

   The local government agencies are making the decisions on what homes and areas are to get municipal water supplies.

4. **Comment:** *People think nothing is being done to define the movement of the contaminated groundwater (plume).*

   Response: EPA and DENR scientists develop the sample collection and analysis plans to assess environmental and human health impacts. DPH makes recommendations to these agencies to ensure that public health issues are addressed. DPH made specific recommendations in the PHA for environmental monitoring to address the public health issues identified during our assessment. These recommendations may or may not require a modification of EPA or DENR's planned activities for the site.

   Studies in addition to the quarterly private well collections are on-going. One is to identify the direction that groundwater flows away from the CTS site.

5. **Comment:** *People who are told they are not at risk from drinking contaminated water now do not feel assured that their health will not be at risk in the future.*

Response: DPH has recommended that movement of contaminants from the site be monitored and controlled to prevent future exposures that could cause negative health effects. EPA and DENR continue to monitor the movement of chemicals off the CTS site. The attribution study is underway to define the complex movement of groundwater in the area. Investigations are also underway to determine the source of the TCE identified in the quarterly private well samples taken since August 2008. It is possible that some of these may not be related to contaminants that came from the CTS site.

Because children live in this community and they tend to be more vulnerable to toxics in the environment, DPH evaluated the potential for adverse health effects associated with children playing in streams formed by springs east of the site. These streams had the highest reported surface water concentrations of TCE. We assessed the potential health risks associated with children accidently drinking this water while they were playing in the streams. Our evaluation results did not indicate the potential for adverse health effects from this activity. To be protective, DPH used the concentration of the TCE in the water where it comes to the surface, not the lower concentration beyond the fence where children would actually have access. The concentration of TCE is highest where the water comes to the surface and it decreases as the water flows downstream, due to the volatility of TCE (it moves from the water to the air). Dose estimates for children accidently drinking water with the highest concentrations of TCE found in the springs do not indicate the potential for adverse health effects.

Cleanup and Remediation

6. **Comment:** *Residents want the site to be cleaned up and remediated immediately.*

   Response: DPH is not involved in the clean-up of contaminated sites. EPA and DENR are responsible for decisions regarding site remediation and determination of when, where and what type of remediation efforts are appropriate.

   Exposure to contaminated groundwater through private wells has been the route by which people may have been harmed by contaminants from the CTS site. Known exposures to contaminated private wells have been removed. EPA is conducting an "attribution study" (groundwater flow study) to identify additional contaminated wells. Wells contaminated above regulatory levels have been closed and safe drinking water supplies provided. The source of the contamination of recently identified private wells has not been confirmed.

   High levels of TCE and other volatile organic compounds (VOCs) are present in spring water immediately east of the site. Access to the springs is blocked by a chain-link fence and the springs have not been used as a drinking water source since 1999. The VOC concentrations decrease as the water moves downstream and do not present an incidental ingestion or inhalation health hazard outside of the fence.

Health Effects

7. **Comments:** *Residents know of people who live in the area who they think have become sick or developed cancer as a result of contact with contaminants from CTS. Some believe the cancer studies conducted to [date] are not valid.*

Response: The existence of cancers and other serious health issues in the community does not mean/imply they are linked to exposures to CTS contaminants. These types of health issues are found in all communities, including those in which environmental exposures have not been identified.

There is strong evidence in the scientific literature that exposure to TCE is associated with liver cancer and non-Hodgkin's lymphoma, and possibly kidney cancer (IRIS 2009). There is not convincing evidence that other types of cancers can be linked to TCE exposure. It also can not be assumed that all persons that have these types of cancers in the area around the CTS facility, or at one time worked at CTS, are the result of TCE exposure. These cancers can also result from other causes. A discussion of the cancer and non-cancer health effects associated with TCE exposure is provided in the PHA (page 34 and Appendix F).

Exposures to specific chemicals result in specific types of health effects. Not all chemicals cause cancer. Chemicals that cause cancer cause specific types of cancer. Cancer is not one disease, it is a group of more than 100 different types of cancer or conditions. Most cancers are a result of our genetic make-up (traits passed from parents to children) and life-style choices (things like our diet, how much time we spend in the sun, how much we exercise, if we smoke). A person's chance of developing cancer increases as we get older. We also know that certain types of cancers may be more prevalent in some families. We know that in N.C. approximately 1 in 2 men, and 1 in 3 women, that live to middle age or older, will develop cancer in their life-time.

When we look for cancer clusters we identify the type of chemicals that people may have been exposed to, how people may be exposed (eating, breathing, touching), where people may have been exposed to the chemical, and the types of cancer these chemicals may cause. We use this information to determine if the numbers of these types of cancers is more than the number that is expected in populations in N.C. not exposed to the contaminant.

For a cancer study we also have to define the area where people were exposed to the specific contaminant. That is why the more we know about where the contamination is moving the better we can focus the study. We did not have as much information when the first cancer study was done as we have today.

DPH has performed 3 separate cancer studies associated with this site. The areas selected for evaluating the number of cancers were based on the best information available at the time each study was initiated. These studies included cancers identified between 1990 and 2006. Data were not available before 1990 or after 2006. None of the 3 cancer studies indicated higher numbers of cancers than would be expected in the study areas.

While we recognize the limitations of this type of study we believe it provides useful information. The results agree with the independent finding of the Public Health Assessment which determined only those persons using the wells identified in 1999 as having been exposed to levels of site contaminants with the potential to cause adverse health effects. Potential adverse health effects were also indicated for the well identified in August 2009 that has yet to be associated with contamination coming from the CTS site. A Health Consultation was published on July 8, 2010 for additional private well samples collected after January 2008 and not included in this PHA (available at: http://www.epi.state.nc.us/epi/oee/hace/ncmap/CountyInfo.html#Buncombe).

Review of the environmental data gathered in the CTS investigations has identified a limited number of environmental samples that had chemical concentrations high enough to indicate that people may have been harmed. DPH Physicians have been in contact with people that may have been harmed to assist them in working with their personal physicians to identify possible health effects that may be associated with their exposures.

8. **Comment:** *Concern that the location specified in Appendix C (demographics data) was used for the cancer study.*

   Response: The figure on page 68 was developed by the EPA EnviroMapper tool and was used only as a general reference for demographic data. It has no implications on the analytical data or population used for the health evaluation or cancer statistics. The cancer cluster investigation study area included all census blocks that intersect a 1-mile radius of the CTS site at 273 Mills Gap Road (Appendix G).

9. **Comment:** *Residents believe their cancers were not taken into account in the cancer study because they were not contacted by government officials regarding their illnesses. As a result, many have asked for a door-to-door survey of health effects including cancer to be conducted in their community.*

   Response: Cancer statistics are gathered through information submitted by health professionals, not through direct contact with cancer patients. In N.C. more than 98% of diagnosed cancers are reported to the N.C. Center for Health Statistics by medical facilities and physicians. The information includes the type of cancer and where the person lived at the time the cancer was first diagnosed.

   The evidence available to date does not suggest that a door-to-door effort will provide the information needed to link past or current health issues to environmental exposures related to CTS. DPH will continue to evaluate the benefit of doing another cancer investigation. Modifications to past studies may include using the findings of the groundwater flow study (attribution study) to focus the area of the cancer study and using additional years of reported cancer statistics that were not available at the time of the prior cancer studies.

Superfund Scoring Process

10. **Comment:** *Multiple people asked about the NPL ("Superfund") scoring process.*

    Response: EPA is responsible for the Superfund scoring process. DPH has not participated in the process of determining whether the site will qualify for Superfund status. DPH's conclusions and recommendations are not impacted by whether the site qualifies for Superfund listing.

Alternative Water Supplies

11. **Comment:** *Concerns about private well locations near the Oaks neighborhood that have not been connected to the municipal water supply.*

    Response: N.C. DPH wants all N.C. citizens to have a safe supply of drinking water. Multiple pockets of contaminated groundwater have been identified in the radius around the CTS site. The EPA feels that some of these localized areas of contamination may not be related to historical activities that took place on the CTS site, but may be related to other business operations that may no longer operate in the area. Investigations are under way to pinpoint the source of these localized areas of contaminated groundwater. If the appropriate agencies involved cannot provide assurances to the local residents of the safety of their private well water supply, then DPH recommends that private well water users near areas of identified groundwater contamination receive assurances by frequent sampling (at least quarterly), by treatment (such as well-maintained effective filtration or treatment systems), or be provided a clean alternative drinking water supply, such as a municipal water system. These issues are also addressed in the separate Health Consultation that examines quarterly private well samples not included in this Public Health Assessment.

    DPH does not make the decisions on who is connected to the municipal supply. Locations of water lines are at the discretion of the local government.

Disagree with PHA Conclusions

12. ***Comment:*** *Many community members expressed considerable mistrust of government agencies and did not believe their health was not at risk from contaminants from the CTS site.*

    Response: The DPH has used the best science available to safeguard the health of the residents near the CTS site. We understand the community is frustrated with the many unknowns that still exist.

13. **Comment:** *One community member asked for the Public Health Assessment to be submitted to a peer-reviewed journal for publication.*

    Response: Prior to publication of a report by DPH or ATSDR it goes through numerous technical reviewers both at DPH and ATSDR. The reviewers have included toxicologists, physicians, epidemiologists, industrial hygiene specialists, and public health specialists.

    N.C. DPH is part of the N.C. Department of Health and Human Services (DHHS), an independent organization from N.C. DENR and U.S. EPA. The findings of the Public Health Assessment were developed independently by DPH.

14. **Comment:** *Comments about the validity of the Camp Lejeune study conducted by ATSDR.*

    Response: The CTS Public Health Assessment has no connection to the Camp Lejeune investigation by Federal agencies. N.C. DPH has not been involved in the Camp Lejeune health evaluations.

15. **Comment:** *Concern with the discussion of the physical properties of TCE and its potential impact on the ultimate exposures of persons using the springs east of the site as drinking water sources until 1999.*

    Response: The reported analytical concentrations were used for determination of potential adverse health effects. The physical properties of TCE are well documented and their impact on the ultimate exposure concentration is supported. The physical properties of TCE are available in numerous references, including the ATSDR Toxicological Profile (reference ATSDR 1997d).

Contaminants of Concern

16. **Comment:** *Question regarding reference to 66 private well samples collected in November and December 2007 (Public Health Assessment page 26) and the number of TCE and bromodichloromethane detections. Concern that contaminants were found in all 66 wells.*

    Response: TCE and bromodichloromethane were not detected in all 66 wells. As discussed on page 19 of the Public Health Assessment, there were 6 VOCs detected in 7 wells. Only TCE in one well and bromodichloromethane in two samples were greater than comparison values and were evaluated for potential health effects.

17. **Comment:** *Action level for lead (15 µg/L) is not a health-based value. Most lead comes from resident's plumbing system, not the water source. Need a systematic study of heavy metals in tap water in vicinity of CTS site.*

    Response: DPH evaluates health hazards regardless of whether the contamination is related to the suspected source that is the focus of the PHA, or to other possibly un-identified sources. The elevated lead addressed in the Summary and Conclusions section (see Conclusion number 4) was observed in groundwater, not a private well sample. As stated in the PHA, there is no indication that anyone was exposed to the groundwater lead or chromium referenced in Conclusion 2, but the discussion was included due to the prevalence of private wells in the area. EPA believes that the source of the elevated lead and chromium noted in Conclusion number 4 may be a local source, a former junkyard (EPA March 16, 2010).

    The PHA includes discussion that children are particularly sensitive to lead, that blood lead levels less than 10 µg/dL in children may result in adverse health effects, and that no safe blood lead level in children has been determined (PHA, pages 18 and 37).

Exposure Routes

18. **Comment:** *Also evaluate metal contaminated soil ingestion hazard.*

    Response: DPH evaluated the potential health risks associated with ingestion of the available site soil data.

19. **Comment:** *A community resident reported playing in creeks flowing from the direction of the CTS plant in the 1970s, near Sweeten Creek Road at Mills Gap Road. The person remembers "foamy like soap bubble" conditions and is concerned that the water was "cancerous".*

    Response: There is no analytical data for this stream for the time period mentioned. There is no way to know what the source of the observed foam may have been. Surfactants, which are components of detergents and soaps, are often the cause of foaming on water surfaces. If there was TCE in the stream the most significant hazard associated with playing in the stream would likely have been unintended ingestion of the water and inhalation.

EPA comments, dated March 16, 2010

1. **EPA Comment:** Page 3; Introduction: CTS (insert "and other operators") manufactured electronic components from 1952 until 1986. A plating line was present (and another company Arden Electroplating also operated on site); but, it is not at all clear that the plating operations are the source of contamination. Given that the primary contaminants of concern, namely TCE and petroleum hydrocarbons, are <u>not</u> directly used in electroplating, the statement that "electroplating operations…are believed to be the source of contamination" is not supportable. The hydrocarbons detected in the subsurface are believed to be associated with at leaking AST; the TCE (and PCE) are believed to be associated with degreasing.

   DPH Response: Text in introduction will be modified to identify operations in addition to CTS operated on the site. DPH will reference "electroplating and associated operations" as the source of the TCE contamination.

2. **EPA Comment:** Page 3; Conclusion 1 (original Conclusion 1 has been re-ordered to Conclusion 3): The following appears out of context as a conclusion: "The DPH makes the following recommendations: Limit access to contaminated stream and spring ("seep") surface waters near the east side of the CTS property." The springs and seeps are already fenced with signage. The stream leading away from the springs is not entirely fenced.

   DPH Response: DPH recognizes that the immediate area around the springs is fenced preventing access to the contaminated groundwater at its point of highest concentration of volatile organics (including TCE) when it reaches the surface. Surface water data collected in November and December 2007 indicated that volatile organics were present in the stream formed by the springs beyond the fence line. Adverse effects are not indicated for incidental ingestion of the spring water. The text in the "Next Steps" will be modified to indicate DPH is recommending to continue to limit access to the springs area.

3. **EPA Comment:** Page 4; Conclusion 2: Conclusion 2 discusses chromium and lead groundwater contamination. Yet, to conclude that chromium and lead contamination are even linked to the site is not supportable based upon available data. In 2007/2008 soil sampling, chromium was detected in offsite samples; however, chromium was not detected in multiple on-site samples taken concurrently. Phase I data (CTS, 2009) shows no elevated chromium in groundwater. Chromium is slightly elevated in historic sediment data from the area of the former contingency basin and the west springs, but not the east springs. The location of the chromium detections in the TN&A 2008 report (GW-05 and GW-06)

coincides with the location of a former auto body shop located to the east of the site. EPA does not yet have specific environmental data on that entity. ….. It is also important to note that the lead detections in groundwater you cite occur in the same monitoring wells as the chromium contamination (GW-05 and GW-06), both of which are off-site and adjacent to the former junkyard. The lead also does not appear to be attributable to the site (see Table 6 and Figure 3 of the TN&A 2008 report). As you will note in Table 5 of the TN&A 2008 report, lead was not elevated in subsurface soils, particularly comparing those results to the background samples from the residential property across the street (SB-05 and SB-06). Furthermore, lead was not found in groundwater or in soils in elevated amounts during the 2009 Phase I Study under IHSB or during the NUS 1990 study, the 1999 START study, or the 2004 MACTEC study.

DPH Response: DPH agrees that the chromium and lead found in the groundwater east of the site may not be attributable to the CTS site. Regardless of the source of the contamination identified during a public health evaluation the potential health risks associated with exposure are evaluated. Text in the PHA will be modified to indicate that EPA believes the source of the elevated lead and chromium is not the CTS site.

4. **EPA Comment:** Page 5, Basis for Decision, Conclusion 3. Regarding the statement "Vinyl chloride was found in groundwater on the CTS property, but not off-site," please see the November 2009 Surface Water Sampling Report prepared by EPA SESD. A sample taken of the stream in November 2009 leading from the springs on the property (immediately east of the CTS site) indicated a level of 2.4 µg/L of vinyl chloride in surface water and 1.3 µg/kg of vinyl chloride in sediment…. This report also showed a slight elevation of chromium in onsite soils, but in line with past analyses of soils, at 67 mg/kg; EPA did not analyze groundwater.

   DPH Response: EPA's November 2009 surface water sampling data (report dated January 2010) was not included in the PHA. The identification of vinyl chloride in the November 2009 surface water data supports DPH's recommendation to continue to monitor the movement of CTS site contaminants and degradation products moving away from the site for potential human exposure concerns.

5. **EPA Comment:** Page 18, it may be misleading to say in the 2nd paragraph that the two lead detections "were from the two sample locations furthest to the east of the site. This wording suggests that they are on site." They should be discussed as off-site samples since they are closer to the former junkyard.

   DPH Response: Text will be added to the PHA for clarification.

6. **EPA Comment:** Arsenic concentrations detected on and near the site are consistent with background values for that are(a) of North Carolina.

   DPH Response: DPH did not locate in the EPA data a site-specific local background concentration of arsenic in soil. DPH discusses background levels of arsenic (determined by the N.C. Department of Agriculture) on page 31 and identifies that the arsenic concentrations observed in the samples are within the range expected for naturally occurring arsenic in N.C. soils.

7. **EPA Comment:** In general, it is difficult to identify the source of the data discussions in this report. To help the reader, particularly the public reader, more easily follow the discussions, references to previous reports should be added whenever sampling data is discussed and the previous report or, at a minimum, the original data tables should be included as appendices to this report. For example: Environmental Sampling Data, page 17: This section references various chemical detections that are not included on the figures provided. The original tables or report listing samples collected and concentrations detected should be included as an appendix for reference.

   DPH Response: PHA figures are provided to identify the spatial extent of the sample collection locations and are not intended as an all inclusive source of data reviewed by DPH for the PHA. DPH does not produce site maps or figures and has taken the best available figures from EPA and DENR reports for use in DPH documents. Due to the extent of data evaluated by DPH a summary of that data is included in a PHA, in keeping with DPH health assessment protocols. Data sources are foot-noted in the text and a reference section is provided in the PHA.

8. **EPA Comment:** With regards to the ambient air sampling, the 277 ppbv value was detected at, not "near" the seep in a fenced area. The August 2008 vapor sampling event included 24 hour summa canister sample taken at the point (Hidden Valley) where the TAGA bus detected 21 ppbv. No TCE was detected in Summa canister at Hidden Valley.

   DPH Response: The text on page 34 will be modified to reflect the 277 ppbv TCE value was collected "at" the seeps.

9. **EPA Comment:** One of the main community concerns raised has been potential exposure at South Side Village (SSV). Many residents question the Buncombe County's decision to permit construction without a complete environmental assessment. To address these concerns, EPA and DENR conducted fairly extensive sampling of all media (except drinking water, which comes from a municipal source). In spite of findings indicating that contamination was minimal, fear continues. If NC Div of Public Health can address contamination and exposure pathways at SSV, such an analysis could be very beneficial.

   DPH Response: DPH looked at the data for all samples collected by EPA and DENR through August 2008 in association with the CTS site. These included a number of different types of samples collected in the South Side Village area. As with all samples evaluated for this Public Health Assessment, South Side Village area samples were evaluated for how local residents could come into contact with the environmental media. Potential health effects associated with coming into contact with all the detected substances in these samples was evaluated. In the South Side Village area DPH evaluated outdoor air collected by stationary and mobile air monitoring devices, sub-slab residential air and subsurface soil gas for potential hazards associated with inhalation (breathing) the chemicals identified in the air. DPH also evaluated potential health risks associated with accidentally ingesting soil and surface water collected in the South Side Village area. To be health protective, the highest concentrations of substances identified in these samples were compared to the most up-to-date health effects values compiled by ATSDR and DPH. No adverse health effects were indicated based on the reviewed data. DPH has recommended continued monitoring of contaminants moving away from the CTS site. DPH will continue to evaluate additional CTS environmental data as it becomes available.

Reference:

(IRIS 2009). *IRIS Toxicological Review of Trichloroethylene (External Review Draft)*. U.S. Environmental Protection Agency, Washington, DC, EPA/635/R-09/011A, 2009. http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=215006

Appendix K

ATSDR Glossary

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 follow-up 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 (t½)
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 remains.

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.