Health Consultation

Groundwater Data Review

CLIFTON PRECISION/LITTON SYSTEMS

MURPHY, CHEROKEE COUNTY, NORTH CAROLINA

EPA FACILITY ID: NCD044438406

NOVEMBER 7, 2007

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

Health Consultation: A Note of Explanation

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

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

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Prepared By:

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Statement of Issues

On November 1, 2007, the U.S. Environmental Protection Agency (EPA) requested that the Agency for Toxic Substances and Disease Registry (ATSDR) evaluate current groundwater data associated with the Clifton Precision/Litton Systems site (the site) in Murphy, Cherokee County, North Carolina. In August, September and October 2007, EPA had collected and analyzed water samples from private wells for volatile organic compounds (VOCs). Homes, churches, and businesses use private wells in this area for water. EPA asked ATSDR *to provide a public health evaluation of the VOC levels detected in private wells.*

Background

The site began operations in 1967 as Clifton Precision, under the ownership of Litton Industries. Clifton Precision manufactured small electric rotary components and motors. From 1984 to 1986, VOCs such as tetrachloroethene (PCE) and trichloroethylene (TCE) were placed in underground storage and treatment tanks. In December 1986, Clifton Precision discovered VOC contamination in some of the plant's onsite industrial water supply wells and in some private drinking water wells located north of the facility. Immediately following this discovery, Clifton Precision provided bottled water to the plant and local residences. In June 1987, carbon adsorption filters were installed on three private residences and two private wells; these residences were eventually connected to the public water supply [EPA 2007].

In 2007, the facility consultant proposed to extend the monitoring well network and to conduct an inventory of residential wells within the immediate area of the facility. In August 2007, the facility consultant sampled 10 private wells and one spring. The results indicated the presence of PCE and TCE above EPA's maximum contaminant levels (MCLs) in two wells serving four residences. These residences were immediately provided with bottled water and the well survey area expanded. In September and October 2007, the facility consultant sampled an additional 30 wells and resampled six wells. Currently, there are 10 residences and two commercial facilities (a community center and a church) with whole-house carbon filtration systems installed. EPA is working with state and local government agencies (the North Carolina Department of Environment and Natural Resources and Cherokee County Health Department) and the community to extend the public water service to all affected residences in the near future.

During the three sampling events, a total of 40 private wells and one spring were sampled (see Figure 1, Attachment C, for their approximate locations). VOCs were detected in 18 wells and the spring. The following text provides further information related to the wells with VOC contamination.

The 18 private wells and spring:

- Well 16 currently supplies water to the Peachtree Community Center. On an intermittent basis, community members use the center for recreational activities such as for Bingo nights and private parties. Recently, bottled water was provided for the center and then a filtration system was installed. Prior to these actions, community members were exposed to the well water during activities such as drinking, cooking, and washing dishes. Because the water is filtered, there are no current exposures to VOC contamination via Well 16.

- Wells 18A, 22A, and 23 currently supply water to five residences. Recently, bottled water was provided for the residents and then whole-house filtration systems were installed in all five residences. Prior to these actions, residents were exposed to the well water during activities such as drinking, cooking, hand washing, and washing dishes. Because the water is filtered, there are no current exposures to VOC contamination via Wells 18A, 22A, and 23.

- Wells 22B and 36 currently are inactive. Well 22B is a new well, but is not used for any purpose at this time. Well 36 supplies an outdoor faucet outside of a pump house, but the well was mostly dry during the sampling events. Future exposures to VOC contamination though use of these wells are possible.

- Well 26 is a spring that provides water to five residences. Recently, bottled water was provided for the residents and then whole-house filtration systems were installed in all five residences. Prior to these actions, residents were exposed to the well water during activities such as drinking, cooking, hand washing, and washing dishes. Because the water is filtered, there are no current exposures to VOC contamination via Well 26.

- Well 38 currently supplies water to a florist business and one residence. The well water is used for showering and washing only.

- Wells 39, 78, and 95 currently supply water to three churches. Well 39 was sampled in September 2007, bottled water was provided, and a filtration system installed. Because the water is filtered, there are no current exposures to VOC contamination via Well 39. Wells 78 and 95 were sampled in October 2007.

- Wells 1, 6A, 37, 51, 58, 69, 89, and 93 currently supply water to residences. Residents are exposed to the well water during activities such as drinking, cooking, hand washing, and washing dishes.

Although people are using the well water from the other 21 wells, no VOC contamination was detected in those wells. ATSDR is focusing our evaluation on the wells with VOC contamination.

Data Quality and Limitations

ATSDR's analyses, conclusions, and recommendations are valid only if the data are complete and reliable. EPA provided groundwater data to ATDSR in electronic form [EPA 2007]. Although ATSDR staff did not receive or review quality assurance/quality control (QA/QC) information, EPA indicated that the sampling data did receive a QA/QC review. As such, ATSDR considers these data adequate for public health evaluation purposes.

ATSDR notes that these limited 2007 sampling data might not be representative of past VOC concentrations in the private wells. Therefore, ATSDR's evaluation of the chemical levels measured during the three sampling events represents only an estimate of chronic exposure conditions.

Discussion

The mission of ATSDR is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease related to toxic substances. For further information regarding the agency, please visit ATSDR's web site at http://www.atsdr.cdc.gov/.

ATSDR provides site-specific public health recommendations on the basis of available toxicologic literature, levels of environmental contaminants detected at a site compared to accepted comparison values, an evaluation of potential exposure pathways, and the characteristics of the exposed population. Whether a person will be harmed by exposure to hazardous substances depends upon several factors, including the type and amount of the contaminant, the manner in which the person was exposed, the duration of the exposure, the amount of the contaminant absorbed by the body, genetic factors, and individual lifestyle factors.

ATSDR's approach to evaluating a potential health concern has two components. The first component involves a screening process that could indicate the need for further analysis of selected contaminants. The second component involves a weight-of-evidence approach that integrates estimates of likely exposure with information about the toxicology and epidemiology of the substances of interest.

Screening is a process of comparing appropriate environmental concentrations and doses to ATSDR or EPA comparison values. These comparison values (CVs) include but are not limited to

- ATSDR's Environmental Media Evaluation Guides (EMEGs),
- ATSDR's Reference Dose Media Evaluation Guides (RMEGs),
- ATSDR's Minimum Risk Levels (MRLs),
- ATSDR's Cancer Risk Evaluation Guidelines (CREGs),
- EPA's Maximum Contaminant Levels (MCLs),
- EPA's Reference Doses (RfDs),
- EPA's Risk-Based Concentrations (RBCs), and
- EPA's Preliminary Remediation Goals (PRGs).

When determining which environmental guideline value to use, ATSDR staff followed the agency's general hierarchy and used professional judgment to select those CVs that best apply to the site conditions [ATSDR 2005a]. For example, some of the CVs and health guidelines used by ATSDR scientists include CREGs, EMEGs, and MRLs. If an ATSDR CV is not available for a particular chemical, ATSDR sometimes screens environmental data with CVs developed by other sources, including EPA's RfDs and EPA's Region III RBCs. These CVs and health guidelines, as well as all other health-based screening criteria, represent conservative levels of safety; they are not thresholds of toxicity. Although concentrations at or below a CV may reasonably be considered safe, concentrations above a CV will not necessarily be harmful. To ensure that they will protect even the most sensitive populations (such as children or the elderly), CVs are intentionally designed to be much lower, usually by two or three orders of magnitude, than the corresponding no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) on which the CVs were based. When a level is above a

comparison value, it does not mean that health effects could be expected—it does, however, represent a point at which further evaluation is warranted.

After identifying potential chemicals of concern through the screening process, ATSDR evaluates a number of parameters depending on the contaminant and site-specific exposure conditions. Such parameters can include biological plausibility, mechanisms of action, cumulative interactions, health outcome data, strength of epidemiological and animal studies, and toxicological and pharmacological characteristics. See Attachment A for more information on ATSDR's CVs and definitions.

For each of the 18 wells and the spring, Table 1 (Attachment B) provides the levels of detected VOCs and Table 2 (Attachment B) provides their respective CVs. The following text outlines ATSDR's public health evaluation. In general, ATSDR considers reducing or minimizing exposures to hazardous chemical contaminants a prudent public health measure.

1,1-Dichloroethane

1,1-Dichloroethane (1,1-DCA) is a colorless, oily liquid with a sweet odor that does not occur naturally in the environment. It evaporates from water rapidly into the air. It was detected in three wells (Wells 16, 22A, and 23) with a maximum concentration of 9.9 micrograms per liter (µg/L). There are no ATSDR or EPA CVs available for 1,1-DCA, but it is considered less toxic than 1,2-dichloroethane.

As stated previously, Well 16 supplies water to the Peachtree Community Center and Wells 22A and 23 supply water to three residences. Because the water is filtered, there are no current exposures to VOC contamination via Wells 16, 22A, and 23. Routes of past exposure are ingestion (drinking), inhalation of vapors (breathing), and dermal contact (skin contact) with the well water.

Overall, very limited information is available about the effects of 1,1-DCA on human health. Some animal studies have shown that it can cause kidney disease after long-term, high-level exposure in the air. 1,1-DCA caused cancer in animals given very high oral doses for a lifetime. Delayed growth was observed in the offspring of animals who breathed high concentrations of 1,1-DCA during pregnancy [ATSDR 1990].

These harmful health effects were observed in animals at very high doses. At this time, there is no information to indicate that these effects occur in humans. The 1,1-DCA levels detected in the wells would result in doses many orders of magnitude below the animal doses that resulted in harmful health effects. Based on the limited 2007 sampling data, past exposures to the levels of 1,1-DCA detected in these three wells are not expected to have harmed exposed residents.

1,1-Dichloroethene

1,1-Dichloroethene (1,1-DCE) is an industrial chemical that is not found naturally in the environment. It is a colorless liquid with a mild, sweet smell. Most 1,1-DCE evaporates quickly. 1,1-DCE was detected in six wells (Wells 16, 22A, 23, 26, 51, and 58). 1,1-DCE was detected above its MCL in one well (Well 23).

Available information indicates that prolonged inhalation of high levels of 1,1-DCE can induce adverse neurological effects and is possibly associated with liver and kidney damage in people. Animals fed food that contained 1,1-DCE developed liver and kidney disease [ATSDR 1994]. At

this time, no firm information exists concerning health effects in people who drink water containing 1,1-DCE.

1,1-DCE concentrations were below all ATSDR and EPA CVs in Wells 16, 22A, 26, 51 and 58, that is, levels considered safe for drinking water. The 1,1-DCE concentration in Well 23 was 8.3 µg/L, which is slightly above EPA's MCL of 7 µg/L. MCLs are the maximum allowable concentration for specific chemicals in public drinking water. MCLs are based partially on the ability of public water systems to detect and remove contaminants, given present technology and resources. ATSDR considers them as a guide because they are considered protective of public health over a lifetime of exposure. The 1,1-DCE concentration detected in Well 23 is below ATSDR's intermediate EMEGs for child and adult exposures. Additionally, because the water is filtered, there are no current exposures to VOC contamination via Well 23. Based on the limited 2007 sampling data, ATSDR determined that harmful noncancer health effects are unlikely to occur from past exposures to Well 23 water.

We do not know whether exposures to 1,1-DCE increase the risk of cancer in people. The U.S. Department of Health and Human Services (DHHS) has not classified 1,1-DCE with respect to carcinogenicity [ATSDR 1994]. The EPA has determined that data for 1,1-DCE are inadequate to assess human carcinogenic potential by the oral route [IRIS 2006]. Several studies examined the possibility that 1,1-DCE may increase the risk of cancer in animals. One of these studies indicated that mice breathing 1,1-DCE for 1 year developed kidney cancer, but the particular type of mouse used may be especially sensitive to 1,1-DCE [ATSDR 1994]. Given the information currently available, ATSDR considers that exposures to 1,1-DCE in water from the six wells are unlikely to result in harmful cancer health effects.

Cis-1,2-Dichloroethene

There are two forms of 1,2-dichloroethene; *cis*-1,2-dichloroethene (*cis*-1,2-DCE) and *trans*-1,2-dichloroethene. DCE is a highly flammable, colorless liquid with a sharp, harsh odor. *Cis*-1,2-DCE was detected in two wells (Wells 16 and 22A). However, the concentrations were below all ATSDR and EPA CVs, that is, levels considered safe for drinking water. Additionally, because the water is filtered, there are no current exposures to VOC contamination via Wells 16 and 22A. Based on the limited 2007 sampling data, past exposures to the levels of *cis*-1,2-DCE detected in these two wells are not expected to cause harmful health effects.

1,1,1-Trichloroethane

1,1,1-Trichloroethane (TCA) is a synthetic chemical that does not occur naturally in the environment. Although TCA was detected in two wells (Wells 23 and 26), its concentrations were below all ATSDR and EPA CVs, that is, levels considered safe for drinking water. Additionally, because the water is filtered, there are no current exposures to VOC contamination via Well 23. Based on the limited 2007 sampling data, exposures to the levels of TCA detected in these wells are not expected to cause harmful health effects.

Tetrachloroethene

Tetrachloroethene (PCE) is a nonflammable liquid at room temperature. It evaporates easily into the air and has a sharp, sweet odor. PCE was detected in seven wells (Wells 16, 18A, 22A, 26, 38, 39, and 78) with a maximum concentration of 56 µg/L. It was above its MCL of 5 µg/L in one well (Well 18A).

When in high concentrations in closed and poorly ventilated areas, PCE can cause dizziness, headache, sleepiness, confusion, nausea, and other adverse effects. The health effects of breathing air or drinking water with low levels of PCE are not known. Animal studies using much greater amounts than those to which most people are exposed, show that PCE can cause liver and kidney damage. The relevance of these animal studies to people is unclear [ATSDR 1997a].

As stated previously, the PCE concentration in Well 18A is above EPA's MCL. However, PCE concentrations in all seven wells, including Well 18A, are below ATSDR's RMEGs for children and adults. Concentrations below ATSDR's RMEGs are unlikely to be associated with noncancer effects over a lifetime of exposure. In addition, because the water is filtered, there are no current exposures to VOC contamination via Wells 16, 18A, 22A, and 39. ATSDR considers that exposures to the levels of PCE detected in these wells are unlikely to result in harmful noncancer health effects.

DHHS has determined that PCE may reasonably be anticipated to be a human carcinogen. High-dose animal studies show that long-term exposure to PCE causes liver cancer in mice and monocellular leukemia and kidney cancers in rats [ATSDR 1997a]. However, humans may respond to PCE differently than mice and rats. Given presently available information, ATSDR considers that exposures to PCE in water from the seven wells are unlikely to result in harmful cancer health effects.

Trichloroethene

Trichloroethene (TCE) is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and a sweet, burning taste. TCE was detected in three wells (Wells 16, 22A, and 26). It was detected above its MCL of 5 µg/L in two wells (Wells 16 and 22A).

TCE was detected in Well 16 at 13 µg/L. In Well 22A, TCE was detected in August and September samples at 180 µg/L and 150 µg/L, respectively. Estimated daily doses to the maximum TCE level detected (180 µg/L) for children and adults are 0.018 milligrams per kilogram per day (mg/kg/day) and 0.005 mg/kg/day, respectively. With the exception of potential developmental effects, the known less serious LOAELs are at least 37 mg/kg/day or higher [ATSDR 1997b], which is more than 2,000 times higher than the estimated site-specific child and adult daily doses. Additionally, because bottled water was provided and then carbon filters were installed, there are no current exposures to TCE contamination via Wells 16, 22A and 26. Again, with the exception of potential developmental effects, ATSDR considers that past exposures to the levels of TCE detected in these wells are unlikely to result in harmful noncancer health effects.

With regard to developmental effects, some epidemiologic studies of persons exposed to TCE in drinking water provide limited support that TCE is a developmental toxicant [ATSDR 1997b, ATSDR 1998a]. At this time, there is ongoing scientific inquiry because available epidemiologic data do not provide firm conclusions on the TCE dose-response relationship. There are limitations in the available studies (such as, information is lacking with regard to exposure levels and durations of exposure, and interpretation is limited in some cases by small sample size). Overall, the body of evidence suggests that the levels found in Well 22A (150 µg/L and 180 µg/L) could be of potential public health concern for developmental effects following chronic exposure. ATSDR cannot fully evaluate the potential for adverse developmental health effects

(1) because past TCE levels in the well water are not fully characterized, and (2) because available experimental and epidemiologic data do not provide firm conclusions on the dose-response relationship at this time.

ATSDR's Toxicological Profile for Trichloroethylene concluded that "The link between trichloroethylene and the incidence of cancer in humans is controversial" [ATSDR 1997b]. Although several studies have reported an association between exposure to TCE in drinking water and cancer, the conclusions of these studies are limited by inadequate characterization of exposure, small cohort size, exposure to multiple contaminants, and other confounding factors. As part of the National Exposure Subregistry, ATSDR compiled data on 4,280 residents of three states (Michigan, Illinois, and Indiana) who had environmental exposure to TCE. An increase of respiratory cancer was noted in older men, but this was thought to result from smoking rather than TCE exposure. A study in New Jersey found an association between leukemia in women and exposure to TCE in the drinking water. A study in Massachusetts found that exposure was associated with leukemia in children. Overall, though, ATSDR found no definitive evidence for an excess of cancers from TCE exposure [ATSDR 1997b]. Given the information presently available, ATSDR considers that past exposures to TCE in water from Wells 16, 22A and 26 are unlikely to result in harmful cancer health effects.

Vinyl Chloride

Vinyl chloride is a colorless gas that is manufactured. It also can be formed in the environment when other manufactured substances, such as TCE, TCA, and PCE, are broken down by certain microorganisms. Breathing high levels of vinyl chloride can cause dizziness. Studies in animals show that extremely high levels of vinyl chloride can damage the liver, lungs, and kidneys. These levels also can damage the heart and prevent blood clotting [ATSDR 2006].

Vinyl chloride was detected in one well (Well 22A) with estimated values of 0.22 µg/L and 0.20 µg/L for August and September, respectively. These values are below ATSDR's EMEGs for children and adults. Concentrations below ATSDR's EMEGs are unlikely to be associated with noncancer effects over a lifetime of exposure. Additionally, because the water is filtered, there are no current exposures to VOC contamination via Well 22A. Based on the limited 2007 sampling data, ATSDR considers that past exposures to vinyl chloride in water from the well are unlikely to result in harmful noncancer health effects.

DHHS has determined that vinyl chloride is a known carcinogen. The International Agency for Research on Cancer has determined that vinyl chloride is carcinogenic to people, and EPA has determined that vinyl chloride is a human carcinogen. There are no drinking water studies of vinyl chloride exposure in humans [ATSDR 2006]. In particular, there is no evidence that vinyl chloride in drinking water, at doses that are achievable outside the laboratory, can cause cancer in humans via the oral route. However, at sufficiently high oral doses, vinyl chloride does cause hepatic angiosarcoma in animals. The lowest recorded cancer effect level (CEL) in laboratory animals exposed orally to vinyl chloride in oil is 300 micrograms per kilogram per day (µg/kg/day) for liver angiosarcoma in Sprague-Dawley rats treated by gavage 5 times a week for a year, i.e., one-third to one-half the animals' lifetime [ATSDR 2006]. In humans, this dose would be numerically (if not biologically) equivalent to 10,500 µg/L in drinking water for an average 70-kilogram (kg) adult drinking 2 liters per day (L/Day), or 3,000 µg/L for a 10-kg child drinking 1 L/day, for several decades. These levels are many times higher than the level of vinyl chloride in the well. Based on the limited 2007 sampling data, it is unlikely that the levels of

vinyl chloride detected in the well would have been high enough to produce cancer health effects.

Freon 113

Freon 113 is also called trichlorotrifluorethane. It is a colorless liquid used as cleaning solvent, as a refrigerant in air conditioning, and as an intermediate in some industrial processes. EPA established an oral reference dose of 30 mg/kg/day [EPA 1994]. ATSDR has RMEGs for child and adult exposures at 300,000 µg/L and 1,000,000 µg/L, respectively. Freon 113 was detected in three wells (Wells 16, 22A and 26) with a maximum concentration of 9.0 µg/L. The levels from all three wells are well below the CVs. Additionally, because the water is filtered, there are no current exposures to VOC contamination via Wells 16, 22A, and 26. Based on the limited 2007 sampling data, ATSDR considers that past exposures to Freon 113 in water from these wells are unlikely to result in adverse health effects.

2-Butanone

2-Butanone is a manufactured chemical but it is also present in the environment from natural sources. It is a colorless liquid with a sharp, sweet odor. It is also known as methyl ethyl ketone (MEK). The known health effects to people from exposure to 2-butanone are irritation of the nose, throat, skin, and eyes. Serious health effects in animals have been seen only at very high levels. When breathed, these effects included birth defects, loss of consciousness, and death. When swallowed, rats had nervous system effects including drooping eyelids and uncoordinated muscle movements [ATSDR 1992].

MEK was detected in Well 22B at 120 µg/L and Well 38 at 1.1 µg/L. These levels are much lower than ATSDR's RMEGs for child and adult exposures of 6,000 µg/L and 20,000 µg/L, respectively. Based on the limited 2007 sampling data, ATSDR considers that exposures to MEK in water from these wells are unlikely to result in adverse health effects.

Methyl Tert-Butyl Ether (MTBE)

MTBE is the common name for a synthetic chemical called methyl tert-butyl ether, a flammable liquid made from combinations of chemicals like isobutylene and methanol. It has a distinctive odor that most people find disagreeable. Although MTBE was detected in four wells (Wells 18A 37, 89, and 95B), its concentrations were below all ATSDR and EPA CVs, that is, levels considered safe for drinking water. Additionally, because the water is filtered, there are no current exposures to VOC contamination via Well 18A. Based on the limited 2007 sampling data, the levels of MTBE detected in all four wells are not expected to cause harmful health effects in exposed residents.

Toluene

Toluene is a clear, colorless liquid with a distinctive smell. Toluene occurs naturally in crude oil and in the tolu tree. Toluene is used in making paints, paint thinners, fingernail polish, lacquers, adhesives, and rubber and in some printing and leather tanning processes. Exposure to high concentrations of toluene can cause headaches, confusion, and memory loss. The ATSDR chronic EMEGs for child and adult exposures are 200 µg/L and 700 µg/L, respectively [ATSDR 2000].

Toluene was detected in Well 1 at 0.64 µg/L and Well 69 at 0.46 µg/L. The concentrations were below all ATSDR and EPA CVs, that is, levels considered safe for drinking water. Based on the limited 2007 sampling data, the levels of toluene detected in these two wells are not expected to cause harmful health effects in currently exposed residents.

Carbon Disulfide

Pure carbon disulfide is a colorless liquid with a pleasant odor that smells sweet. The impure carbon disulfide that is usually used in most industrial processes, however, is a yellowish liquid with an unpleasant odor like that of rotting radishes [ATSDR 1996].

Carbon disulfide was detected in Well 38 at 0.49 µg/L. This level is much lower than ATSDR's RMEGs for child and adult exposures of 1,000 and 4,000 µg/L, respectively. Based on the limited 2007 sampling data, ATSDR considers that exposures to carbon disulfide in water from this well are unlikely to result in adverse health effects.

Chloromethane

Chloromethane (also known as methyl chloride) is a clear, colorless gas. If the levels are high enough (over a million times the natural levels in outside air), even brief exposures to chloromethane can have serious effects on a person's nervous system, including convulsions, coma, and death [ATSDR 1998b].

Chloromethane was detected in Well 51 at 0.14 µg/L, which is below the EPA's lifetime health advisory (LTHA) of 30 µg/L. The LTHA is the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure. Based on the limited 2007 sampling data, ATSDR considers that exposures to chloromethane in water from this well are unlikely to result in adverse health effects.

Trihalomethanes (THMs)

THMs are formed in drinking water as chlorination disinfection byproducts. Chloroform is the most common chlorination byproduct and makes up approximately 90 percent of the mass of total THMs (TTHMs). Other THMs include bromodichloromethane, bromoform, and dibromochloromethane. EPA established a single MCL for TTHMs of 80 µg/L. The MCL is a legally enforceable standard established to protect against possible cancer, liver and kidney effects that could result from exposure to drinking water THMs.

Chloroform was detected in Wells 1, 23, 6A, 36, 89 and 95B with a maximum concentration of 17 µg/L. In Well 36, bromodichloromethane and dibromochloromethane were detected at 1.9 µg/L and 0.32 µg/L, respectively. The total THM concentrations in each well sample are below the MCL and their respective ATSDR EMEGs [ATSDR 1997c; ATSDR 1989; ATSDR 2005b]. Based on the limited 2007 sampling data, exposures are not expected to result in adverse noncancer health effects in the community.

In recent years, health concerns regarding exposures to THMs and other chlorination disinfection byproducts have been broadened to include cancer as well as adverse birth outcomes. Those epidemiological studies provided suggestive but not conclusive evidence of an association between multi-route drinking water exposures (i.e., ingestion, inhalation and dermal exposures) to a mixture of disinfection byproducts including THMs and adverse birth outcomes. There were, however, uncertainties in low-dose exposures to THMs and other disinfection byproducts,

maternal and prenatal pharmacokinetics, accurate exposure doses, and the level of maternal exposure at which adverse developmental or reproductive effects will occur [Graves et al. 2001]. Although bromodichloromethane and dibromochloromethane levels in Well 36 were above their respective ATSDR CREGs [ATSDR 1989; ATSDR 2005b], the well was mostly dry and is currently inactive. Based on the limited 2007 sampling data, exposures to these levels of THMs are not expected to result in any adverse cancer health effects.

Child Health Considerations

Children could be at greater risk than adults are after certain kinds of exposure to hazardous substances. A child's lower body weight results in a greater dose of hazardous substance per unit of body weight. Children also are more active and have higher heart and respiratory rates, causing them to have higher peak and mean exposures. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Based on the limited 2007 sampling data, ATSDR considers that exposures to VOC-contaminated groundwater would not be likely to result in harmful health effects in children, with the possible exception of TCE (see Discussion section).

Conclusions

EPA asked ATSDR *to provide a public health evaluation of the VOC levels detected in private wells in Murphy, North Carolina*. VOCs were detected in 18 area wells and one spring. Based on the limited 2007 sampling data, ATSDR concludes that exposures to the VOC levels detected in private well water are unlikely to result in any adverse noncancer or cancer health effects in area residents, with the possible exception of TCE. Past exposures to the highest detected concentrations of TCE in water may pose a health concern. However, the risk cannot be accurately assessed because of incomplete information on the length and extent of exposure and uncertainty in the dose-response relationship for TCE toxicity. Therefore, past exposures to TCE in drinking water are characterized as an indeterminate public health hazard. Because of recent actions (i.e., bottled water and carbon filters), there are no current exposures to elevated VOC levels through the use of private wells; therefore, current exposures are categorized as presenting no apparent public health hazard. In general, ATSDR considers reducing or minimizing exposures to hazardous chemical contaminants a prudent public health measure.

Recommendations

1. Actions taken to reduce exposures to VOC-contaminated groundwater should continue.
2. Installed filters should be adequately maintained.
3. Monitoring potentially affected wells should continue, with filters added when VOC concentrations exceed MCLs.
4. A more permanent, long-term remedy for well users should be sought (i.e., public water line extension).

Public Health Action Plan

The purpose of the public health action plan is to ensure that this evaluation not only identifies potential and ongoing public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. ATSDR will mail this health consultation to the appropriate personnel at EPA to ensure that they are aware of ATSDR's public health conclusions and recommendations.

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Attachment A. ATSDR's comparison values and definitions

ATSDR comparison values (CVs) are media-specific concentrations considered safe under default exposure scenarios. ATSDR uses them as screening values to identify contaminants (site-specific substances) that require further evaluation to determine the potential for adverse health effects.

Generally, a chemical at a site requires further evaluation when its maximum concentration in air, water, or soil exceeds one of ATSDR's comparison values. Comparison values are not, however, thresholds of toxicity. While concentrations at or below the relevant comparison value may reasonably be considered safe, it does not automatically follow that any environmental concentration that exceeds a comparison value would be expected to produce adverse health effects. Indeed, the purpose behind these highly conservative, health-based standards and guidelines is to enable health professionals to recognize and resolve potential public health problems before they become actual health hazards. The probability that adverse health outcomes will actually occur as a result of exposure to environmental contaminants depends on individual lifestyles and genetic factors and site-specific conditions that affect the route, magnitude, and duration of actual exposure, and not on environmental concentrations alone.

ATSDR derives CVs on the basis of noncancerous effects from NOAELs (no-observed-adverse-effect-levels) and LOAELs (lowest-observed-adverse-effect-levels). The NOAELS and LOAELs stem from animal or human studies. CVs are intentionally designed to be much lower than the corresponding NOAELs or LOAELs by incorporating cumulative safety margins (variously called safety factors, uncertainty factors, or modifying factors) that typically range from 10 to 1,000 or more.

By contrast, cancer-based screening values come from linear extrapolations from animal data obtained at high doses because human cancer incidence data for very low levels of exposure simply do not exist, and probably never will.

Listed below are the CVs that ATSDR uses to select chemicals for further evaluation, along with the abbreviations for the most common units of measure.

EMEG = environmental media evaluation guide

RMEG = reference dose media evaluation guide

MRL = minimal risk level

ppm = parts per million, e.g., mg/L or mg/kg

ppb = parts per billion, e.g., μg/L or μg/kg

kg = kilogram (1,000 gram)

mg = milligram (0.001 gram)

μg = microgram (0.000001 gram)

L = liter

m^3 = cubic meter (= 1,000 liters)

acute exposure: exposure to a chemical for a duration of 14 days or less.

cancer risk evaluation guide (CREG): estimated contaminant concentration in water, soil, or air that would be expected to cause no more than one excess case of cancer in a million persons exposed over a lifetime. CREGs are calculated from EPA's cancer slope factors.

chronic exposure: exposure to a chemical for 365 days or more.

environmental media evaluation guide (EMEG): concentration of a contaminant in water, soil, or air unlikely to produce any appreciable risk of adverse, non-cancer effects over a specified duration of exposure. EMEGs are derived from ATSDR minimal risk levels by factoring in default body weights and ingestion rates. ATSDR computes separate EMEGs for acute (≤14 days), intermediate (15–364 days), and chronic (>365 days) exposures.

intermediate exposure: exposure to a chemical for a duration of 15–364 days.

lowest-observed-adverse-effect-level (LOAEL): The lowest exposure level of a chemical in a study or group of studies that produces statistically or biologically significant increase(s) in frequency or severity of adverse health effects between the exposed and control populations.

minimal risk level (MRL): estimate of daily human exposure to a hazardous substance that is not likely to pose an appreciable risk of adverse noncancer health effects over a specified route and duration of exposure.

no-observed-adverse-effect-level (NOAEL): The dose of a chemical at which no statistically or biologically significant increases in frequency or severity of adverse health effects were seen between the exposed population and its appropriate control**.** Effects may be produced at this dose, but they are not considered to be adverse.

uncertainty factor (UF): a factor used in deriving the MRL or reference dose or reference concentration from exposure data.

Attachment B. Table 1 - Summary of Groundwater Data, 2007. Clifton Precision/Litton System, Murphy, NC

		Summary of Detected Volatile Organic Compounds (µg/L)								
Well Code	**Sample Date**	**1,1-DCA**	**1,1-DCE**	**cis-1,2-DCE**	**1,1,1-TCA**	**PCE**	**TCE**	**Vinyl Chloride**	**Freon-113**	**2-Butanone**
1	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
5	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
9	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
15	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
16	8/30/2007	<1.0	**0.19 J**	**0.40 J**	<1.0	**0.33 J**	**4.2**	<1.0	**2.5**	<5.0
	9/21/2007	**0.57 J**	**0.60 J**	**1.2**	<1.0	**0.80 J**	**13**	<1.0	**9.0**	<5.0
17	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
18A	8/30/2007	<2.0	<2.0	<2.0	<2.0	**56**	<2.0	<2.0	<2.0	<10.0
	9/21/2007	<3.0	<3.0	<3.0	<3.0	**54**	<3.0	<3.0	<3.0	<15
22A	8/30/2007	**9.9**	**3.5**	**24**	<1.0	**2**	**180**	**0.22 J**	**0.45 J**	<5.0
	9/21/2007	**9.3**	**2.7**	**21**	<1.0	**1.1**	**150**	**0.20 J**	**0.31 J**	<5.0
22B	8/30/2007	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	**120**
23	9/21/2007	**4.4**	**8.3**	<1.0	**0.64 J**	<1.0	<1.0	<1.0	<1.0	<5.0
6A	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
26	8/31/2007	<1.0	**0.85 J**	<1.0	<1.0	**0.40 J**	**1.5**	<1.0	**1.5**	<5.0
	9/20/2007	<1.0	**0.83 J**	<1.0	**0.33 J**	**0.42 J**	**1.5**	<1.0	**1.7**	<5.0
28 A	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
28 B	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
31	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
32	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
34	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
33	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
36	9/21/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
37	9/21/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
38	9/20/2007	<1.0	<1.0	<1.0	<1.0	**0.19 J**	<1.0	<1.0	<1.0	**1.1 J**
	10/11/2007	<1.0	<1.0	<1.0	<1.0	**0.22 J**	<1.0	<1.0	<1.0	<5.0
39	9/21/2007	<1.0	<1.0	<1.0	<1.0	**3.1**	<1.0	<1.0	<1.0	<5.0
	10/11/2007	<1.0	<1.0	<1.0	<1.0	**3.0**	<1.0	<1.0	<1.0	<5.0
44	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
51	10/10/2007	<1.0	**0.50 J**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
56	10/9/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
58	10/10/2007	<1.0	**0.64 J**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
59	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
61	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
67	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
69	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
78	10/11/2007	<1.0	<1.0	<1.0	<1.0	**0.30 J**	<1.0	<1.0	<1.0	<5.0
80	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
81	10/9/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
85	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
87	10/9/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
88	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
89	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
93	10/9/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
95A	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
95B	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
100	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
101	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0

Note: Bolded values indicate detections of a chemical.

DCA Dichloroethane
DCE Dichloroethene
PCE Tetrachloroethene
TCA Trichloroethane
TCE Trichlorothene
J estimated value, result is below the reporting limit
< less than the reporting limit shown
µg/L micrograms per liter

Attachment B. Table 1 - Summary of Groundwater Data, 2007. Clifton Precision/Litton System, Murphy, NC (continued)

		Summary of Detected Volatile Organic Compounds (µg/L)						
Well Code	**Sample Date**	**MTBE**	**Chloroform**	**Toluene**	**Carbon Disulfide**	**Bromo dichloro-methane**	**Dibromo chloro-methane**	**Chloromethane**
1	8/30/2007	<1.0	**0.32 J**	**0.64 J**	<1.0	<1.0	<1.0	<1.0
5	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
9	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
15	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
16	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	9/21/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
17	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
18A	8/30/2007	**24**	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	9/21/2007	**28**	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
22A	8/30/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	9/21/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
22B	8/30/2007	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
23	9/21/2007	<1.0	**14**	<1.0	<1.0	<1.0	<1.0	<1.0
6A	8/30/2007	<1.0	**0.11 J**	<1.0	<1.0	<1.0	<1.0	<1.0
26	8/31/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
28 A	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
28 B	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
31	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
32	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
34	9/20/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
33	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
36	9/21/2007	<1.0	**17**	<1.0	<1.0	**1.9**	**0.32J**	<1.0
37	9/21/2007	**1.0**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
38	9/20/2007	<1.0	<1.0	<1.0	**0.49 J**	<1.0	<1.0	<1.0
	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
39	9/21/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
44	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
51	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**0.14 J**
56	10/9/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
58	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
59	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
61	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
67	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
69	10/12/2007	<1.0	<1.0	**0.46 J**	<1.0	<1.0	<1.0	<1.0
78	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
80	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
81	10/9/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
85	10/10/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
87	10/9/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
88	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
89	10/11/2007	**1.1**	**2.6**	<1.0	<1.0	<1.0	<1.0	<1.0
93	10/9/2007	**0.93 J**	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
95A	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
95B	10/12/2007	<1.0	**0.11 J**	<1.0	<1.0	<1.0	<1.0	<1.0
100	10/11/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
101	10/12/2007	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Note: Bolded values indicate detections of a chemical.

MTBE Methyl tert-butyl ether

J estimated value, result is below the reporting limit

< less than the reporting limit shown

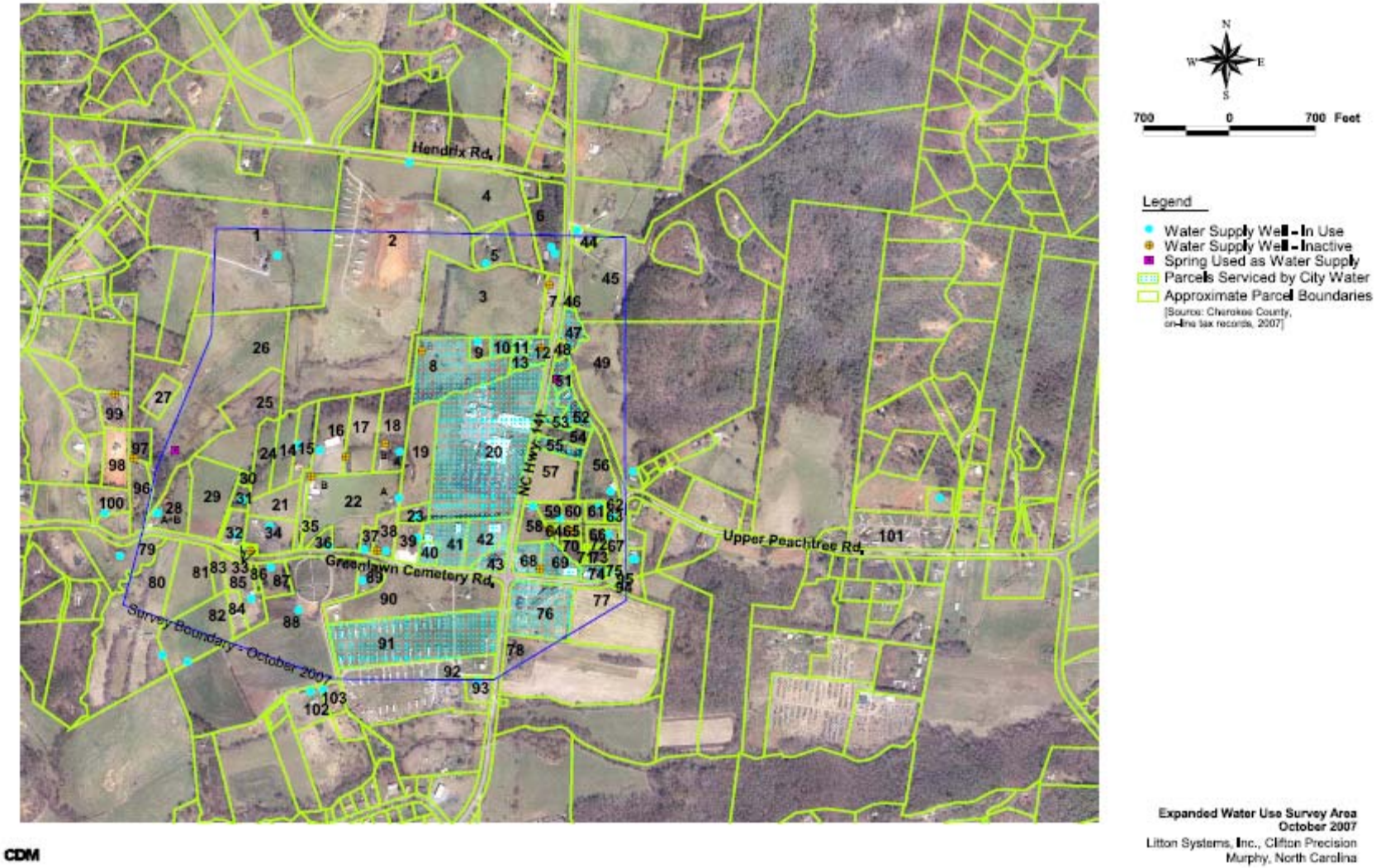
µg/L micrograms per liter

Attachment B. Table 2 - Comparison Values (μg/L)

Chemical	CV	Type of CV	CV	Type of CV	CV	Type of CV
1,1-Dichloroethane	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	90	i-EMEG (child)	300	i-EMEG (adult)	7	MCL
cis-1,2-dichloroethene	3,000	c-EMEG (child)	10,000	c-EMEG (adult)	70	MCL
1,1,1-Trichloroethane	200,000	i-EMEG (child)	700,000	i-EMEG (adult)	200	MCL
Tetrachloroethene	100	RMEG (child)	400	RMEG (adult)	5	MCL
Trichloroethylene	NA	NA	NA	NA	5	MCL
Vinyl chloride	30	c-EMEG (child)	100	c-EMEG (adult)	2	MCL
Freon 113	300,000	RMEG (child)	1000,000	RMEG (adult)	59,000	RBC
2-Butanone	6,000	RMEG (child)	20,000	RMEG (adult)	7,000	RBC
Methyl *tert*-butyl ether	3,000	RMEG (child)	10,000	RMEG (adult)	2.6	RBC
Toluene	200	c-EMEG (child)	700	c-EMEG (adult)	1,000	MCL
Carbon disulfide	1,000	RMEG (child)	4,000	RMEG (adult)	1,000	RBC
Chloromethane	NA	NA	NA	NA	30	LTHA
Chloroform	100	c-EMEG (child)	400	c-EMEG (adult)	80	MCL
Bromodichloromethane	200	c-EMEG (child)	700	c-EMEG (adult)	80	MCL
Dibromochloromethane	900	c-EMEG (child)	3,000	c-EMEG (adult)	80	MCL

CV	comparison value
NA	not available
i-EMEG	ATSDR's Intermediate Environmental Media Evaluation Guide
c-EMEG	ATSDR's Chronic Environmental Media Evaluation Guide
LTHA	EPA's Lifetime Health Advisory for drinking water
MCL	EPA's Maximum Contamination Level
RBC	EPA's Risk-Based Concentration
RMEG	ATSDR's Reference Dose Media Evaluation Guide
μg/L	micrograms per liter

Attachment 3. Figure 1 - Well Location Map*



* Image from reference EPA 2007.