Health Consultation

MORRILL MOTORS INC.

ROCKY FORK, UNICOI COUNTY, TENNESSEE

EPA FACILITY ID: TND987767704

Prepared by the
Tennessee Department of Health

SEPTEMBER 10, 2009

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

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

You May Contact ATSDR Toll Free at
1-800-CDC-INFO
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

MORRILL MOTORS INC.

ROCKY FORK, UNICOI COUNTY, TENNESSEE

EPA FACILITY ID: TND987767704

Prepared By:

Tennessee Department of Health
Under a cooperative agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Foreword

This document summarizes an environmental public health investigation performed by Environmental Epidemiology of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people could be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. Reducing or eliminating the health hazard will prevent possible harmful health effects. The role of Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be actions items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

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

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

Table of Contents

Introduction

The Morrill Motors Inc. plant (the plant) is located at 281 Jennie Moore Road (off Old Ashville Highway) in Rocky Fork, Unicoi County, Tennessee, 38501. The plant is located in the relatively narrow South Indian Creek valley. The Morrill plant is registered with the Tennessee Department of Environment and Conservation (TDEC) Division of Remediation (DoR) as Superfund Site No. 86-505 and Tennessee Hazardous Waste Site No. TND987767704. Manufacturing began at the Morrill plant in 1962 and ceased in approximately 2005. The plant was used to manufacture fractional horsepower electric motors, pumps, fan blades, and motor mountings. The Morrill Motors site is owned by Morrill Motors of Erwin, TN, and is now used as a warehouse for the company.

The plant used 1,1,1-trichloroethane (1,1,1-TCA) as a solvent to remove grease from parts and as a cleaner for the plant's septic system. As early as November 1969, volatile organic chemicals (VOCs) were reported in a water well used to supply water to the plant for operations and drinking. A small community of single-family homes is present downgradient from the plant (Figure 1). Many homes in the community have private water supply wells that were previously used as their source of drinking water. Some of the homes use springs as their household water supply. VOCs have been found in some of the wells that formerly supplied these homes. Homes in the valley contain VOCs while homes on the sides of the valley do not. Most of the homes closer to the plant in the valley have water supplied by a water supply well owned by Morrill. The water is treated through activated carbon treatment before being supplied to the homes. This treatment is monitored by Morrill.

Environmental investigations and remedial efforts have been conducted at, and downgradient from, the plant since the late 1980s. Regularly scheduled groundwater monitoring is conducted and includes former plant water supply wells and the wells at homes downgradient from the former plant. The three main VOCs present in groundwater both upgradient and downgradient from the plant include 1,1,1-TCA, 1,1-dichloroethane, and 1,1-dichloroethene.

As part of a future Record of Decision (ROD) between Morrill and TDEC, a groundwater use restriction is planned for the plant property.

Purpose

The Tennessee Department of Health's (TDH) Environmental Epidemiology Program (EEP) was contacted on October 4, 2008, by TDEC DoR, to evaluate the results of a recent groundwater sampling event conducted in the general area of the site. 1,1,1-trichloroethane, 1,1-dichloroethane, and 1,1-dichloroethene have been found in low concentrations in nearly all the residential wells downgradient from the plant during the many years of regular groundwater monitoring.

Recent monitoring at the most downgradient home (House A - Figure 1) indicated concentrations of one VOC, 1,1-dichloroethene, above its U.S. Environmental Protection Agency (EPA) Primary Drinking Water Maximum Contaminant Level (MCL). An elderly person occupies House A and uses the well as their source of drinking water. The water is also used for other

household purposes such as cooking, bathing, and washing clothes. TDEC is committed to ensuring that this person has a source of safe potable water and that the person is not being adversely affected by vapor from the use of the water. TDEC requested that EEP evaluate the health hazard from drinking water containing 1,1-DCE at the most downgradient residence from the former plant.

Background

The plant was housed in a one story brick and concrete block building that formerly housed a public school. Morrill Motors began operations at the former school building in 1962. The plant is located in a valley along a rural section of a main highway. The plant operated three water supply wells and used septic systems to manage wastes. South Indian Creek flows from the south to the northeast through the valley and alongside the plant site. There are several small single-family homes in the community surrounding the plant and near Rocky Fork. Rocky Fork is a residential community consisting of approximately 25 individuals in the South Indian Creek valley. Most homeowners in the community near the former plant have their own groundwater well that was previously used as their household water source. There is no public water supply in the valley. Since early in the course of environmental investigations at the Morrill site, water from the upgradient Morrill water supply well has been treated and supplied to homes downgradient and close to the former Morrill plant. One home uses a nearby spring as its water source. This spring is located at a much higher elevation than the plant or homes downgradient. At least one home that has its own downgradient well is vacant.

The earliest indication of groundwater contamination at the site was from a groundwater sample collected from one of the plant water supply wells by the Unicoi County Health Department in November 1969. Some VOCs were present in the sample (Marshall Miller & Associates 1996). As was common during the 1960s and early 1970s, chemicals were disposed of on the ground and into the septic system. Additionally, 1,1,1-TCA was reportedly used as a septic tank treatment chemical at the site during this time (John Lilly, TDEC, personal communication). VOCs were re-discovered in late 1988. Active investigation and remedial activities began shortly thereafter. The solvent 1,1,1-TCA, and its breakdown chemicals, 1,1-dichloroethane (1,1-DCA) and 1,1-dichlroethene (1,1-DCE), were the main VOCs identified in groundwater at the site. These same chemicals were later identified in drinking water wells downgradient from the plant site.

Groundwater monitoring of former plant water supply wells, groundwater monitoring wells, and six former and 1 current homeowner drinking water wells (Figure 1) has been performed at the site since the discovery of 1,1,1-TCA, 1,1-DCA, and 1,1-DCE in the late 1980s and early 1990s. The homeowners' well locations are shown on Figure 1. One residence historically monitored in the road loop is now vacant and therefore is temporarily suspended from the monitoring program.

In 1990, a groundwater pump and treat system was installed in select plant water supply wells near the plant to contain the contaminant plume and prevent further downgradient migration. TDEC issued a Consent Order to Morrill on June 5, 1991, to investigate and clean up the site and to identify potentially affected populations and environments (Marshall Miller and Associates

1996). Various reports were generated as part of the TDEC Consent Order. Subsequent investigations found that site soils were not affected by the contamination. Stream water in South Indian Creek was also not affected. Beginning in 1991, water for the plant which was obtained from an upgradient water supply well, was treated with granular activated carbon. Also in 1991 alternative water supplies for residents downgradient of the site were installed. This alternative water supply is treated water from the former Morrill plant production well.
As the groundwater pump and treat operations began in 1990 and had been operating for 5 years, an experiment was tried allowing the pump and treat operation to cease at the end of March 1995. After extensive groundwater sampling during the time from April 1995 to March 1996 showed VOC concentrations increasing, TDEC required the groundwater pumping to resume in April 1996. Pumping was allowed by TDEC to cease again in 2000. In November 2003, an innovative program consisting of monthly injections of molasses and sodium bicarbonate was initiated to stimulate biological degradation of the VOCs (Marshall Miller & Associates 2008).

As part of the remedial effectiveness monitoring at the plant, groundwater samples are collected quarterly (Marshall Miller & Associates 2008). The September 2008 groundwater sampling revealed an increase in 1,1-DCE in the farthest monitored downgradient residential water supply well (House A - Figure 1). The water from the House A well is used by an elderly homeowner for drinking, washing, and other purposes. The House A well also contains low concentrations of 1,1,1-TCA and 1,1-DCA. From April 1998 through June 2008, the amount of 1,1-DCE in the House A well ranged from non-detect to 6.7 parts per billion (ppb). The U.S. Environmental Protection Agency (EPA) primary drinking water maximum contaminant level (MCL) for 1,1-DCE is 7 ppb. The September 2008 sampling result showed 1,1-DCE at a concentration of 8.0 ppb. Because this concentration of 1,1-DCE is above its MCL in the House A well, TDEC requested a review of the possible health effects of drinking water containing 1,1-DCE for the homeowner.

The House A well was re-sampled in October 2008 to verify the September sampling concentration. 1,1-DCE was detected in the October 2008 sample at 11.5 ppb. This concentration remains above the MCL for 1,1-DCE.

Other homeowners having wells downgradient from the plant (those in the road loop in Figure 1) also have all or some of the three main site-related chemicals in their well water. Since 1991 Morrill has supplied treated water for household purposes to these homes. Water from the private water wells downgradient from the site is used for car washing and gardening activities and not for drinking water, cooking, or bathing.

One downgradient home with a water well has the highest concentrations of site-related chemicals. This home is not occupied. When it was occupied, the well at the home had a whole-house filter installed for nearly 3 years to evaluate the effectiveness of this type of water treatment system. This whole-house filter has since been removed and reinstalled on a well at a nearby home. The well at the home that now has the whole-house filter also supplies water to an adjacent home, so two homeowners are getting the benefit of one whole-house filter. As mentioned above water from this well is used for purposes other than drinking, bathing, or cooking, as treated water for drinking is supplied by Morrill Motors. A spring supplies water to one home near the plant. This spring has not been sampled and tested by TDEC or the

responsible party as the spring is reportedly located on a ridge and is at a higher in elevation than the plant and other downgradient homes.

Discussion

Introduction to Chemical Exposure

To determine whether persons have been or are likely to be exposed to chemicals, TDH EEP evaluates mechanisms that could lead to human exposure. An exposure pathway contains five parts:

- a source of contamination
- contaminant transport through an environmental medium
- a point of exposure
- a route of human exposure, and
- a receptor population.

An exposure pathway is considered complete if there is evidence that all five of these elements are, have been, or will be present at the site. A pathway is considered potential if there is a lower probability of exposure. If there is no evidence that at least one of the five elements listed is, has been, or will be present at the site, then it is considered an incomplete exposure pathway. For this site, there is a completed exposure pathway for the ingestion of groundwater contaminated with VOCs. It is unknown if there is a pathway for inhalation of VOCs from the use of groundwater for cooking or showering.

Physical contact alone with a potentially harmful chemical in the environment by itself does not necessarily mean that a person will develop adverse health effects. A chemical's ability to affect public health is controlled by a number of factors, including:

- the amount of the chemical that a person is exposed to (dose)
- the length of time that a person is exposed to the chemical (duration)
- the number of times a person is exposed to the chemical (frequency)
- the person's age and health status, and
- the person's diet and nutritional habits.

The purpose of this public health consultation is to examine any potential health hazard from VOCs present in a residential water supply well downgradient from the plant. To evaluate exposure to a hazardous substance, health assessors often use health comparison values. If the chemical concentrations are below the comparison value, then health assessors can be reasonably certain that no adverse health effects will occur in people who might be exposed. If concentrations are above the comparison values for a particular chemical (ATSDR 2007a, 2008), then further evaluation of that chemical is in order.

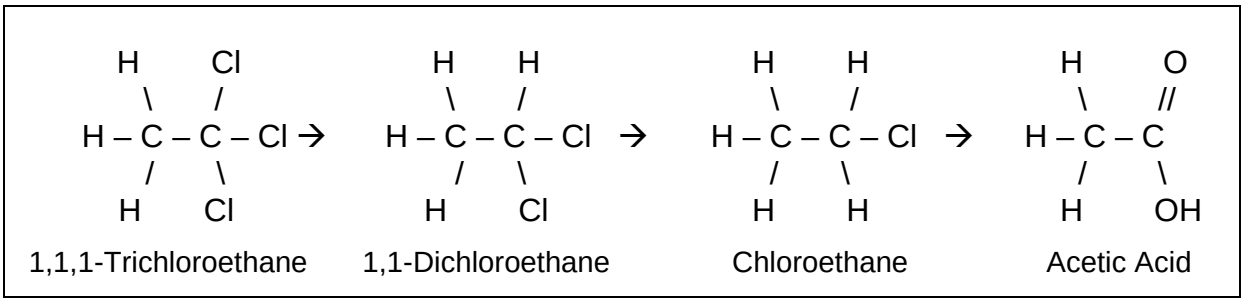
The exposed population would include any homeowner having their own drinking water well. In this case, an elderly homeowner living downgradient from the former plant was being exposed to chemicals in their drinking water. Minor amounts of VOCs have been detected in this

homeowner's well previously, since at least 1990. As of September 2008, concentrations of one VOC, 1,1-DCE, were above its EPA MCL.

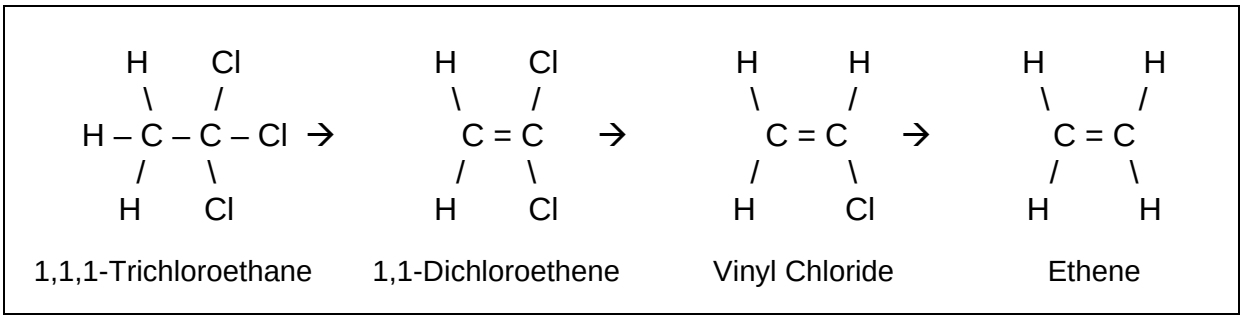
Solvent Explanation

1,1,1-TCA was reportedly used to remove oil and/or grease from parts manufactured at the plant and for septic tank cleaning. It is a colorless liquid and has sweet, sharp odor (ATSDR 2006). 1,1,1-TCA is another volatile organic compound. It will quickly evaporate into a gas at room temperature. As its name implies, 1,1,1-TCA has three chlorine anions on a two-carbon molecule. As these chlorine anions react, the molecule breaks down into other chlorinated volatile organics. Each of these breakdown products has slightly different chemical properties and toxicities. The following diagrams are examples of two different pathways 1,1,1-TCA at the plant can break down to form another chemical.

1,1,1-TCA to 1,1-DCA Pathway (Reductive Dechlorination):



1,1,1-TCA to 1,1-DCE Pathway (Abiotic Dechlorination):



In the first pathway example, 1,1,1-TCA can breakdown to 1,1-DCA, further to chloroethane, and then to a non-hazardous acetic acid. 1,1,1-TCA degrades along this pathway when processes occur allowing microbes to directly remove chlorine atoms from the chemical in order to produce energy. A second breakdown pathway occurs if no microbes are present to remove chlorine atoms. Other processes such as hydrolysis, oxidation, reduction, and photochemical degradation can remove the chlorine atoms from 1,1,1-TCA and change this original parent chemical into 1,1-DCE, then vinyl chloride, and eventually to non-hazardous compounds ethene and ethane. Each of these breakdown reactions can take place independently. The only way to truly know the ratio of these breakdown products is to collect environmental samples. Only the

abiotic breakdown product 1,1-DCE was considered in developing this report as 1,1,1-TCA and 1,1-DCA were both below their respective MCLs, and have been for 19 years.

Environmental Sampling

Environmental sampling has been conducted for many years at wells near the plant and at homes with wells downgradient from the plant. Regular scheduled sampling of on-site groundwater monitoring wells, former plant water supply wells, and homeowner water wells has occurred since 1988. Table 1 shows ranges of chemical concentrations in groundwater and the trends of concentrations of the three main contaminants, 1,1,1-TCA, 1,1-DCA, and 1,1-DCE, in homeowner's water wells downgradient from the plant from 1990 to September 2008. Treated water has been provided by Morrill to homeowner's downgradient from the former plant since 1991, except at House A, the most downgradient home having a drinking water well. As mentioned previously, the highest chemical concentrations were always observed in one particular homeowner's well. This well and other wells with contaminant concentrations are located in the road loop, close to and downgradient from the plant. For study purposes, a whole-house water filter was placed at the well to identify if it would filter out the contaminants for this residence. This pilot study lasted for nearly 3 years from July 2000 until April 2003. The filter decreased chemical concentrations to non-detect levels.

Table 2 shows the ranges of the three main groundwater contaminants in the well at House A. Concentrations of 1,1-DCE showed signs of increasing in House A, beginning in September 2008. Groundwater samples collected from House A prior to September 2008 contained 1,1,1-TCA, 1,1-DCA and 1,1-DCE in concentrations below their EPA primary drinking water MCLs (1,1-DCA does not have an established MCL; however, 1,2-dichloroethane does have an MCL of 5 ppb, which will be used by default). The groundwater sample collected in September 2008, and the confirmation sample collected in October 2008, both contained 1,1-DCE in concentrations exceeding its MCL of 7 ppb. The sample collected in October was analyzed at the State of Tennessee Department of Health analytical laboratory in Nashville and confirmed the concentration to be increasing slightly compared to the previous samples collected.

Chemical of Concern Information and Toxicology

1,1-DCE is a breakdown product of 1,1,1-TCA which was used as a cleaner in the manufacturing processes at the plant and used to clean the plant's septic system. It is not found naturally in the environment. It is a colorless flammable liquid that is heavier than water and evaporates very quickly at room temperature. It has a mild sweet smell and burns quickly.

Detection of 1,1-DCE in House A's drinking water well above its MCL of 7 ppb was cause for concern for TDEC. At these low concentrations, 1,1-DCE has no odor and water containing it will not have a bad taste. Therefore, it is not able to be detected unless the drinking water is sampled and tested. An elderly homeowner uses the water from the well as their primary source of water for drinking and household use. The TDEC project manager for the site requested EEP evaluate any health effects relating to this chemical. The parent compound of 1,1-DCE, 1,1,1-TCA, is also present in the House A's well. However, its concentration is well below its MCL of 200 ppb. Another chemical, 1,1-DCA, is also present in the well water. Its concentrations have

TABLE 1. Groundwater concentration ranges for 1,1,1-Trichloroethane (1,1,1-TCA), 1,1-Dichloroethane (1,1-DCA), and 1,1-Dichloroethene (1,1-DCE) in water wells at homes in facility sampling program located downgradient from the Morrill Motors plant, Rocky Fork, Unicoi County, TN. Data compiled from Marshall Miller & Associates (2008). All results are reported in parts per billion (ppb).

Sampling Dates	**1,1,1-TCA Concentrations**	**1,1-DCA Concentrations**	**1,1-DCE Concentrations**
	ppb	ppb	ppb
Health Comparison Values	200[1]	2.4[2]	7[3]
June 1990 to March 1995 (remedial pumping)	ND – 53.3	ND – 26.3	ND – 32.4
April 1995 to April 1996 (remedial pumping deactivated)	ND – 29.5	ND – 8.4	ND – 32.9
September 1996 to June 1997 (remedial pumping - upgradient well)	ND – 20.4	ND – 7.6	ND – 16.4
September 1997 to December 1997 (pumping and non-pumping scenarios)	ND – 20.9	ND – 5.3	ND – 12.8
March 1998 and June 1998 (remedial pumping)	ND – 20.7	ND – 5.3	ND – 16.9
September 1998 to June 1999 (remedial pumping)	ND – 17.5	ND – 6.2	ND – 13.4
September 1999 to June 2000 (remedial pumping)	ND – 14.5	ND – 8.1	ND – 14.1
September 2000 to June 2003 (no pumping)	ND – 12.0	ND – 4.9	ND – 8.3
September 2003 to March 2008 (no pumping, molasses injections)	ND – 44.5	ND – 18.8	ND – 22.9
June 2008 (no pumping, molasses injections)	ND – 29.7	ND – 25.0	ND – 16.6
September 2008 (no pumping, molasses injections)	ND – 28.9	ND – 15.3	ND – 18.1

Notes:
NE = Not Established
ND = not detected (above the analytical detection limit in the groundwater sample)
NA = not available - concentration data not supplied to EEP
Highest concentrations of 1,1-DCE reported for each time period exceed its EPA Primary Drinking Water MCL of 7 ppb.
ATSDR = Agency for Toxic Substances and Disease Registry
[1] = US EPA Lifetime Health Advisory and Primary Drinking Water Maximum Contaminant Level (MCL) . for 1,1,1-TCA
[2] = EPA Regional Screening Level concentration for 1,1-DCA in groundwater (September 2008) for 1 excess cancer in 1,000,000 individuals.
[3] = US EPA Primary Drinking Water Maximum Contaminant Level (MCL).

TABLE 2. Groundwater concentration ranges for 1,1,1-Trichloroethane (1,1,1-TCA), 1,1-Dichloroethane (1,1-DCA), and 1,1-Dichloroethene (1,1-DCE) in House A from 1990 to 2008. Groundwater samples from this well have recently shown an increase in 1,1-DCE concentrations, above its MCL. Data compiled from Marshall Miller & Associates (2008). All results are reported in parts per billion (ppb).

Sampling Dates	**1,1,1-TCA Concentrations**	**1,1-DCA Concentrations**	**1,1-DCE Concentrations**
	ppb	ppb	ppb
Health Comparison Values	200[1]	2.4[2]	7[3]
June 1990 to March 1995 (remedial pumping)	2.7	0.2	0.6
April 1995 to April 1996 (remedial pumping deactivated)	NS	NS	NS
September 1996 to June 1997 (remedial pumping - upgradient well)	NS	NS	NS
September 1997 to December 1997 (pumping and non-pumping scenarios)	NS	NS	NS
March 1998 and June 1998 (remedial pumping)	0.7 – 1.3	0.3 – ND	1.7 – 2.7
September 1998 to June 1999 (remedial pumping)	ND – 1.6	0.1 – 1.1	0.7 – 4.1
September 1999 to June 2000 (remedial pumping)	0.9 – 1.9	0.2 – 1.6	1 – 5.5
September 2000 to June 2003 (no pumping)	ND – 1.4	0.3 – 1.1	ND – 4.6
September 2003 to March 2008 (no pumping, molasses injections)	ND – 4.0	ND – 2.1	ND – 6.7
June 2008 (no pumping, molasses injections)	3.3	2.1	3.2
September 2008 (no pumping, molasses injections)	3.2/4.4[4]	1.9/**2.9**[4]	**8.0 / 11.5**[4]

Notes:

ND = not detected (above the analytical detection limit in the groundwater sample)
NS = well not sampled
UK = unknown concentrations (data not supplied to EEP)
ATSDR = Agency for Toxic Substances and Disease Registry
[1] = US EPA Lifetime Health Advisory and Primary Drinking Water Maximum Contaminant Level (MCL) . for 1,1,1-TCA
[2] = EPA Regional Screening Level concentration for 1,1-DCA in groundwater (September 2008) for 1 excess cancer in 1,000,000 individuals.
[3] = US EPA Primary Drinking Water Maximum Contaminant Level (MCL).
Bold = value exceeds a guidance value
[4] = September 2008 result confirmed with October 27, 2008 groundwater sampling. Analyzed by TN Dept of Health Laboratory for TDEC

been low and this chemical does not have an established MCL, although EPA has recently revised its screening level for this compound.

The Agency for Toxic Substances and Disease Registry (ATSDR) has established environmental media evaluation guidelines (EMEGs) and minimum risk levels (MRLs) that are based on conservative assumptions about chemical exposure. EMEGs and MRLs consider non-cancer adverse health effects. Exposure durations are defined as acute (14 days or less), intermediate (15–364 days) and chronic (365 days or more) exposures. For cancer effects, ATDSR uses EPA information to set their cancer risk evaluation guidelines (CREGs) for lifetime exposure.

To assess the health effects of drinking water containing concentrations of 1,1-DCE, the concentrations present were compared to its EMEG. ATSDR uses the no observed adverse effect level/uncertainty factor (NOAEL/UF) approach to derive EMEGs for hazardous substances. EMEGs are set below levels that, based on current information, might cause adverse health effects in the people most sensitive to such substance induced effects. EMEGs are derived for acute (1 to 14 days), intermediate (15 to 364 days), and chronic (365 days and longer) exposure durations, and for the oral and inhalation routes of exposure. ATSDR does not use serious health effects (such as irreparable damage to the liver or kidneys, or birth defects) as a basis for establishing EMEGs. Exposure to a level above the EMEG does not mean that adverse health effects will occur. In this case, the results are compared to the chronic EMEG for 1,1-DCE because the exposure has been over a long period of time for the person(s) drinking the water. In cases where no chronic EMEG is published for a compound, the results are compared to an intermediate EMEG concentration, if one is available.

Historic groundwater sampling results show a variable trend in the 1,1-DCE concentrations in House A's well. Sometimes the chemical was not detected and at other times minor concentrations were identified. All previous sampling events before the September 2008 quarterly event have identified 1,1-DCE at concentrations below its MCL of 7 ppb. The September 2008 sampling identified a concentration of 1,1-DCE slightly above the MCL. The measured concentration of 1,1-DCE of 8 ppb was well below the ATSDR EMEG of 300 ppb for an adult and 90 ppb for a child for non-cancerous health effects for this chemical (ATSDR 2008). Therefore, the health risk associated with the concentration of 1,1-DCE found in the House A drinking water well is extremely low. EPA has determined that drinking water containing 3.5 parts per million (ppm) of 1,1-DCE for adults is not expected to cause harmful non-cancerous health effects (ATSDR 1994). ATSDR (1994) also notes 1,1-DCE is rapidly eliminated from the body. 1,1-DCE is not classified with regards to its carcinogenic potential. Therefore, no CREG concentration for one in one million excess cancer risk has been determined. There are no studies located regarding cancer in humans after oral exposure to 1,1-DCE (ATSDR 1994). Some information available indicates that the liver and kidneys in rodents are the primary target organs for 1,1-DCE exposure (ATSDR 1994). ATSDR (1994) also notes that the elderly are one of the groups that should be specifically cautioned against exposure to 1,1-DCE.

There is a large difference between the EPA MCL and the ATSDR EMEG. EPA MCLs are legally enforceable standards that apply to public water systems. These standards protect drinking water quality by limiting the levels of specific contaminants that can cause harmful

effects to public health. These drinking water standards apply to public water systems that provide water for human consumption through at least 15 service connections, or regularly serve at least 25 individuals. The MCL is the highest level of a contaminant that is allowed in publically-supplied drinking water. Commonly, MCLs are set as close to maximum contaminant level goals (MCLGs) as possible using the best available treatment technology and taking cost into consideration. A MCLG is the level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals. The MCL and MCLG for 1,1-DCE are both 7 ppb.

1,1-DCE has a drinking water equivalent level (DWEL) of 300 ppb. A DWEL is the concentration of a contaminant in drinking water that will have no adverse health effect with a margin of safety. Because there is a margin of safety built into the DWEL, exposures above the DWEL are not necessarily considered unsafe. The DWEL for 1,1-DCE is the same as the ATSDR chronic EMEG concentration for an adult consuming 1,1-DCE in tap water. For a child it is 90 ppb. The DWEL assumes all of the exposure to a contaminant is from drinking water, however. The DWEL is calculated by multiplying the reference dose for the chemical by a typical adult body weight (70 kg) and divided by daily water consumption (2 liters). A reference dose (RfD) is an estimate of the amount of a chemical that a person can be exposed to on a daily basis that is not anticipated to cause adverse health effects over a person's lifetime. In RfD calculations, sensitive subgroups are included, and uncertainty may span an order of magnitude. There are several factors with margins of safety that are compounded when calculating EMEGs, providing even more margin of safety. Effects the chemical would have on children and the elderly are considered when calculating a RfD.

The difference between the MCL and the ATSDR EMEG can be explained by when the MCL was established. The MCL for 1,1-DCE was established in 1985 and at the time, there was not as much known about 1,1-DCE as there is now. In August 2002, U.S. EPA published a toxicity reassessment for 1,1-DCE on the Integrated Risk Information System (IRIS) data base. The reassessment for 1,1-DCE involved reclassification of the cancer-causing potential of 1,1-DCE and removal of the cancer dose-response values, development of a new oral RfD, and derivation of an inhalation reference concentration (RfC) that was previously not available. The reassessment on IRIS indicates that the weight-of-evidence for human carcinogenicity is not sufficient to justify calculating a quantitative cancer slope factor or unit risk values for 1,1-DCE. The IRIS file for 1,1-DCE no longer publishes a cancer slope factor (CSF) and unit risk (UR) values. Therefore, a cancer risk does not need to be evaluated. During the reclassification, a new oral RfD of 0.05 mg/kg/day was published, representing a 5-fold increase over the previous RfD of 0.009 mg/kg/day (ABA 2002). The reclassification also resulted in an inhalation RfC of 200 $\mu g/m^3$ being published (ABA 2002).

Historically, 1,1-DCE has been a substantial risk driver in human health risk assessment due to the carcinogenic potency reflected in the previously-published CSF and UR values. With the re-classification, the influence of 1,1-DCE on overall site risk estimates will be reduced. In many cases, remedial standards that were previously based on a practical quantitation limit or background value may now be increased and based on a risk-based level. For example: 1,1-DCE concentrations in indoor air that are considered “unacceptable” could be increased substantially, perhaps as much as 4 orders of magnitude; groundwater cleanup standards that are

based on migration of 1,1-DCE from groundwater to indoor air could be increased by as much as 4 orders of magnitude; and EPA recommends increasing the MCL in response to the proposed changes to toxicity values (EPA 2002). However, U.S. EPA has not yet established a timeline for revising the MCL for 1,1-DCE. Also as a result of the reclassification, soil cleanup standards based on direct contact exposures may also be increased substantially, perhaps as much as 2 orders of magnitude (ABA 2002).

As a result of the recent reclassification of 1,1-DCE, it is thought to have less of an impact on human health and is not classified with respect to being a possible human carcinogen. EPA may in the future require less stringent cleanup standards for 1,1-DCE in air, drinking water, and soil.

Additionally, the 1,1-DCA concentration in the October 2008 confirmatory sampling is above the EPA Regional Screening Level for one excess cancer in 1,000,000. The concentration of 2.9 ppb in the well is slightly higher than the 2.4 ppb screening level. However, it is well within the acceptable EPA cancer risk range of one excess cancer in 10,000 to 1,000,000 (10^{-4} to 10^{-6} risk).

TDEC has sent a letter to the House A owner informing them of the presence and concentration of 1,1-DCE in their well. TDEC has urged the owner of House A to reduce their exposure to 1,1-DCE and the other contaminants (1,1,1-TCE and 1,1-DCA) present in the well, and at a minimum, to obtain an alternate drinking water source. The owner of House A was also urged to limit their exposure to water vapor (showers, spray at the kitchen/bathroom sink). Recent communication with the TDEC Remedial Project Manager (John Lilly, personnal communication) indicated that a whole house filtering system is now installed on the House A's drinking water well.

The effect of inhalation of vapor of 1,1-DCE during showering or running hot water in House A was also evaluated. The concentration of 1,1-DCE in groundwater was incorporated into the Risk Assessment Information system (RAIS) online calculator to obtain a chronic daily intake of vapor. Results were 5.51 micrograms per cubic meter ($\mu g/m^3$) for a non-cancer health value. These concentrations were then compared to ATSDR's comparison values for air. For 1,1-DCE, ATSDR has established an intermediate inhalation exposure (15 days to 365 days) comparison value of 80 $\mu g/m^3$. ATSDR has not established chronic exposure comparison values for 1,1-DCE. EPA has a non-cancer regional screening level of 210 $\mu g/m^3$. The calculated concentration is below the intermediate EMEG and EPA's regional screening value for inhalation. 1,1-DCE is not classified by EPA as a carcinogen (ABA 2002) and hence has no cancer effects comparison value established. Therefore, the 1,1-DCE concentration in House A's well would have to be much higher to become an inhalation concern during showering or cooking.

Past Concerns

According to documents in TDEC files, the Unicoi County Health Department discovered groundwater contamination at the site from a groundwater sample collected from one of the plant water supply wells in November 1969. It is possible that if a water supply well at the plant contained VOCs, residential water wells downgradient from the plant could also have contained VOCs. Downgradient residential water wells were not sampled at the time. During the time

from November 1969 until individual residential water wells were sampled beginning in October 1988 (Marshall Miller and Associates 1996), downgradient residential wells were the source of water for these households. During this 19 year timeframe it is unknown if there were concentrations of VOCs in the residential water wells. Therefore, it is unknown if there were past ingestion and inhalation exposures to residents of select households downgradient from the Morrill plant.

Concerns at Other Residences

TDEC asked EEP to evaluate the exposure from drinking water containing elevated 1,1-DCE concentrations at House A's drinking water well. Another home having a drinking water well closer to the plant had the highest concentration of VOCs. No one lives at this home and thus no one is drinking the water. The whole house water filter that was located on this resident's well has been moved to another home next door. The filter is now on a well that is used for purposes other than drinking, cooking, or bathing. Prior to the filter being installed on the now-vacant home, concentrations of 1,1,1-TCA ranged from 5.2 to 167 ppb; 1,1-DCA ranged from 2.2 to 34.5 ppb; and 1,1-DCE ranged from 6.8 to 94.7 ppb. The highest concentrations of these chemicals were noted prior to Morrill providing treated water to the residence in 1991. Therefore, the residents of this home were exposed to elevated concentrations of 1,1-DCA above the EPA Regional Screening Level of 2.4 ppb and 1,1-DCE above ATSDR's EMEG of 90 ppb. The total duration of this exposure to 1,1-DCA and 1,1-DCE is unknown. All other homes downgradient from the site, except House A, are provided treated water from Morrill. It is unknown as to the amount of water used at the home prior to treated water being provided to the residents in 1991.

Future Concerns

Because the House A's well is the most downgradient sampling point of the current groundwater monitoring program for the site, 1,1-DCE concentrations will likely continue to fluctuate over time. The concentrations may continue to increase. In any event, concentrations will continue to react to remedial measures performed at the former plant. An effective remedy to prevent House A's owner from drinking this water would be to provide a filter unit for their home or provide an alternate water source. Recently (March 2009), a whole house filtering system was installed at House A (J. Lilly, TDEC, personnel communication).

If homeowners in the area sell their homes, there should be a system in place notifying potential buyers that the drinking water wells at the homes are impacted by VOCs.

As mentioned previously there is a home in the area of the plant that has a spring as its water source. No testing has been completed on the spring. Reportedly the spring is located on a ridge at a higher elevation than the Morrill Motors plant and downgradient homes. Even with the consideration of the unpredictable nature of Karst hydrogeology, the spring is likely not impacted.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than adults from certain kinds of exposure to hazardous substances (ATSDR 1997, 1998). Children have lower body weights than adults. Yet, children drink a larger volume of water per mass of body weight than adults. Therefore, a child's lower body weight and higher intake rate results in a greater dose of 1,1-DCE per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are dependent on adults for access to housing, for access to medical care, and for risk identification. Thus, adults need as much information as possible to make informed decisions regarding their children's health.

In preparation of this health document, the health of children was thoughtfully considered. The most important difference in the evaluation of the threat to children and adults who might consume drinking water containing 1,1-DCE is in the use of the EPA maximum contaminant level versus ATSDR comparison values. The EPA MCL of 7 ppb is the regulatory standard for 1,1-DCE. ATSDR 1,1-DCE screening levels for chronic exposure, greater than 365 days, for increased non-cancer adverse health effects is different than the EPA MCL and separate screening levels are established for adults and for children. For children, ATSDR has set the chronic EMEG for 1,1-DCE in drinking water at 90 ppb. The 90 ppb EMEG for children is a screening value only. The EMEG for adults exposed to a chronic duration of 1,1-DCE in drinking water is 300 ppb. This value is the same as the EPA DWEL for 1,1-DCE. Exceedances of this EMEG do not imply health effects will occur.

No children live in House A. Prior to the whole house filter being installed on House A's well, if children did come to visit and drink the water, they would only have spent a limited time at the residence and would have drank limited quantities of water. Concentrations of 1,1-DCE are well below the child EMEG in drinking water at the residence. Generally, there is concern for the health of sensitive population groups (such as children) living in homes downgradient from the Morrill Motors plant in Rocky Fork, Tennessee. Beyond the fact that screening levels for children are lower than adults for 1,1-DCE, no health threats unique to children that require special attention are thought to be present.

Conclusions

1. A "No Apparent Public Health Hazard" exists due to concentrations of 1,1-DCE in the residential water supply well used at House A downgradient from the former Morrill Motors, Inc. plant.

2. A future "Indeterminate Public Health Hazard" exists in homes in the valley downgradient from the former plant that have wells that are not filtered or treated. It is likely that the groundwater contaminant plume containing 1,1,1-TCA, 1,1-DCA, and 1,1-DCE will continue to change over time. The plume may move horizontally, depending

on the hydrology of the area. Concentrations of these chemicals will likely continue to be variable in the future.

3. A "No Apparent Public Health Hazard" exists in other homes in the valley downgradient from the former plant that are provided treated drinking water by Morrill or have drinking water wells and have a properly maintained whole-house filtering system on the well.

4. A past "Indeterminate Health Hazard" existed for residents who lived in homes downgradient from the Morrill plant and used water from their wells. This is especially true for the home with a well closest to the plant. The extent of the contaminant plume downgradient from the Morrill plant was unknown during the 19 year timeframe between when the contamination was first discovered in November 1969 in one of the plant's water supply wells and when residential well sampling began in October 1988. Some residential wells were discovered to be impacted in 1988. It is unknown how long the contamination from the Morrill plant existed and the amount of water used at these residences.

Recommendations

1. As a prudent public health measure, for all homes downgradient from the site having whole house filters, the filter media within the systems should be changed according to the manufactures specifications.

2. As a prudent public health measure, treated water should continue to be provided to those downgradient homes currently receiving it.

3. If home ownership should change downgradient from the plant, the concentrations of the site-related chemicals in the homeowner's wells should be re-evaluated for potential health hazards to any new population that would inhabit the homes.

4. If site conditions or use should change then the site should be re-evaluated for potential health hazards to any new population.

Public Health Action Plan

1. This report and any needed explanation will be provided to TDEC DoR. Upon request, this report will also be provided to the party responsible for clean-up of the site and to homeowners, or future homeowners.

2. TDH EEP will continue to work with TDEC, if requested, as the site continues through the remediation process.

3. TDH EEP will be available to review additional data should the need arise.

Preparer of Report

Joseph P. George, PG, MS
Environmental Epidemiologist

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

Reviewers of Report

Bonnie S. Bashor, MS
Environmental Epidemiology Director
Tennessee Department of Health

David M. Borowski, MS
Environmental Epidemiology Assistant Director
Tennessee Department of Health

John Lilly
Environmental Specialist
Tennessee Department of Environment and Conservation

ATSDR Technical Project Officer

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

References

[ABA] American Bar Association. 2002. Changing cleanup standards for TCE and 1,1-DCE. Last accessed: November 21, 2008. http://www.abanet.org/environ/committees/superfundnatresdamages/newsletter/mar03/cleanup/table1.shtml

[ATSDR] Agency for Toxic Substances and Disease Registry. 1994. Toxicological profile for 1,1-dichloroethene (update), TP-93/07. Atlanta, GA: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1997. Healthy children - toxic environments. Report of the Child Health Workgroup presented to the Board of Scientific Counselors. Atlanta, GA: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 1998. Promoting children's health, progress report of the Child Health Workgroup, Board of Scientific Counselors. Atlanta, GA: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006. Toxicological profile for 1,1,1-trichloroetane (update). Atlanta, GA: US Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2008. Minimal risk levels (MRLs) for hazardous substances. Atlanta, GA: US Department of Health and Human Services. Last accessed October 2008. Available from: www.atsdr.cdc.gov/mrls.html.

[EPA] U.S. Environmental Protection Agency. 2002. Toxicological review of 1,1-Dichloroethyelene, In support of summary information on the integrated risk information system. Washington, DC. June 2002.

[EPA] U.S. Environmental Protection Agency. 2008. Regional screening levels (RSL) for chemical contaminants at superfund sites. Oak Ridge, TN: Oak Ridge National Laboratory. Last accessed: May 14, 2009. Available from: http://epa.gov/region09/superfund/prg/index.html

[MMA] Marshall Miller & Associates. 1996. Evaluation of remedial system feasibility and effectiveness, Morrill Electric Site, Rocky Fork, Tennessee. Bluefield, VA. November 7, 1996.

[MMA] Marshall Miller & Associates. 2008. Results of second quarter 2008 VOC monitoring and molasses injection, Morrill Motors, Inc. Facility at Rocky Fork, Tennessee, Site No. 86-505. Bluefield, VA. September 5, 2008.

[TDEC] John Lilly, Tennessee Department of Environment and Conservation, Division of Remediation, Johnson City, Tennessee Field Office, personal communication, October 29, 2008, November 25, 2008, and March 11, 2009.

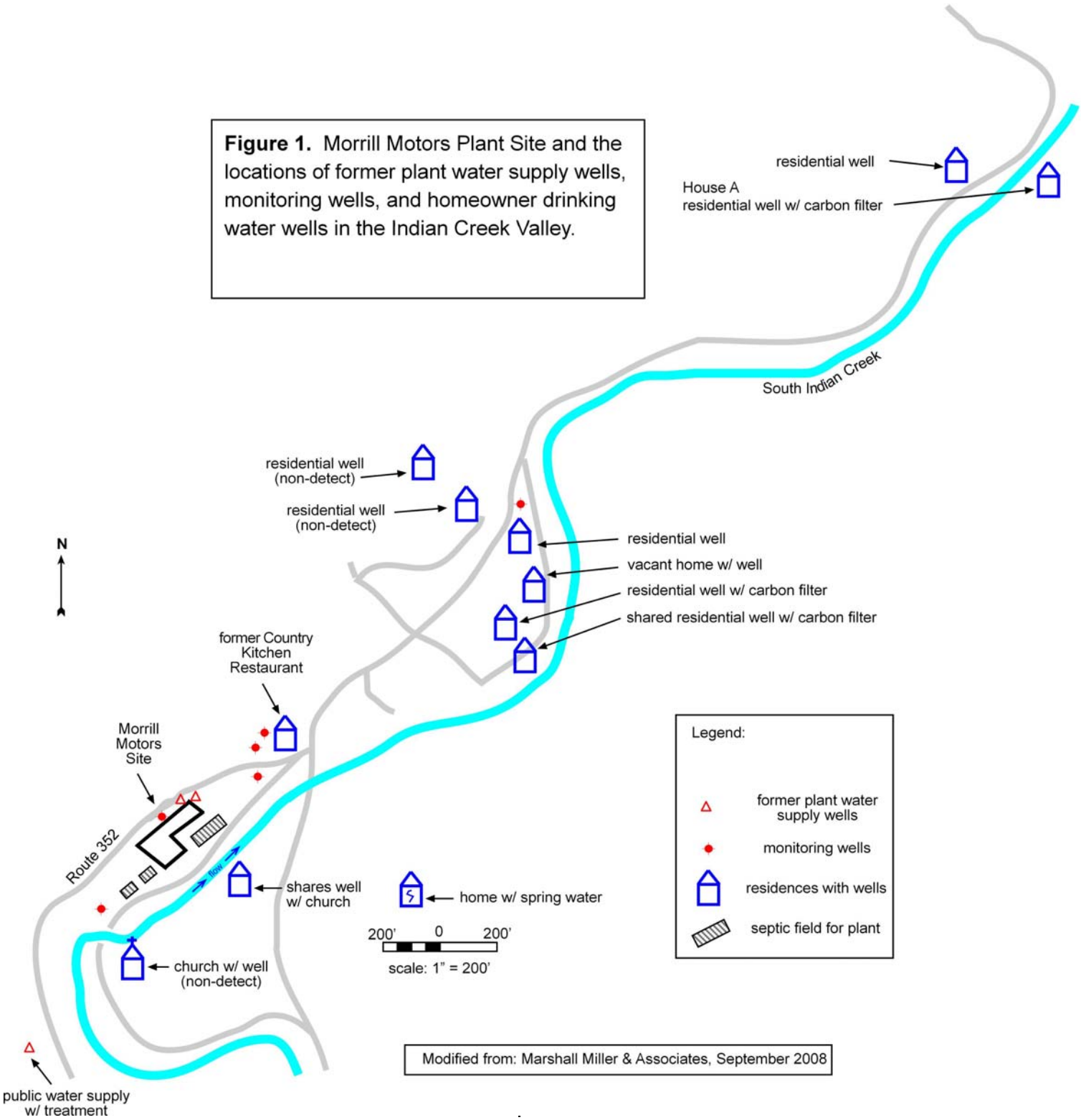


FIGURE 1 - Morrill Motors Plant and Location of Single-Family Homes with Water Wells Downgradient From the Plant, Rocky Fork, Tennessee. (Drawing Credit: Marshall Miller & Associates September 2008)

FIGURE 2 - Photo of the Former Morrill Motors plant site, Rocky Fork, TN (Photo credit: Joe George, TDH, 03/11/09)

FIGURE 3 - View of the public water supply upgradient from the former Morrill Motors plant. Water is treated and piped to downgradient homeowners for household use. (Photo credit: Joe George, TDH, 03/11/09)

FIGURE 4 - Former restaurant north of the former Morrill Motors plant. Plant-related chemicals were not identified in the water from the well used by the restaurant. (Photo credit: Joe George, TDH, 03/11/09)

FIGURE 5 - View of a portion of the residential properties downgradient from the former Morrill Motors plant. (Photo credit: Joe George, TDH, 03/11/09)

FIGURE 6 - More residential properties downgradient from the former Morrill Motors plant. (Photo credit: Joe George, TDH, 03/11/09)

FIGURE 7 - View of South Indian Creek near the former Morrill Motors plant. (Photo credit: Joe George, TDH, 03/11/09)

Certification

This Public Health Consultation: *Morrill Motor, Inc. Site, Rocky Fork, Unicoi County, Tennessee, State of Tennessee Department of Environment and Conservation, Division of Remediation Site No.86-505,* was prepared by the Tennessee Department of Health Environmental Epidemiology under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun.

Technical Project Officer, CAT, SPAB, DHAC, ATSDR

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

Team Leader, CAT, SPAB, DHAC, ATSDR