

Health Consultation

Groundwater Data Review For

WEST HIGHWAY 6 AND HIGHWAY 281 SITE

HASTINGS, ADAMS COUNTY, NEBRASKA

EPA FACILITY ID: NENOOO704738

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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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Summary and Statement of Issues

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health evaluation of the West Highway 6 & Highway 281 site in Hastings, Nebraska in response to the agency's congressional mandate¹.

Tetrachloroethene (PCE) and trichloroethylene (TCE) were detected in the ground water and soil at the site. Concentrations of PCE and TCE in drinking water wells and monitoring wells exceeded the EPA maximum contaminant levels (MCL). The soil contamination appears to be limited to an area beneath the former Dana Corporation facility (Dana). An associated ground water contaminant plume approximately 1.75 miles long and 0.33 mile wide extends from the facility in an east-southeasterly direction. Dana is one of the known sources of this contamination.

The purposes of this health consultation are to review available environmental data, to assess the possible implication of exposures to groundwater contaminants, and to present and address community concerns. This health consultation evaluated the available environmental information and focused on groundwater sampling data for potential exposure to contaminants at the site. Groundwater data included all detected chemicals and other analytes in the Nebraska Department of Health and Human Services (NHHSS) database for the Hastings public water system from 1972 to 2006, survey and sampling information for 45 private wells in the area, and monitoring well sampling data from 1998 to 2007.

Groundwater data review indicated that the maximum levels of 5 chemicals exceeded their respective health comparison values in the city of Hastings municipal wells system. There is no current exposure to site related chemicals because the contaminated municipal wells were taken off line and monitored regularly. ATSDR considers that exposures to the levels of chemicals detected in these wells are unlikely to result in harmful cancer and noncancer health effects. Volatile Organic Compounds (VOCs) were detected in 11 private wells in the area. Although PCE and carbon tetrachloride concentrations in six drinking water wells exceeded their respective MCLs, all detected VOC concentrations are below levels known to result in adverse health effects. There is no current exposure because residents with impacted wells were provided with bottled water initially and later either connected to the city water or installed whole house filtration systems. Monitoring well data indicated an approximately 1.75-mile plume that extends in an east-southeast direction from the former Dana facility but the full extent of contamination may not be defined.

Currently, programs are in place to eliminate exposures when contaminants are detected in municipal or private wells. For example, contaminated municipal wells were shut down and residents with impacted private wells were provided with bottled water initially and later either connected to the city water or installed whole house filtration system. ATSDR concludes that using municipal drinking water and private well water at the site is not expected to harm people's

¹ Congress established ATSDR in 1980 under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as the Superfund law. Under the Superfund law, ATSDR is charged with assessing the presence and nature of health hazards to communities living near Superfund sites, helping prevent or reduce harmful exposures, and expanding the knowledge base about the health effects that result from exposure to hazardous substances [ATSDR 2005a].

health. In general, ATSDR considers reducing or minimizing exposures to hazardous chemical contaminants a prudent public health measure. ATSDR recommends continuing the actions for remediation of the VOC-contaminated groundwater, monitoring potentially affected private wells, and additional investigations to characterize the nature and extent of contamination. ATSDR will review additional environmental data if it becomes available.

Background

In April 2006, EPA added the West Highway 6 & Highway 281 site (the site) to the NPL of uncontrolled hazardous waste sites based on an evaluation under its hazard ranking system (HRS).

The site is located in Hastings, Adams County, Nebraska, to the northwest of the intersection of West Highway 6 & Highway 281. The City of Hastings consists of approximately 24,000 people consuming drinking water from a municipal system and private wells. There is one other NPL site along this highway corridor in Hastings. The Garvey Elevator site (Garvey) is located along this highway corridor in Hastings, about 0.5 mile south of the site. An operating municipal landfill, the Adams County Landfill, is located 1 mile west of the site.

PCE and TCE have been detected in the ground water and soil at the site. Concentrations of PCE and TCE in drinking water wells and monitoring wells exceeded the EPA Maximum Contaminant Levels (MCL). The soil contamination appears to be limited to the area beneath the facility. A ground water contaminant plume, approximately 1.75 miles long by 0.33 mile wide, extends in an east-southeasterly direction from the site. Dana, formerly located at 1900 Summit Avenue in Hastings West Industrial Park, is one of the known sources of this contamination. Dana manufactured a variety of cast piston rings for internal combustion engines. PCE and 1,1,1-trichloroethane (1,1,1-TCA) were used as degreasers to clean the piston rings in vapor degreasing units. Four vapor degreasing units were used at the site from the 1970s through the 1990s. The north vapor degreaser unit #1, unit # 2, and the central vapor degreaser were installed in 1978, 1982, and 1987, respectively. Those three units stopped operation in 2002. The fourth degreaser unit, the Phillips degreaser, was installed in 1983 and decommissioned in 1997 [ERM 2002]. In 1988, one degreaser was found leaking and occasional overfilling of the units resulted in spilled solvent [Tetra Tech 2005a]. Dana first notified the Nebraska Department of Environmental Quality (NDEQ) in October 1998 of the known release of PCE from one of the degreasers [NDEQ 1999].

Since 1998, Dana conducted multiple response actions at the source area under the State of Nebraska's Voluntary Cleanup Program (VCP) including establishing a groundwater sampling program, installing and operating a vapor and groundwater extraction system, and conducting a pilot study of permanganate injection in the affected onsite portion of the aquifer. Groundwater sampling investigations revealed the presence of PCE, TCE, 1,1-dichloroethene (1,1-DCE), 1,1,1-TCA, carbon tetrachloride, and other VOCs in the primary drinking water aquifer within the study area. Two municipal wells and several private wells contained PCE at levels above the MCL. The impacted drinking water wells with contaminant concentrations above MCLs include City of Hastings municipal well number 13, well number 14, and privately owned wells located along West Highway 6 or near the site. Municipal well number 13 was placed on emergency use and shut down in November 1997 [NEDQ 2004]. Municipal well number 14 was used on an as-needed basis and has not been used since 2000 [EPA 2005a].

In May 2006, after Dana declared bankruptcy, EPA initiated removal action activities to continue operating the treatment systems and to assess their effectiveness. Following is a summary of the site operation and investigation history [EPA 2006b].

- In 1978, Dana started operation with three vapor degreasers. 1,1,1 trichloroethane (TCA) was used until 1993. PCE was used in the three vapor degreasers beginning 1993.
- The Phillips degreaser was installed in 1983. PCE was used in this vapor degreaser from 1983 to 1997.
- During 1984 to 1987, Dana reported two accidental releases of PCE from the Phillips degreaser to the degreasing pit. The amount of the PCE released is unknown.
- In 1988, Dana acknowledged that one degreaser was found leaking and occasional overfilling of the units resulted in spilled solvent of unknown amounts.
- In 1995, TCE was found in municipal well number 11 at levels below the MCL.
- In 1997, PCE were found above the MCL in municipal well number 13 and the well was shutdown at that time.
- In 1998, PCE was found in municipal well number 14 at levels above the MCL. This well was used on an as-needed basis and has not been used since 2000.
- In 1998, Dana conducted a Phase I and II environmental site assessments and first notified the NDEQ of the known release of PCE from one of the degreasers.
- In 1999, Dana's contractor performed a soil and groundwater subsurface investigation at the facility.
- In 2002, Dana stopped manufacturing operations.
- In 2003, the soil vapor extraction (SVE) system began operation to remove VOCs from soils beneath the former vapor degreaser locations.
- During 2002-2005, Dana installed a groundwater extraction system to extract VOC-contaminated groundwater.
- In 2004, Tetra Tech EM, Inc (under contract with NDEQ), conducted the Preliminary Assessment /Site Investigation (PA/SI).
- In 2005, Dana completed a well survey; EPA conducted a Removal Assessment.
- In 2006, Dana ceased operation of the vapor and groundwater extraction operations after declaring bankruptcy.
- In 2006, EPA continued to operate the existing treatment system, conduct routine sampling, and characterize the nature and extent of contamination.
- In 2006, EPA initiated a Remedial Investigation/Feasibility Study (RI/FS) to determine the nature and extent of soil and ground water contamination and to evaluate potential remedial options.
- Since 2006, many site activities have taken place as part of the RI/FS. The final report of the RI/FS expected to be released by EPA at the end of 2009.

Community Health Concerns

As part of the health consultation process, ATSDR staff reviewed site documents and conducted a public availability session to understand community member's concerns regarding the contamination, investigation, and remediation of the site. Community members did not identify any health concerns related to environmental contamination.

ATSDR's Exposure Pathway Analysis and Evaluation Process

ATSDR provides site-specific public health recommendations on the basis of toxicologic literature, levels of environmental contaminants detected at a site compared to health-based comparison values, an evaluation of potential exposure pathways and duration of exposure, 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, site conditions, 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. 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 health-based comparison values. These comparison values include but are not limited to:

ATSDR

- Environmental Media Evaluation Guides (EMEGs)
- Reference Dose Media Evaluation Guides (RMEGs)
- Minimum Risk Levels (MRLs)
- Cancer Risk Evaluation Guidelines (CREGs)

EPA

- Reference Doses (RfDs)
- Drinking water Maximum Contamination Levels (MCLs),
- Drinking water Action Levels (AL)
- Life Time Health Advisory (LTHA)

Appendix B contains the definitions of these values. When determining which environmental guideline value to use, this health consultation followed ATSDR's general hierarchy and used professional judgment to select comparison values (CV) that best apply to the site conditions [ATSDR 2005a]. For example, Hierarchy 1 environmental guidelines (such as CREGs and chronic EMEGs), were used. In the absence of these values, Hierarchy 2 intermediate EMEGs or RMEGs, were selected. When environmental guidelines listed in the ATSDR hierarchy are unavailable, those from other sources (e.g., EPA RBCs, state regulations) were considered. These health-based CVs are media-specific concentrations considered safe using default conditions of exposure. Default conditions are typically based on estimates of exposure in most (i.e., the 90th percentile or more) of the general population. Comparison values are not thresholds of toxicity. 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 the substance-specific information depending on the contaminant and site-specific exposure conditions. Such information includes strength of epidemiological and toxicological studies, toxicological and pharmacological characteristics, and other factors that can increase or decrease the potential for harm (e.g., biologic uptake, mechanisms of action, sensitive population and life stages, and cumulative interactions).

Discussion

Available environmental data for the site and data quality evaluation

ATSDR evaluated the available environmental sampling information for soil and groundwater. This health assessment focused on groundwater sampling information for potential exposure to contaminants at the site. The information reviewed included sampling data for municipal wells, private wells, and monitoring wells in the affected area. The exposure pathway analysis determined that people have been exposed to contaminants in private wells and municipal water. Soil and vapor intrusion exposure pathways were determined to be incomplete pathways. Soil exposure pathways are not complete because soil contamination appeared to be limited to the area beneath the building foundation at a depth greater than 2 feet below ground surface, therefore, preventing people from coming in contact with the soil. Vapor intrusion is not identified as a pathway because the lateral and vertical distances from the original VOC source to buildings above are more than 100 feet apart, therefore the migration of VOCs from contaminated soil and groundwater into the buildings is unlikely to produce significant indoor air concentrations [EPA 2002, Lowell and Eklund, 2004].

Groundwater samples analyzed for VOCs, semi-VOCs (SVOCs), and metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) were reviewed. ATSDR reviewed analytical results from laboratory analyses conducted using US EPA Methods 8260, 8270, 6020, and 7470 for the analyses of VOCs, SVOCs, dissolved metals, and mercury, respectively.

ATSDR also reviewed information on Quality Assurance (QA)/Quality Control (QC) procedures for field data quality and laboratory data quality to verify the acceptability and adequacy of data. For example, ATSDR reviewed available Chain of Custody sheets, project narratives, and laboratory certifications. The laboratory analysis methods and the QA/QC procedures were appropriate. The available sampling data for municipal wells included information on detected chemicals only, the total number of samples and description of sampling locations were not available. ATSDR used most conservative assumptions in this evaluation when information was not available. ATSDR considers the data were suitable for its public hazard assessment of the site.

Environmental data evaluation and public health implications

ATSDR used the exposure pathway analysis to evaluate the specific ways in which people might come into contact with environmental contamination at the site. An exposure pathway is the link between environmental releases and local populations that might come into contact with, or be exposed to, environmental contaminants. For the West Highway 6 & Highway 281 site, a completed exposure pathway is the groundwater pathway (private wells and municipal drinking water supply well water). Residents at the site have been exposed to contaminants in the groundwater through drinking of the water, skin contact during showering or bathing, and inhaling VOC vapors released during water use. Inhalation and dermal exposures from non-VOCs (e.g., arsenic) are minimal because of (1) very low levels of non-volatile organic chemicals were estimated to release into air during showering and other uses, (2) exposures to these levels during showering and other indoor water uses are expected to be for short duration, and (3) the lipid barrier of the skin, the absorption of contaminants through dermal exposure is considered to be not significant [ATSDR, 2007a].

Groundwater data are grouped into three categories and discussed in the following sections.

Municipal well water samples

ATSDR reviewed available data for the city of Hastings municipal wells from 1972 to 2006 [EPA 2006c, EPA 2007]. The well data included all detected chemicals and other analytes (including VOCs for which testing started in 1986) in the Nebraska Health and Human Services System (NHHSS) database for the Hastings public water system [Johnson 2007]. Table 1 is a summary of all available well water samples (including samples taken from drinking water supply wells, irrigation wells and cooling water wells). After comparing all available municipal well water sample results with their respective CVs, among 31 detected analytes, ATSDR identified 5 chemicals (4 VOCs and 1 metal) with completed exposure pathways. Further evaluations are discussed below. Table 2 is a summary of the contaminants of concern for Hastings municipal well water samples and their respective comparison values.

Tetrachloroethene (PCE)

Tetrachloroethene (PCE or “perc”) is a chemical used for dry cleaning of fabrics and for metal-degreasing. It is also known by other names, including perc, perchloroethylene, perclene, and perchlor. A nonflammable liquid at room temperature, PCE evaporates easily into the air with a sharp, sweet odor. PCE can also get into the soil and water supplies during disposal of sewage sludge, factory waste, and when leaking from underground storage tanks. Much of the PCE that gets into surface water and soil will evaporate into the air. However, because PCE can travel through soils quite easily, it can get into underground drinking water supplies. If PCE gets into underground water, it may stay there for many years without being broken down. If conditions are right, bacteria will break down some of it and some of the chemicals formed may also be harmful [ATSDR 1997a].

At the West Highway 6 & Highway 281 site, PCE was detected in 19 samples of the well system (detection limit ranged from 0.5 to 1.00 ppb). Concentrations of PCE in the well samples ranged from non-detect to 130 ppb with an average concentration of 9.67 ppb (Table 1). These levels exceed the EPA MCL of 5 ppb and the LTHA of 10 ppb for PCE. See Table 3 for a summary of

detected PCE concentrations in samples taken from drinking water supply wells. Further analysis of the data indicated that:

- PCE was detected in municipal well number 14 in 1998. The maximum concentration of 130 ppb was detected in municipal well number 14 in May, 2000. The average PCE concentration for municipal well 14 was 29.9 ppb. This well is used on an as needed basis only and was shutdown during the winter months. Review of the Hastings Utilities water production log indicated that the last use of this well was the summer of 2000. Well production logs indicate that from the time the well was first utilized in 1978, it was primarily a seasonal well that provided water during peak use periods in the spring, summer, and fall. In addition, water from this well is blended with water from other municipal wells before entering the distribution system. Because the well water was blended with water from other wells, it is unlikely that exposures occurred at the PCE levels found in this well.
- PCE was detected in municipal well number 13 in December 1996. In 1997, the well was shutdown. The highest and average PCE concentrations for municipal well 13 were 17.2 and 4.73 ppb, respectively. Water from this well is blended with water from other municipal wells before entering the distribution system. Again because the well water is blended with water from other wells before being used, it is unlikely that exposures occurred at the PCE levels found in this well
- The latest available samples (collected in July 2006) for both municipal well 13 and 14 indicated that PCE concentrations were below the detection limit of 0.5 ppb.

ATSDR considers actual PCE exposures were likely much lower than the maximum concentration of 130 ppb because 1) the well was used on an as-needed basis only and 2) the water from this well was blended with water from other municipal wells before entering the distribution system thereby diluting the concentrations of contaminants. However, to be conservative, ATSDR used the maximum concentration of 130 ppb to estimate a total exposure dose from ingestion, inhalation and dermal contact based on conservative assumptions (Appendix A). Estimated daily doses to the maximum PCE levels for children and adults (0.6657 and 0.02345 mg/kg/day) are many times less than the lowest levels that cause adverse effects (108 mg/kg/day for human exposure) [ATSDR, 1997a] Therefore ATSDR considers that exposures to the levels of PCE detected in municipal wells number 13 and 14 are unlikely to result in harmful noncancer health effects. In recent years, several studies have reported an association between exposure to PCE in drinking water and adverse effects on reproduction and development; however, the conclusions of these studies are limited by inadequate characterization of exposure, small cohort size, exposure to multiple contaminants, and other confounding factors [Doyle et al, 1997, ATSDR 1998, Sonnenfeld et al, 2001, and Aschengrau et al, 2009].

Results of animal studies, conducted with amounts much higher than those that most people are exposed to, show that PCE can cause liver and kidney damage and liver and kidney cancers even though the relevance to people is unclear. Although it has not been shown to cause cancer in people, the U.S. Department of Health and Human Services has determined that PCE may reasonably be anticipated to be a human carcinogen. The International Agency for Research on Cancer (IARC) has determined that PCE is probably carcinogenic to humans. By apparent species-specific mechanisms of no clear relevance to humans, high chronic oral doses of PCE in

gavage oil (500 mg/kg/day or more) can cause liver cancer in mice (but not in rats), kidney cancers in male (but not female) rats, and monocellular leukemia in Fisher-344 rats (a strain that exhibits an unusually high spontaneous incidence of this cancer) [ATSDR 1997a, IRIS 2008]. However, humans metabolize PCE differently than do mice and rats, producing much lower levels of potentially carcinogenic metabolites. Therefore, based on the low levels of exposure and equivocal cancer effects, ATSDR considers that exposures to PCE in water from the wells are unlikely to result in cancer health effects.

Trichloroethene (TCE)

Trichloroethene (TCE) is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and a sweet, burning taste. It is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, typewriter correction fluids, and spot removers. It evaporates easily into the air but can stay in the soil and in groundwater for a long time.

At this site, TCE was detected in well samples (including samples taken from drinking water supply wells, irrigation wells, and cooling water wells) with concentrations ranging from non-detect to 74 ppb, with an average concentration of 8.18 ppb (Table 1). A summary of TCE in municipal drinking water supply wells is presented in Table 4. Review of the sampling data indicated the following:

- TCE was detected in only two municipal drinking water supply wells (municipal wells 11 and 14).
- The maximum TCE concentration of 3.6 ppb (which is below the MCL) for municipal drinking water supply wells was found in municipal well 11 in 1995.
- TCE was first detected in Well 14 in 1997, with a maximum concentration of 1.3 ppb (which is below the MCL) detected in 2004.

TCE concentrations detected in municipal drinking water supply wells were below the MCL. However, the community has expressed concerns that TCE has been detected in the water supply. Therefore, ATSDR included TCE for further discussion to provide health information to the community.

Drinking small amounts of TCE for long periods may cause liver and kidney damage, impaired immune system function, and impaired fetal development in pregnant women, although the extent of some of these effects is not yet clear. Some epidemiologic studies of persons exposed to TCE in drinking water provide limited support that TCE is a developmental toxicant [ATSDR 1997b, ATSDR 1998, and ATSDR 2003]. A recent animal study indicated that the lowest level that can cause heart defects was 0.05 mg/kg/day [Johnson, et al., 2003]. 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). ATSDR used the maximum concentration of 3.6 µg/L found in the municipal drinking water supply well 11 to estimate a total exposure dose from ingestion, inhalation and dermal contact based on conservative assumptions. Estimated daily doses for children and adults (0.0027 and 0.0016 mg/kg/day) are many times less than the lowest levels that can cause adverse effects of 0.05 mg/kg/day

(Appendix A). ATSDR considers that exposures to the levels of TCE detected in these wells are unlikely to result in harmful noncancer health effects.

Several studies have reported an association between exposure to TCE in drinking water and cancer; however, 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 suggested a link between leukemia in female children (1 to 20 years old) and exposure to TCE in the drinking water (maximum TCE detection of 67 ppb) [New Jersey, 2003]. Massachusetts Department of Public Health [MA DPH, 1997] conducted a case-control study of children less than 20 years old living in Woburn and diagnosed with leukemia between 1969 and 1989 ($n = 21$) and observed that consumption of drinking water increased the risk of leukemia (OR: 3.03, 95% CI: 0.82–11.28), with the highest risk from exposure during fetal development (OR: 8.33, 95% CI: 0.73–94.67). This study found that paternal occupational exposure to TCE was not related to leukemia in the offspring [MA DPH, 1997]. In the most recent update, Costas et al. reported that between the years 1969 and 1997, 24 cases of childhood leukemia were observed when 11 were expected. Risk was calculated for cumulative exposure to contaminated drinking water two years prior to conception (OR_{adj}: 2.61, 95% CI: 0.47–14.97), during pregnancy (OR_{adj}: 8.33, 95% CI: 0.73–94.67), postnatal (OR_{adj}: 1.18, 95% CI: 0.28–5.05), and any of these time periods (OR_{adj}: 2.39, 95% CI: 0.54–10.59). A dose response was observed during pregnancy only. Cases were more likely to be male (76%), <9 years old at diagnosis (62%), breast-fed (OR: 10.17, 95% CI: 1.22–84.50), and exposed during pregnancy (adjusted OR: 8.33, 95% CI: 0.73–94.67). A dose-response was seen during the pregnancy exposure period, with the most exposed having an adjusted OR of 14.30 (95% CI: 0.92–224.52). Other elevated risks observed included maternal alcohol intake during pregnancy (OR: 1.50, 95% CI: 0.54–4.20), having a paternal grandfather diagnosed with cancer (OR: 2.01, 95% CI: 0.73–5.58), father employed in a high risk industry (OR: 2.55, 95% CI: 0.78–8.30), and public water being the subject's primary beverage (OR: 3.03, 95% CI: 0.82–11.28) [Costas 2002]. The levels of TCE found in the studies are much higher compared to the levels found in the Hastings municipal drinking water supply wells (maximum concentrations at 3.6 ppb which is below the MCL of 5.0 ppb). Given the exposure information presently available and the state of the science, ATSDR considers that exposures to TCE in water from Hasting municipal wells are unlikely to result in cancer health effects.

Carbon tetrachloride

In the past, carbon tetrachloride was widely used as a cleaning fluid (in industry and dry cleaning establishments as a degreasing agent, and in households as a spot remover for clothing, furniture, and carpeting). Carbon tetrachloride is a clear liquid that evaporates very easily. Carbon tetrachloride can be found in surface water in small amounts and most of it evaporates to the air within a few days or weeks. It may be trapped in groundwater for longer periods before it is broken down to other chemicals. Carbon tetrachloride can also be found in some drinking water supplies, usually at concentrations less than 0.5 ppb. When people drink water contaminated with carbon tetrachloride, about 85–91% of it can enter the body but much of it leaves the body quickly. Exposure to high levels of carbon tetrachloride can cause adverse health effects on the liver, kidney, and brain. The liver is especially sensitive to carbon tetrachloride [ATSDR 2005b].

For this site, carbon tetrachloride was detected in well samples (including samples taken from drinking water supply wells, irrigation wells and cooling water wells) with concentrations ranging from non-detect to 240 ppb, with an average concentration of 30.2 ppb (Table 1). However, further analysis of the sampling data indicated that the levels of carbon tetrachloride found in municipal drinking water supply wells ranged from non-detect to 5.0 ppb, with an average concentration of 2.43 ppb and:

- Carbon tetrachloride was detected in only two municipal drinking water supply wells (municipal wells 13 and 14).
- The maximum carbon tetrachloride concentration of 5 ppb for municipal wells was found at municipal well 13 in 1997.
- Carbon tetrachloride was detected only one time in municipal well 14 in 1997 at a concentration of 0.5 ppb.

ATSDR has derived MRLs for acute and intermediate duration oral exposures to carbon tetrachloride of 0.02 and 0.007 mg/kg/day, respectively. No data were located on the effects of chronic-duration oral exposure in humans. Animal studies of chronic oral exposures indicated that serious effects were observed at doses at 47 mg/kg/day or higher. Estimated daily doses to the maximum carbon tetrachloride level detected in municipal wells (5 ppb) for children and adults are 0.00256 mg/kg/day and 0.00090 mg/kg/day, respectively (Appendix A). The estimated daily exposure doses are lower than the MRLs. In addition, the levels detected in the wells are equal to or less than the MCL of 5 ppb. Therefore, ATSDR considers that exposures to the levels of carbon tetrachloride detected in these wells are unlikely to result in harmful noncancer health effects.

Studies have not been performed to determine whether ingesting or breathing carbon tetrachloride causes tumors in humans but there is convincing evidence that exposure to carbon tetrachloride leads to hepatic tumors in rodents exposed by inhalation or dosed orally. DHHS has determined that carbon tetrachloride may reasonably be anticipated to be a carcinogen. IARC has classified carbon tetrachloride in Group 2B, possibly carcinogenic to humans. EPA has determined that carbon tetrachloride is a probable human carcinogen. The lowest cancer effect levels were observed for mice are 25,000 ppb by inhalation and 20 mg/kg/day orally [ATSDR 2005b]. Those levels are many times higher than the estimated daily doses for children and adults for the site. Given the information presently available, ATSDR considers that exposures to carbon tetrachloride in water from Hastings municipal wells are unlikely to result in cancer health effects.

Di (2-ethylhexyl) phthalate (DEHP)

DEHP is a manufactured chemical that is commonly added to plastics to make them flexible. It is a colorless liquid which does not evaporate easily. It dissolves more easily in materials such as gasoline, paint removers, and oils than it does in water. When DEHP is released to water, it dissolves very slowly into underground water or surface waters that contact it. After DEHP is ingested, most of it is rapidly broken down into chemicals which are poorly absorbed and leaves the body in the feces. Studies of long-term exposures in rats and mice have shown that high oral doses of DEHP caused health effects mainly in the liver and testes.

DEHP was detected in five samples from Hastings municipal wells. A maximum concentration of 3.8 ppb was detected in Hastings Well 29 on June 5, 2000. ATSDR selected DEHP as a contaminant of concern for this site because the maximum concentration of 3.8 ppb exceeded its CREG of 3 ppb².

For non-cancer health effects, ATSDR has established child and adult EMEGs of 600 and 2,000 ppb for DEHP in drinking water, respectively [ATSDR 2008]. These levels are expected to be safe, daily exposure levels for a lifetime. The EPA MCL for DEHP is 6 ppb. The levels are below the MCL and well below the ATSDR EMEGs for children and adults. Therefore, ATSDR considers that exposures to the levels of DEHP detected in these wells are unlikely to result in harmful noncancer health effects.

No studies have evaluated the potential for DEHP to cause cancer in humans. Eating high doses of DEHP for a long time resulted in liver cancer in rats and mice. DHHS has determined that DEHP may reasonably be anticipated to be a human carcinogen. EPA has determined that DEHP is a probable human carcinogen. These determinations were based entirely on liver cancer in rats and mice. The IARC has recently changed its classification for DEHP from "possibly carcinogenic to humans" to "cannot be classified as to its carcinogenicity to humans," because of the differences in how the livers of humans and primates respond to DEHP as compared with the livers of rats and mice [IARC, 2000]. In addition, the CREG for DEHP in drinking water is 3.0 ppb; which was based on conservative assumptions such as level of risk (i.e., a 1-in-1 million cancer risk) and a life time exposure (i.e., 365 days per year for 70 years). For the site, only one sample (3.8 ppb) was above the DEHP CREG, and the average concentration of the 5 samples was 2.8 ppb. In addition, water from this well is blended with water from other uncontaminated municipal wells before entering the distribution system therefore the exposure is expected to be lower. Given the information presently available, ATSDR considers that exposures to DEHP in water from Hasting municipal wells are unlikely to result in cancer health effects [IARC, 2000].

Arsenic

Arsenic was detected in the municipal system with a maximum concentration exceeding its respective CV.

Arsenic is a naturally occurring element, present at low levels in soil, water, food, and air. The average level of arsenic found in drinking water supplies in the United States is 2 ppb. Drinking water from ground water sources tends to have higher levels of arsenic than surface water sources (i.e., lakes and rivers) [ATSDR 2007a].

The concentration of arsenic in the samples collected from the Hastings municipal water system ranged from "not detected" to 5.6 ppb. At low levels of exposure, the body is able to effectively eliminate arsenic without suffering toxic effects. However, when the body's capacity to detoxify low levels of arsenic is exceeded, blood arsenic levels increase and adverse health effects occur [ATSDR 2007a]. Ingestion of inorganic arsenic (ranging from about 300 to 30,000 ppb in water; more than 100–10,000 times higher than most U.S. drinking water levels of 2 ppb), can cause irritation of stomach and intestines, with symptoms such as stomachache, nausea, vomiting, and

² It does not appear that DEHP source is related to the West Highway 6 and Highway 281 Site.

diarrhea. Other effects include decreased production of red and white blood cells, which may cause fatigue, abnormal heart rhythm, blood-vessel damage resulting in bruising, and impaired nerve function causing a "pins and needles" sensation in hands and feet. The single-most characteristic effect of long-term oral exposure to inorganic arsenic is a pattern of skin changes. These include patches of darkened skin and the appearance of small "corns" or "warts" on the palms, soles, and torso, and are often associated with changes in the blood vessels of the skin. Skin cancer may also develop. Swallowing arsenic has also been reported to increase the risk of cancer in the liver, bladder, and lungs. Assuming that arsenic was detected in the municipal drinking water supply wells, the arsenic levels detected at the site (maximum 5.6 ppb) are below the EPA current MCL for arsenic of 10 ppb. The ATSDR MRL for arsenic is 0.0003 mg/kg/day for chronic oral exposure to arsenic. Based on a conservative dose calculation (Appendix A), estimated daily doses to the maximum arsenic level detected in municipal wells (5.6 ppb) for children and adults are 0.00015 mg/kg/day and 0.00011 mg/kg/day, respectively. ATSDR concluded that consuming this water is unlikely to cause adverse health effects.

DHHS has determined that inorganic arsenic is known to be a human carcinogen. The IARC has determined that inorganic arsenic is carcinogenic to humans. EPA also has classified inorganic arsenic as a known human carcinogen. Theoretically, persons with a long-term exposure (continuously over a lifetime) to an arsenic level of 5.6 ppb, which is equal to 0.0001 mg/kg/day, may face a low increased risk of developing cancer. However, no study has reported any actual increase in cancer rates at doses below 0.001 mg/kg/day via drinking water [ATSDR 2007a].

Evaluating exposure to the mixture of chemicals in municipal wells

The individual contaminants detected at this site are present at levels that are below those that might be expected to result in adverse health effects. Based on information from studies about the effects of chemical mixtures, ATSDR has concluded that the combined effect of the contaminants detected at the site is also not likely to result in adverse health effects. This conclusion is based on studies that suggest a mixture produces no adverse noncancer health effects in dosed animals when the components of that mixture are present at levels well below their individual threshold doses for adverse effects. [Wade et al. 2002, Feron et al. 1993, Jonker et al. 1990, Jonker et al. 1993a, Jonker et al. 1993b, Groten et al. 1991]. Carcinogens exhibit thresholds in the laboratory, no less than do noncarcinogens [SOT 1981, Williams and Weisburger 1991, Cunningham et al. 1994]. It is likely that the previously stated principle regarding mixtures of noncarcinogens applies to mixtures of carcinogens as well. All measured levels of contaminants in the Hastings municipal well system are below all known adverse effect levels published in ATSDR's toxicological profiles. Therefore, ATSDR considers that the combined effect of all of these contaminants is not likely to be of public health concern.

ATSDR recognizes there are uncertainties in evaluating the cumulative effects of chemical mixtures. Because relatively few chemical mixtures studies have assessed toxic interactions in low dose ranges, ATSDR considers it a prudent public health measure to reduce or eliminate exposure to contaminants in the Hastings municipal water system wherever possible.

Private Well Water Samples

There are over 100 active private wells in the area within 4 miles of the site. Among those wells, there are approximately 48, 40, and 19 private drinking water wells in the 3-4, 2-3, and 1-2 mile radius rings around the source area, respectively [NDNR 2005]. Since 2004, NDEQ, Dana,

EPA, and Garvey have conducted well surveys and sampled many private wells in this area for VOC contaminations. The following is a summary of the private well investigations [Tetra Tech 2005b, Tetra Tech 2005c, EPA 2005b, and EPA 2006c]:

2004 PA/SI

- During the 2004 PA/SI, door-to-door well surveys were conducted along the Highway 6 corridor and the industrial park. The PA/SI identified 15 properties with private wells which are not connected to the Hastings municipal water system and sampled 12 of these active wells for VOC contaminations. Among the wells, five private wells were used for drinking water, the rest of the wells were used for irrigation and heat pumps.
- Three private wells detected PCE at concentrations of 65 (PW-1), 230 (PW-2), and 330 ppb (PW-3). The wells are located in business facilities and well water was used for drinking only during business hours. There are a total of 17 adult workers served by those three wells and their exposures are assumed to be ingestion only [Tetra Tech 2005b, 2005c]. ATSDR considers that exposures to PCE at those wells are unlikely to result in harmful health effects because (1) the total exposure duration was less than a year and limited to working hours only, (2) ingestion was the only exposure route therefore exposure doses were significantly lower than the total estimated exposure dose from ingestion, inhalation and dermal contact. The workers were provided with bottled water in 2005 and the businesses were subsequently connected to the Hastings municipal water supply in 2006, therefore there is no current exposure to PCE contamination.
- Two private wells (PW-4 and PW-5) were found to be contaminated with carbon tetrachloride at 16 and 23 ppb, respectively. The carbon tetrachloride contamination is attributable to the Garvey Elevator site. Residents using both wells were provided with bottled water initially, then the home served by PW-4 was connected to city water, and PW-5 installed a whole house filtration system. ATSDR used the maximum concentration of 23 ppb to estimate a total exposure dose from ingestion, inhalation and dermal contact based on conservative assumptions. The estimated daily exposure doses are 0.01178 and 0.00415 mg/kg/day for children and adults, respectively. ATSDR has derived MRLs for acute and intermediate duration oral exposures to carbon tetrachloride of 0.02 and 0.007 mg/kg/day, respectively. Animal studies of chronic oral exposures indicated that serious effects were observed at doses at 47 mg/kg or higher and animal studies of intermediate duration oral exposures indicated that no adverse effects were observed at dose of 0.71 mg/kg. Because the estimated doses are lower than the doses mentioned above and the short exposure duration (less than a year), ATSDR considers that exposures to the levels of carbon tetrachloride detected in these wells are unlikely to result in harmful cancer or noncancer health effects.

2005 well survey

- In October 2005, Dana completed a well survey and identified seven additional domestic private wells (PW-6, PW12, PW-15, PW-16, PW-17, PW-18, and PW-19) in the area [EPA 2005b].
- Among the seven wells, one well (PW-19) was found to be contaminated with carbon tetrachloride (5.2 ppb) and chloroform (0.39 ppb). Residents were provided with bottled water by Garvey initially and then the houses were connected to city water.

- Three wells (PW-12, PW-17, and PW-18) were not in use and the buildings are connected to Hastings municipal water system.
- Two wells (PW-6 and PW-16) were sampled twice and not found to have VOCs above their respective method detection limits by EPA and Garvey in 2004 and 2005[EPA 2005b]. The analytical results and method detection limits were not available to ATSDR for this evaluation.
- One well (PW-15) was tested once and not found to have VOCs above their respective method detection limits.

2005 EPA removal assessment/private well survey

- In late October 2005, EPA representatives conducted a removal assessment/private well survey to oversee Dana's groundwater sampling activities and verify Dana's private well survey activities [EPA 2005b].
- EPA representatives investigated an additional 18 residences/businesses to verify private well water use. Sixteen of the 18 residences/buildings were connected to the municipal water system. No sample was collected at the business with PW-31 which is used by the occupants.

2006 EPA site removal assessment

- In July 2006, EPA's contractor, Tetra Tech EM Inc., conducted another site removal assessment [EPA 2006c]. Three samples were collected from PW-7, PW-13, and PW-14.
- PW-7 contained TCE at 1.3 ppb. This well was routinely sampled by the representatives of the Garvey Elevator site and a whole house filtration system was installed.
- PW-13 was routinely sampled by the representatives of the Garvey Elevator site. The result of this sampling indicated the well was contaminated with carbon tetrachloride at maximum of 21 ppb. As discussed previously in this document, the estimated daily exposure doses for a concentration of 23 ppb are lower than exposure doses that could result in adverse health effects from exposure to carbon tetrachloride; therefore, ATSDR considers that exposures to a concentration of 21 ppb carbon tetrachloride detected in the well are unlikely to result in harmful cancer or noncancer health effects.
- PW-14 was found to contain PCE and TCE at 4.9 and 5.4 ppb, respectively. This is the first time this well was sampled. TCE concentration is slightly over the MCL of 5 ppb; however, this well is not used for drinking water.

In summary, ATSDR reviewed available data for approximately 45 private wells (Table 5). VOC contaminants were detected in 11 wells in the area. All detected VOC concentrations are below levels known to result in adverse health effects. Private wells PW-1, PW-2, PW-3, and PW-4 contained PCE above the MCL; these residences were initially provided bottled water and later connected to the Hastings municipal water system (connection dates for those wells are listed in Table 6). Private wells PW-4, PW-5, PW-13, and PW-19 contained carbon tetrachloride above its MCL. Residents using the wells were provided with bottled water and installed whole house filtration system (PW-5) and connected to the Hastings municipal water system (PW-4, PW-13, and PW-19). One potentially impacted well, PW-10, has not yet been sampled. EPA or responsible parties should take representative samples in this well, and continue monitoring other potentially affected private wells.

Monitoring Well Water samples

Monitoring wells help investigators define the horizontal and vertical extent of groundwater contamination. For the West Highway 6 and Highway 281 site area, we have actual drinking water data to evaluate exposure. The monitoring well data further helps us understand areas where well water might have been affected and what might happen in the future. For those reasons, relevant site monitoring well data were examined.

In the Hastings area, the depth of the ground water table ranges from 100 to 130 feet below ground surface (bgs). Historically, directly beneath the facility, the ground water table is about 94 to 105 feet bgs. In general, regional groundwater flow is in an east-southeast direction. However, the ground water flow direction appears to vary within the small footprint of the facility — from northeast in the north portion of the facility, to south in the southern portion of the facility. EPA considered that pumping associated with the nearby municipal well 13 may cause this flow alteration. The surficial aquifer at the site consists mostly of sands and gravels. A 5-foot thick silty-sandy clay layer has been identified at approximately 120 to 125 feet bgs. A second thin clay layer is reported to the south at a depth of 150 feet bgs. The clay layers are discontinuous within 2 miles and are not present in many of the cross-sections. Although Dana used the first clay layer to distinguish an “upper aquifer zone” and a “middle aquifer zone”, EPA concluded that due to the fact that the layer between the aquifer is discontinuous, thin, and not sufficiently different in its ability to transmit water, the silty-sandy clay layer was not a barrier to contaminant transport [EPA 2006a].

As a result of levels of PCE and carbon tetrachloride (above their respective MCLs) in routine sampling of Hastings Well 13, groundwater investigations were begun to determine the extent of the contaminated groundwater in 1998.

In 1998, Dana’s contractor, Terracon, sampled the groundwater and soil surrounding their building and property. Based on soil samples results surrounding the Phillips degreaser, 4 monitoring wells (MW-01, MW-02, MW-03, and MW-04) were installed. Monitoring well MW-01, the closest well to the source was found to contain the highest PCE level of 59,200 ppb. Monitoring well MW-02 had PCE level of 107 ppb. PCE was not detected in monitoring wells MW-03 and MW-04. TCE was found in MW-01 at a level of 7.5 ppb on 10 August, 1998 and 8.0 ppb on 11 August, 1998. No TCE was found in MW-02 and MW-04. No contamination was found in MW-03 from the August 1998 sampling event [ERM 2005].

Searching for the boundaries of the plume, ERM installed four additional groundwater monitoring wells (MW-05, MW-06, MW-07, and MW-08) in 1999. Of the newly bored wells, well MW-5 had the highest level of PCE at 1,170 ppb. Wells MW-01, MW-02, MW-03, and MW-04 were also sampled again at this time. Similarly to the sampling in August 1998, MW-01 had the highest concentration of PCE at 60,400 µg/l and TCE at 7.9 ppb. TCE was not detected in any of the other monitoring wells [ERM 2005].

In 2000, to further define the edge of the plume, ERM conducted 6 cone penetrometer tests (CPT), four Geoprobe® conductivity borings, one direct-push soil boring sample, and seven direct-push groundwater profiling samples (GWP) along the eastern border of the Dana property. Samples were also collected for VOC analysis from the existing eight groundwater monitoring wells (MW-01 through MW-08). This sampling event showed an increase in PCE concentrations

at MW-01, MW-02, MW-03, and MW-04 compared to the samples taken in 1998 and a decrease in PCE concentrations in MW-05, MW-06, and MW-08. TCE was found at concentrations of 6.6 ppb and 12 ppb in MW-01 and MW-04, respectively. No TCE was found in MW-02, MW-03, or MW-05 through MW-08 [EPA 2005].

In 2001, as a result of the appearance of plume migration from the previous sampling, ERM installed nine more monitoring wells (MW-09M, MW-09U, MW-10U, MW-11M, MW-11U, MW-12M, MW-12U, MW-13M, MW-13U). Of the newly installed monitoring wells, VOCs were not detected in the north and east of the property (MW-11U, MW-11M, MW-12M, and MW-12U). MW-10U was the only well with PCE and TCE contamination indicating that the plume was moving southeasterly from the former Dana facility. The maximum PCE and TCE levels for MW-10U were 29,300 and 4 ppb, respectively [EPA 2005].

In 2002, ERM installed 5 monitoring wells (MW-14U, MW-15U, MW-15M, MW-16U, and MW-16M) off of the Dana property to continue to define the plume as it moved. In addition, a six inch recovery well (RW-01) was installed near the center of the PCE plume for remediation in the future. Samples were collected in October from the newly installed monitoring wells and from the existing monitoring wells. The results from the wells MW-1 through MW-13U show the plume continuing to move in a southeasterly direction away from the Dana property which is consistent with the regional ground water flow direction [EPA 2005].

In 2004, monitoring well 17 (MW-17U) was installed to assess the groundwater in the vicinity of the former Central Degreaser. Additionally, two more recovery wells (RW-2 and RW-3) were installed to provide groundwater hydraulic control in an effort to minimize offsite contaminant migration. Recovery wells RW-1, RW-2, and RW-3 began operation in October 2002, October 2004, and November 2004, respectively. Sampling results for all three recovery wells show a decrease in PCE from 2004 to 2005. RW-1, having a longer sampling history, shows PCE levels increase from 7,100 ppb in October 2002 to 31,684 ppb in December 2003; then steadily decreasing to 6,900 ppb in October 2005 [EPA 2005].

On December 13, 2004, Tetra Tech collected samples from monitoring wells MW-10A and MW-10B, located on the property of Great Plains Packaging in the Hastings West Industrial Park. These wells were installed by Garvey Elevators as part of their off-site investigation of the carbon tetrachloride release [Tetra Tech 2005a]. PCE was not detected in the sample collected from MW-10A. PCE was found in the sample collected from MW-10B at a level of 1.3 ppb.

From October 2004 through March 2005, Tetra Tech collected 68 groundwater samples from 24 Direct Push Technology (DPT) wells along the Highway 6 corridor between Hastings West Industrial Park and Showboat Road. Tetra Tech also collected samples from several other existing monitoring wells within the study area to aid in the determination of the plume boundaries. The DPT data collected in 2004 and 2005 indicate a continuous PCE groundwater plume extending from the eastern boundary of the former Dana facility (Summit Avenue) to Lincoln Park, where Municipal Well No.14 is located. The DPT data also indicate that the depth of PCE contamination within the aquifer appears to be increasing from west to east.

In 2005, quarterly samples were taken. Generally speaking, the concentration of PCE in most wells decreased throughout 2005; four wells, MW-01, MW-08, MW-10U and MW-11U, had an increase of PCE concentrations. Other wells sampled in 2005 include recovery wells (RW-1, RW-2, and RW-3), and the heat pump wells. A fourth recovery well, RW-04, was installed and

began operation in mid 2005. The recovery well results were much lower in October than in February; PCE concentrations in RW-1 decreased from 8,820 ppb to 6,900ppb, RW-2 from 9,941 ppb to 2,800 ppb, and RW-3 from 2,339 ppb to 2,200 ppb, respectively. The heat pump well sample results were almost all non-detect.

In July 2006, Tetra Tech Region 7 Superfund Technical Assessment and Response Team (START) conducted more sampling as part of a removal assessment requested by Region 7 EPA. To determine current contaminant concentrations in groundwater, 24 samples were collected from the monitoring wells on site and on adjacent property. The PCE results ranged from non-detect to 2,200 ppb. TCE was not detected in any of the samples. In comparison to previous sampling, PCE concentrations in most samples decreased except for the wells located in the southeastern area of the site (MW-10U, MW-13M, and MW-13U), and the northeastern area (MW-12M, MW-12U, and MW-15U). PCE concentrations in the four recovery wells ranged from 790 to 7,500 ppb. Additionally, in the July 2006 sampling event, 23 groundwater samples were collected from six Geoprobe® temporary wells (GPW-2 through GPW-7) located east (downgradient) of the former Dana property. The GPW samples had PCE concentrations in the range of 0.73 to 3,300 ppb.

More quarterly samples were collected in October 2006, February 2007, and March 2007. PCE results ranged from non-detect to 12,000 ppb; the greatest concentration was found in MW-07. PCE concentrations showed some fluctuation in the well samples with the exception of wells located north of the facility (MW-15U, and MW-14U) in which PCE concentrations increased.

In summary, review of the monitoring well data indicated that (1) the groundwater VOC contamination originated from the former degreaser areas; (2) an approximately 1.75-mile plume extends in an east-southeast direction from the former Dana facility; (3) the existing treatment systems appeared to be functioning; and (3) the full extent of contamination is not defined. Additional investigations to characterize the nature and extent of contamination should continue.

Child Health Considerations

ATSDR considers children in its evaluations of all exposures, and we use health guidelines that are protective of children. In general, ATSDR assumes that children are more susceptible to chemical exposures than are adults. CVs used for this evaluation are intended to represent exposures that could be continued for a lifetime for the general population—including potentially susceptible subgroups such as children—without appreciable health risks. Some recent studies have reported an association between exposure to VOCs in drinking water and adverse effects on reproduction and development. However, based on the available data that was reviewed for this Health Consultation and based on the exposure scenario developed for this site, no exposures to water from municipal or private wells were identified in this evaluation that are of public health concern for pregnant woman or children. For example, with regard to developmental effects of drinking water PCE exposure, ATSDR considers that the actual exposures would be much lower than the maximum concentrations of 130 ppb detected in municipal well 14 because 1) the well is used on an as-needed basis only and was shutdown during the winter months; 2) a review of the Hastings Utilities water production log indicated that the last use of this well was the summer of 2000 immediately after the detection of the maximum PCE concentration; and 3) water from this well is blended with water from other municipal wells before entering the distribution system therefore reduce the concentration of PCE in the tap water.

Conclusions

After reviewing the available environmental data, ATSDR determined that use of contaminated private and municipal water resulted in completed exposure pathways. Exposure to contaminants in the groundwater occurred through drinking the water, skin contact during showering or bathing, and inhaling VOC vapors released during water use.

Currently, programs are in place to eliminate exposures when contaminants are detected in municipal or private wells. For example, contaminated municipal wells were shut down and residents with impacted private wells were provided with bottled water initially and later either connected to the city water or installed whole house filtration systems.

ATSDR categorizes past exposure to VOCs and arsenic in drinking water from the site as a no apparent public health hazard because the levels of exposure are not anticipated to result in adverse health.

Available data for the city of Hastings municipal wells from 1972 to 2006 indicated that the maximum levels of 5 chemicals (4 VOCs and 1 metal) exceeded their respective comparison values. ATSDR's evaluation of site specific exposures determined that exposures to the levels of chemicals detected in municipal drinking water supply wells are unlikely to result in harmful cancer and noncancer health effects. There is no current exposure because the contaminated municipal wells were shut down and the municipal wells in use are monitored regularly.

VOC contaminants were detected in 11 private wells in the area. Although PCE and carbon tetrachloride concentrations in 6 drinking water wells exceeded their respective MCLs, all detected VOC concentrations are below levels known to result in adverse health effects. In addition, residents with affected wells were provided bottled water initially and later either connected to the city water or installed whole house filtration systems. One potentially impacted well, PW-10, has not been sampled because access was denied.

Monitoring well data indicated an approximately 1.75-mile plume that extends in an east-southeast direction from the former Dana facility and the full extent of contamination has not been defined.

Recommendations

ATSDR considers reducing or minimizing exposures to hazardous chemical contaminants a prudent public health measure. Therefore, ATSDR recommends:

1. Continue the remediation efforts to reduce to the VOC levels in groundwater.
2. Continue to monitor potentially affected private wells to ensure that VOC concentrations remain within drinking water standards.
3. Continue additional investigations to characterize the nature and extent of contamination from the site.
4. Provide education to residents on the required periodic maintenance for all private wells with whole house filtration systems.

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.

1. EPA and Garvey will continue the remediation efforts to reduce to the VOC levels in groundwater.
2. EPA and Garvey will continue monitoring potentially affected private wells to ensure that VOC concentrations remain within safe levels.
3. EPA and Garvey will continue additional investigations to characterize the nature and extent of contamination from the site.
4. EPA and Garvey will provide education to residents on the required periodic maintenance for all private wells with whole house filtration systems.
5. ATSDR will review additional environmental data if it becomes available.

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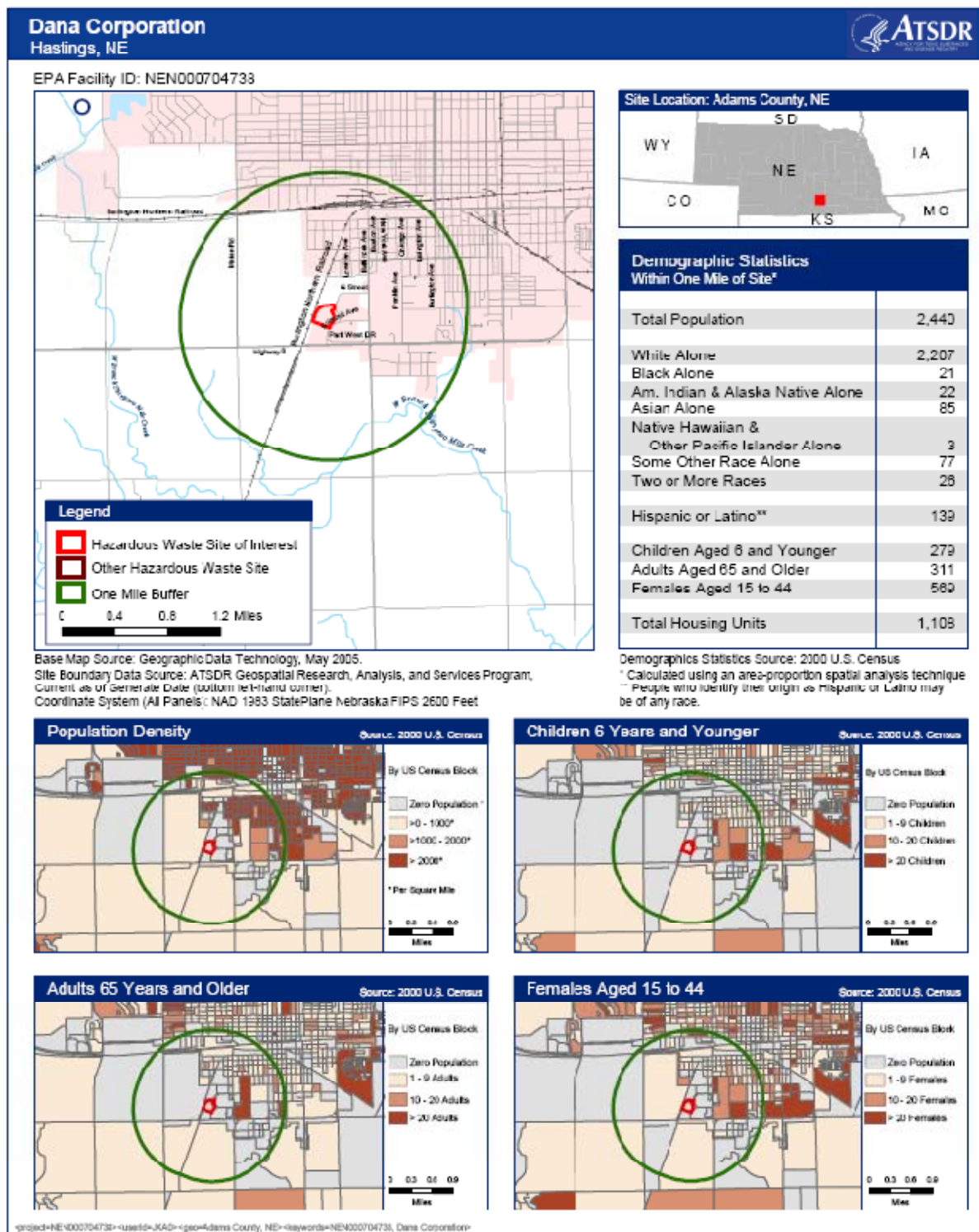
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Figure 1. Intro Map



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Figure 2. Well Location Map, West Highway 6 & Highway 281 Site

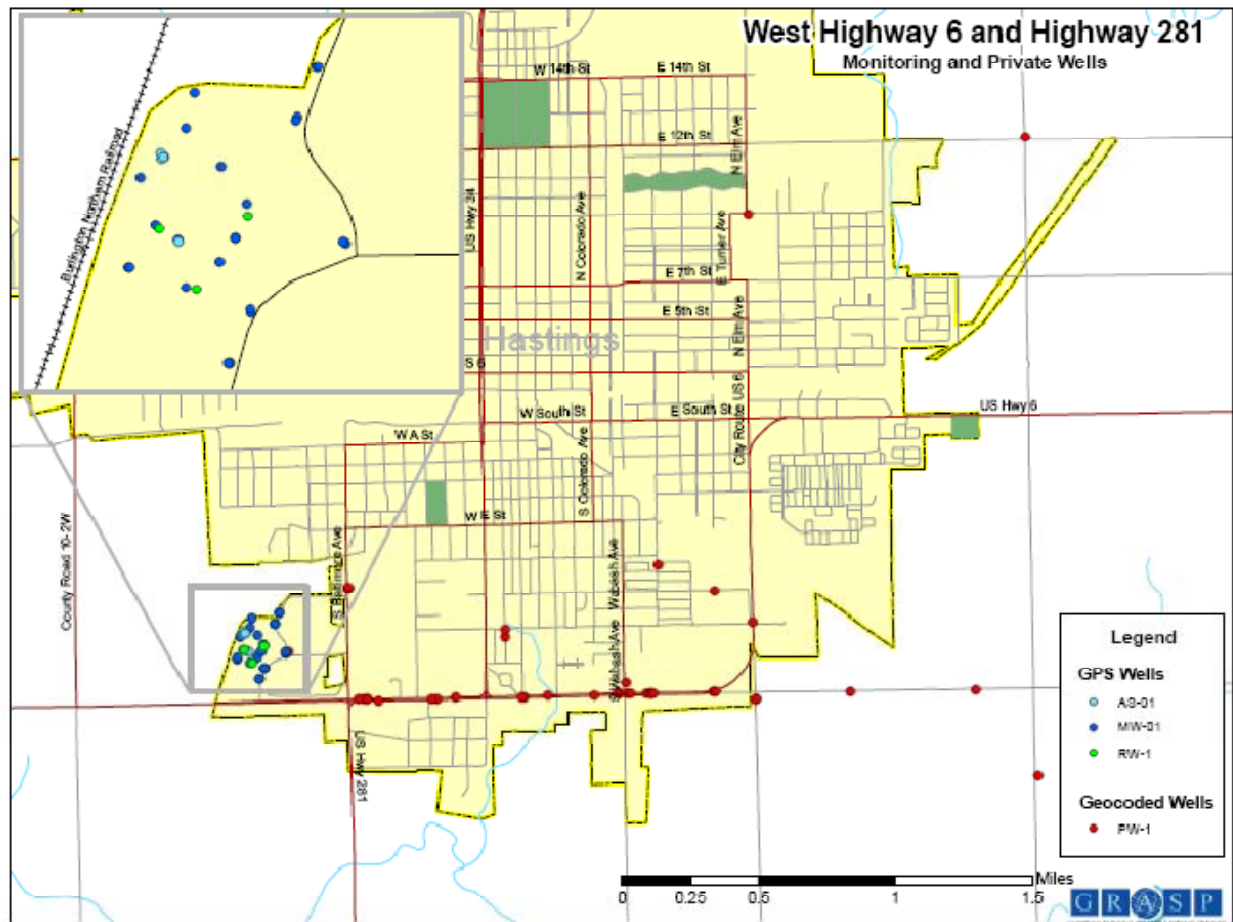


Table 1 - Summary of detected chemicals in the Municipal well (drinking water supply wells, irrigation wells and cooling water wells) water samples, Hastings, NE (1972 to 2007)

Chemical	Maximum Level (ppb)	Mean (ppb)	Median (ppb)
1,1,1-Trichloroethane	1.30	0.69	0.62
1,1-Dichloroethane	1.20	1.15	1.15
1,1-Dichloroethene	9.80	1.87	1.05
1,2-Dibromoethane	1.50	0.25	0.06
1,2-Dichloroethene, CIS-	9.60	1.61	0.48
Antimony	3.36	1.15	1.00
Arsenic	5.64	3.40	3.20
Atrazine	0.11	0.09	0.09
Barium	291.00	183.00	173.00
Bis(2-Ethylhexyl)Adipate	0.61	0.61	0.61
Bromoform	0.54	0.54	0.54
Calcium	63,200.00	58,600.00	58,000.00
Carbon Tetrachloride	240.00	30.20	5.00
Chloroform	1.00	0.55	0.53
Chromium	16.00	4.03	2.00
Copper	3,150.00	452.00	227.00
Di (2-Ethylhexyl) Pthalate	3.80	2.80	2.60
Dichlorodifluoromethane	0.92	0.79	0.79
Ethyl Benzene	0.50	0.50	0.50
Fluoride	390.00	323.00	320.00
Lead	53.80	3.38	1.98
Manganese	7.95	6.36	6.36
Methylene Chloride	0.64	0.64	0.64
Nickel	1,000.00	21.40	2.48
Selenium	20.00	10.80	10.20
Sodium	26,400.00	24,600.00	25,500.00
Stryene	3.40	2.10	2.10
Sulfate	87,300.00	40,900.00	39,400.00
Tetrachloroethylene	130.00	9.67	0.86
Toluene	0.94	0.94	0.94
Trichloroethylene	74.00	8.18	1.10

ppb - parts per billion

Sample means are calculated using detected samples only.

Table 2 - Summary of contaminants of concern for the municipal wells (drinking water supply wells, irrigation wells and cooling water wells), Hastings, NE (1972 to 2007)

Chemical	Maximum Value (ppb)	Mean (ppb)	Median (ppb)	Number of Samples	Number of Detections	Comparison Value (CV) (ppb)	CV Type	Completed exposure pathway
Arsenic	5.64	3.40	3.20	41	41	0.02	CREG	yes
Carbon Tetrachloride	240.00	30.20	5.00	35	31	0.30	CREG	yes
Di (2-Ethylhexyl) Phthalate	3.80	2.80	2.60	5	5	3.00	CREG	yes
Tetrachloroethylene	130.00	9.67	0.86	24	20	5.00	MCL	yes
Trichloroethylene	74.00	8.18	1.10	46	43	5.00	MCL	yes

Notes:

ppb - Parts per Billion

CREG -Cancer Risk Evaluation Guide for 1x10⁴ excess cancer risk.

MCL - Maximum Contaminant Level for drinking water set by EPA.

Table 3 - Summary of municipal well (drinking water supply wells, irrigation wells and cooling water wells) water samples for Tetrachloroethene (PCE)

Drinking water supply wells	Sample ID	PCE (ppb)	Sample Date	Well Average (ppb)
Hastings Municipal Well 13	25VA	0.50	12/9/1996	4.73
	26VA	1.00	3/18/997	
	30VA	17.20	11/10/1997	
	3092-101	ND (0.5)	7/18/2006	
Hastings Municipal Well 14	32VA	5.60	6/23/1998	29.90
	P15300-36	130.00	5/23/2000	
	P24828-37	7.30	4/19/2004	
	NA	3.00	10/25/2004	
	P27409-7	4.20	4/11/2005	
	P29613-6	32.00	5/24/2006	
	3092-102	ND (0.5)	7/18/2006	

Notes:

ppb - parts per billion.

ND - Not Detected. Vales in Parenthesis are the detection limit.

NA – not applicable

1/2 Detection Limit used for statistics

(Well13 and 14).

Table 4 - Summary of Trichloroethene (TCE) concentrations in municipal drinking water supply well samples

Municipal Drinking Water Supply Wells	Sample ID	Sample Date	Contaminant Value (ppb)	Detection Limit (ppb)
Hastings Municipal Well 13	3092-101	7/18/2006	ND	0.5
Hastings Municipal Well 14	28VA	4/28/1997	0.3	ND
Hastings Municipal Well 14	32VA	6/23/1998	0.2	ND
Hastings Municipal Well 14	P15754-21	6/13/2000	0.42	0.19
Hastings Municipal Well 14	P22707-37	4/29/2003	0.65	ND
Hastings Municipal Well 14	P24828-37	4/19/2004	1.3	0.19
Hastings Municipal Well 14	P25681-8	7/7/2004	0.73	0.19
Hastings Municipal Well 14	NA	10/25/2004	1.2	1
Hastings Municipal Well 14	P26465-8	11/1/2004	0.76	0.19
Hastings Municipal Well 14	P27041-8	3/29/2005	0.64	ND
Hastings Municipal Well 14	P27409-7	4/11/2005	0.75	ND
Hastings Municipal Well 14	P28665-7	10/3/2005	2	0.19
Hastings Municipal Well 14	23VA	2/6/1996	0.3	0.19
Hastings Municipal Well 14	P29613-6	5/24/2006	0.87	ND
Hastings Municipal Well 14	3092-102	7/18/2006	ND	0.5
Hastings Municipal Well 11	21VA	2/27/1995	3.6	0.19
Hastings Municipal Well 11	27VA	4/28/1997	2.6	0.19
Hastings Municipal Well 11	31VA	6/23/1998	3.2	0.19

Notes:

ppb - parts per billion ND = not detected

Table 5 - Summary of detected chemical concentrations in private wells

Well ID	Well Status	Analytical Results (mg/L)			
		PCE	TCE	cis-1-2, DCE	Carbon Tetrachloride
PW-1	Bottled water (2005) On city water (2006)	21 65	ND (1.0)	ND (1.0)	ND (1.0)
PW-2	Vacant On city water	230	ND (1.0)	ND (1.0)	ND (1.0)
PW-3	Bottled water (2005) On city water	330	ND (1.0)	ND (1.0)	ND (1.0)
PW-4	Bottled water On city water	ND (1.0)	ND (1.0)	ND (1.0)	16
PW-5	Bottled water Whole house filtration (2006)	ND (0.50)	ND (0.50)	ND (0.50)	23
PW-6	Sampled by EPA and Garvey. No VOCs detected.	NA	NA	NA	NA
PW-7	Sampled by EPA and Garvey. Whole house filtration.	ND (0.50)	1.3	ND (0.50)	ND (0.50)
PW-8	Irrigation only. On city water (1986)	1.3	ND (0.50)	ND (0.50)	ND (0.50)
PW-9	Irrigation only. On city water (1988)	NA	NA	NA	NA
PW-10	Vacant building. No sample.	NA	NA	NA	NA
PW-11	Vacant building. No sample. On city water.	NA	NA	NA	NA
PW-12	On city water	NA	NA	NA	NA
PW-13	Routinely sampled by Garvey.	ND (0.50)	ND (0.50)	ND (0.50)	21
PW-14	Not used for drinking.	4.9	5.4	9.6	ND (0.50)
PW-15	Resident refused access to building. No sample.	NA	NA	NA	NA
PW-16	No VOCs detected.	NA	NA	NA	NA
PW-17	On city water (1990's).	NA	NA	NA	NA
PW-18	On city water	NA	NA	NA	NA
PW-19	Bottled water (Sep 2005). On city water.	ND (0.50)	ND (0.50)	ND (0.50)	5.2
PW-20	On city water	NA	NA	NA	NA
PW-21	On city water	NA	NA	NA	NA
PW-22	On city water	NA	NA	NA	NA

Table 5 - Summary of detected chemical concentrations in private wells (continued)

Well ID	Well Status	Analytical Results (mg/L)			
		PCE	TCE	cis-1-2, DCE	Carbon Tetrachloride
PW-23	On city water	NA	NA	NA	NA
PW-24	On city water	NA	NA	NA	NA
PW-25	On city water	NA	NA	NA	NA
PW-26	On city water	NA	NA	NA	NA
PW-27	On city water	NA	NA	NA	NA
PW-28	On city water	NA	NA	NA	NA
PW-29	On city water	NA	NA	NA	NA
PW-30	On city water	NA	NA	NA	NA
PW-31	Residents use well water. No sample.	NA	NA	NA	NA
PW-32	On city water	NA	NA	NA	NA
PW-33	On city water	NA	NA	NA	NA
PW-34	On city water	NA	NA	NA	NA
PW-35	On city water	NA	NA	NA	NA
PW-36	On city water	NA	NA	NA	NA
PW-37	On city water	NA	NA	NA	NA
PW-38	Heat pump well.	ND	ND	ND	ND
PW-39	Heat pump well.	16	ND	ND	ND
PW-40	Irrigation well. Not in use. No sample.	NA	NA	NA	NA
PW-41	Well inoperable. No sample.	NA	NA	NA	NA
PW-42	Irrigation Well No.1. No sample.	NA	NA	NA	NA
PW-43	Irrigation Well No. 2. No sample.	NA	NA	NA	NA
PW-44	Irrigation well. No sample.	NA	NA	NA	NA
PW-45	Irrigation well. No sample.	NA	NA	NA	NA

Notes: ppb = parts per billion
 NA = data not available
 ND = not detected. Number in parenthesis is the detection limit.
 TCE - trichloroethene
 PCE - tetrachloroethene
 cis-1-2, DCE – Dichloroethene

Appendix A. Dose Calculation for Estimating Drinking Water Exposure Doses

The pathway by which residents can be exposed to contaminants at the site is ingestion of contaminated drinking water. Inhalation and dermal exposures from indoor water use (showering and washing) are also considered for VOCs detected in the drinking water system.

Dose calculation for arsenic and DEHP

The following assumptions were made to estimate ingestion exposure dose for non-VOCs (arsenic and DEHP) found in municipal drinking water supply wells:

The following equation was used:

$$\text{Ingestion Dose} = \text{Water Concentration} \times \text{Intake Rate} \times \text{Exposure Factor} / \text{Body Weight}$$

According to EPA's Child Specific Exposure Factor Handbook, the average 1-2 year old child living in the United States consumes, on average, approximately 0.3 liters of water per day and weighs, on average, approximately 11.4 kg (Child Specific Exposure Factor Handbook, 2008). According to EPA's Exposure Factors Handbook, an average adult living in the United States consumes, on average, approximately 1.41 liters of water per day and weighs, on average, approximately 70 kg (U.S. EPA's Exposure Factors Handbook, 1997). A conservative Exposure Factor of 1 was used to assume a daily exposure.

The following table shows the estimated ingestion exposure doses for non-VOCs:

Chemicals	Concentration in municipal well (ppb) (maximum)	Estimated ingestion Doses in children (mg/kg/day)	Estimated ingestion Doses in adult (mg/kg/day)	MRL/RfD (mg/kg/day)
DEHP	3.8	0.00010	0.00008	0.06 (MRL)
Arsenic	5.6	0.00015	0.00011	0.0003 (MRL)

Dose calculations for PCE, TCE, and carbon tetrachloride

Total exposure dose is the estimated dose from ingestion intake, inhalation intake, and dermal intake.

The following equations were used:

$$\text{Ingestion Dose} = \text{Water Concentration} \times \text{Intake Rate} \times \text{Exposure Factor} / \text{Body Weight}$$

According to EPA's Child Specific Exposure Factor Handbook, the average 1-2 year old child living in the United States consumes, on average, approximately 0.3 liters of water per day and weighs, on average, approximately 11.4 kg (Child Specific Exposure Factor Handbook, 2008). According to EPA's Exposure Factors Handbook, an average adult living in the United States consumes, on average, approximately 1.41 liters of water per day and weighs, on average, approximately 70 kg (U.S. EPA's Exposure Factors

Handbook, 1997). A conservative Exposure Factor of 1 was used to assume a daily exposure.

The following table shows the estimated ingestion exposure doses for VOCs:

<i>Chemicals</i>	<i>Concentration in private well (ppb) (maximum)</i>	<i>Estimated ingestion doses in children (mg/kg/day)</i>	<i>Estimated ingestion doses in adults (mg/kg/day)</i>
PCE	330	0.00868	0.00665
TCE	4	0.00011	0.00008
Carbon tetrachloride	23	0.00061	0.00046
<i>Chemicals</i>	<i>Concentration in municipal drinking water supply well (ppb) (maximum)</i>	<i>Estimated ingestion doses in children (mg/kg/day)</i>	<i>Estimated ingestion doses in adults (mg/kg/day)</i>
PCE	130	0.00342	0.00262
TCE	3.6	0.00009	0.00007
Carbon tetrachloride	5	0.00013	0.00010

$$\text{Inhalation Dose} = C \text{ Air Max} \times \text{Inhalation Rates} / \text{Body Weight}$$

where,

C Air Max = maximum concentration in air during the shower and after period in bathroom = $k \times Fw \times Ts \times Cw / Va$

K = fraction of chemical that evaporates from water while showering (assumed to be 0.6),

Fw = flow rate of water through shower head in L/minute (assumed to be 8 liters/minute),

Ts = duration of shower in minutes (assumed to be 10 minutes for shower and 20 minutes stay after shower in bathroom),

Cw = concentration of chemical in water in mg/L, and

Va = volume of shower and bathroom in liters, (assumed to be 10,000 liters (10 m³), the approximate size of a small bathroom).

According to EPA's Exposure Factors Handbook, for adults the assumed breathing rate for light activity is 1.39 m³/hr = 0.695 m³/half-hr (U.S. EPA's Exposure Factors Handbook, 1997, Table 5-6, female and male average); for children the assumed breathing rate for light activity is 0.72 m³/hr = 0.36 m³/half-hr (Child-Specific Exposure Factor Handbook, September 2008, Table 6-2).

The following table shows the estimated inhalation exposure doses for VOCs:

<i>Chemicals</i>	<i>Concentration in private well (ppb) (maximum)</i>	<i>Estimated inhalation doses in children (mg/kg/day)</i>	<i>Estimated inhalation doses in adults (mg/kg/day)</i>
PCE	330	0.15006	0.04718
TCE	4	0.00182	0.00057
Carbon tetrachloride	23	0.01046	0.00329
<i>Chemicals</i>	<i>Concentration in municipal drinking water supply well (ppb) (maximum)</i>	<i>Estimated inhalation doses in children (mg/kg/day)</i>	<i>Estimated inhalation doses in adults (mg/kg/day)</i>
PCE	130	0.05912	0.01859
TCE	3.6	0.00164	0.00051
Carbon tetrachloride	5	0.00227	0.00071

Dermal Dose = Skin Permeability constant x Duration of Exposure x Total Body Surface Area x Percent of Body Surface Area Exposed x Chemical Concentration in Water x Fraction Remaining After Volatilization x Conversion Factor / Body Weight

Units: Skin Permeability Constant =cm/hr; Duration of Exposure= hr (assumed to be 10 minutes for shower); Total Body Surface Area= cm²; Percent of Body Surface Area Exposed = cm² hr (assumed to be 100% while in shower); Chemical Concentration in Water= mg/L; Fraction Remaining After Volatilization = expressed as percentage; Conversion Factor =1 L/1,100 cm³; Body Weight=kg.

The permeability constant for chlorinated organic chemicals is assumed to be 0.001 L/cm-hr (Brown et al. 1984) and 40% of the chemicals are assumed to remain in the shower water after volatilization (Andelman 1985, McKone 1991). For skin surface area, the assumed area is 18,150 cm² for adults (U.S. EPA 1997) and 5,300 cm² for children (Child-Specific Exposure Factor Handbook, September 2008, Table 7-1).

The following table shows the estimated dermal exposure doses for VOCs:

<i>Chemicals</i>	<i>Concentration in private well (ppb) (maximum)</i>	<i>Estimated dermal doses in children (mg/kg/day)</i>	<i>Estimated dermal doses in adults (mg/kg/day)</i>
PCE	330	0.01023	0.00570
TCE	4	0.00012	0.00007
Carbon tetrachloride	23	0.00071	0.00040
<i>Chemicals</i>	<i>Concentration in municipal drinking water supply well (ppb) (maximum)</i>	<i>Estimated dermal doses in children (mg/kg/day)</i>	<i>Estimated dermal doses in adults (mg/kg/day)</i>
PCE	130	0.00403	0.00225
TCE	3.6	0.00011	0.00006
Carbon tetrachloride	5	0.00015	0.00009

Total Dose = the sum of all doses (ingestion + inhalation + dermal = total dose)

The following table shows the estimated total exposure dose from all routes combined:

<i>Chemicals</i>	<i>Concentration in private well (ppb) (maximum)</i>	<i>Estimated total doses in children (mg/kg/day)</i>	<i>Estimated total doses in adults (mg/kg/day)</i>	<i>LOAEL/NOAEL (mg/kg/day)</i>	<i>References</i>
PCE	330	0.16898	0.05953	108 (LOAEL)	ATSDR 1997
TCE	4	0.00205	0.00072	0.05 (LOAEL)	Johnson, et al., 2003
Carbon tetrachloride	23	0.01178	0.00415	0.71(NOAE)	ATSDR 2005b
<i>Chemicals</i>	<i>Concentration in municipal drinking water supply well (ppb) (maximum)</i>	<i>Estimated total doses in children (mg/kg/day)</i>	<i>Estimated total doses in adults (mg/kg/day)</i>	<i>LOAEL/NOAEL (mg/kg/day)</i>	<i>References</i>
PCE	130	0.06657	0.02345	108 (LOAEL)	ATSDR 1997
TCE	3.6	0.00184	0.00065	0.05 (LOAEL)	Johnson, et al., 2003
Carbon tetrachloride	5	0.00256	0.00090	0.71 (NOAEL)	ATSDR 2005b

Appendix B. ATSDR's comparison values and definitions

ATSDR comparison values (CVs) are media-specific concentrations considered safe under default exposure scenario. 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 an exposure pathway such as 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.

For example, the ATSDR minimal risk levels (MRLs) are estimate doses of daily human exposure to hazardous substances that are not likely to pose an appreciable risk of adverse noncancer health effects over a specified route and duration of exposure. These values derived for substances on the basis of noncancerous effects by factoring the most relevant documented NOAEL (no observed adverse effect level) or LOAELs (lowest observed adverse effect level) and an uncertainty factor (typically range from 10 to 1,000 or more).

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

AL = action level

CREG = cancer risk evaluation guide

EMEG = environmental media evaluation guides

RMEG = reference dose media evaluation guide

MRLs = minimal risk levels

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

m³ = cubic meter (= 1,000 liters)

action level (AL): The concentration of lead or copper in tap water which determines whether a system may be required to install corrosion control treatment, collect WQP samples, collect lead and copper source water samples, replace lead service lines, and/or deliver public education about lead. The action level for lead is 0.015 mg/L or 15 ppb in more than 10% of customer taps sampled. The action level for copper is 1.3 mg/L or 1300 ppb in more than 10% of customer taps sampled.

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.

life time health advisory (LTHA): The concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects for a lifetime of exposure. The Lifetime HA is based on exposure of a 70-kg adult consuming 2 liters of water per day. The Lifetime HA for Group C carcinogens includes an adjustment for possible carcinogenicity.

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.

maximum contaminant level (MCL): The MCL represents contaminant concentrations in drinking water that EPA deems protective of public health (considering the availability and economics of water treatment technology) over a lifetime (70 years) at an exposure rate of 2 liters of water per day.

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.

reference dose media evaluation guide (RMEG): The concentration of a contaminant in air, water, or soil that corresponds to EPA's RfD for that contaminant when default values for body weight and intake rates are taken into account.

reference dose (Rfd): An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is likely to cause harm to humans.

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

Appendix C. ATSDR's levels of public health hazard

Category A: Urgent Public Health Hazard

This category is used for sites where short-term exposures (<1 year) to hazardous substances or conditions could result in adverse health effects that require rapid intervention.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Evaluation of available relevant information* indicates that site-specific conditions or likely exposures have had, are having, or are likely to have an adverse impact on human health that requires immediate action or intervention. Such site-specific conditions or exposures may include the presence of serious physical or safety hazards, such as open mine shafts, poorly stored or maintained flammable or explosive substances, or medical devices, which, if ruptured, could release radioactive materials.

Category B: Public Health Hazard

This category is used for sites that pose a public health hazard because of the existence of long-term exposures (>1 yr) to hazardous substances or conditions that could result in adverse health effects.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Evaluation of available relevant information* suggests that, under site-specific conditions of exposure, long-term exposures to site-specific contaminants (including radionuclides) have had, are having, or are likely to have an adverse impact on human health that requires one or more public health interventions. Such site-specific exposures may include the presence of serious physical hazards, such as open mine shafts, poorly stored or maintained flammable or explosive substances, or medical devices, which, if ruptured, could release radioactive materials.

Category C: Indeterminate Public Health Hazard

This category indicates that a professional judgment on the level of health hazard cannot be made because information critical to such a decision is lacking.

Criteria:

This category is used for sites for which available *critical* data are insufficient with regard to the extent of exposure and/or toxicological properties at estimated exposure levels. Using professional judgment, the health assessor must determine the importance of such data and the likelihood that the data can and will be obtained in a timely manner.

Where some data—even limited data—are available, health assessors should, to the extent possible, select other hazard categories and support their decision with a clear narrative that explains the limits of the data and the rationale for the decision.

Category D: No Apparent Public Health Hazard

This category designates sites where human exposure to contaminated media may be occurring, may have occurred in the past, and/or may occur in the future, but the exposure is not expected to cause any adverse health effects.

This determination represents a professional judgment based on critical data that ATSDR has judged sufficient to support a decision. Such a designation does not necessarily mean that the available data are complete; in some cases, additional data may be required to confirm or further support the decision made.

Criteria:

Available relevant information* indicates that, under site-specific conditions of exposure, exposures to site-specific contaminants in the past, present, or future are not likely to result in adverse impact on human health.

Category E: No Public Health Hazard

This category is used for sites that, because of the absence of exposure, do *not* pose a public health hazard.

Criteria:

Sufficient evidence indicates that no human exposures to contaminated media have occurred, none are occurring, and none are likely to occur in the future.

** Examples include environmental, demographic, health outcome, exposure, toxicological, medical, or epidemiologic data, as well as community health concerns information.*