Health Consultation

Site Update and Review

Northern Engraving Corporation/Ceridian Corporation
Spring Grove Site

SPRING GROVE, HOUSTON COUNTY, MINNESOTA

EPA FACILITY ID: NA

February 13, 2015

Prepared by the

Minnesota Department of Health, Environmental Health Division

Under Cooperative Agreement with the

Agency for Toxic Substances and Disease Registry

U.S. Department of Health and Human Services

This document has not been reviewed and cleared by ATSDR.

FOREWORD

This document summarizes public health concerns related to contamination at a site in Minnesota. It is based on a formal evaluation prepared by the Minnesota Department of Health (MDH). For a formal site evaluation, a number of steps are necessary:

- *Evaluating exposure:*
  MDH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present and how people might be exposed to it. Usually, MDH does not collect its own environmental sampling data. Rather, MDH relies on information provided by the Minnesota Pollution Control Agency (MPCA), the US Environmental Protection Agency (EPA), and other government agencies, private businesses, and the general public.

- *Evaluating health effects:*
  If there is evidence that people are being exposed—or could be exposed—to hazardous substances, MDH scientists will take steps to determine whether that exposure could be harmful to human health. MDH's report focuses on public health— that is, the health impact on the community as a whole. The report is based on existing scientific information.

- *Developing recommendations:*
  In the evaluation report, MDH outlines its conclusions regarding any potential health threat posed by a site and offers recommendations for reducing or eliminating human exposure to pollutants. The role of MDH is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. If, however, an immediate health threat exists, MDH will issue a public health advisory to warn people of the danger and will work to resolve the problem.

- *Soliciting community input:*
  The evaluation process is interactive. MDH starts by soliciting and evaluating information from various government agencies, the individuals or organizations responsible for the site, and community members living near the site. Any conclusions about the site are shared with the individuals, groups, and organizations that provided the information. Once an evaluation report has been prepared, MDH seeks feedback from the public. If you have questions or comments about this report, we encourage you to contact us.

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List of Acronyms

CW	City Well
DCE	cis-1,2-dichloroethylene
EPA	United States Environmental Protection Agency
GAC	granular activated carbon
HBV	Health Based Value
HRL	Health Risk Limit
MCL	Maximum Contaminant Limit
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MPCA	Minnesota Pollution Control Agency
MW	monitoring well
NEC	Northern Engraving Corporation
ppb	parts per billion
RAL	Recommended Allowance Limit
TCE	trichloroethylene
SWBCA	Special Well and Boring Construction Area
WPA	Wellhead Protection Area

I. Summary

INTRODUCTION

The Minnesota Department of Health's (MDH) mission is to protect, maintain, and improve the health of all Minnesotans.

For communities living near state or federal Superfund sites, MDH's goal is to protect people's health by providing health information the community needs to take actions to protect their health. MDH also evaluates environmental data, and advises MPCA, MDA and local governments on actions that can be taken to protect public health.

The Northern Engraving Corporation/Ceridian Corporation (NEC) is located on property formerly owned by Control Data Corporation, in the city of Spring Grove, Minnesota. Soil and groundwater beneath the site is contaminated with trichloroethylene (TCE) which has also been detected in three of the city's four water supply wells and several private wells at homes and businesses. NEC has worked with the Minnesota Pollution Control Agency (MPCA) to investigate and clean up the site through a combination of soil excavation, soil vapor extraction, and a groundwater pump-and-treat system. However, the TCE concentrations in the treated water from City Well #3 (CW-3) exceed the new MDH Health Based Value (HBV) of 0.4 parts per billion (ppb). As a result, additional sampling and treatment options are being considered.

OVERVIEW

This report summarizes the current status of the site with respect to human exposure to site-related contaminants and provides recommendations regarding additional actions needed to protect public health. MDH reached three main conclusions in this Health Consultation update of the Northern Engraving Corporation/Ceridian Corporation Spring Grove site.

CONCLUSION 1

TCE is found in one of two municipal drinking water wells. Concentrations from CW-3 after treatment are below the Maximum Contaminant Level (MCL), but above the MDH HBV.

BASIS FOR CONCLUSION	Sampling since 1984 has detected TCE in Spring Grove's municipal wells. In March 2014, CW-3 contained 26 ppb TCE, which was reduced to 2.4 ppb TCE after treatment. The distribution system at that time contained TCE at 1.7 ppb and 2.1 ppb at two different locations. The July 2014 sample from CW-3 after treatment contained 2.1 ppb TCE.
NEXT STEPS	Additional treatment of the water from CW-3 is needed to reduce TCE levels below the new HBV. City Well #4 (CW-4), which does not contain TCE, has been used as the lead well since April 2014. CW-4 should continue to be used until additional treatment for CW-3 is installed.
CONCLUSION 2	Private wells need continued monitoring for TCE and well advisories issued if concentrations exceed the MDH HBV.
BASIS FOR CONCLUSION	One private well in 2013 sampling exceeded the MDH HBV for TCE, several others had detections between 0.1 – 0.4 ppb, and more are likely present in areas where groundwater may be contaminated with TCE.
NEXT STEPS	Sample additional private wells to define the area in which TCE in groundwater exceeds the lab reporting level (0.1 ppb), provide treatment to any wells that exceed the HBV, and continue sampling any private wells with detections of TCE below the HBV to ensure they do not exceed allowable levels in the future.
CONCLUSION 3	TCE vapor may be moving into the indoor air in buildings above and near the groundwater plume and source area. Movement of contaminants from soil or groundwater to indoor air is called vapor intrusion.
BASIS FOR CONCLUSION	Buildings are present near areas where there are high TCE concentrations in the groundwater.
NEXT STEPS	A vapor intrusion investigation is needed to determine if vapor intrusion is occurring.

II. Introduction

Spring Grove is located in southeastern Minnesota (see Figure 1) and has a population of approximately 1,300. In 1984, routine monitoring of Spring Grove's municipal wells by MDH identified trichloroethylene (TCE) contamination at 33 ppb in City Well #3 (CW-3) (MPCA, 1998). The source of the contamination was identified as the site of the Northern Engraving Corporation (NEC), which had previously been used by Control Data Corporation (now Ceridian Corporation) as a printed circuit board manufacturing facility. Ultimately, TCE concentrations in the municipal water were reduced by use of an air stripper on CW-3 and the installation of a new well (City Well #4; CW-4). Granular activated carbon (GAC) treatment systems have been installed at residences where TCE concentrations are above drinking water standards. MDH wrote a Health Consultation on the site contamination (MDH, 1999) and established a Special Well and Boring Construction Area (SWBCA) in 2007 (shown in Figure 1). In 2013, MDH completed a toxicological review of TCE and subsequently lowered the drinking water guidance value for TCE from 5 ppb to 0.4 ppb. As a result, additional sampling of private wells was completed in the area and the results compared to the new HBV; one well was found to exceed 0.4 ppb and was provided a GAC filter system. This document serves to compile site history and provide an update of the current site conditions.

III. Background and Site History

Municipal Wells

In June 1984, MDH first detected TCE in Spring Grove CW-3 at 33 ppb and City Well #2 (CW-2) at 1.1 ppb. All three of the city wells were sampled later that year and City Well #1 (CW-1) was found to contain 100 ppb TCE. CW-1 has never been used due to sand entering the well (MPCA, 1987b). Because of the contamination, CW-3 was removed from service in November 1984 and CW-2 was used for all of the demand (MPCA, 1987b). However, to meet peak summer demand, a temporary carbon filter was installed in August 1985 to treat water from CW-3 (MPCA, 1987b). Subsequently, CW-3 was only used to supply non-contact cooling water to the Northern Engraving plant (MPCA, 1987). By November 1986, TCE concentrations in the municipal wells increased significantly, with CW-2 at 9 ppb and CW-3 at 53 ppb (MPCA, 1987b). By December of 1986, TCE in CW-2 rose to 12 ppb (Eder Associates, 1987b). CW-2 was still meeting the drinking water standard for TCE at that time, which was the MDH Recommended Allowable Limit (RAL) of 31 ppb (MPCA, 1989a).

In 1987, the city began drilling an additional well (CW-4) into a deeper aquifer outside the area of TCE contamination. Also in 1987, treatment of CW-3 by air stripping was selected as the best long-term solution to the city's water supply needs (an air stripper moves air through contaminated water to help evaporate volatile chemicals). CW-4 was planned to be the secondary well. CW-2 continued to supply the city's water and contained 16 ppb TCE by December 1987 (MPCA, 1987a). In June and July of 1988 the city water from CW-2 was tested weekly to ensure it remained below the MDH RAL. The concentrations ranged from 15-28 ppb (MPCA, 1989a). CW-4 began operating in the summer/fall of 1988 (MPCA, 1989a).

In March 1989, the air stripper on CW-3 began operation. This reduced the TCE in the water to below 2 ppb (MPCA, 1989b), meeting the new drinking water standard [the federal Maximum Contaminant Level (MCL) of 5 ppb that was established by U.S. Environmental Protection Agency (EPA) that year]. CW-2 was no longer used and CW-3 and CW-4 have been providing the public water supply since 1989. CW-3 is the primary water supply for the city (Gannett Fleming, 2014). TCE concentrations measured in CW-3 after treatment since 1994 can be found in Table 1.

MDH is currently assisting the city in preparing a Wellhead Protection Plan for the city wells. This will include designating a wellhead protection area (WPA) and a plan for the city to manage potential contamination sources within the WPA.

Carbon Treatment of Private Wells

A number of private wells were also contaminated with TCE (See Section V below). Whole-house treatment systems (using granular activated carbon, or GAC) were provided by Northern Engraving/Ceridian if the TCE concentration was above 5 ppb. Six treatment systems were installed in 1988 (Gannett Fleming, 2014). Three of these systems are no longer operated – one business connected to municipal water, another no longer uses its well for potable water, and one served a residence that is now vacant.

MDH designated a Special Well and Boring Construction Area (SWBCA) in 2007 to ensure people are not exposed to TCE or other contaminants at levels of health concern. A SWBCA is a mechanism that controls drilling or alteration of public and private water supply wells, and monitoring wells in an area where groundwater contamination has, or may, result in risks to the public health. The boundaries of the SWBCA are shown on Figure 1 and encompass land sections 11, 12, 13, and 14.

Geology and Hydrology

The city of Spring Grove is underlain by a generally thin (less than 20 feet) layer of sand, gravel, and clays that were deposited by glaciers and by melt-water streams as the glaciers retreated. The bedrock beneath these deposits consists of layers of sandstone, limestone, dolomite, and shale (Broussard, et al., 1975). The uppermost of these is the Galena Dolomite, which is underlain by the Decorah Shale, Platteville Limestone, and Glenwood Shale. These three formations below the Galena Dolomite are referred to as “aquitards”, meaning they help to slow (or retard) the movement of groundwater and contaminants to the lower formations. However, in the Spring Grove area, these formations are permeable enough that water and contaminants can move downward through them. Beneath the Glenwood Shale is the St. Peter Sandstone, which in turn is underlain by the Prairie du Chien Group (mainly dolomite), Jordan Sandstone, St. Lawrence Formation (another aquitard composed of dolomite and shale), Lone Rock Formation (sandstone and shale, formerly known as the Franconia Formation), and the Wonewoc Sandstone (formerly known as the Ironton Sandstone and Galesville Sandstone). A geologic column showing the formations described above is provided in Figure 2.

Although groundwater may be encountered in the Galena Dolomite, and some wells in the area draw water from the St. Peter Sandstone, the majority of wells in the Spring Grove area draw water from either the Prairie du Chien-Jordan or Wonewoc aquifers. An “aquifer” is a bedrock unit in which all the pore space and fractures are filled with groundwater and is permeable enough to supply water to a pumping well. Spring Grove’s CW-1, CW-2 and CW-3 are completed in the Jordan Sandstone and CW-4 is completed in the deeper Wonewoc Sandstone.

Spring Grove is located on a ridge between the Upper Iowa River watershed to the south and the Root River watershed to the north. These rivers are major discharge points for both surface water and groundwater in this area. As a result, groundwater in the northernmost part of Spring Grove tends to flow north toward the Root River, while groundwater beneath most of the city tends to flow south toward the Upper Iowa River. Water level data for the area indicates that groundwater south of the divide and beneath the western part of Spring Grove tends to flow to the south-southwest while groundwater beneath the eastern part of the city tends to flow to the south-southeast. The approximate location of this groundwater divide and general groundwater flow directions are shown in Figure 3.

Remedial Investigations and Response Actions

Site investigations in 1986 and 1987 located the source of the TCE contamination in the soil at the Northern Engraving Corporation site, previously occupied by Control Data Corporation (now Ceridian Corporation) (Eder Associates, 1987a). Infiltrating rainwater leached TCE to shallow groundwater and it likely entered the Prairie du Chien-Jordan Aquifer through uncased abandoned or inactive private wells that were open to the Galena through Prairie du Chien aquifers (Eder Associates, 1987a) and by leakage through the Decorah-Platteville-Glenwood aquitard (Blum, 2014). Four uncased wells were identified, lined with steel casings to prevent the wells from being open to more than one aquifer, and converted to monitoring wells (MW-1 to MW-4) (Eder Associates, 1987a; Ceridian, 2003). MDH was unable to find any sampling results from MW-3 and MW-4, which reportedly were sampled at least twice in the mid-1980s (NEC, 2015; MPCA, 2014). At that time TCE concentrations in MW-4 were found to be below the MCL and thereafter used only for monitoring water levels, but MPCA has requested that it be sampled again in early 2015 (MPCA, 2014). Although no record exists of the TCE concentrations detected in MW-3, it too has been used only for measuring water levels since the late 1980s. Two more shallow monitoring wells (MW-5A and MW-5B) were installed at NEC; however MW-5B typically has been dry since installation (Ceridian, 2003; Gannett Fleming, 2014). Well locations are shown on Figure 4.

In 1988, the source area soil was capped with asphalt to prevent further leaching of TCE (Ceridian, 2003). In March 1989, CW-1 was converted to an extraction well to remove TCE from the aquifer and prevent further downgradient migration (Ceridian, 2003). CW-1 discharged over a stair-step cascade to passively aerate the water to reduce the level of TCE prior to discharge to surface water (Eder Associates, 1989). This well is now pumped prior to quarterly sampling for VOCs (NEC, 2015; Table 2).

CW-3 is also considered a remediation well, because pumping it and treating the water for the city's drinking water reduces the amount of TCE in the aquifer and helps limit its downgradient migration (Gannett Fleming, 2014).

MW- 5A and MW-2 were converted to extraction wells in 1991 and 1993, respectively (Ceridian, 2003). Initially, TCE in groundwater pumped from MW-5A was removed by carbon treatment prior discharge to the sanitary sewer (Ceridian, 2003). Groundwater pumped from MW-2 was discharged directly to the sanitary sewer (Ceridian, 2003).

In 2000, a vapor extraction system was installed at MW-5A (Ceridian, 2003). During installation of the system, approximately 30-35 cubic yards (42 tons) of TCE-contaminated soil were excavated at the source area (Ceridian, 2003). Low levels of TCE remain in some soils at the site which are capped with asphalt to reduce leaching of TCE to the groundwater (Gannett Fleming, 2014). In 2010, the vapor extraction system was temporarily shut off, at the request of MPCA, to provide an accurate baseline of TCE concentrations that still exist in the groundwater (Gannett Fleming, 2014). It was then restarted in January 2012, run intermittently in 2013, and will continue to operate until air emissions monitoring results indicate it is not needed (Gannett Fleming, 2014).

In early 2011, pumping from CW-1 was stopped at the request of the MPCA to allow an evaluation of TCE concentrations over time under non-pumping conditions (Gannett Fleming, 2014). It was restarted in 2012 to measure rebound of the water levels and TCE concentrations. Private wells, city wells, monitoring wells, and several surface water locations continue to be sampled regularly (Gannett Fleming, 2014).

Although TCE concentrations in the groundwater at and near the source area remain high and continue to fluctuate, they have been decreasing over time in samples from monitoring wells, CW-1, CW-2 and CW-3 (Table 2, Figures 5a and 5b). Also the area of higher TCE concentrations (greater than 30 ppb) appears to be decreasing (Gannett Fleming, 2014). However, there is insufficient information provided in site reports to evaluate whether pumping of CW-3 provides sufficient three-dimensional capture of the groundwater to prevent TCE from continuing to migrate away from the site.

IV. Chemicals of Interest

Trichloroethylene (TCE)

Trichloroethylene (TCE) is a nonflammable, colorless liquid with a chloroform-like odor. Production of TCE began commercially in the 1920s (USEPA, 2011). Historically, the most important use of TCE has been vapor degreasing of metal parts (ATSDR, 2014). In 2004, 73% of TCE use in the U.S. was estimated to be as a feedstock for HRC-134a, a refrigerant that was introduced as a replacement for CFC-12 in the

1990s (ATSDR, 2014). Metal degreasing accounted for approximately 24% of TCE use in 2004 (ATSDR, 2014). TCE is also widely used as a solvent for extraction, waterless drying and finishing, and as a general purpose solvent in adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners (ATSDR, 2014).

TCE is a common environmental contaminant; widespread in ambient air, indoor air, soil, and groundwater (USEPA, 2011). TCE is extremely volatile and most TCE released into the environment will evaporate into the air. TCE released to soil or leaking from underground storage tanks or landfills can also migrate through soil into groundwater due to its moderate water solubility. Once in groundwater, TCE tends to "sink" downward in an aquifer because it is more dense than water. Under the right conditions, TCE may biodegrade in soil and groundwater with half-lives on the order of months to years (USEPA, 2011). Its relatively slow degradation rate means TCE can persist in groundwater and it is one of the most frequently detected groundwater contaminants.

In 2011, EPA completed a thorough toxicological review of TCE, compiling all available human epidemiologic data and experimental animal data (USEPA, 2011). EPA concluded that TCE poses a potential human health hazard for non-cancer toxicity to the central nervous system, kidney, liver, immune system, male reproductive system, and developing fetus. The most sensitive effects appear to be developmental, kidney, and immunological (adult and developmental) effects. TCE is also considered a carcinogen by all routes for exposure. High exposures to TCE can cause kidney cancer in humans. There is also evidence of an association between high levels of TCE exposure and non-Hodgkin's lymphoma and liver cancer. Less human evidence is found for an association between TCE exposure and other types of cancers (USEPA, 2011).

A toxicological review of TCE in drinking water by MDH in 2013 agreed with EPA's conclusions. MDH identified immune effects as the most sensitive health effect caused by exposure to TCE. MDH has developed a Health Based Value (HBV) for TCE in drinking water of 0.4 ppb. This is a safe level that is protective for immune system effects and other health effects. This value is safe for all life stages (including developing fetuses, infants, and children) and for those with impaired immune systems. MDH determined that 2 ppb is protective for cancer for all individuals, even for lifelong exposure. A TCE concentration of 2 ppb TCE in drinking water is also a safe level for healthy adults who are only exposed after age 18; this level is also safe for pregnant women to protect the developing fetus from heart defects.

V. Discussion

Spring Grove Municipal Water Supply

Public water supplies are regulated by the federal government under the Safe Drinking Water Act and the U.S. Environmental Protection Agency establishes enforceable standards, Maximum Contaminant Levels (MCLs). These are legal limits intended to both protect human health and be economically feasible for water systems to achieve through the use of best available technology or treatment techniques. The current MCL of 5 ppb for TCE was established in 1989.

Under the Minnesota Groundwater Protection Act, MDH may also establish drinking water standards and guidance values for groundwater contaminants. These standards, known as Health Risk Limits (HRLs), and guidance values, known as Health Based Values (HBVs), are used to evaluate groundwater quality and provide drinking water advice. HRLs are defined as levels of contaminants that are likely to pose little or no health risk to a population. The HBVs are very similar to HRLs; the difference is that HRLs are formally adopted in Minnesota Rules and HBVs have not gone through rulemaking.

From 2002 until May 2013, MDH advice for TCE was 5 ppb (this value was formally adopted as an HRL in 2007). In 2013, MDH completed a new toxicological review of TCE in drinking water and replaced the HRL with an HBV of 0.4 ppb. In situations where contamination exists in a public water supply at levels below the MCL but above a HRL/HBV, MDH may issue a Notice of Health Risk Advisory to inform the public water supply operator of the potential health risks from the use of the water. Such a notice was issued to Spring Grove on February 28, 2014.

The city reports the amount of TCE measured in the municipal water to residents in the annual Consumer Confidence Report. Table 1 shows the TCE concentrations since 1994 from CW-3, the primary source of Spring Grove drinking water. There has never been a violation of the MCL since it was established in 1989, which is measured as an average of four quarterly samples. In 2008, a result of 28 ppb TCE revealed a maintenance issue with the air stripper on CW-3. The air stripper was quickly fixed and the TCE concentration was 0.8 ppb when the water was resampled 13 days later (because this was a maintenance issue that was quickly corrected, this result was not considered a violation of the MCL). The average concentration of TCE in water from CW-3 after treatment was approximately 1 ppb over the past ten years and the latest sample from July 2014 had 2.1 ppb. Despite a substantial reduction of TCE by the air stripper, water from CW-3 does not meet the new TCE HBV of 0.4 ppb.

Because the city typically uses both CW-3 and CW-4 and water from CW-4 does not contain any TCE, it is expected that the mixture will lower TCE concentrations when it reaches homes and businesses. MDH sent a Notice of Health Risk Advisory to the city on February 28, 2014 and recommended sampling within the distribution system (which is not routinely tested) to determine whether "mixing" of water from CW-3 and CW-4 reduces TCE concentrations to acceptable levels. Two samples collected from the distribution system in March 2014 showed TCE concentrations of 1.7 and 2.1 ppb, indicating that mixing does not reduce TCE to levels below the HBV. Consequently, NEC plans to upgrade the air stripper system on CW-3 to ensure TCE concentrations in water from that well are below 0.4 ppb (W. Sarappo, pers. comm., 7/29/2014). In the meantime, the city is relying primarily on CW-4 for their water supply.

Private Wells

Since 1984, twenty-three private wells have been tested to measure TCE and other VOCs (Table 3, Figure 4). As described in Section III, six wells (W-1, W-2, W-3, W-5, W-9 and W-17) exceeded the HRL, which was 5 ppb at that time. Whole-house GAC filter systems were provided to eliminate further TCE exposure. Of these six wells, only W-1, W-5 and W-9 are still used as drinking water wells and continue to be treated with GAC filters. Regular monitoring of these six wells indicates that, despite significant fluctuations in TCE concentrations in individual wells, overall TCE concentrations are decreasing over time (Figure 6).

As previously discussed, MDH established a new Health Based Value (HBV) of 0.4 ppb for TCE in May 2013. In July 2013, MDH and MPCA staff sampled 13 private wells including W-5 and W-9 described above (Table 3, Figure 4). TCE was measured above the TCE HBV at only one residence (0.61 ppb) and Northern Engraving provided a whole-house GAC filter system. (In 2014, TCE was again detected above the HBV in an unfiltered sampled from this well, at 0.87 ppb). Six other residences sampled by MDH and MPCA in 2013 had measurable levels of TCE between 0.04-0.23 ppb. Trace levels of xylenes (0.28 ppb) and chloroform (0.05 ppb) were detected at two separate residences, well below levels of health concern (the HRLs are 300 ppb for xylenes and 30 ppb for chloroform). Currently there are four carbon filter systems in operation (W-1, W-5, W-9, W-21).

The results of groundwater sampling by NEC, MPCA and MDH are illustrated in Figure 7. A fairly large area of groundwater surrounding the NEC site has TCE at concentrations greater than 10 ppb (shown with a solid yellow line), but this area is much smaller than it was in 1990 (Gannett Fleming, 2014). The TCE source area is located just south of the groundwater divide and near the point where the southerly flow of groundwater divides to either the southeast or southwest (as described in Section IIIA). As a result, the TCE plume appears to have two major "lobes" to the southeast and southwest of the site and a smaller "lobe" to the north. Although the TCE source area is located south of the groundwater divide, fracture flow and the influence of nearby pumping wells likely may have allowed some of it to migrate north of the divide.

As shown in Figure 7, the area in which TCE exceeds the new HBV of 0.4 ppb appears to have been fairly well defined (solid orange line), although there is a lack of water quality data between the two southern lobes of the plume and immediately to the northwest of City Well #1. The dashed green line in Figure 7 shows the approximate extent of TCE impacts below 0.4 ppb. The presence of TCE in wells W-05 to the north and W-06, W-07, W-08, W-19 and W-20 to the south, beyond which no sampling has occurred, suggests that TCE may be present at low concentrations beyond the dashed green line. Also, groundwater in the Prairie du Chien moves primarily through fractures which can result in less predictable contaminant migration pathways. Widely spaced sampling locations, such as the private wells shown in Figure 7, may not adequately define the potential impacts of the contaminant plume. For this reason, all drinking water wells near the edge of the TCE plume should be sampled to ensure they meet state drinking water advice levels. Finally, it should be noted that, although the shape of the plume is consistent with available groundwater elevation data, only one sample was collected between the two apparent southern "lobes", so the actual shape of this portion of the plume may change with additional sampling. MDH understands that MPCA plans to discuss the need for additional private well sampling with NEC (C. Sykora, pers. comm., 10/29/2014).

Vapor Intrusion Potential

TCE can evaporate from polluted soil and groundwater and rise toward the ground surface. If TCE vapors encounter a building as they travel to the surface, they may enter through cracks in the foundation, around pipes, or through a sump or drain system. In this way, TCE vapors may enter buildings and contaminate the indoor air, a process called vapor intrusion. In some cases, TCE may accumulate in indoor spaces to levels that pose health concerns.

Although more information is needed to evaluate the potential for vapor intrusion into buildings near the site, the following conditions suggest it may occur:

- The continued presence of relatively high levels of TCE in groundwater in the vicinity of well MW-5A (i.e., 461 and 190 ppb in September and December 2013, respectively);
- A large area of groundwater contamination at greater than 25 ppb TCE surrounding the site (solid red line on Figure 7);
- The reported presence of contaminated soils remaining at the site; and
- The presence of residential buildings within 100 feet of the site.

MDH understands that MPCA plans to discuss the need for a vapor intrusion investigation with NEC (C. Sykora, pers. comm., 10/29/2014).

VI. Conclusions

- In the mid- to late 1980s, Spring Grove residents were exposed to TCE in municipal drinking water at concentrations that exceed the current MCL and HBV.
- Treated water from CW-3 currently exceeds the MDH HBV for TCE.
- The city currently relies on CW-4, which does not contain TCE, for the majority of its water supply.
- Four private wells currently exceed the HBV for TCE and were provided GAC filter systems.
- There may be more private wells that use groundwater contaminated with TCE
- TCE may be entering buildings above or near the groundwater plume and source area by vapor intrusion. MDH supports MPCA's plan to evaluate the potential for vapor intrusion impacts to nearby homes and businesses.

VII. Recommendations

- MDH recommends that the city continue to use CW-4 as its primary well until additional treatment is installed on CW-3 and shown to be effective.
- MDH recommends that whole-house GAC filter systems or another alternative water supply is provided for any additional private wells that exceed the TCE HBV of 0.4 ppb.
- MDH recommends all private drinking water wells in which TCE or related VOCs have been measured at or above the laboratory Method Detection Limit continue to be monitored to ensure the HBV is not exceeded in the future.

- MDH recommends that the status of well W-17 be determined and, if no longer in use, it should be properly sealed in accordance with the Minnesota well code (MDH was unable to locate well W-17 during the 2013 sampling effort and has no record of it having been sealed).
- MDH recommends that any other unused wells in the area of TCE contamination be identified and properly sealed in accordance with the Minnesota well code.

VIII. Public Health Action Plan

- MDH will work with the MPCA to support implementation of the recommendations in this report.
- MDH will assist the city in finalizing the Wellhead Protection Plan for the city wells.
- The TCE plume extends beyond the boundaries of the Special Well and Boring Construction Area. MDH will evaluate whether the SWBCA needs to be expanded after additional sampling results are available.
- MDH will evaluate additional environmental data as it becomes available and provide recommendations as needed.
- MDH will communicate with the community regarding health risk as needed.

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MPCA (1989b) Start-Up Operation of City Well 3, Spring Grove Site. Letter from MPCA to Northern Engraving Corporation and Control Data Corporation, April 11, 1989.

MPCA (1987a) Sampling of Municipal Wells – Spring Grove. Memo from the MPCA to MDH, December 3, 1987.

MPCA (1987b) Spring Grove Municipal Well Sampling. Memo from the MPCA to MDH, February 23, 1987.

NEC (2015) MDH Health Consultation Review. Email from Darrell Zietlow (NEC) to Emily Hansen (MDH) on Jan. 6, 2015.

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REPORT PREPARATION

This Health Consultation for the Northern Engraving Corporation/Ceridian Corporation Spring Grove Site was prepared by the Minnesota Department of Health under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with the approved agency methods, policies, procedures existing at the date of publication. Editorial review was completed by the cooperative agreement partner. ATSDR has reviewed this document and concurs with its findings based on the information presented. ATSDR's approval of this document has been captured in an electronic database, and the approving agency reviewers are listed below.

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CERTIFICATION

This Health Consultation was prepared by the Minnesota Department of Health (MDH) with support from the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun. This document has not been reviewed and cleared by ATSDR. Editorial review was completed by additional programs of MDH.

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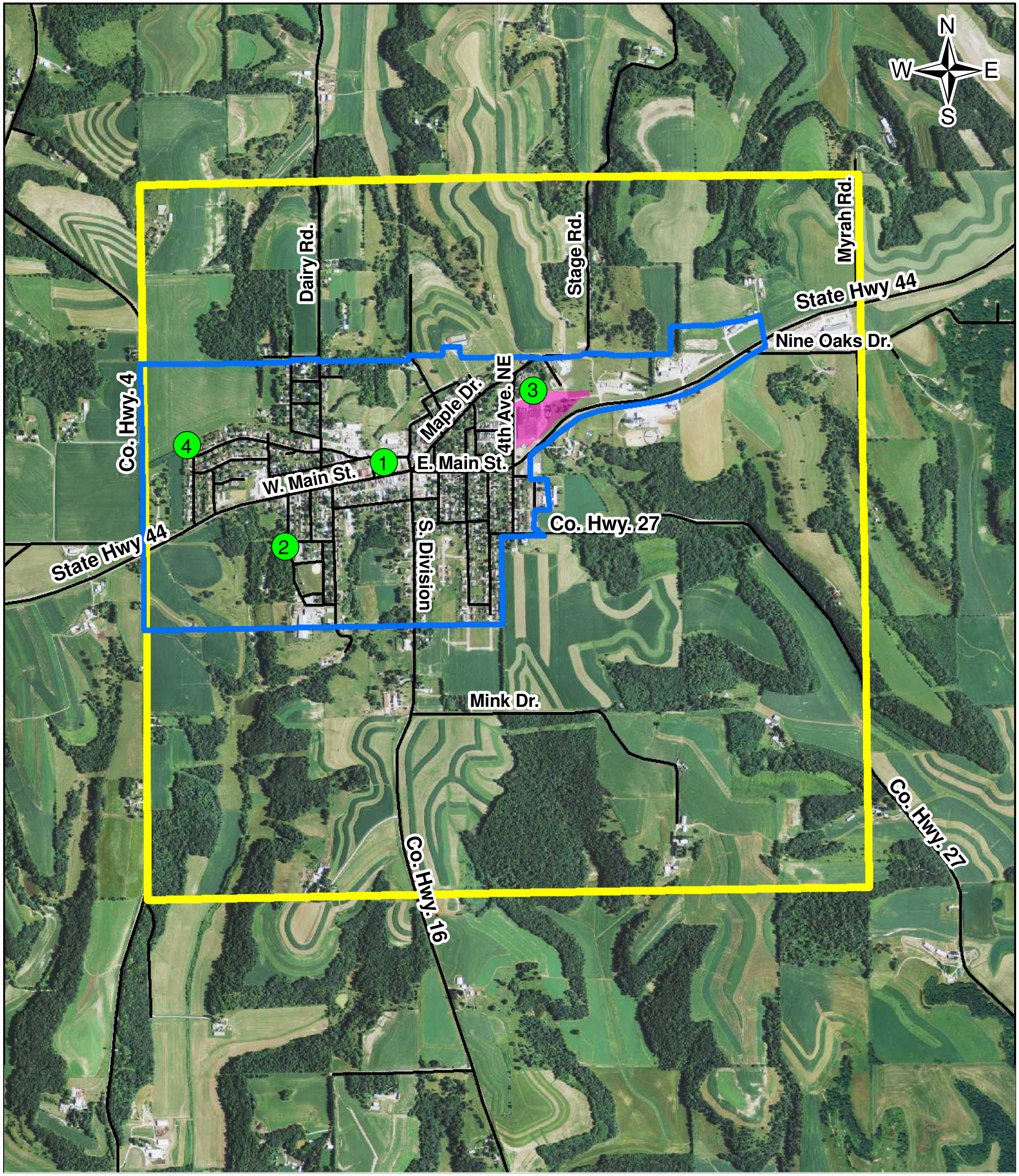


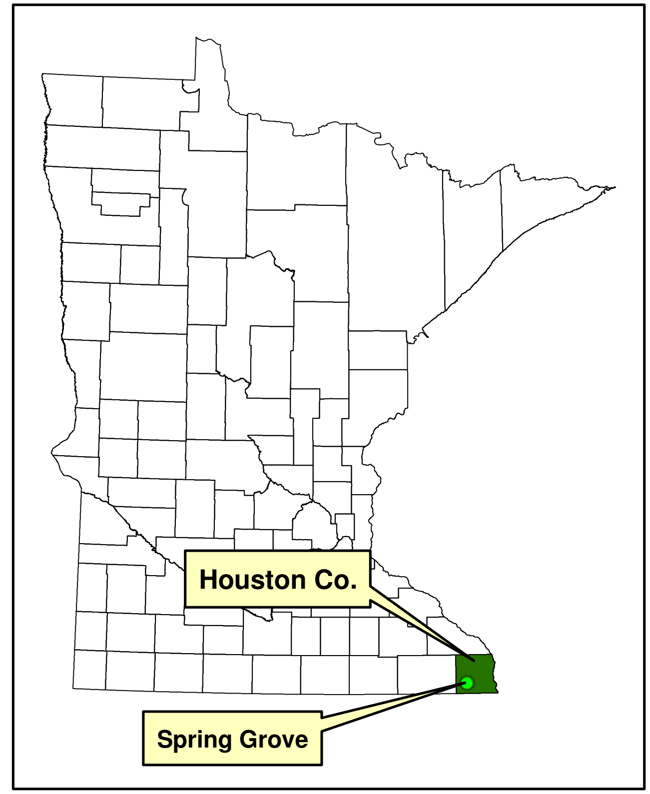


Figure 1: Location Map

Spring Grove city limits

Northern Engraving Corporation site

Spring Grove city wells (locations approx.)

Spring Grove SWBCA

MDH, 8/11/2014

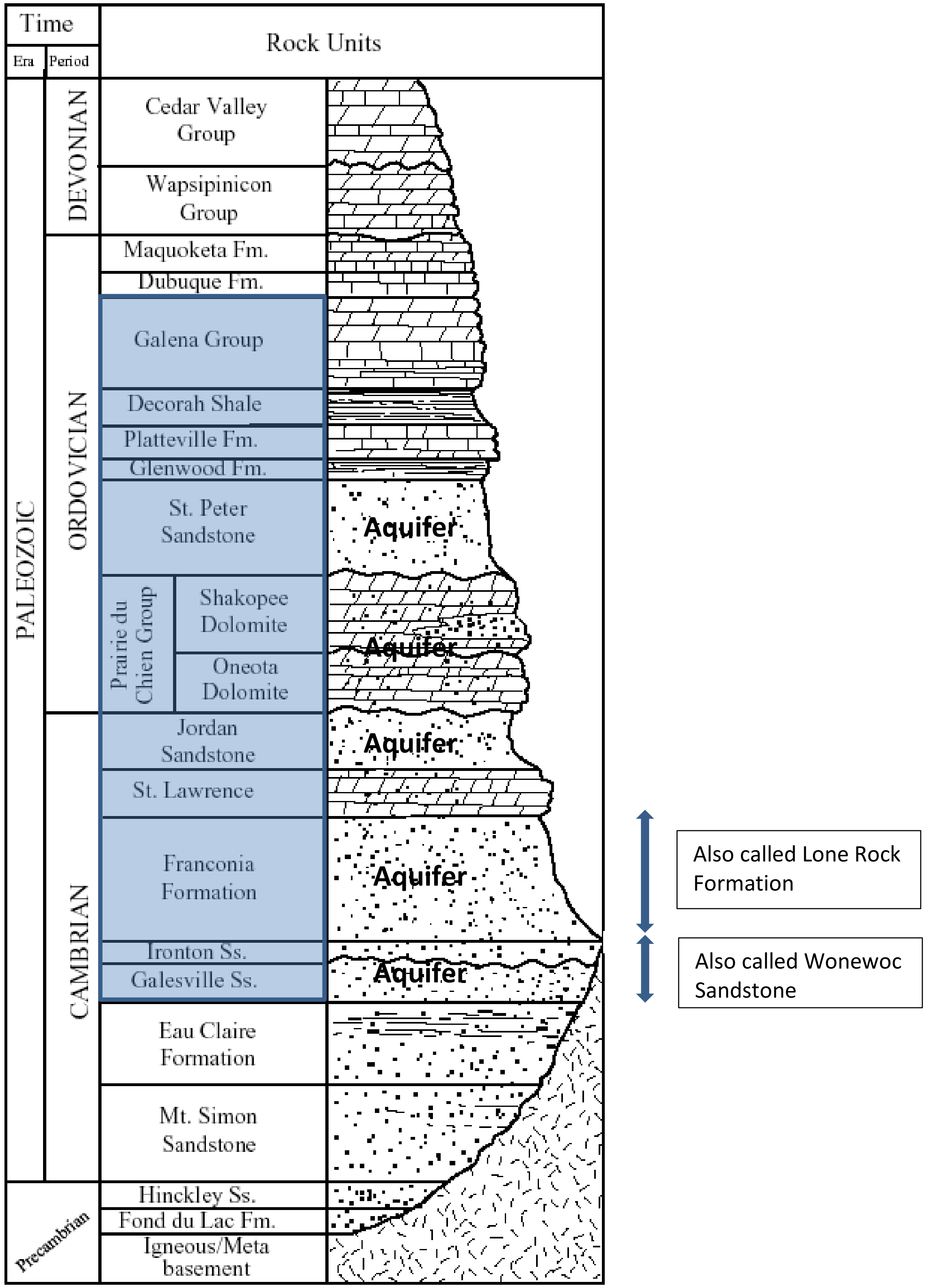


Figure 2: Generalized geologic column for southeast Minnesota
Bedrock units present beneath Spring Grove are highlighted in blue and formations that are considered aquifers for the Spring Grove area are labeled. (Modified from Ojakangas, 2009)

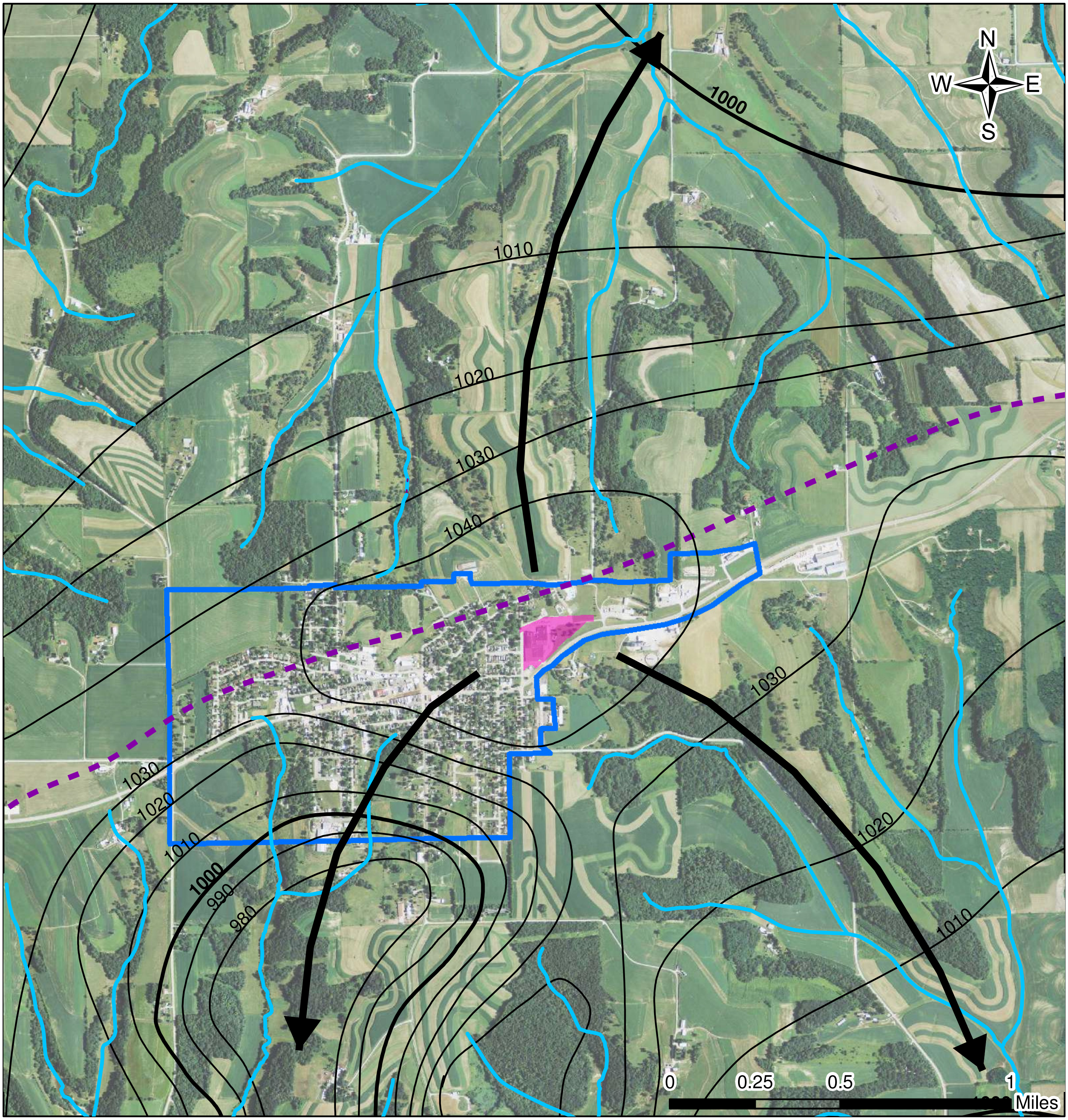


Figure 3: Surface Water Features and Groundwater Flow Directions in the Spring Grove Area

Spring Grove
Northern Engraving
Groundwater divide (approx.)
Stream
Water level elevation - 50 ft contour
Water level elevation - 10 ft contour
Generalized groundwater flow direction
Groundwater elevations in feet above mean sea level

MDH, 8/11/2014

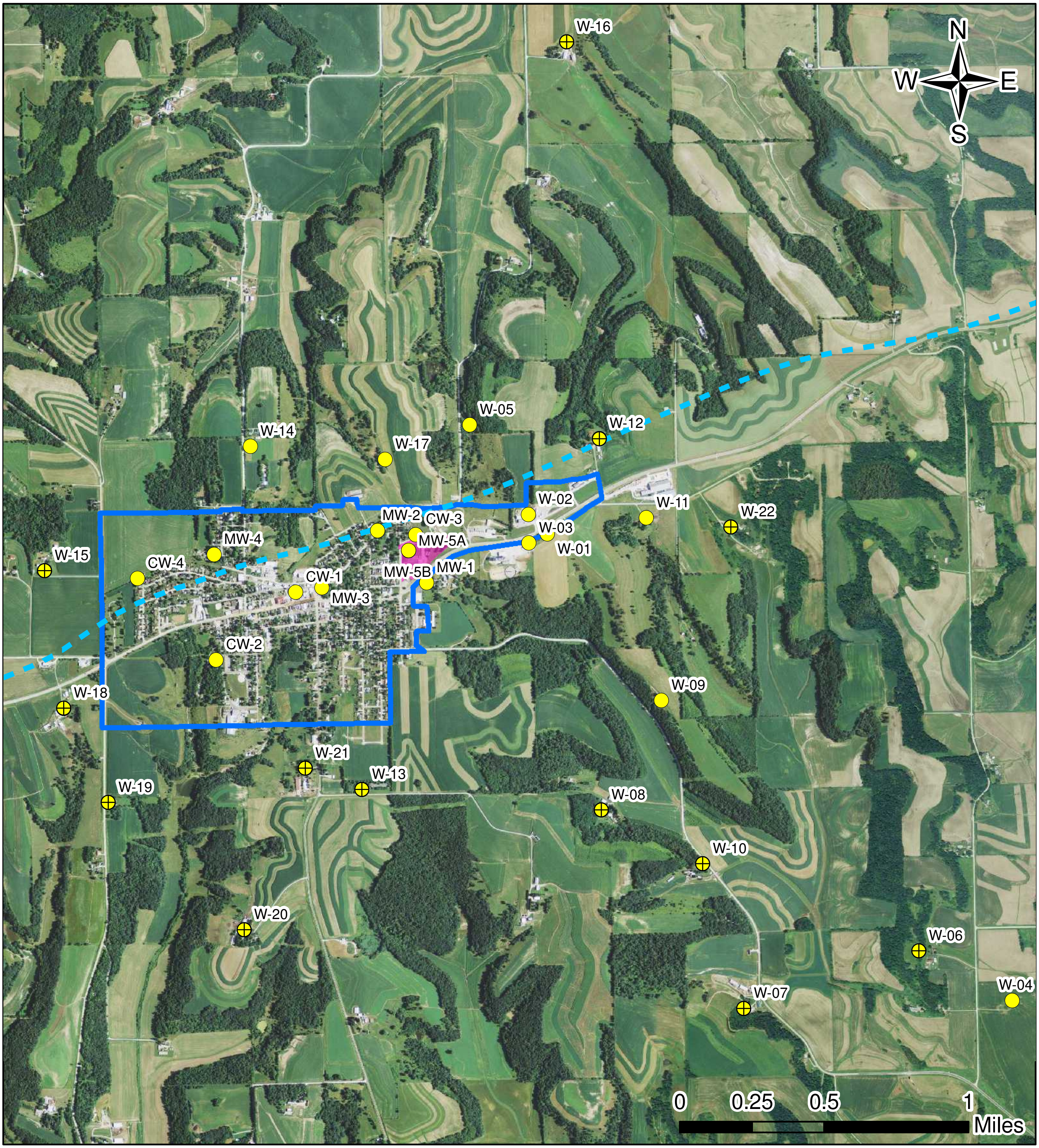


Figure 4 - Well Sample Locations

- Well sample location
- MDH/MPCA 2013 sample
- Northern Engraving
- Spring Grove city limits
- Groundwater flow divide (approx.)

MDH, 8/12/2014

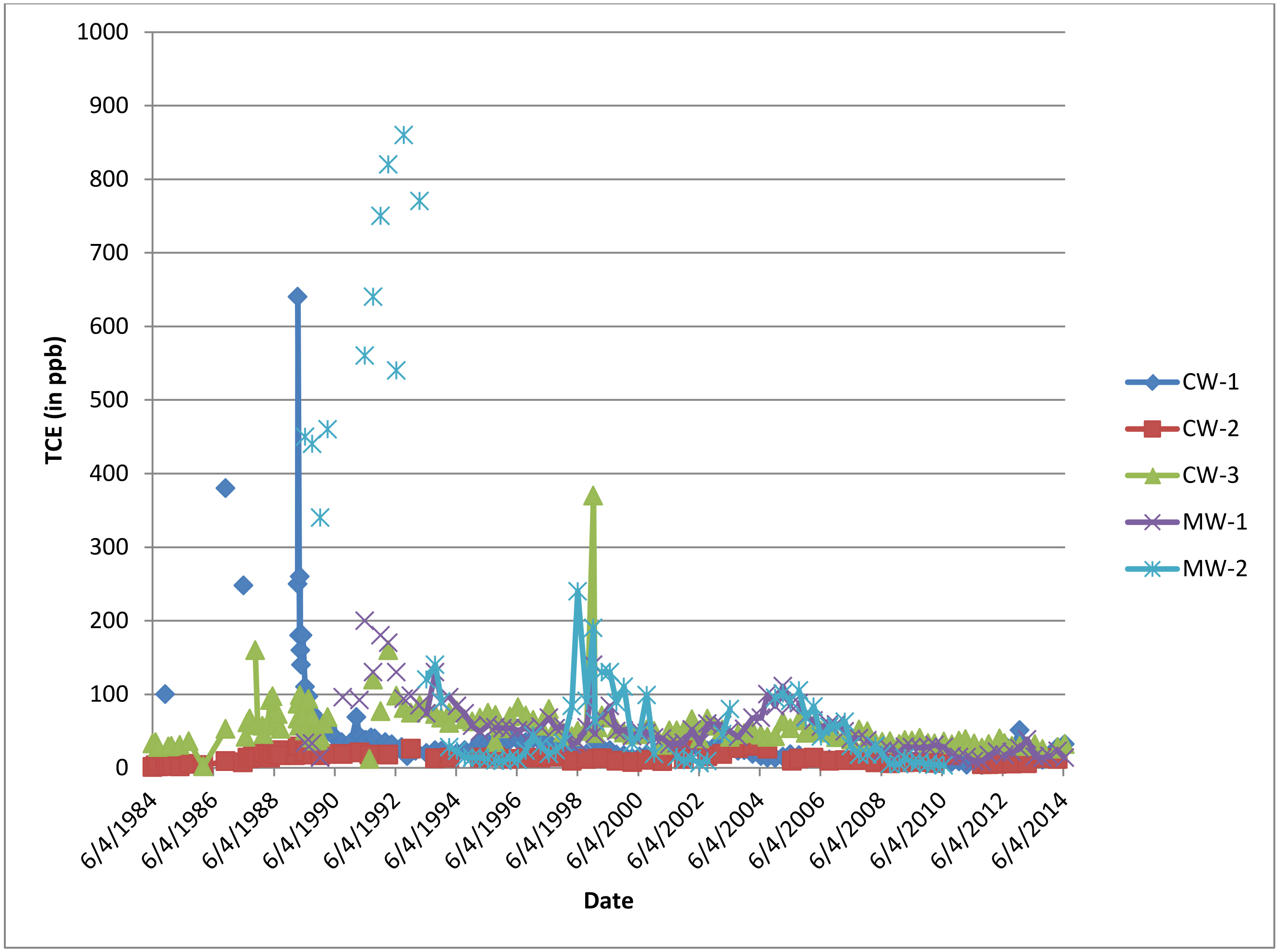
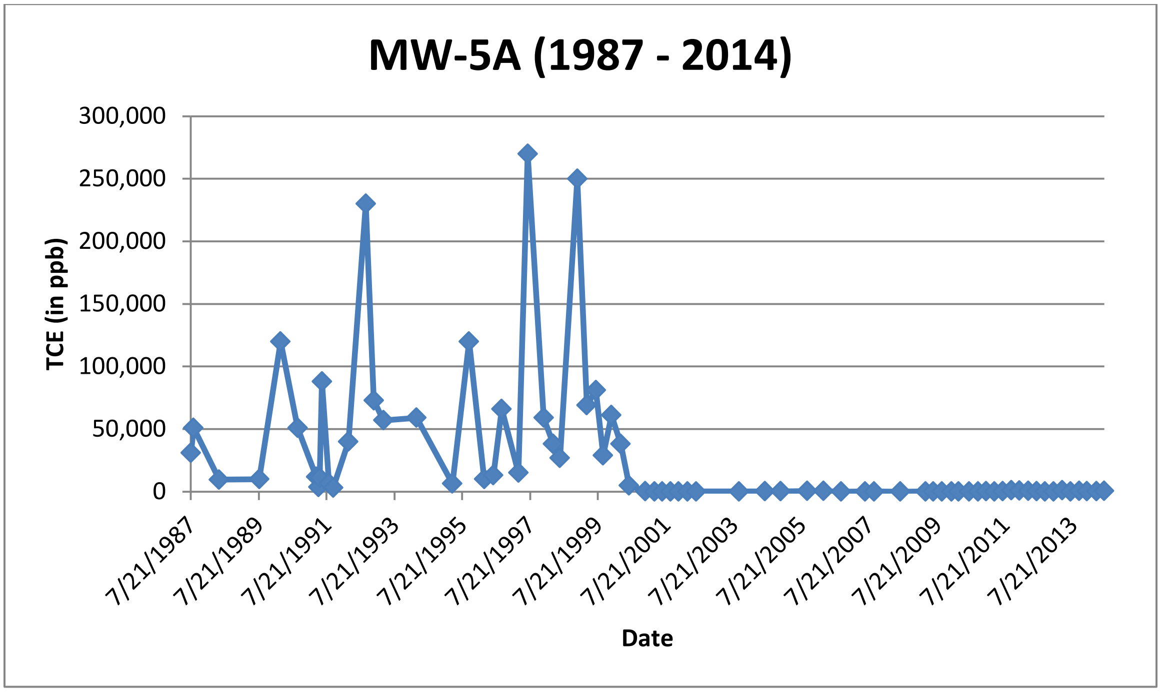


Figure 5a: TCE Concentrations in City Wells and Monitoring Wells over Time

This graph shows the trends in TCE concentrations for all city and monitoring wells over time, except city well #4 (in which no TCE has been detected) and MW-5A. The trend graph for MW-5A is provided in Figure 5b to allow for a much larger TCE concentration scale, due to the much higher levels detected in that well. Data for this graph is provided in Table 2.



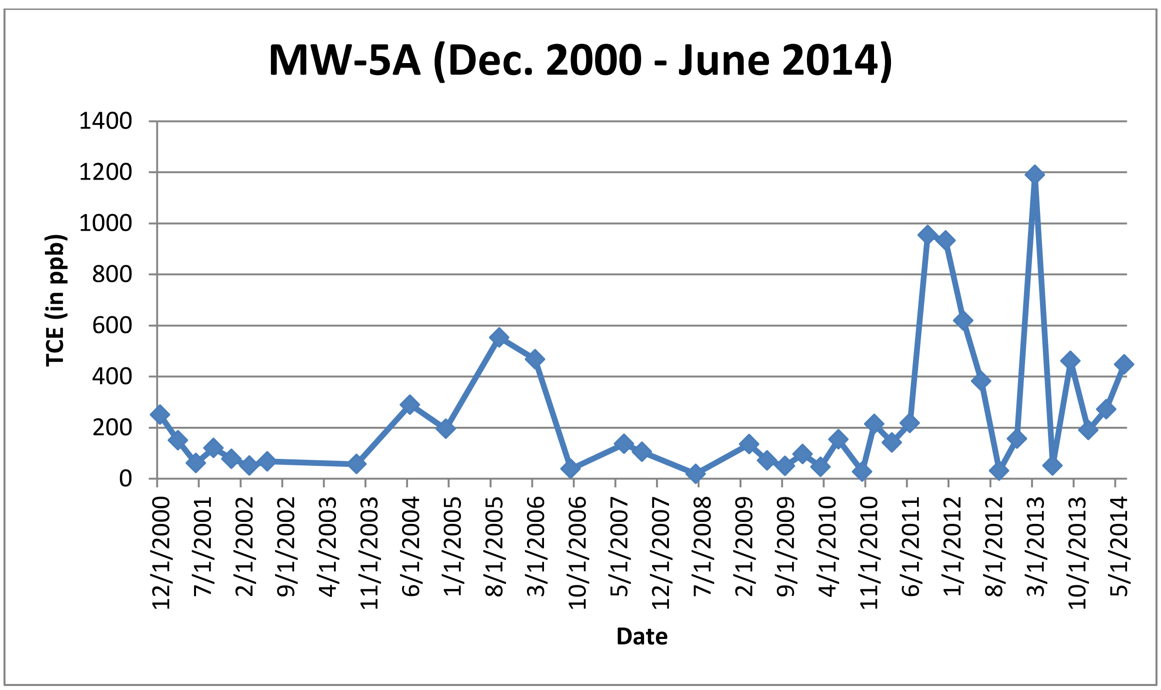


Figure 5b – TCE Concentrations in Monitoring Well MW-5A over Time

The upper graph shows all data from MW-5A. Because of the very high concentrations detected prior to December 2000, the lower graph is provided to show more detail of recent concentration trends. Data for this graph is provided in Table 2.

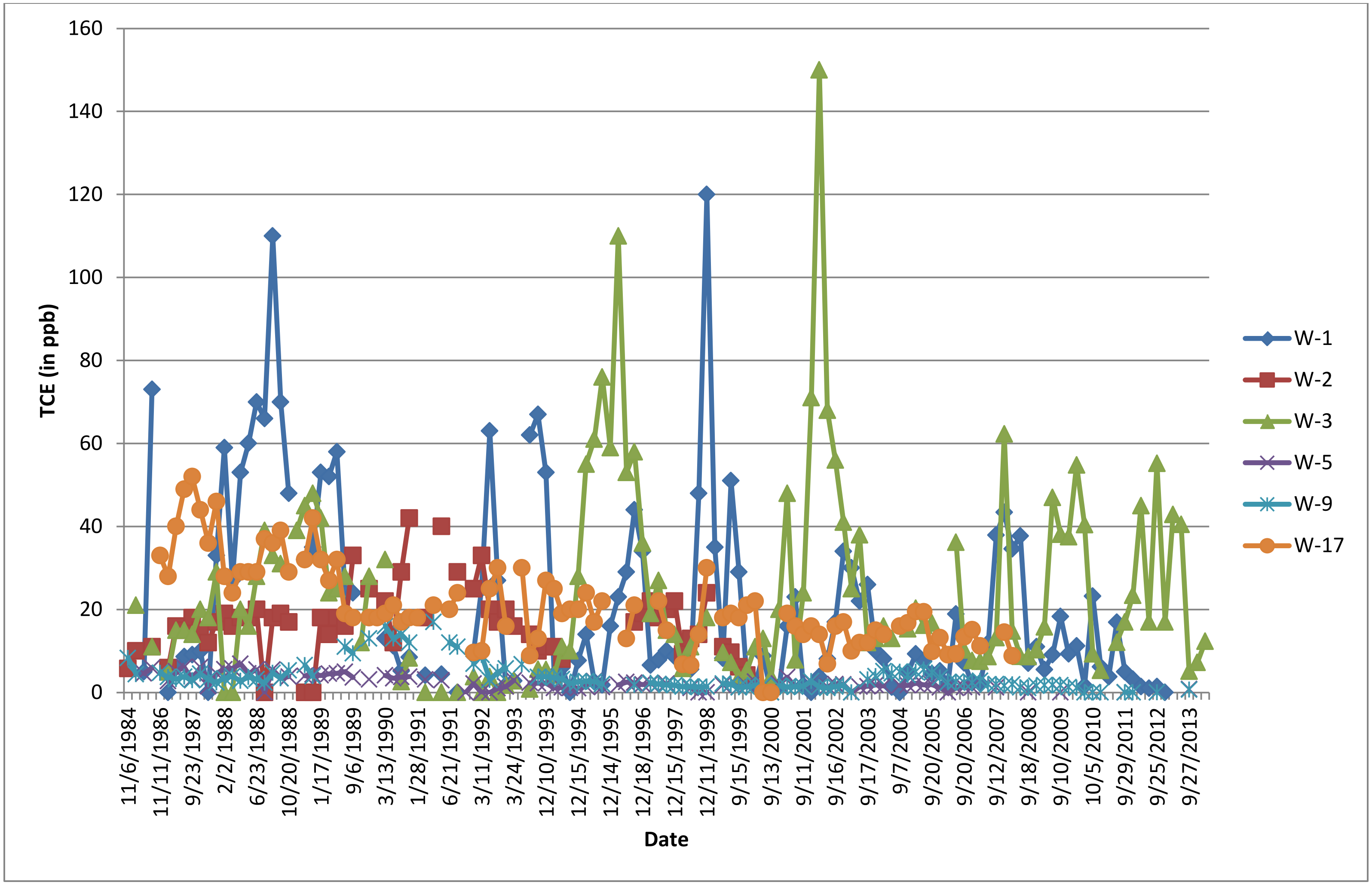


Figure 6: TCE Concentrations in Spring Grove Private Wells over Time

Data for this figure is provided in Table 3. TCE concentrations reported as less than (<) the reporting limit are assigned a value of 0 in this graph, but trace concentrations may have been present.

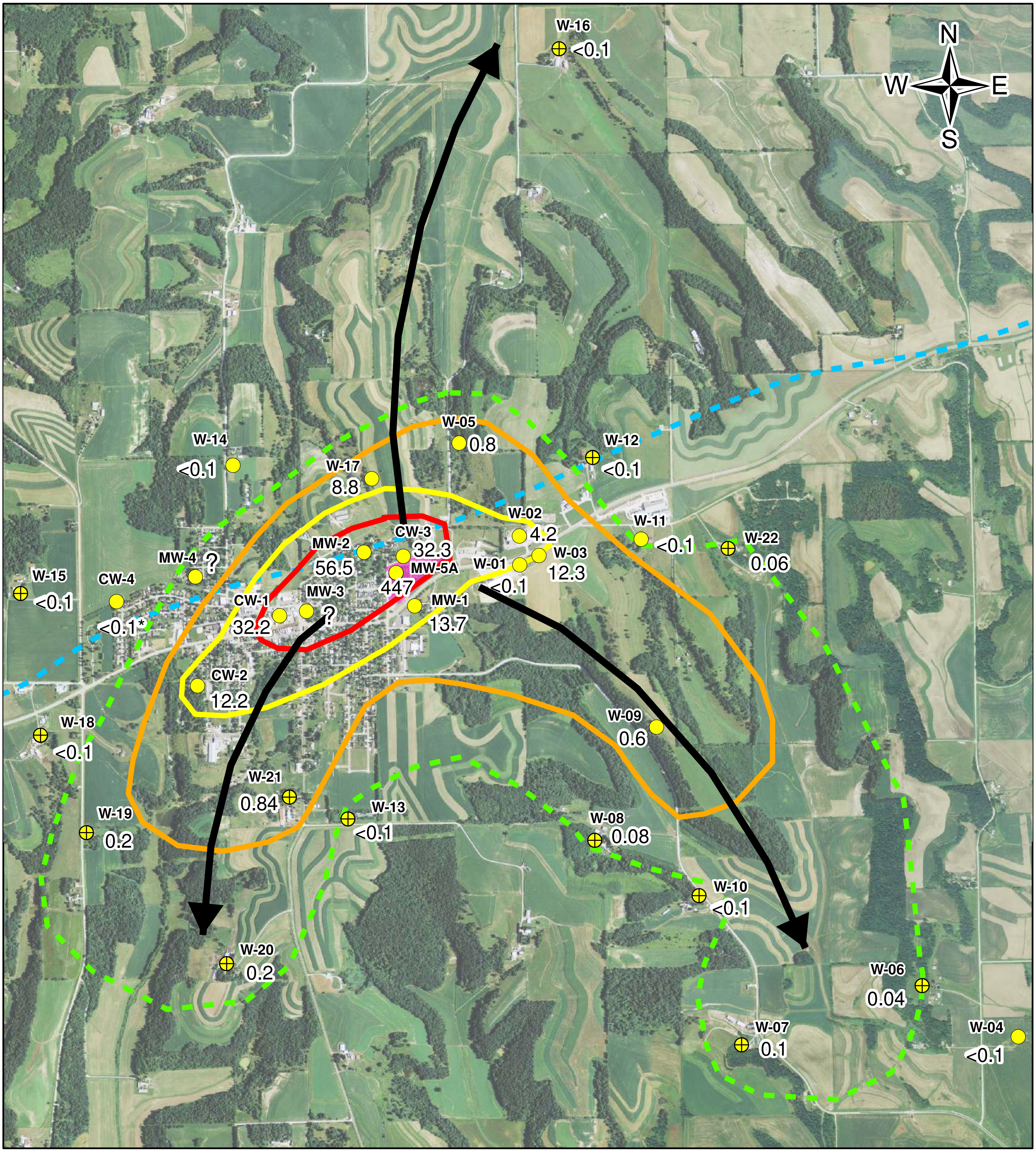


Figure 7 - TCE Concentrations in Groundwater (in ppb)

TCE greater than 25 ppb

TCE greater than 10 ppb

TCE greater than 0.4 ppb

TCE plume extent (>0.05 ppb)

Well sample location

MDH/MPCA 2013 sample location

Northern Engraving

Groundwater divide (approx.)

Generalize groundwater flow direction

Note: TCE concentrations shown are most recent results from that well, see Table 3 for details

* This well is completed in a deeper aquifer than the other wells shown

MDH, 10/29/2014

Table 1 - TCE Concentrations Detected in the Primary Municipal Water Supply After Treatment (Well #3) from 1994-2014 (in ppb)

Date	Result
3/15/1994	1.6
9/20/1994	4.1
12/1/1994	< 0.1
3/31/1995	1.5
6/21/1995	8.2
9/19/1995	1
12/15/1995	0.7
3/29/1996	0.8
6/21/1996	0.5
9/30/1996	0.7
12/12/1996	0.6
3/28/1997	0.5
6/23/1997	0.4
9/16/1997	0.7
12/22/1997	0.6
3/13/1998	0.7
6/30/1998	0.9
9/30/1998	0.8
2/4/1999	1.2
3/30/1999	1.2
6/30/1999	7.5
9/30/1999	0.7
12/13/1999	1.2
3/31/2000	0.6
6/29/2000	0.4
9/28/2000	0.5

Date	Result
2/15/2001	0.6
5/18/2001	0.5
9/25/2001	0.4
1/31/2002	0.5
4/16/2002	0.5
8/29/2002	0.6
12/23/2002	0.8
3/21/2003	0.8
6/16/2003	0.6
12/29/2003	0.8
3/30/2004	1
6/22/2004	1
9/16/2004	1
11/17/2004	1.4
2/23/2005	2.6
5/9/2005	0.6
9/28/2005	0.6
12/19/2005	1
3/20/2006	1.3
6/27/2006	1.5
9/27/2006	0.7
12/18/2006	0.7
3/28/2007	0.8
6/11/2007	0.8
9/27/2007	0.7
12/10/2007	0.6

Date	Result
3/27/2008	28
4/9/2008	0.8
6/20/2008	0.7
9/17/2008	0.8
12/16/2008	2
3/26/2009	0.7
4/22/2009	0.7
9/16/2009	0.5
11/3/2009	0.4
2/25/2010	0.7
5/27/2010	0.6
9/17/2010	0.66
12/22/2010	0.74
3/17/2011	0.76
5/17/2011	0.69
7/27/2011	0.61
11/15/2011	0.63
2/24/2012	0.72
4/27/2012	0.72
8/3/2012	0.69
10/31/2012	0.68
1/16/2013	0.93
4/25/2013	0.76
9/27/2013	1.7
3/31/2014	2.4
7/2/2014	2.1

NOTES:

TCE = trichloroethylene

ppb = parts per billion

<0.1 = TCE not detected at or above the reporting limit of 0.1 ppb

Table 2 - City and Monitoring Well TCE Concentrations (in ppb)

Date	Sampled By	CW-1	CW-2	CW-3	CW-4	MW-1	MW-2	MW-5A	MW-5B
6/4/1984	NEC		1.1	33					
7/12/1984	NEC		3.1	35					
8/9/1984	NEC		2.2	28					
11/6/1984	NEC	100	3.2						
12/11/1984	NEC		2.6	29					
1/16/1985	NEC		2.6	30					
4/29/1985	NEC		2.1	31					
8/14/1985	NEC		5.4	36					
2/4/1986	NEC		3.6	2					
11/1/1986	NEC	380	9	53					
5/29/1987	NEC		7.5			Re-cased[a]	Re-cased[a]		
6/6/1987	NEC	248							
6/29/1987	NEC			42				Drilled[b]	Drilled[b]
7/21/1987	NEC		14	62				31,000	
8/18/1987	NEC		13	67	Drilled[b]			51,000	
9/23/1987	NEC		15						
10/22/1987	NEC		16	160					
11/19/1987	NEC		14	58					
1/19/1988	NEC		15	57					
2/2/1988	NEC		20	46					
3/17/1988	NEC		18	59					
4/21/1988	NEC		14	92					
5/19/1988	NEC		20	97				9,600	
6/23/1988	NEC		19	60					
7/20/1988	NEC		24	73					
8/25/1988	NEC		17	53					
2/15/1989	NEC		17						
3/15/1989	NEC	250		87					

Table 2 - City and Monitoring Well TCE Concentrations (in ppb)

Date	Sampled By	CW-1	CW-2	CW-3	CW-4	MW-1	MW-2	MW-5A	MW-5B
3/17/1989	NEC	640	29	67					
4/5/1989	NEC	180		57					
4/12/1989	NEC	260		99					
4/19/1989	NEC	160		59					
4/26/1989	NEC	140		72					
5/17/1989	NEC	180		69					
6/13/1989	NEC	110	21	51		34	450		
7/27/1989	NEC	97		94				9,900	4.2
8/24/1989	NEC			41					
9/6/1989	NEC	74	18	69		33	440		
10/18/1989	NEC			37					
11/17/1989	NEC	65		38					
12/12/1989	NEC	58	17	42		14	340		
1/22/1990	NEC			60					
2/12/1990	NEC	51							
3/13/1990	NEC	54	19	69			460	120,000	21
6/22/1990	NEC	40							
8/29/1990	NEC	35							
9/13/1990	NEC		19			96		51,000	
12/18/1990	NEC	35							
2/21/1991	NEC	69							
4/1/1991	NEC	42	21			92		11,900	
4/8/1991	NEC	42							
4/18/1991	NEC							11,900	
4/25/1991	NEC							3,510	
5/8/1991	NEC							10,920	
6/1/1991	NEC	38				200	560	88,000	
6/18/1991	NEC	38							

Table 2 - City and Monitoring Well TCE Concentrations (in ppb)

Date	Sampled By	CW-1	CW-2	CW-3	CW-4	MW-1	MW-2	MW-5A	MW-5B
7/30/1991	NEC		18	12					
8/15/1991	NEC	41						6,820	
9/11/1991	NEC			120		130	640		
10/1/1991	NEC	40						3,000	
12/11/1991	NEC	20		77		180	750		
2/5/1992	NEC	35							
3/11/1992	NEC		18	160		170	820	40,000	
4/22/1992	NEC	32							
6/16/1992	NEC	26		98		130	540		
8/17/1992	NEC	28							
9/15/1992	NEC			81		94	860	230,000	
10/26/1992	NEC	16							
12/10/1992	NEC	25	26	75		98		73,000	
2/4/1993	NEC	23							
3/24/1993	NEC			85		85	770	57,000	
3/26/1993	NEC			85					
6/14/1993	NEC	20		81		74	120		
9/25/1993	NEC	24	13	73		130	140		
12/10/1993	NEC	23		68		89	90		
3/15/1994	MDH			75					
3/16/1994	NEC	19	14	61		96	28	59,000	
6/15/1994	NEC	20		78		84	23		
9/16/1994	NEC	24		66		74	14		
12/1/1994	MDH				<0.1				
12/15/1994	NEC	23		63		57	14		
3/18/1995	NEC	35	14	68		49	14		
4/6/1995	NEC							6,410	
6/23/1995	NEC	34		75		58	12		

Table 2 - City and Monitoring Well TCE Concentrations (in ppb)

Date	Sampled By	CW-1	CW-2	CW-3	CW-4	MW-1	MW-2	MW-5A	MW-5B
9/19/1995	MDH			35					
9/20/1995	NEC	33	15	72		55	10		
10/2/1995	NEC							120,000	
12/14/1995	NEC	29		54		54	9.6		
3/14/1996	NEC	38	12	70		54	13	10,000	
6/19/1996	NEC	38		82.5[c]		51	11	13,000	
9/18/1996	NEC	35	14	71		54	23	66,000	
12/18/1996	NEC	40		65		47	44		
3/18/1997	NEC	36	14	57		56	30	15,000	
6/25/1997	NEC	34	16	80		68	19	270,000	
9/17/1997	NEC	28	15	56		54	24		
12/15/1997	NEC	27		48		56	34	59,000	
3/27/1998	NEC	10	9.6	43		32	84	38,000	
6/6/1998	NEC	23		50		35	240	27,000	
9/23/1998	NEC	21	12	55		55	91		
12/11/1998	NEC	39		370		140	190	250,000	
1/1/1999[d]	NEC	20		46.9		46.2	62.9		
2/4/1999	MDH			55					
3/23/1999	NEC	27	13	71		69	130	69,000	
6/29/1999	NEC	24		68		84	130	81,000	
9/15/1999	NEC	18	9.8	53		50	89	29,000	
12/14/1999	NEC	17		48		51	110	61,000	
3/22/2000	NEC	15	7.9	45		43	33	38,000	
6/20/2000	NEC	17		46		50	47	5,000	
9/13/2000	NEC	18	11	52		47	99		5.2
12/12/2000	NEC	17		50		41	19	250	
3/20/2001	NEC	20	9.1	31		40		150	
6/13/2001	NEC	19		51		32		61	

Table 2 - City and Monitoring Well TCE Concentrations (in ppb)

Date	Sampled By	CW-1	CW-2	CW-3	CW-4	MW-1	MW-2	MW-5A	MW-5B
9/11/2001	NEC	20	27	51		33	15	120	
12/4/2001	NEC	22	12	51		34	10	78	
3/13/2002	NEC	31	39	66		52	12	51	
6/12/2002	NEC	25		40		33	6.3	68	
9/16/2002	NEC	25	16	67		60	9.2		
12/9/2002	NEC	29		57		59			
3/12/2003	NEC	30	19	52		58	46		
6/12/2003	NEC	27		42		50	80		
9/17/2003	NEC	23	27	46		42		57	
12/2/2003	NEC	24		47		53			
12/29/2003	MDH				<0.1				
3/10/2004	NEC	19	30	50		68			
6/21/2004	NEC	16		45		68		290	
9/7/2004	NEC	14	26	42		100			
12/7/2004	NEC	13.2		42.7		83.7	95	195	
3/9/2005	NEC	15.2		63		111	101		
6/7/2005	NEC	18.3		53.8		85.1	90.7		
6/27/2005	NEC		9.8						
9/20/2005	NEC	17.3	12.4	64.4		88.1	105	553	
12/12/2005	NEC	12.7		47.5		69.2	67.5		
3/15/2006	NEC	13.8	13.9	57.7		64.5	83.3	468	
6/10/2006	NEC	11.5		50.5		55.9	42.4		
9/20/2006	NEC	11.2	9.5	47.8		59.1	56.1	38.4	
12/12/2006	NEC	10.2		41.4		58.9	56.5		
3/27/2007	NEC	10	10.4	43.3		49.8	62.6		
6/6/2007	NEC	9.4		38.3		39.3	29.4	136	
9/12/2007	NEC	9.8	10.4	52.1		40.5	17.4	105	
12/10/2007	MDH			36					

Table 2 - City and Monitoring Well TCE Concentrations (in ppb)

Date	Sampled By	CW-1	CW-2	CW-3	CW-4	MW-1	MW-2	MW-5A	MW-5B
12/21/2007	NEC	8.2		49.4		37.3	18.1		
3/26/2008	NEC	7.7	7.7	34.4		29.3	30.4		
6/19/2008	NEC	7.5		35.4		23.1	18.4	18.7	
9/18/2008	NEC	7.2	6.3	36.3		24.9	5.2		
1/7/2009	NEC	8.2		32.2		21.1	5.1		
3/17/2009	NEC	8.5	7.6	37.6		28.6	13.2	135	
4/22/2009	MDH				<0.1				
6/9/2009	NEC	8.4		37.1		28	7.1	71.9	
9/10/2009	NEC	10.8	7.8	40.6		27.3	7.4	49.5	
12/22/2009	NEC	11.7		33.7		28.2	4.8	96.6	
3/9/2010	NEC	10.7	6.7	33		31.2	4.3	46.3	
6/29/2010	NEC	10.7		35.6		28.2	3.4	154	
10/5/2010	NEC	8.1	17.4	31.9		15.8		27.6	
12/29/2010	NEC	8.6		36.9		14.5		214	
3/17/2011	MDH			39					
3/30/2011	NEC	4.1		30		14.7		142	
6/27/2011	NEC	9		33		9.3		218	
9/29/2011	NEC	3.9	4.8	27.1		8.8		954	
12/22/2011	NEC	7.3	4.8	32.3		17.4		933	
3/30/2012	NEC	16.3	5.2	31.2		21.8		619	
4/27/2012	MDH			40					
6/27/2012	NEC	31.1		33.6		17.5		382	
9/25/2012	NEC	28	5.9	30		21.6		30.6	
12/27/2012	NEC	51.1		30		26.3		157	
3/28/2013	NEC	14.4	6.4	29.4		38.7		1190	
6/26/2013	NEC	15		32.5		15.1		51.9	
7/23/2013	MDH								
9/27/2013	NEC	10.7	13.3	25.7		13.5		461	

Table 2 - City and Monitoring Well TCE Concentrations (in ppb)

Date	Sampled By	CW-1	CW-2	CW-3	CW-4	MW-1	MW-2	MW-5A	MW-5B
12/18/2013	NEC	19.3				16.5		190	
3/31/2014	MDH			26					
3/31/2014	NEC	28.3	12.2	28.3		23		272	
6/23/2014	NEC	32.2		32.3		13.7		447	

NOTES:

a - this well was previously open to several aquifers and was re-constructed to prevent cross-contamination

b - these wells were installed in the summer of 1987

d - Samples collected in January 1999, but actual date not provided.

c - This is an average concentration of the sample (67 ppb) and duplicate (98 ppb)

TCE = trichloroethylene

ppb = parts per billion

NEC = Northern Engraving Corporation or their consultant

MDH = Minnesota Department of Health

<0.1 = TCE not detected at or above the reporting limit of 0.1 ppb

Table 3 - Private Well TCE Concentrations (in ppb)

Date	W-1[a]	W-2[a]	W-3[a]	W-4[a]	W-5[b]	W-6	W-7	W-8	W-9[b]
11/6/1984		5.8		0.3				0.7	8.3
2/4/1986		10	21	0.2		0.6	0.9	1.2	4.4
3/21/1986	5				4.6				
11/1/1986	73	11	11	<0.5	5.9				
11/11/1986						2.3	2.3	<0.5	4.7
5/29/1987	<0.5	6	4.9		2.7			0.8	3.7
7/21/1987	6	16	15		5.1			1.1	3.2
8/18/1987	8.6	15	15		6.1			0.6	3.8
9/23/1987	9.1	18	14		3.1	<0.5	0.8	0.8	2.9
10/22/1987	9.9	15	20		6.1			0.7	4.5
11/19/1987	<0.5	12	18		1.5			0.9	3.1
1/19/1988	33	17	29		4.6			0.8	2.4
2/2/1988	59	19	<0.5	<0.5	5.6	0.9	1	1.2	3.4
3/17/1988	27	16	<0.5		5.8			3.7	3.9
4/21/1988	53	18	20		6.9			1	2.8
5/19/1988	60	18	16		4.6			0.9	3.7
6/23/1988	70	20	28	<0.5	5.5	0.5	0.8	1.3	3.2
7/20/1988	66	<0.5	39		<0.5			0.9	2.3
8/25/1988	110	18	33		5.5			3.7	4.7
9/21/1988	70	19	31	<0.5	3.4	0.7	0.7	1.1	3.4
10/20/1988	48	17			3.8			0.6	5.3
10/26/1988			39						
11/21/1988	32	<0.5	45		4			0.9	6.6
12/14/1988	35	<0.5	48	<0.5	4.3	<0.5	<0.5	0.6	3.9
1/17/1989	53	18	42		4.1			1.6	
2/15/1989	52	14	24		4.5			0.9	
3/17/1989	58	18	25	<0.5	4.6	0.6	0.6	1	
6/13/1989	24	16	28	<0.5	5	0.9	0.6	1.4	11
7/27/1989									
9/6/1989	24	33		<0.5	3.6	0.5	0.7	1	9.4
10/18/1989			12						
12/12/1989	18	25	28	<0.5	3.1	0.7	<0.5	1.2	13
1/22/1990									
3/13/1990	13	22	32	<0.5	4.1	0.5	0.7	1.3	16
6/22/1990	11.2	12			3.4				13
9/13/1990	5.2	29	2.6	<0.5	3.7	0.8	0.9	<0.5	14
12/18/1990	8.5	42	8.3		3.8				12
1/28/1991									
4/1/1991	4.1	18	<0.5	<0.5	3.1				
4/18/1991						0.5	0.6	0.9	17
6/1/1991	4.4	40	<0.5		2.9				
6/21/1991									12
9/11/1991	<0.5	29	<0.5	<0.5		<0.5	<0.5	<0.5	11
10/1/1991					<0.5				
12/11/1991	9.8	25	3.8		2.1				6.9
3/11/1992	25	33	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	9
6/16/1992	63	20	3.8		<0.5	3			3
9/15/1992	27	17	<0.5	<0.5	1	0.5	<0.5	<0.5	4.9
12/10/1992	1.7	20	1.7		1.4				5.8
3/24/1993	2.8	16	2.8	0.6	2.9				

Table 3 - Private Well TCE Concentrations (in ppb)

Date	W-1[a]	W-2[a]	W-3[a]	W-4[a]	W-5[b]	W-6	W-7	W-8	W-9[b]
3/26/1993						1.4	0.8	0.9	6.8
6/14/1993	62	14	0.8		2.3				
9/25/1993	67	10	5.6	<0.5	2.2	1.5	0.7	<0.5	3.7
12/10/1993	53	11	5.5		2.2				3.8
3/16/1994	4.25[d]	11	4.2		1.1	0.8	0.5	<0.5	3.5
6/15/1994	5.95[d]	8	11		1.2				3.2
9/16/1994	<0.5		10		1.1	<0.5	<0.5	0.6	2.2
12/15/1994	7.7		28		1				2.5
3/18/1995	14		55		1.5	<0.5	<0.5	0.5	2.7
6/23/1995	2.6		61	<0.5	2.7				2.6
9/20/1995	1.8		76		1.3	<0.5	<0.5	<0.5	2
12/14/1995	16		59						
3/14/1996	23		110		1.8	<0.5	<0.5	<0.5	
6/19/1996	29		53		2.5				
9/18/1996	44	17	58		2.3	0.7	<0.5	0.6	1.8
12/18/1996	34	19	36		1.9				
3/18/1997	6.6	22	19		2.1	0.7	<0.5	<0.5	2.3
6/25/1997	7.8	18	27	<0.5	2				2
9/17/1997	10	20	15		2.1	<0.5	<0.5	<0.5	1.8
12/15/1997	8.7	22	14						1.7
3/27/1998	8.4	9.3	5.8			<0.5	<0.5	<0.5	1.4
6/6/1998	5.6	13	11		1.1				1.4
9/23/1998	48	14	15		<0.5	<0.5	<0.5	<0.5	1.3
12/11/1998	120	24	18		<0.5			<0.5	1.4
1/1/1999[e]	35								
3/23/1999	8.2	11	9.6		1.8	1.1	<0.5	<0.5	2.1
6/29/1999	51	9.7	7.2		2				1.9
9/15/1999	29	6.2	3.5	<0.5	1.3	0.4	0.2	0.2	1.2
12/14/1999	2.9	4.2	5.3		1.7				1.4
3/22/2000	2		11		2.6	<0.5	<0.5	<0.5	1.7
6/20/2000	8.8		13		1.6				1.7
9/13/2000	<0.5		3.7		<0.5	<0.5	<0.5	<0.5	<0.5
12/12/2000	1.4		20		2.1				1.6
3/20/2001	16		48		3.7	<0.5	<0.5	<0.5	1.3
6/13/2001	23		7.8		1.4				1.4
9/11/2001	1.7		24	<0.5	1.5	<0.5	<0.5	<0.5	1.5
12/4/2001	<0.5		71		2.5				2.7
3/13/2002	3.8		150		1.5	<1.0	<1.0	<1.0	1.3
6/12/2002	8.1		68		1.4				1.1
9/16/2002	17		56		2	<1.0	<1.0	<1.0	1.4
12/9/2002	34		41		1.9				1.7
3/12/2003	30		25		<1.0	<1.0	<1.0	<1.0	<1.0
6/12/2003	22		38		1.4				
9/17/2003	26		12	<1.0	1.5	<1.0	<1.0	<1.0	3.1
12/2/2003	10		13		1.8				3.9
3/10/2004	8.1		16		1.6	<1.0	<1.0	<1.0	5.1
6/21/2004	1.3		13						4.6
9/7/2004	<1.0				1.7	<1.0	<1.0	<1.0	5
12/7/2004	4.7		15.3		1.7				4.2

Table 3 - Private Well TCE Concentrations (in ppb)

Date	W-1[a]	W-2[a]	W-3[a]	W-4[a]	W-5[b]	W-6	W-7	W-8	W-9[b]
3/9/2005	**9.3**		**20.3**		**2.2**	<1.0	<1.0	<1.0	**5**
6/7/2005	**7.5**		**16.2**		**1.8**				**5.5**
9/20/2005	**4.5**		**16.7**	<1.0	**1.9**	<1.0	<1.0	<1.0	**4.8**
12/12/2005	**5.2**				**1.2**				**3.6**
3/15/2006	**2.2**				<1.0				**2.4**
6/10/2006	**18.9**		**36.2**		**1.1**				**2.6**
9/20/2006	**7.1**		**10.2**		**1.3**	<1.0	<1.0	<1.0	**2.4**
12/12/2006	**2.3**		**7.7**		**1.2**				**2.3**
3/27/2007	**2.2**		**7.5**						**2.8**
6/6/2007	**11.9**		**8.6**						**1.9**
9/12/2007	**37.9**		**13.2**		**1.2**				**2**
12/21/2007	**43.4**		**62.3**						**1.6**
3/26/2008	**34.6**		**14.8**						**1.9**
6/19/2008	**37.7**		**8.7**						**1.2**
9/18/2008	**7**		**8.6**		<1.0				**1.1**
1/7/2009	**11**		**10.3**						**1.6**
3/17/2009	**5.5**		**15.8**						**1.7**
6/9/2009	**9.1**		**47**						**1.8**
9/10/2009	**18.3**		**38.1**		<1.0				**1.7**
12/22/2009	**9.3**		**37.5**						**1.3**
3/9/2010	**11.2**		**54.8**						**1.1**
6/29/2010	**1.6**		**40.4**						<1.0
10/5/2010	**23.2**		**9.3**		<1.0				<1.0
12/29/2010	**6.2**		**5.3**						<1.0
3/30/2011	**3.8**								
6/27/2011	**16.9**		**12.1**						
9/29/2011	**5**		**17**		<1.0				<1.0
12/22/2011	**3.2**		**23.4**						<1.0
3/30/2012	**1.4**		**45**						
6/27/2012	**1**		**17**						
9/25/2012	**1.4**		**55.2**		<1.0				<1.0
12/27/2012	<1.0		**17**						
3/28/2013			**42.9**						
6/26/2013			**40.5**						
7/23/2013						**0.04 J**	**0.1**	**0.08 J**	
9/27/2013			**5.1**		**0.8**		<0.40		**0.64**
12/18/2013			**7.2**						
3/31/2014									
6/23/2014			**12.3**						

Table 3 - Private Well TCE Concentrations (in ppb)

Date	W-10	W-11	W-12	W-13	W-14	W-15	W-16	W-17	Farm
11/6/1984	<0.5								**0.2**
2/4/1986	<0.5		<0.5						**0.2**
3/21/1986		<0.5		<0.5	<0.5	<0.5			
11/1/1986									
11/11/1986								**33**	**2.2**
5/29/1987								**28**	
7/21/1987								**40**	
8/18/1987								**49**	
9/23/1987	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**52**	
10/22/1987								**44**	
11/19/1987								**36**	
1/19/1988								**46**	
2/2/1988	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	**28**	
3/17/1988								**24**	
4/21/1988						<0.5		**29**	
5/19/1988								**29**	
6/23/1988	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**29**	
7/20/1988								**37**	
8/25/1988								**36**	
9/21/1988	**0.6**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**39**	
10/20/1988								**29**	
10/26/1988									
11/21/1988								**32**	
12/14/1988	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	**42**	
1/17/1989								**32**	
2/15/1989								**27**	
3/17/1989	<0.5		<0.5	<0.5	<0.5	<0.5		**32**	
6/13/1989		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**19**	
7/27/1989	<0.5								
9/6/1989	**0.7**				<0.5	<0.5	<0.5	**18**	
10/18/1989		<0.5	<0.5	<0.5					
12/12/1989	**1**	**0.5**		<0.5	<0.5	<0.5	<0.5	**18**	
1/22/1990								**18**	
3/13/1990	**1.3**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**19**	
6/22/1990			**0.7**					**21**	
9/13/1990	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**17**	
12/18/1990								**18**	
1/28/1991								**18**	
4/1/1991									
4/18/1991	**1.3**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**21**	
6/1/1991									
6/21/1991								**20**	
9/11/1991	**1.1**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**24**	
10/1/1991									
12/11/1991								**9.6**	
3/11/1992	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**10**	
6/16/1992								**25**	
9/15/1992	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**30**	
12/10/1992								**16**	
3/24/1993									

Table 3 - Private Well TCE Concentrations (in ppb)

Date	W-10	W-11	W-12	W-13	W-14	W-15	W-16	W-17	Farm
3/26/1993	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	**30**	
6/14/1993								**8.9**	
9/25/1993	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**13**	
12/10/1993								**27**	
3/16/1994	<0.5							**25**	
6/15/1994								**19**	
9/16/1994	<0.5							**20**	
12/15/1994								**20**	
3/18/1995	<0.5							**24**	
6/23/1995		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**17**	
9/20/1995	<0.5							**22**	
12/14/1995									
3/14/1996	<0.5								
6/19/1996								**13**	
9/18/1996	**9**							**21**	
12/18/1996									
3/18/1997	<0.5								
6/25/1997		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**22**	
9/17/1997	<0.5							**15**	
12/15/1997									
3/27/1998	<0.5							**6.8**	
6/6/1998								**6.6**	
9/23/1998	<0.5							**14**	
12/11/1998								**30**	
1/1/1999*									
3/23/1999	<0.5							**18**	
6/29/1999								**19**	
9/15/1999	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**18**	
12/14/1999								**21**	
3/22/2000	<0.5							**22**	
6/20/2000								<0.5	
9/13/2000	<0.5							<0.5	
12/12/2000									
3/20/2001	<0.5							**19**	
6/13/2001								**16**	
9/11/2001	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**14**	
12/4/2001								**16**	
3/13/2002	<1.0							**14**	
6/12/2002								**6.9**	
9/16/2002	<1.0							**16**	
12/9/2002								**17**	
3/12/2003	<1.0							**10**	
6/12/2003								**12**	
9/17/2003	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**12**	
12/2/2003								**15**	
3/10/2004	<1.0							**14**	
6/21/2004									
9/7/2004	<1.0							**16**	
12/7/2004								**16.8**	

Table 3 - Private Well TCE Concentrations (in ppb)

Date	W-10	W-11	W-12	W-13	W-14	W-15	W-16	W-17	Farm
3/9/2005	<1.0							**19.5**	
6/7/2005								**19.4**	
9/20/2005	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	**9.9**	
12/12/2005								**13.2**	
3/15/2006								**9.1**	
6/10/2006								**9.3**	
9/20/2006	<1.0							**13.4**	
12/12/2006								**15.1**	
3/27/2007								**11.2**	
6/6/2007									
9/12/2007									
12/21/2007								**14.5**	
3/26/2008								**8.8**	
6/19/2008									
9/18/2008									
1/7/2009									
3/17/2009									
6/9/2009									
9/10/2009									
12/22/2009									
3/9/2010									
6/29/2010									
10/5/2010									
12/29/2010									
3/30/2011									
6/27/2011									
9/29/2011									
12/22/2011									
3/30/2012									
6/27/2012									
9/25/2012									
12/27/2012									
3/28/2013									
6/26/2013									
7/23/2013	<0.1		<0.1	<0.1		<0.1	<0.1		
9/27/2013									
12/18/2013									
3/31/2014									
6/23/2014									

Table 3 - Private Well TCE Concentrations (in ppb)

Date	W-18[c]	W-19[c]	W-20[c]	W-21[c]	W-22[c]
3/14/1996				<0.5	
6/19/1996				<0.5	
9/18/1996				<0.5	
12/18/1996	–			<0.5	
3/18/1997	<0.5	<0.5	<0.5	<0.5	
6/25/1997	<0.5	<0.5	<0.5	<0.5	
9/17/1997	<0.5	<0.5	<0.5	<0.5	
12/15/1997	<0.5	<0.5	<0.5	<0.5	
3/27/1998	<0.5	<0.5	<0.5	<0.5	
6/6/1998	<0.5	<0.5	<0.5	<0.5	
9/23/1998	<0.5	<0.5	<0.5	<0.5	
12/11/1998	<0.5	<0.5	<0.5	<0.5	
3/23/1999	<0.5	<0.5	<0.5	<0.5	
6/29/1999	<0.5	<0.5	<0.5	<0.5	
9/15/1999	<0.5	0.2	<0.5	<0.5	
12/14/1999	<0.5	<0.5	<0.5	<0.5	
3/22/2000	<0.5	<0.5	<0.5	<0.5	
6/20/2000	<0.5	<0.5	<0.5	<0.5	
9/13/2000	<0.5	<0.5	<0.5	<0.5	
12/12/2000	<0.5	<0.5	<0.5	<0.5	
3/20/2001	<0.5	<0.5	<0.5	<0.5	
6/13/2001	<0.5	<0.5	<0.5	<0.5	
9/11/2001	<0.5	<0.5	<0.5	<0.5	
12/4/2001	<0.5	<0.5	<0.5	<0.5	
3/13/2002	<1.0	<1.0	<1.0	<1.0	
9/16/2002	<1.0	<1.0	<1.0	<1.0	
9/17/2003	<1.0	<1.0	<1.0	<1.0	
9/7/2004	<1.0	<1.0	<1.0	<1.0	
9/20/2005	<1.0	<1.0	<1.0	<1.0	
9/20/2006	<1.0	<1.0	<1.0	<1.0	
3/28/2013	<1.0				
7/23/2013	<0.1	**0.2**	**0.2**	**0.61**	**0.06 J**
9/27/2013		<0.40	<0.40	**0.65**	
12/18/2013				**1.1**	
3/31/2014				**0.84**	
6/23/2014					

NOTES

a - Well sealed or not currently used for drinking water source

b - GAC filter system currently in use at this property

c - Well not sampled for TCE before 1996, 1997, or 2013

d - This is an average concentration of the sample and duplicate sample collected on the same day

e- Samples collected in January 1999, but actual date not provided.

TCE = trichloroethylene

ppb = parts per billion

NEC = Northern Engraving Corporation (or their consultant)

MDH = Minnesota Department of Health

ND = not detected at or above reporting limit (but reporting limit not provided)

<1.0 = not detected at or above reporting limit value shown

J = concentration detected is below the reporting limit and the amount is estimated

Shading indicates concentration is greater than current HBV (0.4 ppb)