Health Consultation

NORTH OAKS PRIVATE WELL CONTAMINATION
ASSOCIATED WITH THE HIGHWAY 96 DUMP

CITY OF NORTH OAKS, RAMSEY COUNTY, MINNESOTA

EPA FACILITY ID: MND980679369

MARCH 28, 2006

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

Health Consultation: A Note of Explanation

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

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

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Prepared by:

The Minnesota Department of Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry
U.S. Department of Health and Human Services

FOREWORD

This document summarizes public health concerns related to a hazardous waste site in Minnesota. It is based on a formal site 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, where it is found on the site, 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, responsible parties, 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.*

Please write to: Community Relations Coordinator
Site Assessment and Consultation Unit
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OR call us at: (651) 201-4897 *or* 1-800-657-3908
(toll free call - press "4" on your touch tone phone)

On the web: http://www.health.state.mn.us/divs/eh/hazardous/index.html

Summary

Groundwater contamination associated with the former Highway 96 Dump has been detected by routine monitoring of private wells in the City of North Oaks. Based on existing information, three private wells on the west side of Gilfillan Lake had detections of vinyl chloride in 2004 and 2005; one of the homes with vinyl chloride in their well was issued a drinking water advisory letter by MDH. Sampling of surrounding private wells shows that the affected area is confined to a limited number of wells. As a conservative measure, residences with vinyl chloride detections in drinking water wells are being provided with bottled water as an interim response action while more permanent solutions are being evaluated. Because no exposures above existing health-based criteria are taking place, and routine monitoring of private and public wells in the area of concern in southeast North Oaks is occurring, the situation represents no apparent public health hazard at this time.

I. Site Background and History

The Highway 96 Dump is a former dump site listed on the Permanent List of Priorities, the Minnesota state Superfund list. The site is located in White Bear Lake Township in Ramsey County. The area around the site is suburban and is experiencing ongoing residential and commercial development. Immediately west of the site is the community of North Oaks. The location of the site and the surrounding areas discussed in this report are provided in Figure 1.

The Highway 96 dump received commercial, industrial and household wastes for more than 50 years, from the 1920s until 1973 (MDH 1991, MDH 1993, MDH 2003, CRA 2005). During the late 1960s, hazardous industrial wastes such as paints, solvents, and oils and greases, were disposed there. During site investigation, groundwater under the site was shown to be contaminated with high concentrations of volatile organic compounds (VOCs). The principle VOCs in groundwater at the site are 1,1-dichloroethane, cis-1,2-dichloroethene, methyl ethyl ketone (MEK), and vinyl chloride. Of these, vinyl chloride has historically been the contaminant of most concern.

In 1989, a groundwater extraction well and sump system were installed at the site to remove contaminated groundwater and leachate at the source. This groundwater remediation system has been in operation ever since. Other remedial actions taken at the site by the responsible parties and their consultant, Conestoga-Rovers & Associates (CRA) under the oversight of the MPCA include the removal of buried drums, the consolidation of waste materials, the installation of a cap over the remaining wastes on site, and improvements to the gas venting system (CRA 2005). Specific information on the operation of the Highway 96 Dump, and remedial actions taken for drum removal, soil cleanup, and site closure are described in previous MDH reports on the site (see MDH 1991, MDH 1993, and MDH 2003).

Site Geology and Hydrology

The area at and around the site is underlain by 50 to 160 feet of glacial drift. This drift is a

complex of lacustrian clay, glacial alluvium and till. There are a series of distinct scarp valleys representing glacial water drainage ways that are associated with Gilfillan Lake. The main valley, which contains the lake, extends from the north to across Highway 96. There is a large tributary valley extending northeast from the eastern edge of Gilfillan Lake. The drift in these valleys is thicker (usually in excess of 100 feet) and composed of sandy, transmissive materials with local areas of lacustrian clays. The upland areas outside the valleys are primarily underlain by loamy to clayey till.

Although small areas of Platteville Formation are present southeast of Gilfillan Lake and in isolated buttes, the underling bedrock is St. Peter sandstone. The St. Peter has an uneroded thickness of about 140 feet and may be completely removed in local bedrock valleys. These valleys are roughly co-incident with the glacial scarp valleys described above. There appears to be a consistent layer of clayey sandstone about five feet thick at the base of the St. Peter.

Intermittent areas of perched groundwater are present at the dump site. The first true groundwater unit is in the glacial drift and is known as the Lower Sand aquifer. This unit is connected to the underlying St. Peter sandstone bedrock aquifer. Underlying the St. Peter, and generally separated from it by the layer of clayey sandstone (usually referred to as the basal St. Peter) are the Prairie du Chien limestone aquifer and the deeper Jordan sandstone aquifer.

In general terms, groundwater in the area moves westward from the site toward the residential neighborhoods of North Oaks. This conclusion about flow direction is based on the historical distribution of groundwater contaminants from the dump and groundwater elevation measurements taken in private wells and in monitoring wells on and near the site.

A review of the available records in the County Well Index for the area shows that about 80% of the private wells in the site vicinity are completed in the lower portion of the St. Peter sandstone, about 15% are open to some portion of the Prairie du Chien/Jordan aquifer and about 5% are alluvial/drift wells. This is based upon incomplete records of well construction as formal well logs are available for only 10-20% of the wells in the area.

History of Private Well Sampling Associated with the Highway 96 Dump

In 1988, MDH issued drinking water advisories for wells at three homes in North Oaks due to the presence of low levels of VOCs in samples from the wells. None of the VOCs exceeded MDH standards of the day; however, it was MDH policy at that time to issue drinking water advisories when four or more related compounds were detected in a well. Households that received the advisories were provided with alternate drinking water by the responsible parties taking action for the site investigation and cleanup. After additional monitoring showed that MDH health-based guidelines for the contaminants were not exceeded in repeated sampling of the wells, MDH rescinded the advisories in January 1991.

MDH prepared a health assessment for the site in 1991 (MDH 1991). The report recommended ongoing monitoring of private wells situated downgradient (west) of the dump in North Oaks. Continued monitoring of residential wells after the drinking water advisories were lifted did not

show any increase in the levels of groundwater contaminants off-site until 1993.

In January 1993, MPCA notified MDH of a tentative finding of vinyl chloride (reported at 4.0 μg/L -- with the result considered suspect due to analytical problems) in a sample from a newly installed well on Robb Farm Road. This finding exceeded the Recommended Allowable Limit (RAL) of 0.1 μg/L, the health-based guideline used by MDH at that time for vinyl chloride. In response to this new data and the possibility that vinyl chloride might be present in groundwater used for potable purposes, MDH recommended to the MPCA in a Health Consultation (MDH 1993) that the wells in the area be sampled and tested using a laboratory method which would improve the sensitivity of the test for vinyl chloride. Although this extra laboratory work was above and beyond normal procedures, such confirmatory testing was needed in order to determine if the "tentative" detection was real. This increased effort was considered necessary because vinyl chloride is a known human carcinogen, its detection can be very difficult, and it was present in groundwater under the Highway 96 Dump.

In 1993 and 1994, water samples were collected from 76 homes in the southeast corner of North Oaks (CRA 2005). The sampling found a plume of groundwater contamination in North Oaks from the Highway 96 Dump. MDH evaluated the results, and issued drinking water advisories to 12 homes where vinyl chloride exceeded the RAL of 0.1 μg/L. The maximum concentration of vinyl chloride detected and confirmed in a residential well was 3 μg/L; typical ranges in these wells were between 0.1 to 2 μg/L. Later in 1993, a Minnesota Decision Document was executed outlining the proposed remedy for the contamination at and off the dump site. This remedy, recommended by the responsible parties for the site and approved by the MPCA, ultimately involved the connection of 60 homes in the affected area of southeast North Oaks to the White Bear Township municipal water supply. Five of the private wells were converted to monitoring wells (one of which was sealed in 2000). The remedy was completed in 1994. The area served by the municipal water system is shown in Figure 2. The remedy also called for continued regular sampling of private wells in North Oaks that were located outside the area served by the White Bear Township water supply to monitor for contamination.

From 1993 until 2004, the responsible parties for the site monitored 50 private wells in North Oaks on a regular basis, including homes on the north, south, and west sides of Gilfillan Lake. The monitoring was conducted every year, and beginning in 2000 every other year (with the approval of the MPCA) due to the lack of detection of contaminants. Not all of the wells were sampled each year. The MPCA typically selected which wells were to be sampled in a given year, although all 50 wells have been sampled at least twice. Monitoring wells located on the site, as well as the converted private wells located east of Gilfillan Lake have been sampled on an annual basis.

Vinyl chloride was detected in one residential well on the west side of Gilfillan Lake (on West Shore Road) at a maximum concentration of 0.075 μg/L in 1993. As a precaution, this well and five others on the west shore of Gilfillan Lake were sampled for VOCs on an annual basis between 1994 and 2000, and every two years between 2000 and 2004. Very low levels of five other VOCs (but not vinyl chloride) were intermittently detected in these wells between 1994

and 2003. All but two of the 74 samples collected had laboratory detection limits for vinyl chloride between 0.036 μg/L to 0.2 μg/L. The historical sample results for the six wells on the west side of Gilfillan Lake monitored by CRA between 1993 and 2004 are presented in Table 1. Note that individual addresses have been removed for privacy reasons.

In 1994, MDH enacted a new standard for vinyl chloride, known as a Health Risk Limit (HRL), of 0.2 μg/L. The HRL represents a level of contamination in drinking water that MDH considers acceptable for daily human consumption over a lifetime, and is a promulgated rule.

Routine sampling by CRA in October 2004 detected vinyl chloride at identical concentrations of 0.12 μg/L in two of 16 residential wells on the west side of Gilfillan Lake (both along West Shore Road). No VOCs were detected in the other 14 wells. As a result of the detection of vinyl chloride in the two wells, at the direction of the MPCA an enhanced private well monitoring program was implemented in January 2005 to evaluate the extent of vinyl chloride contamination in North Oaks. The MPCA informed MDH of the 2004 sample results, and requested MDH assistance in evaluating the problem. In August 2005 MPCA staff formally requested that MDH prepare a health consultation regarding the vinyl chloride contamination detected in private wells in North Oaks.

Private Well Sampling in 2005

The enhanced private well monitoring program began in January 2005 with the collection of residential well water samples from the two affected wells along West Shore Road by CRA for analysis at Interpoll, a local analytical laboratory (CRA 2005). Vinyl chloride was detected at concentrations of 0.12 and 0.16 μg/L in the two wells, respectively. Water samples from the two wells were collected again in February 2005 by CRA (for analysis by Severn Trent Laboratories, an out of state laboratory) and by the MPCA (for analysis at the MDH Public Health Laboratory). Vinyl chloride was not detected in the sample analyzed by Severn-Trent Laboratories, but was detected at estimated concentrations of 0.15 and 0.11 μg/L in the two wells along West Shore Road, respectively, by the MDH laboratory. These results raised questions regarding Severn Trent Laboratories and their ability to achieve the low detection limits needed for vinyl chloride. As a result, CRA discontinued the use of Severn Trent Laboratories. Water samples subsequently collected from private and public wells in North Oaks (by CRA, MPCA, and MDH staff) in 2005 have been analyzed primarily by the MDH Public Health Laboratory.

Through August 2005, water samples were collected by CRA and MPCA staff from 52 private wells in North Oaks. Some wells were sampled only once, while others were sampled on an approximately monthly basis. All of the samples were analyzed for up to 68 VOCs. The results of these samples (VOC detections only) are provided in Table 2. Note that individual addresses have been removed for privacy reasons. To date, vinyl chloride has been detected in three residential wells in North Oaks, on the west side of Gilfillan Lake: the same two wells along West Shore Road, and a third well a short distance away on Hummingbird Hill. The general locations where recent private well samples were collected for which validated data are available (August 2005), and where vinyl chloride was detected and are shown in Figure 3. One of the three wells was not sampled in August due to lack of access. Low levels of other VOCs have

also been detected in some wells, all at concentrations far below their respective HRLs. The suite of VOCs detected (with the possible exception of benzene, toluene, chloroform, and methylene chloride) is similar to the VOCs routinely detected in groundwater at the Highway 96 Dump. This indicates that the source of the low levels of site-related VOCs found in the private wells in North Oaks likely continues to be the Highway 96 Dump. As the data show, the area of vinyl chloride contamination in private wells appears to be confined to a small area on the west side of Gilfillan Lake.

On May 6, 2005, MDH issued a drinking water advisory letter to the occupants of one home on West Shore Road based on the results of a sample collected from the well on March 30, 2005. While the vinyl chloride concentration in the well (0.2 μg/L) did not exceed the current HRL, very low concentrations of several other VOCs that are considered potential carcinogens (chloroform and methylene chloride) were also detected. MDH staff evaluated the combined effect of having multiple known or potential carcinogens in drinking water. The combined ratios of the three known or potential carcinogens relative to their respective HRLs slightly exceeded an additivity index of one. As a result, MDH issued the drinking water advisory letter recommending that the water not be used for drinking or cooking purposes.

The three residences with private wells where vinyl chloride has been detected are being provided with bottled water for drinking and cooking purposes by the responsible parties for the site. A formal offer has been made by the responsible parties for the site to install new, deeper drinking water wells for the three homes where vinyl chloride has been detected in their wells.

In November 2005, CRA and the MPCA collected samples from 67 private wells in North Oaks for analysis for VOCs. Preliminary results show that low levels of vinyl chloride were found in the same two wells that had detections of vinyl chloride in the August 2005 sample event (on West Shore Road and Hummingbird Hill); no other wells showed detectable levels of vinyl chloride (F. Campbell, MPCA, personal communication 2005). Because validated laboratory results are not yet available, the results of the November 2005 sample event were not included in this report. They have been made available on the City of North Oaks web site (http://www.cityofnorth-oaks.com/).

The City of North Oaks also has an arrangement with a local chapter of the League of Women Voters to collect water samples from 50 private wells in the city each year to monitor for the presence of nitrates and coliform bacteria, the most common contaminants of well water. This program provides general monitoring of groundwater quality in the city, but does not provide information to individual homeowners on the condition of their well and the quality of their well water except on an infrequent basis.

Public Water Supply Monitoring

MDH is responsible for monitoring the quality of regulated public drinking water supplies under the federal Safe Drinking Water Act. As a result, MDH staff regularly sample wells that provide drinking water at churches, recreation centers, beaches, and other areas frequented by the public on a seasonal or year-round basis. This monitoring typically involves analysis for only a limited

number of contaminants, usually nitrates and coliform bacteria. However, due to concerns over contamination related to the Highway 96 Dump, since 1993 MDH staff have collected water samples for analysis for VOCs (including vinyl chloride) from eleven such wells in North Oaks. The wells, their locations, well depth and aquifer information where available, and the dates and results of analyses for vinyl chloride are shown in Table 3. The geographic locations of the wells are shown in Figure 4.

Many of these wells, especially those located in the southeast part of North Oaks, have been sampled more frequently recently due to renewed concerns in the community. Vinyl chloride has not been detected in any of these public water supply wells. While reporting limits have varied over the years, the most recent (2004 and 2005) samples had reporting limits of 0.2 μg/L for vinyl chloride. The MDH laboratory method detection limit for these recent samples was lower, closer to 0.1 μg/L, and the laboratory staff stated there were no detections of vinyl chloride above the method detection limit but below the reporting limit for any of these samples (P. Swedenborg, MDH Public Health Laboratory, personal communication, 2005). Only one other VOC (styrene) has been detected in any of these public wells. The styrene detection was in a sample collected from a water fountain on the North Oaks golf course. Styrene is a component of many plastics and is also a combustion product, so it is possible that detection is a result of plastic parts in the drinking water fountain, or from emissions from nearby vehicles. The concentration of styrene (0.9 μg/L) was far below the federal regulatory standard (100 μg/L) for styrene in public water systems under the Safe Drinking Water Act, known as the Maximum Contaminant Level (MCL).

The public wells are completed at a variety of depths in several aquifers, including the surficial, St. Peter, Prairie du Chien, and Jordan aquifers. The wells at the North Oaks Golf Club and East Recreation Center are located closest to the private wells that have had detections of vinyl chloride in 2004 and 2005. The well at the East Recreation Center has been sampled for VOCs by MDH seven times since 1993. Vinyl chloride has not been reported in any of the samples. Vinyl chloride was not found in any of the recent samples from the five wells serving the North Oaks Golf Club, which is located approximately ½ mile west and downgradient in terms of groundwater flow from the three private wells that have had detections of vinyl chloride.

While the reporting limits for some of the samples collected in the past from the public water supply wells in North Oaks were above the current HRL for vinyl chloride, they were in all cases below the applicable regulatory standard (the MCL) for vinyl chloride for public water systems of 2.0 μg/L (see the Discussion section below for more information on standards for vinyl chloride).

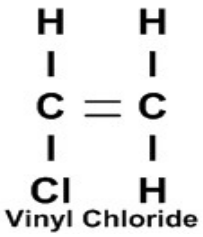
Under the federal Safe Drinking Water Act, MDH is also responsible for monitoring the safety of the White Bear Township public water supply, which serves 60 homes in the southeast corner of North Oaks. MDH staff have collected samples from the White Bear Township system for analysis for VOCs three times in 2005. No VOCs (including vinyl chloride) have been detected in the system in any of the samples.

Site Visit

MDH staff have made numerous visits to the Highway 96 Dump and surrounding areas, most recently on January 20, 2006. The dump itself is dotted with monitoring wells and gas vents, and is not fenced. A paved recreational trail runs partially around its perimeter. The monitoring wells and associated groundwater pumping equipment are locked and appear to be in good condition. Three gas vents are completed eight feet above grade; more recently five additional gas vents were installed and are five to six feet above grade and topped by rotating turbines. All would be difficult to reach without a ladder, especially for children.

II. Discussion

Vinyl chloride is a man-made colorless gas at normal room temperature (ATSDR 1997). Most of the vinyl chloride manufactured today is used in producing polyvinyl chloride (PVC), a common plastic used in many commercial products including water pipes. It can also be produced in the environment from the degradation of other chlorinated solvents such as trichloroethene (TCE) and tetrachloroethene. Vinyl chloride may also be found in tobacco smoke from cigarettes and cigars. A molecule of vinyl chloride consists of two carbon atoms linked by a double bond, three hydrogen atoms, and a chlorine atom. The molecular structure of vinyl chloride is shown below:



Vinyl Chloride

In water, most people begin to taste vinyl chloride only at levels higher than about 3.4 milligrams per liter, or 3.4 parts per million (ATSDR 1997). Vinyl chloride is easily absorbed via inhalation or ingestion, but absorption through the skin is negligible. Once absorbed, vinyl chloride rapidly enters the bloodstream where it is metabolized by the liver. The metabolites are eventually excreted by the kidneys. The metabolites of vinyl chloride, some of which can damage DNA, are likely responsible for the adverse health effects associated with it.

Studies in animals exposed to very high levels of vinyl chloride in air show that the chemical can damage the liver, lungs, kidneys, and heart (ATSDR 1997). People exposed on the job to high levels of vinyl chloride in air may show changes in the liver, nerve damage, immune system effects, reproductive effects, and blood flow problems (Bolt 2005). These types of high workplace exposures generally occurred in the past and are uncommon today, and adverse health effects have not been seen from exposures outside the workplace.

Vinyl chloride has been shown to cause cancer in laboratory animals. Based on epidemiological studies in humans, it is classified by the U.S. EPA as a known human carcinogen (EPA 2005,

Bolt 2005). Studies in test animals and in workers exposed to high levels of vinyl chloride (in air) on the job indicate a relation between exposure to high levels of vinyl chloride and angiosarcoma, a rare type of liver cancer. Published data also suggest a possible relation between exposure to vinyl chloride and brain cancer. The adverse effects of exposure to high levels of vinyl chloride on the liver may be exacerbated by concurrent exposure to ethanol or infection by the hepatitis virus (Mastrangelo et al 2004). There have been no human studies of the potential adverse health effects from exposure to low levels of vinyl chloride in drinking water. However, the types of adverse health effects associated with occupational exposure to high levels in air do not seem likely to occur at common environmental exposure levels in water.

Drinking Water Criteria for Vinyl Chloride

MDH developed the Health Risk Limits (HRLs) for groundwater in part to provide advice to private well owners about the suitability of their water supply for daily consumption and other potable uses. They are strictly health-based criteria. They are often used by regulatory agencies (such as the MPCA) as the basis for decisions regarding the investigation and remediation of contaminated groundwater.

The existing HRL for vinyl chloride (0.2 μg/L) was promulgated in 1994. It is based on cancer as the health effect of concern, using the assumptions that a 70-kilogram (approximately 154 pound) adult is drinking two liters (just over ½ gallon) of water per day over a lifetime. The cancer potency slope factor (a measure of the potency of a carcinogen) used to derive the HRL was 1.9 per mg/kg-day (EPA 2005). The excess incremental lifetime cancer risk used in deriving HRLs is 1×10^{-5}, or one excess case of cancer per 100,000 exposed persons. MDH considers this a very low (or 'negligible') amount of risk. Because of their inherent conservatism, MDH believes that the existing HRLs are also protective of other populations, such as children, the elderly, and those with compromised immune systems.

Contaminant levels in public water supplies, such as the White Bear Township system that supplies residents on the east side of Gilfillan Lake, are regulated at the federal level. EPA has developed Maximum Contaminant Levels (MCLs) for public water supplies that incorporate factors such as technical feasibility, analytical detection limits, and cost of treatment in addition to health-based factors. As a result, MCLs may be different than Minnesota's strictly health-based HRLs. The current MCL for vinyl chloride in public water supplies is 2.0 μg/L.

In 2000, EPA issued new estimates of the carcinogenic potency of vinyl chloride (EPA 2005). Instead of issuing one new cancer potency slope factor for all exposures, they issued two – one for adult exposure and one for exposure from birth. The new cancer slope factor for adult exposure is 0.72 per mg/kg-day; the new cancer slope factor for exposure from birth is 1.4 per mg/kg-day. Both are lower than the previous slope factor, indicating that vinyl chloride is considered less carcinogenic than previously thought – even if exposure occurs from birth.

In 2002, the Minnesota Legislature enacted a law that directed MDH to more transparently account for children's exposure to contaminants when water quality standards for environmental contaminants are established or revised (MN Stat. § 144.0751). MDH is currently revising the HRL rule. This is a formal process, with several opportunities for public input. As a part of this

process, MDH has posted the proposed HRLs, including proposed HRLs for vinyl chloride, on the MDH web site at http://www.health.state.mn.us/divs/eh/groundwater/hrlgw/index.html. The current proposed HRL rule uses a factor (of three) to account for the relative higher intake of water by children. Another factor (of two) is proposed to account for the possible increased sensitivity of children to carcinogens.

The proposed HRL for vinyl chloride, based on carcinogenic effects is 0.08 µg/L. It uses the EPA exposure from birth cancer slope factor of 1.4 per mg/kg-day, so the early-life potency adjustment factor proposed by MDH was not applied. The proposed cancer HRL does include the intake adjustment factor for children. The result is a proposed HRL that is 2.5 times lower than the current HRL. It is still based on a calculated incremental lifetime cancer risk of 1×10^{-5}, or one excess case of cancer per 100,000 exposed persons.

For the revised HRL rule MDH staff also derived a proposed HRL for vinyl chloride based on non-cancer effects (on the liver and immune system). The proposed non-cancer HRL of 7 µg/L includes the intake adjustment factor for children. Because the proposed non-cancer based HRL is higher than the proposed cancer-based HRL, the cancer-based HRL is the criterion that would typically be used to evaluate water quality. Because the HRL revision process is not complete, the proposed HRLs for vinyl chloride may change before the rule becomes final, which is not expected to occur until late 2006.

The existing HRL of 0.2 µg/L and the proposed HRL of 0.08 µg/L are both protective of human health. The highest level of vinyl chloride detected in a private well in 2005 was 0.20 µg/L. Using the current HRL, if a resident at this location consumed two liters of this water everyday for a lifetime their corresponding calculated risk of developing cancer would be 1.0×10^{-5}, or 1 in 100,000. Using the proposed HRL in the same scenario, the corresponding calculated risk would be 2.5×10^{-5}, or 1 in 40,000. Both are very small risks and represent an upper bound estimate of the potential risk. The true health risk is unknown and is likely to be lower, possibly even zero.

These incremental lifetime cancer risks are on top of the background cancer incidence rate in Minnesota residents. Nearly one in two Minnesotans will be diagnosed with cancer during their lifetimes. That corresponds to a background cancer risk of between 40,000 – 50,000 in 100,000.

Exposure to VOCs Through Pathways other than Ingestion

Some older studies suggested that exposure to VOCs (such as vinyl chloride) in drinking water through inhalation or skin contact during activities such as showering, bathing, or washing dishes could be significant in certain situations. The ratio of inhalation uptake versus direct ingestion of contaminated water was estimated to be as high as six to one (McKone 1989) or as low as less than one to one (Lindstrom and Pleil 1996). A more recent study (Kerger et al 2000) using water and air measurements taken in actual home bathrooms estimated that the exposure through inhalation of volatile organics (such as vinyl chloride) from showering and bathing in contaminated water is less than the ingestion exposure by a factor of three to four. Previous studies typically used laboratory or simulated shower facilities, which tend to be smaller than

standard home showers and less well ventilated, resulting in higher estimates of exposure through inhalation.

A large number of variables are involved in assessing inhalation exposure from drinking water sources, making accurate estimates very difficult. These variables include such things as water temperature, size of the shower enclosure, the type of shower head used, length of time spent in the shower, and ventilation. One study (Lee et al 2002) identified the contaminant level and the time spent in the shower as the key variables that determine the level of exposure. Several studies have demonstrated that simply ventilating the shower stall can greatly reduce the estimated exposure to VOCs in shower air (McKone and Knezovich 1991; Aggarwal 1994). Estimates of additional exposure through skin contact with contaminated water are generally thought to be less than for inhalation exposure, and have been estimated to be in the range of one to one or less (McKone 1989). One study (Lee et al 2002) estimated that intake through dermal absorption would account for only about 2% of the total intake through inhalation and dermal contact while showering. This is especially true for vinyl chloride due to its high volatility.

The route of exposure, however affects the rate at which VOCs are absorbed and metabolized by the body; even if the same dose is received via different routes (i.e., ingestion, inhalation, or skin contact) the resulting toxicity may be different (Weisel and Jo 1996). A review of studies by ATSDR in their toxicological profile for vinyl chloride suggests that absorption of vinyl chloride through the gastro-intestinal tract as a result of oral exposure is "rapid and virtually complete." While absorption of inhaled vinyl chloride in human lungs is "rapid," on average only 42% of inhaled vinyl chloride is retained in the body, at least at higher concentrations (ATSDR 1997).

Some pharmacokinetic models developed by EPA also suggest that the levels of VOC metabolites formed by the body may be higher as a result of oral exposure than inhalation exposure (ATSDR 1997). For instance, small amounts of VOCs that are ingested are often quickly metabolized by the liver, while small amounts of VOCs that are inhaled or absorbed through the skin are typically distributed throughout the body prior to metabolism by the liver, and are therefore metabolized more slowly. The toxic effects of exposure to VOCs are mainly due to the action of their metabolites within the body. This implies that for equal (low) doses the ingestion of VOCs in water may be of greater consequence within the body than inhalation or dermal absorption because ingestion produces higher concentrations of toxic metabolites in a shorter amount of time.

Child Health Considerations

ATSDR and MDH recognize that the unique vulnerabilities of infants and children make them of special concern to communities faced with contamination of their water, soil, air, or food. Children are at greater risk than adults from certain kinds of exposures to hazardous substances. They are more likely to be exposed because they play outdoors and they often bring food into contaminated areas. They are smaller than adults, which means they breathe dust, soil, and heavy vapors close to the ground. Children also weigh less, resulting in higher doses of chemical exposure per body weight. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Most importantly, children

depend completely on adults for risk identification and management decisions, housing decisions, and access to medical care.

Children may be exposed to low levels of VOCs if they consume water from the affected private wells in North Oaks. At the current time there are very low levels of vinyl chloride in three private drinking water wells on the west side of Gilfillan Lake. Exposure to vinyl chloride through ingestion has been eliminated by the use of bottled water provided by the responsible parties for the site to the three homes where vinyl chloride has been detected. Additional remedial actions are being evaluated that should reduce or eliminate dermal and inhalation exposures to low levels of vinyl chloride in the three affected private wells. Routine monitoring of private wells and public water supplies for the presence of VOCs in the affected area of North Oaks will continue.

III. Conclusions

Groundwater contamination associated with the former Highway 96 Dump site has been detected by routine monitoring of private wells in the City of North Oaks. Three private wells have had detections of vinyl chloride at concentrations at or just below the current HRL for vinyl chloride of 0.2 μg/L; the occupants of one the homes with vinyl chloride in their well were issued a drinking water advisory letter by MDH in May 2005 because of the combined presence of vinyl chloride and two other possible carcinogens. The residences with vinyl chloride detections are being provided with bottled water as an interim response action while more permanent solutions are being evaluated. Because no exposures above existing health-based criteria are taking place, and routine monitoring of private and public wells in the area of concern in southeast North Oaks is occurring, the situation represents no apparent public health hazard.

IV. Recommendations

1. Routine monitoring of private wells in the affected area of North Oaks should continue as proposed by the responsible parties for the Highway 96 Dump site and approved by the MPCA. Analytical detection limits for vinyl chloride should be as low as possible.
2. If vinyl chloride or other contaminants are detected in a private well at a concentration in excess of the current HRL, or in excess of the additivity index when other potentially carcinogenic contaminants are also detected, bottled water should be provided until a more permanent solution can be implemented.
3. Investigation of the extent of the groundwater contamination (both laterally and vertically) should continue under the oversight of the MPCA.
4. The long-term remedial actions should continue at the Highway 96 Dump site, and people should avoid trespassing on the site itself.
5. While the City of North Oak's program to collect samples from 50 wells each year for analysis for nitrates and coliform bacteria is a good check on overall groundwater quality, MDH recommends that owners of private wells have their wells tested every one to two years for these contaminants.

6. Septic systems should be maintained as required by local ordinances, and not be used for disposal of household chemicals. The city of North Oaks should continue its efforts to educate its citizens regarding septic system maintenance.
7. If contacted by the MPCA or CRA to request a water sample for analysis for VOCs, residents of North Oaks should make every effort to facilitate the collection of the water sample.

V. Public Health Action Plan

MDH's Public Health Action Plan for the site consists of continued consultation with MPCA and City of North Oaks staff and area citizens on water sampling and analysis, assistance with communication of the results to affected and interested residents near the site, and participation in any planned public outreach activities. At the request of the North Oaks City Council, MDH will develop a public health education plan that provides contextualized scientific information for affected and unaffected residents to promote appropriate responses and proper maintenance of private wells and septic systems. MDH will continue to monitor public water supplies in North Oaks for the presence of VOCs according to designated schedules, and the results will be provided to the city and owners of the public water supply systems.

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CERTIFICATION

This Highway 96 Dump / North Oaks Private Wells Health Consultation was prepared by the Minnesota Department of Health under a cooperative agreement with 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. Editorial review was completed by the Cooperative Agreement partner.

Jeff Kellam
Technical Project Officer, SPS, SSAB, DHAC
ATSDR

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

Alan Yarbrough
Chief, State Program Section, SSAB, DHAC, ATSDR

Table 1

Historical VOC Detections in Private Wells
West Shore of Gilfillan Lake
(ug/L)

Compound		1,1-Dichloroethane	1,2-Dichloroethane	Chloroform	Isopropylbenzene	Toluene	Vinyl chloride
MDH HRL		70	4	60	300	1,000	0.2
Location	Date						
XX Poplar Lane	8/5/1993	<0.1	<0.075	<0.15	<0.047	<0.15	<0.036
XX Poplar Lane	8/5/1993 (dup*)	<0.2	<0.2	<0.1	<0.5	<0.2	<0.3
XX Poplar Lane	4/19/1994	<0.1	<0.075	<0.15		<0.15	<.036
XX Poplar Lane	11/3/1994	<0.1	<0.075	<0.15		<0.15	<0.1
XX Poplar Lane	10/26/1995	<0.16	<0.12	<0.4	<0.073	<0.24	<0.056
XX Poplar Lane	10/9/1996	<0.1	<0.075	<0.15	<0.047	<0.15	<0.1
XX Poplar Lane	10/8/1997	<0.2	<0.1	<0.5	<0.21	<0.2	<0.1
XX Poplar Lane	10/29/1998	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XX Poplar Lane	10/29/1998 (dup)	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XX Poplar Lane	10/12/1999	<0.2	**0.24**	<0.5	**0.61**	<0.75	<0.2
XX Poplar Lane	10/4/2000	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XX Poplar Lane	10/1/2002	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XX Poplar Lane	10/19/2004	<0.062	<0.076	<0.053	<0.1	<0.2	<0.083
XX West Shore	8/5/1993	<0.1	<0.075	<0.15	<0.047	**0.2**	<0.036
XX West Shore	4/19/1994	<0.1	<0.075	<0.15		<0.15	<0.036
XX West Shore	11/3/1994	<0.1	<0.075	<0.15		<0.15	<0.1
XX West Shore	10/26/1995	<0.16	<0.12	<0.4	<0.073	<0.24	<0.056
XX West Shore	10/10/1996	<0.1	<0.075	<0.15	<0.047	<0.15	<0.1
XX West Shore	10/8/1997	<0.2	<0.1	<0.5	<0.21	<0.2	<0.1
XX West Shore	10/29/1998	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XX West Shore	10/12/1999	<0.2	**0.19**	<0.5	<0.21	<0.75	<0.2
XX West Shore	10/4/2000	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XX West Shore	10/1/2002	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XX West Shore	10/19/2004	<0.062	<0.076	<0.053	<0.1	<0.2	<0.083
XY West Shore	10/27/1993	<0.1	<0.075	<0.15	<0.047	<0.15	<0.036
XY West Shore	4/19/1994	<0.1	<0.075	<0.15		<0.15	<0.036
XY West Shore	11/3/1994	<0.1	<0.075	<0.15		<0.15	<0.1
XY West Shore	10/26/1995	<0.16	<0.12	<0.4	<0.073	<0.24	<0.056
XY West Shore	10/9/1996	<0.1	<0.075	<0.15	<0.047	<0.15	<0.1
XY West Shore	10/8/1997	<0.2	<0.1	<0.5	<0.21	<0.2	<0.1
XY West Shore	10/29/1998	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XY West Shore	10/29/1998 (dup)	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XY West Shore	10/12/1999	<0.2	<0.1	<0.5	**0.39**	<0.75	<0.2
XY West Shore	10/12/1999 (dup)	<3	<1.5	<7.5	<3.2	<11	<3
XY West Shore	10/4/2000	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XY West Shore	10/1/2002	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XY West Shore	10/19/2004	<0.062	<0.076	<0.053	<0.1	<0.2	<0.083
XZ West Shore	8/5/1993	<0.1	<0.075	<0.15	<0.047	<0.15	**0.071**
XZ West Shore	8/16/1993	<0.1	<0.075	<0.15	<0.047	**0.3**	**0.075**
XZ West Shore	8/16/93 (dup)	<0.1	<0.075	<0.15	<0.047	**0.25**	**0.066**
XZ West Shore	4/19/1994	<0.1	<0.075	<0.15		<0.15	<0.036
XZ West Shore	11/3/1994	<0.1	<0.075	<0.15		<0.15	<0.1
XZ West Shore	12/22/1994	<0.1	<0.075	<0.15		<0.15	<0.2
XZ West Shore	5/17/1995	<0.1	<0.075	<0.15	<0.047	<0.15	<0.036
XZ West Shore	10/26/1995	<0.16	<0.12	<0.4	<0.073	<0.24	<0.056
XZ West Shore	10/26/95 (dup)	<0.16	<0.12	<0.4	<0.073	<0.24	<0.056
XZ West Shore	10/9/1996	<0.1	<0.075	<0.15	<0.047	<0.15	<0.1
XZ West Shore	10/8/1997	<0.2	<0.1	<0.5	<0.21	<0.2	<0.1
XZ West Shore	10/29/1998	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XZ West Shore	10/12/1999	<0.2	**0.22**	<0.5	**0.5**	<0.75	<0.2
XZ West Shore	10/4/2000	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XZ West Shore	10/1/2002	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2

Table 1

Historical VOC Detections in Private Wells
West Shore of Gilfillan Lake
(ug/L)

Compound		1,1-Dichloroethane	1,2-Dichloroethane	Chloroform	Isopropylbenzene	Toluene	Vinyl chloride
MDH HRL		70	4	60	300	1,000	0.2
Location	Date						
XZ West Shore	10/1/02 (dup)	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XZ West Shore	10/19/1994	**0.14**	<0.076	**0.06**	<0.1	<0.2	**0.12**
XA West Shore	4/19/1994	<0.1	<0.075	<0.15		<0.15	<0.036
XA West Shore	11/3/1994	<0.1	<0.075	<0.15		<0.15	<0.1
XA West Shore	11/3/94 (dup)	<0.1	<0.075	<0.15		<0.15	<0.1
XA West Shore	10/9/1996	<0.1	<0.075	<0.15	<0.047	<0.15	<0.1
XA West Shore	10/8/1997	<0.2	<0.1	<0.5	<0.21	<0.2	<0.1
XA West Shore	10/29/1998	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XA West Shore	10/4/2000	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XA West Shore	10/1/2002	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XA West Shore	10/19/2004	**0.14**	<0.076	**0.065**	<0.1	<0.2	**0.12**
XA West Shore	10/19/04 (dup)	**0.14**	<0.076	**0.086**	<0.1	<0.2	**0.12**
XB West Shore	10/27/1993	<0.1	<0.075	<0.15	<0.047	<0.15	<0.036
XB West Shore	4/19/1994	<0.1	<0.075	<0.15		<0.15	<0.036
XB West Shore	10/26/1995	<0.16	<0.12	<0.4	<0.073	<0.24	<0.056
XB West Shore	10/9/1996	<0.1	<0.075	<0.15	<0.047	<0.15	<0.1
XB West Shore	10/8/1997	<0.2	<0.1	<0.5	<0.21	<0.2	<0.1
XB West Shore	10/29/1998	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XB West Shore	10/12/1999	<0.2	**0.3**	<0.5	<0.21	<0.75	<0.2
XB West Shore	10/4/2000	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XB West Shore	10/1/2002	<0.2	<0.1	<0.5	<0.21	<0.75	<0.2
XB West Shore	10/19/2004	<0.062	<0.076	<0.053	<0.1	<0.2	<0.083

Bold indicates detection
MDH HRL = Minnesota Dept. of Health, Health Risk Limit
(dup*) = Duplicate sample collected by MPCA, analyzed by MDH Lab.

Table 2

2005 VOC Detections in Private Wells
(ug/L)

Sample Location	Date	Lab	Dup?	1,1-Dichloroethane	Benzene	Chloroform	cis-1,2-Dichloroethene	Dichlorodifluoromethane	Methyl ethyl ketone	Methylene chloride	Toluene	Vinyl chloride
MDH HRL				70	10	60	70	1000	4000	50	1000	0.2
XX Buffalo	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XY Buffalo	5/24/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XX Eagle Ridge	3/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XY Eagle Ridge	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XZ Eagle Ridge	3/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XA Eagle Ridge	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	COL	D	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/29/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XB Eagle Ridge	4/1/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XX Thompson Lane	4/1/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	4/1/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	6 J	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	0.1 J	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XY Thompson Lane	3/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	6 J	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XZ Thompson Lane	3/28/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/28/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
XA Thompson Lane	8/30/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XX Hummingbird Hill	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	6 J	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XY Hummingbird Hill	3/28/05	MDH		0.13 J	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	4/29/05	MDH		0.13 J	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	0.2
	5/23/05	MDH		0.11 J	< 0.2	< 0.1	< 0.2	< 1	6 J	< 0.5	< 0.5	0.16 J
	6/27/05	MDH		0.14 J	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	0.18 J
XX East Oak	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XY East Oak	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XZ East Oak	4/14/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XA East Oak	3/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XB East Oak	4/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/24/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XS Poplar Lane	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XT Poplar Lane	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XU Poplar Lane	4/14/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XV Poplar Lane	4/1/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	4/1/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XW Poplar Lane	3/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	3/31/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XX Poplar Lane	5/24/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/24/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XX Robb Farm Road	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	5.34 J	< 0.5	< 0.5	< 0.2
XY Robb Farm Road	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
XZ Robb Farm Road	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	1.7	< 0.2
XA Robb Farm Road	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	0.3 J	< 0.2
XB Robb Farm Road	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	7.37 J	< 0.5	< 0.5	< 0.2
XC Robb Farm Road	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
XX Ski Lane	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XY Ski Lane	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/28/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	8/31/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5

Table 2

2005 VOC Detections in Private Wells
(ug/L)

Sample Location	Date	Lab	Dup?	1,1-Dichloroethane	Benzene	Chloroform	cis-1,2-Dichloroethene	Dichlorodifluoromethane	Methyl ethyl ketone	Methylene chloride	Toluene	Vinyl chloride
MDH HRL				70	10	60	70	1000	4000	50	1000	0.2
	8/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XZ Ski Lane	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XA Ski Lane	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XB Ski Lane	7/6/05	COL		< 0.5	< 0.5	< 0.5	< 0.5	**0.47 J**		< 0.5	< 0.5	< 0.2
	7/6/05	COL	D	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.2
	9/6/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XC Ski Lane	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	**6 J**	< 0.5	< 0.5	< 0.2
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XD Ski Lane	5/24/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/28/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	6/28/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XE Ski Lane	5/24/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	6/28/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1 UJ	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XO West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XP West Shore	3/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XQ West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XR West Shore	3/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XS West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XT West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XU West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	3/29/05	MDH	D	< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XV West Shore	8/29/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XW West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	0.9	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XX West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/24/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XY West Shore	3/28/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/23/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
XZ West Shore	1/12/05	INTCP		**0.13 J**	< 0.076	< 0.053	**0.088 J**	< 0.097		< 0.2	< 0.2	**0.12** J
	2/16/05	MDH	L	**0.19 J**	< 0.2	< 0.1	< 0.2	< 1	< 10	**0.26 J**	< 0.5	**0.15** J
	2/16/05	STLBU		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.5	< 0.5	< 0.5	< 0.5
	3/31/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	4/29/05	MDH		**0.13 J**	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	**0.14** J
	5/24/05	MDH		**0.12 J**	< 0.2	< 0.1	< 0.2	< 1	**6 J**	< 0.5	< 0.5	**0.14** J
	5/24/05	MDH	D	**0.13 J**	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	**0.12** J
	6/27/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	**0.19** J
	8/31/05	COL	L	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	< 0.5	**0.16** J
	8/31/05	MDH		**0.2**	< 0.2	< 0.1	**0.13 J**	< 1	< 10	< 0.5	< 0.5	**0.19** J
XA West Shore	1/14/05	INTCP		**0.18 J**	< 0.076	< 0.053	**0.12 J**	< 0.097		< 0.23 U	< 0.2	**0.16** J
	2/16/05	MDH	L	0.18 J	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	**0.11** J
	2/16/05	STLBU		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 2.5	< 0.5	< 0.5	< 0.5
	3/30/05	MDH		**0.3**	< 0.2	**0.2**	0.2 J	< 1	< 10	**0.28 J**	< 0.5	**0.2**
	4/29/05	MDH		**0.2**	< 0.2	**0.5**	0.13 J	< 1	< 10	< 0.5	< 0.5	**0.2**
XB West Shore	3/29/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	5/24/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2
	8/30/05	MDH		< 0.2	< 0.2	< 0.1	< 0.2	< 1	< 10	< 0.5	< 0.5	< 0.2

D= Duplicate sample, same lab L= Split sample, different lab
Detections shown in **bold** type.

Lab Key:
MDH= Minnesota Department of Health Public Health Laboratory
COL= Columbia Analytical Services, Kelso, Washington
INTCP= Interpoll Laboratories, Inc., Circle Pines, Minnesota
STLBU= Severn Trent Laboratories, Buffalo, New York

Data Flags:
U - Not present at or above the associated value.
J - Estimated concentration.
UJ - Estimated reporting limit.

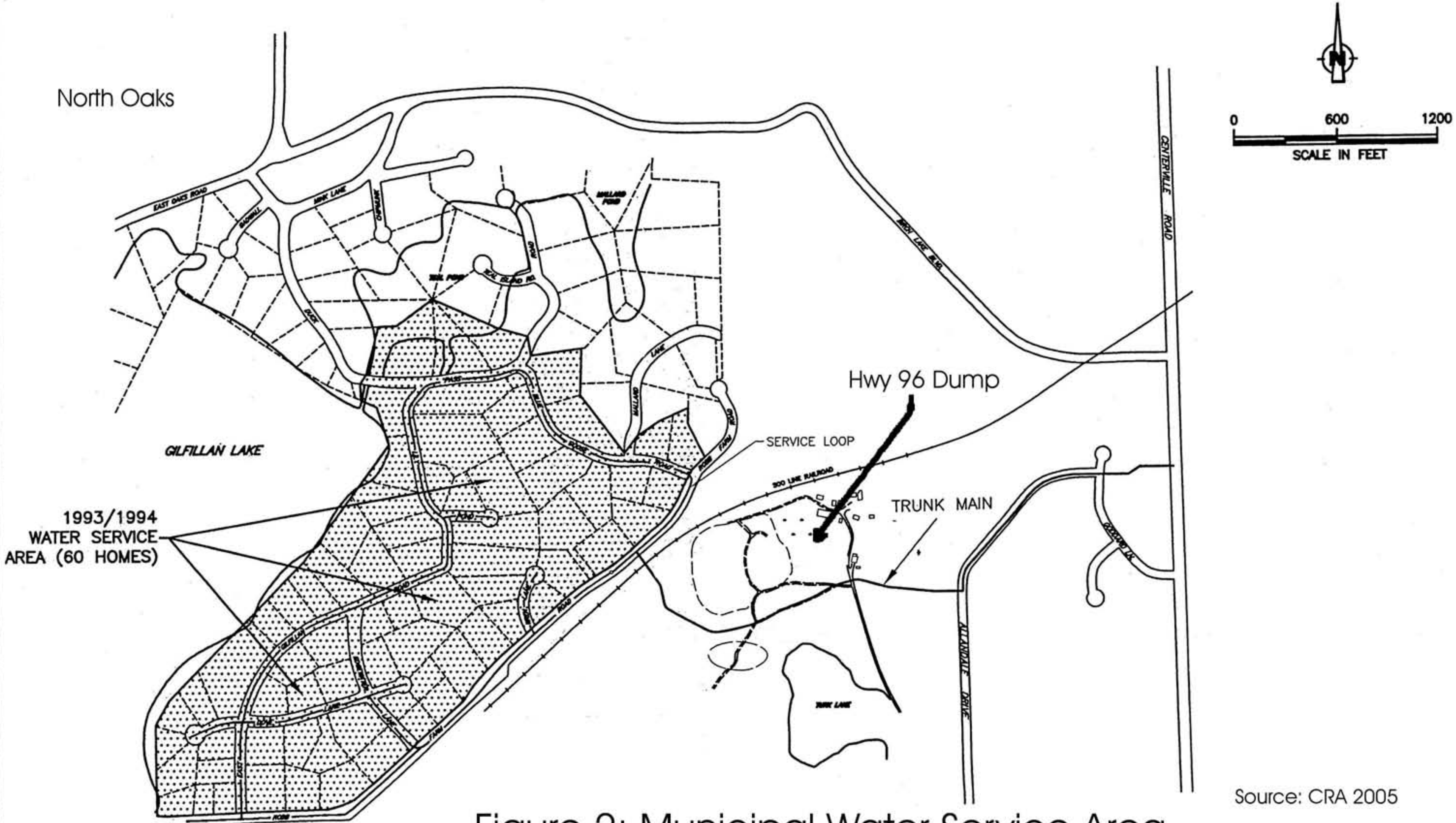
Table 3

MDH Public Water Supply Monitoring Data - Vinyl Chloride

PWS ID	Well Location	Well Unique #	Depth	Aquifer	Date	Compound	Result		
5620002	North Oaks East Recreation Center	248543	unk.	unk.	3/30/2005	Vinyl chloride	<	0.20	ug/L
	5 Mink Lane				2/24/2004		<	0.50	ug/L
					1/11/2001		<	0.50	ug/L
					2/18/1998		<	0.50	ug/L
					1/25/1995		<	0.50	ug/L
					3/15/1994		<	0.50	ug/L
					5/11/1993		<	1.00	ug/L
5620522	North Oaks Golf Club - Clubhouse	471073	281	St. Peter	11/12/2004	Vinyl chloride	<	0.20	ug/L
	54 East Oaks Road				4/16/2001		<	0.50	ug/L
					4/7/1995		<	0.50	ug/L
					4/12/1994		<	0.50	ug/L
					5/11/1993		<	1.00	ug/L
1620027	Home of the Good Shephard	208239	318	Jordan	2/28/2001	Vinyl chloride	<	0.50	ug/L
	5100 Hodgson Road				7/12/1994		<	0.50	ug/L
					11/29/1993		<	1.00	ug/L
1620036	Charley Lake Townhome Assoc.	235302	261	Jordan	10/20/2004	Vinyl chloride	<	0.20	ug/L
	52 Wildflower Way				8/2/2000		<	0.50	ug/L
					11/26/1997		<	0.50	ug/L
5620004	Incarnation Lutheran Church	410966	215	St. Peter	4/2/1993	Vinyl chloride	<	1.00	ug/L
	4880 Hodgson Road								
5620839	North Oaks Beach	564729	164	St. Peter / OPDC	8/24/2005	Vinyl chloride	<	0.20	ug/L
	10 Sandpiper Lane								
5620791	North Oaks West Recreation Center	261139	unk.	unk.	8/24/2005	Vinyl chloride	<	0.20	ug/L
	14 West Pleasant Lake Road								
5620844	North Oaks Golf Club Seasonal Wells								
	54 East Oaks Road								
	Pop Shack	620511	192	St. Peter	8/24/2005	Vinyl chloride	<	0.20	ug/L
	Maintenance Shack	534322	230	St. Peter	8/24/2005	Vinyl chloride	<	0.20	ug/L
	Hole #4	620545	115	Surficial	8/24/2005	Vinyl chloride	<	0.20	ug/L
	Hole #13	620509	120	Surficial	8/24/2005	Vinyl chloride	<	0.20	ug/L

Note: All analyses conducted by the MDH Public Health Laboratory

Figure 1 : Site Location, Highway 96 Dump and Southeast North Oaks



Source: CRA 2005

Figure 2: Municipal Water Service Area

NOTE: FIGURE TAKEN FROM "REMEDIAL ACTION FINAL REPORT" CRA (1996)

MUNICIPAL WATER SYSTEM
Hwy. 96 Site

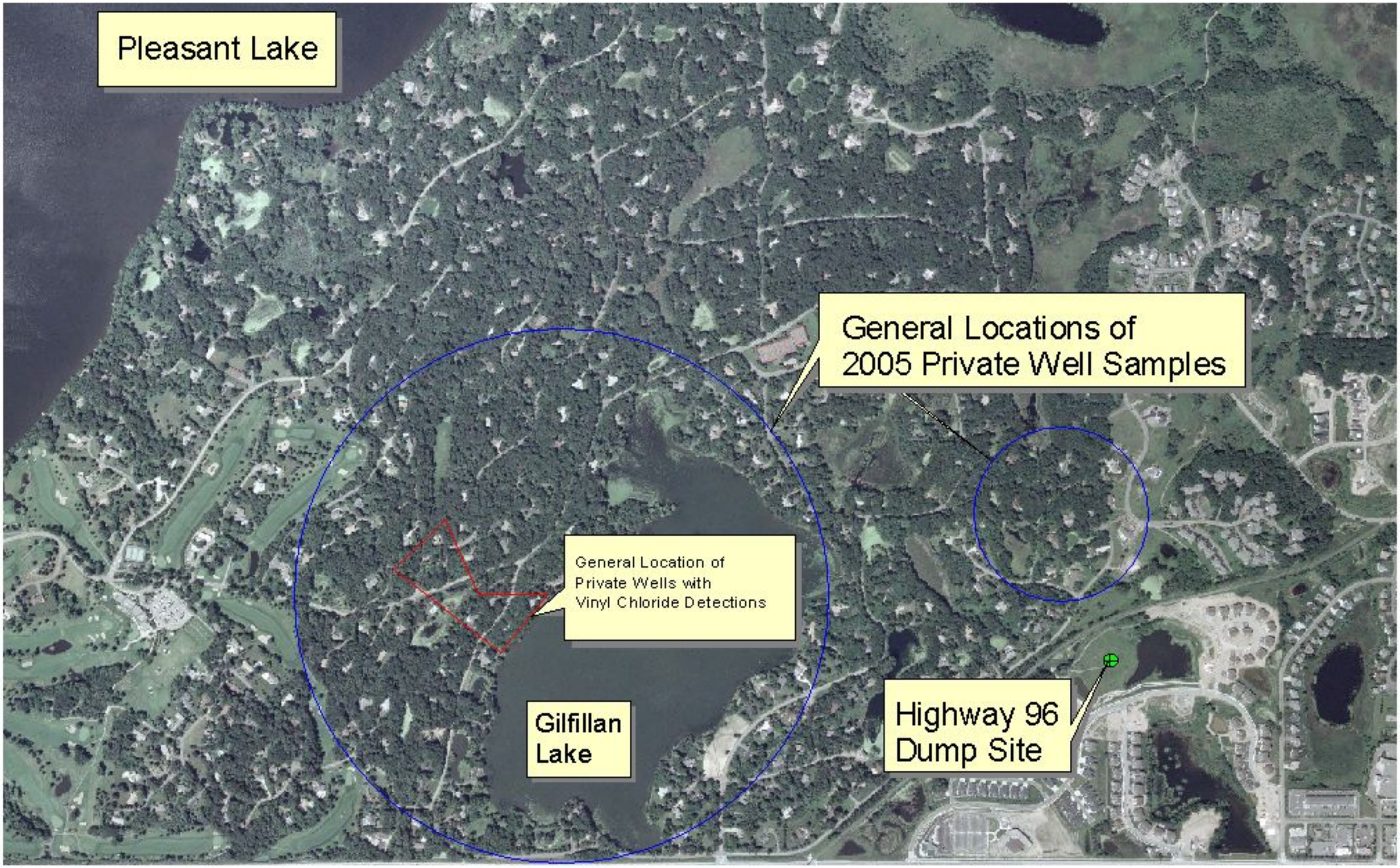


Figure 3: North Oaks 2005 Private Well Sample Areas and Vinyl Chloride Detections

Figure 4:Public Wells Monitored for Vinyl chloride in North Oaks