Health Consultation

Potential for TCE Exposure in Indoor and
Ambient Air at the Source Area:
Baytown Township Groundwater Contamination Site

Baytown Township, Washington County, Minnesota

EPA Facility ID: MND982425209

Prepared by the
Minnesota Department of Health

JULY 17, 2009

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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FOREWORD

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

- 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. We rely on information provided by the Minnesota Pollution Control Agency (MPCA), U.S. Environmental Protection Agency (EPA), and other government agencies, 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. The report focuses on public health—the health impact on the community as a whole—and 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 contaminants. The role of MDH in dealing with individual sites is primarily advisory. For that reason, the evaluation report will typically recommend actions to be taken by other agencies—including EPA and MPCA. However, if there is an immediate health threat, MDH will issue a public health advisory warning 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 organizations responsible for cleaning up the site, and the community surrounding the site. Any conclusions about the site are shared with the 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 Minnesota Department of Health 625 Robert Street N. / Box 64975 St. Paul, MN 55164-0975
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

I. Summary of Background and History

Executive Summary

In 2004, the source of the trichloroethylene (TCE) at the Baytown Township Groundwater Contamination Site was discovered at what is now a small market and gas station in Lake Elmo, Minnesota. Remedial actions are under way to remove the TCE from the groundwater at the source through air stripping. Based on indoor and ambient air data collected to date, it appears that any exposures to TCE at the source area are minor for employees or visitors at the market, and do not represent a public health concern.

Purpose

This purpose of this Health Consultation is to evaluate the potential for exposure to TCE in indoor and ambient air at the source of the TCE contamination in Lake Elmo. The Minnesota Department of Health (MDH) was requested to evaluate TCE data for the site by the Minnesota Pollution Control Agency (MPCA) and the owners of the market and determine if TCE exposure was of concern from a public health standpoint.

Background

The Baytown Township Groundwater Contamination Site was first discovered in 1987, and investigation and response actions by state and local entities have been ongoing since that time. The Site is primarily the result of the disposal or spillage of an unknown quantity of trichloroethylene (a.k.a. trichloroethene, or TCE) at what was once a metal fabricating shop located in the city of Lake Elmo; other minor sources may also exist. The Site consists of an area of groundwater contamination that is in excess of six square miles, and affects four major groundwater aquifers. The MDH has enacted a Special Well Construction Area (SWCA) at the Site to regulate the construction of new wells. The boundaries of the SWCA, which essentially define the Site, are shown in Figure 1. Also shown in Figure 1 are the location of the source of the TCE contamination mentioned above and the Lake Elmo Airport, a major surface feature of the Site that was once considered the most likely source of the TCE.

Several hundred private water supply wells in Baytown and West Lakeland Townships, and private and public wells in the City of Bayport have been impacted by the TCE contamination. The highest current concentration of TCE in a private well (approximately 100 micrograms per liter; μg/L) has been found at the Lake Elmo Airport. Exposure to TCE above Minnesota health-based criteria in private wells (i.e., the MDH Health Risk Limit (HRL) of 5 μg/L) is currently being prevented by requiring property owners to have new private water supply wells constructed to deeper, clean aquifers where possible, or by the use of large, whole-house granular activated carbon (GAC) filtration units for existing private wells and new private wells where a clean aquifer is not available or feasible and concentrations of TCE exceed the HRL.

GAC filters for private wells are typically provided by the MPCA. However, for wells on properties platted after April 9, 2002, GAC filters are not provided by the MPCA. To protect public health in these cases, Baytown and West Lakeland Townships, with the assistance of MDH, enacted ordinances to ensure that newer homes not provided GAC filters by the MPCA will have appropriate GAC filter systems installed and maintained by the homeowners. To date, approximately 200 GAC systems are in place on private wells in Baytown and West Lakeland

Townships and the City of Bayport due to levels of TCE at or above the HRL, and are being tracked and managed by the MPCA or the two townships. Additional private well owners with levels of TCE below the HRL have installed GAC filter systems on their own.

One municipal well serving the City of Bayport water supply had TCE levels in excess of the federal Maximum Contaminant Level (MCL) of 5 μg/L. A treatment system (air stripper) was installed by the MPCA to remove TCE to below detectable levels. Two other municipal wells in Bayport have also shown low levels of TCE, typically around 1 μg/L.

General information on the geology and hydrogeology of the area, previous investigations, and past response activities at the Site was most recently summarized in a Public Health Assessment (MDH 2004). The generation of nitrite from nitrate within GAC filter systems in operation on certain wells at the Site was reviewed in a Health Consultation dated November 9, 2007 (MDH 2007a).

This Health Consultation will focus on the potential for exposure to TCE in air at the source of the TCE contamination in Lake Elmo, both inside the building at the Site as well as in ambient air as a result of a groundwater treatment system installed at the Site. Groundwater conditions at and downstream of the source will be reviewed in a future document.

Identification of the TCE Source

For many years, the Lake Elmo Airport was considered the most likely source of the TCE at the Site because of its history of aircraft operation, maintenance and repair, and the Metropolitan Airports Commission (MAC) was considered the responsible party under state and federal Superfund law. In 2002, after many years of investigation at the Lake Elmo Airport failed to identify a significant source of TCE, the MAC asked their consultant, Conestoga-Rovers & Associates (CRA) to review historical records for the City of Lake Elmo, located “upstream” in terms of groundwater flow. The purpose of the review was to identify potential users (and possible releases) of TCE based on location, type of business, or other records. The review involved examining historical aerial photographs, telephone directories, insurance maps, and conducting interviews with former local officials (CRA 2002). It is apparent that the review was incomplete, or records for the area where the source was eventually discovered were unavailable. The report concluded that there was no evidence of a TCE source in Lake Elmo that could have caused the groundwater problem in Baytown and West Lakeland Townships.

From 2002 to 2004 the MPCA conducted a series of soil and groundwater investigations at and to the west of the Lake Elmo Airport with the goal of finding the source of the TCE contamination (Terracon 2004a, 2004b). Soil gas, soil, and selected groundwater samples were collected at three commercial properties in the City of Lake Elmo, including an automotive repair shop, and two properties whose previous uses were thought to be consistent with the possible use of solvents such as TCE. No evidence of TCE contamination was found at the three commercial properties. However, groundwater samples collected in the agricultural fields located to the west of the Lake Elmo Airport showed levels of TCE that were higher than those typically found at the Lake Elmo Airport. This suggested that the main TCE source could be located in Lake Elmo.

Further investigative work by the MPCA eventually led to the discovery of what is likely the major source of the TCE contamination in groundwater at the Site, beneath what is now Hagberg's Country Market, a small family owned grocery store and gas station located 11325 Stillwater Blvd. (MN Highway 5) in Lake Elmo (see Figure 1). A part of the building currently used for the grocery store was once occupied by Neilsen Products Company, a metal working or tool and die shop that reportedly operated from approximately the 1940s or early 1950s until 1968. Hagberg's moved their grocery business to the site, expanded the existing site building, and opened the grocery store in 1972.

Information on the operations of Neilsen Products Company is limited. What information has been obtained was collected from interviews conducted by MPCA staff with former workers and local residents. From these interviews it was learned that the Neilsen business involved manufacturing specialized tools and equipment for the tire retreading industry. One former worker confirmed that solvents were indeed used by the company. Neilsen Products Company had three structures at two locations in Lake Elmo. The main office was located at 11227 Stillwater Blvd., in a building that most recently housed Leslie's Floor Décor. Next to this main office was a Quonset hut that was also part of the operation. A third building at 11325 Stillwater Blvd. was reportedly used for heat treating metal parts. Figure 2 is a 1961 aerial photo of Lake Elmo that shows all three buildings.

Several photographs obtained from the Minnesota Historical Society's collections show both the interior and exterior of Neilsen's operation in February 1959 (Figure 3). The photographs suggest that it was a fairly typical metal working shop, with various lathes, drill presses, and other equipment visible. Such operations typically employed lubricating or cutting oils, and solvents such as TCE were often used for cleaning metal parts. Photograph #1 in Figure 3 shows the exterior of the building at 11227 Stillwater Blvd., while photographs #2 and #3 show the interior of the adjacent Quonset hut. Photograph #4 appears to be of the interior of the heat treating building, which is now a storage area at the rear of the grocery store.

The MPCA's investigations in 2004 confirmed that the former Neilsen heat treating site is the main source of TCE contamination for the Baytown Township Groundwater Contamination Superfund Site (Terracon 2004c). Soil gas samples collected at 11227 Stillwater Blvd., the other Neilsen building that most recently housed Leslie's Floor Décor, showed no TCE. A water sample from a well of unknown depth located in the basement of the 11227 Stillwater Blvd. building also showed no TCE.

The specific location, mechanism, amount, or timing of the TCE release is not clear. Investigative work has been hindered by the need to work around the existing grocery store, which has been expanded several times over the years. Figure 4 shows the existing layout of the site, and the locations of soil borings, monitoring wells, and other sample locations. TCE as high as 89,000 μg/L has been found in shallow groundwater beneath the site, in MW-18. High levels of TCE indicative of a specific release point have not been detected in soil samples collected to date, however.

In 2007 the MPCA conducted a shallow soil gas investigation to provide further data on the location of the original TCE release (Terracon 2007a). The investigation used 20 passive soil gas

monitors installed at depths of up to four feet, both inside (through the concrete floor slab) and outside the site building. The passive soil gas monitors were left in place for two weeks, removed, and sent to a laboratory for analysis. The results for TCE are shown in Figure 5. Because the detectors passively absorb volatile contaminants such as TCE from an unknown quantity of soil vapor, the results are reported as the mass of the contaminant only, instead of the more common mass per volume of media (e.g. air, soil, or water) sampled. The data indicate that the largest mass of TCE lies beneath the site building. Actual soil vapor samples were collected from the passive monitoring points installed inside the site building at a later date, as discussed below.

Indoor and Ambient Air Sampling Results

When it was discovered that the main source of TCE was beneath the building currently occupied by Hagberg's Country Market, MDH recommended to the MPCA that an assessment be made of the potential for TCE vapors to enter the building, and to determine if there was any subsequent impact on indoor air quality.

In October 2004, MDH staff accompanied MPCA Superfund Program staff on a site visit to Hagberg's Country Market for the purposes of screening potential subsurface vapor entry points and identifying indoor air sampling locations. The MPCA's contractor, Terracon Consultants, Inc. (Terracon), conducted the screening using a Thermo Environmental Instruments, Inc. Model 580B organic vapor monitor (OVM), which has a detection limit in the low part per million range (ppm). The screening was intended to identify likely vapor entry points, and determine if high levels of vapor were present that could pose an acute health risk. The screening was focused on floor drains, a sump pit, and any other identified penetrations of the floor slab that could serve as a point of vapor entry. The specific locations included:

- The shower/floor drain in the former bathroom by the loading dock
- Along the south wall by the loading dock, near the electrical boxes
- Kitchen area floor drain
- Several openings to the sump/compressor pit beneath the meat coolers
- Smoker area floor drain
- Meat cutting room floor drain
- In the main store, in the corners where pipes come up through the slab
- In the main store, in small drains beneath the produce and freezer cabinets

There were no detections of organic vapors in any areas screened with the OVM. The sump/compressor pit itself had also been screened on an earlier visit, and there were no detections of organic vapors at that time. Beneath the compressors is a small pit filled with cinders that also serves as a drain for condensation water from the compressors. The constant water drainage may inhibit vapor intrusion at this location.

Indoor air sampling to detect lower concentrations of TCE was conducted using six-liter Summa canisters (non-reactive, coated stainless steel canisters placed under a vacuum), which are portable and can be used to collect air samples in a variety of settings. A low-flow restrictor valve was used with the Summa canister to collect air samples over a period of approximately 24 hours. The air samples were analyzed for selected VOCs at a fixed laboratory using EPA

Method TO-15, the standard method for this type of sample. This sampling has been repeated several times to monitor indoor air conditions over time. The sample locations have included:

- Beneath a wash sink in the kitchen/produce area, next to a floor drain and the sump/compressor pit ("produce area")
- In the back office area, beneath the west wall window ("Hagberg's office")
- In the rental space office, in the back office/break room ("rental office")
- In the sump/compressor pit ("pit")
- In the loading dock area ("loading dock")
- Outside the building, along the south wall of the office/feed store ("outside/ambient")

The indoor/ambient air sample results are presented in Table 1.

Table 1: Indoor/Ambient Air Sample Results

Sample Location	**Date**	**TCE, ug/m^3**
Produce Area	10/22/04	ND, 3.9
	11/19/04	**7.1**
	9/2/05	ND, 130
Hagberg's Office	10/22/04	ND,<4.7
	11/19/04	ND,<3.9
	12/3/08	ND,<2.1
Rental Office	10/22/04	ND,<5.1
	11/19/04	ND,<4.5
Pit	12/3/08	ND,<2.0
Loading Dock	12/3/08	ND,<1.7
Outside / Ambient Air	10/22/04	ND,<4.7
	11/19/04	**5.4**
	9/2/05	ND,<4.7
	12/3/08	ND,<1.7

ND = Not Detected, laboratory detection limit

Results for other chlorinated VOCs that are common breakdown products of TCE (cis-1,2-dichloroethene and vinyl chloride) were all below laboratory detection limits. Detection limits for one sample were elevated due to sample interference from non-target compounds.

TCE was detected in two samples: first, at a concentration of 5.4 micrograms per cubic meter ($\mu g/m^3$) in an outside/ambient sample, and secondly at a concentration of 7.1 $\mu g/m^3$ in one produce area sample. These results are below the MPCA Intrusion Screening Value (ISV) for TCE of 8 $\mu g/m^3$ for commercial/industrial exposure scenarios. The ISVs are intended to be protective of human health from long-term exposure to contaminants in air that result from vapor intrusion, and can be found on the MPCA's web site at http://www.pca.state.mn.us/cleanup/riskbasedoc.html#vaporintrusion.

The low level TCE detections, both on November 19, could have been related to the field work (soil borings and monitoring well installation) that was conducted at the site just prior to the

November 2004 sample event. Subsurface work could have disturbed pockets of vapor below the ground, or created preferential migration routes. As with any indoor air sampling for potential vapor intrusion, other random events such as changing weather conditions, a release from a nearby VOC source, or a change in building heating or ventilation could also influence the results.

Sub-slab Sampling Event

In conjunction with the most recent round of indoor air sampling in December 2008, sub-slab vapor samples were collected from the permanent monitoring points installed during the passive soil gas sampling effort described above. The sample locations (PSG-2 – PSG-7) are shown in Figure 4 (and Figure 5). The samples were collected as short-term (less than one hour) samples, which is common for sub-slab samples that are intended to evaluate the potential for vapors to intrude into overlying structures. Grab samples of vapor were also collected from two monitoring wells at the site, MW-18 and MW-37. The samples were analyzed using EPA method TO-15 for a variety of VOCs. The results for TCE and other related chlorinated VOCs are presented in Table 2, along with the MPCA screening value for sub-slab and shallow soil vapor. The screening values represent ten times the commercial/industrial ISV for indoor air, which experience at other sites in Minnesota and nationwide has shown to be an appropriate adjustment/attenuation factor.

Table 2: Sub-slab and Monitoring Well Vapor Sample Results, in µg/m^3, December 2008

Sample Location	TCE	1,1-Dichloroethane	Tetrachloroethene	cis/trans-1-2-dichloroethene
PSG-2	**11.4**	**3.3**	**8.6**	ND, <1.1
PSG-3	**30.8**	ND, <1.1	**2.2**	ND, <1.1
PSG-4	ND, <1.5	ND, <1.1	**3.6**	ND, <1.1
PSG-5	ND, <1.5	ND, <1.1	**2.1**	ND, <1.1
PSG-6	**4.9**	ND, <1.1	ND, <1.9	ND, <1.1
PSG-7	**7.8**	ND, <1.1	**18.8**	ND, <1.1
MW-18	**78,300**	ND, <1.1	**6.0**	**16.8**
MW-37	**33,300**	ND, <1.1	**5.1**	**13**
Screening Value	80	10,000	600	200

ND = Not Detected, laboratory detection limit

The results show relatively low levels of TCE and other VOCs in soil vapor below the building floor slab, but much higher levels (not surprisingly) of TCE in vapor samples collected just above the groundwater in the monitoring wells. Other VOCs were detected in the sub-slab samples, including petroleum related VOCs. These VOCs were well below relevant screening levels, and are likely related to the presence (for decades) of underground gasoline tanks and fuel pumps on the northern portion of the property.

TCE Emissions from the Treatment System at the Site

In 2007, the MPCA amended the Superfund Record of Decision for the Baytown Township Groundwater Contamination Site to include the source of the TCE as a separate operable unit, and to provide for remedial actions to address the TCE source. After exploring a number of alternatives, the MPCA determined that containment of the TCE at the source was a feasible and

appropriate response action. In early 2008, the MPCA's consultant for the site, Terracon, completed installation of a groundwater pump-and-treat system to control and remove TCE and other VOC contamination from groundwater at and beneath Hagberg's Country Market (Terracon 2007b). The system became operational in March 2008.

The system consists of four groundwater extraction wells (RW-1 to RW-4) with overlapping 50 foot radius capture zones south and east of the market (see Figure 4). A treatment building was constructed approximately 50 feet south of the market. Treatment consists of a five-tray air stripper. TCE removed from the groundwater is expelled from a 6.1 meter high stack by an 1,800 cubic feet per minute (CFM) blower. The treated water is pumped offsite and infiltrated through a horizontal drain tile located beneath an adjacent athletic field.

Based on preliminary design assumptions and field tests, Terracon determined that the optimum pumping rate for the four extraction wells would be approximately 100 gallons per minute (GPM). In addition, they anticipated that the influent TCE concentrations at startup would be about 1,200 ug/L of TCE. Using these estimates, and an effluent TCE concentration of 0.1 ug/L in the treated water, Terracon calculated a total of about 0.33 tons per year TCE would be emitted from the treatment system stack. In a memorandum to MPCA staff, MDH staff estimated that if the average TCE concentration of the treatment influent remained at 1200 ug/L, the yearly emissions would only be about 0.263 tons per year (MDH 2007b). This amount of TCE was well below a site-specific emission limit of 0.438 tons per year of TCE to the atmosphere calculated by Terracon under MPCA guidance. This value was calculated using basic site information regarding the distance to likely receptors, the height of the stack, and basic air dispersion and exposure assumptions.

Performance data for the groundwater extraction and treatment system is presented in Table 3. The actual operating data differs from the design assumptions in several ways, primarily in that the influent TCE concentration has been at levels one-half or less of the design criteria of 1,200 ug/L. The total system pumping rate has not been calculated by Terracon, as it would involve many calculations from individual data points. However, it appears that the sum of the average pumping rates of the four wells has been between 50 and 70 GPM, which is less than the design rate of 100 GPM.

Table 3: Groundwater Treatment System Performance Data

Month, Year	Total Volume (liters)	Influent TCE Concentration (ug/L)	Mass of TCE Removed (kilograms)
March 2008	370,986	603	0.22
April 2008	311,161	596	0.19
May 2008	8,108,352	450[#]	3.65
June 2008	5,173,333	400[#]	2.07
July 2008	3,344,688	350[#]	1.17
August 2008	9,932,803	304	3.02
September 2008	8,256,820	29.2	0.03
October 2008	10,243,210	287	2.94
November 2008	7,950,012	145	1.15

December 2008	8,864,382	170	1.51
January 2009	8,503,375	358	3.04
February 2009	7,572,610	299	2.26
Totals	**78,631,732**		**21.25**

[#] MDH estimated value

No TCE has been detected in the treated water from the system, indicating it is very effective at removing the TCE from the extracted groundwater. To date, the system has removed an estimated 21 kilograms of TCE from the groundwater at the site over a twelve-month period. This is well below the site-specific emission limit of 0.438 tons per year (approximately 400 kilograms per year) calculated by Terracon under MPCA guidance.

Private Well Sample Results

For many years, potable water for Hagberg's Country Market was provided by a private well on the property, which was of unknown depth and construction. Water from the well was used in food preparation at the market; as a result the well and water supply were regularly inspected and tested by the Minnesota Department of Agriculture (MDA) under their licensing authority. Sampling of the well by MDA and MPCA in the 1980s and 1990s detected the presence of TCE on only one occasion, 0.1 μg/L in October 1996. In 2005, four water samples collected from the well showed the presence of low levels of TCE, ranging from 0.2 to 0.9 μg/L. Subsequently, in 2006 the well was disconnected and the business connected to the Lake Elmo municipal water supply under an agreement with the MPCA.

Soil Gas Investigations Downgradient

The City of Lake Elmo is proposing a new comprehensive development plan that may include new residential and commercial development in the area to the east of Hagberg's Country Market, in what are now agricultural fields. The plan is available on the City of Lake Elmo web site (http://www.lakeelmo.org/). Developers interested in building on some of these parcels have conducted limited soil gas investigations under the oversight of the MPCA to determine if vapors from the underlying TCE plume, which is relatively shallow near the source (less than 100 feet), could potentially infiltrate any new structures (Liesch 2004). Low levels of TCE (3.5 to 38.2 $\mu g/m^3$) were detected in two of ten samples in this investigation. This is likely to only be a concern nearest the TCE source, as the plume moves downward and is diluted as it moves to the east. No VOCs were detected in a soil boring near an existing home southeast of the source, indicating TCE vapors are not a concern in this area.

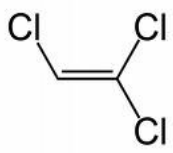
Site Visits

MDH Site Assessment & Consultation Unit staff have participated in the collection of indoor air, soil, and groundwater samples at the TCE source, made numerous site visits to the Baytown site for sample collection, community meetings, and local government meetings, and met with the staff at Hagberg's Country Market on a number of occasions to discuss sample results. There is no evidence of contamination at the surface, or of other physical or chemical hazards at the site not normally associated with the operation of a gas station or small grocery store. Hagberg's Country Market is bordered by Minnesota Highway 5 to the north, agricultural fields to the east, a park to the south, and commercial properties to the west.

II. Discussion

Evaluation of Toxicity and Exposure to Site Contaminants

Trichloroethylene (TCE) is a nonflammable, colorless liquid with a slightly sweet odor and taste (ATSDR 1997). TCE is extremely volatile, and most TCE released into the environment will evaporate into the air. It can persist in groundwater, however, due to the limited contact between groundwater and air. Its chemical structure consists of two carbon atoms linked by a double bond, with three chlorine atoms as shown below:



TCE was marketed under a variety of trade names (e.g. Triclene, Vitran, Triad) and was used extensively as a degreasing solvent in a variety of industries. While its use as a solvent has been declining, it is also used in the manufacture of other chemical products (ATSDR 1997). Due to its extensive use, TCE is one of the most common contaminants found at Superfund sites across the United States, especially in groundwater. It has been listed as a hazardous pollutant, hazardous waste, or hazardous substance under a variety of federal and state environmental regulations (EPA 2001).

Under certain conditions, TCE will degrade in the subsurface environment following predictable pathways (ATSDR 1997). There are many factors that determine the rate at which TCE will degrade, such as the amount of oxygen in the groundwater, the pH of the water, or the concentrations of other substances needed by microorganisms to help them break down the TCE. The common breakdown products of TCE have not been consistently detected in water or air samples collected at the site. This indicates that up until this point TCE is not been significantly biologically degraded at the source. The reasons for this are not clear, but likely include the geochemical conditions of the site (such as the presence of oxygen in the groundwater, which inhibits degradation of TCE), a possible lack of nutrients needed by microorganisms, and the speed at which the groundwater is moving. The lack of biological degradation is in and of itself not a cause for concern, because at least one of the environmental breakdown products of TCE (vinyl chloride) is significantly more toxic than TCE itself. The MPCA will need to consider this fact and monitor for these contaminants when injecting materials into the ground intended to speed the natural degradation of TCE.

Exposure Pathway Evaluation

Workers and customers at Hagberg's Country Market could have been exposed to low levels of TCE through drinking water or inhalation of TCE that evaporated from drinking water prior to 2006, when the well was sealed and the business was connected to the Lake Elmo municipal water supply. TCE was not consistently detected in the well until 2005, however, and the levels were well below the MDH HRL of 5 μg/L.

TCE has only been detected once in indoor air inside the market, at a level below the MPCA ISV for commercial/industrial exposures. It is also below levels (12 $\mu g/m^3$ based on lifetime cancer

risk and 10 μg/m^3 based on non-cancer risk) recommended by EPA in a recent guidance memorandum on evaluating TCE at vapor intrusion sites (EPA 2009a). This memorandum was subsequently withdrawn due to concerns regarding the non-cancer value (EPA 2009b).

Customers typically spend a half-hour or less inside the market while shopping for groceries, and would therefore only be exposed to TCE on a transitory basis, if at all. Employee exposures would be considered episodic at best, as they often move from place to place within the building and do not typically spend an entire shift in the produce area, where the sole TCE detection occurred. MDH staff have also noted that the market is well-ventilated, with a great deal of air exchange. Doors are opened often as customers come and go, and in some cases are intentionally left open. The high rate of air exchange may further reduce the potential for exposures to TCE at the site.

TCE emissions from the groundwater treatment system appear to be well within emission limits developed for the site. Overall, cumulative exposures to TCE in air at the site appear to be minimal and well within health-based exposure limits.

Toxicity of TCE

Exposure to large amounts of TCE in air can affect the central nervous system, producing headaches, dizziness or even unconsciousness (ATSDR 1997). These concentrations have typically only been found in occupational settings, or cases of intentional exposure (i.e., intoxication or suicide attempts), and have not been observed at the Baytown site. In rare instances, however people living in communities near facilities using and releasing very large amounts of TCE to the air and groundwater (exposing people through multiple pathways) have experienced neurological symptoms (Kilburn 2002). The concentrations of TCE reported to have produced these effects were as high as 10,000 μg/L in groundwater, and releases to the ambient air were significant enough to produce reportable odors near the source. The odor threshold of TCE in air is approximately 100 parts per million (ppm; or 537,000 μg/m3; ATSDR 1997). These are much higher concentrations of TCE in air and water than have been observed at the site.

The most common environmental or community exposure pathway for TCE is through ingestion of contaminated drinking water. Ingestion of TCE in drinking water results in exposure within the body to a mixture of TCE and its metabolites, and much of the toxicity attributed to TCE is likely due to its metabolites (EPA 2001; Chiu et al 2006). Many of these metabolites are formed through the action of enzymatic pathways in the liver and kidney that also metabolize other substances such as alcohol, pain relievers such as acetaminophen, and other drugs and environmental contaminants. Exposure to these other common substances or contaminants at the same time may therefore affect (either reduce or enhance) the metabolism of TCE.

Animal studies show that the ingestion of TCE at very high doses (e.g., hundreds to thousands of times above what is found at the site) may cause nerve damage, liver and kidney damage, and may also be associated with reproductive or development effects. The neurological effects of exposure to TCE may occur only after inhalation and not ingestion of TCE contaminated water, according to some animal studies (Waseem et al 2001). Animal studies have shown that high doses of TCE can cause tumors of the liver, kidney, and lymphatic system in rats and mice.

Differences in how TCE is metabolized at different doses by different species may be related to the different mechanisms by which TCE causes disease (EPA 2001). For instance, kidney tumors in rats that have been exposed to large doses of TCE may be the result of direct toxicity to kidney cells, while kidney tumors in rats exposed to lower doses may be the result of mutations in kidney cells induced by metabolites of TCE.

Occupational exposure to high levels of TCE in air has been associated with an increased risk of kidney and other cancers in some studies; however other studies have failed to reliably demonstrate a relation between kidney cancer and TCE exposure (Bruning et al 2003; Cherrie et al 2001). In many occupational epidemiologic studies, accurate measurements of exposure are lacking, complicating the interpretation of the studies (Scott and Chiu 2006).

TCE is classified as a "probable human carcinogen" under EPA's current cancer guidelines based on "limited" human evidence and "sufficient" animal evidence of carcinogenicity, and would be characterized as "highly likely to produce cancer in humans" under cancer guidelines proposed for adoption by EPA in 1999 (EPA 2001).

Exposure guidelines, standards and emission limits for TCE in water and air developed by MDH and MPCA are based on a hazard index of one for non-cancer effects, and/or a lifetime incremental excess cancer risk of 1.0×10^{-5} for individuals exposed to those concentrations for a lifetime. A hazard index of one or less means that exposures are unlikely to result in adverse health impacts to an individual, even a sensitive individual, who is exposed for up to a lifetime. A lifetime incremental cancer risk of 1×10^{-5} is the default value used in Minnesota as an appropriate level of risk to consider when making risk management decisions.

Child Health Considerations

ATSDR's Child Health Initiative recognizes 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 at waste disposal sites. 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 trace levels of TCE in air at the market or in the immediate area. The exposures are expected to be minimal and of short duration, and do not represent a public health concern.

III. Conclusions

The discovery of the source of the TCE at the Baytown Township Groundwater Contamination Site was a major accomplishment. It has allowed remedial actions to begin that will over time reduce the levels of TCE in private and public wells located downgradient of the source. Due to the amount of TCE in groundwater at the source and the installation of the groundwater remediation system, monitoring of potential TCE exposures in air at Hagberg's Country Market is ongoing. Based on data collected to date, it appears that any exposures to TCE are minor, even for employees at the market; visitors to the market are even less exposed. Therefore, the situation currently represents no apparent public health hazard; monitoring should be continued to ensure this remains the case.

IV. Recommendations

1. At least one additional round of sub-slab, indoor, and ambient air samples should be collected by the MPCA at Hagberg's Country Market during a different time of year to verify that TCE remains at levels below health concern under different seasonal conditions.
2. Additional sub-slab and indoor air sampling should also be conducted by the MPCA following major response activities at the site, such as installation of new extraction or monitoring wells in or near the building, or injection of large amounts of materials intended to speed the degradation of TCE.
3. Analysis of sub-slab vapor or indoor air samples should include common breakdown products of TCE, such as vinyl chloride.
4. The MPCA should continue to monitor the groundwater extraction system to verify it meets emission limits for TCE.
5. Prior to any residential or commercial development between the TCE source and Manning Avenue (Co. Road 15), a thorough soil vapor study should be conducted by the developer.
6. In this area, appropriate steps should be taken by the developer to prevent vapor intrusion into overlying structures. This will also prevent the infiltration of naturally occurring radon, a significant public health benefit.

V. Public Health Action Plan

MDH's Public Health Action Plan for the site will consist of: A letter to the MPCA, city, and county authorities and the property owner advising them of these conclusions and recommendations; communication with local residents; and a review of any additional available data and participation in any meetings or other public outreach activities.

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CERTIFICATION

This Baytown Township Groundwater Contamination Site 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.

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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

Figure 1
Baytown Site Location and Special Well Construction Area

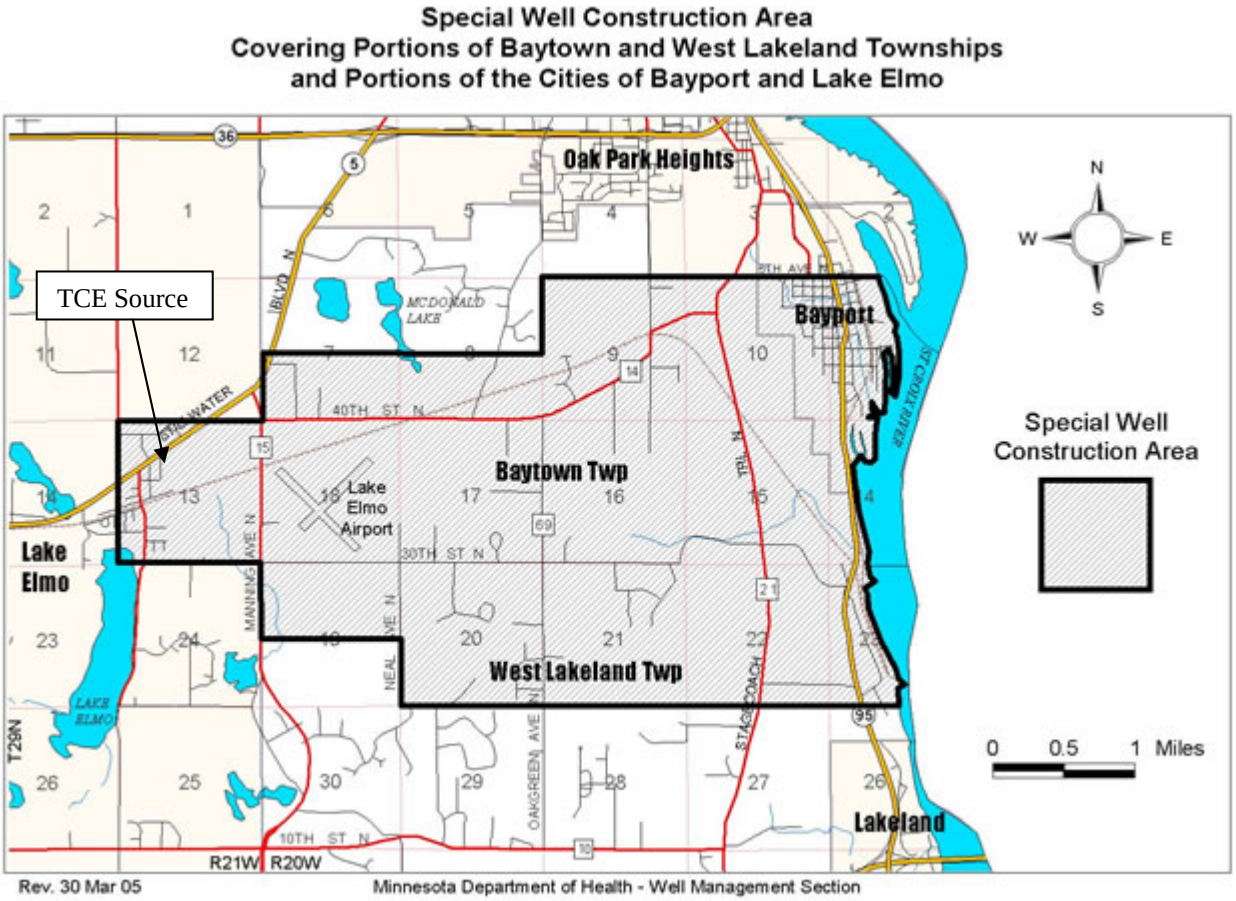

Figure 2
Historical Aerial Photo of Lake Elmo, c. 1961
(used by permission of the MN Historical Society)

Photo Credit: St. Paul Dispatch & Pioneer Press

Neilsen Products Co.
11325 Stillwater Blvd.
Heat Treating Building

MN 5

Neilsen Products Co., Main Building & Quonset Hut, 11227 Stillwater Blvd.

Figure 3
Historical Photos of Neilsen Products Company, c. 1959
(used by permission of the MN Historical Society)

1. Exterior of Main Building, 11227 Stillwater Blvd. (photo credit: Norton & Peel)

2. Interior, Quonset Hut (photo credit: Norton & Peel)

3. Interior, Quonset Hut (photo credit: Norton & Peel)

4. Interior, Heat Treating Area (?), 11325 Stillwater Blvd. (photo credit: Norton & Peel)