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Modeling Potential Impacts of Heavy Metals and BTEX Compounds from the former Year-A-Round Cab Company on Hiniker Pond

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MODELING POTENTIAL IMPACTS OF HEAVY METALS AND BTEX COMPOUNDS FROM THE FORMER YEAR-A-ROUND CAB COMPANY ON HINIKER POND.

By

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This thesis has been examined and approved by the following members of the thesis committee.

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ENVIRONMENTAL SCIENCE

A Determination of Possible Heavy Metal and Organic Pollutant Contamination of Hiniker Pond Mankato, Minnesota.

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The Year-A-Round Cab Company (an industrial metal preparation, painting, and welding facility) in Mankato, MN has a history of numerous environmental violations. The site is located 300 yards north of Hiniker Pond, a popular swimming spot. The primary purposes of my research were to determine if BTEX (ethyl benzene, toluene, and xylenes) and heavy metals had reached Hiniker Pond, and model estimated contaminate plumes from the Year-A-Round Cab Company. Lead, cadmium, and chromium were found in sediments at levels of up to 30 times higher near the site as compared to the control lake, Hallett's Pond. Although BTEX were not found in surface water or sediment samples, it has been confirmed to be in manholes on the site at levels of up to 6,000 mg/L by the MPCA in September, 2010. GFLOW, MODFLOW and the transport engines MT3DMS (lead as surrogate) and RT3D (toluene as surrogate) were used to predict the spread of contamination off site. Based on the modeling, heavy metal contamination most likely has occurred through surface runoff and BTEX contamination is possible through groundwater flow. A comprehensive testing plan should be developed based on current models to understand the full extent of the BTEX, lead, cadmium, and chromium contamination. Column studies should be completed to refine the GFLOW and MODFLOW models.

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List of Acronyms, Abbreviations, and Specific Terms

ACOE- The United States Army Corps of Engineers

BTEX- Benzene, Toluene, Ethyl Benzene, and Xylenes (m, o, p)

EPA- United States Environmental Protection Agency

GFLOW- Ground water Flow model

Log K_{ow}- Log of the octanol-water partition coefficient

MODFLOW- the U.S. Geological Survey modular finite-difference flow model, which is a computer code that solves the groundwater flow equation.

MPCA- Minnesota Pollution Control Agency

MT3DMS- Modular Transport Three Dimensional Model Simulator

NRCS- Natural Resource Conservation Service

PE Ladder- The measure of negative logarithm of the electron potential from lowest to highest of a compound

pH- The negative log of the concentration of H+ ions in a solution

Porosity- ability of an aquifer to transmit water

RT3D- Reactive Transport in 3-Dimensions

Specific Yield- the amount of water an aquifer will yield under gravity

Storativity- the amount of water released per unit volume of aquifer

Superfund- Referring to the United States Comprehensive Environmental Response, Compensation, and Liability Act’s fund to remediate pollution sites.

USDA- United States Department of Agriculture

USDPH- U.S. Department of Public Health and Human Services

USGS- United State Geological Survey

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CHAPTER I

INTRODUCTION

Hiniker Pond (MNDNR Lake # 07-014700) is a very popular swimming area in Mankato, Minnesota. It was an active gravel pit from 1936 to 1972 (Preuhs, 1998). During its operation, approximately one million cubic yards of sand and gravel were removed and rinsed at a wash station setup on the pond (Fischenich, 2009; Preuhs, 1998). Hiniker Pond covers 18-acres and has a maximum depth of 21 feet with an average depth of 9 feet (Minnesota DNR, 2007; United States, 1980).

Adjacent to Hiniker pond is a small oxbow that was formed when the U.S. Army Corps of Engineers (ACOE) moved the Minnesota River in the early 1950's as part of a flood control project (Water Resource Center, Minnesota State University, 2002). It is locally referred to as "Oxbow Lake" (Minnesota Pollution Control Agency, 2010a). A gate valve flow over system allows water to travel between the two water bodies (United States, 1980). A drainage ditch, known as the US-14 ditch flows into Oxbow Lake as well as a seasonal overflow canal that originates from Spring Lake, a small water body located to the south of Hiniker Pond (Minnesota Pollution Control Agency, 2010a).

In 1975 the Hiniker Pond was sold to the City of Mankato, Minnesota for one dollar (Blue Earth County Minnesota, 1975). Due to the heavy use of Hiniker Pond as a "rebel swimming hole," the City of Mankato worked with the ACOE to develop the pond and surrounding property into the multi-use recreational park that it is today (United

States, 1980). According to the ACOE (1980), Hiniker Pond was considered to have "excellent water quality for recreational use", but Oxbow Lake was considered unsuitable for recreation due to a high fecal coliform bacteria count (United States, 1980).

In the September of 2010, the Minnesota Pollution Control Agency (MPCA), found a site 300 yards north of Hiniker Pond at 110 West Lind Street, North Mankato, Minnesota, to be contaminated with organic chemicals. The site was used for metal forming, welding, preparation and painting from at least 1966 through 2010 (Minnesota Pollution Control Agency, 2010b). There has been a long history of heavy metal disposal on site and numerous other environmental problems (see appendix I-IV) (Minnesota Pollution Control Agency, 2010b; Minnesota Pollution Control Agency, 2010c; State of Minnesota, 1985). Suspected disposal onsite included incinerator ash, metal cleaning and painting solvents. The West Lind site is currently being considered for listing as a state superfund site or long term remediation site by the state of Minnesota (Minnesota Pollution Control Agency, 2010a). Year-A-Around Cab Company owned the site from 1966 until 2010, and specialized in the preparation and painting of farm tractor cabs, farm implements, and corn stoves (Burman, 2011). In 2010 the property was purchased by Heratаus properties.

Tests conducted by the MPCA on September 24, 2010 found high levels of ethyl benzene, toluene, and xylenes (ortho, meta, and para), in the following levels in manholes. The MPCA data are presented below:

ethyl benzene	1,901	ppm
toluene	638	ppm
m-Xylene and p-Xylene	6,847	ppm
o-Xylene	2,169	ppm

(Minnesota Pollution Control Agency, 2010c)

Benzene, toluene, ethyl eenzene, and isomers of xylene are referred to as BTEX compounds.

The MPCA has confirmed that manholes from the facility flow directly into the US-14 ditch (Minnesota Pollution Control Agency, 2010c). The MPCA found that the paint washing system and underground storage tanks empty directly into a drainage field behind the buildings, and in turn drain into the US-14 ditch.

In 1985 samples from the tanks mentioned above had chromium (Cr), lead (Pb), and cadmium (Cd) in the following levels:

Chromium	18,000 ppb
Lead	520 ppb
Cadmium	210 ppb
	(State of Minnesota, 1985).

In July 1985 soil samples taken from 4 holes (#16, 18, 19, 20) at depths between 1-1.5 feet had up to 200 µg/g of toluene and xylenes plus over 50 µg/g of ethyl benzene. A diagram where the samples were collected and results of analyses are included in Appendix I.

Hallett's Pond, formally known as "unnamed lake 52-0001" in Saint Peter, Minnesota served as a comparison site (Minnesota DNR, 1999). Hallett's Pond is very similar to Hiniker pond in that it was a gravel pit that was closed and sold to the City of St. Peter in 1974 (Linehan, 2007). Hallett's Pond covers 12 acres and has a maximum depth of 35 feet with an average depth of 12 feet (Minnesota DNR, 1999). It is used for fishing, but swimming is not allowed. It is also used for emergency storm water storage and discharge.

The purpose of my research was three fold: (1) determine if there were higher levels of BTEX compounds and heavy metals (Cd, Cr, and Pb) in Hiniker Pond, Oxbow Lake, and/or the US-14 ditch when compared to Hallett's Pond; (2) develop surface water and ground water models with GFLOW and MODFLOW to estimate the transport and fate of BTEX compounds and heavy metals from Year-A-Round Cab Company at different time intervals; and (3) determine if seasonal levels of total phosphorous (TP), ortho phosphorus (P-PO4), nitrogen in the form of nitrate (N-NO3) , nitrite (N-NO2), and ammonia (N-NH3), sulfates (SO4), E. Coli, Secchi Disk, pH, conductivity, temperature, and dissolved oxygen (DO) were different between Hiniker Pond and Hallett's Pond.

CHAPTER II

LITERATURE REVIEW

A. BTEX Compounds

Benzene, toluene, ethyl benzene, and the three isomers of xylene, are collectively known as BTEX. The structure of several BTEX compounds are presented in Figure 1, and the chemical characteristics of BTEX compounds are summarized in Table 1. (EUGRIS, 2012).

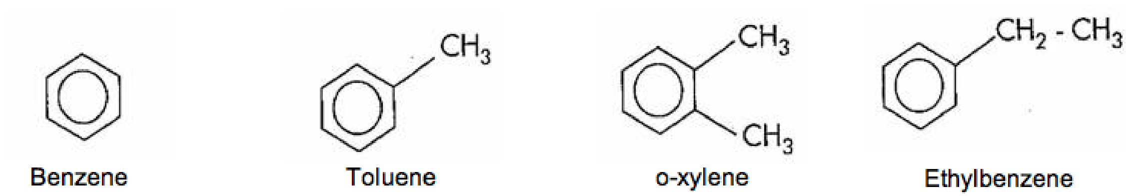

Figure 1. The structure of several BTEX compounds (EUGRIS, 2012)

Table I. Properties of BTEX compounds

Compound	Mole weight g $mole^{-1}$	Density g ml^{-1}	Boiling point °C	Water solubility mg l^{-1}	Vapor pressure mm Hg	Log K_{ow}
Benzene	78	0.88	80.1	1780	76	2.13
Toluene	92	0.87	110.8	535	22	2.69
o-Xylene	106	0.88	144.4	175	5	2.77
m-Xylene	106	0.86	139	135	6	3.20
p-Xylene	106	0.86	138.4	198	6.5	3.15
Ethyl benzene	106	0.87	136.2	152	7	3.15

(EUGRIS 2012)

BTEX compounds are found in many petroleum products including gasoline, fuel oil waste, and in a wide variety of common contaminants such as industrial cleaning wastes (Chang Chien et al., 2010). BTEX compounds are extremely dangerous to human health, are not easily degraded, and even trace amounts pose a threat to human life and aquatic organisms (Kahan & Donaldson, 2010). BTEX compounds are listed as carcinogens, endocrine disruptors, neurotoxins, and reproductive inhibitors by the U.S. Department of Health (U.S. Department of Health and Human Services, 1986). In studies, they have also been linked to kidney and liver damage (Batlle-Aguilar et al., 2009). Benzene is known to cause bone marrow damage leading to anemia and Lukemia.

B. BTEX Transport and Fate

There are many processes that affect the mobility and persistence of BTEX compounds in the environment. These processes include dispersion in water, sorption by soil organic matter (SOM), volatilization into the air or into soil air spaces, and microbial degradation. They can also undergo oxidation, reduction, hydrolysis, and polymerization reactions (Batlle-Aguilar et al., 2009; Epstein & Chaney, 1978; Kahan & Donaldson, 2010). The type of degradation is dictated by the medium (water, soil, or air), as well as pH, surface activity, and solubility (Epstein & Chaney, 1978).

Chang et al. (2010) recently completed a study on how BTEX compounds are transported or absorbed by Humic Acids (HA) in SOM. This occurs because aromatic hydrocarbons are very hydrophobic, having low water solubility (Chang Chien et al., 2010). Chang et al. confirmed that HA's had a higher sorption rate of BTEX compounds (toluene used as the indicator) at lower pHs. Larger BTEX compounds were absorbed by

SOM and contamination was transported less distance, therefore remaining closer to the initial source of contamination (Chang Chien et al., 2010).

Kahan, T., & Donaldson, D., (2010) looked at how BTEX compounds in surface water degrade with cold temperatures and ice. In the normal degradation process, hydroxyl radicals in the atmosphere react with BTEX and remove them in small quantities over time (Batlle-Aguilar et al., 2009). This process occurs naturally in surface waters and is a very slow process. They found that when aromatic hydrocarbons were present on the surface of ice, that the ice-air interface would block hydroxyl radicals. This causes the BTEX compounds to become more persistent in an area that experiences freezing temperatures (Kahan & Donaldson, 2010).

Microbial degradation of the BTEX compounds is very dependent on dissolved oxygen levels, pH, and temperature. Under anaerobic conditions the presence of nitrates and sulfates are important (Epstein & Chaney, 1978). Morgan et al. (1993) studied the rate and extent of biodegradation of BTEX compounds in ground water and found that elevating the incubation temperature of the test sample, and the addition of inorganic or organic nutrients had no affect on the rate or extent of biodegradation of BTEX. The only limiting factor they could find associated with the degradation of BTEX was oxygen (Morgan et al. 1993). Morgan et al.(1993) also studied degradation of BTEX compounds under anaerobic conditions. No breakdown occurred unless nitrates were added to increase microbial activity and respiration. Morgan et al. (1993) was able to achieve biodegradation, at a much slower rate than in an aerobic environment, of benzene, ethyl-benzene, toluene, m-xylene, and p-xylene, but o-xylene was unaffected. BTEX compounds can also biodegrade under strict anaerobic conditions, degrading simultaneously as sulfate reduction occurs, but less favorable under denitrifying conditions (Cunningham et al., 2001). Due to the persistence of these compounds under anaerobic conditions, they can be transported rather long distances (Cunningham et al., 2001).

C. Heavy Metals

The term heavy metal generally refers to metals that have a specific density of at least 5 g/cm3 (Järup, 2003). Heavy metals identified at the Year-A-Round site by the MPCA are Cd, Cr, and Pb (State of Minnesota, 1985). The eco-toxicological impact of a metal in water is highly dependent on pH, alkalinity, hardness of the water, and the presence of other ions, such as sulfates (Malakootian, Nouri, & Hossaini, 2009). Heavy metals currently are the most common problem in soil contamination and are present in at least 60% of the sites listed on U.S. Environmental Protection Agency's (EPA) National Priority List (Peters, 1999). Heavy metals do not degrade and tend to accumulate in organisms and systems over time, causing numerous disorders and diseases in humans (Malakootian et al., 2009). Metals found on this site that pose the highest risk to human health, when factoring in exposure, dose, toxicity, and route of exposure are lead, cadmium, and chromium (Järup, 2003; Minnesota Pollution Control Agency, 2010c). The form a metal will take when it is in sediments is very dependent on the pH and Eh (electron activity) of the water.

1. Cadmium

Cadmium (Cd), which naturally occurs in ore together with lead, is typically used as color a pigment in industrial paint, as a chemical stabilizer in PVC products, and in household batteries (Järup, 2003). Cadmium exposure to humans in developed nations has increased dramatically over the twentieth century due to the increased use and lack of recycling of the products coupled with increased dumping of household waste (Järup, 2003). In surface or ground water, insoluble Cd compounds can form (Figure 2) and will be deposited in sediment (Wang, Chen, Yeh, & Shue, 2001).

At low pH's, Cd uptake in soils by plants is optimized (Järup, 2003; Wang et al., 2001). The health effects of Cd include kidney damage, particularly damage to tubules, resulting from renal lesions, and an increase in kidney stones. Long-term exposure can cause mineralization of the bones or early onset osteoporosis, similar to that seen in Japan with the Itai-Itai (ouch-ouch) disease incident (Järup, 2003).

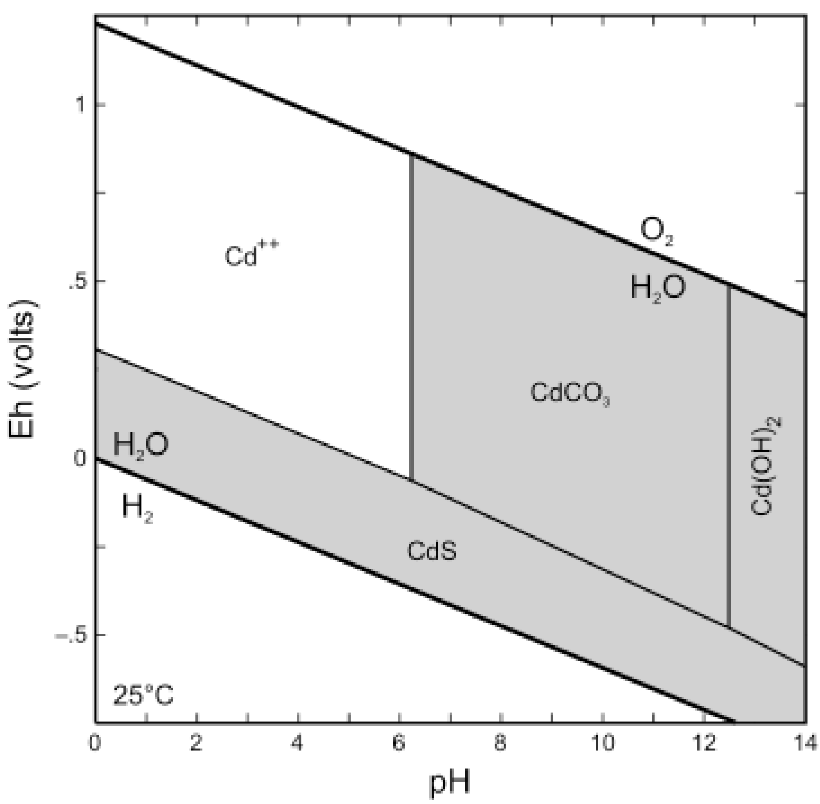

Figure 2. Speciation of cadmium in the aqueous environment (shaded areas are insoluble compounds) (US EPA 2007)

2. Lead

Lead (Pb) is a naturally found in ore with cadmium. It is commonly used in industrial paints that protect metals subjected to high corrosion conditions and in automotive batteries (Järup, 2003). Lead exposure is one of the most common toxic exposures to humans in the 20th century. These exposures usually occur equally between both inhalation and ingestion from food (Järup, 2003). Lead has a history of causing permanent neurologic damage and has been linked to lowered IQ scores in adults when exposed during childhood (Järup, 2003). While the half-life of Pb in the blood is only usually 1 month, it can persist in the skeleton for up to 30 years (Järup, 2003). Long-term exposures to lead can cause peripheral nervous system deterioration, psychosis, reduced consciousness, and death. Lead forms insoluble compounds in an aqueous environment (Figure 3). (Wang et al., 2001).

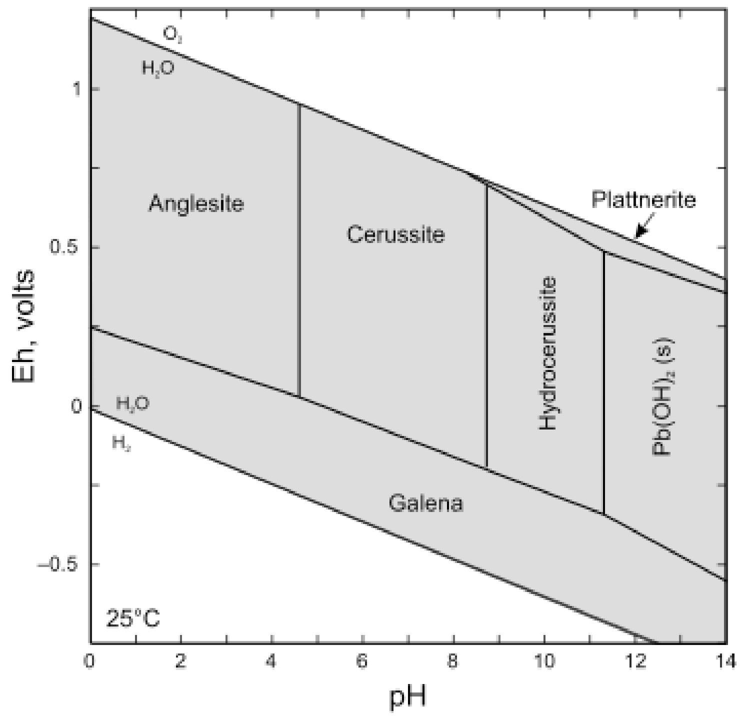

Figure 3. Speciation of lead in the aqueous environment
(shaded areas are insoluble compounds) (US EPA 2007)

The chemical composition of the compounds in Figure 3 is as follows: Anglesite, PbSO4; Cerussite, PbCO3; Hydrocerussite, Pb3(CO3)2(OH)2; Galena, PbS; and Plattnerite, PbO2.

3. Chromium

Chromium (Cr) is a widely used metal in industrialized nations. Chromium is used extensively as a pigment in paints, industrial paint primers, electroplating, and steel productions (Goldoni et al., 2006; Sabty-Daily, Luk, & Froines, 2002). It has two oxidation states, trivalent (Cr III) and hexavalent (Cr VI). Chromium (III) is naturally occurring in the environment, is needed in the body as an essential nutrient and its toxicity is considered to be very low (Demir & Arisoy, 2007). Chromium (VI) does not normally occur in the environment, is recognized as being highly toxic, and classified as a Class I human carcinogen by the International Agency for Research on Cancer (IARC) (Goldoni et al., 2006). Chromium (VI) is the form that is used in industrial paints and primer due to the red color and superior ability to inhibit corrosion (Sabty-Daily et al., 2002). Both Cr (VI), which is much more toxic to humans, and Cr (III) can exist as a solid or in aqueous forms, as an oxide or hydrated oxide when in solution and will bond with other species to form soluble and insoluble compounds as seen in Figure 4. (Demir & Arisoy, 2007).

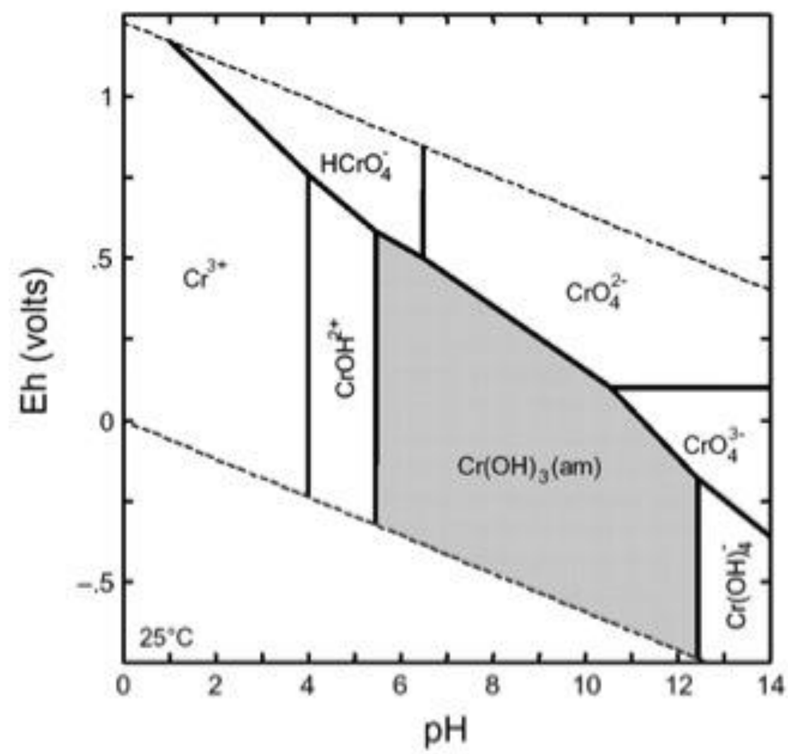

Figure 4. Speciation of Chromium in the aqueous environment (shaded areas are insoluble compounds) (US EPA 2007)

D. Heavy Metal Transport

The movement of metals in soil, surface water, and in ground water is very complex. In soils the transport, fate, mobilization, or immobilization of these metals are controlled by a range of factors that include: SOM, pH (soil acidity), the metal species (oxidized or reduced form dependent on anaerobic or aerobic conditions), and Cation Exchange Capacity (CEC) of the soils (Baumann et al., 2006). According to Epstein (1978) heavy metals applied to soils will be immobilized through REDOX (dependent on dissolved oxygen) reactions, adsorption by colloids, bind with soil organic matter, or be taken up by plants. Generally uptake by plants happens when the pH is below 7.5 (Epstein & Chaney, 1978). According to Hochella et al. (2005) Pb and Cr will form sulfates or metal hydroxides, while Cd will form carbonates or phosphates.

In water, pH, alkalinity, presence of carbonates, phosphates, sulfates, and hydroxides are factors that would decide immobilization or transport (Epstein & Chaney, 1978; Hochella Jr. et al., 2005; Wang et al., 2001). Heavy metal transport in the ground water environment was heavily dependent on colloids of differing sizes (Baumann, Fruhstorfer, Klein, & Niessner, 2006). Colloids are particles between 5-200 nanometers and can have a positive, negative or zero charge. Negatively charged colloids interact with free metal ions (positively charged). In soils and groundwater the colloid-metal ion complex may cause "clogs" in the system (Baumann et al, 2006).

E. pH

The solubility's of many substances are affected by the pH of the solution. Under basic conditions many metals form insoluble compounds (hydroxides) while under acidic conditions they are soluble. Under acidic conditions, metals are more likely to form complexes including carbonates, bi-carbonates, chlorides, and sulfates (Peters, 1999). The pH of many eutrophic/hyper eutrophic lakes change during 24-hour diurnal cycle due to photosynthesis (Carpenter et al., 1998).

In soils, SOM is more likely to bind heavy metals at pHs at or below pH 7.5. For copper with each unit of pH increase, the activity decreases by 100 fold (Epstein & Chaney, 1978). Toluene was found to have a higher sorption rate in lake sediment with high humic acid content between the pHs of 4-8 (Chang Chien et al., 2010).

F. Dissolved Oxygen

Dissolved oxygen (DO) is essential for supporting life, an important indicator of ecosystem health, and determines if microbial degradation will be aerobic or anaerobic. In nutrient rich lakes abundant algae growth is common. When these algae blooms die off they result in decreased DO levels due to microbial degradation (Carpenter et al., 1998). The DO solubility is temperature dependent. Oxygen is more soluble in cold water than warm water. Dissolved oxygen is the electron acceptor. If DO is limited other compounds (N-NO3, SO4, etc.) become the electron acceptor per the pE ladder. This can influence the form of the metal and there by the solubility and toxicity of metals (Epstein & Chaney, 1978;Hochella Jr. et al., 2005).

G. Sulfates

Sulfate compounds heavily influence heavy metal transport and availability different metal. Sulfate is the oxidized form of sulfur and most metal sulfates except lead sulfate are soluble (Hochella Jr. et al., 2005). The reduced form of sulfur is sulfide. Most metal sulfides are insoluble, and hydrogen sulfide (H2S) is toxic (Chang Chien et al., 2010). Sulfates are ecologically important in the aquatic realm, are necessary for plant growth and when in short supply decrease phytoplankton growth. Sulfates are important in the anaerobic degrade BTEX compounds in groundwater and are a key predictor to the mobilization of heavy metals under sulfate reducing conditions (Batlle-Aguilar et al., 2009).

H. Eutrophication

Eutrophication accounts for about half of the impaired lakes on the US impaired waters listings. Eutrophication is usually caused by excessive inputs of phosphorus. Non-point source pollution of nutrients includes agriculture (fertilizers and animal wastes), residential and urban areas (commercial fertilizers), and soil erosion (Carpenter et al., 1998). Point sources include discharges from sewage treatment plants and industrial sources. Eutrophication often results in is the excessive growth of algae (blooms) that can affect the DO and pH of lake water.

Kattner et al. found that in gravel pits many decades after their closure, the sediment and dead organic material start to seal them off from groundwater movement (Kattner, Schwarz, & Maier, 2000). Kattner et al. believed this "sealing off" might help prevent eutrophication.

1. Phosphorus

Phosphorus is found in two forms: total phosphorus (TP) and orthophosphorus (P-PO4). Orthophosphorus is water-soluble and can be used by plants immediately (Carpenter et al., 1998). Phosphorus is the limiting nutrient controlling algae growth in lakes. Phosphorous adsorbs easily to soil particles and runoff containing large amounts of soil usually are responsible for large phosphorous additions to water bodies (Kattner et al., 2000; Reckhow, 1979).

2. Nitrogen

Nitrogen is found in several forms (nitrate, nitrite, and ammonia) in aquatic systems. Nitrate is the most oxidized form of nitrogen and ammonia is the most reduced for of nitrogen. On the pE ladder, nitrate follows oxygen as the electron acceptor. When DO levels are very low or zero, nitrate becomes the electron acceptor. When ammonia is converted to nitrite or nitrate, large quantities of oxygen are used (Carpenter et al., 1998; Helmer & Labroue, 1993). Nitrogen can be introduced into a lake through non-point source pollution from the atmosphere (automobile combustion), manure runoff, fertilizers, wastewater, and soil erosion. Atmospheric deposition is believed to be the main source of increased N in the eutrophication process with the influx of N correlating to an increase in fossil fuel emissions during the same period of time historically since 1900 (Carpenter et al., 1998).

I. Escherichia coli (E. coli)

The US Environmental Protection agency has encouraged the adoption of E. coli as a new standard of waterborne pathogen testing. E. Coli bacteria are a sub-group of fecal coliform bacteria. Both are used as indicator organisms to predict water contamination (Minnesota Pollution Control Agency, 2008a). They originate from human and animal feces as a product of the digestive system.

Factors that affect the behavior and survival of E. coli bacteria in urban areas include seasonal weather, water temperature, sewage overflows, and rainfall. In urban areas, the most likely sources of E. coli include sewage overflow and storm water runoff as well as pet and bird feces. The current E. coli swimming standard for acceptable surface water is an 126 cfu/100ml maximum monthly average (minimum of 5 samples in the 30 day period) and 235 cfu/100ml maximum any single test. When these levels are exceeded the water is considered impaired, swimming is not recommended, and an advisory is issued (Minnesota Pollution Control Agency, 2008a).

J. Water Clarity

Transparency is measured using a Secchi disk. The Secchi disk provides a direct measurement of light transmission and an indirect measurement of suspended material in the water. Overtime, Secchi data can be use to show trends and predict eutrophication (Carlson & Simpson, 1996). Turbidity, closely related to Secchi disk measurements, is a measure of how cloudy or murky water is. Turbidity is caused by suspended particles in water or dissolved solids that scatter light. The solids and particles are more often than not from sediment and are composed of clays, silt, fine organic and inorganic matter, algae, and other microscopic organisms. High turbidity decreased the aesthetic value of waters as well as harming fish and other aquatic life reducing food supplies, decreasing light for photosynthesis, and affecting gill function. Natural and human sources of turbidity include erosion from upland areas or development, or increased phosphorus levels then causing increased algal growth. The current standard for recreation is 25 Nephelometric Turbidity Units (NTU)'s (Minnesota Pollution Control Agency, 2008b).

K. Conductivity

Conductivity is the ability of a substance to conduct electricity in water. It is an indicator of the amount of dissolved ions in the water (Minnesota Pollution Control

Agency, 2008b). Road salt is a substance that would cause increased conductivity in an urban area from non-point source run-off. This can be associated with the increased salinity of surface water body, which can cause shifts in pH and stress fish and other organisms due to the increased chloride concentrations, as well as free sulfates that are present in a system (Kattner et al., 2000).

L. Carlson's Trophic State Index

The Carlson Trophic State Index (TSI) is the most widely used standard to classify lake trophic state in the United States (Carlson & Simpson, 1996). Trophic state is the productivity of a lake (Carlson & Simpson, 1996). It is an easy way to characterize a lakes overall health using total phosphorus, Secchi disk, and Chlorophyll-A measurements. The Carlson's Trophic Index is presented in Figure 5.The trophic levels range from Oligotrophic (nutrient poor), Mesotrophic, Eutrophic (nutrient rich), and Hyper-eutrophic (very nutrient rich) (Carlson & Simpson, 1996). The anticipated effects of various TSI levels on a water body are summarized in Figure 6.

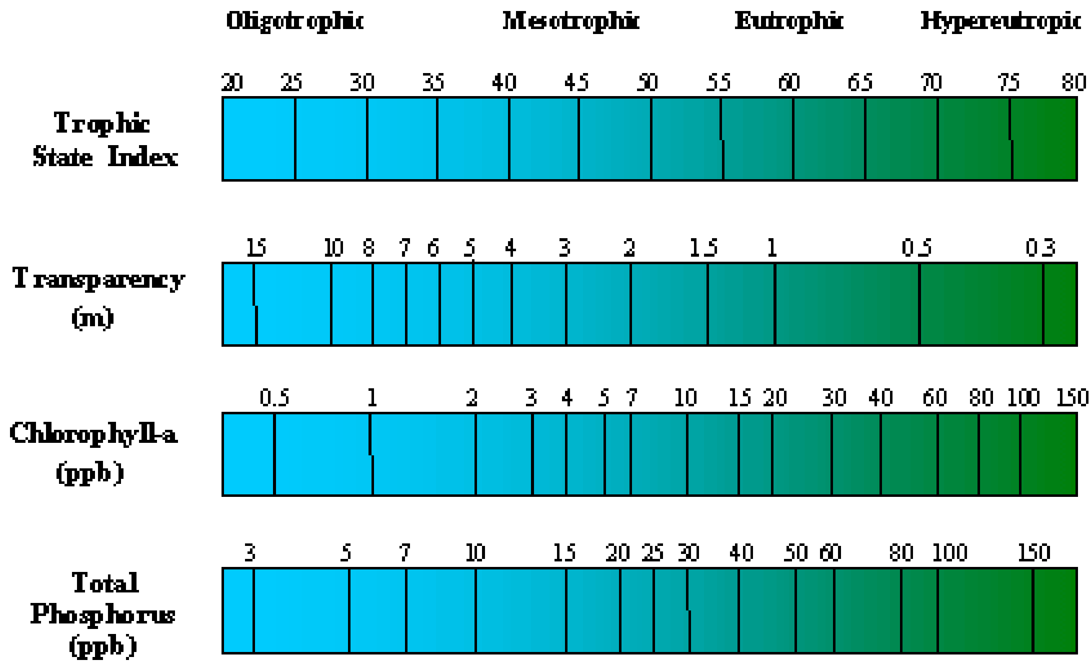

Figure 5. Carlson's Trophic State Index Chart (Carlson & Simpson, 1996)

TSI < 30 Classical Oligotrophy: Clear water, oxygen throughout the year in the hypolimnion, salmonid fisheries in deep lakes.

TSI 30 - 40 Deeper lakes still exhibit classical oligotrophy, but some shallower lakes will become anoxic in the hypolimnion during the summer.

TSI 40 - 50 Water moderately clear, but increasing probability of anoxia in hypolimnion during summer.

TSI 50 - 60 Lower boundary of classical eutrophy: Decreased transparency, anoxic hypolimnia during the summer, macrophyte problems evident, warm-water fisheries only.

TSI 60 - 70 Dominance of blue-green algae, algal scums probable, extensive macrophyte problems.

TSI 70 - 80 Heavy algal blooms possible throughout the summer, dense macrophyte beds, but extent limited by light penetration. Often would be classified as hypereutrophic.

TSI > 80 Algal scums, summer fish kills, few macrophytes, dominance of rough fish.

Figure 6. Anticipated effects of various TSI levels on a water body (Carlson & Simpson, 1996)

M. Ground Water Flow Modeling

Computer ground water models are used to simulate the water levels of certain areas, the flow patterns, and the transport of chemical constituents. They provide hydro geologists the means to organize massive amounts of data, to display the data in a visible way, and they help forecast future water demands (US Geological Survey, 2009). Models take a mathematical approach to make estimates over a given time period, based on the change in dependent variables, including properties of the aquifer and contaminant characteristics (US Environmental Protection Agency, 1992). In 1935 the United States Geological Survey (USGS) first recognized groundwater flow modeling based on the research of C.V. Theism (US Geological Survey, 2009). Theis determined that the flow of groundwater through porous media was similar to the flow of heat through materials and developed a simplified formula that was an accurate estimate of subsurface water flow (US Geological Survey, 2009). The Theis formula led to numerical groundwater modeling developed by the USGS that could take into account many different factors in various aquifer systems (US Geological Survey, 2009).

GFLOW is a two-dimensional program that follows a step-wise modeling concept using a single layer element analytical code, based on Dupuit-Forcheimer assumptions (Dunning et al., 2003). Dupuit-Forcheimer assumptions state that the majority of the flow in an aquifer is essentially horizontal and vertical flow can be ignored (Fetter, 2001). These assumptions will be true and a two-dimensional model can be valid if the study area of lateral flow is large enough to make the vertical flow, or depth of the aquifer is essentially inconsequential (Dunning et al., 2003). The stepwise modeling concept can used to solve for a single layer solution to determine heads, flux, and flow rates and patterns (Haitjema, 2000). GFLOW does not support multi aquifer flows nor does it take into account vertical conductivities that may be important in determining the true flow pattern in the aquifer (Haitjema, 2000). Generally, inaccuracies can occur in cases of varying aquifer thickness, fractures in confining layers, or a leaky unconfined aquifer (US Environmental Protection Agency, 1992).

MODFLOW was created by the USGS in 1983 as a finite modular three-dimensional ground water flow computer code. The MODFLOW code can be used by a number of interfaces and allows for the addition of add-on packages to trace particle flow or contamination spread (US Geological Survey, 2009). MODFLOW can import a two-dimensional GFLOW output file to add a third-dimension of vertical flow to the model with additional parameter input. The addition of vertical flow will allow the modeling of multiple aquifers, leaky aquifers, and fractured confining layers, greatly increase the accuracy of the model (Gao, 2011; US Environmental Protection Agency, 1992; Fetter, 2001).

MODFLOW differs from GFLOW by using a finite difference solution as the primary modeling method. MODFLOW is accepted as an industry standard both in North America as well as in Europe to model groundwater flows (Gao, 2011). In MODFLOW, layers are setup to represent three-dimensional lattices of the earth based on soil, aquifer, and bedrock properties and dimensions (Gao, 2011).

MODFLOW requires that you add surface terrain elevations and hydrological features such as constant head boundaries, sinks, rivers, and lakes. These features determine the direction and amount of flow of groundwater in the model. Evapotranspiration and annual recharge values must be added as well. Known head values from well and boring logs are used to increase the accuracy of the model and the output will be in the form of a potentiometric map showing flow directions, velocities, flux, boundaries (Gao, 2011). The output from this step is saved and can be used later to determine contaminant transport and estimate pollution spread.

Along with the numerical solutions to calculate regional ground water flow, algorithms that solve advanced linear equations can be used to simulate contaminant transport (Prommer et al., 2002). Once a ground water solution has been achieved through MODFLOW, contaminate transport can then be modeled with the potentiometric output from MODFLOW. The algorithms account for the main principles of the transport of solutes: diffusion, advection, dispersion, and retardation. Diffusion is the process of a solute flowing from a place of higher concentration to lower concentration based on chemical activity; advection is the process by which moving groundwater carries dissolved solutes; dispersion is a process that dilutes the solute and lowers it's concentration though mechanical and hydrodynamic means; retardation is the chemical and physical processes that slow a solute's movement, working directly against advection (Fetter, 2001). Diffusion is solved by using Fick's Law in the following equation (Fetter, 2001):

$$F = -D\, dC/dx \qquad \text{(Fetter Equation 10.2)}$$

where:
F = mass flux of solute per unit area per unit time
D = diffusion coefficient (area/time)
C = solute concentration (mass/volume)
dC/dx = concentration gradient (mass/volume/distance)

Advection is determined by Darcy's law in the following equation (Fetter, 2001):

$$v_x = - K/n_e \times dh/dl \qquad \text{(Fetter Equation 10.4)}$$

where:
v_x = average linear velocity
K = hydraulic conductivity
n_e = effective porosity
dh/dl = hydraulic gradient

Dispersion occurs by both mechanical and hydrodynamic means. Mechanical dispersion is dependent on three factors: fluid moves faster through the center than edges of a pore due to friction; some fluid travels in longer pathways than other fluid due to the route between media particles it takes; fluid travels faster through larger pores than small ones (Fetter, 2001).

Hydrodynamic dispersion combines the processes of molecular diffusion and mechanical dispersivity. It is impossible to solve the molecular and mechanical dispersivity separately, so a coefficient is used. The following equation describes hydrodynamic dispersion (Fetter, 2001):

$$D_L = a_L v_x + D^* \qquad \text{(Fetter Equation 10.6)}$$

where:
D_L = longitudinal coefficient of hydrodynamic dispersion
a_L = dynamic dispersivity
v_x = average linear groundwater velocity
D^* = effective molecular diffusion coefficient

Retardation is based on the adsorption of a solute or contaminant to the soil or aquifer material. It can be estimated with an adsorption isotherm, or an equation that estimates sorption. When an adsorption relationship can be plotted as a straight line on log-log paper, it can be described by the Freundlich Isotherm, in following equation (Fetter, 2001):

$$C^* = K_f C^j$$ (Fetter Equation 10.11)

where: C^* = mass of solute sorbed per bulk unit dry mass of soil
C = solute concentration
K_f, j = coefficients

In contrast, a Langmuir Isotherm is determined by plotting C/C* versus C on arithmetic paper. If the points fall on a straight line, then a Langmuir Isotherm is correct, and is described in the following equation (Fetter, 2001):

$$C/C^* = 1/\beta_1 \beta_2 + C/\beta_2$$ (Fetter Equation 10.13)

where: C = equilibrium concentration of the ion in contact with the soil (mg/L)
C^* = dynamic dispersivity
β_1 = average linear groundwater velocity
β_2 = effective molecular diffusion coefficient

Either a Langmuir or Freundlich can be used to determine adsorption of a solute to materials, based on which isotherm is most accurate to the data plotted after a column study has been completed. Biological degradation of organic compounds is another means by which the spread of a solute can be slowed.

There are numerous contaminant transport engines available to use with MODFLOW. These include MT3DMS, RT3D, and PHT3D. These engines use a finite difference upstream solution that is capable of accounting for natural degradation, dispersion, and diffusion, that can be based on calculated or default values including sulfate reduction, nitrate reduction, and the difference in aquifer materials (Prommer et al., 2002). When using MT3DMS, developed by the USGS, electron receptors are used to determine sorption along with the option of using a Freundlich or Langmuir adsorption isotherm curve (Shlumberger Water Services, 2012). The engine PHT3D uses the same method, but takes into account the USGS geochemical code PHREEQC-2 that predicts fate based on constant and default parameters (Shlumberger Water Services, 2012). The RT3D engine is similar to the MT3DMS engine, but is specifically designed to work with BTEX compounds. Default values for sulfates, irons, and oxygen can be used coupled with default isothermal constants to simulate natural sorption and biodegradation in most aquifer types (Prommer et al., 2002).

CHAPTER III

DESCRIPTION OF STUDY AREA

A. Hiniker Pond

Hiniker Pond (MNDNR Lake # 07-014700) is an 18-acre pond with a maximum depth of 21 feet and an average depth of 9 feet (Minnesota DNR, 2007; United States, 1980). The site where Hiniker Pond is located, Government Lot 2 in Section 1 Township 108 North, Range 27 West, was purchased by the Hiniker family, on January 25, 1936 (Blue Earth County Minnesota, 1936). In 1936 the land was very close to the Minnesota River and was part of a meander that had not been previously farmed (Figure 7.)

Figure 7. Aerial view of future Hiniker Pond Mankato, MN in 1938 before excavation (USDA 1938)

When Mr. Hiniker began plowing the property he found that the land was almost pure gravel and sand so he started a sand and gravel company on the site (Preuhs, 1998). He found that the water table was only 2-3 feet deep, which led him to start a mining process known as "slack line cable-way mining" (Preuhs, 1998). In 1946 Joseph Hiniker sold the gravel pit to his son for five thousand dollars (Blue Earth County Minnesota, 1946). From 1946 until it was closed in 1972, approximately one million cubic yards of sand and gravel were removed from the gravel pit site (Preuhs, 1998). Due to urban sprawl and impending retirement, John Hiniker sold the closed gravel pit to the City of Mankato, Minnesota for one dollar on August 12, 1975 (Preuhs, 1998; Blue Earth County Minnesota, 1975; Fischenich, 2009). An aerial view of Hiniker Pond and nearby Oxbow Lake can be seen in Figure 8.

Figure 8. Aerial view of Hiniker Pond Mankato, MN in 1973 at cessation of mining

(USGS 1973)

Adjacent to Hiniker Pond is a small Oxbow that was created when the ACOE moved the Minnesota River in the early 1950's (Water Resource Center, Minnesota State University, 2002). Hiniker Pond and Oxbow Lake are connected by a gate well system that allows water to travel between the two water bodies (United States, 1980). The US-14 ditch runs along US-14 and then drains into Oxbow Lake. South of Oxbow Lake is the remains of the old North Mankato dump which was in operation from 1950 until 1973. It is located 500 yards due south of the southern most point of Hiniker Pond (U.S. Department of Public Health and Human Services, 2001).

In the 1980's Hiniker Pond was a very popular "rebel swimming hole" so the City of Mankato worked with the ACOE to develop the pond and surrounding property into the multi-use recreational park that it is today as seen in Figure 9 (United States, 1980).

According to the ACOE (1980), Hiniker Pond was considered to have excellent water quality for recreational use. However, Oxbow Lake was considered unsuitable for anything due to high levels of fecal coliform bacteria. The ACOE (1980) also predicted that should there ever be a problem with the water quality at Hiniker Pond, the easiest solution would be to drain the pond and allow natural ground water to refill it.

Figure 9. Aerial view of Hiniker Pond and Oxbow Lake, Mankato, MN in 2009 (USDA 2009)

B. 110 and 112 West Lind Street Sites

Approximately 300 yards north of Hiniker Pond at 110 and 112 West Lind street was where the Year-A-Round Cab Company was located (Figure 10.). Year-A-Round

Cab Company, specialized in the preparation and painting of industrial equipment (Burman, 2011). The company was founded in 1966 by Charles Anderson and was in operation until 2010, when it was sold to Herateus Properties. After the sale, Mr. Herateus found Underground Storage Tanks (UST's) and an abandoned industrial water well (Minnesota Pollution Control Agency, 2010c). Mr. Herataus contacted the MPCA who tested the sludge in manholes/tanks (Minnesota Pollution Control Agency, 2010c).

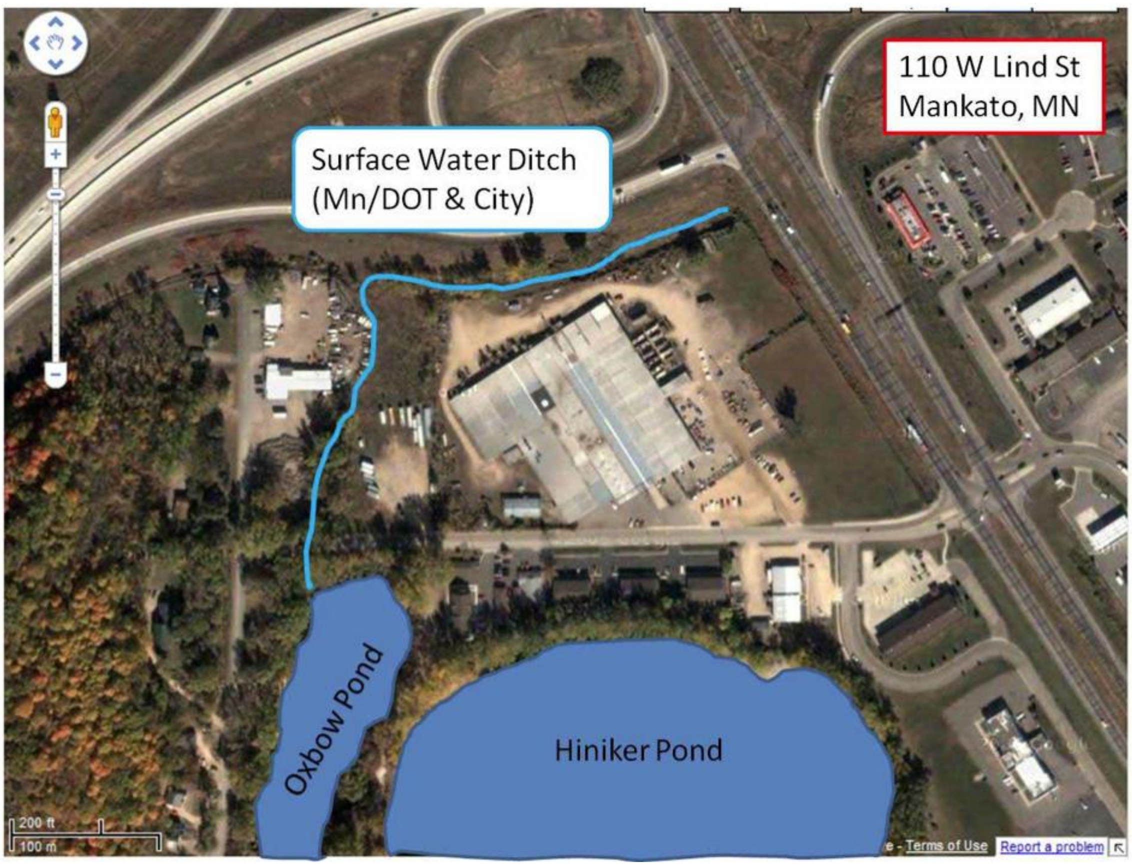

Figure 10. Site overview of Hiniker Pond, US-14 ditch, Oxbow lake, and 110 W. Lind St. (Minnesota Pollution Control Agency, 2010b)

In September 2010 the MPCA sampled sludge on the West Lind St. site and the following level of compounds were found:

Ethyl Benzene	1,901	ppm
Toluene	638	ppm
m-Xylene and p-Xylene	6,847	ppm
o-Xylene	2,169	ppm

(Minnesota Pollution Control Agency, 2010c)

Prior to September 2010 there were numerous issues with the site. Some of the environmental issues are presented in Appendix I-IV. In 1985 soil samples were found to contain metals at the levels listed below:

Chromium	18,000 ppb
Lead	520 ppb
Cadmium	210 ppb

(State of Minnesota, 1985)

In July 1985 soil samples taken from 4 holes (#16, 18, 19, 20) at depths between 1-1.5 feet had up to 200 ug/g of toluene and xylenes plus over 50 ug/g of ethyl benzene.

Details of the contamination and soil survey completed by the MPCA are presented in Appendix I. The MPCA confirmed that some drainage pipes from the facility flow directly into the ditch. There are numerous drains in the facility that have unknown pipe routing or final termination, most notably ones from the painting preparation and materials cleaning room (Figure 11.) (Minnesota Pollution Control Agency, 2010c). Additionally, the MPCA found that a paint waste tank and underground storage tanks empty directly into a drainage field behind the buildings, which in turn drain into the US-14 ditch (Figure 12.) (Minnesota Pollution Control Agency, 2010c). . The site is currently being considered for listing as a state superfund site for long term remediation (Minnesota Pollution Control Agency, 2010a).

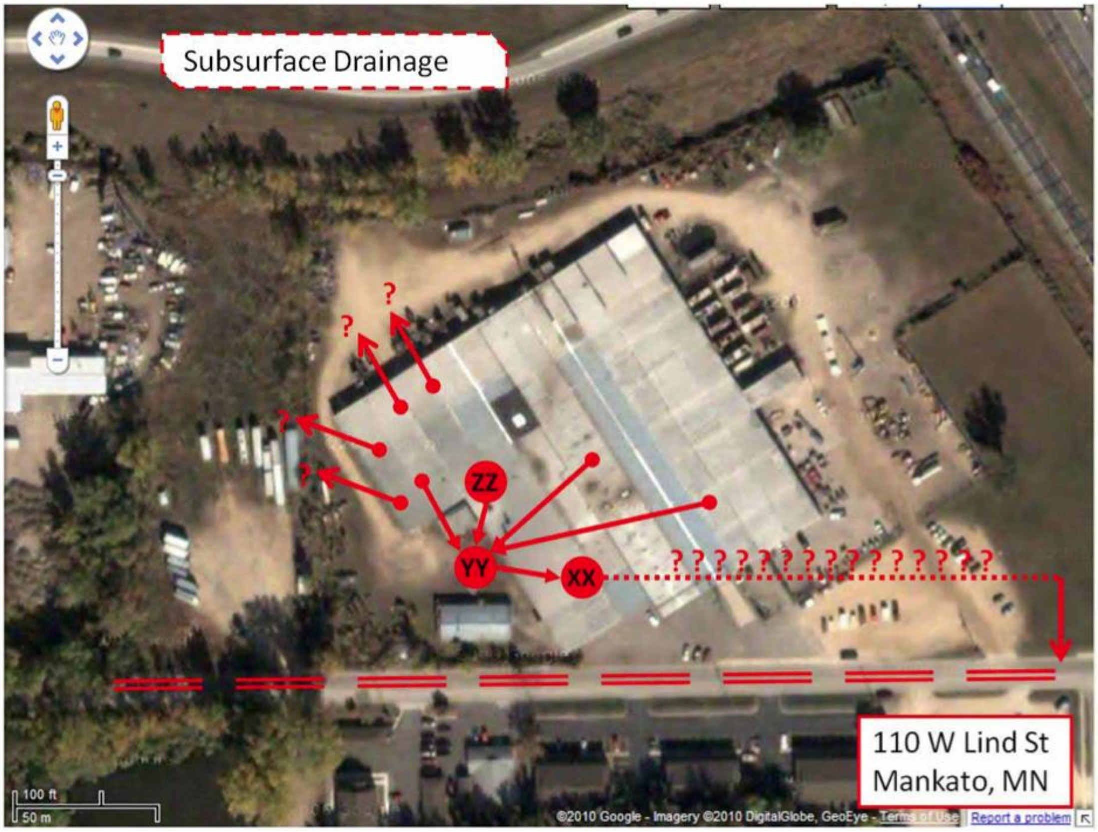

Figure 11. Unknown subsurface drainage from internal waste drains, 110 W. Lind St. (Minnesota Pollution Control Agency, 2010b)

There is a lengthy history of fines and charges per the MPCA against Year-A-Round Cab Company. These are presented in Appendix II. The case development form supplied by the MPCA details the unknown status of drainage routing as well as all previous fines and violations and a noted concern about the long-term affect on nearby Hiniker Pond (Appendix II.) (Minnesota Pollution Control Agency, 2010a).

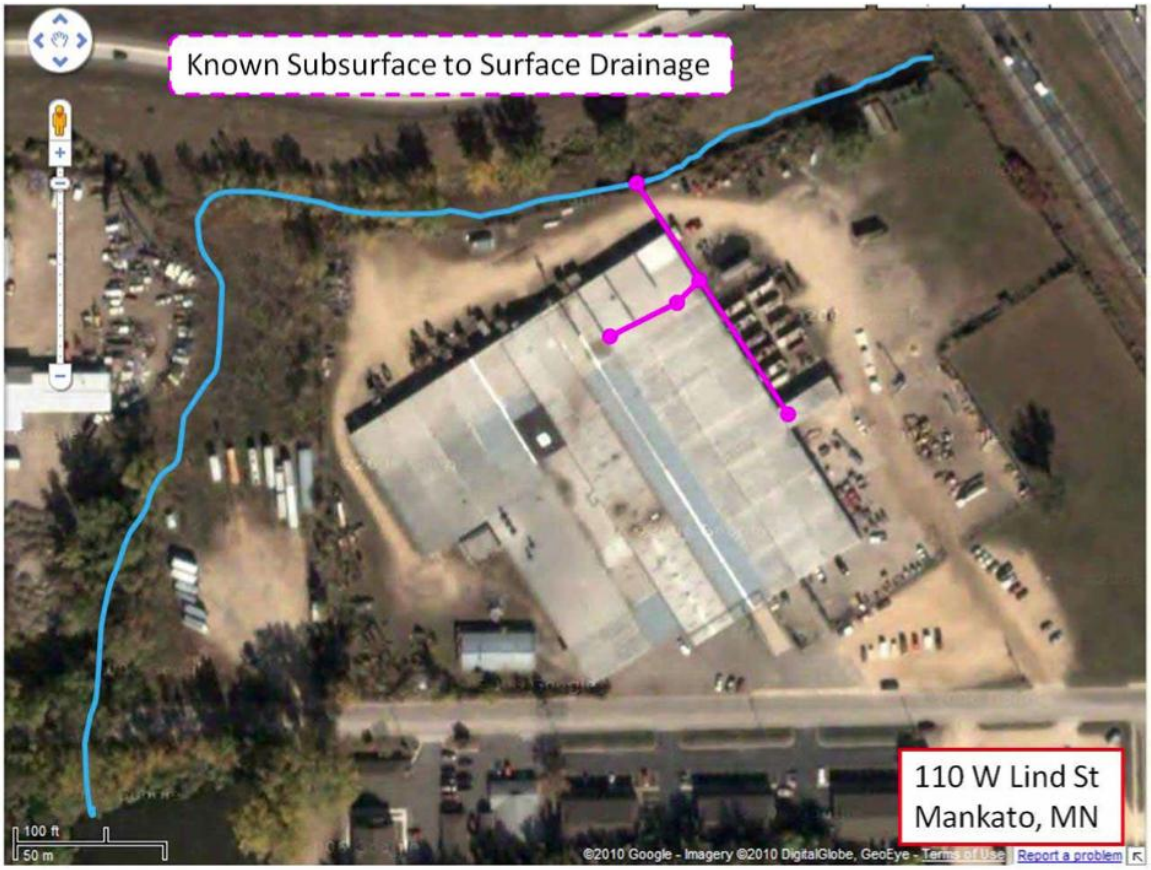

Figure 12. Known subsurface drainage into US-14 ditch at 110 W. Lind St. (Minnesota Pollution Control Agency, 2010b)

Concerns about illegal fill activities that have taken place, written complaints by workers and citizens whom allegedly had spoken to the previous owner of the site about burning of drums in out buildings are presented in Appendix III. A MPCA letter formally confirming the presence of drums containing hazardous waste and requiring them to be disposed of is presented in Appendix IV (Minnesota Pollution Control Agency, 2010a). A criminal complaint was later filed against the owner for the alleged burial of hazardous waste drums, possible burning of hazardous waste, and improper disposal methods as well as disregarding administrative orders issued by the MPCA (Appendix V.) (Minnesota Pollution Control Agency, 2010a).

C. Hallett's Pond

Hallett's Pond "unnamed lake 52-0001," is located in the City of Saint Peter, Minnesota. It was formerly a gravel pit that was closed and sold to the city (Linehan, 2007). Hallett's Pond was mined in the 1930's. After it closed it became an unofficial swimming area until 1974 when the City of St. Peter purchased it. The city banned swimming, and used the pond for storm water run-off.

Hallett's Pond is 12 acres in size, has a maximum depth of 35 feet, and is very similar to that of Hiniker Pond as you can see in Figure 13. (Minnesota DNR, 1999). Immediately next to Hallett's Pond is a new storm water run-off holding pond, which is connected to Hallett's pond by an overflow grating. Occasionally, the new storm water pond receives untreated sewage from the adjacent wastewater treatment plant (Linehan, 2007).


Figure 13. Aerial Photo of Hallett's Pond 2009

(USDA 2009)

CHAPTER IV

MATERIALS AND METHODS

A. Sample Collection

Water and sediment samples were collected bi-weekly from Hiniker Pond, Hallett's Pond, Oxbow Lake and US-14 ditch from May to November 2011. The GPS coordinates for the sampling location at each site are provided in Appendix VI. These samples were collected using methods and containers provided by the Minnesota Valley Testing Laboratory, New Ulm, MN (MVTL). All collection procedures and analytical methods conform to U.S. EPA protocols.

B. BTEX Compounds, Cadmium, Chromium, and Lead

1. Water Samples

For BTEX monitoring, surface water samples were collected, placed in bottles containing hydrochloric acid (no headspace) and put into an ice filled cooler. They were transported to MVTL under chain of custody. Per EPA Quality Control (QC) procedures a field duplicate and field blank were included. For metal monitoring (Cd, Cr, Pb), surface water samples were collected at the same time and location as the BTEX samples. The water was placed in containers containing nitric acid, placed into a cooler and transported to MVTL under chain of custody. Standard EPA QA procedures were followed. Summarized in Table II is the EPA methods and holding times for the BTEX and heavy metals.

Table II. Summary of water quality parameter holding times and standard methods of analysis for targeted metals and BTEX compounds

Parameter	Maximum Holding Time	Method
Chromium	6 months	SW6010
Cadmium	6 months	SW6010
Lead	6 months	SW6010
Ethyl Benzene	14 days	SW8260B
Toluene	14 days	SW8260B
Xylenes-O	14 days	SW8260B
Xylenes-M & P	14 days	SW8260B

(U.S. Environmental Protection Agency, 2003)

2. Sediment Samples

Sediment samples were collected from Hiniker Pond, Hallett's Pond, Oxbow Lake and US-14 ditch. Sediment samples were collected from the deepest water in Hiniker Pond and Hallett's Pond with an Ekman dredge. Sediments were collected from Oxbow Lake and US-14 ditch with a shovel. For organic analyses, thirty grams of sediment were placed into each container and methanol was added on top the sediment. The samples were placed in an ice chest and transported to MVTL under chain of custody. Sediment for metal analyses were placed in the appropriate polypropylene containers, placed in the ice chest, and transported to MVTL under chain of custody. A field duplicate and field blank were also taken. Summarized in Table III are the EPA methods and holding times for the organic and metals measured in the sediment samples from Hiniker Pond, Hallett's Pond, Oxbow Lake and US-14 ditch in 2011.

Table III. Summary of sediment parameter holding times and standard methods of analysis for targeted metals and BTEX Compounds

Parameter	Maximum Holding Time	Method
Chromium	6 months	SW-846 6010
Cadmium	6 months	SW-846 6020
Lead	6 months	SW-846 6010
Ethyl benzene	14 days	8021
Toluene	14 days	8021
Xylenes-O	14 days	8021
Xylenes-M & P	14 days	8021

(U.S. Environmental Protection Agency, 2003)

3. Analysis of Water and Sediment Samples for BTEX and Metals

Water and sediment samples were analyzed by MVTL for BTEX, cadmium, chromium, and lead because the appropriate equipment was not available at Minnesota State University-Mankato. Due to financial constraints, these analyses were conducted one time on May 19, 2011.

C. Field Parameters

Listed in Table IV are methods used to measure select water quality parameters in the field.

Table IV. Summary of standard methods used to measure select water qualities in the field

Parameter	Method
Temperature	SM 2550
Dissolved Oxygen	SM 45000-G
pH	EPA 9040A
Conductivity	EPA 120.1
Secchi Disk	N/A
Copper	HACH 8506

(U.S. Environmental Protection Agency, 2003)

For Hiniker Pond and Hallett's Pond, temperature, dissolved oxygen, and conductivity were measured at intervals of 5 foot from the surface of the lakes. Secchi Disk and pH were measured at the surface. For US-14 ditch and Oxbow Lake, temperature, conductivity, dissolved oxygen, pH, and turbidity tube were measured on the surface only and Secchi Disk readings were not taken.

D. Nutrients, Sulfates, and E. Coli Water Samples

Surface water samples were also collected bi-weekly from May until November 2011. In addition, water was collected from a depth of 10ft in Hiniker Pond and Hallett's pond. These water samples were analyzed for total phosphorus (TP), soluble reactive phosphorus (P-PO4), nitrate (N-NO3), nitrite (N-NO2), ammonia nitrogen (N-NH3), sulfates (SO4), E. Coli, and copper (Cu) . Summarized in Table V is a list of water quality parameters and its holding time and method of analysis.

Table V. Summary of water quality holding times and standard methods of analysis

Parameter	Maximum Holding Time	Method
E. coli	24 hours	EPA 1903
P-PO4	24 hours	EPA 365.2
TP	24 hours	EPA 365.4
N-NO3	28 days	EPA 352.1
N-NO2	28 days	EPA 353.2
N-NH3	28 days	EPA 350.1
SO4	28 days	EPA 4035

(U.S. Environmental Protection Agency, 2003)

Standard EPA QA/QC procedures were followed. These included field duplicates, field blanks, laboratory blanks, laboratory duplicates, were analyzed. All of these samples were analyzed at Minnesota State University, Mankato, MN.

E. Statistical Analysis

SPSS was used to calculate descriptive statistics (mean, standard deviation, standard error, and), a Wilcoxon 1 way T-test was used to calculate P-values (Non-Parametric) and Sigma Plot was used to plot linear regressions.

F. Carlson Trophic State Index

The Carlson's Trophic State Index was determined using two parameters, total phosphorous and Secchi disk.

G. Rainfall Data

Rainfall data was from May-November 2011was downloaded from the National Weather Service (NWS). The NWS data are an average of 3 different stations close to Mankato and St. Peter, MN. There locations include: The Mankato Regional Airport, Minnesota State University, Mankato Campus, and the Minnesota Department of Transportation Mankato field office.

H. ARC GIS

ARC GIS 10 was use to geo-reference all US Department Agriculture (USDA) and US Geological Survey (USGS) Digital Elevation Maps (DEM) and digital aerial photos, or Orthophoto Quadrangles (DOQ). The maps were layered after they were geo-referenced to document changes that occurred over since the 1930's. Well data were downloaded from the Minnesota County Well Index and plotted.

I. Ground Water Modeling

1. GFLOW

GFLOW (Haitjema software version 2.1.2) was used to model groundwater flow through the aquifer in the area of Hiniker Pond and Oxbow Lake. This was a two-dimensional model to determine the potentiometric field to determine flow paths. Constant head elevations were retrieved by using the depth to ground water information from the county well index data (Minnesota Department of Health, 2012). The well and boring data logs are presented in Appendix VII. Hiniker Pond was used as a constant head boundary due to its documented elevation (Minnesota DNR, 2007). The Minnesota River was used as a sink for the area due to the nature of the decreasing ground water elevation and known draw towards the river. US EPA DOQ's were retrieved through GFLOW and used as a base map. Based on the GFLOW output, flow paths were drawn using Adobe Illustrator.

2. MODFLOW

Visual MODFLOW Premier, an interface from Schlumberger Water Services Inc.,that uses the MODFLOW computer code was used to build a three-dimensional model of subsurface water flow. The model was designed to cover the area of Hiniker Pond and Oxbow Lake running from the old North Mankato dump on the south to US-14 on the north and from the Minnesota River on the East, west to the bluffs in North Mankato. This area was chosen based on historical imagery of the area before the Minnesota River meander was cutoff making it fairly homogenous throughout as shown in Figure 7. The area was approximately 400 meters wide and 450 meters from south to north so a grid of 40 by 45 cells were used, making all cells about 10 meters square. An annual recharge rate of 28 inches per year and an annual evapotranspiration rate of 23 inches per year were applied to the model based local knowledge (Hippie, 2012). Hiniker Pond and Oxbow Lake were added as lake features, using depths and properties as indicated by the Minnesota DNR (Minnesota DNR, 2007). The Minnesota River was added as a river boundary using an average depth of 12 feet (Hoppie, 2012). Both the lake and river boundary areas and shapes were input by tracing the features on the DOQ of the area.

The surface layer of the model was based on the latest soil survey completed in 1983 by the Natural Resource Conservation Service (NRCS). The top layer corresponds to code 1007, (Alluvial Outwash) and values used for this layer were calculated from available data from the survey (Natural Resource Conservation Service, 1983). Topographical data was downloaded from the USDA with 2-foot elevation differentials and applied to the surface to show terrain. This layer was made 5 feet thick based on a boring report from the Minnesota Department of Transportation from 1969 at the US-14 overpass from the north, the NRCS soil survey report, and the report by the USDPH on the old North Mankato dump on the south (Minnesota Department of Transportation, 1969; Natural Resource Conservation Service, 1983; U.S. Department of Public Health and Human Services, 2001).

The second layer of the model was designed using values that were calculated in the lab. A sample of aquifer material was collected from 2 feet below the sediment of Hiniker Pond. The conductivity was calculated from a constant head test conducted using a piezometer following standard lab methods (Hoppie, 2012). Porosity and bulk density were calculated using a quanta chrome pycnometer and a certified scale (Hoppie, 2012).

The equations, reports, and data used to determine final values are presented in Appendix VII. The elevation of the top of layer two was achieved using the top layer elevation data and using ARC GIS to subtract five feet from it to represent the assumed thickness of the top layer. The bottom of layer two was set to the bedrock, known to be at about 700 feet above sea level from the geological atlas for Nicollet County, MN (Water Resource Center, 2012).

The values for the last layer, the bedrock, were set to near to zero as possible and the layer was made 1foot thick with a slight elevation change from 700 feet on the south to 693 feet on the north based on the geological atlas and US-14 boring report (Minnesota Department of Transportation, 1969; Water Resource Center, 2012). Values that were required for each layer include storativity (the amount of water released per unit volume of aquifer), specific yield (the amount of water an aquifer will yield under gravity), conductivity (the flow rate in an aquifer), and porosities (ability of an aquifer to transmit water) were calculated using equations or available data as presented in Appendix VII. MODFLOW was set to 9,990 days (27 years approximately) to represent the total time frame that Year-A-Round Cab Company had been in business (Minnesota Pollution Control Agency, 2010c).

a. Heavy Metal Transport

MT3DMS was used as the engine to predict heavy metal contaminant transport using lead as the surrogate. This engine is the best choice when biodegradation is not a factor when dealing with heavy metals that are persistent (Prommer et al., 2002). The adsorption coefficients were also most appropriate with the MT3DMS engine with lead only having one oxidation state. The initial concentration of lead was based on the assumption of a constant leakage of 1 mg/L per day for 9,990 days (27 years). This was the best estimate of constant leakage from the paint tanks on the site since the first complaint in 1985 (Minnesota Pollution Control Agency, 2010c).

A Langmuir sorption curve was used with values used for calculations presented in Appendix VII. Langmuir was used over Freundlich due to the losses from a single spill incident assumed to be two orders of a magnitude greater through the ground and a very little clay in the soils of the region. The engine was run using the conductivity for the media as calculated in the lab of 59 feet per day horizontally. Vertical conductivity was set to 5.9 feet per day based on default vertical conductivity solutions in the model. Changing the conductivity, dispersivity, and adsorption coefficients tested the model's sensitivity to parameter adjustment. This process allowed the groundwater model to be delineated for the maximum, minimum, and most probable extent of contamination. The model was run and outputs were recorded at different time intervals to show the size and extent of the lead contamination plume.

b. BTEX Transport.

The RT3D transport engine was used to model BTEX compound transport of a simulated leak. The engine was chosen because of the available built in default parameters for sulfates, iron, and oxygen in the soil and the chemical properties of BTEX already existing in the code. The option of using a first order engine was used with default values to simulate an aerobic environment for biological degradation to occur. The initial concentration for the BTEX plume was based on the assumption of a constant release of 1 mg/L per day for 5 years. Toluene was used as the surrogate for BTEX compounds. A Langmuir adsorption curve was used due to the chemical properties of

BTEX based on prior research by Prommer et al. (Prommer et al., 2002). Aquifer properties were manipulated from the calculated values to determine the maximum, minimum, and most probable extent of contamination. The data used for aquifer properties in the model is presented in Appendix VII. The model was run and outputs were recorded at different time intervals to show the size and extent of the BTEX contamination plume.

CHAPTER V

RESULTS

A. BTEX and Metals

Results of analyses for BTEX compounds and heavy metals in water and in sediment are summarized in Table VI and VII respectively. These analyses were only conducted once due to financial limitations. Detailed laboratory results for all organic compounds in water are in Appendix VIII and sediment results are in Appendix IX.

Table VI. Levels of heavy metals (Cd, Pb, Cr) and BTEX in water samples collected on May19, 2011 by site

Water Body	Cadmium (µg/L)	Chromium (µg/L)	Lead (µg/L)	Ethyl Benzene (µg/L)	Toluene (µg/L)	m/p/o Xylenes (µg/L)
US 14 Ditch	< 0.005	< 0.01	< 0.03	< 1	<1	<1
Oxbow Lake	< 0.005	< 0.01	< 0.03	< 1	<1	<1
Hiniker Pond	< 0.005	< 0.01	< 0.03	< 1	<1	<1
Hallett's Pond	< 0.005	< 0.01	< 0.03	< 1	<1	<1

Table VII. Levels of heavy metals (Cd, Pb, Cr) and BTEX in surface sediment samples collected on May19, 2011 by site

Water Body	Cadmium (mg/kg)	Chromium (mg/kg)	Lead (mg/kg)	Ethyl Benzene (µg/kg)	Toluene (µg/kg)	m/p/o Xylenes (µg/kg)
US 14 Ditch	1.25	20.7	30.8	< 50	< 50	< 50
Oxbow Lake	0.471	11.6	7.01	< 50	< 50	< 50
Hiniker Pond	0.208	3.49	<0.694	< 50	< 50	< 50
Hallett's Pond	0.129	2.01	<0.709	< 50	< 50	< 50

B. Field Parameters and Nutrient Testing

Summarized in Table VIII are the dates field water quality measurements and samples were collected for analyses for nutrients, sulfates, and E. coli by location.

Table VIII. Summary of the dates water quality measurements were taken by site

Date (2011)	Hiniker Pond	Hallett's Pond	Oxbow Lake	US-14 ditch*
May 19	XX	XX	XX	XX
June 1	XX	XX	XX	
June 14	XX	XX	XX	XX
June 22	XX	XX	XX	XX
July 12	XX	XX	XX	
July 27	XX	XX	XX	XX
August 15	XX	XX	XX	XX
August 30	XX	XX	XX	
September 13	XX	XX	XX	
September 27	XX	XX	XX	
October 11	XX	XX	XX	
October 25	XX	XX	XX	
November 9	XX	XX	XX	

*US-14 ditch was unable to be sampled due to lack of water on some occasions

Summarized in Table IX, X, XI, and XII are the means, minimums, maximums, range, and standard errors of all field parameters, phosphorus, nitrogen, sulfates, and E. coli levels for each water body. Detailed results are presented in Appendix X.

Table IX. Descriptive statistics for US-14 ditch by parameter during sampling season May- November 2011

Parameter	# of Samples	Minimum	Maximum	Mean	Standard Error	Standard Deviation
E. ecoli (CFU/100ml)	3	488.4	1,203.3	780.17	216.57	375.12
Turbidity (cm)	4	4	29	16.75	6.80	13.60
pH	4	4.1	8.6	7.03	1.00	2.00
Conductivity Surface (mohm/cm)	5	0.180	1.967	1.00	0.39	0.86
Temperature Surface (°C)	5	15.9	28.0	21.94	2.27	5.07
Dissolved Oxygen Surface (ppm)	5	4.40	15.11	7.61	1.98	4.44
TP Surface (ppm)	5	0.13	1.30	0.44	0.22	0.49
P-PO4 Surface (ppm)	5	0.03	0.14	0.09	0.02	0.04
N-NO2Surface (ppm)	5	0.0062	0.0462	0.0248	0.01	0.02
N-NO3Surface (ppm)	5	0.7	1.4	0.94	0.12	0.27
N-NH3 Surface (ppm)	2	0.1	5.0	2.55	2.45	3.46
SO4 Surface (ppm)	4	0.2	284.0	105.68	66.62	133.23
Copper Surface (ppm)	2	0.019	1.990	1.00	0.99	1.39

Table X. Descriptive statistics for Oxbow Lake by parameter during sampling season May- November 2011

Parameter	# of Samples	Minimum	Maximum	Mean	Standard Error	Standard Deviation
E. ecoli (CFU/100ml)	10	22.60	2419.60	1546.48	334.50	1057.77
Turbidity (cm)	11	2.00	32.00	14.91	2.63	8.73
pH	12	5.70	7.50	6.81	0.14	0.47
Conductivity Surface (mohm/cm)	12	0.12	1.20	0.53	0.09	0.33
Temperature Surface (°C)	12	6.70	26.00	17.63	1.41	4.87
Dissolved Oxygen Surface (ppm)	12	0.24	6.80	3.26	0.72	2.49
TP Surface (ppm)	12	0.10	1.11	0.49	0.10	0.34
P-PO4 Surface (ppm)	12	0.02	0.44	0.15	0.03	0.12
N-NO2 Surface (ppm)	12	0.0075	0.7650	0.1122	0.06	0.21
N-NO3 Surface (ppm)	12	0.10	1.20	0.63	0.10	0.36
N-NH3 Surface (ppm)	3	0.20	3.70	1.50	1.11	1.92
SO4 Surface (ppm)	11	0.20	114.80	33.57	11.74	38.93
Copper Surface (ppm)	2	0.02	0.03	0.03	0.01	0.01

Table XI. Descriptive statistics for Hiniker Pond by parameter during sampling season May- November 2011

Parameter	# of Samples	Minimum	Maximum	Mean	Standard Error	Standard Deviation
E. ecoli (CFU/100ml)	13	0.0	2,419.6	198.21	185.26	667.96
pH	13	4.5	8.0	7.23	0.25	0.90
Conductivity Surface (mohm/cm)	13	0.986	1.123	1.05	0.01	0.05
Conductivity 5ft (mohm/cm)	13	0.986	1.141	1.06	0.02	0.05
Conductivity 10ft (mohm/cm)	13	0.989	1.144	1.07	0.02	0.06
Conductivity 15ft	12	1.010	1.153	1.10	0.02	0.06
Temperature Surface (°C)	13	8.1	30.0	20.40	1.66	5.99
Temperature 5ft (°C)	13	8.2	27.9	19.90	1.59	5.73
Temperature 10ft (°C)	13	8.2	24.4	17.67	1.35	4.88
Temperature 15ft (°C)	12	8.2	20.3	13.58	1.11	3.86
Secchi Disk (M)	13	0.5	2.5	1.38	0.17	0.61
Dissolved Oxygen Surface (ppm)	13	8.30	15.70	10.07	0.57	2.04
Dissolved Oxygen 5ft (ppm)	13	6.98	15.40	9.74	0.58	2.11
Dissolved Oxygen 10ft (ppm)	13	0.20	10.00	3.76	0.98	3.53
Dissolved Oxygen 15ft (ppm)	12	0.00	8.75	1.23	0.72	2.51
TP Surface (ppm)	13	0.07	0.66	0.14	0.04	0.16
TP 10ft (ppm)	13	0.06	0.15	0.11	0.01	0.03
P-PO4 Surface (ppm)	13	0.02	0.59	0.12	0.04	0.15
P-PO4 10ft (ppm)	13	0.02	0.14	0.06	0.01	0.04
N-NO2 Surface (ppm)	13	0.0003	0.0120	0.01	0.00	0.00
N-NO2 10ft (ppm)	13	0.0026	0.0184	0.01	0.00	0.00
N-NO3Surface (ppm)	12	0.1	1.2	0.71	0.10	0.34
N-NO310ft (ppm)	12	0.4	1.5	0.75	0.08	0.26
N-NH3 Surface (ppm)	3	0.2	3.5	1.43	1.04	1.80
N-NH3 10ft ((ppm)	3	0.1	5.4	2.10	1.66	2.88
SO4 Surface (ppm)	12	97.4	129.4	109.77	3.37	11.68
SO4 10ft (ppm)	12	88.8	123.0	106.08	3.42	11.84
Copper Surface (ppm)	3	0.050	0.864	0.32	0.27	0.47
Copper 10ft (ppm)	3	0.116	1.720	0.84	0.47	0.81

Table XII. Descriptive statistics for Hallett's Pond by parameter during sampling season May- November 2011

Parameter	# of Samples	Minimum	Maximum	Mean	Standard Error	Standard Deviation
E. ecoli (CFU/100ml)	13	0.0	1,553.1	142.44	118.72	428.06
pH	12	6.4	8.4	7.62	0.17	0.58
Conductivity Surface (mohm/cm)	13	0.458	0.675	0.57	0.02	0.07
Conductivity 5ft (mohm/cm)	12	0.461	0.675	0.59	0.02	0.07
Conductivity 10ft (mohm/cm)	12	0.475	0.684	0.59	0.02	0.06
Conductivity 15ft	10	0.540	0.936	0.66	0.04	0.11
Temperature Surface (°C)	13	8.3	30.4	20.74	1.71	6.15
Temperature 5ft (°C)	12	8.5	29.2	20.33	1.78	6.17
Temperature 10ft (°C)	12	8.7	26.3	19.55	1.60	5.56
Temperature 15ft (°C)	10	8.7	24.1	18.21	1.68	5.30
Secchi Disk (M)	12	0.8	3.5	2.19	0.28	0.97
Dissolved Oxygen Surface (ppm)	13	8.20	17.00	10.09	0.63	2.27
Dissolved Oxygen 5ft (ppm)	12	7.80	19.00	10.24	0.88	3.03
Dissolved Oxygen 10ft (ppm)	12	7.90	16.10	10.87	0.78	2.70
Dissolved Oxygen 15ft (ppm)	11	0.66	18.50	7.50	1.64	5.45
TP Surface (ppm)	13	0.02	0.90	0.15	0.06	0.23
TP 10ft (ppm)	13	0.03	0.11	0.07	0.01	0.02
P-PO4 Surface (ppm)	13	0.01	0.16	0.04	0.01	0.05
P-PO4 10ft (ppm)	13	0.01	0.09	0.03	0.01	0.02
N-NO2 Surface (ppm)	13	0.0240	0.0498	0.0350	0.00	0.01
N-NO2 10ft (ppm)	13	0.0243	0.0505	0.0376	0.00	0.01
N-NO3 Surface (ppm)	12	1.2	3.5	2.00	0.23	0.78
N-NO3 10ft (ppm)	12	1.5	3.4	2.32	0.20	0.68
N-NH3 Surface (ppm)	3	0.1	4.7	1.63	1.53	2.66
N-NH3 10ft (ppm)	3	0.1	2.7	1.07	0.82	1.42
SO4 Surface (ppm)	12	27.8	46.8	35.58	1.63	5.65
SO4 10ft (ppm)	12	28.5	45.0	35.74	1.50	5.21
Copper Surface (ppm)	3	0.021	0.037	0.03	0.01	0.01
Copper 10ft (ppm)	3	0.007	0.025	0.02	0.01	0.01

C. Statistical Analysis

Results of a statistical analysis using a Wilcoxon non-parametric T-test comparing Hiniker Pond to Hallett's Pond for field parameters, sulfates, and nutrient levels is presented in Table XIII. The lower the P-value for each parameter, the more similar

Hiniker and Hallett's Ponds were to each other and any changes were the same for the other. A P-value of 0.05 was used as a standard showing a 95% confidence interval.

Table XIII. Summary of a Wilcoxon non-parametric T-test (bold indicates significant correlation at a 95% confidence interval) between Hiniker and Hallett's Ponds for data collected May – November 2011.

Parameter	P-Value
E. ecoli (CFU/100ml)	0.861
pH	0.061
Conductivity Surface (mohm/cm)	**0.001**
Conductivity 5ft (mohm/cm)	**0.002**
Conductivity 10ft (mohm/cm)	**0.002**
Conductivity 15ft	**0.005**
Temperature Surface (°C)	0.074
Temperature 5ft (°C)	**0.003**
Temperature 10ft (°C)	**0.003**
Temperature 15ft (°C)	**0.005**
Secchi Disk (M)	**0.015**
Dissolved Oxygen Surface (ppm)	0.753
Dissolved Oxygen 5ft (ppm)	0.583
Dissolved Oxygen 10ft (ppm)	**0.002**
Dissolved Oxygen 15ft (ppm)	**0.003**
TP Surface (ppm)	0.157
TP 10ft (ppm)	**0.006**
P-PO4 Surface (ppm)	**0.005**
P-PO4 10ft (ppm)	**0.003**
N-NO2 Surface (ppm)	**0.001**
N-NO2 10ft (ppm)	**0.001**
N-NO3 Surface (ppm)	**0.003**
N-NO3 10ft (ppm)	**0.003**
SO4 Surface (ppm)	**0.002**
SO4 10ft (ppm)	**0.002**
N-NH3 Surface (ppm)	1.000
N-NH3 10ft ((ppm)	0.285
Copper Surface (ppm)	0.109
Copper 10ft (ppm)	0.109

Numbers in bold in Table XIII indicate that there was a significant correlation between Hiniker and Hallett's Pond with respect to that parameter. This indicates that the two water bodies responded to seasonal variations similarly. E. Coli, SO4, and dissolved oxygen showed a significant difference between Hiniker and Hallett's Pond in respect to seasonal variation.

D. Carlson Trophic State Index

The Carlson Trophic State Index was determined for Oxbow Lake, Hiniker Pond and Hallett's Pond using average total phosphorous and Secchi Disk levels. These data are presented in Table XIV.

Table XIV. Summary of Carlson Trophic State Index by water body in 2011

Water Body	Mean TP (ppb)	Mean Secchi/ Turbidity Tube (M)	Value	Description
Oxbow lake	489	0.15	>80	Hyper eutrophic
Hiniker Pond	127	1.39	67	Eutrophic
Hallett's Pond	109	2.18	56	Eutrophic

E. Rainfall Data

Summarized in Table XV are the rainfall data, based on 7-day totals for May to November 2011. The testing season was significantly drier than in previous years. Traditionally July is the wettest season, but in this case was very dry while August was significantly wetter than normal (Minnesota DNR, 2007).

Table XV. Regional rainfall data based on 7-day totals from the National Weather Service for Mankato, MN, May to November 2011

Week of:	Total Precipitation (inches)	Week of:	Total Precipitation (inches)
4-May	0.38	10-Aug	0.1
11-May	0.34	17-Aug	0.18
18-May	0.45	24-Aug	0
25-May	0.35	31-Aug	0.16
1-Jun	0	7-Sep	0
8-Jun	0.11	14-Sep	0
15-Jun	1.77	21-Sep	0.16
22-Jun	0.69	28-Sep	0
29-Jun	0.27	5-Oct	0
6-Jul	0	12-Oct	0.46
13-Jul	2.62	19-Oct	0
17-Jul	0.68	26-Oct	0
24-Jul	0.09	2-Nov	0
3-Aug	**8.11**	9-Nov	0

F. Ground Water Flow Modeling

1. GFLOW

The results of the GFLOW model are shown in Figure 14. The flow lines show that the majority of the aquifer (groundwater) flows to the northwest into the Minnesota River.

Figure 14. GFLOW model results showing estimated subsurface water flow for Hiniker Pond and surrounding areas, North Mankato, MN

2. MODFLOW

The MODFLOW simulation showing the layer setup, wells, surface terrains (with 2x vertical exaggeration), lakes, rivers, and bedrock are presented in Figure 15. A heavy metal contamination plume was simulated using the MT3DMS engine using values presented in Appendix VII. Figures 16, 17, and 18 shows the heavy metal plume (lead as indicator) modeled by various time stages, 30 days, 1 year, and 4.5 years, respectively. A conductivity of 59 feet per day horizontally and 5.9 feet per day vertically was used based on lab piezometer test averages (Hoppie, 2012). As the plume undergoes advection and slowly diffuses laterally, it makes contact with the Minnesota River, never contacting

Hiniker Pond or Oxbow Lake through subsurface flow. Using higher and lower conductivities, adsorption coefficients, and dispersivity values, minimum, maximum, and most probable cases of contamination showed negligible difference in the size and extent of the contamination plume. These numbers were determined by using a plus or minus one standard deviation on either side of the averages. Only when dispersivity was changed to be 100 times the calculated conductivity of the aquifer material was lead able to reach Hiniker Pond and Oxbow Lake. However this output is not a possible real life situation.

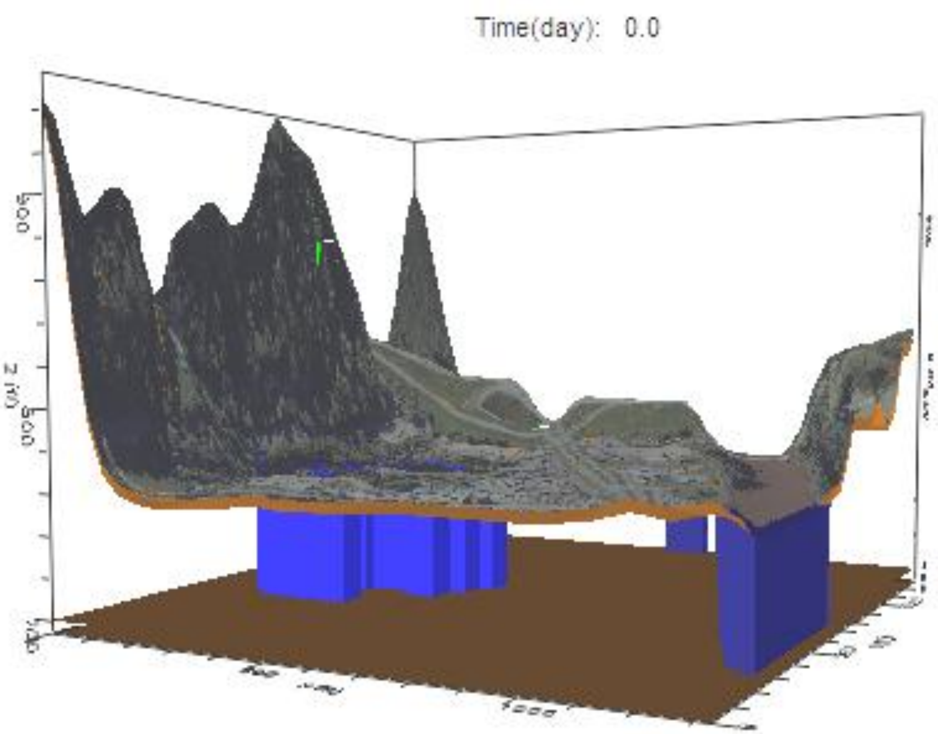

Figure 15. A three-Dimensional view of Hiniker Pond area with all hydrological features using Visual MODFLOW Premier. The top layer shows terrain, light blue is Hiniker Pond and Oxbow Lake, dark blue indicates the Minnesota River, light brown is the first layer of soil, and dark brown shows the bedrock.

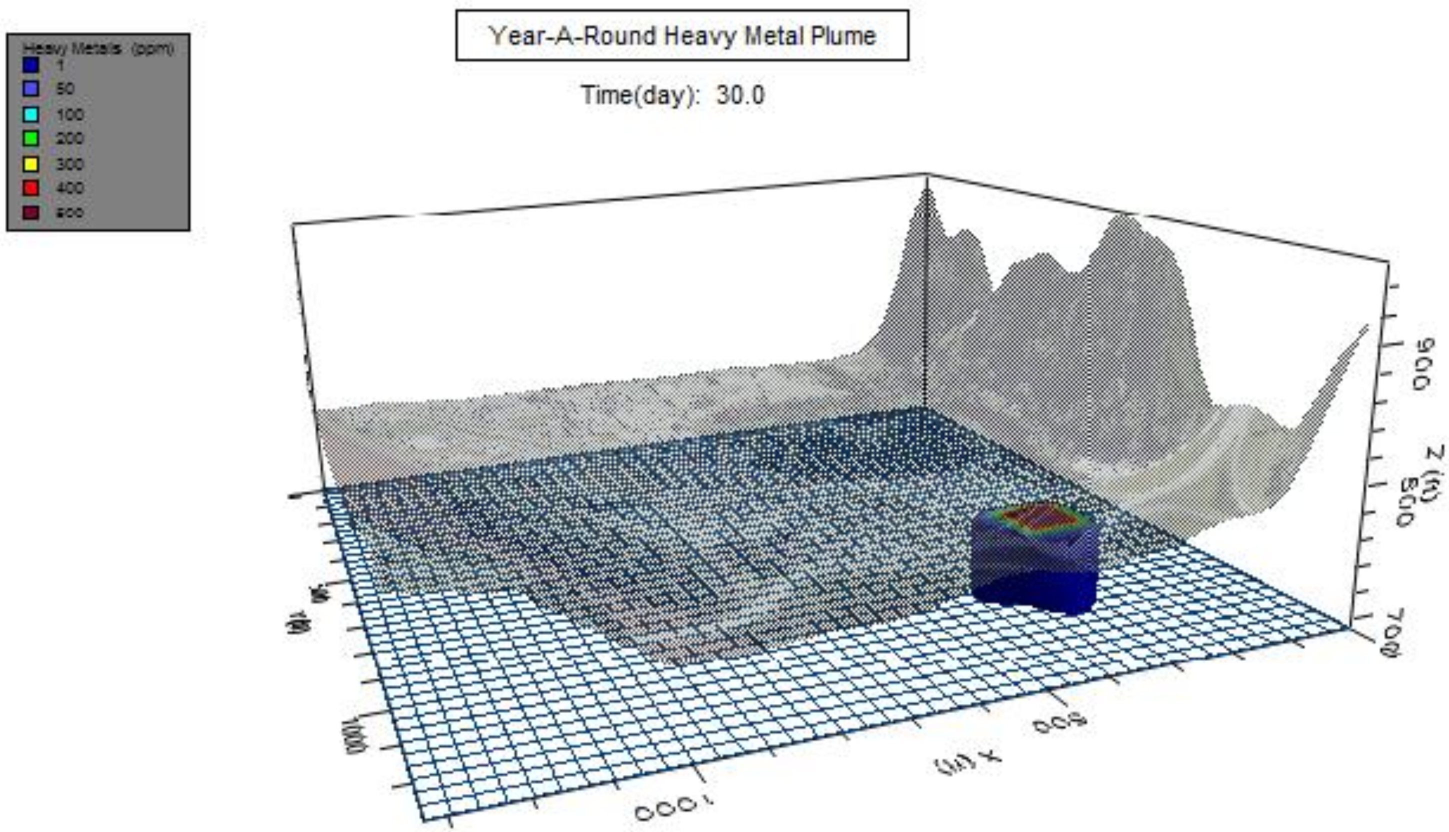

Figure 16. Estimated heavy metal plume (lead as a surrogate) from Year-A-Round Cab Company after 30 days.

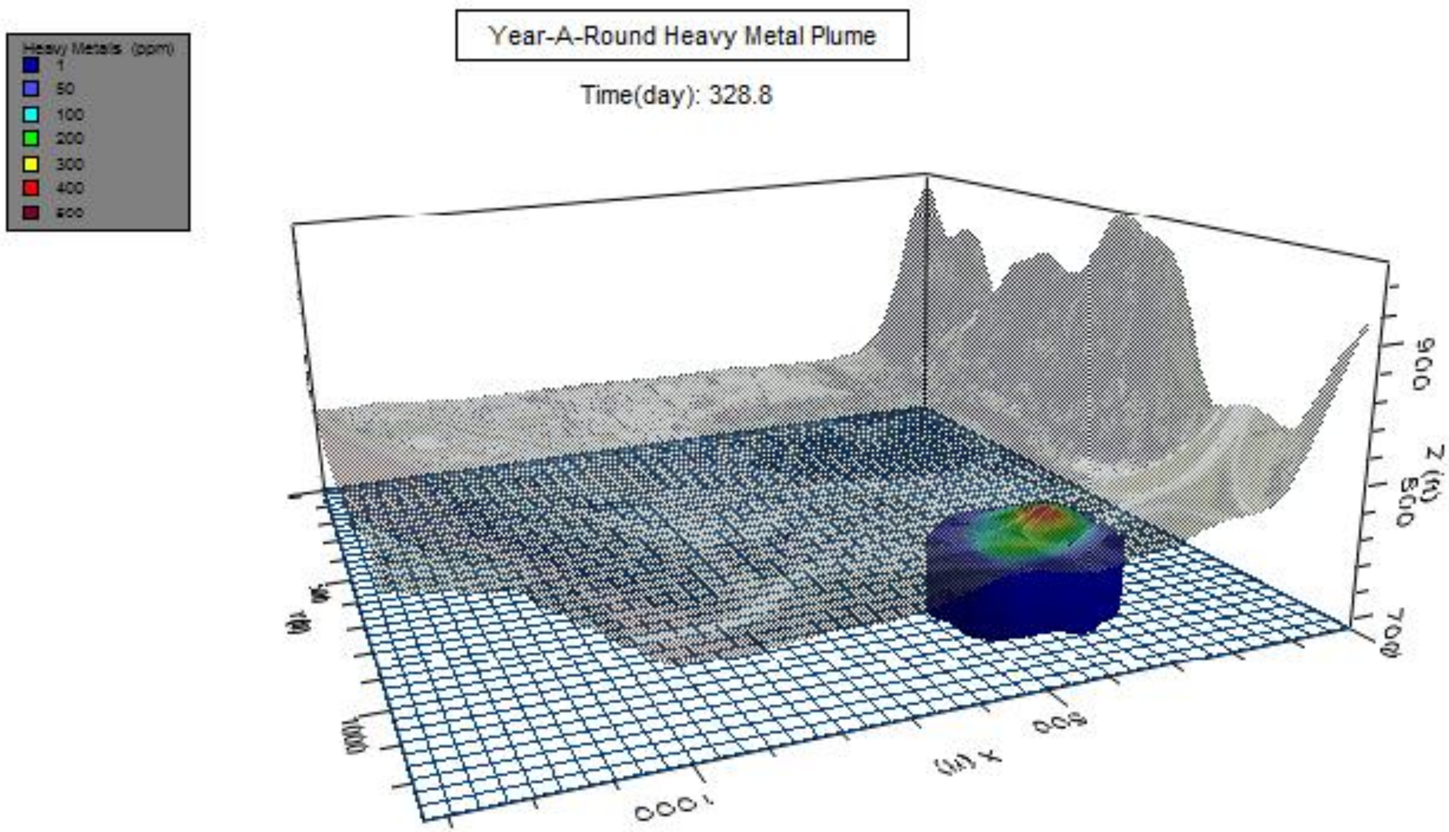

Figure 17. Estimated heavy metal plume (lead as a surrogate) from Year-A-Round Cab Company after 329 days.

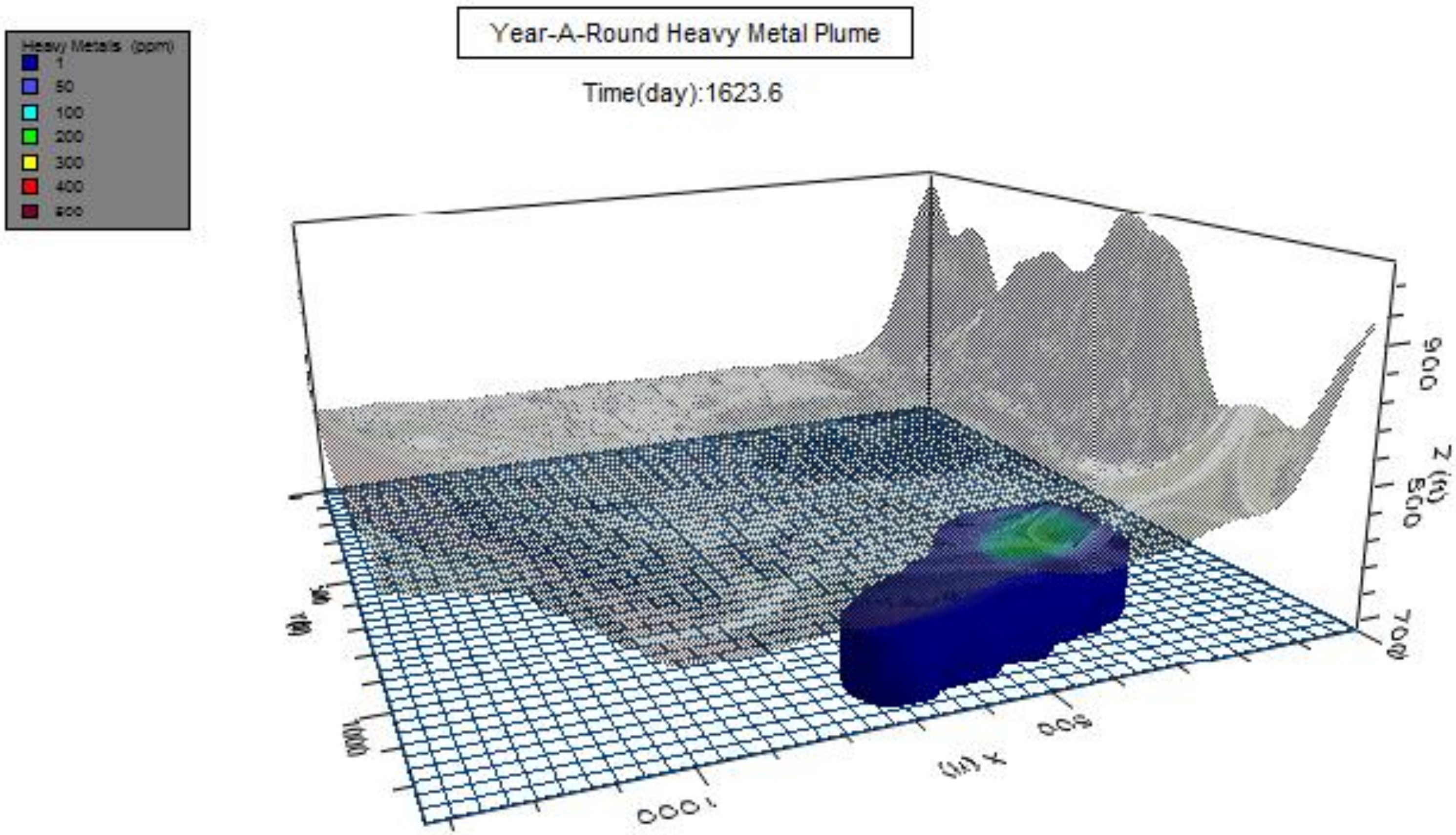

Figure 18. Estimated heavy metal plume (lead as a surrogate) from Year-A-Round Cab Company after 1623 days.

The results of a simulated BTEX plume were modeled using the RT3D engine. The properties of the layers and the model were not changed from what was used to model the lead contamination plume and are presented in Appendix VII. The BTEX plume models can be seen in Figures 19, 20, 21, and 22 at intervals of 30, 90, 365 days, and 5 years, respectively. The values of conductivity and dispersivity to obtain minimum, maximum, and most probable cases of contamination were calculated by using plus or minus one standard deviation of the averages as with heavy metals. The changes showed no discernable or relevant impact on the general shape, size, or final concentration of the BTEX contamination plume. The plume contacts both Hiniker Pond and Oxbow Lake within 30 days as seen in Figure 19, and continues to grow as it makes contact with the Minnesota River at about one year, and then shrinks as it flows into the river. Cases of minimum and maximum contamination also contacted Hiniker Pond and Oxbow Lake in less than 30 days and the Minnesota River slightly before or after one year, but within a few days.

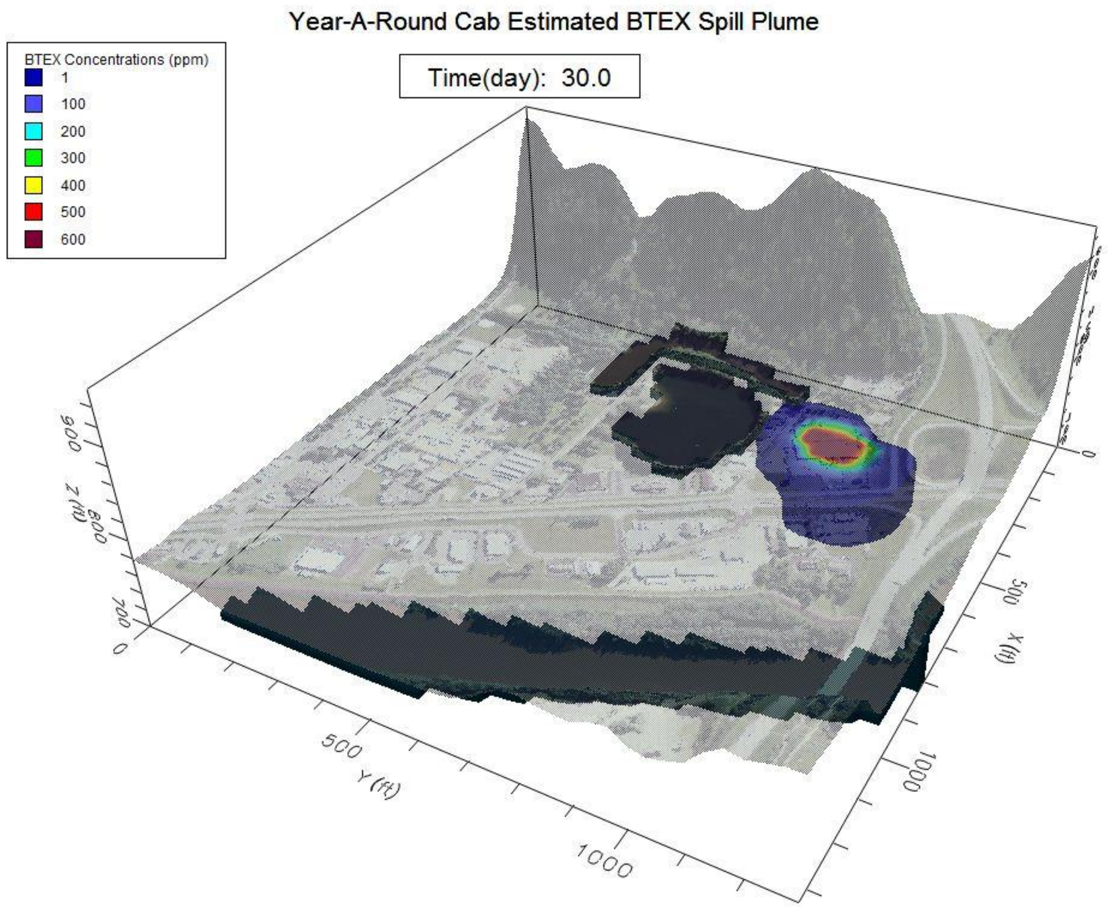

Figure 19. Estimated BTEX plume (toluene as a surrogate) from Year-A-Round Cab Company after 30 days.

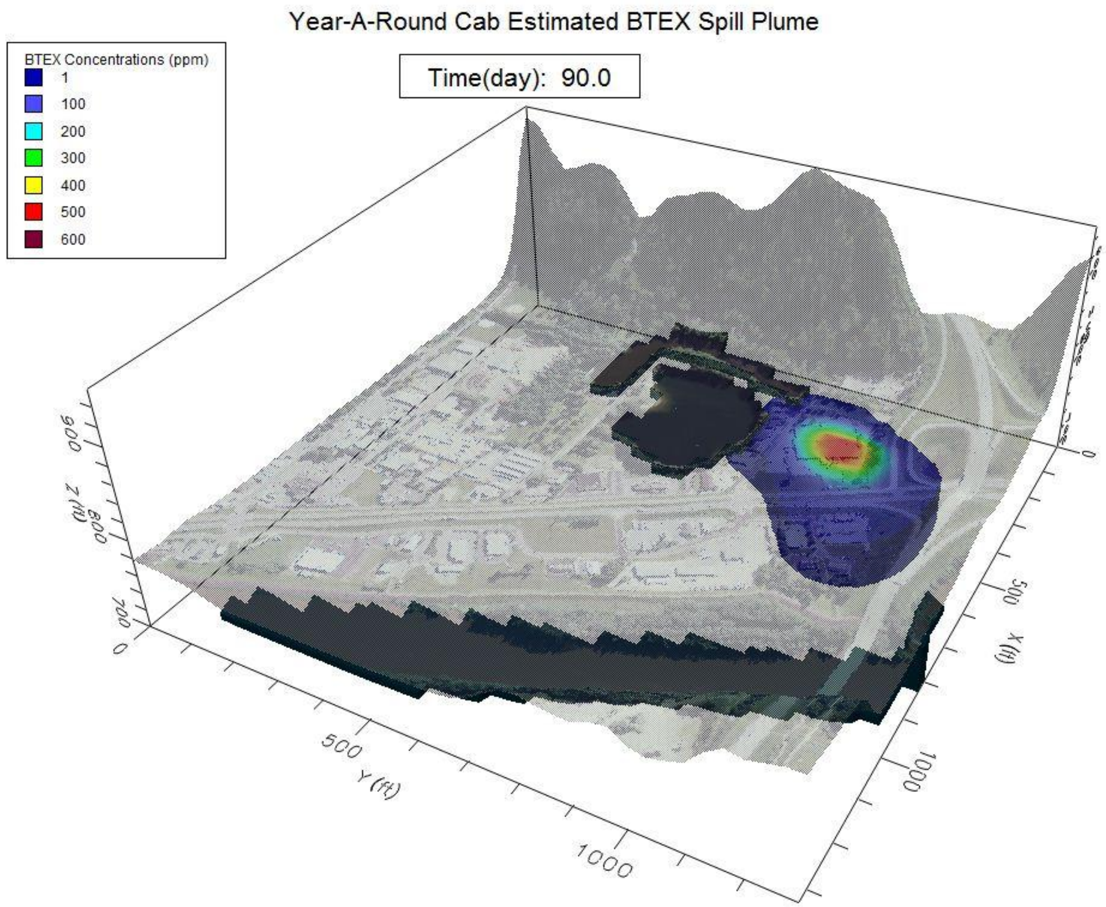

Figure 20. Estimated BTEX plume (toluene as a surrogate) from Year-A-Round Cab Company after 90 days.

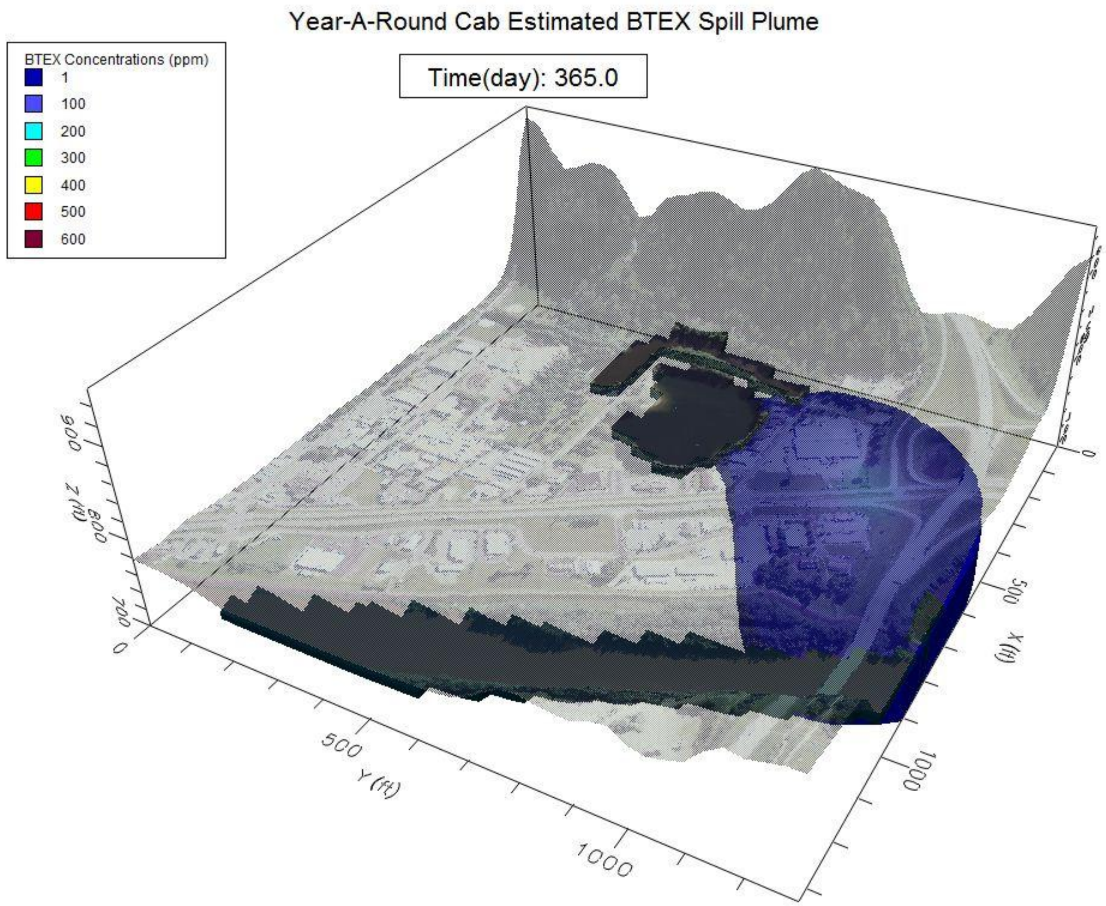

Figure 21. Estimated BTEX plume (toluene as a surrogate) from Year-A-Round Cab Company after 365 days.

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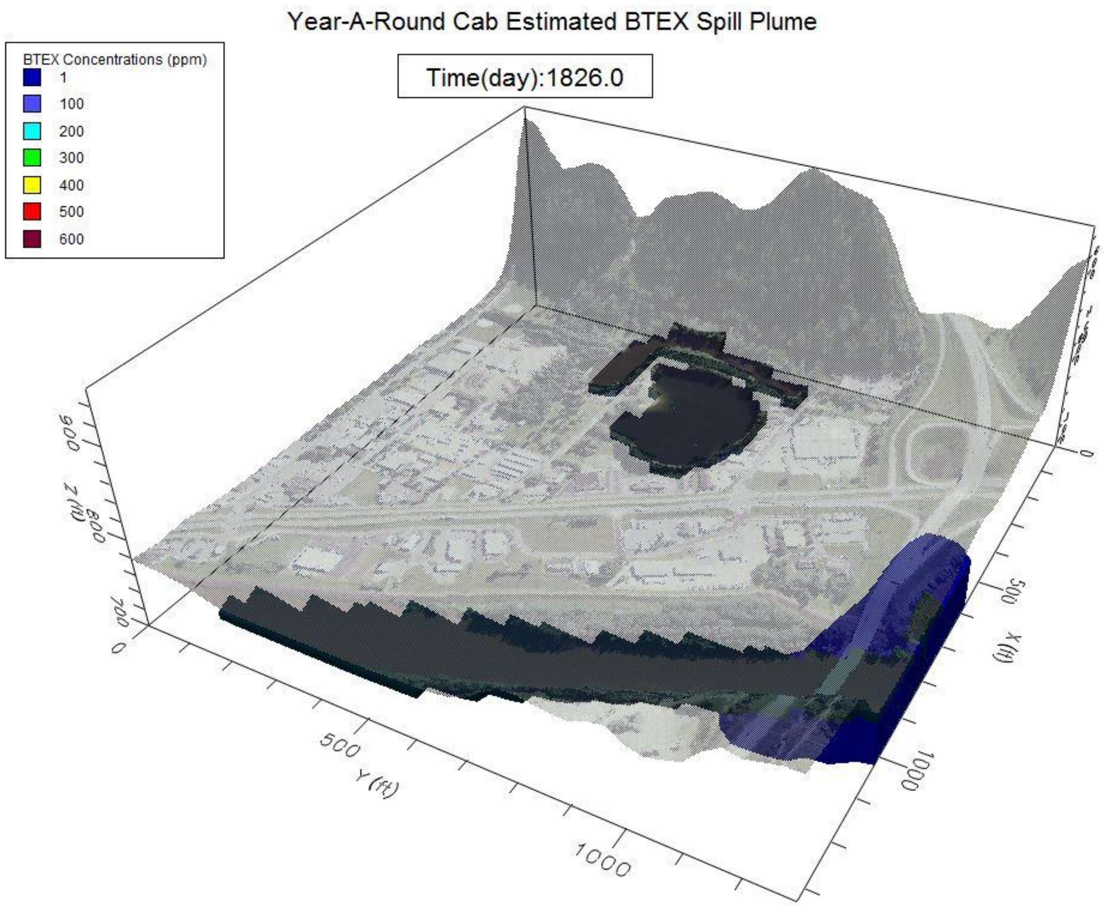

Figure 22. Estimated BTEX plume (toluene as a surrogate) from Year-A-Round Cab Company after 1,826 days.

CHAPTER VI

DISCUSSION

A. BTEX and Heavy Metals

BTEX compounds were not found in any of the sediment or water samples. This could be due to a number of factors. One possible reason is the small number of samples taken due to the project's financial constraints. Only surface samples were tested. However, BTEX compounds in soil were found at the site at depths of 1-1.5 feet in 1985 and at an even greater depth in 2010 (manholes). Given the documented contamination, physical evidence such as discolored soils and heavy sheening observed in 2011 at the US-14 ditch and Oxbow lake, Figure 23 and 24 respectively, it is likely that hydrocarbons are present at the site. Our sampling was limited to public access points in US-14 ditch, Oxbow Lake, and Hiniker and Hallett's Ponds. We did not have permission to go on site. (110 and 112 West Lind Street).

The MODFLOW with the RT3D engine suggests that BTEX contamination is likely to enter Hiniker Pond and Oxbow Lake through ground water. This was consistently demonstrated with the model using the minimum, maximum, and most probable cases of contamination. As of September 24, 2010, there was a significant amount of BTEX on site.

Water samples did not contain Pb, Cd, or Cr. However, the GFLOW potentiometric map indicated, if metals were present in Oxbow Lake, they would be transported into Hiniker Pond. These metals would probably be incorporated in to the sediments. Dissolved oxygen levels in the lower depths of Hiniker Pond were less than 1 mg/L 9 out of 12 times. When DO levels are this low, it is highly probable that Pb, Cd, Cr, and phosphorous nutrients would be mobilized from sediment into the water column. To support this idea, using copper (Cu) as a surrogate for Pb, Cd, and Cr, Cu levels on 7/27/2011 were 1.7 mg/L and DO was near zero. On 10/25/2012, Cu levels were 0.116 mg/L and DO was greater than 2 mg/L. On 10/25/2012 when DO was 2 mg/L Cu levels were ten-fold lower than DO was near zero.

Heavy metals, Cr, Pb, and Cd, were found in sediment samples at varying levels. The US-14 ditch sediment had 30 times higher level of Pb than sediment collected from Hallett's Pond. US-14 ditch had 10 times higher levels of Cd and Cr then Hallett's Pond. These data are shown in Figure 25. Oxbow Lake, which is directly down stream from the US-14 ditch, had 4-5 times higher levels of Pb, Cd, and Cr than Hallett's Pond. Using Pb as a representative of heavy metals, the MODFLOW MT3DMS model indicated that the metals are being transported by surface runoff.

Figure 23. Heavy sheening present in Oxbow Lake on May 19, 2011

Figure 24. Drainpipe confirmed by MPCA to be running from internal drains of former Year-A-Round Cab Company into US-14 Ditch with sheening and discoloration.

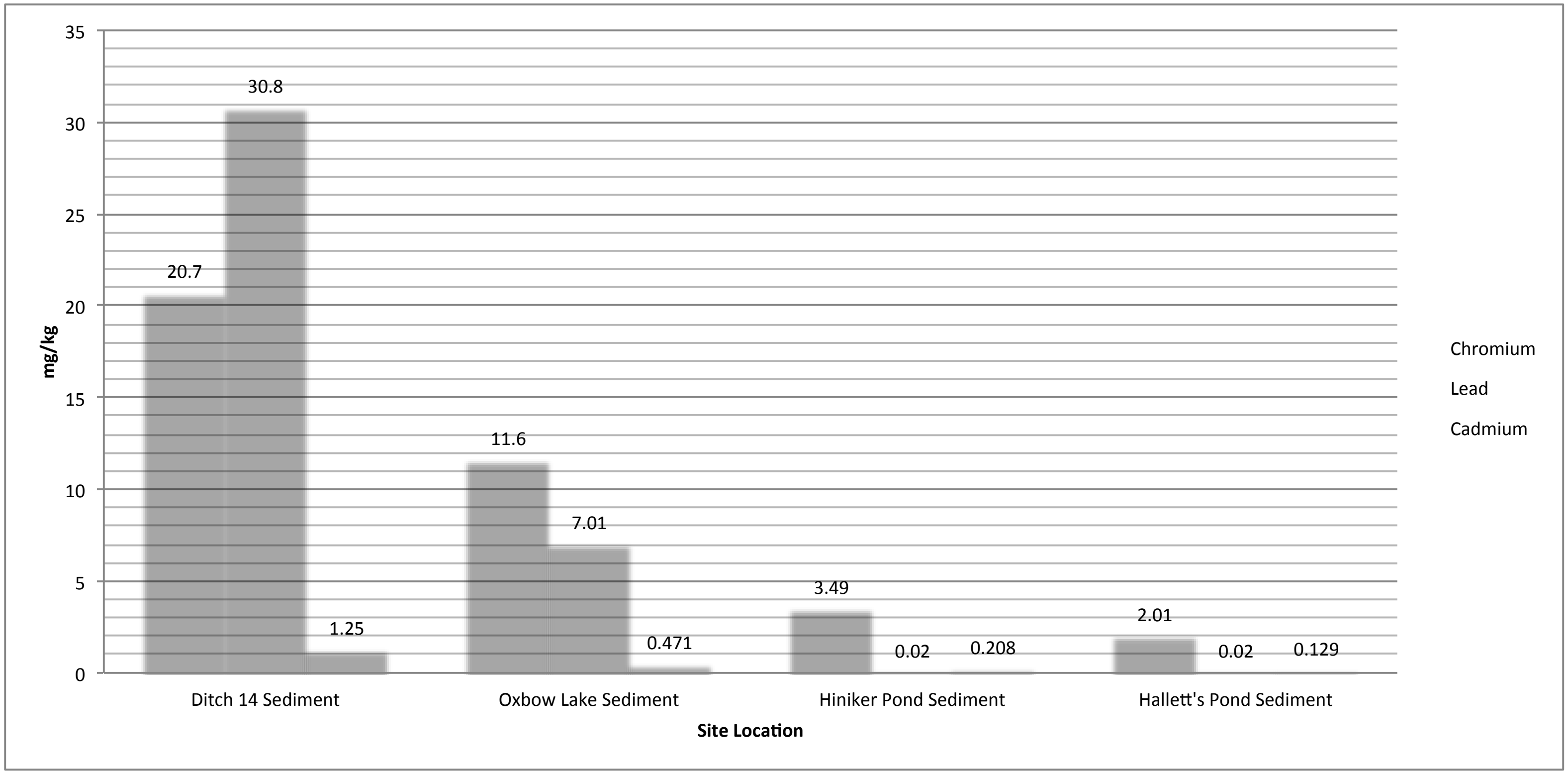

Figure 25. Heavy metals found in sediment at study locations, May 19, 2011

B. Water Quality

1. Total Phosphorus (TP) and Reactive Phosphorus (P-PO4)

Hiniker and Hallett's Pond were both classified as eutrophic on the Carlon's Trophic State Index. Oxbow lake is hyper-eutrophic. It is very shallow, only 4 feet deep and receives storm water run-off a number of pipes. Hiniker Pond is influenced by surface runoff from Oxbow Lake and ground water flow, as shown in Figure 14. Hiniker Pond and Hallett's Pond have very similar levels of TP and P-PO4 (Figures 26 and 27 respectively). Throughout most the season the TP and P-PO4 levels were below 0.20 ppm (12 out of 13 times for Hiniker Pond and 11 out of 13 times for Hallett's Pond). After the 8 inches of precipiation (Figure 28) received during the week of 8/3/2011, TP and P-PO4 levels increased dramatically in both Hiniker and Hallett's Ponds. However, TP and P-PO4 levels in Hiniker Pond were two times greater than the increased levels measured in Hallett's Pond. This may be explained by differences in the watershed. Hiniker Pond is surrounded by a park, residential areas, and urban areas, while Hallett's Pond has an externsive a riparian buffer zone. The correlation between precipitation events and changes in surface phosphorus is fairly strong, showing an R value of 0.91 in a linear regression, presented in Appendix XI.

In early September, in Hallett's Pond TP and P-PO4 levels increased dramatically, even higher than 8 inch storm event. This was not related to a storm event or low DO levels in the bottom of the pond (8 mg/L). There was now corresponding increase in Hiniker Pond. There had to be another source of phosphorus to Hallett's Pond.

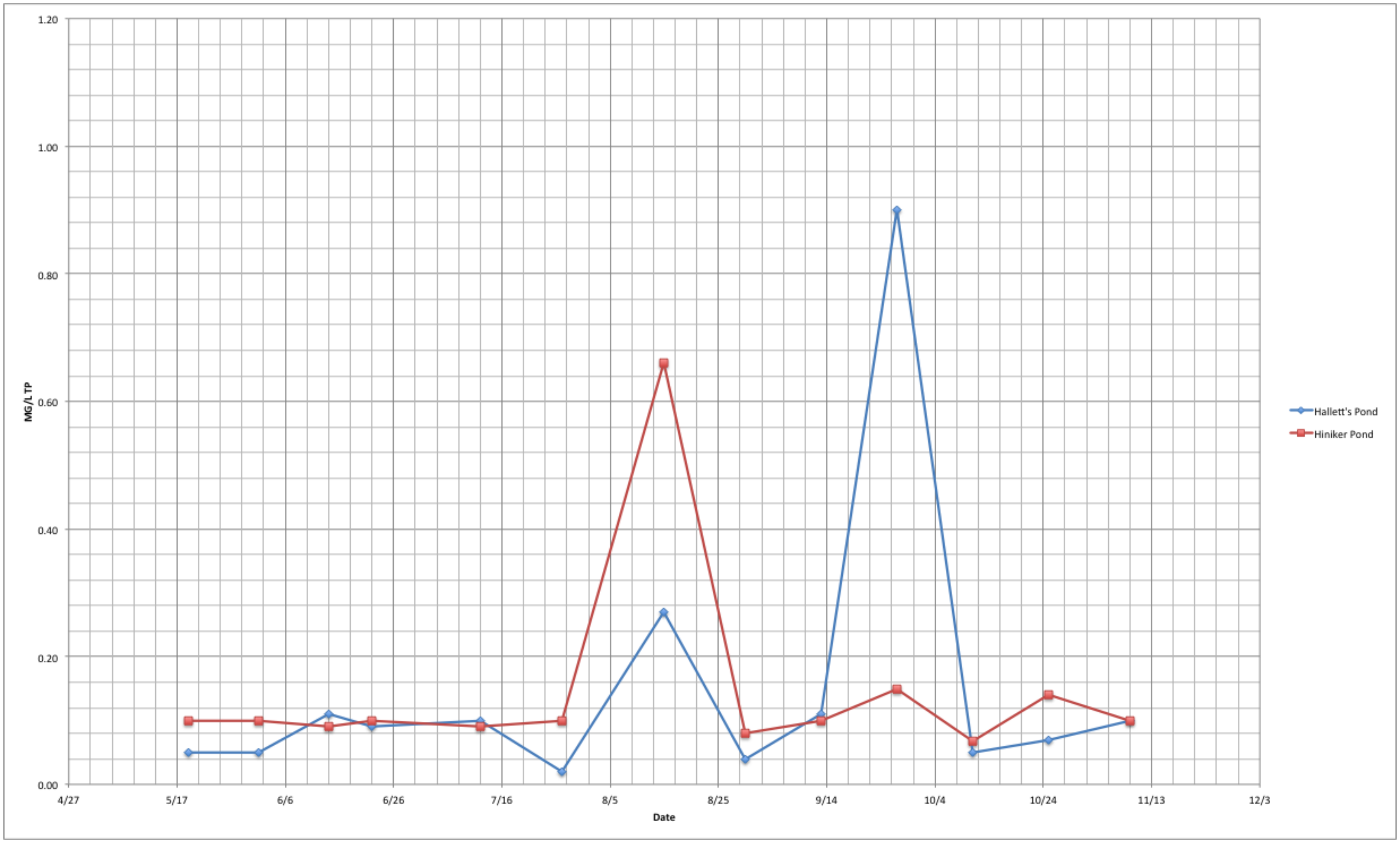

Figure 26. Total phosphorus measured in Hiniker and Hallett's Pond May - November 2011 recorded in mg/L P in surface water sample

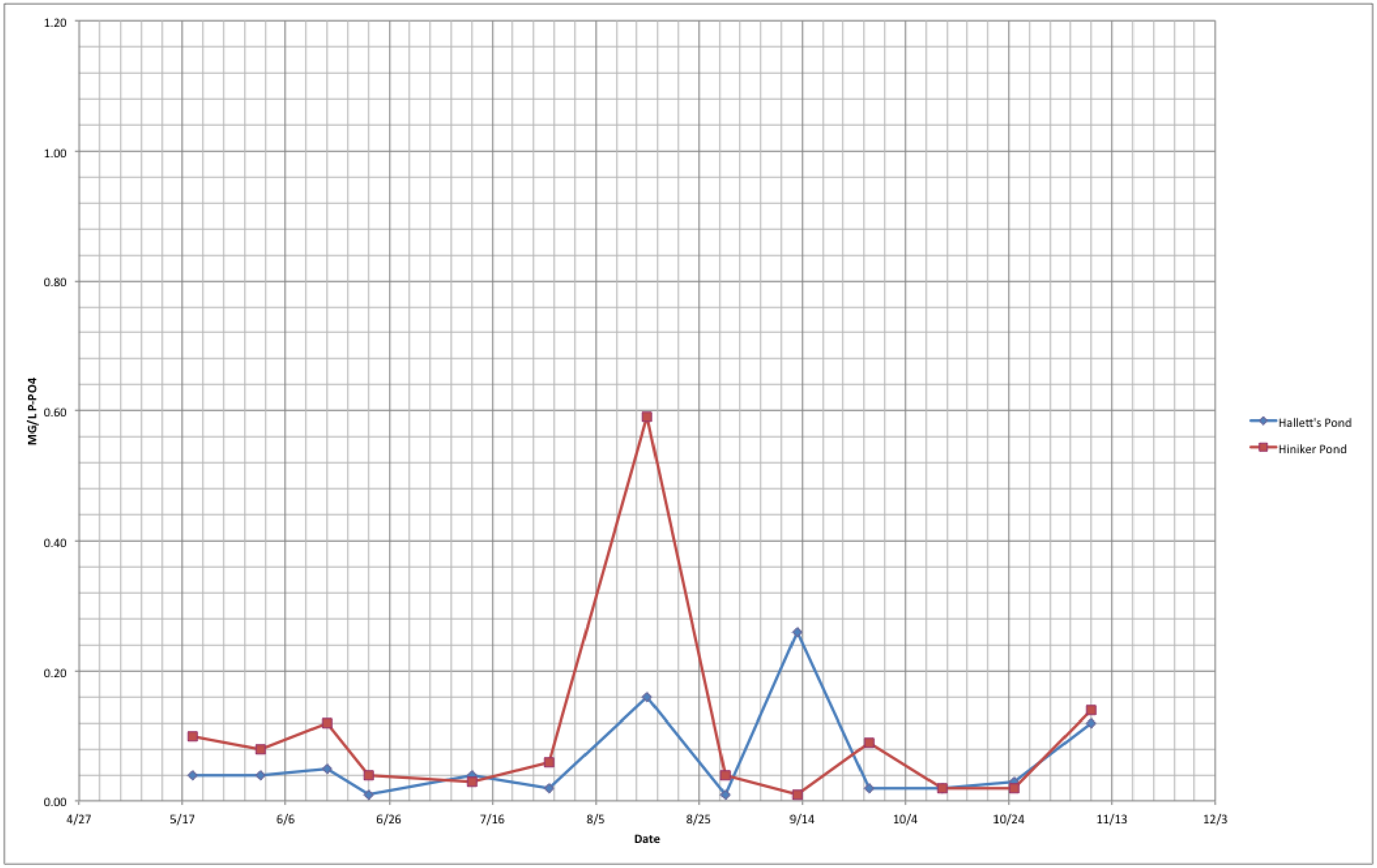

Figure 27. Reactive phosphorus measured in Hiniker and Hallett's Pond May - November 2011 recorded in mg/L P in surface water samples

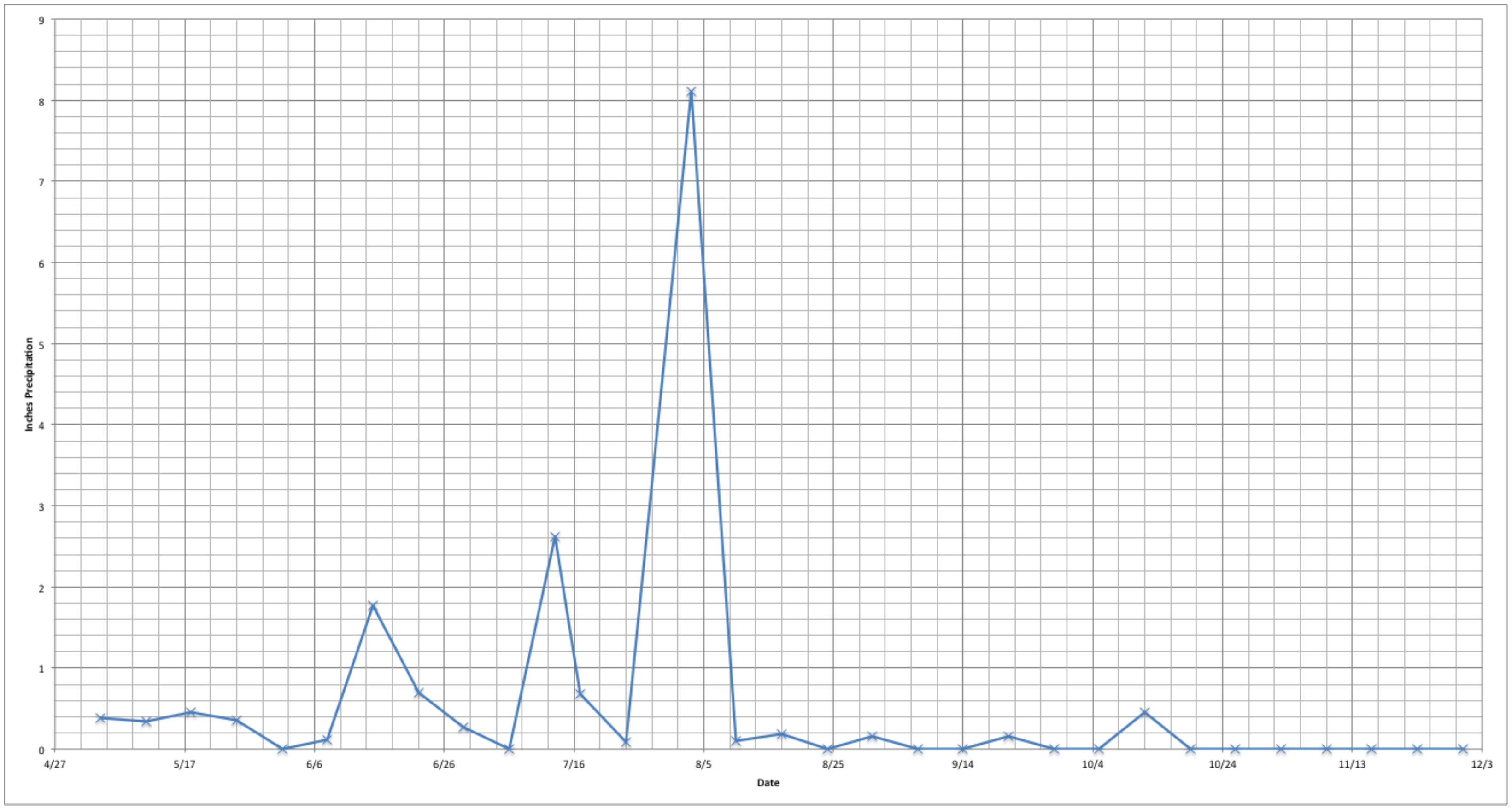

Figure 28. Total weekly precipitation for Mankato and surrounding areas in inches, May -November 2011.

2. Nitrate and Nitrite

Nitrate measured as N-NO3, fluctuated in both ponds over the sampling season (Figure 29). In samples collected before August 15, 2011 Hallett's Pond had as high as four times the amount of nitrate than was in Hiniker Pond. The storm event the week of August 3, 2011 had an effect on Hiniker and Hallett's Ponds. On Hallett's Pond, the nitrate levels were at their lowest levels after the storm. For Hiniker Pond, the nitrate levels were the highest after the storm. The levels of nitrate 10 feet deep mirrored the surface nitrate levels in both ponds (Figure 30).

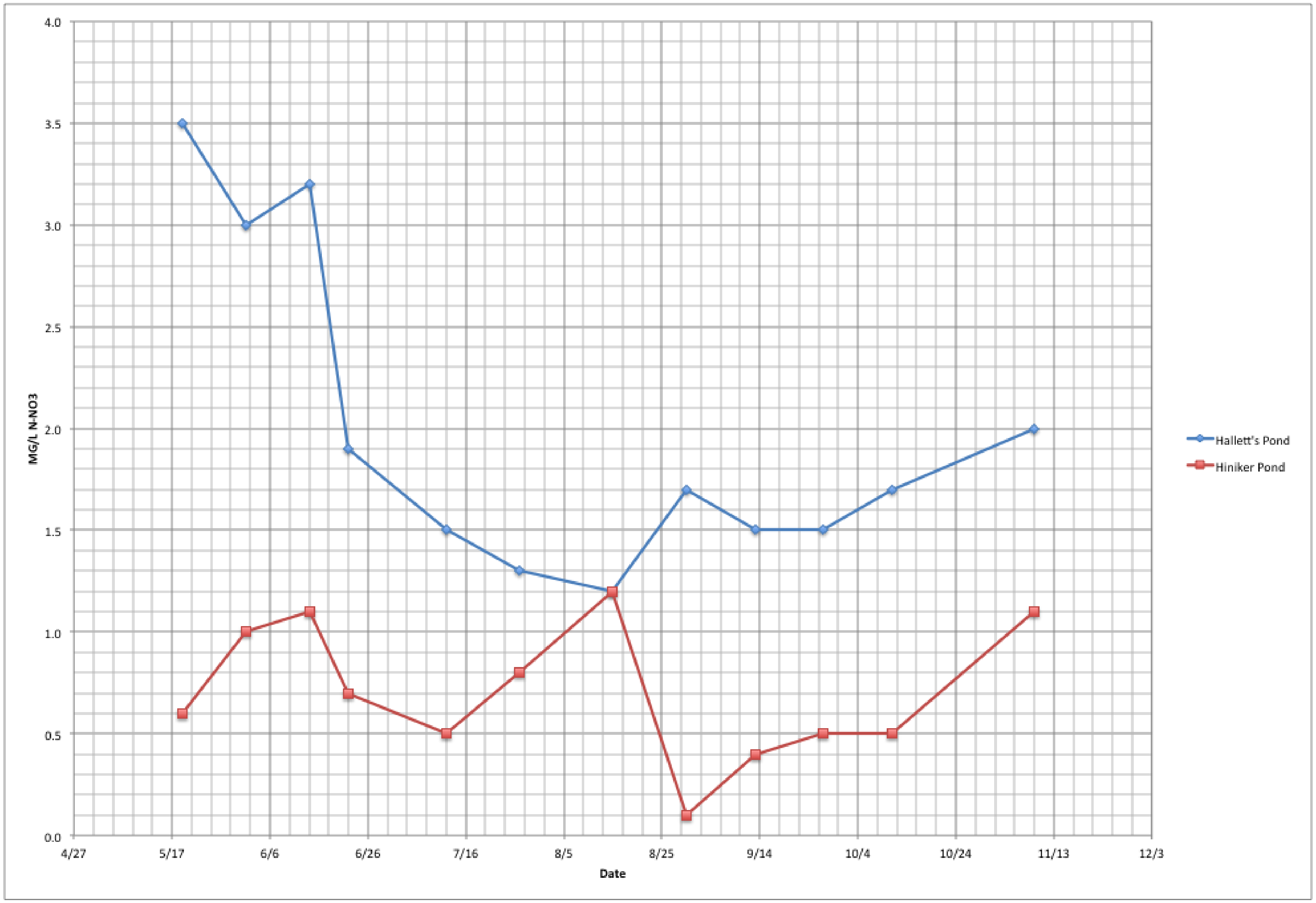

Figure 29. Surface N-NO3 measured in mg/L in surface water samples from Hiniker and Hallett's Ponds May - November 2011.

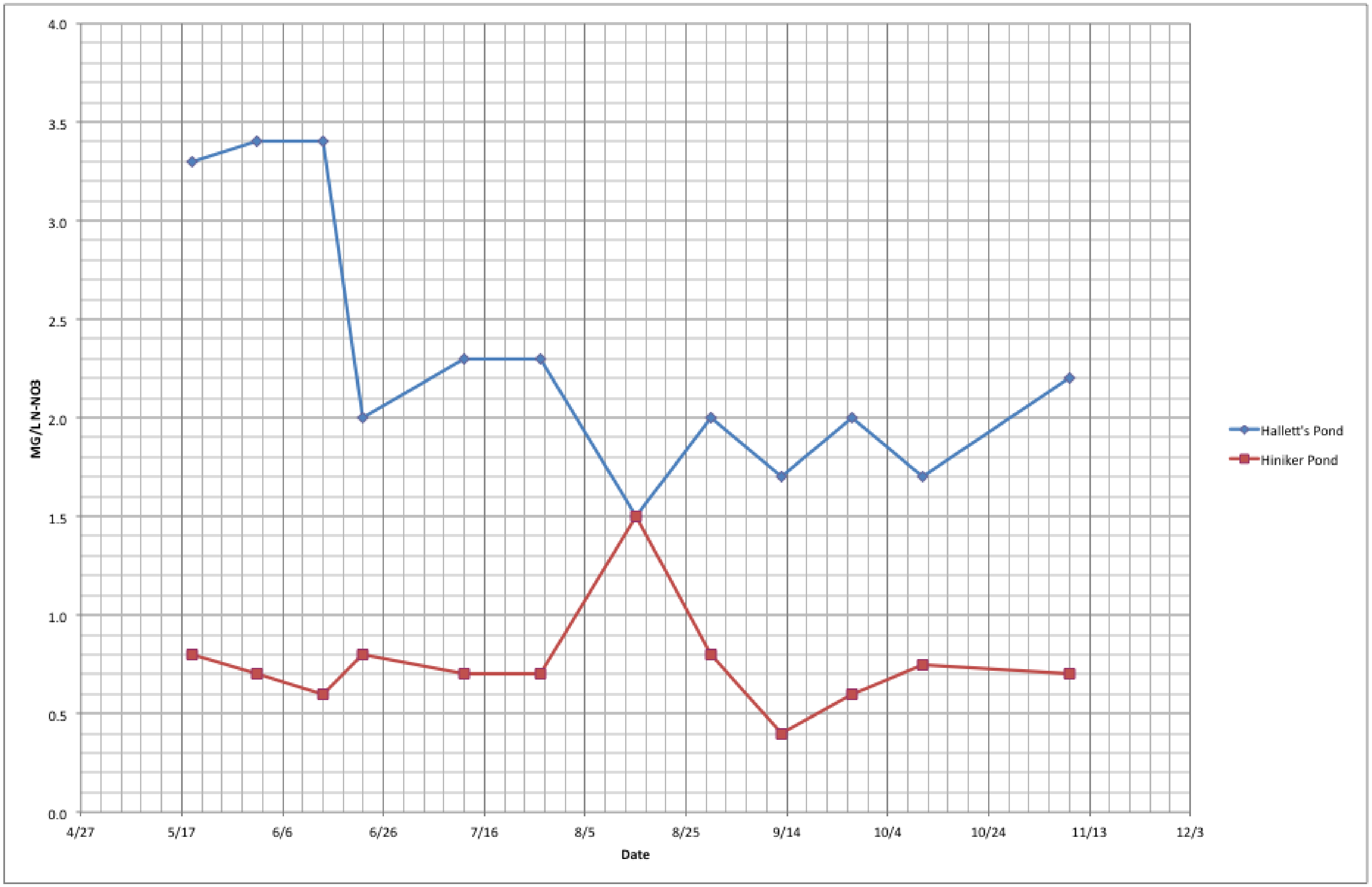

Figure 30. N-NO3 measured at a depth of 10 feet in mg/L in surface water samples from Hiniker and Hallett's Ponds May - November 2011.

3. Sulfates and Conductivity

Sulfate levels were quite different between Hiniker and Hallett's Pond as shown in Figure 31. On average Hiniker Pond maintained a sulfate level of about three times that of Hallett's Pond. Sulfate levels at the surface and 10 foot depths were consistently the same in each pond (Appendix XII).

Conductivity is an indicator of the dissolved ions in water. The conducitvity of Hiniker Pond is higher then the conductivity of Hallett's Pond as shown in Figure 32. This is due to the differences in the sulfate levels described above. The lowest conducitivty in Hallett's Pond was after the storm of event the week of August 3rd, 2011. There was no dilution effect (decrease in conductivity) on Hiniker Pond after the storm event.

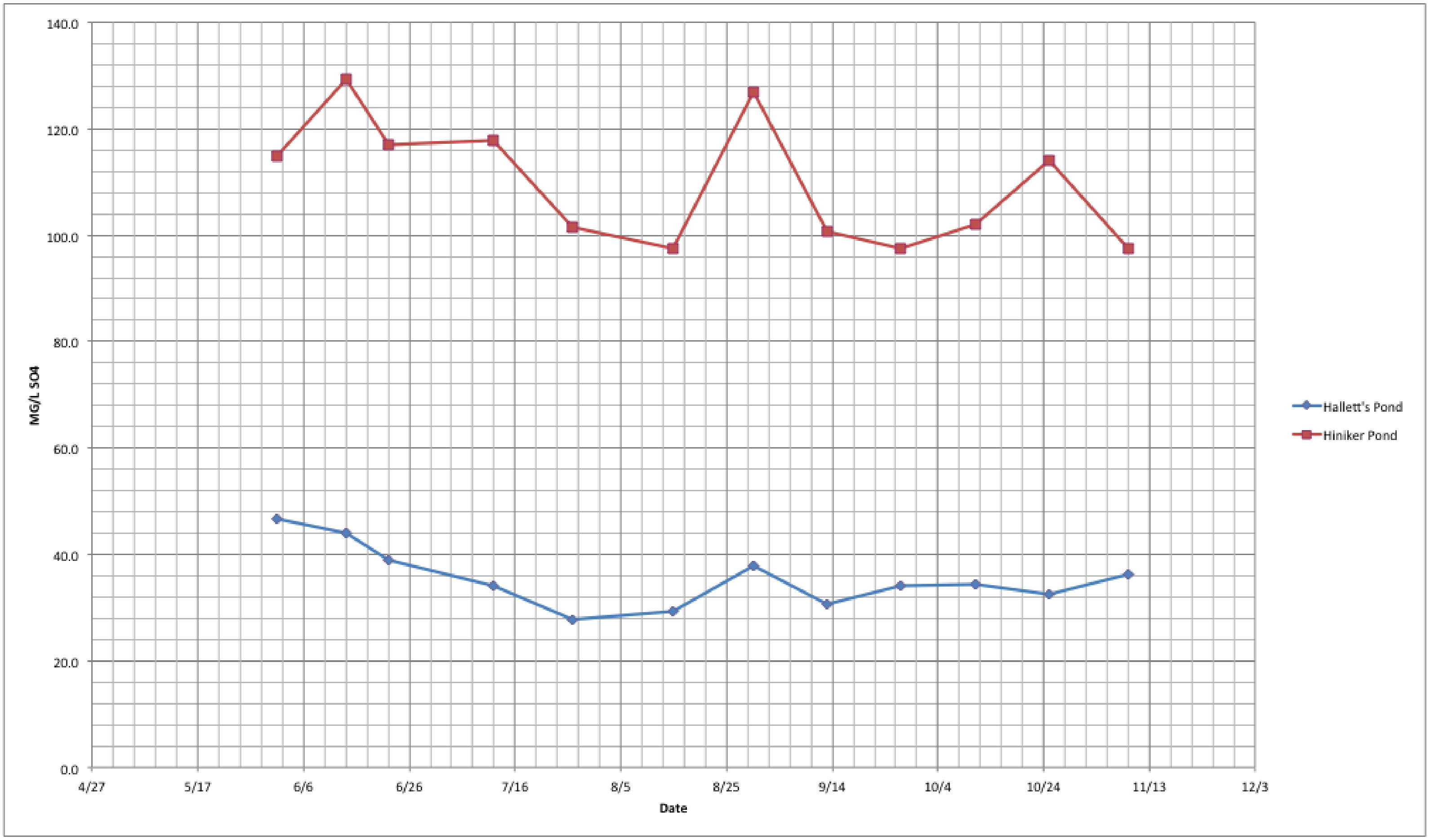

Figure 31. Surface sulfate levels in Hiniker and Hallett’s Pond measured as mg/L SO4 from May - November 2011.

Figure 32. Surface conductivity levels in Hiniker and Hallett's Pond measured as mohm/cm from May - November 2011.

4. Temperature and pH

The temperature of Hiniker and Hallett's Ponds followed a predictable seasonal change and mirrored each other (Figure 33). The warmest temperature was in July and coolest was the end of October.

The pH profiles for Hiniker and Hallett's Ponds are presented in Figure 34. Other then the July 28th measurements, the ponds have very similar pHs. Hiniker Pond and to a lessor extent Hallett's Pond had a significant drop in pH in mid July. These data points are questionable.

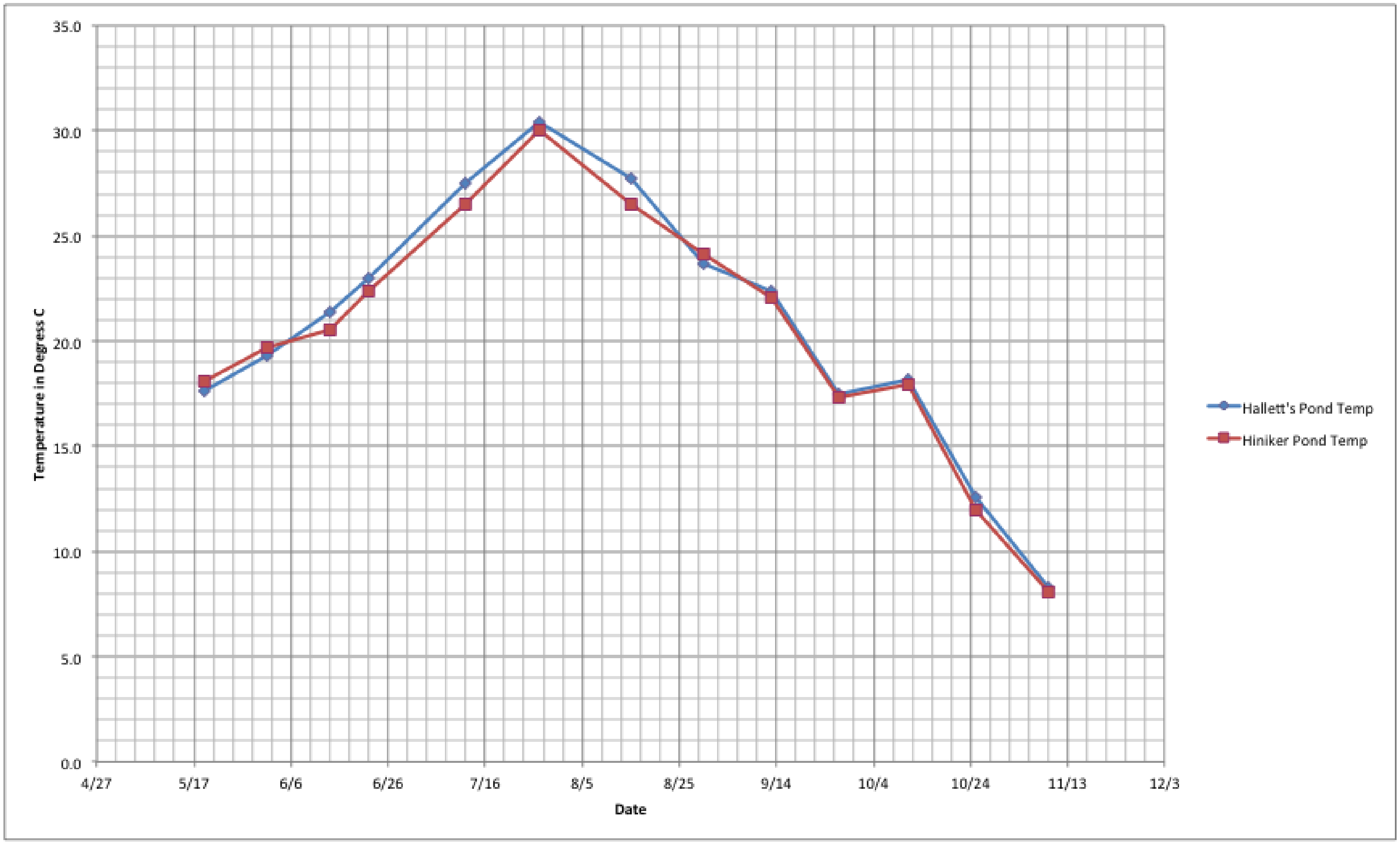

Figure 33. Surface water temperatures in degrees celsius for Hiniker and Hallett's Ponds May - November 2011.

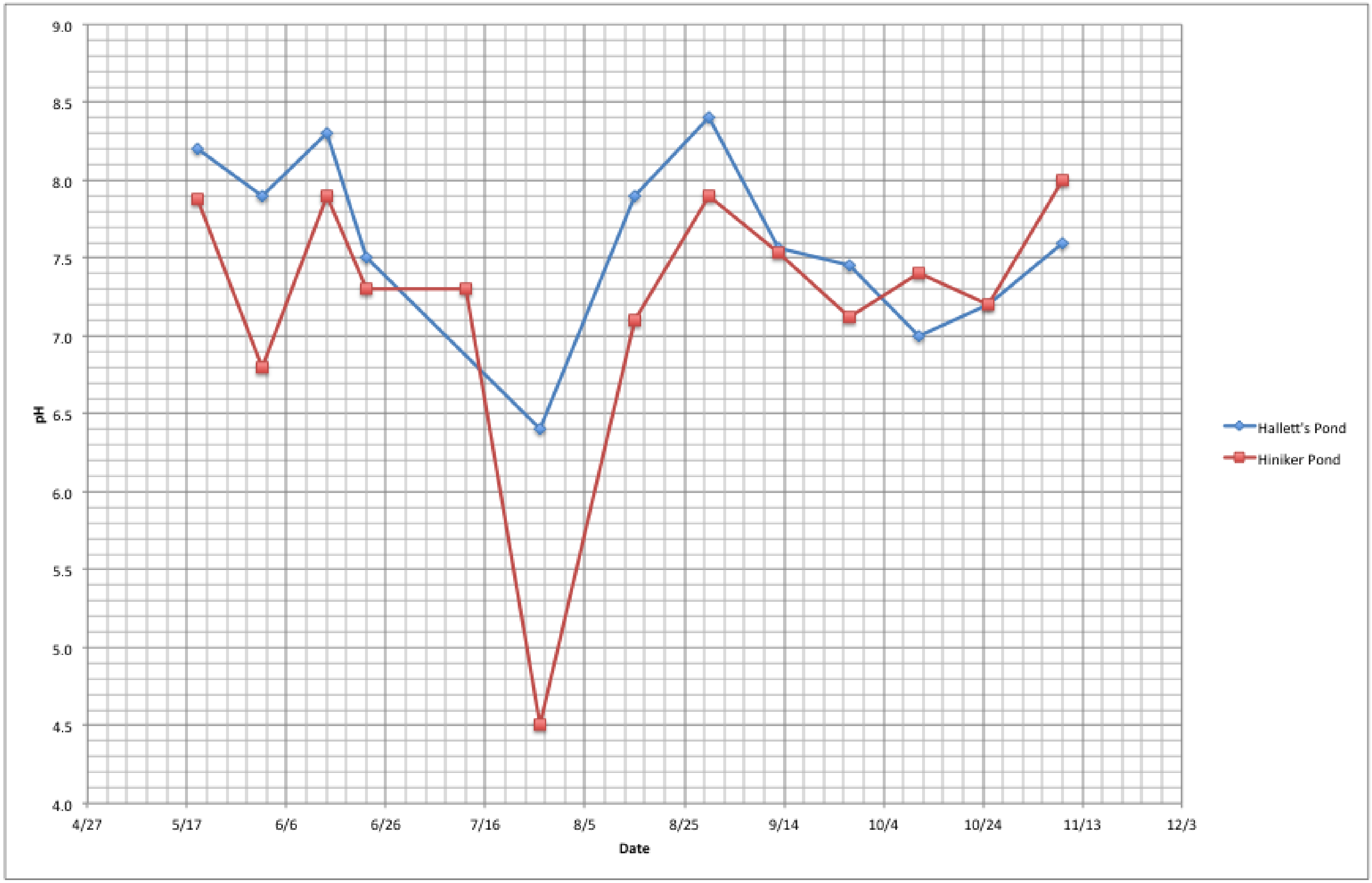

Figure 34. Surface water pH of Hiniker and Hallett's Pond May – November 2011.

5. Dissolved Oxygen

The Dissolved Oxygen (DO) profiles for Hiniker and Hallett's Ponds are presented in Figures 35 and 36 respectively. In Hiniker Pond the surface and 5 foot levels mostly remained above 8 mg/L. However, in the deepest water, the DO was close to zero 9 out of 12 times. For Hiniker Pond the low DO levels in the water just above the sediment allows mass transport of heavy metals and phosphorus into the water.

For Hallett's Pond DO levels in the surface and 5 foot levels also remained above 8 mg/L and was even supersaturated in August. Supersaturation was probably due to algae photosysnthesis. In the deepest water, the DO level was less than 2 mg/L 1 out of 13 times. There was a dramatic increase in DO levels in the deepest waters July 14th. This data point is suspect.

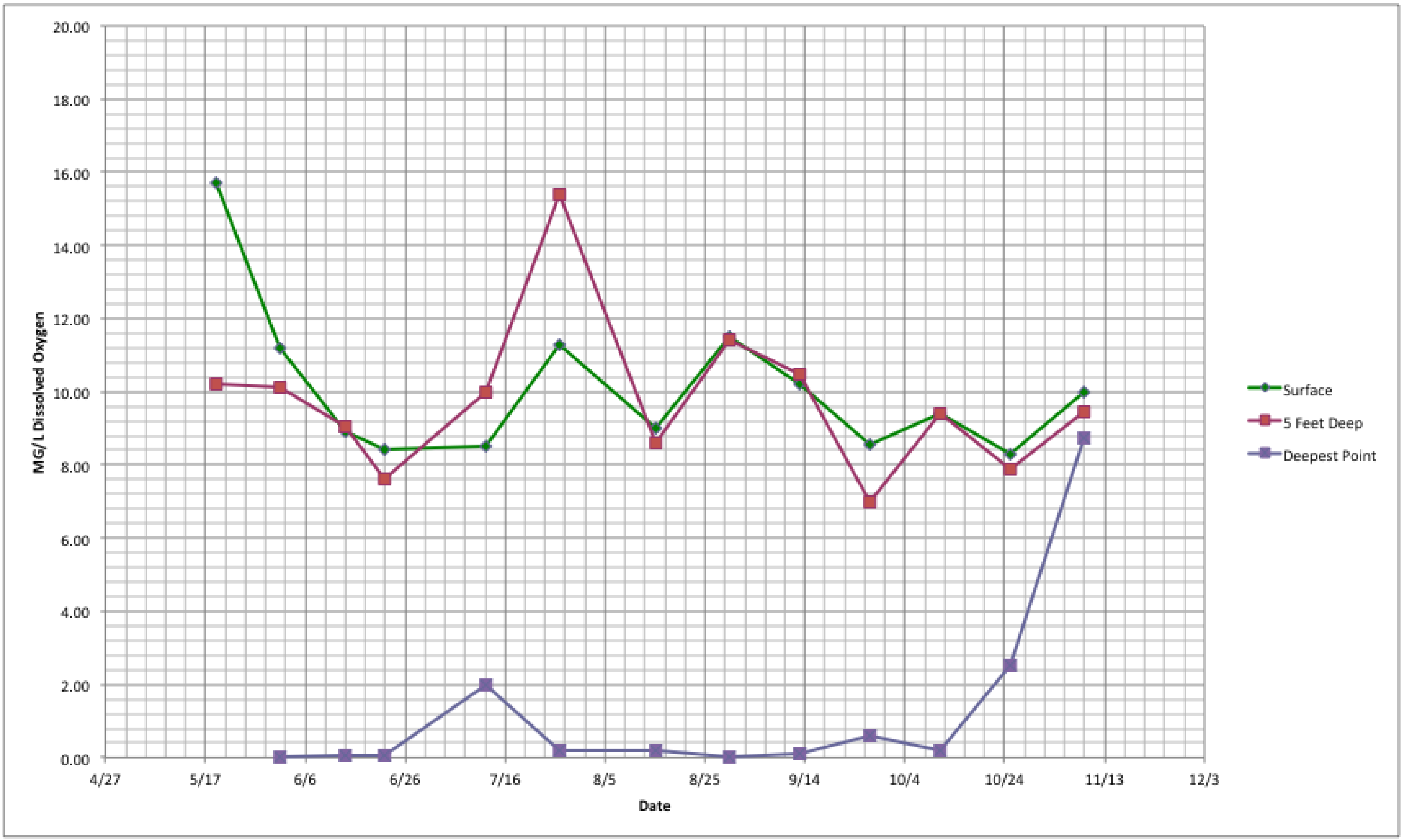

Figure 35. Dissolved oxygen levels in Hiniker Pond measured in mg/L at 5 foot interval May- November 2011

Figure 36. Dissolved oxygen levels in Hallett's Pond measured in mg/L at 5 foot interval May- November 2011

6. E. Coli

E. Coli levels for Hiniker and Hallett's Ponds are presented in Figure 37. E. Coli levels exceeded health standards once after the week of August 3^{rd} storm event. Hiniker Pond had 5 times the levels of E. Coli as that of Hallett's Pond.

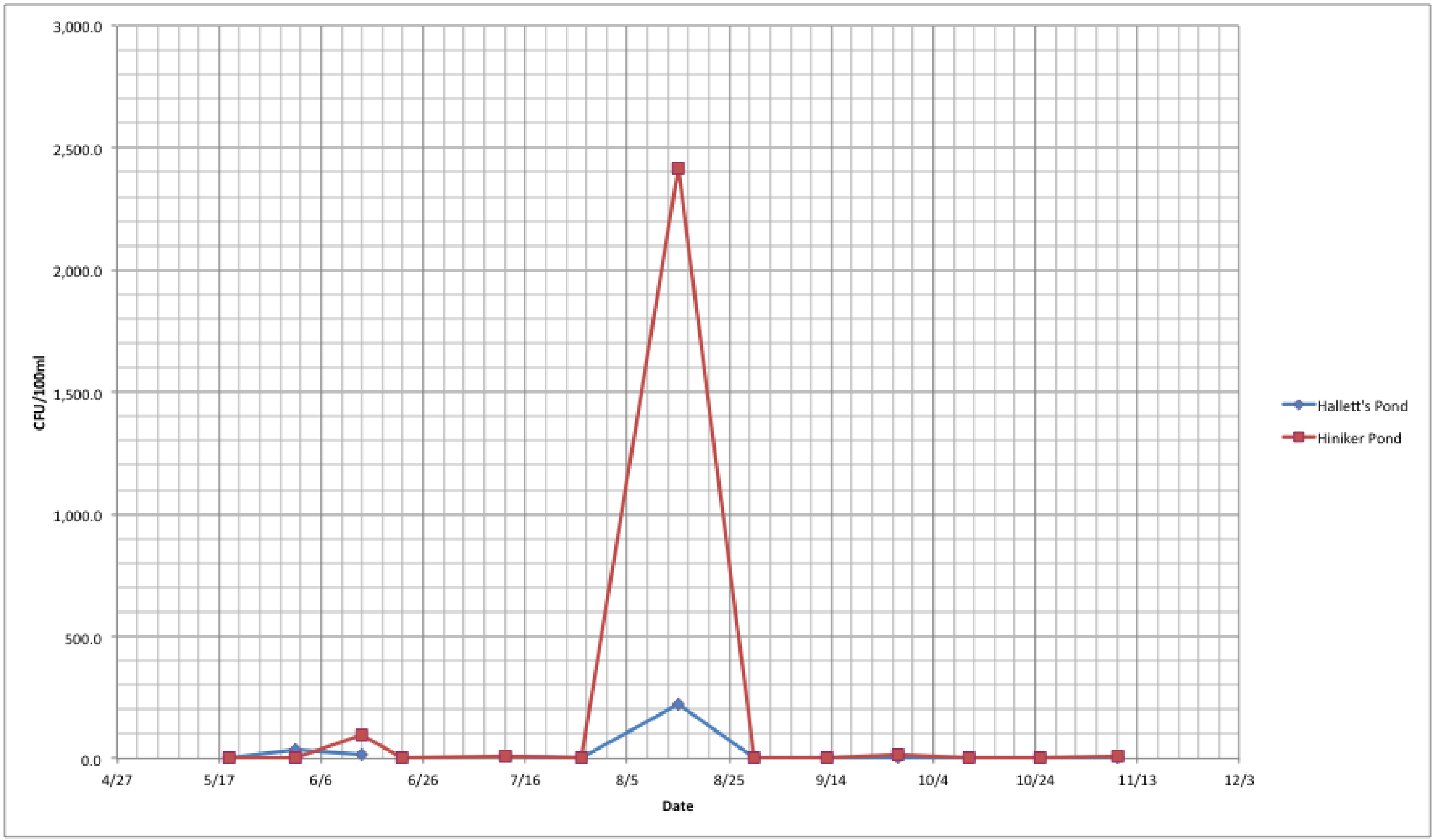

Figure 37. E. Coli Levels in Hiniker and Hallett's Ponds in CFU/100ml samples May-November, 2011

C. Conclusions

(1) The results of sediment testing and ground water modeling strongly suggest that the former Year-A-Round Cab Company site was a source of heavy metals to the US-14 ditch, Oxbow Lake, and potentially Hiniker Pond. Based on models, the heavy metals would reach Hiniker Pond primarily through surface water run off. These heavy metals would probably wind up in the sediments. Low DO levels in the deepest water could result in the release of heavy metals back into the water column.

(2) Based on models, if BTEX compounds are being released from the former Year-A-Round Cab Company site, they will reach Hiniker Pond through ground water.

(3) Hallett's Pond is a good reference site for Hiniker Pond excluding sulfates, N-NO3 and DO (deepest water).

D. Recommendations

1. Heavy Metals

Continued and more extensive sampling for heavy metals in the sediment of Hiniker Pond, Oxbow Lake, and US-14 ditch would paint a better picture of probable metal contamination in the area. Funding will need to be found to complete this. Gaining access to the West Lind street site would allow the opportunity to test the soil and compare those results to those in Appendix I. This would also show more evidence as to the source of the metals. More extensive testing of the water at the sediment water interface would be very important to determining if metals are released into the water column under low (less than 2 mg/L) DO conditions. Storm water monitoring would also be important to determining the path of the metals if contamination is spreading by the flow in the ditches. A testing season that has a higher number of storm events would be beneficial.

2. BTEX

BTEX samples should be taken at levels deeper than 1.5 feet in areas where the models indicuated BTEX would probably exist. Gaining access to the site and sampling sediment and groundwater near the manholes in the flow path, at known distances in the estimated plume, and in the direction towards Hiniker Pond and Oxbow Lake would be beneficial to determining contamination if it is present. Ground water sampling wells should be installed based on BTEX MODFLOW models for long term monitoring of the site and adjacent areas.

3. Modeling

More extensive modeling with MODFLOW should be completed. Through the use of column studies, more accurate adsoption, dispersion, and degradation values will be achieved for each metal and BTEX compound being tested for. More soil, sediment, and aquifer material testing will also yield more accurate modeling parameters.

4. Nutrient Testing

Hallett's Pond should be continued to be used as a reference site for Hiniker Pond and Hiniker Pond should be continued to be tested for nutrients due to a lack of long term data available.

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APPENDIX I

1985 SOIL TESTING RESULTS FOR HEAVY METALS AND VOLATILE ORGANIC COMPOUNDS 110 WEST LIND STREET, MANKATO, MN.

YEAR-A-ROUND CAB COMPANY

YEAR-A-ROUND CORPORATION
(MND006457642)
Mankato, Minnesota

Condensed Results - Soil Sampling
July 25, 1985

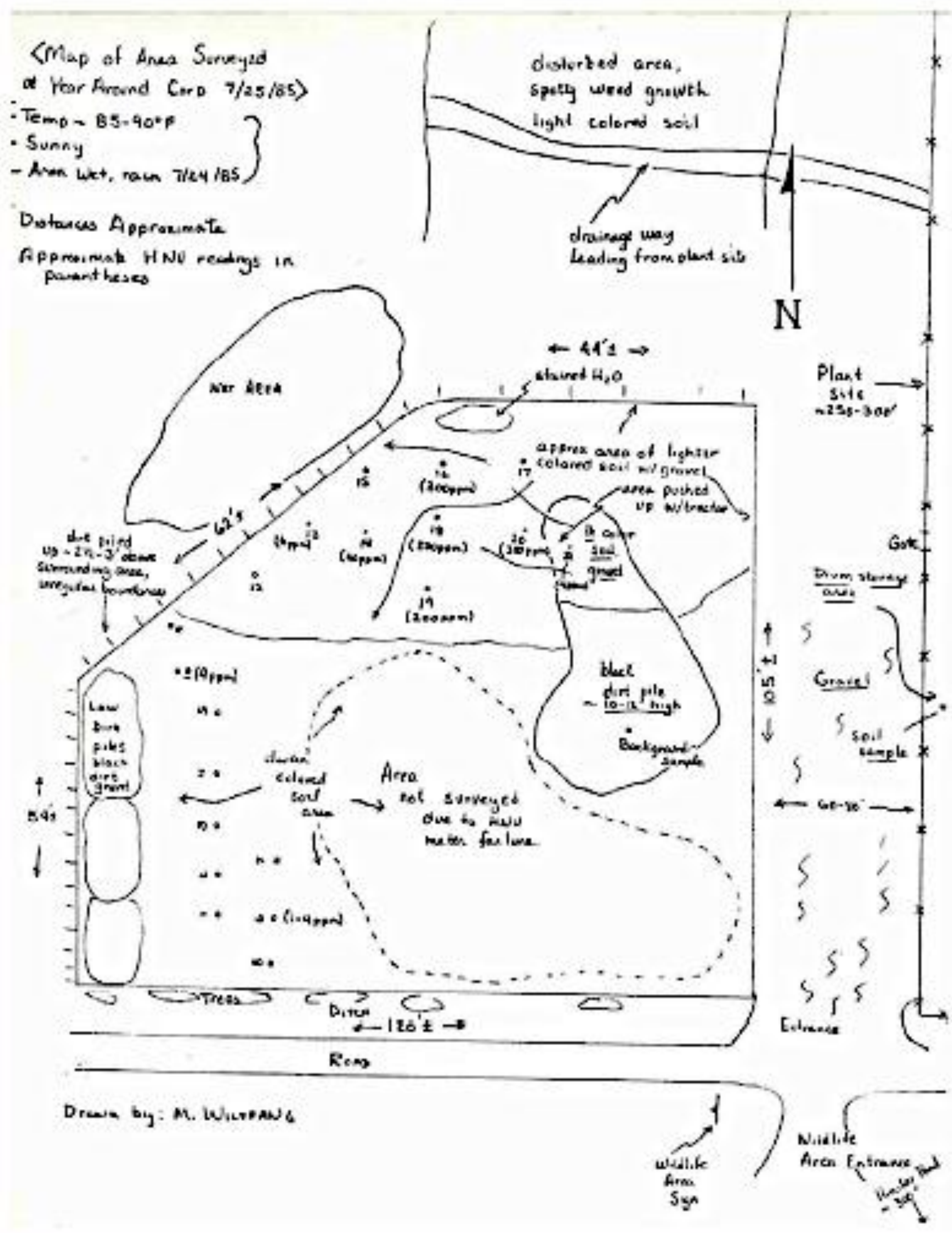
Prepared by Bill Thompson MPCA

Laboratory Sample No.	Sampling Location, Point	Acetone	Toluene	M-Xylene	O-Xylene P-Xylene	MIK*	Ethyl Benzene	Methylene Chloride
		Volatile Hydrocarbons (ug/gm)						
126284	Unfenced area - hole 16	--	2.4	11.	20.	3.8	1.0	--
126285	Unfenced area - hole 20	17.	3.3	1.7	1.8	--	--	--
126286	Unfenced area - hole 18	--	200.	170.	200.	--	55.	11.
126287	Unfenced area - hole 19	--	120.	120.	130.	1.8	36.	2.7
126288	Black Dirt Pile	--	0.7	1.5	1.1	--	--	--
126289	Old Drum Storage Area	--	1.9	--	--	--	--	--

*MIK = Methyl Isobutyl Ketone

Method: Soil samples were taken with a bucket auger at depth of 1 - 1½ feet. Samples were placed in 40 ml glass vials with teflon lids and immediately placed on ice. The bucker auger was washed with soap and water after each boring, followed by rinsing with deionized water and ~~benzene~~.

These data are condensed from the Minnesota Department of Health laboratory report sheets. Please refer to these sheets for complete analytical results.



<Map of Area Surveyed
at Year Around Corp 7/25/85>
- Temp ~ 85-90°F
- Sunny
- Area Wet, rain 7/24/85
Distances Approximate
Approximate HNU readings in parentheses
disturbed area, spotty weed growth light colored soil
drainage way leading from plant site
N
Plant site ~250-300'
stained H₂O
approx area of lighter colored soil w/ gravel
area pushed up w/tractor
Gate
Drum storage area
Gravel
Soil sample
black dirt pile ~10-12' high
Background sample
darker colored soil area
Area not surveyed due to HNU meter failure
dirt piled up ~2-3' above surrounding area, irregular boundaries
Low dirt piles black dirt gravel
Trees
Ditch
Road
Entrance
Drawn by: M. WILTFANG
Wildlife Area Sign
Wildlife Area Entrance

MINNESOTA DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY

VOLATILE HYDROCARBONS IN SOLIDS/LIQUIDS

SAMPLE NUMBER: 116234
LAB BLANK #: 116270

MPCA-26 S...

DATE SAMPLED: 07/25/85
DATE ANALYZED: 08/0?/85
DATE PRINTED: 08/1?/85

NON-HALOGENATED (CODE 463)

ACETONE	*<	20.	UG/GM	TETRAHYDROFURAN	<	10.	UG/GM
ETHYL ETHER	<	2.?	UG/GM	METHYL ETHYL KETONE	<	10.	UG/GM
BENZENE	<	1.0	UG/GM	METHYL ISOBUTYL KETONE		3.9	UG/GM
TOLUENE		3.4	UG/GM	* ETHYL BENZENE		1.0	UG/GM
CUMENE	<	1.?	UG/GM	O-XYLENE + P-XYLENE		20.	UG/GM
M-XYLENE		11.	UG/GM				

HALOGENATED (CODE 464)

CHLOROMETHANE	ND			* DICHLORODIFLUOROMETHANE	ND		
VINYL CHLORIDE	ND			* BROMOMETHANE	ND		
CHLOROETHANE	ND			DICHLOROFLUOROMETHANE	ND		
METHYLENE CHLORIDE	<	2.0	UG/GM	* TRICHLOROFLUOROMETHANE	<	0.40	UG/GM
ALLYL CHLORIDE	<	1.0	UG/GM	* 1,1-DICHLOROETHYLENE	<	0.40	UG/GM
1,1-DICHLOROETHANE	<	0.40	UG/GM	* TRANS-1,2-DICHLOROETHYLENE	<	0.40	UG/GM
CIS-1,2-DICHLOROETHYLENE	<	0.40	UG/GM	* CHLOROFORM	<	0.40	UG/GM
1,2-DICHLOROETHANE	<	0.40	UG/GM	DIBROMOMETHANE	<	2.0	UG/GM
1,1,1-TRICHLOROETHANE		0.50	UG/GM	* CARBON TETRACHLORIDE	<	0.40	UG/GM
BROMODICHLOROMETHANE	<	1.0	UG/GM	DICHLOROACETONITRILE	ND		
2,3-DICHLORO-1-PROPENE	<	0.40	UG/GM	* 1,2-DICHLOROPROPANE	<	0.40	UG/GM
1,1-DICHLORO-1-PROPENE	<	0.40	UG/GM	* TRANS-1,3-DICHLORO-1-PROPENE	<	0.40	UG/GM
1,1,2-TRICHLOROETHYLENE	<	0.40	UG/GM	1,3-DICHLOROPROPANE	ND		
CHLORODIBROMOMETHANE	<	2.0	UG/GM	* 1,1,2-TRICHLOROETHANE	<	0.40	UG/GM
CIS-1,3-DICHLORO-1-PROPENE	<	0.40	UG/GM	1,2-DIBROMOETHANE	<	1.0	UG/GM
2-CHLOROETHYLVINYL ETHER	ND			* BROMOFORM	<	2.0	UG/GM
1,1,1,2-TETRACHLOROETHANE	<	0.40	UG/GM	1,2,3-TRICHLOROPROPANE	ND		
1,1,2,2-TETRACHLOROETHANE	<	4.0	UG/GM	* 1,1,2,2-TETRACHLOROETHYLENE	<	4.0	UG/GM
PENTACHLOROETHANE	<	4.0	UG/GM	* CHLOROBENZENE	<	1.0	UG/GM
1,1,2-TRICHLOROTRIFLUOROETHANE	<	1.0	UG/GM	* 1,3-DICHLOROBENZENE	<	2.0	UG/GM
1,2-DICHLOROBENZENE	<	2.0	UG/GM	* 1,4-DICHLOROBENZENE	<	2.0	UG/GM

++ "QUALITATIVE ANALYSIS ONLY"
* "PRIORITY POLLUTANT"
< "LESS THAN"
*< "PEAK DETECTED BELOW 'LESS THAN' VALUE"

MINNESOTA DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY

VOLATILE HYDROCARBONS IN SOLIDS/LIQUIDS

SAMPLE NUMBER: [illegible]
FIELD NUMBER: [illegible]

TPCA-2e 3544

DATE SAMPLED: 07/23/85
DATE ANALYZED: 08/05/85
DATE PRINTED: 05/1?/8?

RECEIVED
SEP 06 1985
MPCA, SOLID & HAZ. WASTE DIVISION

NON-HALOGENATED (CODE 462)

ACETONE		12.	UG/GM	TETRAHYDROFURAN	<	5.0	UG/GM
ETHYL ETHER	<	1.5	UG/GM	METHYL ETHYL KETONE	<	5.0	UG/GM
BENZENE	<	0.30	UG/GM	METHYL ISOBUTYL KETONE	<	1.5	UG/GM
TOLUENE		3.7	UG/GM	* ETHYL BENZENE	<	0.50	UG/GM
CUMENE	<	0.50	UG/GM	O-XYLENE + P-XYLENE		1.7	UG/GM
[illegible]		1.7	UG/GM				

HALOGENATED (CODE 464)

CHLOROMETHANE	ND			* DICHLORODIFLUOROMETHANE	ND		
VINYL CHLORIDE	ND			* BROMOMETHANE	ND		
CHLOROETHANE	ND			DICHLOROFLUOROMETHANE	ND		
METHYLENE CHLORIDE	<	1.5	UG/GM	* TRICHLOROFLUOROMETHANE	<	0.50	UG/GM
ALLYL CHLORIDE	<	0.25	UG/GM	* 1,1-DICHLOROETHYLENE	<	0.30	UG/GM
1,1-DICHLOROETHANE	<	[illegible]	UG/GM	* TRANS-1,2-DICHLOROETHYLENE	<	0.33	UG/GM
CIS-1,2-DICHLOROETHYLENE	<	[illegible]	UG/GM	* CHLOROFORM	<	0.30	UG/GM
1,2-DICHLOROETHANE	<	0.30	UG/GM	DIBROMOMETHANE	<	1.5	UG/GM
1,1,1-TRICHLOROETHANE	<	0.15	UG/GM	* CARBON TETRACHLORIDE	<	[illegible]	UG/GM
BROMODICHLOROMETHANE	<	[illegible]	UG/GM	DICHLOROACETONITRILE	NG		
2,3-DICHLORO-1-PROPENE	<	0.15	UG/GM	* 1,2-DICHLOROPROPANE	<	0.50	UG/GM
1,1-DICHLORO-1-PROPENE	<	[illegible]	UG/GM	* TRANS-1,3-DICHLORO-1-PROPENE	<	0.30	UG/GM
1,1,2-TRICHLOROETHYLENE	<	[illegible]	UG/GM	1,3-DICHLOROPROPANE	ND		
CHLORODIBROMOMETHANE	<	1.[illegible]	UG/GM	* 1,1,2-TRICHLOROETHANE	<	0.50	UG/GM
CIS-1,3-DICHLORO-1-PROPENE	<	0.50	UG/GM	1,2-DIBROMOETHANE	<	0.30	UG/GM
2-CHLOROETHYLVINYL ETHER	NG			* BROMOFORM	<	1.5	UG/GM
1,1,1,2-TETRACHLOROETHANE	<	0.50	UG/GM	1,2,3-TRICHLOROPROPANE	ND		
1,1,2,2-TETRACHLOROETHANE	<	[illegible]	UG/GM	* 1,1,2,2-TETRACHLOROETHYLENE	<	1.0	UG/GM
PENTACHLOROETHANE	<	3.5	UG/GM	* CHLOROBENZENE	<	0.50	UG/GM
1,1,2-TRICHLOROTRIFLUOROETHANE	<	0.20	UG/GM	* 1,3-DICHLOROBENZENE	<	1.5	UG/GM
1,2-DICHLOROBENZENE	<	1.5	UG/GM	* 1,4-DICHLOROBENZENE	<	1.5	UG/GM

NG "QUALITATIVE ANALYSIS ONLY"
* "PRIORITY POLLUTANT"
< "LESS THAN"

MINNESOTA DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY

VOLATILE HYDROCARBONS IN SOLIDS/LIQUIDS

SAMPLE NUMBER: 126259
FIELD BLANK #: 126270

RPCA-26 TANK

DATE SAMPLED: 07/25/85
DATE ANALYZED: 08/07/85
DATE PRINTED: 08/19/85

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ. WASTE DIVISION

NON-HALOGENATED (CODE 462)

ACETONE	<	15.	UG/GM		TETRAHYDROFURAN	<	7.0	UG/GM
ETHYL ETHER	<	7.5	UG/GM		METHYL ETHYL KETONE	<	7.0	UG/GM
BENZENE	<	[illegible]	UG/GM		METHYL ISOBUTYL KETONE	<	1.5	UG/GM
TOLUENE		200.	UG/GM	*	ETHYL BENZENE		35.	UG/GM
CUMENE	<	0.70	UG/GM		O-XYLENE + P-XYLENE		200.	UG/GM
XYLENES		170.	UG/GM					

HALOGENATED (CODE 464)

CHLOROMETHANE	ND			*	DICHLORODIFLUOROMETHANE	ND		
VINYL CHLORIDE	ND			*	BROMOMETHANE	ND		
CHLOROETHANE	ND				DICHLOROFLUOROMETHANE	ND		
METHYLENE CHLORIDE		11.	UG/GM	*	TRICHLOROFLUOROMETHANE	<	0.50	UG/GM
ALLYL CHLORIDE	<	0.70	UG/GM	*	1,1-DICHLOROETHYLENE	<	0.30	UG/GM
1,1-DICHLOROETHANE	<	0.30	UG/GM	*	TRANS-1,2-DICHLOROETHYLENE	<	0.30	UG/GM
CIS-1,2-DICHLOROETHYLENE	<	0.30	UG/GM	*	CHLOROFORM	<	0.30	UG/GM
1,2-DICHLOROETHANE	<	0.30	UG/GM		DIBROMOMETHANE	<	1.5	UG/GM
1,1,1-TRICHLOROETHANE		4.5	UG/GM	*	CARBON TETRACHLORIDE	<	0.30	UG/GM
DIBROMOCHLOROMETHANE	<	0.70	UG/GM		DICHLOROACETONITRILE	ND		
2,3-DICHLORO-1-PROPENE	<	0.30	UG/GM	*	1,2-DICHLOROPROPANE	<	0.30	UG/GM
1,1-DICHLORO-1-PROPENE	<	0.30	UG/GM	*	TRANS-1,3-DICHLORO-1-PROPENE	<	0.30	UG/GM
1,1,2-TRICHLOROETHYLENE	<	0.30	UG/GM		1,3-DICHLOROPROPANE	ND		
CHLORODIBROMOMETHANE	<	1.5	UG/GM	*	1,1,2-TRICHLOROETHANE	<	0.30	UG/GM
CIS-1,3-DICHLORO-1-PROPENE	<	0.30	UG/GM		1,2-DIBROMOETHANE	<	0.70	UG/GM
2-CHLOROETHYLVINYL ETHER	ND			*	BROMOFORM	<	1.5	UG/GM
1,1,1,2-TETRACHLOROETHANE	<	0.30	UG/GM		1,2,3-TRICHLOROPROPANE	ND		
1,1,2,2-TETRACHLOROETHANE	<	3.0	UG/GM	*	1,1,2,2-TETRACHLOROETHYLENE	<	5.0	UG/GM
PENTACHLOROETHANE	<	3.0	UG/GM	*	CHLOROBENZENE	<	0.70	UG/GM
1,1,2-TRICHLOROTRIFLUOROETHANE	<	0.70	UG/GM	*	1,3-DICHLOROBENZENE	<	1.5	UG/GM
1,2-DICHLOROBENZENE	<	1.5	UG/GM	*	1,4-DICHLOROBENZENE	<	1.5	UG/GM

NQ "QUALITATIVE ANALYSIS ONLY"   < "LESS THAN"
* "PRIORITY POLLUTANT"

MINNESOTA DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY

VOLATILE HYDROCARBONS IN SOLIDS/LIQUIDS

SAMPLE NUMBER: 126267
FIELD BLANK #: 126290

MPCA-26 15Hw

DATE SAMPLED: 07/23/85
DATE ANALYZED: 08/08/85
DATE PRINTED: 08/19/85

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ. WASTE DIVISION

NON-HALOGENATED (CODE 462)

ACETONE	P<	14.	UG/GM		TETRAHYDROFURAN	<	7.0	UG/GM
ETHYL ETHER	<	1.4	UG/GM		METHYL ETHYL KETONE	<	7.0	UG/GM
BENZENE	<	0.70	UG/GM		METHYL ISOBUTYL KETONE		1.8	UG/GM
TOLUENE		120.	UG/GM	*	ETHYL BENZENE		36.	UG/GM
CUMENE	<	0.70	UG/GM		O-XYLENE + P-XYLENE		130.	UG/GM
M-XYLENE		120.	UG/GM					

HALOGENATED (CODE 454)

CHLOROMETHANE	NQ			*	DICHLORODIFLUOROMETHANE	NQ		
VINYL CHLORIDE	NQ			*	BROMOMETHANE	NQ		
CHLOROETHANE	NQ				DICHLOROFLUOROMETHANE	NQ		
METHYLENE CHLORIDE		2.7	UG/GM	*	TRICHLOROFLUOROMETHANE	<	0.30	UG/GM
ALLYLCHLORIDE	<	0.70	UG/GM	*	1,1-DICHLOROETHYLENE	<	0.30	UG/GM
1,1-DICHLOROETHANE	<	0.30	UG/GM	*	TRANS-1,2-DICHLOROETHYLENE	<	0.30	UG/GM
CIS-1,2-DICHLOROETHYLENE	<	0.30	UG/GM	*	CHLOROFORM	<	0.30	UG/GM
1,2-DICHLOROETHANE	<	0.30	UG/GM		DIBROMOMETHANE	<	1.4	UG/GM
1,1,1-TRICHLOROETHANE		6.7	UG/GM	*	CARBON TETRACHLORIDE	<	0.30	UG/GM
BROMODICHLOROMETHANE	<	0.70	UG/GM		DICHLOROACETONITRILE	NQ		
2,3-DICHLORO-1-PROPENE	<	0.30	UG/GM	*	1,2-DICHLOROPROPANE	<	0.30	UG/GM
1,1-DICHLORO-1-PROPENE	<	0.30	UG/GM	*	TRANS-1,3-DICHLORO-1-PROPENE	<	0.30	UG/GM
1,1,2-TRICHLOROETHYLENE	<	0.30	UG/GM		1,3-DICHLOROPROPANE	NQ		
CHLORODIBROMOMETHANE	<	1.4	UG/GM	*	1,1,2-TRICHLOROETHANE	<	0.30	UG/GM
CIS-1,3-DICHLORO-1-PROPENE	<	0.30	UG/GM		1,2-DIBROMOETHANE	<	0.70	UG/GM
2-CHLOROETHYLVINYL ETHER	NQ			*	BROMOFORM	<	1.4	UG/GM
1,1,1,2-TETRACHLOROETHANE	<	0.30	UG/GM		1,2,3-TRICHLOROPROPANE	NQ		
1,1,2,2-TETRACHLOROETHANE	<	3.0	UG/GM	*	1,1,2,2-TETRACHLOROETHYLENE	<	3.0	UG/GM
PENTACHLOROETHANE	<	3.0	UG/GM	*	CHLOROBENZENE	<	0.70	UG/GM
1,1,2-TRICHLOROTRIFLUOROETHANE	<	0.70	UG/GM	*	1,3-DICHLOROBENZENE	<	1.4	UG/GM
1,2-DICHLOROBENZENE	<	1.4	UG/GM	*	1,4-DICHLOROBENZENE	<	1.4	UG/GM

NQ "QUALITATIVE ANALYSIS ONLY"
* "PRIORITY POLLUTANT"
< "LESS THAN"
P< "PEAK DETECTED BELOW 'LESS THAN' VALUE"

MINNESOTA DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY

VOLATILE HYDROCARBONS IN SOLIDS/LIQUIDS

SAMPLE NUMBER: [illegible]
FIELD BLANK #: [illegible]

MPCA-26 [illegible]

DATE SAMPLED: 07/2[illegible]/85
DATE ANALYZED: 08/0[illegible]/85
DATE PRINTED: 08/19/85

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ. WASTE DIVISION

NON-HALOGENATED (CODE 462)

ACETONE	<	12.	UG/GM		TETRAHYDROFURAN	<	6.0	UG/GM
ETHYL ETHER	<	1.2	UG/GM		METHYL ETHYL KETONE	<	6.0	UG/GM
BENZENE	<	0.60	UG/GM		METHYL ISOBUTYL KETONE	<	1.2	UG/GM
TOLUENE		0.70	UG/GM	*	ETHYL BENZENE	<	0.60	UG/GM
CUMENE	<	0.50	UG/GM		O-XYLENE + P-XYLENE		1.1	UG/GM
M-XYLENE		1.2	UG/GM					

HALOGENATED (CODE 464)

CHLOROMETHANE	NQ			*	DICHLORODIFLUOROMETHANE	NQ		
VINYL CHLORIDE	NQ			*	BROMOMETHANE	NQ		
CHLOROETHANE	NQ				DICHLOROFLUOROMETHANE	NQ		
METHYLENE CHLORIDE	<	1.2	UG/GM	*	TRICHLOROFLUOROMETHANE	<	0.30	UG/GM
ALLYLCHLORIDE	<	0.60	UG/GM	*	1,1-DICHLOROETHYLENE	<	0.30	UG/GM
1,1-DICHLOROETHANE	<	0.30	UG/GM	*	TRANS-1,2-DICHLOROETHYLENE	<	0.30	UG/GM
CIS-1,2-DICHLOROETHYLENE	<	0.30	UG/GM	*	CHLOROFORM	<	0.30	UG/GM
1,2-DICHLOROETHANE	<	0.30	UG/GM		DIBROMOMETHANE	<	1.2	UG/GM
1,1,1-TRICHLOROETHANE	<	0.30	UG/GM	*	CARBON TETRACHLORIDE	<	0.30	UG/GM
BROMODICHLOROMETHANE	<	0.60	UG/GM		DICHLOROACETONITRILE	NQ		
2,3-DICHLORO-1-PROPENE	<	0.30	UG/GM	*	1,2-DICHLOROPROPANE	<	0.30	UG/GM
1,1-DICHLORO-1-PROPENE	<	0.30	UG/GM	*	TRANS-1,3-DICHLORO-1-PROPENE	<	0.30	UG/GM
1,1,2-TRICHLOROETHYLENE	<	0.30	UG/GM		1,3-DICHLOROPROPANE	NQ		
CHLORODIBROMOMETHANE	<	1.2	UG/GM	*	1,1,2-TRICHLOROETHANE	<	0.30	UG/GM
CIS-1,3-DICHLORO-1-PROPENE	<	0.30	UG/GM		1,2-DIBROMOETHANE	<	0.60	UG/GM
2-CHLOROETHYLVINYL ETHER	NQ			*	BROMOFORM	<	1.2	UG/GM
1,1,1,2-TETRACHLOROETHANE	<	0.30	UG/GM		1,2,3-TRICHLOROPROPANE	NQ		
1,1,2,2-TETRACHLOROETHANE	<	3.0	UG/GM	*	1,1,2,2-TETRACHLOROETHYLENE	<	3.0	UG/GM
PENTACHLOROETHANE	<	3.0	UG/GM	*	CHLOROBENZENE	<	0.60	UG/GM
1,1,2-TRICHLOROTRIFLUOROETHANE	<	0.60	UG/GM	*	1,3-DICHLOROBENZENE	<	1.2	UG/GM
1,2-DICHLOROBENZENE	<	1.2	UG/GM	*	1,4-DICHLOROBENZENE	<	1.2	UG/GM

NQ "QUALITATIVE ANALYSIS ONLY" < "LESS THAN"
* "PRIORITY POLLUTANT"

MINNESOTA DEPARTMENT OF HEALTH
ENVIRONMENTAL LABORATORY

VOLATILE HYDROCARBONS IN SOLIDS/LIQUIDS

AMPLE NUMBER: 126249
IELD BLANK #: 126293

MPCA-26 S&HW

DATE SAMPLED: 07/25/85
DATE ANALYZED: 08/06/85
DATE PRINTED: 08/19/85

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ. WASTE DIVISION

NON-HALOGENATED (CODE 462)

ACETONE	<	10. UG/GM	TETRAHYDROFURAN	<	5.0 UG/GM
ETHYL ETHER	<	1.0 UG/GM	METHYL ETHYL KETONE	<	5.0 UG/GM
BENZENE	<	0.50 UG/GM	METHYL ISOBUTYL KETONE	<	1.0 UG/GM
TOLUENE		1.9 UG/GM	* ETHYL BENZENE	<	0.50 UG/GM
CUMENE	<	0.50 UG/GM	O-XYLENE	<	0.50 UG/GM
M-XYLENE	<	0.50 UG/GM	P-XYLENE	<	0.50 UG/GM

HALOGENATED (CODE 464)

CHLOROMETHANE	NQ		* DICHLORODIFLUOROMETHANE	NQ	
VINYL CHLORIDE	NQ		* BROMOMETHANE	NQ	
CHLOROETHANE	NQ		DICHLOROFLUOROMETHANE	NQ	
METHYLENE CHLORIDE	<	1.0 UG/GM	* TRICHLOROFLUOROMETHANE	<	0.20 UG/GM
ALLYL CHLORIDE	<	0.50 UG/GM	* 1,1-DICHLOROETHYLENE	<	0.20 UG/GM
1,1-DICHLOROETHANE	<	0.20 UG/GM	* TRANS-1,2-DICHLOROETHYLENE	<	0.20 UG/GM
CIS-1,2-DICHLOROETHYLENE	<	0.20 UG/GM	* CHLOROFORM	<	0.20 UG/GM
1,2-DICHLOROETHANE	<	0.20 UG/GM	DIBROMOMETHANE	<	1.0 UG/GM
1,1,1-TRICHLOROETHANE	<	0.20 UG/GM	* CARBON TETRACHLORIDE	<	0.20 UG/GM
BROMODICHLOROMETHANE	<	0.50 UG/GM	DICHLOROACETONITRILE	NQ	
2,3-DICHLORO-1-PROPENE	<	0.20 UG/GM	* 1,2-DICHLOROPROPANE	<	0.20 UG/GM
1,1-DICHLORO-1-PROPENE	<	0.20 UG/GM	* TRANS-1,3-DICHLORO-1-PROPENE	<	0.20 UG/GM
1,1,2-TRICHLOROETHYLENE	<	0.20 UG/GM	1,3-DICHLOROPROPANE	NQ	
CHLORODIBROMOMETHANE	<	1.0 UG/GM	* 1,1,2-TRICHLOROETHANE	<	0.20 UG/GM
CIS-1,3-DICHLORO-1-PROPENE	<	0.20 UG/GM	1,2-DIBROMOETHANE	<	0.50 UG/GM
2-CHLOROETHYLVINYL ETHER	NQ		* BROMOFORM	<	1.0 UG/GM
1,1,1,2-TETRACHLOROETHANE	<	0.20 UG/GM	1,2,3-TRICHLOROPROPANE	NQ	
1,1,2,2-TETRACHLOROETHANE	<	2.0 UG/GM	* 1,1,2,2-TETRACHLOROETHYLENE	<	2.0 UG/GM
PENTACHLOROETHANE	<	2.0 UG/GM	* CHLOROBENZENE	<	0.50 UG/GM
1,1,2-TRICHLOROTRIFLUOROETHANE	<	0.50 UG/GM	* 1,3-DICHLOROBENZENE	<	1.0 UG/GM
1,2-DICHLOROBENZENE	<	1.0 UG/GM	* 1,4-DICHLOROBENZENE	<	1.0 UG/GM

NQ "QUALITATIVE ANALYSIS ONLY" < "LESS THAN"
* "PRIORITY POLLUTANT"

Year-A-Round Corp File Copy BT

SPECIAL SAMPLE DATA SHEET

Page 1 of 2

Collected by Bill Thompson
MDH Coordinator Bill Scruton

Date Collected 7/25/85
Expected Compl. Date 8/8/85

Report to Gary Eddy
Date Rec'd By Lab 7/26/85 ***

Program Element # MPCA 26
Lab. Sample # 126284-89****

Chain of Custody Record No 06433

SPECIAL SAMPLE DESCRIPTION: X Chain of Custody

___ Water ___ Sediment ___ Sludge ___ Fish ___ Soil ___ Other (specify)

SAMPLE NUMBER	FIELD NUMBER	SAMPLING POINT OR SOURCE	TYPE OF BOTTLES **	TOTAL # OF EACH
a. 126284	I, 1- A,B,C	Soil Dump Site, Hole 16	vials	3
b. 126285	I, 2- A,B,C	Soil Dump Site, Hole 20	vials	3
c. 126286	I, 3- A,B,C	Soil Dump Site, Hole 18	vials	3
d. 126287	I, 4- A,B,C	Soil Dump Site, Hole 19	vials	3
e. 126288	I, A, B,C	Black Dirt Pile (Background)	vials	3
f. 126289	II, 2- A,B,C	Old Drum Storage Area - Inside Fence	vials	COMPLETED

SPECIAL SAMPLE ANALYSES REQUESTED: *

Halogenated and Non-Halogenated Volatile Scan

AUG 28 1985 ENVIRONMENTAL LAB

* ___ OTHER ANALYSES REQUESTED ALSO AND WILL BE REPORTED SEPARATELY FROM SPECIAL SAMPLE ANALYSES.

SPECIAL INSTRUCTIONS AND COMMENTS:

*** Samples previously numbered 126284-302. When PCA filled out the data sheets, they put each vial on a separate line, and that's how our receiving desk personnel numbered them. They have been consolidated on this data sheet. See attached for information as originally given. - AG

**** These samples were taken in cooperation with the Minnesota Bureau of Criminal Apprehension for possible criminal prosecution. Please report results in standard turn-around time. Many thanks.

RESULTS:

See attached printouts for completed data.

RECEIVED SEP 04 1985 MPCA, SOLID & HAZ. WASTE DIVISION

**Please list bottles received for Special Sample Analysis only .

Please Fill Out
In Triplicate

466

Mike Wittfong
Paul Klinge

SPECIAL SAMPLE DATA SHEET

Page 1 of ___

Collected by Bill Thompson

MDH Coordinator ___

Date Collected 7-25-85

Expected Compl. Date ___

Report to Gary Eddy - MPCA

Date Rec'd By Lab 7/26/85

Program Element # MPCA 26

Lab. Sample # 126284 - 285

C of C 06433

SPECIAL SAMPLE DESCRIPTION:

Yes Chain of Custody ✓ 506433

___ Water ___ Sediment ___ Sludge ___ Fish SOIL Other (specify)

(Note: Please List Town)

SAMPLE NUMBER	FIELD NUMBER	SAMPLING POINT OR SOURCE	TYPE OF BOTTLES **	TOTAL # OF EACH
a 126284	I - 1A	Soil Dump Site Hole 16	Vials	1
b 126284	I - 1B	Soil Dump Site Hole 16	"	1
c 126284	I - 1C	Soil Dump Site Hole 16	"	1
d 126285	I - 2A	Soil Dump Site Hole 20	"	1
e 126285	I - 2B	Soil Dump Site Hole 20	"	1
f 126285	I - 2C	Soil Dump Site Hole 20	"	1

SPECIAL SAMPLE ANALYSES REQUESTED: • Halogenated and non-halogenated Volatile Organic Scan

* ___ OTHER ANALYSES REQUESTED ALSO AND WILL BE REPORTED SEPARATELY FROM SPECIAL SAMPLE ANALYSES.

SPECIAL INSTRUCTIONS AND COMMENTS:

These samples were taken in cooperation with the Minnesota Bureau of criminal apprehension for possible criminal prosecution. Please report results in standard turn-around time. Many thanks.

RESULTS:

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ. WASTE DIVISION

**Please list bottles received for Special Sample Analysis only .

Please Fill Out
In Triplicate.

(466)

SPECIAL SAMPLE DATA SHEET

Page 2 of ___

Collected by Mike Wiltfang, Paul Klinge, Bill Thompson

MDH Coordinator ___

Date Collected 7-25-85

Expected Compl. Date ___

Report to Gary Eddy - MPCA

Date Rec'd By Lab 7/26/85

Program Element # MPCA 26

Lab. Sample # 126286 - 289

C of C 06433

SPECIAL SAMPLE DESCRIPTION:

Yes Chain of Custody 506433

___ Water ___ Sediment ___ Sludge ___ Fish SOIL Other (specify)

(Note: Please List Town):

SAMPLE NUMBER	FIELD NUMBER	SAMPLING POINT OR SOURCE	TYPE OF BOTTLES **	TOTAL # OF EACH
126286	I-3A	Soil Dump Site Hole 18	VIALS	1
126286	I-3B	Soil Dump Site Hole 18	"	1
126286	I-3C	Soil Dump Site Hole 18	"	1
126287	I-4A	Soil Dump Site Hole 19	"	1
126287	I-4B	Soil Dump Site Hole 19	"	1
126287	I-4C	Soil Dump Site Hole 19	"	1

SPECIAL SAMPLE ANALYSES REQUESTED: * Halogenated and non-halogenated Volatile Organic Scan

* ___ OTHER ANALYSES REQUESTED ALSO AND WILL BE REPORTED SEPARATELY FROM SPECIAL SAMPLE ANALYSES.

SPECIAL INSTRUCTIONS AND COMMENTS:

These samples were taken in cooperation with the Minnesota Bureau of Criminal Apprehension for possible criminal prosecution. Please report results in standard turn-around time. Many thanks.

RESULTS:

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ. WASTE DIVISION

**Please list bottles received for Special Sample Analysis only.

Please Fill Out
In Triplicate

A66

SPECIAL SAMPLE DATA SHEET

Page 3 of ___

Collected by Mike Wiltfang, Paul Klinge, Bill Thompson   MDH Coordinator ___

Date Collected 7-25-85   Expected Compl. Date ___

Report to Gary Eddy - MPCA   Date Rec'd By Lab 7/26/85

Program Element # MPCA 26   Lab. Sample # 126288 - 289

C of C 06433

SPECIAL SAMPLE DESCRIPTION: Yes X Chain of Custody 506433

___ Water ___ Sediment ___ Sludge ___ Fish SOIL (specify) Other

(Note: Please List Town)

SAMPLE NUMBER	FIELD NUMBER	SAMPLING POINT OR SOURCE	TYPE OF BOTTLES **	TOTAL # OF EACH
126288	I-Background A	Black Dirt Pile	VIALS	1
126288	I-Background B	" " "	"	1
126288	I-Background C	" " "	"	1
126289	II-2A	OLD DRUM STORAGE AREA Inside fence	"	1
126289	II-2B	" " "	"	1
126289	II-2C	" " "	"	1

SPECIAL SAMPLE ANALYSES REQUESTED: * Halogenated and non-halogenated Volatile Organic Scan

* ___ OTHER ANALYSES REQUESTED ALSO AND WILL BE REPORTED SEPARATELY FROM SPECIAL SAMPLE ANALYSES.

SPECIAL INSTRUCTIONS AND COMMENTS:

These samples were taken in cooperation with the Minnesota Bureau of Criminal Apprehension for possible criminal prosecution. Please report results in standard turn-around time. Many thanks.

RESULTS:

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ
WASTE DIVISION

**Please list bottles received for Special Sample Analysis only.

Minnesota Pollution Control Agency
Solid Hazardous Waste Division
1935 West County Road B2
Roseville, Minnesota 55113
(612) 296-7373

RECEIVED
SEP 04 1985
MPCA, SOLID & HAZ.
WASTE DIVISION

S 06433

CHAIN OF CUSTODY RECORD

Project Name: YEAR-A-ROUND

Name of Sampler: Bill Thompson, Mike Wiltfang, Paul Klinge

Field Number	Date	Time	Sample Type(s): monitoring well	existing well	surface water	wastewater	waste	other (SOIL)	Sample Location	Analyses Requested	Comments on Samples
I-1A,B,C	7-25-85	2:20PM						X	Soil Dump Site HOLE 16	Hal. and Nonhal. Volatile Organic Scan	
I-2A,B,C	7-25-85	2:30PM						X	" " HOLE 20	Same Analyses	
I-3A,B,C	7-25-85	2:40PM						X	" " " HOLE 18	" "	
I-4A,B,C	7-25-85	2:50PM						X	" " " HOLE 19	" "	
I-Background A,B,C	7-25-85	3:25PM						X	Dirt Pile-Background	" "	
II-2A,B,C	7-23-85	9:10PM						X	old drum storage area within fence	" "	

Remarks on Site: Chain of Custody Tag # ~~[illegible]~~ 0000552 BT 7-25-85 7:50PM

Samples Relinquished by	Samples Received by	Comments	Date/Time
Bill Thompson	[illegible signature]		7/26/85 10:33A
Samples Relinquished by	Samples Received by	Comments	Date/Time
Samples Relinquished by	Samples Received by	Comments	Date/Time

Means of Delivery: MPCA Ford Van

Seals intact: ☒ YES ☐ NO ☐ N.A.

Original and yellow copies to lab. Pink copy to MPCA. Lab forwards completed yellow copy to MPCA with analytical results.
PQ-00343-01 (12/83)

APPENDIX II

MINNESOTA POLLUTION CONTROL AGENCY

CASE DEVELOPMENT FORM DECEMBER 23, 2010

CASE DEVELOPMENT FORM

1. GENERAL CASE INFORMATION:

Case Lead: Joshua Burman

Forum Date/Time: 12/23/10:0930
Forum Location: Desktop Video

CDF Revision Date: 12/23/10

Scheduled Attendees: Joshua Burman, John Elling, Steve LaRoque, Tanya Maurice, Bev Conerton, Larry Pry, Jon Gegen, Kit Grayson, Paul Kimman, Sherry Bock, Hannah Pierce

Regulated Party Name:
A-1. Charles Merton Anderson Trust (Anderson Trust)
A-2. Year-A-Round Cab Co., doing business as Year-A-Round (Year-A-Round)
B-1. Hertaus Properties, LLC (Hertaus Properties)
B-2. Year-A-Round Cab Co., doing business as Jari USA (Jari)

Regulated Party Address: *see Contacts

Status of Regulated Party:
A-1. Trust
A-2. Domestic Corporation
B-1. Domestic Limited Liability Company
B-2. Domestic Corporation

Regulated Party Contact:
A-1. c/o Mr. David Lamm
Lamm, Nelson, & Cich Law Office
151 Saint Andrews Court, Suite 1310
Mankato, MN 56001-8821
507-345-4607
dlamm@lammnelsoncich.com
A-2. See B-2.
B-1. c/o Mr. Steven Fink
Farrish Johnson Law Office
1907 Excel Dr
Mankato, MN 56001-6281
507-625-2525
sfink@farrishlaw.com
B-2. Mr. Alan Hertaus (Hertaus)
110 W. Lind St
Mankato, MN 56001-0412
507- 625-9381
AHertaus@jariusa.com

Site at Which Noncompliance Occurred:	110 W. Lind St., Mankato, MN (Factory) 112 W. Lind St., Mankato, MN (Vacant Lot)
Date of Violations Confirmation and Method of Discovery	10/04/10 Inspection 10/12/10 Inspection
Delta Program Preferred ID#:	MND006457642
*Case-involved Agencies (in addition to MPCA):	C. City of Mankato (City) c/o Rick Baird D. Blue Earth County (County) c/o Tim Grant; Peter Otterness E. Minnesota Department of Transportation (Mn/DOT)

2. LEAD PROGRAM/MEDIA IN WHICH THE VIOLATIONS OCCURRED:

Hazardous Wastes, Industrial Division

3. FACTUAL SUMMARY:

Historic Background:

Year-A-Round was founded in 1966 by Charles Merton Anderson and manufactured welded and painted metal products, including farm tractor cabs and implement accessories, mailboxes, and finally corn stoves. The business reached a peak at over 300 employees at the Factory, and has been in a long gradual decline, with only approximately 5-10 employees at the Factory at the time of sale. The majority of these employees were not retained at the time of sale, and the staff and management are therefore essentially new.

Year-A-Round has a long history of hazardous waste mismanagement cited by the MPCA, including confirmed burning, alleged dumping, and failure to evaluate wastes disposed on-site and off-site. Enforcement has included the full range of administrative actions (LOW, NOV, APO, and Stipulation Agreement) and a dismissed criminal case.

Current Case Background:

The Anderson Trust entered into a contract-for-deed with Hertaus Properties for the Factory on 05/20/10. The contract did not include the Vacant Lot, though the two areas were legally one parcel. Mr. Hertaus stated that he attempted to purchase the entire parcel, but the Anderson Trust refused. Subsequently, the parcel was platted and subdivided, under joint application from Mr. Hertaus and the Anderson Trust.

Simultaneously, Mr. Hertaus purchased the Year-A-Round business and operations and now operates it under the assumed name of Jari, USA. Mr. Hertaus has stated that he was and is in no way connected to Mr. Anderson or the Anderson Trust except through this sale.

In clearing the site for use, Mr. Hertaus found Tank YY, the cover of which was buried under soil. [Map101207YearARound.pdf] When opened, Tank YY reportedly smelled of sewage and a strong solvent odor. Dye and camera testing indicated that the majority of plumbing fixtures, both toilet and industrial, in the facility drained to Tank YY, and subsequently to the City sanitary sewer. The soil surrounding Tank YY appeared stained and tested positive for Gasoline-Range Organics (GRO).

Subsequent excavation by Mr. Hertaus has reportedly found additional collection tanks sealed under the Factory at multiple locations. An abandoned water supply well is located on the south side of the Factory.

Mr. Hertaus has requested guidance from all of the involved agencies as to what activities he may perform at the site and what cleanup he must, or is allowed to, perform. Given the historic lack of coordination between the City, County, and MPCA at the site previously, the City and County have requested that their responses be coordinated with the MPCA's.

The City's primary concerns are:
1) the integrity of the wastewater collection system at the Factory and the accumulated contaminants in and potentially be released from that system;
2) the potential presence of contaminants in and under the fill soil on the Vacant Lot.

The County's primary concerns are:
3) sealing of the abandoned water supply well at the Factory;
4) contamination of the surface water and Mn/DOT ditch drainage.

Mn/DOT's primary concerns are:
5) potential presence of contaminants in the US14 ditch.

After the initial inspection on October 4, 2010, under the belief that Mr. Hertaus had in fact outright purchased the Factory property, he was directed to the Voluntary Investigation & Cleanup Program (VIC). They directed him to hire a qualified environmental consultant for the site. The VIC questioning also revealed that Mr. Hertaus was not the actual landowner at the site, and VIC referred him back to Hazardous Waste Compliance & Enforcement staff.

The Factory is currently nearly totally shut down, awaiting direction from the MPCA as to cleanup and allowed activities. Mr. Hertaus has inquired whether Jari may resume manufacturing operations or, alternatively, may sell the Factory property.

4. DOCUMENTATION OF VIOLATIONS:

Documentation of each issue is referenced in the right-hand column of this CDF below.

5. CORRESPONDENCE RELEVANT TO THE VIOLATIONS:

See Documentation.

6. VIOLATIONS:

WATER QUALITY/SEWERING ISSUES

6.1. SURFACE FLOW

At least two interior floor drains of the Factory discharge to an exterior tile line which drains to the eastbound US14 Mn/DOT ditch, which drains to Oxbow Pond. These floor drains are located in the former Maintenance area. The discharge of all other floor drains is unknown. Oxbow Pond drains into Hiniker Pond, which is an undeveloped recreational swimming site.

These floor drains do not appear to have been included in any previous enforcement action to Year-A-Round.

Currently, Hertaus Properties controls the Factory and associated surface flow.

12/07/10	Map of known floor drains discharge	[Map101207YearARound.pdf]
10/12/10	Floor drain tile photographs	[Pics101012YearARound.pdf]

6.2. SUBSURFACE FLOW

As of the date of this CDF, it appears that the majority of the drains in the Factory, including the paint booth water wall tank (Tank ZZ) and all known toilets, drain to Tank YY outside the Factory, from there to Tank ZZ under the Factory floor, and subsequently through unlocated piping to a connection with the City sanitary sewer near the east end of the Factory site.

It appears that, either through miscommunication or deliberate misdirection, Year-A-Round previously simultaneously told the MPCA that wastewater from the Factory was discharged to the City sanitary sewer and told the City that no wastewater was discharged from the site except in once-a-decade batch dumps, which the City then monitored.

The status and use of Tank YY (and the rest of the wastewater collection system), and corrective actions to resolve them, were addressed in the 1985 NOV and 1986 draft STIP, however no information was found in the file to indicate what, if any, action was actually taken by Year-A-Round. None of the subsequent inspections or enforcement actions addressed this issue except to note that wastewater from the site was sewered and noted as 'Compliant'. Tank YY, and the entire wastewater collection system, unarguably remained in continuous use.

Prior testing of the sewered discharge of the Factory during batch dumps have now been shown to be ineffective, as all such testing was performed downstream of discharge into the City sewer of the apartment buildings south of the Factory.

Tank YY currently holds approximately 550 gallons of liquid waste. Testing of the sludge in Tank YY shows high toluene (638ppm), xylene (9036ppm), and ethyl benzene (1901ppm). These concentrations are not sufficient to render the sludge a hazardous waste in and of itself.

Additional waste currently entering Tank YY from the Factory flows through the tank and discharges to the City sewer.

Additional floor and equipment drains in the northwest portion of the Factory drain to unknown locations. The trend lines of pipes leaving these floor drains is to the north and northwest.

Currently, Hertaus Properties controls the Factory and associated subsurface flow, however the Anderson Trust has asserted that Hertaus Properties' control is limited to that granted in the contract-for-deed, and does not include demolition of structures or portions of structures.

12/07/10	Map of estimated sewered flow	[Map101207YearARound.pdf]
10/12/10	Tank YY is sewered (+bathrooms)	[Msg101012YearARound_DrainPlumbing[RB].pdf]
10/04/10	Tank YY sludge test	[Doc101004YearARound_SludgeSamplingResults.pdf]
10/04/10	Tank YY photographs	[Pics101004YearARound.pdf]
03/05/97	Complaint - paint system to soil	[Insp970305YearARound_TankYYIsSewered.pdf]
01/10/96	Tank YY not sewered claim	[Insp960110YearARound_WashBoothNotSewered.pdf]
12/09/93	Complaint - paint system to drain	[Cmp931209YearARound_PaintSystemLeaksIntoDrain.pdf]
10/30/87	Tank YY sewered claim	[CAL871030YearARound_StatementOfDischarge.pdf]
12/23/86	MPCA inquiry of Tank YY status	[CAL861223YearARound_OpenStatusOfTankYY.pdf]
06/03/86	Tank YY sewered claim	[Resp860603YearARound_TankYYIsSewered.pdf]
04/03/86	Tank YY sewered claim	[Insp860403YearARound_TelephoneInterview.pdf]
03/12/86	Tank YY not sewered claim	[CAL860312YearARound_StatementOfNoDischarge.pdf]
11/06/85	Tank YY not sewered claim	[Doc851106YearARound_StatusMtg.pdf]
09/30/85	Tank YY assumed description	[Insp850930YearARound_TankYY.pdf]
09/24/85	Tank YY not sewered claim	[Doc850924YearARound_StatementOfNoDischarge.pdf]

LAND CONTAMINATION ISSUES

6.3. VACANT LOT

Very large amounts of fill have been added to the vacant lot since 1985, without apparent and justifiable reason. Simultaneously, numerous allegations of dumping of contaminated soil removed from the Factory site and contents, both liquid and solid, removed from waste drums at the Factory have been made to the City, County, and MPCA. Soil testing in 1985 of a portion of the then-current surface of the Vacant Lot (now estimated to be buried under at least 5 feet, and likely more, of additional fill) revealed various levels of contamination. An apparent decision for unknown reasons was made internally at the MPCA in 1988 to drop corrective actions related to the potential soil contamination.

Almost all of the fill on the Vacant Lot has been performed either without City or County permits or in violation of City or County stop-work orders. Substantial amounts of fill received from verifiable 'clean' sources, including the North Mankato Library Addition (2009) and Mankato Menards Addition (2009), are believed to cover the majority of the site.

Review of staff observations and submitted complaints indicates that if any wastes were dumped or buried on the Vacant Lot, they were not whole drums or other containers, but instead the liquid or solid contents of the drums.

Currently, the Anderson Trust controls the Vacant Lot.

11/08/10	Vacant Lot platted	[Doc101108YearARound_VacantLotPlatting2[CoM].pdf]
10/19/10	Vacant Lot raised 4.5ft since 1996	[Msg101019YearARound_VacantLotElevations[RB].pdf]
07/10/09	Vacant lot additional fill after order	[Msg101019YearARound_DNR-CDOs[RB].pdf]
06/25/09	Vacant Lot fill Stop Work Order	no copy available

09/24/97	Complaint - drum contents dumped	[Insp970924YearARound_VacantLotDumping.pdf]
12/05/88	Soil sampling requirement dropped	[Doc881205YearARound_StatusMtg.pdf]
10/09/86	Drum burial complaint	[Cmp861009YearARound_DrumBurialUnderBuilding.pdf]
07/22/86	Additional MPCA response to fill	[CAL860722YearARound_FillRequestResponse.pdf]
07/16/86	Additional Fill request	[Resp860716YearARound_FillRequest.pdf]
06/06/86	MPCA response to fill request	[CAL860606YearARound_MPCAResponseToFillRequest.pdf]
11/06/85	Soil contamination map	[Doc851106YearARound_StatusMtg.pdf]
09/24/85	Soil testing results	[CAL850924YearARound_SoilTestingResults.pdf]
07/31/85	Soil dumping interview	[Insp850731YearARound_SoilDumpingInterview.pdf]
07/25/85	Soil contamination sampling & testing	[Insp850725YearARound_SoilSampling&TestResults.pdf]
07/10/85	Contaminated soil dumping observation	[Insp850710YearARound_VacantLotSurveillance.pdf]

7. CORRECTIVE ACTIONS:

Refer to Superfund Site Assessment and Voluntary Investigation & Cleanup (VIC) Programs

8. PROGRAM/MEDIA SPECIFIC QUESTIONS/INFORMATION:

8.1. Site EPA ID# MND006457642

8.2. Current Generator/TSD/Transporter Status? Non-generator

8.3. Does this case meet the federal definition of a Significant Non-Complier? No

9. INSPECTION HISTORY:

October 12, 2010
October 4, 2010
Numerous inspections preceding each prior enforcement action.

10. ENFORCEMENT HISTORY:

04/29/03	LOW	closed 09/05/03	[LOW030609YearARound.pdf]
05/30/00	NOV	closed 07/25/00	no copy found
02/24/96	STIP	closed 03/25/97	[Stip960220YearARound.pdf]
01/19/94	NOV	closed 03/25/97	no copy found
02/23/93	APO	closed 03/25/97	[APO930223YearARound.pdf]
04/08/92	NOV	closed 03/25/97	[NOV920408YearARound.pdf]
12/23/88	LOW	closed 02/16/89	[LOW881223YearARound.pdf]
07/19/88	NOV	closed 02/16/89	[NOV880719YearARound.pdf]
02/06/86	STIP	withdrawn	[Stip860821YearARound_Draft2.pdf]
10/04/85	Criminal charge	dismissed 02/12/86	[Doc851004YearARound_CriminalComplaint.pdf] [Doc860212YearARound_CriminalDismissal.pdf]
05/28/85	NOV	closed 02/16/89	[NOV850528YearARound.pdf]

11. PERMIT HISTORY:

None.

APPENDIX III

1986 COMPLAINT AGAINST YEAR-A-ROUND CAB COMPANY

FOR ALLEGEDLY BURYING DRUMS ON-SITE

TELEPHONE CALL

To/From Bill Thompson / Larry Brikerman Tel No

Company Nicollet, Brown County Sanitation City Mankato

~~Rec'd By~~ Date Oct. 9, 1986 (3:45 pm)

Subject Year-A-Round Corporation, Mankato

Larry said he had talked to a citizen who said that Morton Anderson had buried drums in one of his out-buildings so as to make the burial undetected. The person was not specific as to which out-building was used or when the burial took place.

I asked Larry about the person and if it was the same concerned citizen that we had dealt with earlier in the case – Larry said no, this is a different person.

Larry and I discussed the case a bit and I thanked him for the call. He advised me to use it as I can.

MN-COMP-A 0082579

APPENDIX IV

1986 LETTER FROM MPCA TO YEAR-A-ROUND CAB COMPANY

INDICATING 20-30 DRUMS OF HAZARDOUS WASTE ON SITE

Minnesota Pollution Control Agency

December 23, 1986

Mr. Merton Anderson
Year-A-Round Corporation
Highway 169 North
Mankato, Minnesota 56001

Dear Mr. Anderson:

RE: General Update

I am taking this opportunity to update you on various items, most of which were discussed in the October 27, 1986 negoitations meeting held at the Minnesota Pollution Control Agency's (MPCA) office.

1. Soil/Ground Water Investigation - Final Report

   During the October meeting, Bill Welbes of Twin City Testing (TCT) provided a preliminary report on the soil and ground water investigations that took place last fall at Year-A-Round Corporation (YARC). At that time we asked for a final report so that all the information available could be reviewed and commented on. Mr. Welbes talked to me on November 20, 1986 and indicated that he would complete a final report and provide the Agency with copies. Since we have not to date received a copy of this, we can not respond to some of the questions which you asked at the meeting. Please see that a copy of the report is provided to me as soon as possible, but no later than December 30, 1986.

2. Financial Statement Review

   Soon after the October meeting your accountants provided the MPCA with an August 31, 1986 financial statement. We had requested this statement at the meeting, and had promised to review the statement and provide you with a decision on future Agency actions. At this time I can report to you that the financial review has been completed and a decision is now being made by MPCA management on your situation. I anticipate that a letter will be sent to you within two weeks outlining the MPCA actions.

3. <u>Disclosure/Annual Update</u>

   Linda Tanner of the MPCA's Disclosure Unit has advised me that YARC's disclosure is not up-to-date. Please be advised that an Annual Report sheet will be sent to you in early January, 1987. This is to be completed and returned to Linda Tanner so that your files can be accurate and fees can be calculated correctly. Ms. Tanner's phone number is 612/296-9395 if you have any questions on this process.

4. <u>Tank Examination</u>

   The issue of the underground cement tank was also raised at the October, 1986 meeting. At this point I believe that further evaluation is needed. I anticipate the need for a site visit to complete the evaluation.

5. <u>Off-spec paint and waste solvents</u>

   You indicated that YARC has stored 15-20 drums of waste paint and thinners which are classified as hazardous wastes. At the meeting you reported that YARC would make arrangements to have these materials shipped off-site for recycling or disposal. Please update me on this situation. If these wastes have not been shipped yet, YARC is now given 60 days in which to remove the wastes off-site for proper management. If this is not done in the time specified, the MPCA will require YARC to apply for a hazardous waste storage permit.

Please take the necessary actions to these items as specified. Call me at 612/296-8454 with any questions or concerns you may have. Thank you for your cooperation.

Sincerely,

Bill Thompson

Bill Thompson
Hazardous Waste Enforcement Unit
Hazardous Waste Section
Solid and Hazardous Waste Division

BT/jmh

cc: Bill Welbes, Twin City Testing, St. Paul
Herb Wenkel, Blue Earth County, Mankato
Larry Landherr, MPCA Regional Director, Rochester

APPENDIX V

1985 FELONY CRIMINAL COMPLAINT AGAINST YEAR-A-ROUND

CAB COMPANY INDICATING TWO ALLEGED COUNTS

OF ILLEGAL DISPOSAL OF HAZARDOUS WASTE

State of Minnesota County of BLUE EARTH DISTRICT Court

CCT	SECTION/Subdivision	U.O.C.	GOC	CTY. ATTY. FILE NO.	CONTROLLING AGENCY	CONTROL NO.
I	Minn. Stat. §§ 115.071, subd. 2b and 609.05	M6205	X	35.X408.0706	MN 062015A	
II	Minn. Stat. §§ 115.071, subd. 2b and 609.05	M6205	X	COURT CASE NO. 07-K1-85-1412		DATE FILED 10-4-85

✓ if more than 6 counts (see attached)

Complaint

X SUMMONS
WARRANT
ORDER OF DETENTION

State of Minnesota PLAINTIFF,

VS.

X FELONY
GROSS MISDEMEANOR

NAME: first, middle, last

YEAR-A-ROUND CAB COMPANY DEFENDANT.

Date of Birth: N/A

SJIS COMPLAINT NUMBER: 07-31-7-000002

COMPLAINT

The Complainant, being duly sworn, makes complaint to the above-named Court and states that there is probable cause to believe that the Defendant committed the following offense(s). The complainant states that the following facts establish PROBABLE CAUSE:

I, James D. Massoth, am a Special Agent with the Minnesota Bureau of Criminal Apprehension (BCA). In that capacity, I have investigated the defendant YEAR-A-ROUND CAB CO. (YEAR-A-ROUND) and its president, the defendant Charles Merton Anderson, DOB 4/25/27, for the unlawful disposal of hazardous waste. In the course of this investigation I have talked to or interviewed William Thompson of the Minnesota Pollution Control Agency (MPCA); the defendant Charles Merton Anderson; Clarence Al Battey, an employee of defendant YEAR-A-ROUND; Walter Wolf and Mitchell Wolf of W. W. Blacktopping, 1400 Lake Street, North Mankato, Minnesota; and Special Agent Marvin Seman of the BCA, who assisted me in this investigation. I have reviewed the Articles of Incorporation of YEAR-A-ROUND. I have also reviewed documents and files on YEAR-A-ROUND provided by the MPCA, as well as reviewed documents and examined material seized under a search warrant executed at the busines situs of the YEAR-A-ROUND corporation. These documents and materials include correspondence, legal papers, purchase receipts for gravel and chemicals, a file labelled hazardous wastes containing safety data sheets, and samples of waste material and chemicals found on the company premises. I have also reviewed laboratory results of soil samples taken from an unfenced area to the immediate west of YEAR-A-ROUND's fenced-in plant in Mankato, which property is also owned by YEAR-A-ROUND. As a result of this investigation, I believe the following to be true and correct.

Its articles of incorporation state that defendant YEAR-A-ROUND is a Minnesota corporation engaged primarily in the business of manufacturing and selling cabs for agricultural machinery. Listed among the incorporators is defendant Charles Merton Anderson, who is also listed as one of the first directors of the corporation. Defendant Anderson told me that he is the sole owner of YEAR-A-ROUND, and is the president of the corporation. The address of YEAR-A-ROUND is Highway 169 North, Mankato, Minnesota. Both the plant site and all adjacent property referred to in this complaint are located in Blue Earth County, Minnesota.

According to William Thompson of the MPCA, he and other personnel of his agency conducted a preliminary inspection of the YEAR-A-ROUND plant site on March 16, 1985. During this inspection it was discovered that the company washed and painted the parts used in its manufacturing process in such a manner as to generate large quantitites of hazardous waste, including paint thinner solvent containing xylol (xylene). Xylol (xylene) is a volatile hydrocarbon that, according to Thompson, is a hazardous waste under Minn. Stat. ch. 116 and MPCA rules.

During the March 16, 1985, preliminary inspection defendant Charles Merton Anderson represented the company. According to William Thompson's report of that inspection, Anderson told the MPCA that the accumulated wastes from his painting operations were stored in sealed 55-gallon drums on pallets behind the main plant. The MPCA inspectors noted, according to Thompson's report, that:

> "Near the southwest corner of the property, the company had stored about 400, 55-gallon drums (rough estimate). Most of the drums were double-stacked and occupied an area about 30 yeards square. Drums were stored directly against the west fence. The drums were not labeled or marked in any manner to

> indicate which type of waste was contained. Some drums were marked "Waste." Many drums were open, leaning or tipped over. No segregation of drums according to waste type was present. Many drums were stored either directly on the ground or on a broken or deteriorated pallet. Many drums were rusted and deteriorated. I observed one drum that had been punctured by a forklift prong."

Following a tour of the company premises, the inspection party returned to defendant Anderson's office. There William Thompson told defendant that there should be no shipment of any stored wastes from the site without MPCA approval. Defendant Anderson was also told that evaluation of the wastes needed to be completed in order to determine an appropriate management plan. The overall inspection result, as stated in Thompson's report, was:

> "Based on this preliminary investigation, numerous violations were observed. Additionally, since many of the containers stored outdoors were deteriorated, the possibility exists for soil and ground water contamination."

In a letter mailed from the MPCA to defendant Charles Merton Anderson on April 10, 1985, William Thompson wrote:

> "This letter will serve to document our phone conversation of April 4, 1985. During that conversation we agreed upon an inspection date and time of April 15, 1985 at about 10:00 a.m.
>
> . . . As I stressed during my initial visit on March 15, 1985, and again during our phone conversation, no wastes should be shipped off-site to a landfill or any other facility until management plans have been approved by the MPCA."

On April 15, 1985, a full inspection of the YEAR-A-ROUND plant site was conducted by the MPCA. Defendant Charles Merton Anderson again represented the company. During that inspection, MPCA employees noted that about 400 drums of waste which had previously been stored outside had been moved inside a nearby storage shed. Of those 400 drums, about 180 contained paint sludges, 20 contained wash sludge, and about 200 contained waste solvent.

Also noted by the MPCA during the April 15, 1985, inspection were several damaged drums of waste solvents that were leaking onto the ground in the southwest corner of the plant site near the south edge of the outdoor drum storage area.

As a result of this full inspection the MPCA mailed a hazardous waste Notice of Violation (NOV) dated May 28, 1985, to defendant Charles Merton Anderson as president of YEAR-A-ROUND. In its cover letter forwarding the NOV the MPCA expressly wrote to defendant Anderson that:

> "As indicated in April 10, 1985, correspondence to you, no hazardous or potentially hazardous wastes are to be shipped off-site to a landfill or other facility until management plans have been approved by the MPCA."

In the attached NOV itself, the MPCA listed the hazardous waste violations it found and the requirements which the company must undertake to bring itself into conformity with the law. Among these requirements in the NOV was that:

> "5. Until the Company has obtained an EPA identification number, evaluated all waste streams, and has management plans approved by the MPCA, no hazardous wastes should be shipped off-site."

(Emphasis in the original).

During my interview of defendant Charles Merton Anderson (during the execution of the search warrant on July 25, 1985) he admitted receiving the above-mentioned documents and letters from the MPCA.

Despite these explicit instructions from the MPCA, I have found out from Walter Wolf that in late June 1985, either defendant Charles Merton Anderson, or his son Michael Anderson, contracted with Wolf's Company (W. W. Blacktopping of Mankato) to remove dirt and crushed rock from inside the southwest corner of YEAR-A-ROUND's fenced-in plant site. This is the area of the previously identified drum storage site. On June 26, 1985, Walter Wolf's son, Mitchell Wolf, acting as an employee of W. W. Blacktopping, removed dirt and gravel from the southwest corner of YEAR-A-ROUND's fenced-in area and dumped it over the fence. Mitchell Wolf told me that he was directed in this work by the older person who was in charge at YEAR-A-ROUND. Mitchell Wolf described this older person as a man of tall stature with gray hair, glasses and somewhere in his mid-fifties. Defendant Charles Merton Anderson's driving license record shows that he is 6 feet, 2 inches tall; weighs 210 pounds and was 58 years old in June 1985. My own observation of defendant Anderson showed that he had gray hair and wore glasses.

On July 1 and July 3, 1985, William Thompson of the MPCA received information from Herb Wenkels, the Blue Earth County Sanitarian. Wenkels advised having observed approximately ten barrels on fire inside of the fenced-in area at the YEAR-A-ROUND property on July 1, 1985. Wenkels contacted the corporation president, defendant Anderson, who claimed that only paper and wood scraps were being burned in the drums. However, Wenkels found flames shooting from one of the drums and the intensity of the fire indicated that the barrels contained dried paint sludges or similar materials. On July 3, 1985, Herb Wenkels checked the area where the drums were burned and noted evidence of digging in the vicinity of the burn site.

William Thompson told me that, based on this report from Wenkels, and also because the MPCA had told defendant Anderson that there would be another inspection on July 18, 1985, he decided to conduct a surveillance of the YEAR-A-ROUND site.

On July 10, 1985, Thompson conducted his surveillance of YEAR-A-ROUND. During that time he observed defendant Anderson directing an employee in the scraping of surface soils with a tractor and bucket from the area in and around the old outdoor drum storage site lcoated in the southwest corner of YEAR-A-ROUND's fenced-in area. The soils were taken in the bucket to an area outside the fence to the west of the plant and dumped.

After dumping about fifteen bucket loads of soil, the tractor operator graded the dump site using black soil piled nearby to cover up the excavated soils. The tractor operator then spread gravel over the excavated area inside the fence. William Thompson took pictures of this activity using a zoom lens. These photographs have been developed into a number of slides which I have viewed and they show defendant Charles Merton Anderson present during, and directing, the above-described excavating activities.

Clarence A. Battey, an employee of YEAR-A-ROUND working in the maintenance department, has told me that he was the employee driving the tractor during the July 10, 1985 excavation. Battey advised that he was told by defendant Charles Merton Anderson to remove dirt from the southwest corner of YEAR-A-ROUND's fenced-in area and to take the dirt and dump it in a field approximately 100 to 150 feet west of the fence. He further advised that defendant Anderson checked on the progress of the job during the day.

During execution of the search warrant on July 25, 1985, a number of soil samples were taken from bore holes at various locations in the unfenced area west of YEAR-A-ROUND's plant site. These soil samples were analyzed by both the BCA and Minnesota Department of Health. The test results show that the soil contained amounts of toluene and xylenes, which are volatile hydrocarbons considered hazardous wastes under Minn. Stat. ch. 116 and MPCA rules. Components of mineral spirits were also indicated in three of the soil samples. Under Minn. Stat. ch. 115 and 116, such hazardous waste products are to be disposed of only at authorized facilities. The area west of defendant YEAR-A-ROUND's Mankato plant site is not an authorized facility.

COMPLAINT/INDICTMENT SUPPLEMENT

CCT SECTION/Subdivisio. U.O.C. GOC

PAGE 7 of 9

SJIS COMPLAINT NUMBER(S):

The above facts constitute complainant's basis for believing that on the dates specified in the following counts, in the City of Mankato, County of Blue Earth, Minnesota, the defendants YEAR-A-ROUND CAB CO. and Charles Merton Anderson committed the following described offenses:

COUNT I

CHARGE:	Unlawful Disposal of Hazardous Waste
IN VIOLATION OF:	Minn. Stat. § 115.071, subd. 2b; and 609.05
MAXIMUM PENALTY:	Five years/$25,000

That on or about June 26, 1985, Charles Merton Anderson and YEAR-A-ROUND CAB CO., each aiding, advising, hiring, counseling, or conspiring with one another, did knowingly, or with reason to know, dispose of hazardous waste in a manner contrary to the provisions of Chapters 115 or 116, or the standards or rules adopted in accordance with those chapters relating to disposal, to wit: by having a contractor (W. W. Blacktopping) remove dirt and gravel contaminated with hazardous waste from the southwest corner of YEAR-A-ROUND's fenced-in plant site and dumping it over the fence into an open area, which location is not permitted for the disposal of hazardous waste.

COMPLAINT SUPPLEMENT

CCT SECTION/Subdivision U.O.C. GOC

SJIS COMPLAINT NUMBER(S):

COUNT II

CHARGE:	Unlawful Disposal of Hazardous Waste
IN VIOLATION OF:	Minn. Stat. §§ 115.071, subd. 2b; and 609.05
MAXIMUM PENALTY:	Five Years/$25,000

That on or about July 10, 1985, Charles Merton Anderson and YEAR-A-ROUND CAB CO., each aiding, advising, hiring, counseling, or conspiring with one another, did knowingly, or with reason to know, dispose of hazardous waste in a manner contrary to the provisions of Chapters 115 or 116, or the standards or rules adopted in accordance with those chapters relating to disposal, to wit: by instructing and directing an employee to remove soils contaminated with hazardous waste from the southwest corner of YEAR-A-ROUND's fenced-in plant site, dump the soils so removed into an open area west of the fence and grading the dump area with black soil to cover up the excavated soils, which dump area is not a location permitted for the disposal of hazardous waste.

THEREFORE, Complainant requests that said Defendant, subject to bail or conditions of release be:
(1) arrested or that other lawful steps be taken to obtain defendant's appearance in court; or
(2) detained, if already in custody, pending further proceedings;
and that said Defendant otherwise be dealt with according to law.

COMPLAINANT'S NAME: JAMES D. MASSOTH

COMPLAINANT'S SIGNATURE:

Being duly authorized to prosecute the offense(s) charged, I hereby approve this Complaint.

DATE:

PROSECUTING ATTORNEY'S SIGNATURE:

PROSECUTING ATTORNEY:
NAME/TITLE: PAUL R. KEMPAINEN
Special Assistant Attorney General

ADDRESS/TELEPHONE: 117 University Avenue
St. Paul, MN 55155
(612) 296-7573

Court Case #:

FINDING OF PROBABLE CAUSE

From the above sworn facts, and any supporting affidavits or supplemental sworn testimony, I, the Issuing Officer, have determined that probable cause exists to support, subject to bail or conditions of release where applicable, Defendant(s) arrest or other lawful steps be taken to obtain Defendant(s) appearance in Court, or his detention, if already in custody, pending further proceedings. The Defendant(s) is/are thereof charged with the above-stated offense.

XX

SUMMONS

THEREFORE You, THE ABOVE-NAMED DEFENDANT(S, ARE HEREBY SUMMONED to appear on the day of , 19 at AM/PM before the above-named court at to answer this complaint.

IF YOU FAIL TO APPEAR in response to this SUMMONS, a WARRANT FOR YOUR ARREST shall be issued.

WARRANT

EXECUTE IN MINNESOTA ONLY

To the sheriff of the above-named county; or other person authorized to execute this WARRANT: I hereby order, in the name of the State of Minnesota, that the above-named Defendant(s) be apprehended and arrested without delay and brought promptly before the above-named Court (if in session, and if not, before a Judge or Judicial Officer of such Court without unnecessary delay, and in any event not later than 36 hours after the arrest or as soon thereafter as such Judge or Judicial Officer is available) to be dealt with according to law.

ORDER OF DETENTION

Since the above-named Defendant(s) is/are already in custody;

I hereby order; subject to bail or conditions of release, that the above-named Defendant(s) continue to be detained pending further proceedings.

Bail:

Conditions of Release:

This COMPLAINT – SUMMONS, WARRANT, ORDER OF DETENTION was sworn to subscribed before, and issued by the undersigned authorized Issuing Judicial Officer this day of , 19

JUDICIAL OFFICER:

Name: *Signature:*

Title:

Sworn testimony has been given before the Judicial Officer by the following witnesses:

STATE OF MINNESOTA *COUNTY of* BLUE EARTH **State of Minnesota** *Plaintiff,* *vs.* YEAR-A-ROUND CAB COMPANY, *Defendant(s)*	*Clerk's Signature or File Stamp:* *RETURN OF SERVICE* *I hereby Certify and Return that I have served a copy of this COMPLAINT - SUMMONS, WARRANT, ORDER OF DETENTION upon the Defendant(s) herein-named.* *Signature of Authorized Service Agent*

FORM J-1

APPENDIX VI

GPS COORDINATES OF SAMPLING SITES

GPS Coordinates of Sampling Sites

Site	Latitude	Longitude
Hiniker Pond	44° 11.182’ N	94° 01.065’ W
Hallett’s pond	44° 20.289’ N	93° 57.171’ W
Oxbow Lake	44° 11.271’ N	94° 01.178’ W
US -14 Ditch	44° 11.381’ N	94° 01.103’ W

APPENDIX VII

CALCULATIONS AND DATA SOURCES FOR GFLOW

AND MODFLOW GROUNDWATER MODELS

Layer 1 Properties
(trial and error also used to keep cells wet)

B (Aquifer Thickness) = 5 feet
Default bulk density: 43.198kg/ft3
Ss (Specific Storage) =0.0001
Sy (Specific Yield) =0.2
Pe (Effective Porosity) =0.2
Pt (Total Porosity) =0.3
Kx/y (Horizontal/Lateral Conductivity)= 3.97feet/day
Kz (Vertical Conductivity) (Kxy/10)=0.397 feet/day

Layer 2 Properties

B (Aquifer Thickness) = 50 feet (estimated on borings)
Ss (Specific Storage) =0.0001
Sy (Specific Yield) =0.27 (calculated)
Pe (Effective Porosity) =0.38 (calculated)
Pt (Total Porosity) =0.5
Kx/y (Horizontal/Lateral Conductivity)= 59 feet/day
Kz (Vertical Conductivity) (Kxy/10)=5.9 feet/day

Calculations for layer 2:

Conductivity: K as tested in Lab using constant head test:

Trial 1 and 2:

H (cm)	rH (cm)	V (ml)	Constants:	
54	5	104	A (cm3)	31.2
42	5	59	L (cm)	14
69	5	141	t (sec)	60
70	5	288		
45	5	195		
26	5	126		

K=(VL)/(AtH)

Averages= 0.0233cm/sec=18.4M/day=59.0feet/day

Porosity:

(Vd/Vw)/(Vw)=P Averaged P= 0.365

Vw	Vd
14.687	9.269
15.107	9.560
14.902	9.558

Dry Density:

24.911g/9.269cm3
25.589g/9.560cm3
25.768g/9.558cm3
=Averaged: 2.68g/cm3
=2680kg/m3

Dispersion default: 32.808 feet/day

Lead parameters:

DL=0.01754L^1.46 Fetter Equation (10.9)
L=300M (0.3KM)
DL= (0.003) (default 0.011)

SP1= 235 (based on pH of 7.2 in soil on semi logarithmic plot of C/C0
(Lee et al., 1998)

SP2= 0.2
(Shawabkeh, R. & Mahasneh, B., 2004)

Coeff= 1 (default)

BTEX parameters:

All used as default

Minnesota Unique Well No.

190612

County Nicollet
Quad Mankato West
Quad ID 59A

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 04/13/1988
Update Date 05/07/2010
Received Date

Well Name WOLFE, WALLY

Township Range Dir Section Subsections Elevation 774 ft.

108 27 W 1 BDDCDA Elevation Method 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
83 ft.	82 ft.	03/03/1984

Drilling Method Non-specified Rotary

Well Address

NORTH MANKATO MN 56001

Geological Material	Color	Hardness	From	To
DIRT	BLACK	SOFT	0	1
CLAY	YELLOW	SOFT	1	25
CLAY	BLUE	SOFT	25	76
SAND	BROWN	SOFT	76	83
ROCK			83	83

Drilling Fluid –

Well Hydrofractured? ☐ Yes ☐ No
From ft. to ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below 1 ft.

Casing Diameter 5 in. to 76 ft. Weight lbs./ft. Hole Diameter 9 in. to 82 ft.

Open Hole from ft. to ft.

Screen YES Make JOHNSON Type stainless steel

Diameter 4 Slot/Gauze 18 Length 7 Set Between 76 ft. and 82 ft.

Static Water Level
65 ft. from Land surface Date Measured 03/03/1984

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 35 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
ROCK AT 83 FT.

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 35 ft. 0

Located by: Mankato State University Method: Digitized - scale 1:24,000 or larger (Digitizing Table)

Unique Number Verification: Information from owner Input Date: 01/01/1990

System: UTM - Nad83, Zone15, Meters X: 419494 Y: 4893380

Nearest Known Source of Contamination
50 feet S direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☑ Not Installed Date Installed 04/25/1984
Manufacturer's name RED JACKET Model number 9BC9 HP 0.5 Volts 230
Length of drop Pipe 60 ft. Capacity 10 g.p.m Type Submersible Material Plastic

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

St. Peter Well Drilling	03072	VOLK, J.
License Business Name	Lic. Or Reg. No.	Name of Driller

First Bedrock St.Lawrence Formation
Last Strat St.Lawrence Formation
Aquifer Quat. Buried Artes. Aquifer
Depth to Bedrock 83 ft.

County Well Index Online Report **190612** Printed 5/17/2012 HE-01205-07

Minnesota Unique Well No. **452663**

County: Nicollet
Quad: Mankato West
Quad ID: 59A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING RECORD
Minnesota Statutes Chapter 103I

Entry Date: 06/28/1991
Update Date: 06/08/2010
Received Date:

Well Name: MICHELS, DENNIS

Township Range Dir Section Subsections Elevation: 771 ft.
108 26 W 7 BBACDD
Elevation Method: 7.5 minute topographic map (+/- 5 feet)

Well Depth: 55 ft. | Depth Completed: 55 ft. | Date Well Completed: 03/05/1963

Drilling Method: Non-specified Rotary

Well Address
1102 RIVER DR N
NORTH MANKATO MN 56001

Drilling Fluid: Bentonite
Well Hydrofractured? Yes No
From ft. to ft.

Use: Domestic

Geological Material	Color	Hardness	From	To
BLACK TOP	BLACK	HARD	0	1
GRAVEL	BROWN	SOFT	1	5
CLAY	BROWN	SOFT	5	15
SAND	BROWN	SOFT	15	55

Casing Type: Plastic Joint: No Information Drive Shoe? Yes ☑ No Above/Below: 2 ft.

Casing Diameter: 5 in. to 50 ft. Weight: lbs./ft. Hole Diameter: 9 in. to 55 ft.

Open Hole: from ft. to ft.

Screen: YES Make: JOHNSON Type: stainless steel

Diameter	Slot/Gauze	Length	Set Between
5	18	7.5	50 ft. and 55 ft.

Static Water Level
30 ft. from Land surface Date Measured: 03/05/1963

PUMPING LEVEL (below land surface)
0 ft. after hrs. pumping 10 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
Casing Protection 12 in. above grade
At-grade (Environmental Wells and Borings ONLY)

Grouting Information: Well Grouted? ☑ Yes No

Grout Material: Neat Cement from 0 to 30 ft. 0.5 yds.
Grout Material: Bentonite from 30 to 42 ft. 0

NO REMARKS

Located by: Minnesota Geological Survey
Method: Digitized - scale 1:24,000 or larger (Digitizing Table)
Unique Number Verification: Information from neighbor
Input Date: 06/01/1993
System: UTM - Nad83, Zone15, Meters X: 418663 Y: 4892284

Nearest Known Source of Contamination
53 feet E direction Septic tank/drain field type
Well disinfected upon completion? Yes No

Pump: Not Installed Date Installed
Manufacturer's name Model number HP 0 Volts
Length of drop Pipe ft. Capacity g.p.m Type Material

Abandoned Wells: Does property have any not in use and not sealed well(s)? Yes No

Variance: Was a variance granted from the MDH for this well? Yes No

Well Contractor Certification
Sander Well Co. — License Business Name
68038 — Lic. Or Reg. No.
VOLK, J. — Name of Driller

First Bedrock
Last Strat: sand-brown
Aquifer: Quat. Buried Uncon. Aquifer
Depth to Bedrock: ft.

County Well Index Online Report | 452663 | Printed 5/17/2012 HE-01205-07

Minnesota Unique Well No.

568068

County Nicollet
Quad Mankato West
Quad ID 59A

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 04/02/1996
Update Date 12/30/2008
Received Date

Well Name HENSEL, GORDON

Township	Range	Dir	Section	Subsections	Elevation	
108	27	W	1	CAABCC	Elevation Method	810 ft. 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
81 ft.	81 ft.	08/10/1995

Drilling Method Non-specified Rotary

Well Address

NORTH MANKATO MN 56003

Geological Material	Color	Hardness	From	To
SOIL	BLACK	SOFT	0	2
CLAY	YELLOW	SOFT	2	10
CLAY	BLUE	SOFT	10	65
SAND	BROWN	SOFT	65	81

Drilling Fluid Water

Well Hydrofractured? ☐ Yes ☐ No
From ft. to ft.

Use Domestic

Casing Type Plastic Joint No Information Drive Shoe? ☐ Yes ☑ No Above/Below 0 ft.

Casing Diameter	Weight	Hole Diameter
5 in. to 75 ft.	lbs./ft.	6.75 in. to 81 ft.

Open Hole from ft. to ft.

Screen YES Make COOK Type stainless steel

Diameter	Slot/Gauze	Length	Set Between
5	18	7.5	76 ft. and 81 ft.

Static Water Level
30 ft. from Land surface Date Measured 08/10/1995

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 20 g.p.m.

Well Head Completion
Pitless adapter manufacturer MAASS Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Bentonite from 0 to 30 ft. 2 bags

Located by: Minnesota Geological Survey
Method: Digitized - scale 1:24,000 or larger (Digitizing Table)

Unique Number Verification: Tag on well
Input Date: 06/01/1993

System: UTM - Nad83, Zone15, Meters
X: 418397 Y: 4893159

Nearest Known Source of Contamination
60 feet North East direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☑ Not Installed Date Installed 08/14/1995
Manufacturer's name AERMOTOR Model number 812058 HP 0.5 Volts 230
Length of drop Pipe 60 ft. Capacity 12 g.p.m Type Submersible Material Plastic

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

First Bedrock
Last Strat sand-brown

Aquifer Quat. Buried Artes. Aquifer
Depth to Bedrock ft.

Well Contractor Certification

Sander Well Co.	58058	VOLK, J.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report

568068

Printed 5/17/2012
HE-01205-07

APPENDIX VIII

DETAILED RESULTS OF LABORATORY ANALYSIS CONDUCTED ON WATER SAMPLES COLLECTED MAY 19, 2011 BY MINNESOTA VALLEY TESTING LABORATORIES, NEW ULM, MINNESOTA

MINNESOTA VALLEY TESTING LABORATORIES, INC.

MVTL
1126 N. Front St. ~ New Ulm, MN 56073 ~ 800-782-3557 ~ Fax 507-359-2890
1411 S. 12th St. ~ Bismarck, ND 58502 ~ 800-279-6885 ~ Fax 701-258-9724
51 L Avenue ~ Nevada, IA 50201 ~ 800-362-0855 ~ Fax 515-382-3885
www.mvtl.com

MEMBER ACIL

Page: 1 of 3

Report Date: 3 Jun 2011
Lab Number: 11-A22680
Work Order #:22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 9:30
Date Received: 20 May 2011

Temp at Receipt: 0.5 C

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Sample Description: MSU 1A, 1B, 1C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Water Digestions					26 May 11	JMS
Cadmium	< 0.005	mg/L	0.005	SW6010	26 May 11 20:45	MM
Chromium	< 0.01	mg/L	0.01	SW6010	26 May 11 20:45	MM
Lead	< 0.03	mg/L	0.03	SW6010	26 May 11 20:45	MM

Approved by: [signature]

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix
! = Due to sample quantity
= Due to concentration of other analytes
+ = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 [illegible]

MINNESOTA VALLEY TESTING LABORATORIES, INC.

MVTL

1126 N. Front St. ~ New Ulm, MN 56073 ~ 800-782-3557 ~ Fax 507-359-2890
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MEMBER ACIL

Report Date: 3 Jun 2011
Lab Number: 11-A22680
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Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 9:30
Sampled By:
Date Received: 20 May 2011

Temp at Receipt: 0.5 C

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Sample Description: MSU 1A, 1B, 1C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Acetone	67-64-1	< 10	ug/L	10	SW8260B	1 Jun 11	DWR
Allyl Chloride	107-05-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Benzene	71-43-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromobenzene	108-86-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromochloromethane	74-97-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromodichloromethane	75-27-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromoform	75-25-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromomethane	74-83-9	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
n-Butylbenzene	104-51-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
sec-Butylbenzene	135-98-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
t-Butylbenzene	98-06-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Carbon Tetrachloride	56-23-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chlorobenzene	108-90-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chlorodibromomethane	124-48-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Ch[illegible]ethane	75-00-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Ch[illegible]form	67-66-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chloromethane	74-87-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
2-Chlorotoluene	95-49-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
4-Chlorotoluene	106-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Cumene	98-82-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dibromo-3-chloropropane	96-12-8	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
1,2-Dibromoethane	106-93-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dibromomethane	74-95-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichlorobenzene	95-50-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3-Dichlorobenzene	541-73-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,4-Dichlorobenzene	106-46-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dichlorodifluoromethane	75-71-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloroethane	75-34-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichloroethane	107-06-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloroethene	75-35-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
cis-1,2-Dichloroethene	156-59-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
trans-1,2-Dichloroethene	156-60-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dichlorofluoromethane	75-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichloropropane	78-87-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3-Dichloropropane	142-28-9	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
2,2-Dichloropropane	594-20-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloropropene	563-58-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
cis-1,3-Dichloropropene	10061-01-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
trans-1,3-Dichloropropene	10061-02-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Ethyl Benzene	100-41-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR

Reporting limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
\# = Due to sample matrix   # = Due to concentration of other analytes
! = Due to sample quantity   + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 ND LAB # [illegible] ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: 132 IA LAB #: [illegible]

MINNESOTA VALLEY TESTING LABORATORIES, INC.
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MEMBER ACIL

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
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Report Date: 3 Jun 2011
Lab Number: 11-A22680
Work Order: 22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 9:30
Sampled By:
Date Received: 20 May 2011

Temp at Receipt: 0.5 C

Sample Description: MSU 1A, 1B, 1C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Ethyl Ether	60-29-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Hexachlorobutadiene	87-68-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
p-Isopropyltoluene	99-87-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Methyl Ethyl Ketone	78-93-3	< 5	ug/L	5	SW8260B	1 Jun 11	DWR
Methyl Isobutyl Ketone	108-10-1	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Methyl tert-butyl Ether	1634-04-4	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Methylene Chloride	75-09-2	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Naphthalene	91-20-3	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
n-Propylbenzene	103-65-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Styrene	100-42-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,1,2-Tetrachloroethane	630-20-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,2,2-Tetrachloroethane	79-34-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Tetrachloroethene	127-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Tetrahydrofuran	109-99-9	< 5	ug/L	5	SW8260B	1 Jun 11	DWR
To[illegible]e	108-88-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,[illegible]Trichlorobenzene	87-61-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,4-Trichlorobenzene	120-82-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,1-Trichloroethane	71-55-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,2-Trichloroethane	79-00-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichloroethene	79-01-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichlorofluoromethane	75-69-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,3-Trichloropropane	96-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichlorotrifluoroethane	76-13-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,4-Trimethylbenzene	95-63-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3,5-Trimethylbenzene	108-67-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Vinyl Chloride	75-01-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
m-Xylene and p-Xylene	179601-23-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
o-Xylene	95-47-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR

DIBROMOFLUOROMETHANE (SURROGATE) RECOVERY: 97 %
TOLUENE-d8 (SURROGATE) RECOVERY: 92 %
4-BROMOFLUOROBENZENE (SURROGATE) RECOVERY: 97 %

Approved by: R. Dan O'Connell

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

Reporting limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
= Due to sample matrix * = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND ENVIRO # R-040 IA LAB #: 132 IA LAB #: 032

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-A22681
Work Order #:22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 10:00
Date Received: 20 May 2011

Sample Description: MSU 2A, 2B, 2C

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Water Digestions					26 May 11	JMS
Cadmium	< 0.005	mg/L	0.005	SW6010	26 May 11 20:45	RH
Chromium	< 0.01	mg/L	0.01	SW6010	26 May 11 20:45	RH
Lead	< 0.03	mg/L	0.03	SW6010	26 May 11 20:45	RH

Approved by: [signature]

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
[illegible]

CERTIFICATION: MN LAB # [illegible] WI LAB # [illegible] ND MICRO # [illegible] ND WATER # [illegible] IA LAB #: [illegible] IA LAB #: [illegible]

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-A22481
Work Order: 22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 10:00
Sampled By:
Date Received: 20 May 2011

Sample Description: MSU 2A, 2B, 2C

Temp at Receipt: 0.5 C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Acetone	67-64-1	< 10	ug/L	10	SW8260B	1 Jun 11	DWR
Allyl Chloride	107-05-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Benzene	71-43-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromobenzene	108-86-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromochloromethane	74-97-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromodichloromethane	75-27-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromoform	75-25-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromomethane	74-83-9	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
n-Butylbenzene	104-51-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
sec-Butylbenzene	135-98-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
t-Butylbenzene	98-06-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Carbon Tetrachloride	56-23-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chlorobenzene	108-90-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chlorodibromomethane	124-48-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chl thane	75-00-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chl form	67-66-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chloromethane	74-87-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
2-Chlorotoluene	95-49-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
4-Chlorotoluene	106-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Cumene	98-82-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dibromo-3-chloropropane	96-12-8	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
1,2-Dibromoethane	106-93-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dibromomethane	74-95-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichlorobenzene	95-50-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3-Dichlorobenzene	541-73-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,4-Dichlorobenzene	106-46-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dichlorodifluoromethane	75-71-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloroethane	75-34-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichloroethane	107-06-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloroethene	75-35-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
cis-1,2-Dichloroethene	156-59-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
trans-1,2-Dichloroethene	156-60-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dichlorofluoromethane	75-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichloropropane	78-87-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3-Dichloropropane	142-28-9	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
2,2-Dichloropropane	590-20-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloropropene	563-58-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
cis-1,3-Dichloropropene	10061-01-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
trans-1,3-Dichloropropene	10061-02-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Ethyl Benzene	100-41-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR

. Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: 132 IA LAB #: 002

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Report Date: 3 Jun 2011
Lab Number: 11-A22681
Work Order: 22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 10:00
Sampled By:
Date Received: 20 May 2011

Temp at Receipt: 0.5 C

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Sample Description: MSU 2A, 2B, 2C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Ethyl Ether	60-29-7	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Hexachlorobutadiene	87-68-3	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
p-Isopropyltoluene	99-87-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Methyl Ethyl Ketone	78-93-3	< 5	ug/L	5	SW8260B	1 Jun 11	DMR
Methyl Isobutyl Ketone	108-10-1	< 2	ug/L	2	SW8260B	1 Jun 11	DMR
Methyl tert-butyl Ether	1634-04-4	< 2	ug/L	2	SW8260B	1 Jun 11	DMR
Methylene Chloride	75-09-2	< 2	ug/L	2	SW8260B	1 Jun 11	DMR
Naphthalene	91-20-3	< 2	ug/L	2	SW8260B	1 Jun 11	DMR
n-Propylbenzene	103-65-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Styrene	100-42-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,1,1,2-Tetrachloroethane	630-20-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,1,2,2-Tetrachloroethane	79-34-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Tetrachloroethene	127-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Tetrahydrofuran	109-99-9	< 5	ug/L	5	SW8260B	1 Jun 11	DMR
Tol e	108-88-3	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2 Trichlorobenzene	87-61-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2,4-Trichlorobenzene	120-82-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,1,1-Trichloroethane	71-55-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,1,2-Trichloroethane	79-00-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Trichloroethene	79-01-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Trichlorofluoromethane	75-69-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2,3-Trichloropropane	96-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Trichlorotrifluoroethane	76-13-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2,4-Trimethylbenzene	95-63-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,3,5-Trimethylbenzene	108-67-8	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Vinyl Chloride	75-01-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
m-Xylene and p-Xylene	179601-23-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
o-Xylene	95-47-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR

DIBROMOFLUOROMETHANE (SURROGATE) RECOVERY: 99 %
TOLUENE-d8 (SURROGATE) RECOVERY: 92 %
4-BROMOFLUOROBENZENE (SURROGATE) RECOVERY: 97 %

Approved by: R. Dan O'Connell

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

RL Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: 136 IA LAB #: 332

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56[illegible]

Report Date: 3 Jun 2011
Lab Number: 11-A22882
Work Order #:22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 11:00
Date Received: 20 May 2011

Sample Description: MSU 3A, 3B, 3C

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Water Digestions					26 May 11	JMS
Cadmium	< 0.005	mg/L	0.005	SW6010	26 May 11 20:45	RH
Chromium	< 0.01	mg/L	0.01	SW6010	26 May 11 20:45	RH
Lead	< 0.03	mg/L	0.03	SW6010	26 May 11 20:45	RH

Approved by: [signature]

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

Reporting limit

The reporting limit was elevated for any analyte requiring a dilution as noted below:
@ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # [illegible] WI LAB # [illegible] ND MICRO # [illegible] ND WATER # [illegible] IA LAB #: [illegible] SD LAB #: [illegible]

MINNESOTA VALLEY TESTING LABORATORIES, INC.
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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-A22682
Work Order: 22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 11:00
Sampled By:
Date Received: 20 May 2011

Sample Description: MSU 3A, 3B, 3C

Temp at Receipt: 0.5 C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Acetone	67-64-1	< 10	ug/L	10	SW8260B	1 Jun 11	DWR
Allyl Chloride	107-05-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Benzene	71-43-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromobenzene	108-86-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromochloromethane	74-97-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromodichloromethane	75-27-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromoform	75-25-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Bromomethane	74-83-9	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
n-Butylbenzene	104-51-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
sec-Butylbenzene	135-98-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
t-Butylbenzene	98-06-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Carbon Tetrachloride	56-23-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chlorobenzene	108-90-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chlorodibromomethane	124-48-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chl [illegible]thane	75-00-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chl [illegible]form	67-66-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Chloromethane	74-87-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
2-Chlorotoluene	95-49-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
4-Chlorotoluene	106-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Cumene	98-82-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dibromo-3-chloropropane	96-12-8	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
1,2-Dibromoethane	106-93-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dibromomethane	74-95-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichlorobenzene	95-50-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3-Dichlorobenzene	541-73-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,4-Dichlorobenzene	106-46-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dichlorodifluoromethane	75-71-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloroethane	75-34-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichloroethane	107-06-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloroethene	75-35-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
cis-1,2-Dichloroethene	156-59-2	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
trans-1,2-Dichloroethene	156-60-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Dichlorofluoromethane	75-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2-Dichloropropane	78-87-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3-Dichloropropane	142-28-9	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
2,2-Dichloropropane	594-20-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1-Dichloropropene	563-58-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
cis-1,3-Dichloropropene	10061-01-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
trans-1,3-Dichloropropene	10061-02-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Ethyl Benzene	100-41-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR

RL = Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: [illegible] IA LAB #: [illegible]

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Report Date: 3 Jun 2011
Lab Number: 11-A22682
Work Order: 22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 11:00
Sampled By:
Date Received: 20 May 2011

Temp at Receipt: 0.5 C

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Sample Description: MSU 3A, 3B, 3C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Ethyl Ether	60-29-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Hexachlorobutadiene	87-68-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
p-Isopropyltoluene	99-87-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Methyl Ethyl Ketone	78-93-3	< 5	ug/L	5	SW8260B	1 Jun 11	DWR
Methyl Isobutyl Ketone	108-10-1	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Methyl tert-butyl Ether	1634-04-4	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Methylene Chloride	75-09-2	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Naphthalene	91-20-3	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
n-Propylbenzene	103-65-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Styrene	100-42-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,1,2-Tetrachloroethane	630-20-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,2,2-Tetrachloroethane	79-34-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Tetrachloroethene	127-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Tetrahydrofuran	109-99-9	< 5	ug/L	5	SW8260B	1 Jun 11	DWR
To' e	108-88-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,. Trichlorobenzene	87-61-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,4-Trichlorobenzene	120-82-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,1-Trichloroethane	71-55-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,2-Trichloroethane	79-00-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichloroethene	79-01-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichlorofluoromethane	75-69-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,3-Trichloropropane	96-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichlorotrifluoroethane	76-13-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,4-Trimethylbenzene	95-63-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3,5-Trimethylbenzene	108-67-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Vinyl Chloride	75-01-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
m-Xylene and p-Xylene	179601-23-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
o-Xylene	95-47-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR

DIBROMOFLUOROMETHANE (SURROGATE) RECOVERY: 98 %
TOLUENE-D8 (SURROGATE) RECOVERY: 94 %
4-BROMOFLUOROBENZENE (SURROGATE) RECOVERY: 98 %

Approved by:

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

[illegible]

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: [illegible]

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-A22483
Work Order #:22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 13:30
Date Received: 20 May 2011

Sample Description: MSU 5A, 5B, 5C

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Water Digestions					26 May 11	JMS
Cadmium	< 0.005	mg/L	0.005	SW6010	26 May 11 20:45	RH
Chromium	< 0.01	mg/L	0.01	SW6010	26 May 11 20:45	RH
Lead	< 0.03	mg/L	0.03	SW6010	26 May 11 20:45	RH

Approved by: [signature]

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
= Due to sample matrix ! = Due to sample quantity
& = Due to concentration of other analytes + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WATER # R-040 IA LAB #: 102 IA LAB #: 312

MINNESOTA VALLEY TESTING LABORATORIES, INC.
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51 E. Avenue ~ Nevada, IA 50201 ~ 800-362-0855 ~ Fax 515-382-3885
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MEMBER ACIL

Report Date: 3 Jun 2011
Lab Number: 11-A22683
Work Order: 22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 13:30
Sampled By:
Date Received: 20 May 2011

Temp at Receipt: 0.5 C

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Sample Description: MSU 5A, 5B, 5C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Acetone	67-64-1	< 10	ug/L	10	SW8260B	1 Jun 11	DMR
Allyl Chloride	107-05-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Benzene	71-43-2	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Bromobenzene	108-86-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Bromochloromethane	74-97-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Bromodichloromethane	75-27-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Bromoform	75-25-2	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Bromomethane	74-83-9	< 2	ug/L	2	SW8260B	1 Jun 11	DMR
n-Butylbenzene	104-51-8	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
sec-Butylbenzene	135-98-8	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
t-Butylbenzene	98-06-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Carbon Tetrachloride	56-23-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Chlorobenzene	108-90-7	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Chlorodibromomethane	124-48-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Ch) ethane	75-00-3	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Ch. form	67-66-3	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Chloromethane	74-87-3	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
2-Chlorotoluene	95-49-8	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
4-Chlorotoluene	106-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Cumene	98-82-8	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2-Dibromo-3-chloropropane	96-12-8	< 2	ug/L	2	SW8260B	1 Jun 11	DMR
1,2-Dibromoethane	106-93-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Dibromomethane	74-95-3	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2-Dichlorobenzene	95-50-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,3-Dichlorobenzene	541-73-1	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,4-Dichlorobenzene	106-46-7	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Dichlorodifluoromethane	75-71-8	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,1-Dichloroethane	75-34-3	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2-Dichloroethane	107-06-2	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,1-Dichloroethene	75-35-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
cis-1,2-Dichloroethene	156-59-2	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
trans-1,2-Dichloroethene	156-60-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Dichlorofluoromethane	75-43-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,2-Dichloropropane	78-87-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,3-Dichloropropane	142-28-9	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
2,2-Dichloropropane	594-20-7	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
1,1-Dichloropropene	563-58-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
cis-1,3-Dichloropropene	10061-01-5	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
trans-1,3-Dichloropropene	10061-02-6	< 1	ug/L	1	SW8260B	1 Jun 11	DMR
Ethyl Benzene	100-41-4	< 1	ug/L	1	SW8260B	1 Jun 11	DMR

. Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: [illegible] IA LAB #: [illegible]

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Report Date: 3 Jun 2011
Lab Number: 11-A22683
Work Order: 22-2238
Account #: 013359
Sample Matrix: GROUNDWATER
Date Sampled: 19 May 2011 13:30
Sampled By:
Date Received: 20 May 2011

Temp at Receipt: 0.5 C

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Sample Description: MSU 5A, 5B, 5C

	CAS #	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Ethyl Ether	60-29-7	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Hexachlorobutadiene	87-68-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
p-Isopropyltoluene	99-87-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Methyl Ethyl Ketone	78-93-3	< 5	ug/L	5	SW8260B	1 Jun 11	DWR
Methyl Isobutyl Ketone	108-10-1	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Methyl tert-butyl Ether	1634-04-4	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Methylene Chloride	75-09-2	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
Naphthalene	91-20-3	< 2	ug/L	2	SW8260B	1 Jun 11	DWR
n-Propylbenzene	103-65-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Styrene	100-42-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,1,2-Tetrachloroethane	630-20-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,2,2-Tetrachloroethane	79-34-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Tetrachloroethene	127-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Tetrahydrofuran	109-99-9	< 5	ug/L	5	SW8260B	1 Jun 11	DWR
To[illegible] s	108-88-3	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,[illegible] Trichlorobenzene	87-61-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,4-Trichlorobenzene	120-82-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,1-Trichloroethane	71-55-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,1,2-Trichloroethane	79-00-5	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichloroethene	79-01-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichlorofluoromethane	75-69-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,3-Trichloropropane	96-18-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Trichlorotrifluoroethane	76-13-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,2,4-Trimethylbenzene	95-63-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
1,3,5-Trimethylbenzene	108-67-8	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
Vinyl Chloride	75-01-4	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
m-Xylene and p-Xylene	179601-23-1	< 1	ug/L	1	SW8260B	1 Jun 11	DWR
o-Xylene	95-47-6	< 1	ug/L	1	SW8260B	1 Jun 11	DWR

DIBROMOFLUOROMETHANE (SURROGATE) RECOVERY: 97 %
TOLUENE-D8 (SURROGATE) RECOVERY: 93 %
4-BROMOFLUOROBENZENE (SURROGATE) RECOVERY: 97 %

Approved by:

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

\- Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
§ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: 132 CA LAB #: [illegible]

APPENDIX IX

DETAILED RESULTS OF LABORATORY ANALYSIS CONDUCTED ON SOIL/SEDIMENT SAMPLES COLLECTED MAY 19, 2011 BY MINNESOTA VALLEY TESTING LABORATORIES, NEW ULM, MINNESOTA

MINNESOTA VALLEY TESTING LABORATORIES, INC.

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Page: 1 of 2

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-N5323
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 9:30
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 1
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
DRO Solvent Addition					26 May 11	SP
ICP-MS Wet Digestion				SW-846 3050	23 May 11	RBK
Wet Digestion				SW-846 3050	23 May 11	RBK
Percent Moisture	48.8	%	N/A	WI LUST	26 May 11	DWR
Chloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chloromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Bromomethane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Dichlorodifluoromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Vinyl Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Methylene Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Trichlorofluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
[illegible]oroform	* < 50	ug/Kg	50	8021	26 May 11	DWR
[illegible]-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Carbon Tetrachloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromodichloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorodibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromoform	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Tetrachloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Toluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,4-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Allyl Chloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromoethane	* < 50	ug/Kg	50	8021	26 May 11	DWR

RL - Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
\# = Due to sample matrix ; * = Due to concentration of other analytes
! = Due to sample quantity ; : = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: 132 IA LAB #: 002

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-N5323
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 9:30
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 1
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Methyl Ethyl Ketone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Methyl Isobutyl Ketone	* < 200	ug/Kg	200	8021	26 May 11	DWR
Tetrahydrofuran	* < 500	ug/Kg	500	8021	26 May 11	DWR
m-Xylene and p-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
o-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Cumene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichlorotrifluoroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
Acetone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Dibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
2,2-Dichloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Bromochloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
hyl tert-butyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
rene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Propylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
2-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3,5-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
4-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
t-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,4-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
sec-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
p-Isopropyltoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromo-3-chloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
1,2,4-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Hexachlorobutadiene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Naphthalene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Dichlorodifluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chromium	11.6	mg/Kg	0.987	SW-846 6010	26 May 11 14:01	RH
Lead	7.01	mg/Kg	2.96	SW-846 6010	26 May 11 14:01	RH
Cadmium	0.471	mg/Kg	0.019	SW-846 6020	31 May 11 14:31	TB

1-CHLORO-4-FLUOROBENZENE (SURROGATE) RECOVERY: 97 %

* VOCs reported on Dry basis.

Approved by: R. Dan O'Connell

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

! Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix   # = Due to concentration of other analytes
! = Due to sample quantity   + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125   WI LAB # 999447680   ND NDCHS # [illegible]   ND NR/DW # R-040   IA LAB #: 132   IA LAB #: 012

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-M5324
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 10:00
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 2
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
DRO Solvent Addition					26 May 11	SD
ICP-MS Wet Digestion				SW-846 3050	23 May 11	MDE
Wet Digestion				SW-846 3050	23 May 11	MDE
Percent Moisture	45.7	%	N/A	[illegible]	26 May 11	DWR
Chloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chloromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Bromomethane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Dichlorodifluoromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Vinyl Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Methylene Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Trichlorofluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
[illegible]oroform	* < 50	ug/Kg	50	8021	26 May 11	DWR
[illegible]-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Carbon Tetrachloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromodichloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorodibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromoform	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Tetrachloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Toluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,4-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Allyl Chloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromoethane	* < 50	ug/Kg	50	8021	26 May 11	DWR

* = Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 1013-M ND WW/DW # R-040 IA LAB #: 368 IL LAB #: 200

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-N5324
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 10:00
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 2
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Methyl Ethyl Ketone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Methyl Isobutyl Ketone	* < 200	ug/Kg	200	8021	26 May 11	DWR
Tetrahydrofuran	* < 500	ug/Kg	500	8021	26 May 11	DWR
m-Xylene and p-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
o-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Cumene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichlorotrifluoroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
Acetone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Dibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
2,2-Dichloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Bromochloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
hyl tert-butyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
yrene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Propylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
2-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3,5-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
4-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
t-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,4-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
sec-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
p-Isopropyltoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromo-3-chloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
1,2,4-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Hexachlorobutadiene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Naphthalene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Dichlorofluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chromium	20.7	mg/Kg	0.830	SW-846 6010	26 May 11 14:01	KH
Lead	30.8	mg/Kg	2.49	SW-846 6010	26 May 11 14:01	KH
Cadmium	1.25	mg/Kg	0.010	SW-846 6020	31 May 11 14:31	TB

1-CHLORO-4-FLUOROBENZENE (SURROGATE) RECOVERY: 98 %

* VOCs reported on Dry Basis.

Approved by: R. D. O'Connell

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

&. Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
= Due to sample matrix
! = Due to sample quantity
& = Due to concentration of other analytes
+ = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 ND LAB # R-040 IA LAB #: 132 IA LAB #: [illegible]

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-N5325
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 11:00
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 3
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
DRO Solvent Addition					26 May 11	SP
ICP-MS Wet Digestion				SW-846 3050	23 May 11	RBK
Wet Digestion				SW-846 3050	23 May 11	RBK
Percent Moisture	69.6	%	N/A	WI LUST	26 May 11	DWR
Chloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chloromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Bromomethane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Dichlorodifluoromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Vinyl Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Methylene Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Trichlorofluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
oroform	* < 50	ug/Kg	50	8021	26 May 11	DWR
-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Carbon Tetrachloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromodichloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorodibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromoform	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Tetrachloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Toluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,4-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Allyl Chloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromoethane	* < 50	ug/Kg	50	8021	26 May 11	DWR

RL = Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as noted below:
@ = Due to sample matrix   # = Due to concentration of other analytes
! = Due to sample quantity   + = Due to internal standard response

IDENTIFICATION: MN LAB # [illegible] WI LAB # [illegible] ND NDCHS # [illegible] SD SWL/DW # [illegible] IA LAB #: [illegible] IA LAB #: [illegible]

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-N5325
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 11:00
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 3
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Methyl Ethyl Ketone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Methyl Isobutyl Ketone	* < 200	ug/Kg	200	8021	26 May 11	DWR
Tetrahydrofuran	* < 500	ug/Kg	500	8021	26 May 11	DWR
m-Xylene and p-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
o-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Cumene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichlorotrifluoroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
Acetone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Dibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
2,2-Dichloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Bromochloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
hyl tert-butyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
rene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Propylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
2-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3,5-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
4-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
t-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,4-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
sec-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
p-Isopropyltoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromo-3-chloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
1,2,4-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Hexachlorobutadiene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Naphthalene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Dichlorofluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chromium	3.45	mg/Kg	0.231	SW-846 6010	26 May 11 14:01	RH
Lead	< 0.694	mg/Kg	0.694	SW-846 6010	26 May 11 14:01	RH
Cadmium	0.200	mg/Kg	0.002	SW-846 6020	31 May 11 14:31	TB

1-CHLORO-4-FLUOROBENZENE (SURROGATE) RECOVERY: 96 %

* VOCs reported on Dry basis.

Approved by: R. D. O'Connell

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

[illegible]

The reporting limit was elevated for any analyte requiring a dilution as coded below:
[illegible]

CERTIFICATION: MN LAB # 027-015-125 WI LAB # 999447680 ND MICRO # 2011-M ND WW/DW # R-040 IA LAB #: 132 IA LAB #: [illegible]

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Page: 1 of 2

BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-N5326
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 13:30
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 5
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
DRO Solvent Addition					26 May 11	SP
ICP-MS Wet Digestion				SW-846 3050	23 May 11	RSE
Wet Digestion				SW-846 3050	23 May 11	RSE
Percent Moisture	82.1	%	N/A	MI LUST	26 May 11	DWR
Chloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chloromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Bromomethane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Dichlorodifluoromethane	* < 200	ug/Kg	200	8021	26 May 11	DWR
Vinyl Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Methylene Chloride	* < 100	ug/Kg	100	8021	26 May 11	DWR
Trichlorofluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
loroform	* < 50	ug/Kg	50	8021	26 May 11	DWR
2-Dichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Carbon Tetrachloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromodichloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
trans-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorodibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2-Trichloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,3-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromoform	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,2,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Tetrachloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Toluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Benzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,4-Dichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
cis-1,2-Dichloroethene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3-Dichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichloropropane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Allyl Chloride	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromoethane	* < 50	ug/Kg	50	8021	26 May 11	DWR

* - Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
@ = Due to sample matrix   # = Due to concentration of other analytes
! = Due to sample quantity   + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125   WI LAB # 999447680   ND WW/DW # 1013-M   SD WW/DW # R-040   IA LAB #: 132   IA LAB #: 031

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BETH PROCTOR
MN STATE UNIVERSITY/MANKATO
415 MALIN ST
MANKATO MN 56001

Report Date: 3 Jun 2011
Lab Number: 11-N5326
Work Order #:22-2238
Account #: 013359
Sample Matrix: SOIL
Date Sampled: 19 May 2011 13:30
Date Received: 20 May 2011
PO #: PREPAID

Sample Description: MSU 5
SEDIMENT

Temp at Receipt: 0.5 C

	As Received Result		Method RL	Method Reference	Date Analyzed	Analyst
Methyl Ethyl Ketone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Methyl Isobutyl Ketone	* < 200	ug/Kg	200	8021	26 May 11	DWR
Tetrahydrofuran	* < 500	ug/Kg	500	8021	26 May 11	DWR
m-Xylene and p-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
o-Xylene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Cumene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1,1,2-Tetrachloroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,1-Dichloropropene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Trichlorotrifluoroethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Ethyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
Acetone	* < 500	ug/Kg	500	8021	26 May 11	DWR
Dibromomethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
2,2-Dichloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
Bromochloromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
[illegible]thyl tert-butyl Ether	* < 50	ug/Kg	50	8021	26 May 11	DWR
[illegible]ene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Propylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Bromobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
2-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,3,5-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
4-Chlorotoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
t-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,4-Trimethylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
sec-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
p-Isopropyltoluene	* < 50	ug/Kg	50	8021	26 May 11	DWR
n-Butylbenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2-Dibromo-3-chloropropane	* < 100	ug/Kg	100	8021	26 May 11	DWR
1,2,4-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Hexachlorobutadiene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Naphthalene	* < 50	ug/Kg	50	8021	26 May 11	DWR
1,2,3-Trichlorobenzene	* < 50	ug/Kg	50	8021	26 May 11	DWR
Dichlorofluoromethane	* < 50	ug/Kg	50	8021	26 May 11	DWR
Chromium	2.01	mg/Kg	0.236	SW-846 6010	26 May 11 14:01	RH
Lead	< 0.709	mg/Kg	0.709	SW-846 6010	26 May 11 14:01	RH
Cadmium	0.129	mg/Kg	0.002	SW-846 6020	31 May 11 14:31	TB

1-CHLORO-4-FLUOROBENZENE (SURROGATE) RECOVERY: 59 %

* VOCs reported on Dry basis.

Approved by:

Dan O'Connell, Chemistry Laboratory Manager New Ulm, MN

Reporting Limit

The reporting limit was elevated for any analyte requiring a dilution as coded below:
[illegible] = Due to sample matrix # = Due to concentration of other analytes
! = Due to sample quantity + = Due to internal standard response

CERTIFICATION: MN LAB # 027-015-125 [illegible]

APPENDIX X

DETAILED FIELD PARAMETER, NUTRIENT LEVEL, SULFATE,

AND E. COLI RESULTS MAY-NOVEMBER 2011

Lake/ Waterbody	Date	E. ecoli (CFU/100ml)	pH	Conductivity Surface (mohm/cm)	Conductivity 5ft (mohm/cm)	Conductivity 10ft (mohm/cm)
HINIKER	5/19	2.0	7.9	1.098	1.114	1.144
HINIKER	6/1	2.0	6.8	1.041	1.095	1.133
HINIKER	6/14	98.7	7.9	1.119	1.119	1.127
HINIKER	6/22	5.1	7.3	1.086	1.117	1.138
HINIKER	7/12	6.3	7.3	1.123	1.141	1.128
HINIKER	7/27	4.1	4.5	1.057	1.073	1.112
HINIKER	8/15	2,419.6	7.1	1.060	1.058	1.070
HINIKER	8/30	0.0	7.9	1.011	1.012	1.045
HINIKER	9/13	4.1	7.5	1.014	1.014	1.042
HINIKER	9/27	18.7	7.1	0.999	1.000	1.002
HINIKER	10/11	4.1	7.4	0.986	0.986	0.989
HINIKER	10/25	3.0	7.2	1.019	1.019	1.019
HINIKER	11/9	9.0	8.0	1.011	1.010	1.010

Lake/ Waterbody	Date	Conductivity 15ft (mohm/cm)	Temperatur e Surface (°C)	Temperature 5ft (°C)	Temperatur e 10ft (°C)	Temperatur e 15ft (°C)
HINIKER	5/19	1.152	18.1	16.0	12.7	9.6
HINIKER	6/1	1.153	19.7	18.5	13.7	10.0
HINIKER	6/14	1.139	20.5	20.7	18.5	11.0
HINIKER	6/22	1.128	22.4	21.8	18.2	11.1
HINIKER	7/12	1.134	26.5	26.4	20.8	18.9
HINIKER	7/27	1.112	30.0	27.9	22.1	14.7
HINIKER	8/15	1.110	26.5	25.4	24.4	14.7
HINIKER	8/30	1.153	24.1	24.1	23.3	15.8
HINIKER	9/13	1.099	22.1	22.6	21.6	20.3
HINIKER	9/27	1.012	17.3	17.1	16.9	16.7
HINIKER	10/11		17.9	18.0	17.3	
HINIKER	10/25	1.019	12.0	12.0	12.0	12.0
HINIKER	11/9	1.010	8.1	8.2	8.2	8.2

Lake/ Waterbody	Date	Secchi Disk (M)	Dissolved Oxygen Surface (ppm)	Dissolved Oxygen 5ft (ppm)	Dissolved Oxygen 10ft (ppm)	Dissolved Oxygen 15ft (ppm)
HINIKER	5/19	1.5	15.70	10.20	3.50	
HINIKER	6/1	1.0	11.20	10.10	0.20	0.00
HINIKER	6/14	1.5	8.93	9.04	0.75	0.08
HINIKER	6/22	2.5	8.40	7.60	1.70	0.07
HINIKER	7/12	2.5	8.50	10.00	10.00	2.00
HINIKER	7/27	1.8	11.30	15.40	0.40	0.20
HINIKER	8/15	1.8	9.00	8.60	2.00	0.20
HINIKER	8/30	1.0	11.50	11.40	0.30	0.00
HINIKER	9/13	1.0	10.20	10.50	2.50	0.10
HINIKER	9/27	0.5	8.54	6.98	3.60	0.60
HINIKER	10/11	1.0	9.40	9.40	6.90	0.20
HINIKER	10/25	1.0	8.30	7.90	7.60	2.50
HINIKER	11/9	1.0	10.00	9.45	9.45	8.75

Lake/ Waterbody	Date	Total P Surface (ppm)	Total P 10ft (ppm)	P-PO4 Surface (ppm)	P-PO4 10ft (ppm)	N-NO2 Surface (ppm)
HINIKER	5/19	0.10	0.12	0.10	0.14	0.0069
HINIKER	6/1	0.10	0.11	0.08	0.11	0.0030
HINIKER	6/14	0.09	0.06	0.12	0.11	0.0076
HINIKER	6/22	0.10	0.08	0.04	0.02	0.0037
HINIKER	7/12	0.09	0.11	0.03	0.04	0.0013
HINIKER	7/27	0.10	0.14	0.06	0.04	0.0120
HINIKER	8/15	0.66	0.10	0.59	0.05	0.0061
HINIKER	8/30	0.08	0.15	0.04	0.05	0.0064
HINIKER	9/13	0.10	0.13	0.26	0.02	0.0003
HINIKER	9/27	0.15	0.09	0.09	0.02	0.0053
HINIKER	10/11	0.07	0.08	0.02	0.02	0.0070
HINIKER	10/25	0.14	0.13	0.02	0.04	0.0015
HINIKER	11/9	0.10	0.11	0.14	0.10	0.0046

Lake/ Waterbody	Date	N-NO2 10ft (ppm)	N-NO3 Surface (ppm)	N-NO3 10ft (ppm)	SO4 Surface (ppm)	SO4 10ft (ppm)
HINIKER	5/19	0.0071	0.6	0.8		
HINIKER	6/1	0.0064	1.0	0.7	115.0	114.0
HINIKER	6/14	0.0071	1.1	0.6	129.4	121.0
HINIKER	6/22	0.0032	0.7	0.8	117.0	117.0
HINIKER	7/12	0.0026	0.5	0.7	117.8	111.8
HINIKER	7/27	0.0184	0.8	0.7	101.6	99.4
HINIKER	8/15	0.0147	1.2	1.5	97.6	88.8
HINIKER	8/30	0.0118	0.1	0.8	127.0	123.0
HINIKER	9/13	0.0087	0.4	0.4	100.8	91.2
HINIKER	9/27	0.0031	0.5	0.6	97.6	94.2
HINIKER	10/11	0.0068	0.5	0.8	102.0	106.4
HINIKER	10/25	0.0042			114.0	110.0
HINIKER	11/9	0.0044	1.1	0.7	97.4	96.2

Lake/ Waterbody	Date	N-NH3 Surface (ppm)	N-NH3 10ft (ppm)	Copper Surface (ppm)	Copper 10ft (ppm)
HINIKER	5/19				
HINIKER	6/1				
HINIKER	6/14				
HINIKER	6/22				
HINIKER	7/12	3.5	5.4		
HINIKER	7/27	0.6	0.8	0.864	1.720
HINIKER	8/15	0.2	0.1	0.050	0.690
HINIKER	8/30				
HINIKER	9/13				
HINIKER	9/27				
HINIKER	10/11				
HINIKER	10/25			0.050	0.116
HINIKER	11/9				

Lake/ Waterbody	Date	E. ecoli (CFU/100ml)	pH	Conductivity Surface (mohm/cm)	Conductivity 5ft (mohm/cm)	Conductivity 10ft (mohm/cm)
HALLETT	5/19	3.1	8.2	0.675	0.675	0.684
HALLETT	6/1	33.6	7.9	0.620	0.661	0.665
HALLETT	6/14	18.1	8.3	0.668	0.668	0.671
HALLETT	6/22	1,553.1	7.5	0.572		
HALLETT	7/12	7.4		0.577	0.577	0.595
HALLETT	7/27	0.0	6.4	0.524	0.525	0.564
HALLETT	8/15	221.1	7.9	0.458	0.461	0.475
HALLETT	8/30	3.0	8.4	0.475	0.675	0.568
HALLETT	9/13	1.0	7.6	0.511	0.511	0.511
HALLETT	9/27	5.1	7.5	0.565	0.565	0.566
HALLETT	10/11	5.2	7.0	0.584	0.583	0.584
HALLETT	10/25	0.0	7.2	0.604	0.605	0.608
HALLETT	11/9	1.0	7.6	0.628	0.627	0.628

Lake/ Waterbody	Date	Conductivity 15ft (mohm/cm)	Temperature Surface (°C)	Temperature 5ft (°C)	Temperature 10ft (°C)	Temperature 15ft (°C)
HALLETT	5/19	0.708	17.6	17.1	15.9	12.9
HALLETT	6/1	0.693	19.3	18.8	18.4	12.4
HALLETT	6/14	0.678	21.4	21.4	20.9	20.0
HALLETT	6/22		23.0			
HALLETT	7/12	0.679	27.5	27.8	25.1	19.0
HALLETT	7/27	0.602	30.4	29.2	26.3	24.1
HALLETT	8/15	0.570	27.7	26.3	25.3	23.8
HALLETT	8/30	0.936	23.7	24.2	24.0	21.4
HALLETT	9/13	0.540	22.4	22.8	22.9	22.6
HALLETT	9/27	0.575	17.5	17.4	17.4	17.2
HALLETT	10/11		18.2	17.9	17.7	
HALLETT	10/25		12.6	12.6	12.0	
HALLETT	11/9	0.627	8.3	8.5	8.7	8.7

Lake/ Waterbody	Date	Secchi Disk (M)	Dissolved Oxygen Surface (ppm)	Dissolved Oxygen 5ft (ppm)	Dissolved Oxygen 10ft (ppm)	Dissolved Oxygen 15ft (ppm)
HALLETT	5/19	3.5	10.40	9.90	12.30	
HALLETT	6/1	3.5	8.20	8.00	7.90	14.70
HALLETT	6/14	2.0	8.24	8.30	8.90	4.20
HALLETT	6/22		9.90			
HALLETT	7/12	3.5	8.40	7.80	16.02	18.50
HALLETT	7/27	1.8	10.80	12.10	16.10	2.30
HALLETT	8/15	0.8	17.00	19.00	11.30	4.00
HALLETT	8/30	0.8	10.80	10.86	10.70	0.66
HALLETT	9/13	2.0	9.00	9.00	9.30	3.70
HALLETT	9/27	1.5	10.00	9.76	9.51	7.99
HALLETT	10/11	2.5	9.00	8.50	8.70	6.60
HALLETT	10/25	2.0	9.30	9.30	9.40	9.60
HALLETT	11/9	2.5	10.12	10.31	10.25	10.26

Lake/ Waterbody	Date	Total P Surface (ppm)	Total P 10ft (ppm)	P-PO4 Surface (ppm)	P-PO4 10ft (ppm)	N-NO2 Surface (ppm)
HALLETT	5/19	0.05	0.05	0.04	0.05	0.0487
HALLETT	6/1	0.05	0.05	0.04	0.05	0.0416
HALLETT	6/14	0.11	0.06	0.05	0.05	0.0485
HALLETT	6/22	0.09	0.09	0.01	0.01	0.0498
HALLETT	7/12	0.10	0.08	0.04	0.02	0.0332
HALLETT	7/27	0.02	0.08	0.02	0.01	0.0315
HALLETT	8/15	0.27	0.03	0.16	0.02	0.0310
HALLETT	8/30	0.04	0.04	0.01	0.04	0.0243
HALLETT	9/13	0.11	0.08	0.01	0.01	0.0240
HALLETT	9/27	0.90	0.04	0.02	0.02	0.0253
HALLETT	10/11	0.05	0.11	0.02	0.02	0.0262
HALLETT	10/25	0.07	0.08	0.03	0.03	0.0363
HALLETT	11/9	0.10	0.08	0.12	0.09	0.0350

Lake/ Waterbody	Date	N-NO2 10ft (ppm)	N-NO3 Surface (ppm)	N-NO3 10ft (ppm)	SO4 Surface (ppm)	SO4 10ft (ppm)
HALLETT	5/19	0.0436	3.5	3.3		
HALLETT	6/1	0.0424	3.0	3.4	46.8	45.0
HALLETT	6/14	0.0500	3.2	3.4	43.9	44.0
HALLETT	6/22	0.0505	1.9	2.0	39.0	41.0
HALLETT	7/12	0.0404	1.5	2.3	34.0	35.6
HALLETT	7/27	0.0484	1.3	2.3	27.8	31.4
HALLETT	8/15	0.0398	1.2	1.5	29.3	30.2
HALLETT	8/30	0.0258	1.7	2.0	38.0	36.0
HALLETT	9/13	0.0243	1.5	1.7	30.7	28.5
HALLETT	9/27	0.0261	1.5	2.0	34.1	34.1
HALLETT	10/11	0.0282	1.7	1.7	34.5	35.9
HALLETT	10/25	0.0342			32.6	32.3
HALLETT	11/9	0.0353	2.0	2.2	36.2	34.9

Lake/ Waterbody	Date	N-NH3 Surface (ppm)	N-NH3 10ft (ppm)	Copper Surface (ppm)	Copper 10ft (ppm)
HALLETT	5/19				
HALLETT	6/1				
HALLETT	6/14				
HALLETT	6/22				
HALLETT	7/12	4.7	2.7		
HALLETT	7/27	0.1	0.1	0.021	0.014
HALLETT	8/15	0.1	0.4	0.021	0.007
HALLETT	8/30				
HALLETT	9/13				
HALLETT	9/27				
HALLETT	10/11				
HALLETT	10/25			0.037	0.025
HALLETT	11/9				

Lake/ Waterbody	Date	E. ecoli	Turbidity	pH	Conductivity Surface (mohm/cm)	Temperature Surface (°C)
OXBOW	5/19	22.6		7.2	1.202	14.2
OXBOW	6/1	2,419.6	17	6.4	0.253	14.5
OXBOW	6/14	142.4	7	6.8	0.727	17.1
OXBOW	6/22	2,419.6	13	6.8	0.464	19.5
OXBOW	7/12	2,419.6	13	6.7	0.119	22.2
OXBOW	7/27	2,419.6	15	5.7	0.187	26.0
OXBOW	8/15	1,299.7	32	7.0	0.432	22.0
OXBOW	8/30		25	6.9	0.419	18.4
OXBOW	9/13		22	7.4	0.272	18.7
OXBOW	9/27	178.2	7	6.8	0.938	16.2
OXBOW	10/11	2,419.6	11	6.7	0.790	16.0
OXBOW	10/25	488.4	39	6.9	0.461	11.0
OXBOW	11/9	1,723.9	2	7.5	0.594	6.7

Lake/ Waterbody	Date	Dissolved Oxygen Surface (ppm)	Total P Surface (ppm)	P-PO4 Surface (ppm)	N-NO2 Surface (ppm)	N-NO3 Surface (ppm)
OXBOW	5/19	6.80	0.10	0.09	0.0075	0.1
OXBOW	6/1	0.24	0.90	0.44	0.0323	0.5
OXBOW	6/14	1.04	0.56	0.16	0.0147	0.9
OXBOW	6/22	4.40	0.29	0.14	0.0365	0.6
OXBOW	7/12	5.70	0.16	0.08	0.0460	0.8
OXBOW	7/27	4.60	0.14	0.07	0.0473	1.1
OXBOW	8/15	2.00	0.22	0.08	0.1142	1.2
OXBOW	8/30	0.88	0.44	0.08	0.0226	0.8
OXBOW	9/13	6.72	1.11	0.28	0.1085	0.3
OXBOW	9/27	1.56	0.47	0.02	0.0123	0.8
OXBOW	10/11	0.41	0.98	0.22	0.7650	0.2
OXBOW	10/25	6.62	0.14	0.02	0.0020	
OXBOW	11/9	4.72	0.50	0.08	0.1398	0.3

Lake/ Waterbody	Date	SO4 Surface (ppm)	N-NH3 Surface (ppm)	Copper Surface (ppm)
OXBOW	5/19			
OXBOW	6/1	14.0		
OXBOW	6/14	5.8		
OXBOW	6/22	24.8		
OXBOW	7/12	1.3	3.7	
OXBOW	7/27	0.2	0.2	0.032
OXBOW	8/15	34.4	0.6	0.021
OXBOW	8/30	19.3		
OXBOW	9/13	6.8		
OXBOW	9/27	96.2		
OXBOW	10/11	114.8		
OXBOW	10/25	104.4		0.066
OXBOW	11/9	51.7		

Lake/ Waterbody	Date	E. ecoli	Turbidity	pH	Conductivity Surface	Temperature Surface (°C)
DITCH 14	5/19				1.967	15.9
DITCH 14	6/1					
DITCH 14	6/14		6	8.6	0.832	18.7
DITCH 14	6/22	1,203.3	29	7.5	0.185	20.9
DITCH 14	7/12					
DITCH 14	7/27	648.8	28	4.1	0.180	28.0
DITCH 14	8/15	488.4	4	7.9	1.822	26.2
DITCH 14	8/30					
DITCH 14	9/13					
DITCH 14	9/27					
DITCH 14	10/11					
DITCH 14	10/25					

Lake/ Waterbody	Date	Dissolved Oxygen Surface (ppm)	Total P Surface (ppm)	P-PO4 Surface (ppm)	N-NO2 Surface (ppm)	N-NO3 Surface (ppm)
DITCH 14	5/19	4.40	0.13	0.10	0.0062	0.9
DITCH 14	6/1					
DITCH 14	6/14	15.11	0.37	0.07	0.0328	1.4
DITCH 14	6/22	4.66	0.20	0.11	0.0120	0.9
DITCH 14	7/12					
DITCH 14	7/27	5.80	0.20	0.14	0.0267	0.7
DITCH 14	8/15	8.10	1.30	0.03	0.0462	0.8
DITCH 14	8/30					
DITCH 14	9/13					
DITCH 14	9/27					
DITCH 14	10/11					
DITCH 14	10/25					

Lake/ Waterbody	Date	Sulfates Surface (ppm)	N-NH3 Surface (ppm)	Copper Surface (ppm)
DITCH 14	5/19			
DITCH 14	6/1			
DITCH 14	6/14	131.2		
DITCH 14	6/22	0.2		
DITCH 14	7/12			
DITCH 14	7/27	7.3	0.1	0.019
DITCH 14	8/15	284.0	5.0	1.990
DITCH 14	8/30			
DITCH 14	9/13			
DITCH 14	9/27			
DITCH 14	10/11			
DITCH 14	10/25			

APPENDIX XI

LINEAR REGRESSION FOR TOTAL PHOSPHORUS MEASURED

ON THE SURFACE OF HINIKER POND AND TOTAL WEEKLY

RAINFALL MAY- NOVEMBER 2011

Linear Regression for Surface TP Hiniker Pond and Total Weekly Precipitation

Data source: Data 1 in Notebook1

Col 3 = 0.0887 + (0.0702 * Col 2)

N = 13 Missing Observations = 0

R = 0.991 Rsqr = 0.981 Adj Rsqr = 0.980

Standard Error of Estimate = 0.022

	Coefficient	**Std. Error**	**t**	**P**
Constant	0.0887	0.00659	13.459	<0.001
Col 2	0.0702	0.00291	24.112	<0.001

Analysis of Variance:

	DF	**SS**	**MS**	**F**	**P**
Regression	1	0.288	0.288	581.412	<0.001
Residual	11	0.00545	0.000496		
Total	12	0.294	0.0245		

Normality Test (Shapiro-Wilk) Passed (P = 0.698)

Constant Variance Test: Passed (P = 0.352)

Power of performed test with alpha = 0.050: 1.000

APPENDIX XII

FIGURE 38. SULFATE LEVELS FOR HINIKER AND HALLETT'S PONDS

AT THE SURFACE AND DEPTH OF 10 FEET.

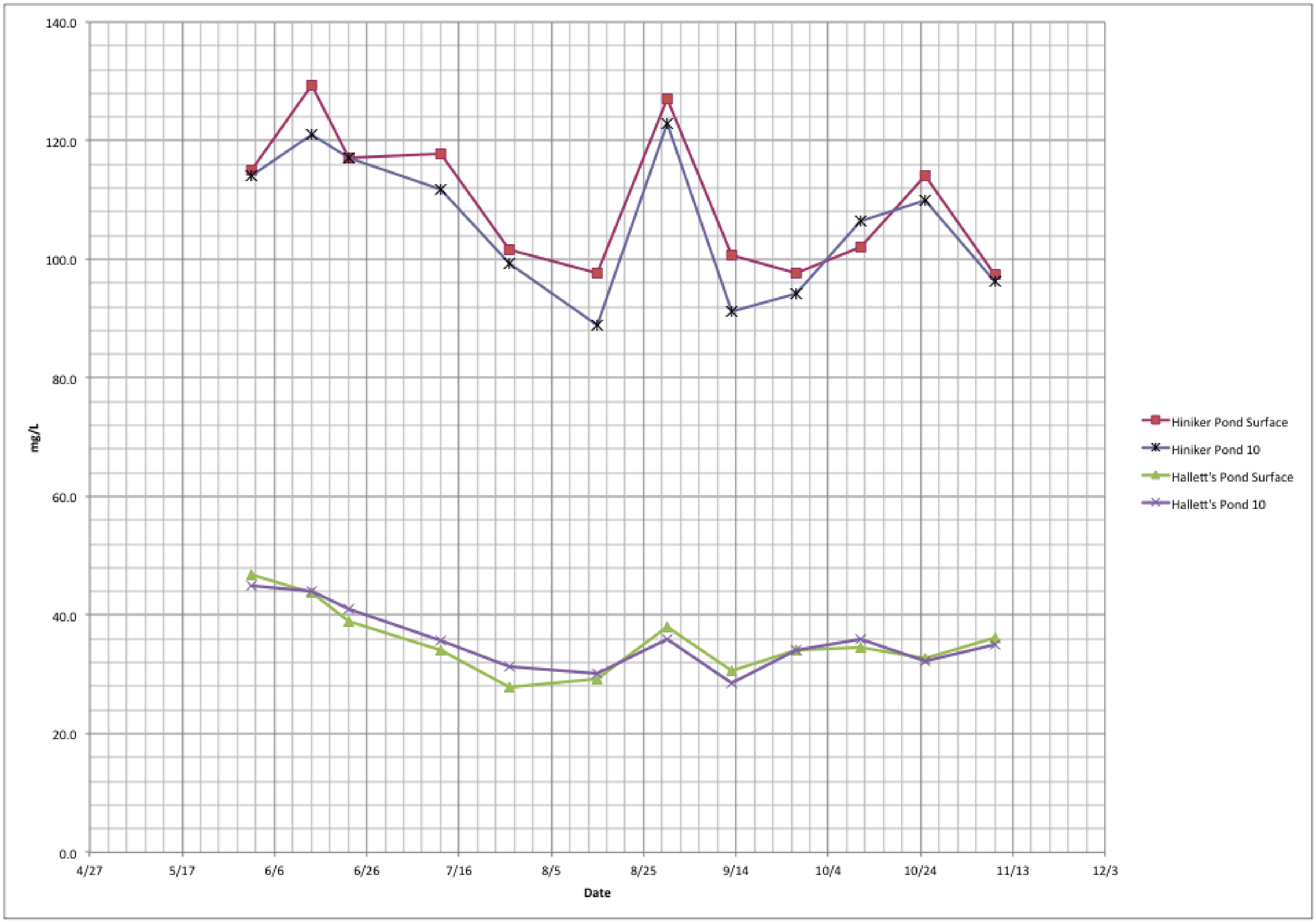

Figure 38. Sulfate levels in Hiniker and Hallett's Ponds, Mankato, MN May 2011-November 2011