Aerial photograph from above Lake Winnebago facing west across the City of Oshkosh and a portion of the source water area (Courtesy of The Carl Guell Slide Collection)

Source Water Assessment for Appleton Waterworks

Appleton, Wisconsin
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A report by the
Wisconsin Department of Natural Resources
Bureau of Drinking Water and Groundwater

WISCONSIN
DEPT. OF NATURAL RESOURCES

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Summary

The 1996 amendments to the Safe Drinking Water Act require that States complete source water assessments for all public drinking water systems. The primary purpose of this assessment is to determine the relative susceptibility of Appleton's source water to contamination. For this assessment, susceptibility is defined as the likelihood that a contaminant of concern will enter a public water supply at a level that may result in adversely impacting human health. Source water is untreated water from streams, rivers, lakes, and groundwater aquifers. A susceptibility determination is based on a stepwise synthesis of information regarding the well or surface water intake vulnerability and the source water's sensitivity to a potential source of a contaminant of concern.

Affordable, safe drinking water is essential to the health, development and stability of all communities. Conventionally, treatment has been the only step in maintaining safe drinking water for surface water systems. The quality of your community's drinking water is a function of the pretreatment water quality. Little concern has been paid to a preventive approach of protecting the source water. One of the best ways to ensure safe drinking water is to develop a local program designed to protect the source of drinking water against potential contamination. Not only does this add a margin of safety, but it also raises the awareness of consumers and/or the community of the risks of drinking water contamination. It is expected that source water assessment results will provide a basis for developing a source water protection program.

The city of Appleton is located in East Central Wisconsin at Lake Winnebago's discharge into the Lower Fox River. Appleton's more than 70,000 inhabitants rely solely on Lake Winnebago for their public drinking water source. Appleton Waterworks also exports drinking water to an additional 21,301 consumers served by the Grand Chute Sanitary District #1 and the Waverly Sanitary District.

A source water area is the area that contributes source water to the public drinking water system. Located in East Central Wisconsin, Appleton's delineated source water area is over 5,700 square miles. Appleton's source water area includes all land drained by Lake Winnebago. Soils, topography, land cover and water quality in the source water area vary widely. Generally, the western and northern portions of the source water area have relatively permeable hilly, sandy and rocky soils with high percentages of natural vegetative land cover. The eastern and southern regions of the source water area have relatively less permeable, flat, clayey soils with higher percentages of agricultural and urban land coverage. These differences create varying water quality in the source water area. Streams in the western and northern portions of the source water area generally have higher water quality than streams in the eastern and southern portions.

Historically, Appleton Waterworks has reliably provided high quality drinking water to its customers. Water demand ranges from 9 million gallons per day (mgd) in the winter to 20 mgd in the summer. Their facility has a maximum capacity of 24 mgd. The treatment process involves lime softening, granular activated carbon contractors, ultrafiltration and chlorination.

This assessment determined that Appleton's source water has a relatively high susceptibility to contamination and is significantly impacted by the source water area. This is due to the distribution of land uses and potential contaminant sources in the eastern and southern portions of the source water area along with the turbid nature of Lake Winnebago. The physical characteristics of Lake Winnebago and the source water area's high concentrations of urbanized and agricultural land, make Appleton's source water particularly susceptible to microbial, volatile organic and synthetic organic compound contamination.

Source water protection should begin with the formation of a source water protection team composed of delegates from private parties and local, regional, state and federal organizations. This group is needed to coordinate and implement best management practices in the source water area to prevent source water contamination. Protection efforts should first focus on preventing urban and construction site runoff from urban areas near Lake Winnebago and controlling agricultural runoff from the eastern and southern portions of the source water area.

A hard copy of the detailed assessment is available at the Appleton Public Library. An electronic file of the detailed assessment is accessible on the Wisconsin Department of Natural Resources website at http://www.dnr.state.wi.us/org/water/dwg/gw/SWP.HTM.

Introduction

In 1996, the U.S. Congress amended the Safe Drinking Water Act to provide resources for states to conduct source water assessments. Information about Wisconsin's Source Water Assessment Program can be found on the Wisconsin Department of Natural Resources (WDNR) website mentioned previously. The WDNR has developed a method outlined in Wisconsin's Source Water Assessment Program for conducting Source Water Assessments for water supplies that use Lake Winnebago as their water source. A source water assessment involves identifying a source water area, analyzing the sensitivity of the source to natural conditions, conducting potential contaminant source inventories and determining the susceptibility of the source to contamination.

The requirements for public water supplies in Wisconsin to meet U.S. Environmental Protection Agency maximum contaminant levels (MCLs) provide a base level of assurance of safe drinking water. However, all systems are vulnerable to some degree to potential contamination. With this in mind, susceptibility determinations were made qualitatively relative to other systems.

Purpose of this Assessment

Safe, affordable drinking water is essential to the health, development and stability of all communities. Conventionally, treatment has been the only step in maintaining safe drinking water for surface water systems and little concern has been paid to a preventive approach of protecting the source water. The quality and cost of treated drinking water is often a function of pretreatment source water quality. The purpose of this source water assessment is to determine the susceptibility of Appleton's source of drinking water to contamination and to make recommendations on how to help protect this valuable resource.

Clean source water can be ensured through the implementation of a source water protection program. A source water protection program is composed of four steps: assessment, planning, implementation and long term management. By assessing localized impacts on source water quality, this assessment completes the first step in a source water protection program. For more information on completing a source water protection program please visit http://www.epa.gov/safewater/protect/protect.html on the World Wide Web.

Source Water Contaminant Categories

Source water can be contaminated by microbial, inorganic, synthetic organic, volatile organic, precursors of disinfection by-products and radioactive contaminants. These contaminants can enter source water through various means. Pathways of contamination can be split into two major categories, point source pollution and nonpoint source pollution. Point source pollution includes specific, identifiable dischargers of contaminants. Examples of these include industrial and municipal wastewater outfalls. Point source dischargers are more easily regulated and held accountable for contaminating source water. Nonpoint source pollution comes from no specific source and diffusely enters source water. Examples of nonpoint source pollution include runoff from land cover and atmospheric deposition.

This assessment describes the following general contaminant categories associated with potential contaminant sources. For a more detailed description of contaminants associated with potential contaminant sources please visit http://www.epa.gov/OGWDW/swp/sources1.html on the World Wide Web. For information on health effects and methods of protection from particular chemical contaminants please visit http://www.epa.gov/safewater/hfacts.html on the World Wide Web.

- *Microbial contaminants*, such as viruses and bacteria, which may come from, sewage treatment plants, septic systems, agricultural livestock operations, and wildlife. Microbial contaminants can lead to widespread acute illnesses in customers of a contaminated drinking water system. Examples of microbial contaminants include *Giardia*, *Cryptosporidium* and *E. coli*.

- *Inorganic contaminants*, such as salts and metals, which can occur naturally or result from among other sources, urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming. Among other detrimental health affects, inorganic contaminants can negatively impact various organs and the circulatory system in the human body. Some examples of inorganic contaminants include nutrients such as nitrogen and phosphorous and heavy metals such as cadmium, lead and mercury.

- *Synthetic organic contaminants*, such as industrial products, pesticides and herbicides, which may come from a variety of sources such as agriculture, storm water runoff, industrial activities, landfills, wastewater treatment facilities and residential areas. As well as being carcinogenic, synthetic organic contaminants can negatively impact the nervous system, liver and kidneys and affect development. Some examples of synthetic organic contaminants include the pesticides atrazine and lindane as well as industrial products such as polychlorinated bi-phenyls (PCBs).

- *Volatile organic contaminants*, such as petroleum products, solvents, cleaners and degreasers, which may come from industrial activities, petroleum production, gas stations, urban storm water runoff, wastewater treatment facilities and septic systems. As well as being carcinogenic, volatile organic contaminants can negatively impact the nervous system, liver and kidneys and affect development. Some examples of volatile organic contaminants include benzene, vinyl chloride and styrene.

- *Precursors of disinfection by-products* lead to the formation of carcinogenic byproducts during source water treatment. Some examples of these include dissolved organic carbon and bromide. Likely sources of dissolved organic carbon are from agricultural and urban storm water runoff.

- *Radioactive contaminants*, can be naturally occurring or be the result of oil and gas production and mining activities. Radioactive contaminants are carcinogenic. Some examples of radioactive contaminants include radium and uranium.

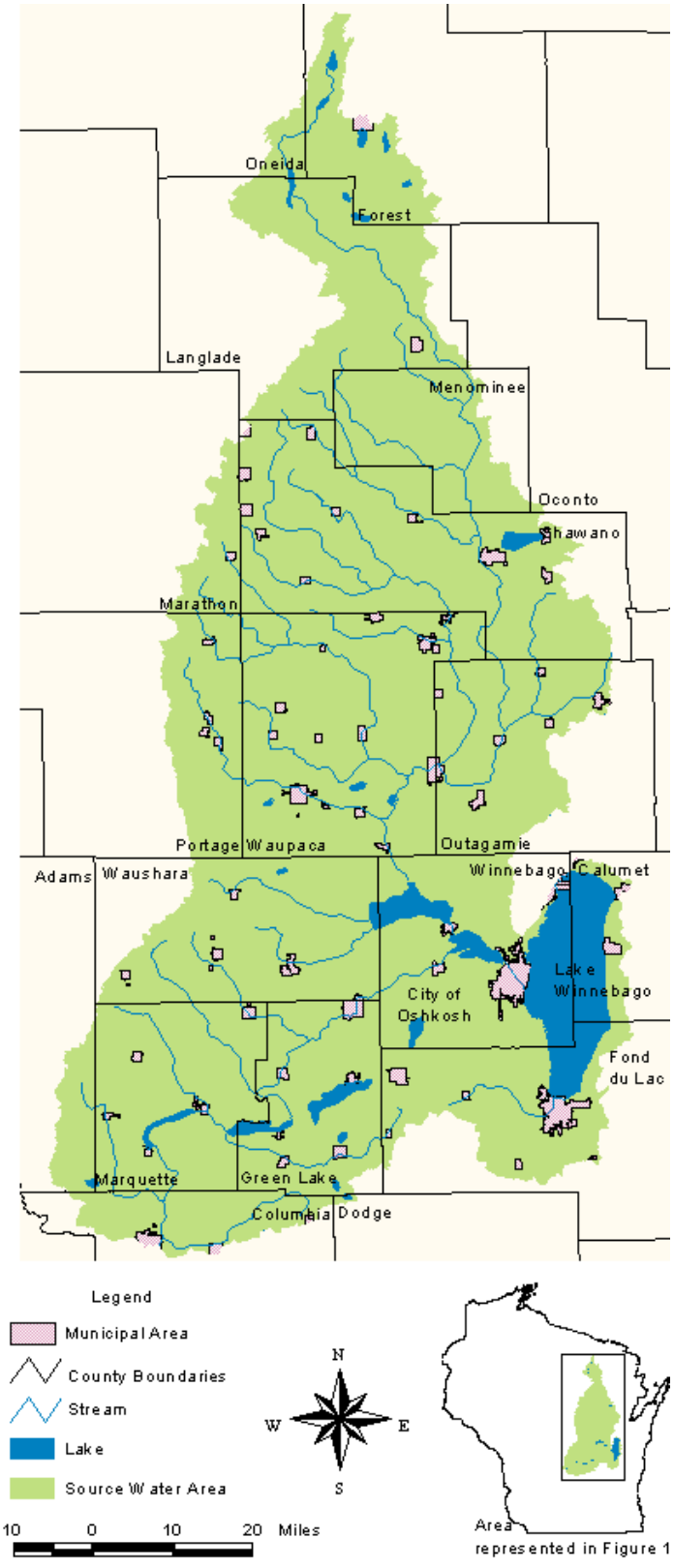
Hydrologic Setting

Description of the Source Water Area

Source water areas were assigned to specific surface water intakes based on proximity of drainage basins and potential affect on source water quality at the intake. Source water areas for this assessment were delineated based on Wisconsin DNR surface watersheds, not groundwater basins. Generally, groundwater basin boundaries are similar to their surface water counterparts but may vary due to geology. For security reasons locations for surface water intakes in this assessment are not depicted with a high level of accuracy.

As shown in Figure 1, Appleton's source water area is located in East Central Wisconsin. It includes all or portions of Fond du Lac, Western Calumet, Winnebago, Green, Marquette, Northern Columbia, Eastern Adams, Waushara, Western Outagamie, Waupaca, Eastern Portage, Shawano, Eastern Marathon, Menominee, Langlade, Southeastern Oneida and Southwestern Forest Counties. Larger municipal areas encompassed at least partially by the source water area are Oshkosh, Fond du Lac, Neenah, Portage, Menasha, Crandon, Berlin, Shawano, Waupaca, Ripon and Clintonville. Appleton's source water area is over 5,700 square miles.

Figure 1: Source Water Area

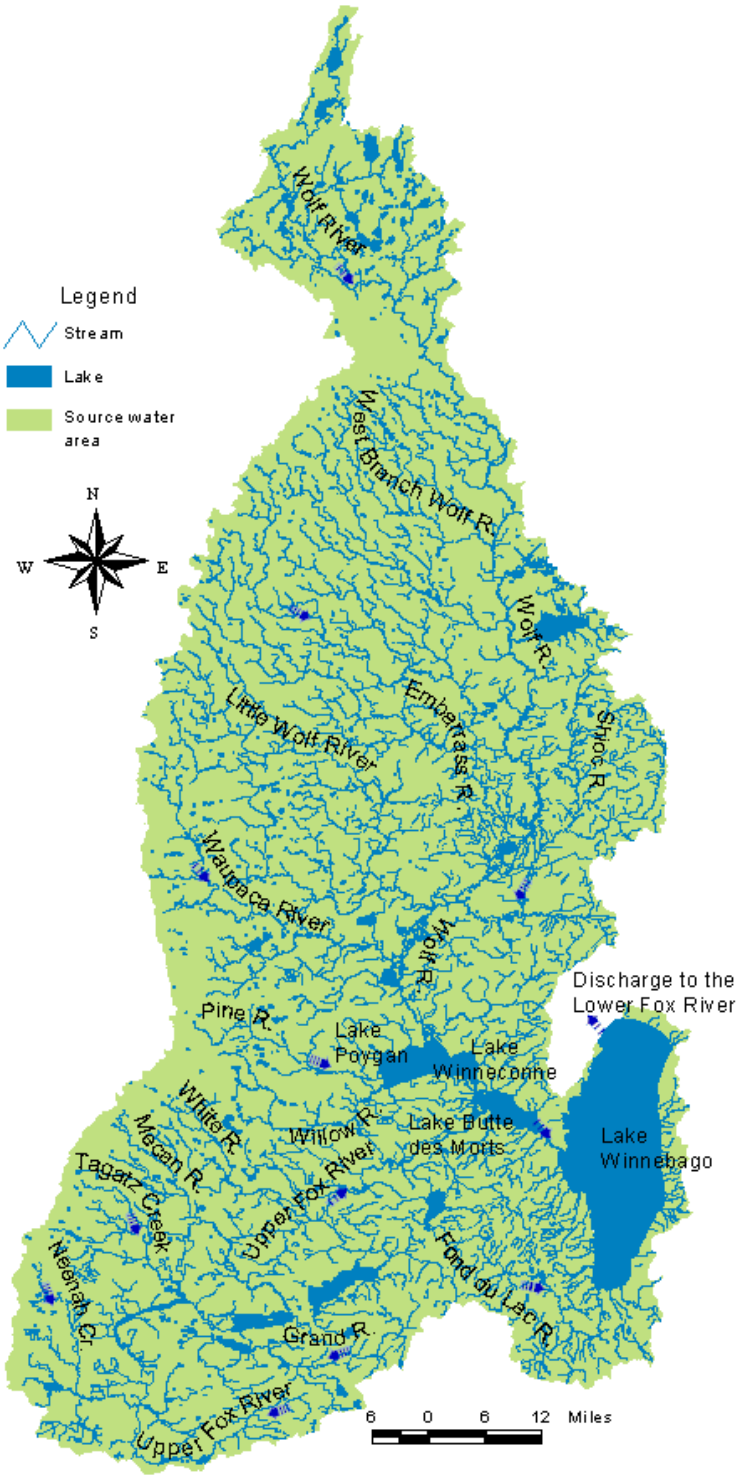


Hydrology

As shown in Figure 2, the source water area encompasses all land that drains into Lake Winnebago. This includes the Upper Fox and Wolf River drainage basins. Originating in Forest County, the Wolf River flows from south receiving input from the West Branch of the Wolf River, the Shioc River, the Embarrass River, the Little Wolf River and the Waupaca River. It then enters Lakes Poygan, Winneconne and Butte des Morts where it merges with the Upper Fox River. The Upper Fox River originates in Green Lake County receiving flow from Neenah Creek, Tagetz Creek, Grand River, Mecan River, White River and Silver Creek, before entering Lake Butte des Morts. The Upper Fox drains Lake Butte des Morts to the east and discharges into Western Lake Winnebago. Land adjacent to Lake Winnebago, which is drained by Van Dynes Creek, Fond du Lac River, Pipe Creek, Johnson Creek, Mud Creek and Mill Creek is also part of the source water area. Lake Winnebago discharges to the Lower Fox River on the northern shore at the cities of Neenah and Menasha.

The western and northern portions of the source water area are characterized by hilly to flat topography, sandy loam soils with moderate and high rates of permeability, cold ground water fed streams of high water quality and a mix of agricultural and natural vegetative land cover types. The eastern and southern portions of the source water area are typified with flat topography, clayey soils with moderate to low permeability, flashy warm water streams of lower water quality and intensive agricultural and urban land coverage.

Figure 2: Drainage Pattern of Source Water Area



Land Cover

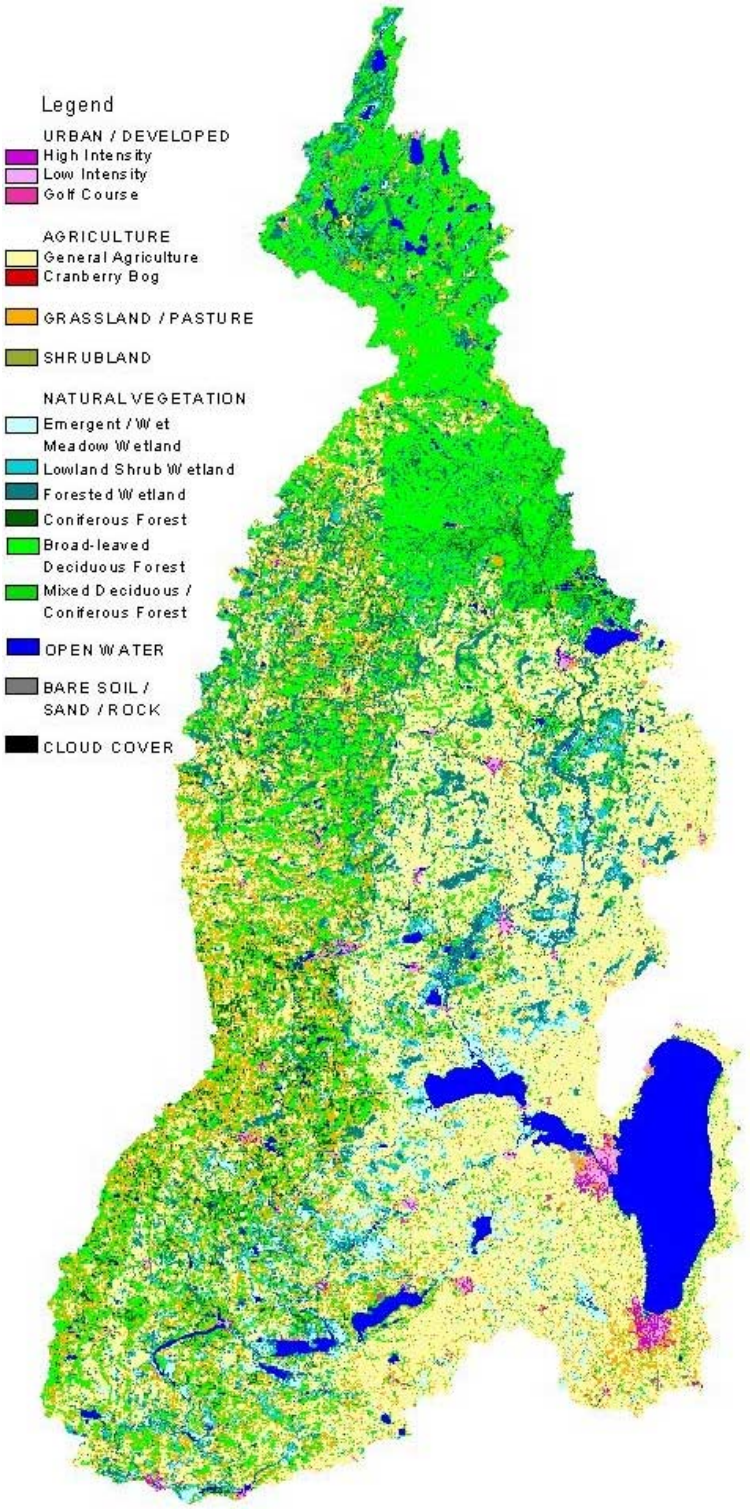
Land cover can play a major role in source water quality. Land cover can affect source water negatively and / or positively. Spatial data in Figure 3 was generated from interpretations of aerial photographs taken from 1971 to 1982.

- *Agricultural*

For this assessment agricultural land cover includes cropland, pasture, orchards and nurseries. Agricultural practices generally cause the land to be more susceptible to erosion and runoff than naturally vegetated land. Due to common practices and activities, agricultural land cover can be a major source of inorganic, treatment byproduct precursors, microbial and synthetic organic contaminants for the source water.

The majority of land coverage in the eastern and southern portions of the source water area is agriculture. Corn and livestock are the predominant types of agricultural activities. The Wisconsin DNR identified nonpoint source pollution from agricultural land as negatively impacting source water in the majority of streams in the source water area. Barnyard runoff and stream bank pasturing were also identified as negative impacts on source water. Particular agricultural areas of severe degradation include portions of the source water area located in Fond du Lac, Winnebago, Northern Green Lake, Calumet and Outagamie Counties. These areas contribute the most total suspended solids and phosphorous to Lake Winnebago and have the highest rates of erosion in the source water area.

Figure 3: Land Cover of the Source Water Area



- *Urban*

  Urban areas depicted in Figure 3 include residential, industrial and commercial activities. Contaminants associated with residential land cover include synthetic organic, volatile organic, inorganic, precursors of disinfection by-products and microbial contaminants. Due to high concentrations of impermeable surfaces, such as streets, driveways, parking lots, sidewalks and roofs, urban areas have increased potential to create large quantities of runoff during and following precipitation events. Runoff from residential areas transports contaminants associated with this land cover into source water. These contaminants can also enter source water from residential areas through point source discharges and atmospheric deposition.

  Urban runoff was identified by the Wisconsin DNR as negatively impacting Lake Winnebago and streams in Winnebago County. The largest urban areas in the source water area are Oshkosh and Fond du Lac, which have concentrated populations, low overall permeability and a wide array of recreational, industrial and commercial activities requiring the storage and use of toxic chemicals. Other urban areas within the source water area include the cities and towns of Berlin, Omro, New London, Seymour, Clintonville, Marion, Shawano, Princeton, Stockbridge, Winneconne, Fremont, Hortonville, Shiocton, Black Creek, Embarrass, Bonduel, Cecil, Rosendale, Oakfield, Redgranite and Lohrville.

- *Natural vegetation*

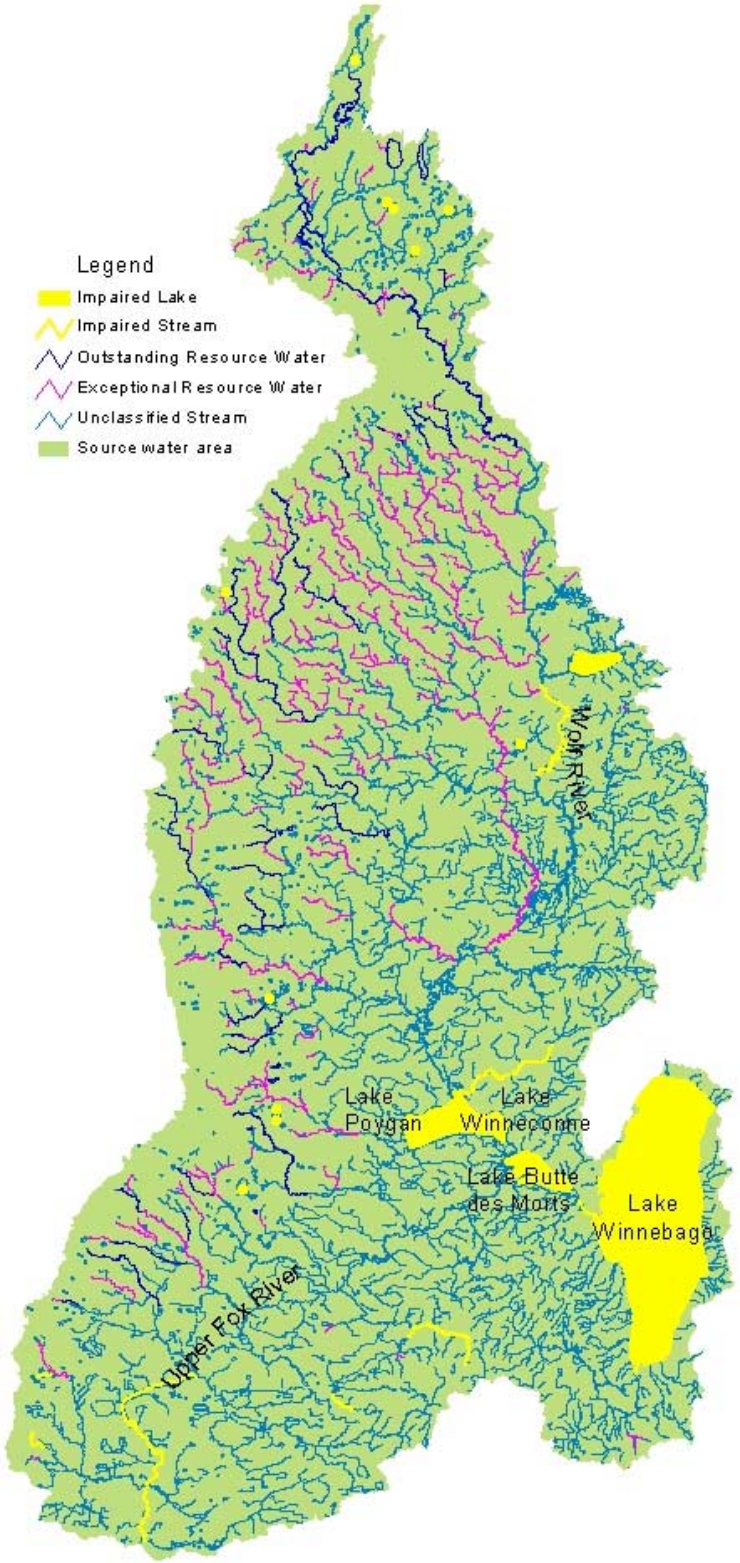
  For this assessment, natural vegetation includes wetlands, woodlands and some unused lands. Generally, natural vegetation has positive impacts on source water. These impacts include increased infiltration of precipitation into the ground, decreased quantity of storm water runoff, removal of contaminants from source water, reduced potential for erosion and less drastic fluctuations of streamflow.

  Areas of natural vegetation, such as wetlands and forests are most dominant in the northern portion of the source water area in the counties of Langlade, Forest, Oneida and Menominee. These areas of natural vegetation aid in protecting source water by filtering and removing contaminants, reducing sedimentation of waterbodies and reducing the amount of runoff from precipitation events.

Water quality

Water quality throughout the source water area varies widely. Streams in the northern and western portions of the source water area are groundwater-fed streams with few water quality problems. As shown in Figure 4, many streams in this area are ranked by the Wisconsin DNR as exceptional and outstanding resource waters. Outstanding resource waters are defined as a lake or stream having excellent water quality, high recreational and aesthetic value, high quality fishing and free from point and nonpoint source pollution. Exceptional resource waters are defined as a stream exhibiting the same high quality resource values as outstanding waters but may be impacted by point source or have the potential for future discharge from a small sewered community. Streams in the eastern and southern portions of the source water area have more water quality problems. As shown in Figure 4, multiple streams and lakes in these areas are listed on the WDNR impaired waterbodies list. Typical problems in these streams include contaminated sediments, inorganic and synthetic organic compound contamination, sedimentation and hydrologic modifications. Sources of these problems include stream bank erosion, barnyard runoff, cropland erosion, agricultural and urban nonpoint source pollution. Synthetic organic contamination of groundwater has been detected in Northern Winnebago County.

Figure 4: Water Quality in the Source Water Area



Description of Lake Winnebago

Physical Characteristics

With a surface area of nearly 138,000 acres, Lake Winnebago is the largest lake in the state. Its maximum depth is only 21 feet. With an average depth of 15.5 feet, the lake has a calculated volume of 696 billion gallons. It has a length of about 28 miles and a width of about 10 miles. Lake Winnebago normally experiences ice over from late December to April. These physical characteristics coupled with resuspension of sediments by wind and high pollutant loading associated with land activities throughout the source water area combine to make Lake Winnebago a warm water, highly productive, lake with poor water quality.

Wind

Wind plays a major role in the water quality of Lake Winnebago. Wind frequently suspends sediments in the lake water. Locally, this churns and redistributes contaminants that would normally remain in lake bottom sediments. The extent of lake-wide redistribution and mixing caused by wind is not fully understood.

Water Quality

Existing monitoring data indicates that Appleton's source water is highly turbid with poor water quality for microbial, organic and inorganic parameters. Generally, water quality is highest during late winter. This is due to lower inputs from the source water area and ice cover preventing resuspension of sediments. Water quality is lowest during late summer and early fall when wind storms of varying direction resuspend sediments, water temperatures rise, and more pollutant loading from the source water area occurs. Day-to-day fluctuations in water quality occur as a result of wind. Periods of southerly winds often coincide with poor source water quality. Spring runoff from melt water strongly affects seasonal and long-term water quality in Lake Winnebago. It is important to note that water quality data of source water at the intakes is based almost entirely on periodic monitoring that occurs at the drinking water intakes. Few contaminants have been comprehensively monitored in source water at the intakes.

Monitoring of microbial contaminants has revealed high levels of total coliform and frequent detects of fecal coliform in the source water at the public drinking water intake. *Cryptosporidium* has been detected in Lake Winnebago, but not at the Appleton water intake. *Giardia* has been detected twice in source water entering the intake. Source water concentrations of microcystin toxins, caused by lake wide blue green algal blooms frequently reach levels that are above the World Health Organization's standard for drinking water during late summer. Concentrations of treatment by-products in finished water reveal that high levels of dissolved organic carbon, a precursor to treatment by-products exist in the source water.

From 1992 to 2002 three detections of a volatile organic contaminant associated with commercial and industrial activities were detected in the source water at the intake. During that same time, synthetic organic contaminants were not detected in source water at the drinking water intake. Phosphorous, an inorganic contaminant associated with agricultural and urban runoff, does not have a direct impact on human health, but high lake-wide levels support the summer blue green algal blooms that release microcystin toxins.

Susceptibility Assessment

For the purposes of Wisconsin's source water assessments, susceptibility is defined as the likelihood that a contaminant of concern will enter a public water supply at a level that may result in an adverse human health impact. A susceptibility determination is based on a stepwise synthesis of information regarding the well or surface water intake vulnerability and the source water's sensitivity to a potential source of a contaminant of concern.

Methodology

Detailed guidelines for completing this source water assessment can be found in Wisconsin's Source Water Assessment Program Plan (W-DNR, 1999).

An initial survey was performed on the Appleton source water area to assess local impacts to the source water. The initial survey included interviewing intake operators and reviewing existing data. The

preliminary survey revealed the source to be significantly impacted by the source water area and highly susceptible to contamination.

A second, more detailed assessment was conducted in order to determine which areas and activities within the source water area were negatively impacting the source water quality. This more in-depth study reviewed the impact of particular potential contaminant sources in the source water area, a detailed analysis of historical water monitoring data throughout the source water area and characteristics of Lake Winnebago. An assessment of potential danger from major spills was also carried out to determine how Appleton's source water quality would be impacted in the event of a large contaminant spill.

Sensitivity Analysis

Sensitivity is defined as the likelihood that source water will be impacted by contaminants due to the intrinsic physical attributes of the source water area. Sensitivity is determined from the natural setting of the source water and indicates the natural protection afforded the source water. Factors in sensitivity include hydrologic characteristics of the source water area, proximity, direction and quantity of discharge relative to the intake and degree of dilution afforded by distance from shore and depth of intake.

Due to the physical characteristics of Lake Winnebago, all surface water intakes are considered to have very high sensitivities.

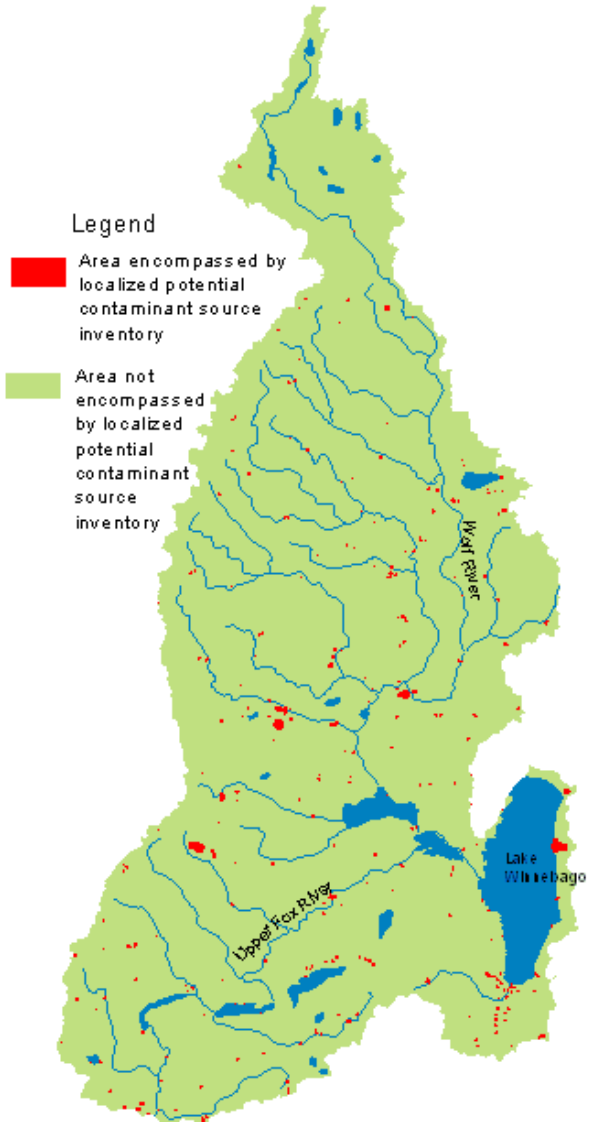
Potential Contaminant Source Inventory

A major component of the susceptibility determination is based on the distribution of potential contaminant sources in the source water area. A high density of potential contaminant sources in the source water area would indicate a higher probability of contaminating source water. Source water from a source water area with a low density of potential contaminant sources would be less likely to become contaminated.

It is important to understand that a potential contaminant source is not necessarily a source of contaminants. It has the potential to become a source of contaminants but if managed properly won't impact the source water.

Data used in the significant potential contaminant source inventory includes area wide and localized information sources. Area-wide and region-wide locational data is displayed in Figures 6, 7, 8 and 9. Information for the remainder of the potential contaminant sources was inventoried only within source water areas for ground water systems. These areas of localized potential contaminant source inventories are shown on Figure 5. Information concerning the distribution of localized significant potential contaminant sources is not available for land outside of the red areas in Figure 5. Potential contaminant sources inventoried within these areas are shown in Figures 10, 11, 12 and 13.

Figure 5: Areas of Local Potential Contaminant Source Inventory



Animal feeding operations

Animal feeding operations are agricultural operations where animals are kept and raised in confined situations. Animal feeding operations generally congregate animals, feed, manure, dead animals, and production operations on a relatively small area of land. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain), and manure spreading practices. Animal feeding operations have the potential to contribute pollutants such as inorganic, synthetic organic and microbial contaminants as well as hormones and antibiotics to the source water.

Animal feeding operations shown on Figures 6, 7, 8 and 9 include only the larger animal feeding operations (over 1,000 animal units), which are regulated for wastewater discharge. This does not include the more common smaller animal feeding operations. A limited distribution of smaller animal feeding operations in the source water area is depicted in Figure 10.

Wastewater Treatment Facilities

Wastewater treatment facilities (WWTFs) include municipal and industrial operations. Municipal facilities can be sources of inorganic, microbial, synthetic organic and volatile organic contaminants as well as hormones, pharmaceuticals and other organic contaminants that have been linked to developmental and reproductive defects in animals. Following treatment, effluent is frequently discharged through an outfall directly into surface water. Typical treated and disinfected sewage contains low concentrations of contaminants. A municipal WWTF may be inundated with more raw sewage than it can process. In the event of this a bypass or sanitary sewer overflow occurs. This allows untreated sewage to enter directly into surface water. A typical bypass may contain high concentrations of contaminants associated with urban runoff and WWTFs. Contaminants associated with industrial WWTFs are dependent upon the specific industry but may include microbial, volatile organic, inorganic and synthetic organic contaminants.

As shown in Figures 6, 7, 8 and 9, there are numerous WWTFs that discharge to surface water distributed throughout the source water area. According to the Wisconsin DNR's list of impaired waterbodies, Lakes Winnebago and Butte des Morts are being negatively impacted by municipal treatment systems. From 1996 to 2000 there were at least 25 storm sewer overflows within the entire source water area. These storm sewer overflows had a combined discharge of nearly 80 million gallons of raw sewage.

Landfills

In the past landfills were unregulated and were common sources of contaminants. Licensed landfills are now strictly regulated and monitored. Closed and active landfills can be sources for inorganic, synthetic organic and volatile organic contaminants in source water.

Figure 6 shows the distribution of licensed landfills and waste disposal sites located in the source water area. There are twenty-six licensed landfills and 300 waste disposal sites in the source water area. Two of these are considered leaking underground storage tanks and six are classified as Environmental Repair Program. Two closed landfills in the source water area are classified as Superfund sites. Leaking underground storage tank, Environmental Repair Program and Superfund sites are discussed below.

Wisconsin DNR's Bureau of Remediation and Redevelopment Tracking System

The WDNR Remediation and Redevelopment Program keeps track of sites where chemical contamination of soil, surface water and/or groundwater has occurred. The Bureau of Remediation and Redevelopment Tracking System (BRRTS) is the Department's database for tracking the status of investigation and cleanup activities at these sites. There are several types of sites that are tracked by BRRTS, including leaking underground storage tank sites, Environmental Repair Program sites, spill sites and Superfund sites. For information on specific contamination sites in Wisconsin please visit BRRTS at, http://www.dnr.state.wi.us/org/aw/rr/brrts/index.htm on the World Wide Web.

- *Leaking Underground Storage Tank sites*

  A Leaking Underground Storage Tank (LUST) site is defined as a leaking underground storage tank that has contaminated soil and/or groundwater with petroleum.

As shown in Figure 7, there are 10 LUSTs in the source water area within 5 miles of the drinking water intake. Many of these are located along the northern shores of Lake Winnebago. Other high concentrations of LUSTs in the source water area are generally found in urban areas. The municipal area of Oshkosh has 238 LUSTs and Fond du Lac has 175 LUSTs.

- *Environmental Repair Program sites*

  Environmental Repair Program (ERP) sites are sites other than LUSTs that have contaminated soil and/or groundwater. Often, these are old historic contaminant releases to the environment. They frequently include abandoned landfills, coal gasification and metal stripping sites, among other contaminant sources.

  As shown in Figure 7, there are 4 ERP sites in the source water area within 5 miles of the drinking water intake. These ERP sites are located approximately a mile to a mile and a half to the west of the water intake. Other high concentrations of ERP sites in the source water area are generally found in urban areas. The municipal areas of Oshkosh and Fond du Lac have 78 and 145 ERP sites, respectively.

- *Spill sites*

  Spills are defined as a discharge of hazardous substances that may adversely impact, or threaten to adversely impact public health, welfare or the environment. No locational data is available for spill sites.

  It is important to note that the number of unreported spills is unknown, but is probably well beyond those spills that have been reported. As of 2001, there have been 214 spills reported in the municipality of Oshkosh and 218 spills reported in the municipality of Fond du Lac. Of these 432 reported spills, 54 spills entered surface water directly and 36 entered storm sewers. Storm sewers can act as conduits for contaminants to reach surface water.

- *Superfund sites*

  Superfund sites are highly contaminated areas that have been set aside for cleanup by the USEPA. For more information on the Superfund program and individual sites please see http://www.epa.gov/superfund/ on the World Wide Web.

  As shown in Figure 6, there are 2 active Superfund sites in the source water area. They are the Schmalz Dump site located in the town of Harrison and the Ripon City Landfill site located in western Fond du Lac County.

  The Schmalz Dump site covers ¾-acre near the northern shore of Lake Winnebago. Unauthorized dumping of ash and demolition debris contaminated with synthetic organic contaminants occurred at the site from 1968 to 1979. Water from the site flows 500 feet before discharging into northern Lake Winnebago. Lead and chromium contaminate groundwater near the site. Soil, lake sediments and surface water near the site were contaminated with inorganic and synthetic organic contaminants. This Superfund site is located slightly over a mile from the drinking water intake.

  The Ripon City Landfill site is an area historically used by the city of Ripon and an appliance manufacturer for waste disposal. The synthetic organic and volatile organic contamination of groundwater has been detected in groundwater beneath the site.

Hazardous Waste Generators

Hazardous waste generators are defined as facilities, which handle materials classified as hazardous waste. Hazardous waste is defined as any substance that is toxic to humans. Contaminants associated with hazardous waste generators are site specific. Hazardous waste generators include a wide array of facilities ranging from hospitals and schools to manufacturing and industrial operations.

As shown in Figure 6, there are 39 large quantity hazardous waste generators located in the source water area. They are concentrated in the Cities of Fond du Lac and Oshkosh. This does not depict the more numerous small quantity hazardous waste generators, which are found throughout the source water area.

Pipelines

Pipelines have the potential to be major sources of contaminants to source water. Contaminants associated with pipelines are specific to individual pipelines, but generally contain volatile organic contaminants. Contaminants from pipelines may enter source water through small leaks or accidental spills.

A gasoline and distillate pipeline and a crude oil pipeline cross the southwestern portion of the source water area. These pipelines are both underground and cross multiple streams in the source water area.

Construction Sites

Due to uncovered material, handling of toxic chemicals and exposed ground, mismanaged construction sites can impact the source water more intensely than urban land coverage. For more information on impacts and regulations of construction sites please visit http://cfpub1.epa.gov/npdes/stormwater/const.cfm?program_id=6 on the World Wide Web.

There has recently been rapid urban and residential development in close proximity to the drinking water intake. From 1990 to 2000 Winnebago County grew by 11.7 percent and Calumet County grew by 18.5 percent. Particular areas of heavy development near the intake include the residential developments near Oshkosh, Neenah, Menasha and lakefront property on Lake Winnebago between Oshkosh and Neenah.

Boating-related Activities

Boating-related activities are potential sources of volatile organic, inorganic and microbial contaminants to the source water. Contaminants can enter directly into the source water through spills or indirectly through runoff from marinas and shipyards where many cleaning agents, paints, petroleum products and other chemicals are commonly stored and used. For more information on the effects of and preventive measures for boating related activities please visit http://www.epa.gov/owow/nps/mmsp/index.html

Recreational boating is very popular throughout Lake Winnebago.

Figure 6: Area wide Potential Contaminant Source Inventory

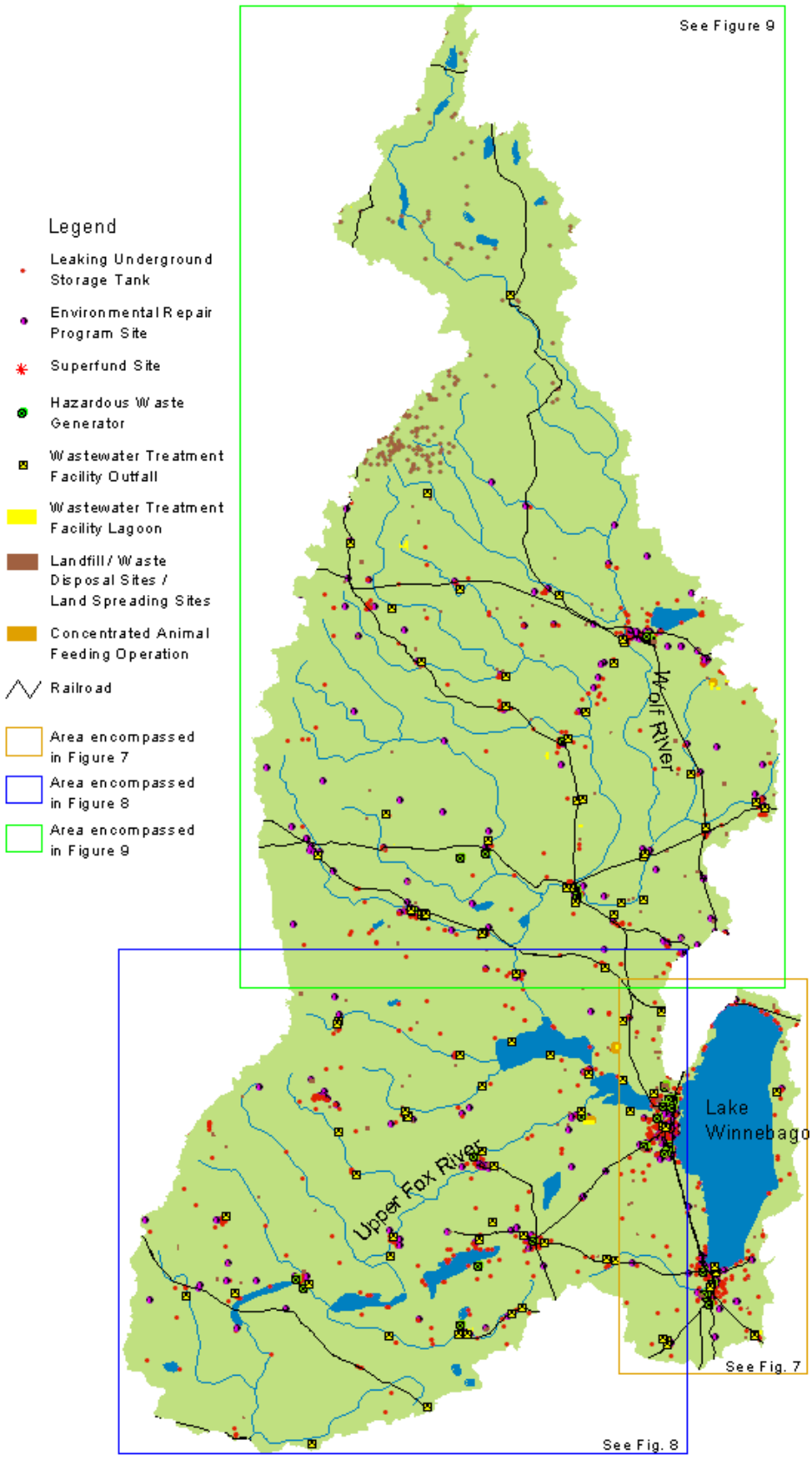


Figure 7: Lake Winnebago Area Potential Contaminant Source Inventory

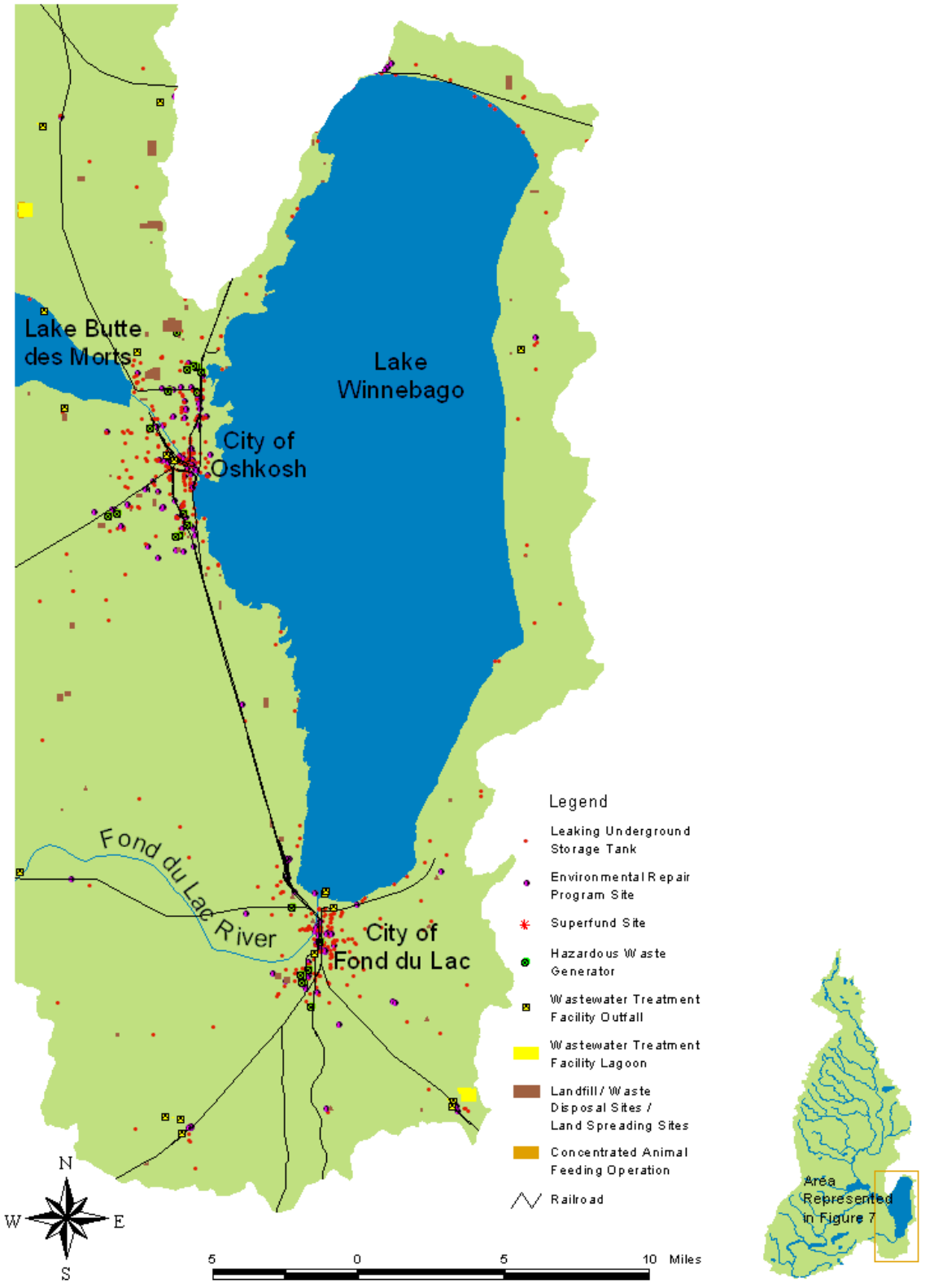


Figure 8: Upper Fox River Area Potential Contaminant Source Inventory

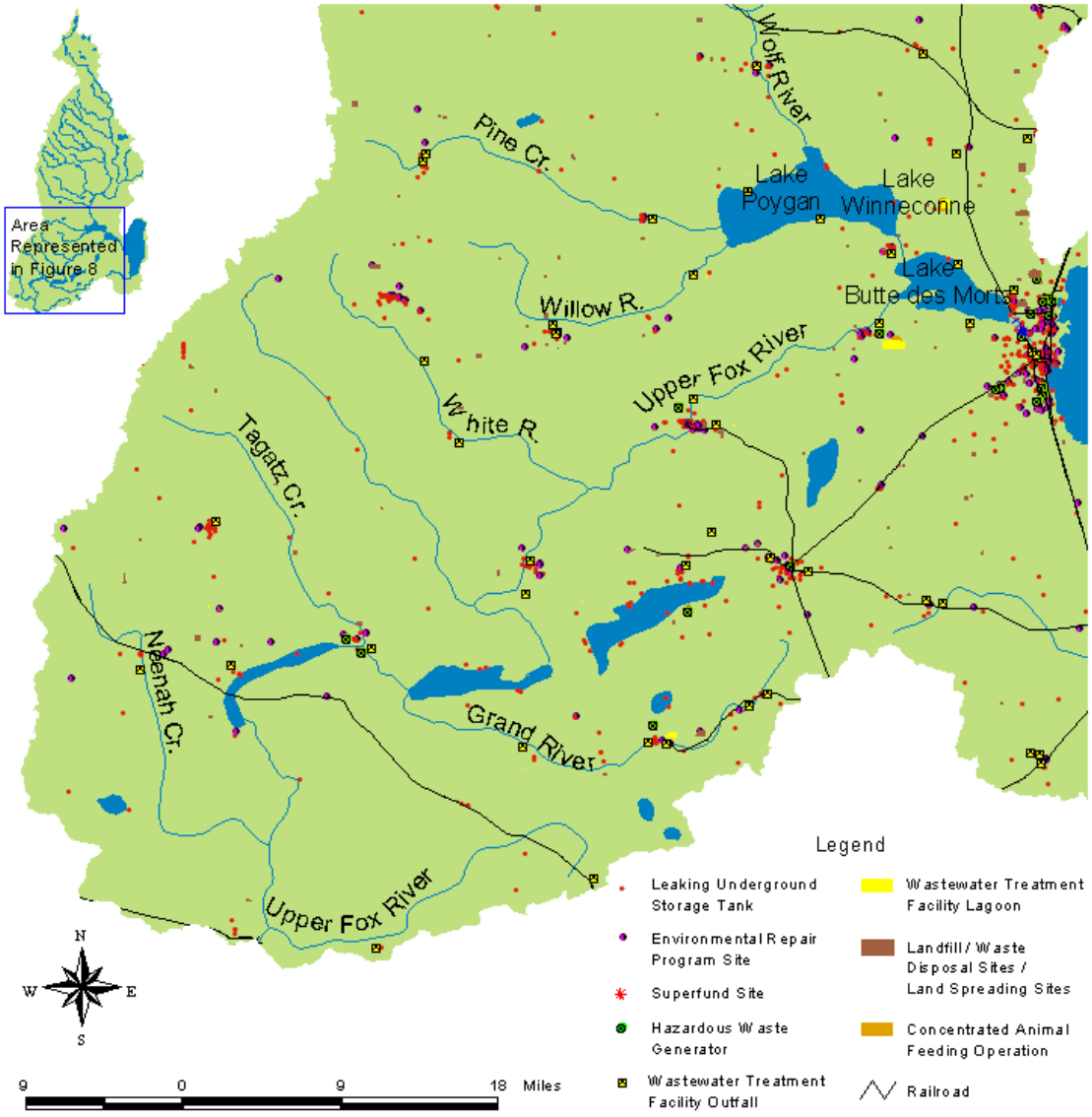
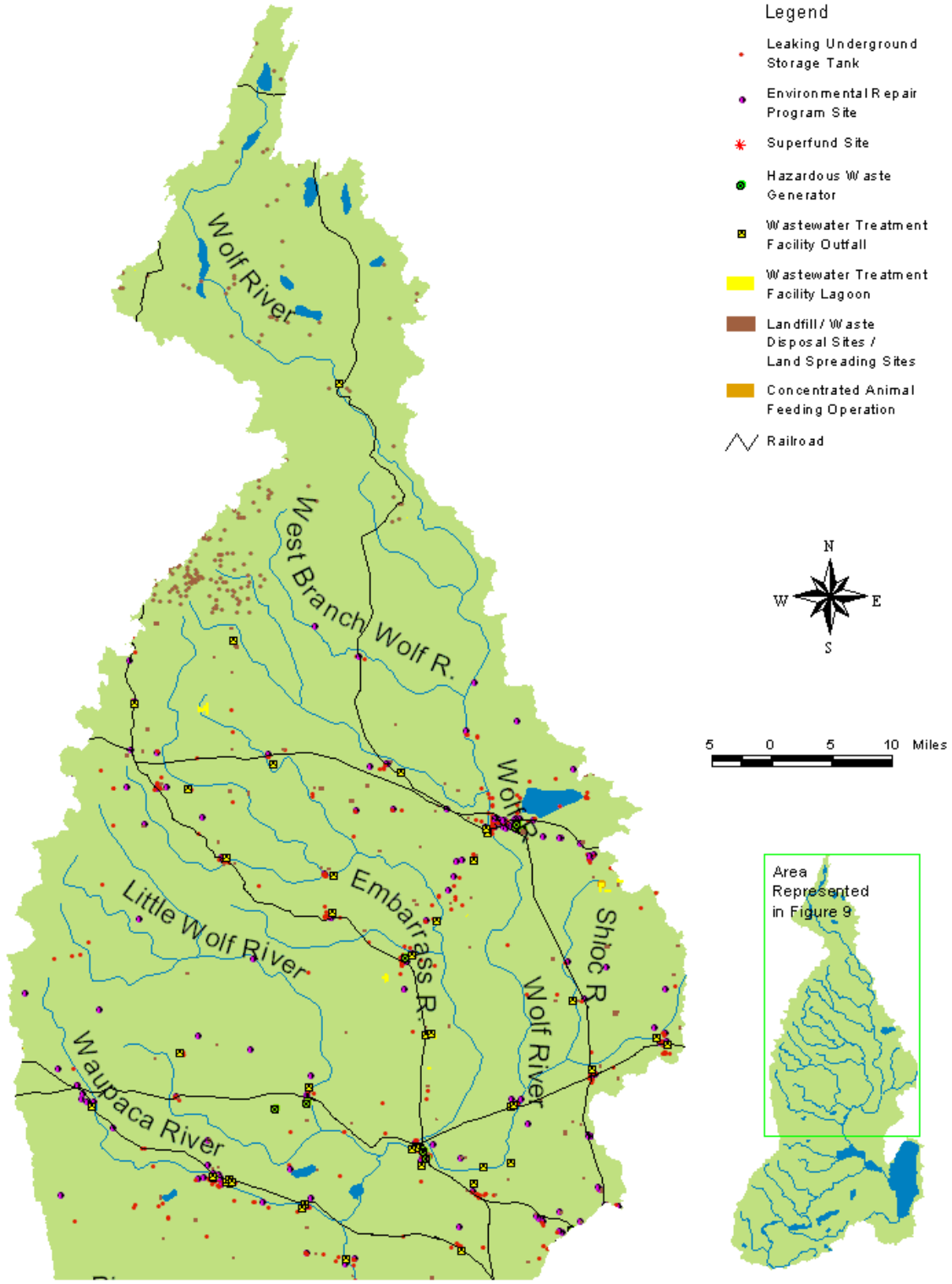


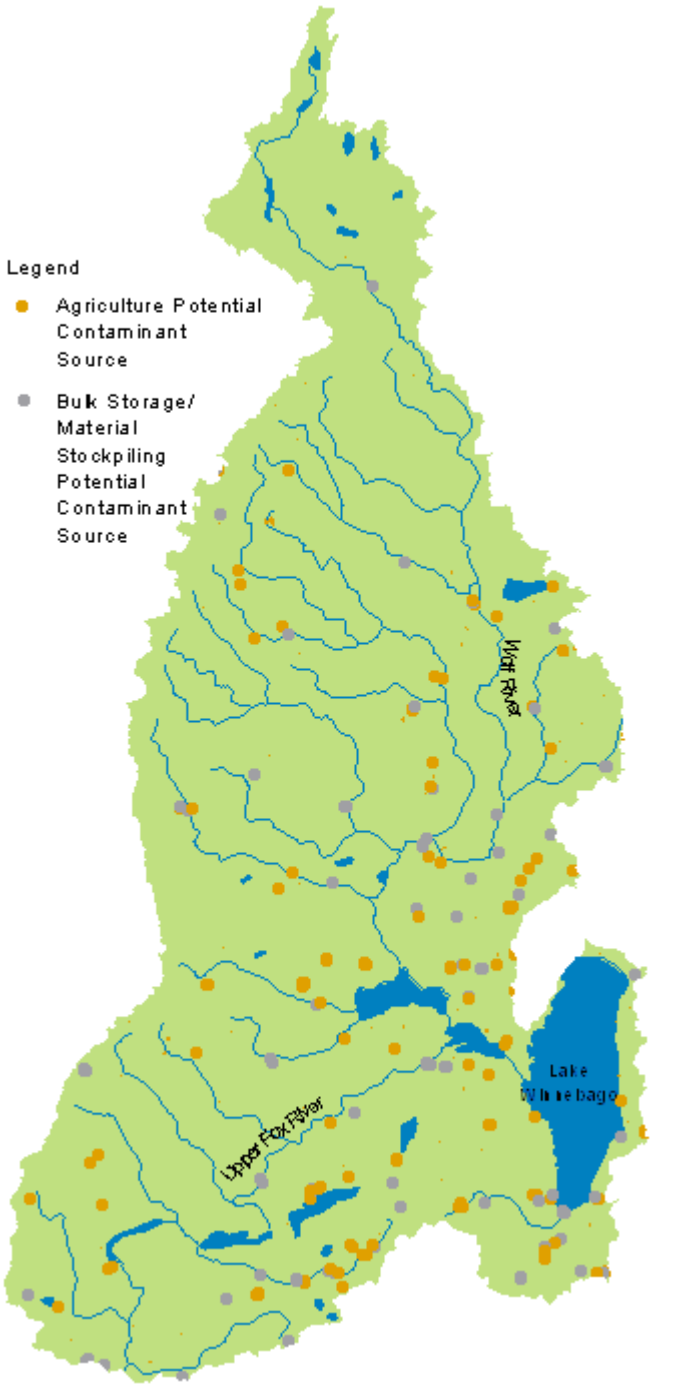
Figure 9: Wolf River Area Potential Contaminant Source Inventory



Localized Agricultural and Bulk Storage Potential Contaminant Sources

Localized agricultural and bulk storage potential contaminant sources are shown in Figure 10. Agricultural potential contaminant sources include active farming operations, animal feedlots, agricultural irrigation and lined and unlined manure storage facilities. These activities are potential sources of synthetic organic, inorganic and microbial contaminants. Bulk storage potential contaminant sources include feed mills, agricultural co-ops, 500 gallon and larger petroleum and chemical storage sites and road salt storage sites. Contaminants associated with storage facilities are largely site-specific, but generally they are potential sources of inorganic, synthetic organic and volatile organic contaminants.

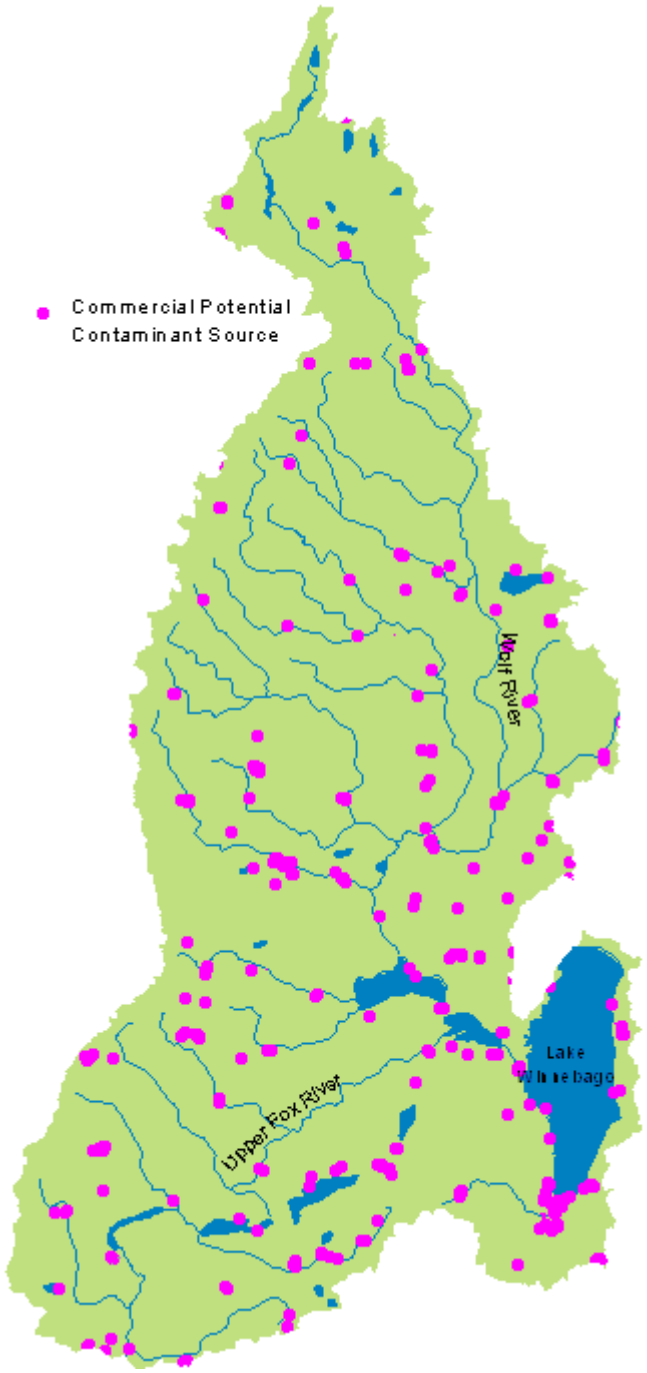
Figure 10: Agricultural and Bulk Storage Potential Contaminant Sources



Localized Commercial Potential Contaminant Sources

Localized commercial potential contaminant sources are shown in Figure 11. Commercial potential contaminant sources include airports, auto body shops, boat yards, car washes and Laundromats in unsewered areas, cemeteries, dry cleaners, gas service stations, machine/metal working shops, motor vehicle repair shops, paint shops, photo processing facilities, jewelry and metal plating facilities, printing facilities, rail yards, rail road tracks, scrap/junk yards and seed production plants. These activities are frequently associated with inorganic and volatile organic contaminants.

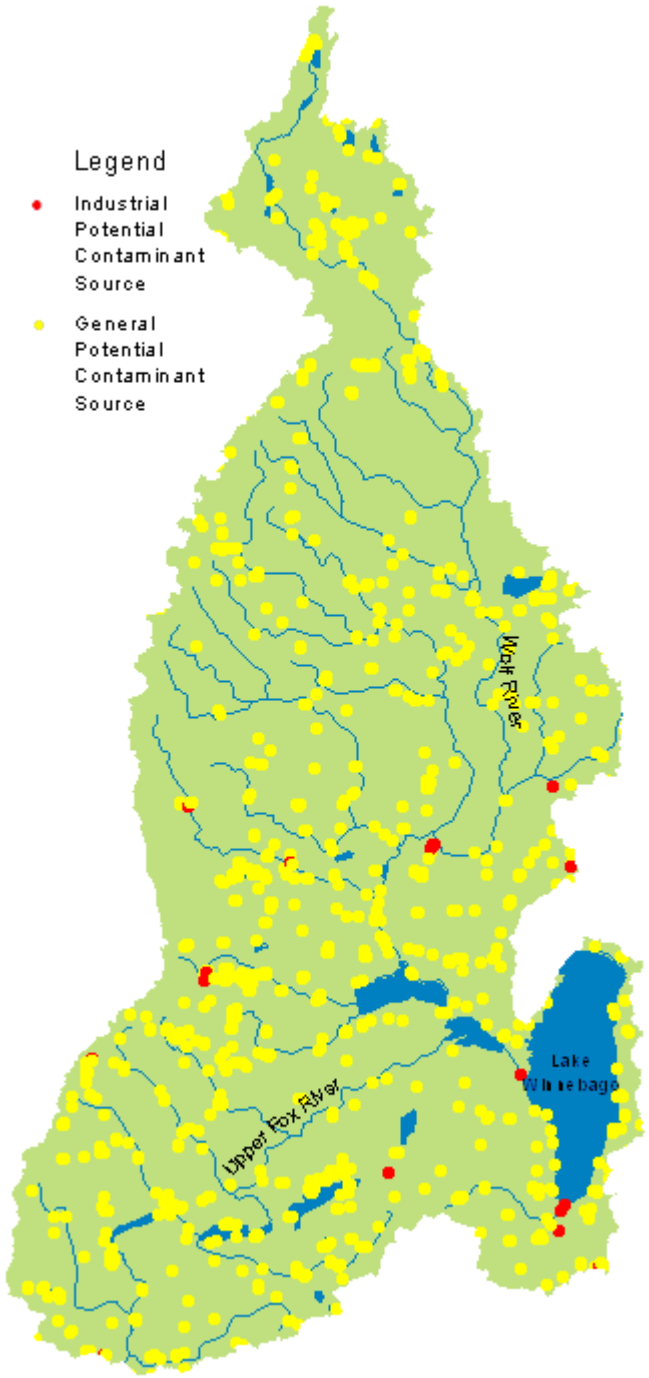
Figure 11: Commercial Potential Contaminant Sources



Localized General and Industrial Potential Contaminant Sources

Localized general and industrial potential contaminant sources are shown in Figure 12. General activities include above ground and below ground storage tanks, municipal and non-municipal sewer lines, sewage holding tanks, septic tanks, sumps, drainfields, mounds and dry wells. These activities are potential sources for synthetic organic, volatile organic, inorganic and microbial contaminants. Industrial potential contaminant sources include asphalt plants, industrial chemical production facilities, electronic product manufacturers, electroplating / metal finishing facilities, furniture or wood manufacturing / refinishing / stripping facilities, foundries / smelting plants, mining operations / mine waste sites, paper mills, petroleum and chemical pipelines, plastics manufacturer / molding facilities, wood preserving facilities. These activities are potential sources of volatile organic, synthetic organic and inorganic contaminants.

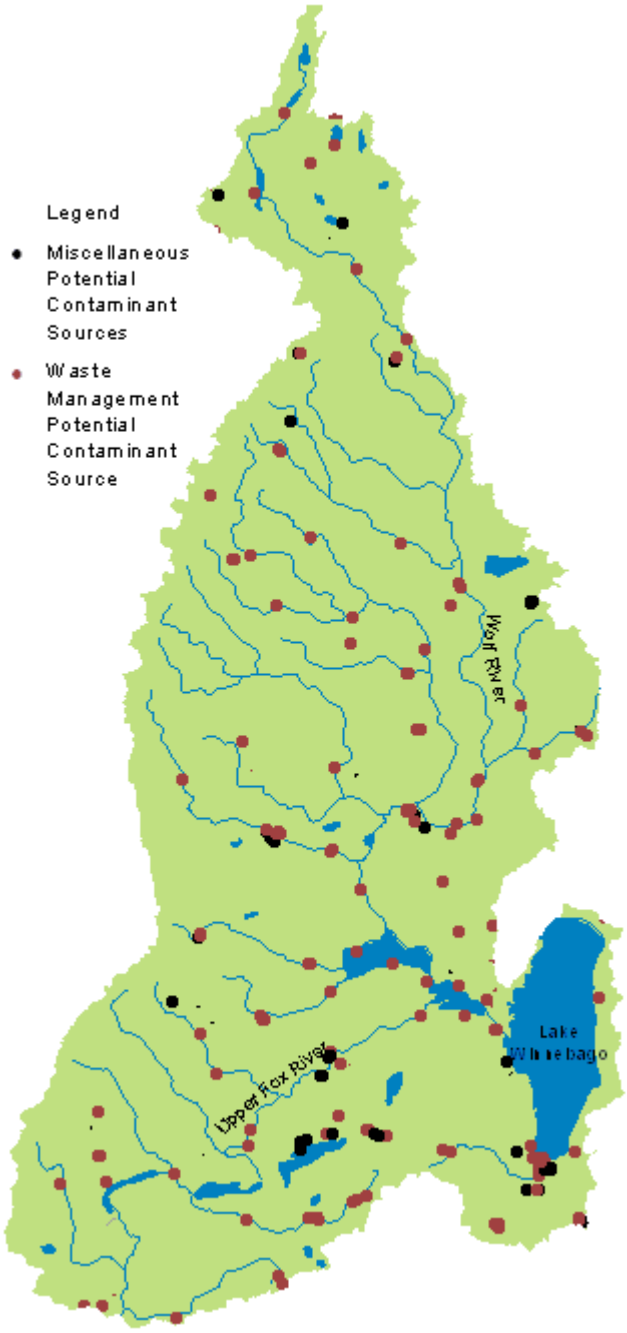
Figure 12: Industrial and General Potential Contaminant Sources



Localized Waste Management and Miscellaneous Potential Contaminant Sources

Localized waste management and miscellaneous potential contaminant sources are shown in Figure 13. Waste management potential contaminant sources include municipal incinerators, injection wells, sludge spreading sites, solid waste transfer stations and wastewater lagoons. These activities are potential sources of inorganic, synthetic organic, microbial and volatile organic contaminants. Miscellaneous potential sources include fire training facilities, golf courses, gasification plants, laboratories and military installations. These sources are associated with microbial, synthetic organic and volatile organic contaminants.

Figure 13: Miscellaneous and Waste Management Potential Contaminant Sources



Description of Public Drinking Water Treatment Facilities

Appleton Waterworks has reliably provided high quality drinking water to its customers. The average drinking water demand ranges from almost 20 million gallons per day (mgd) in summer to 9 mgd in winter. The water treatment facility has a summer capacity of 24 mgd and a winter capacity of 18 mgd.

Source water enters the treatment facilities through an intake located in Northern Lake Winnebago. Potassium permanganate is added at the intake to control zebra mussels. Upon entering the treatment facilities, powdered activated carbon is added to the source water in a .74 million gallon enclosed basin. Water then passes through lime softeners, recarbonation basins, granular activated carbon contractors, ultrafiltration membranes and free chlorine contact chambers. Ammonia is added to the treated water to form chloramines in the distribution system to deactivate microbial contaminants.

Susceptibility Determination

This assessment found Appleton's source water to have a relatively high susceptibility to contamination. The physical characteristics of Lake Winnebago and the high concentrations of urbanized and agricultural land in the eastern and southern portions of the source water area make Appleton's source water particularly susceptible to microbial, volatile organic and synthetic organic contaminants, along with precursors of treatment byproducts. Due to the slow flushing time of water in Lake Winnebago, Appleton's source water also has a relatively high susceptibility to contamination from large spills.

Recommendations

Source water protection should begin with the formation of a source water protection team composed of delegates from private parties and local, regional, state and federal organizations. This group is needed to coordinate and implement best management practices in the source water area to prevent source water contamination. Initial source water protection efforts of this team should focus on managing the following,

- Storm water runoff from urban areas near Lake Winnebago
- Storm water runoff from agricultural activities in the eastern and southern portions of the source water area
- Waterfront residential developments
- Landfills and industrial activities near Lake Winnebago
- Boating related activities on / near Lake Winnebago

As mentioned previously a comprehensive source water protection plan is beyond the scope of this assessment. The source water protection team may consider using resources provided by the USEPA at http://www.epa.gov/safewater/protect/sources.html on the World Wide Web for overall source water protection planning. This website offers general source water information, financial assistance contacts, source water protection case studies, contaminant source inventories and contingency planning among other subjects. For specific information concerning best management practices and dealing with potential contaminant sources please visit http://www.epa.gov/ogwdw/protect/swpbull.html on the World Wide Web.

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