Oconto County groundwater information for comprehensive planning

March 21, 2007

Executive summary

Maintaining the quality AND quantity of groundwater is vital to safeguarding the economy and quality of life in Oconto County, and protecting the health of its residents.

The following table summarizes the findings of this report.

GROUNDWATER FINDINGS
Susceptibility of groundwater to pollutants
• Susceptibility varies throughout county. • The majority of highly susceptible groundwater areas are in the north part of county.
Sources of drinking water
• 26% of county residents get drinking water from five municipal water utilities. • 74% of county residents get drinking water from private wells.
Groundwater quality
• 97% of 941 private well samples met the health standard for nitrate. • 92% of 203 private well samples met the health standard for arsenic. • 80% of private well samples met the health standard for bacteria. • Limited testing for pesticides. • Public wells have consistently met health standards with the exception of arsenic in two of the Village of Suring wells.
Potential contaminants
• 3 confined animal feeding operations (large dairies). • 40 sites with contaminated groundwater and/or soil. • Naturally occurring contaminants such as arsenic, radium, radon and chloride. • No currently licensed landfills and no Superfund sites.
Groundwater quantity
• Water use in 2000 is ~25% less than in 1979. • No regional effects of pumping are observed, but there is always the possibility of local effects from high capacity wells.
Money spent on cleanup
• Over $12 million has been spent on petroleum cleanup from leaking underground storage tanks which works out to $332 per county resident.
Groundwater protection policies
• Of 5 municipal water utilities, only Suring has a wellhead protection plan. Gillett, Lena and Oconto Falls have one in progress or plan to start soon. • Of 5 water utilities, only Suring has a wellhead protection ordinance. • County has manure management ordinance for areas outside of cities and villages.

Recommended groundwater policies

Based on the facts in the table above, the authors of this report recommend the following policies to protect groundwater in Oconto County.

GROUNDWATER POLICY RECOMMENDATIONS

1. Adopt county approved wellhead protection plans and wellhead protection ordinances for municipal wells that don't currently have them. These plans and ordinances are used to avoid locating petroleum and other potential groundwater contaminants in areas where contaminants could enter drinking water supplies. These areas often include land within the city/village and land in the towns which are under county zoning. See the *Goals and Policies* section for a table summarizing where plans and ordinances are needed.

2. Identify and properly seal unused wells. Unused wells can act as a direct conduit for contaminants to quickly travel from the land surface to the groundwater. Portage County Groundwater Specialist Ray Schmidt (715-346-1334) has developed a program to seal unused wells which may serve as a useful model. Unused wells may be identified using the Farm-A-Syst program or by driving around to look for abandoned farmsteads and old wind mills. Soon the DNR will have well abandonment forms scanned that could be crossed with the well construction report files to identify unused wells which have not been properly abandoned/sealed.

3. Provide educational programs for private well users about the responsibilities and protection measures that come with private wells. 74% of county residents get their drinking water from private wells. Water testing and drinking water programs are available through UW-Extension. In addition, the Wisconsin Groundwater Directory contains a section listing organizations and resources for groundwater education at www.uwsp.edu/cnr/gndwater/info/WI%20Groundwater%20Directory%202006.pdf

4. Encourage farmers to adopt nutrient management planning, integrated pest management and rotational grazing practices which all reduce use of potential groundwater contaminants. These practices are particularly valuable near or in recharge areas for public wells, regions where there are a high density of private wells and around karst areas. For a description of karst and recommended actions to prevent groundwater contamination in karst areas see http://basineducation.uwex.edu/rockriver/documents/2005karst.pdf.

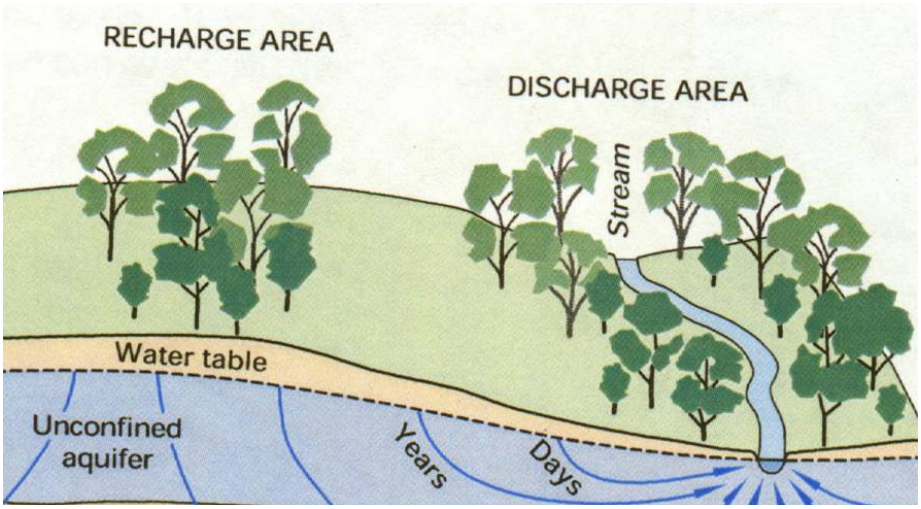
5. Encourage water conservation for businesses and residents on municipal water systems to avoid the increased expenses incurred when additional wells are needed.

Introduction

This report provides a county-wide look at groundwater resources. Site specific planning is necessary to analyze specific proposals.

Groundwater is the water that occupies the spaces in between soil particles and rocks below the earth. As shown in Figure 1, groundwater, lakes and rivers are all connected because water commonly flows between them. So if a substance gets in the groundwater it will eventually spread to nearby lakes and rivers and vice-versa. Groundwater is also connected to the surface of the land by rain and melted snow which carry substances from the surface of the land down to the groundwater and nearby drinking water wells.

Figure 1: Groundwater, lakes and streams are all connected



One hundred percent of water used by municipalities and in homes in Oconto County comes from groundwater. Industrial water users in Oconto County use surface water and groundwater.

Fertilizers, manure, land application of sewage, pesticides, on-site sewage disposal systems, chemical spills, leaking underground storage tanks, landfills, existing land uses and landowner practices are all potential pollutants for drinking water wells.

The remainder of this paper is organized as follow:

1) Groundwater inventory and analysis
    a. Groundwater susceptibility to contaminants
    b. Sources of drinking water
    c. Groundwater quality
    d. Potential sources of groundwater contaminants
    e. Groundwater quantity
    f. Geology and aquifers
    g. Money spent on cleanup
2) Groundwater goals and policies
    a. Goals
    b. Policies
    c. Next steps

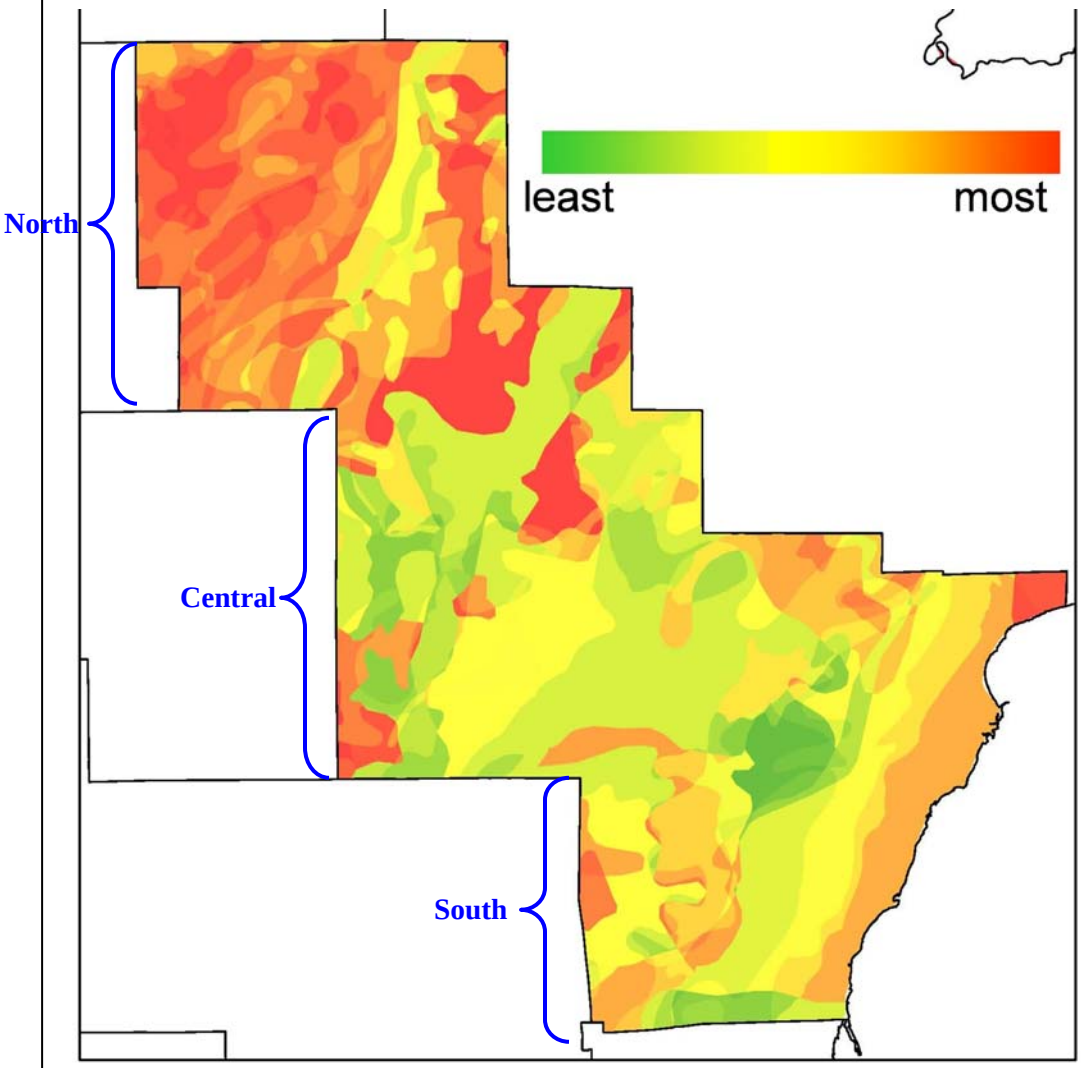
Groundwater Inventory and Analysis

Susceptibility of groundwater to contamination

The susceptibility of groundwater to contamination from land-use activities can be highly variable depending on location. It is important to keep in mind that the types of land use activities that are allowed, where they are located, and how carefully those activities are performed ultimately determine whether the groundwater resource becomes contaminated. Currently, the groundwater in the county that has been impacted most heavily by humans is in the central area as detailed in the groundwater quality section of this report.

Figure 2 indicates the relative susceptibility of groundwater to contamination from sources located on or near the land surface. The map is based on several factors thought to influence susceptibility, including depth to bedrock, aquifer type, soil type, and depth to groundwater.

Figure 2: Susceptibility of groundwater to contamination



The majority of highly susceptible groundwater areas are in the north part of the county with scattered highly susceptible areas elsewhere. Groundwater is generally less susceptible in the central and south parts of the county. For further information about the groundwater susceptibility factors, see the geology section of this paper.

Sources of drinking water

Municipal wells
As shown in Figure 3, five municipalities in Oconto County have 15 municipal wells that provide drinking water to 9,939 residents, or 26% of county residents.

Figure 3: Municipal drinking water systems[1]

Water system	**Wells and aquifers**	**Population served**
Gillett	3 wells in sand & gravel; 1well planned in sand & gravel	1,356
Lena	2 wells in bedrock	585
Oconto	3 wells in bedrock	4,505
Oconto Falls	3 wells in bedrock	2,892
Suring	2 wells in gravel; 1 well in sandstone	601
All municipal systems	**15 wells + 1 well planned**	**9,939**

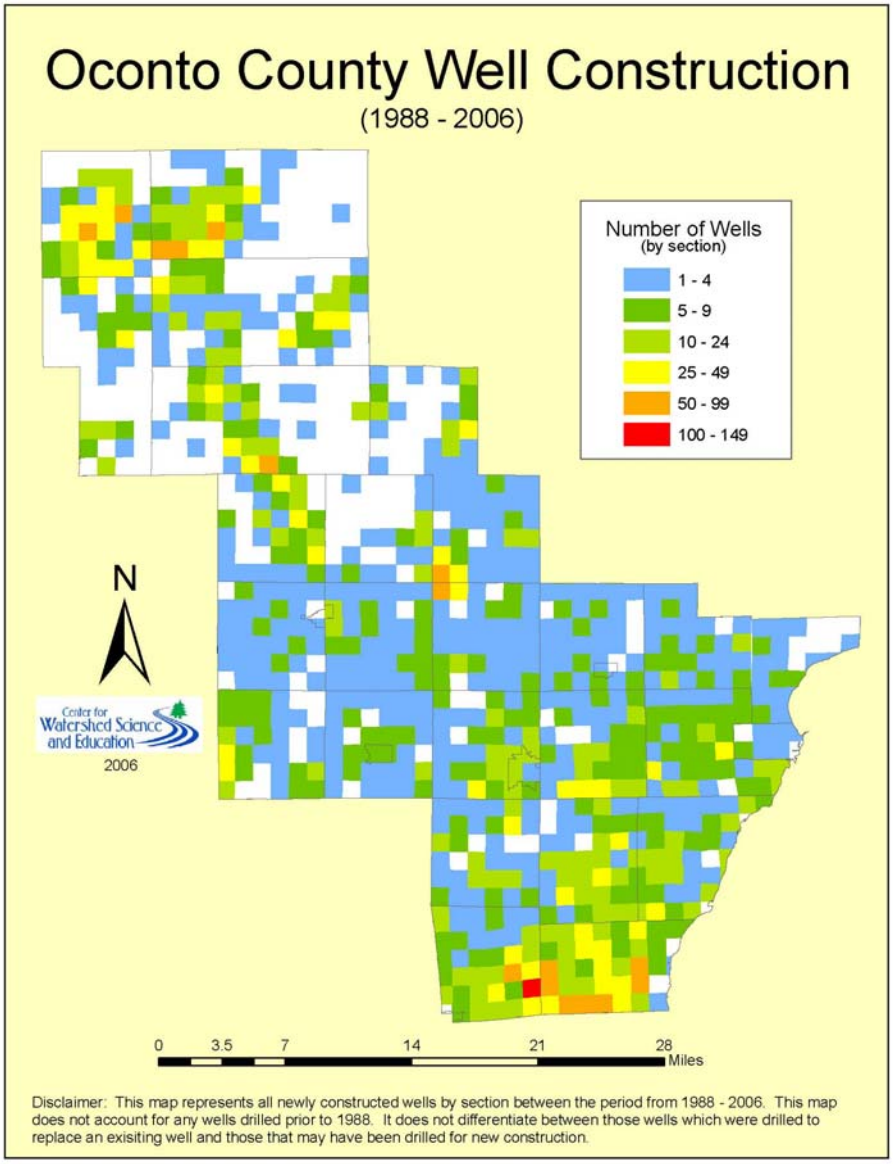
Municipal water systems are regulated by the WI Department of Natural Resources, meaning that they have to regularly test their water and must notify the public if water exceeds certain drinking water standards. In the case of municipal wells, if water does exceed drinking water standards additional steps must eventually be taken to ensure that the standards are met before the water is distributed to the individual homes in the community. Municipal systems provide reasonable assurance that drinking the water will not result in any acute or chronic health effects. The municipal wells in Lena, Oconto and Oconto Falls draw water from bedrock. The Gillett municipal wells draw water from the sand and gravel aquifer. Of the Suring municipal wells, two draw water from the sand and gravel aquifer and one from the sandstone aquifer. These aquifers are described in the geology section of this paper.

[1] DNR well data base, compiled by Ed Morse, Wisconsin Rural Water Association.

Private Wells

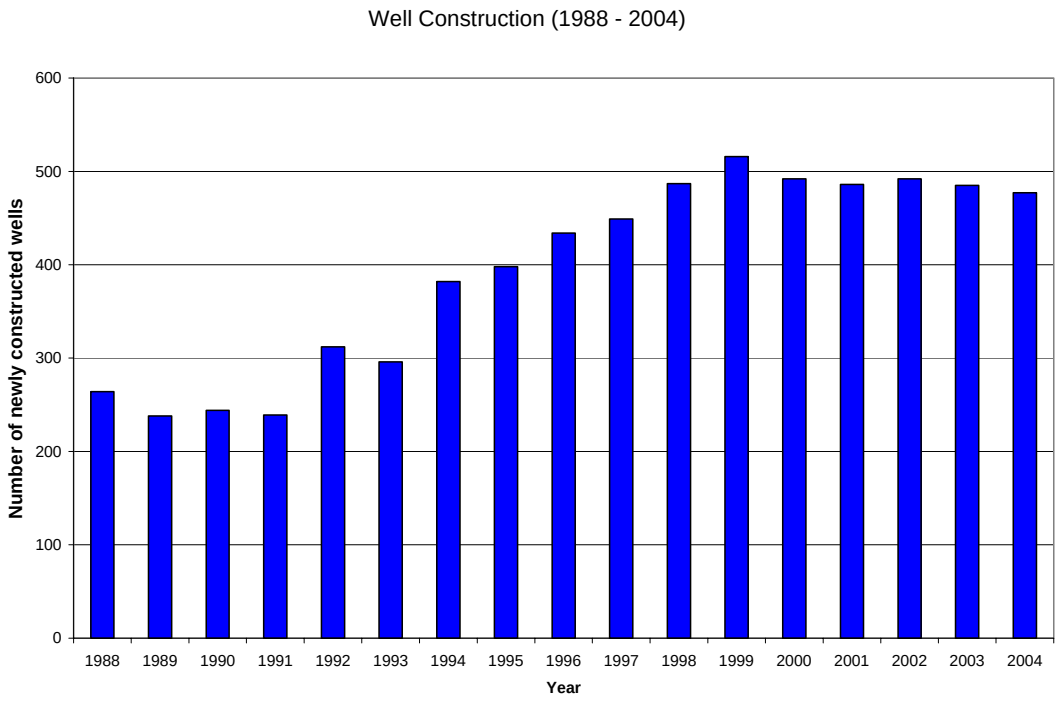
There have been over 12,000 wells constructed in Oconto County alone, the vast majority of which are private wells. Approximately 27,700 county residents, or 74%, get their drinking water from private wells. Figure 4 shows that from the period from 1988-2004 over 7,000 wells have been constructed, many of those newly constructed wells are concentrated in certain parts of the county.

Figure 4



The number of wells constructed each year in Oconto County has increased since 1988 as shown in Figure 5.

Figure 5: New well construction



Well construction which is regulated by the WI DNR (NR 812) is based on the premise that if a well and water system is properly located, constructed, installed and maintained the well should provide safe water continuously without the need for treatment. These regulations have specific guidelines regarding materials and methods used to construct a well, in addition to separation distances from potential sources of contamination. A coliform bacteria test is also required on all newly constructed private wells to ensure that the well is sanitary. This is a one time initial test and the only test that is required for private wells. While the majority of private wells in the state do produce high quality safe drinking water, some private wells may provide contaminated water to unsuspecting families."

After a well is drilled most homeowners are unaware of their responsibilities when it comes to owning a private well. The decision to test, and which contaminants to test for, is solely the responsibility of the individual well owner. If there is something wrong with the water supply it is the individual well owner's responsibility to determine what the risks are and whether those risks are great enough to correct the problem or find an alternative source of drinking water.

Unlike municipal wells, private wells are not required to have a wellhead protection plan. The recharge area for private wells is generally local and discrete. Therefore, it is

important for homeowners and well drillers to evaluate potential contamination sources when placing and deciding on the depth of a new well and casing in order to reduce the chances of drinking unsafe water. Incorporating such things as groundwater flow direction into the placement and design of a well are critical to providing the safest source of water possible. This is of particular concern for new subdivisions where the density is such that private wells often intercept effluent from upgradient septic systems. Simple groundwater flow models may enable wellhead protection strategies to be incorporated into new subdivision design. Considering the large increase in private wells, local governments should look for ways to take a proactive role in protecting public health by developing and incorporating drinking water protection policies for their community.

Groundwater quality

Nitrate

Nitrate is the most widespread groundwater contaminant in Wisconsin. While nitrate can end up in groundwater through naturally occurring processes, natural levels in Wisconsin are generally less than 2 mg/L of nitrate as nitrogen. Nitrate-nitrogen concentrations above 2 mg/L generally suggest that groundwater has been impacted by local land-use activities. The majority of nitrate in groundwater is a result of nitrogen fertilizer use, manure and municipal waste spreading, and septic system effluent.

Excessive nitrate levels are a health concern for humans and livestock. Women who are or are trying to become pregnant; and infants less than 6 months of age should not drink water that exceeds the safe drinking water standard of 10 mg/L of NO_3-N because of the concerns related to miscarriages, birth defects and methemoglobinemia, also known as "blue baby disease". High nitrate levels in feedstocks combined with high nitrate levels in water can be a lethal combination for livestock. In addition to health concerns, nitrate is also an environmental concern since it may be toxic to aquatic life and can cause excessive vegetative growth in aquatic systems. Nitrate is also considered an indicator of other health related contaminants such as pesticides if the source is fertilizer use or contaminants like pharmaceuticals or viruses if the source is septic system effluent.[2]

The ideal solution to high nitrate levels and other water quality problems caused by human activity is to eliminate the contamination source. In cases where the source of contamination is obvious, such as fertilizers or a nearby septic system, it may be easy to eliminate the source. However, identifying contamination sources can often be difficult or challenging, especially when dealing with non-point pollutants like nitrate. In addition, eliminating the contamination source may not result in a change in water quality for a long time since it may take years for newer uncontaminated water to replace the contaminated groundwater within the aquifer. While improving land management practices to reduce contamination or taking additional steps to eliminate groundwater contamination should be a goal of everyone in the community, it is important to realize

[2] Kevin Masarik, Central Wisconsin Groundwater Center.

that temporary solutions also often have to be implemented to avoid drinking unsafe drinking water in the short-term.[3]

Drilling deeper wells is sometimes a way to reduce nitrate levels because shallow wells are more susceptible to contamination from the surface of the land. However, it is important to note that drilling a deeper well does *not* guarantee lower nitrate levels. Nitrate levels can also be reduced by home water treatment systems that are certified specifically for nitrate removal and are capable of removing the amount of nitrate present.

Nitrate levels in Oconto County are generally low compared to other parts of the state. Of the 941 nitrate samples that have been collected in the county, 82 samples (11%) were above 2 mg/L and indicate that land use has likely affected groundwater quality; only 26 samples (3%) exceeded the safe drinking water standard.[4] Much of the information about nitrate in the county is due to information, education and water testing services provided by the Oconto County UW-Extension Office over the years. Residents of Oconto County should be encouraged by the low levels of nitrate in groundwater; however there are areas for improvement. As shown in Figure 6, most of the samples where nitrate levels were elevated were located in the central part of the county.[5] This may be because karst areas (limestone outcroppings and sink holes) are more common in the central part of the county than in the south. These out crops are farmed around and may act as conduits from the land's surface to the groundwater.[6] While some nitrate leaching is expected under agricultural lands and septic systems, extra precautions should be taken or encouraged to ensure that nitrate does not reach problem levels in other parts of the county.

[3] Kevin Masarik, Central Wisconsin Groundwater Center.
[4] WI DNR groundwater retrieval network.
[5] Map created by Kevin Masarik, Central Wisconsin Groundwater Center. The land use layer is from WISCLAND Land Cover created from satellite imagery collected in 1991 – 1993.
[6] Oconto County Planning and Zoning.

Figure 6: Nitrate and land use

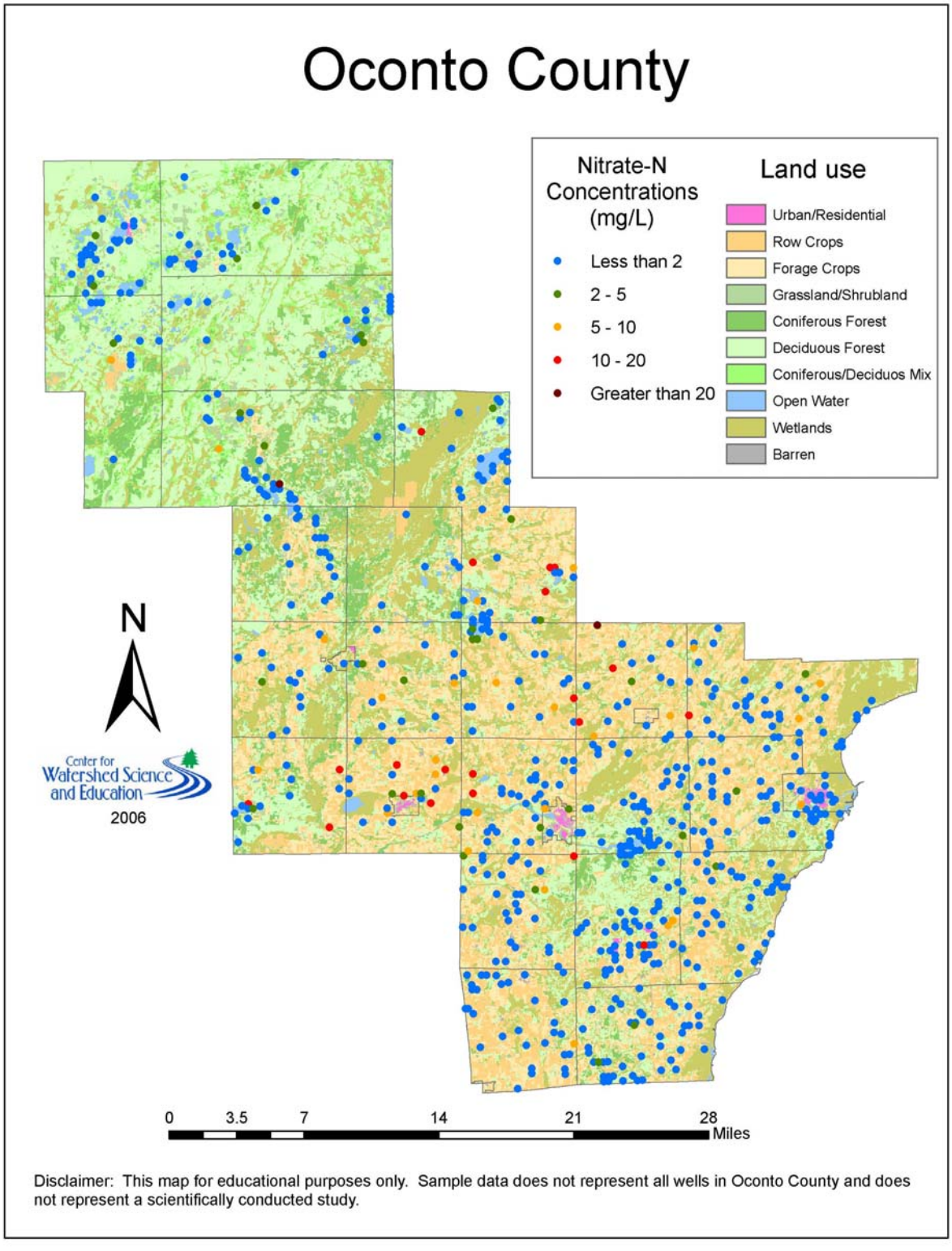
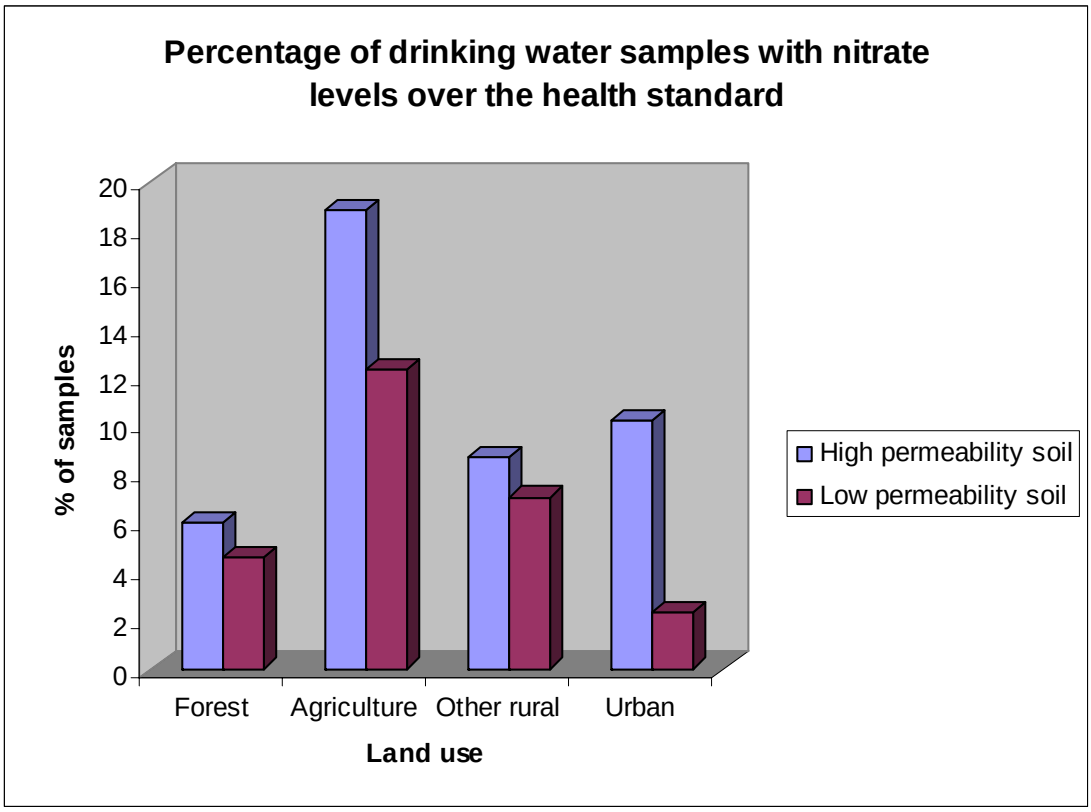


Figure 7 explains how the forest land use in the northwest part of the county probably protects the water quality despite its high susceptibility to contamination.[7]

Figure 7: Land use – nitrate connection



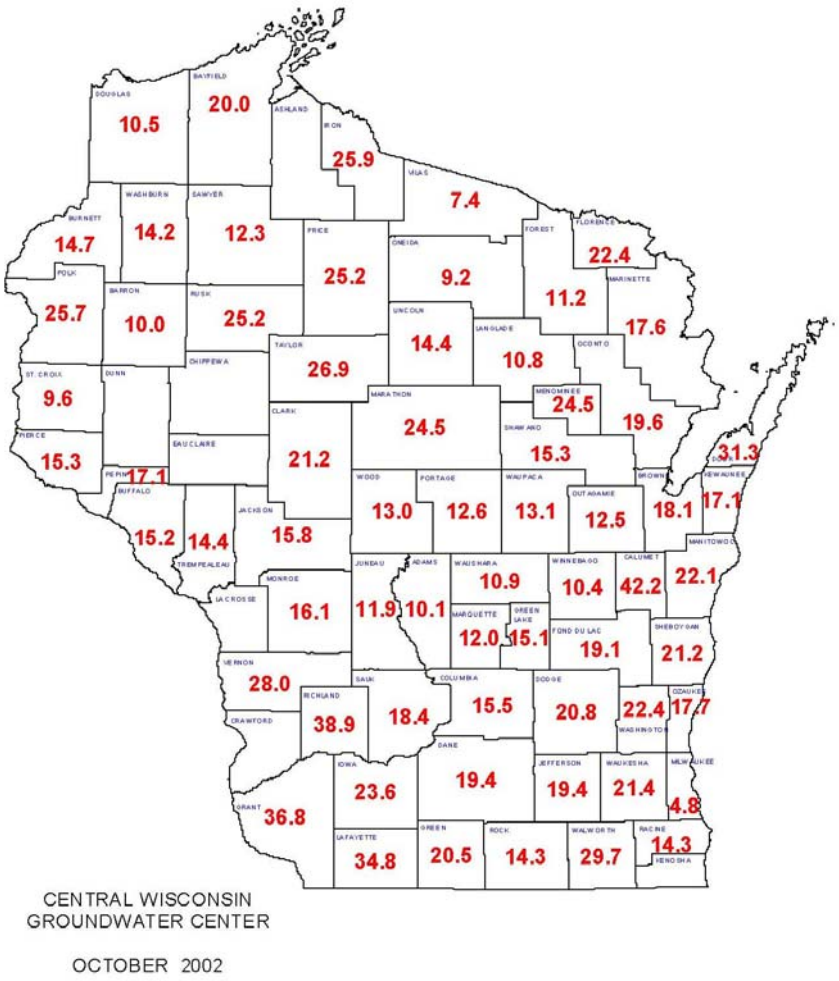
An analysis of over 35,000 Wisconsin private well samples found that drinking water is three times more likely to be unsafe to drink due to high nitrates in agricultural areas compared to forested areas. High nitrate levels are also more common in sandy areas where the soil is more permeable. Groundwater from forested areas is less likely to contain fertilizers and pesticides because such chemicals aren't typically applied to forest land. In addition, forests act as a natural filter removing chemicals and other contaminants that pass through it.

Bacteria

Testing for coliform bacteria helps to determine if a private well is bacterialogically safe. All wells that supply drinking water should be absent of bacteria including coliform bacteria. Figure 8 shows the percentage of sampled private wells that have been contained bacteria for each county in Wisconsin. In Oconto County 19% of samples tested positive for bacteria.

[7]Sample results compiled by David Mechenich at the Central Wisconsin Groundwater Center.

Figure 8



In most cases a properly constructed well (Well Construction is regulated by NR 812) will prevent bacteria and other disease causing organisms from entering a well. Soils are usually able to filter bacteria out of water before it reaches the saturated zone. Unfortunately in areas with thin soils or in karst regions, bacteria can more easily contaminate the groundwater aquifer. Under these conditions even a properly constructed well may become contaminated with bacteria. Installing wells according to required distances from septic systems, animal feedlots and manure pits should help in avoiding potential bacteria problems. Also, ensuring that pets are not allowed in the area directly surrounding the well is a good precaution. Bacteria can also enter wells through sanitary defects such as compromised well caps or well casings.[8]

[8] Kevin Masarik, Central Wisconsin Groundwater Center.

Pesticides
Pesticides include compounds used to kill weeds, insects, nematodes and fungi. When pesticides are spilled, disposed of, or applied on the soil, some amount can be carried into the surrounding surface water or groundwater. These products move with water and can eventually enter nearby drinking water wells. In a recent study of pesticides in Wisconsin groundwater the following commonly used herbicides (weed killers) and their metabolites were detected in varying percentages of private drinking water wells: alachlor (28% of wells), metolachlor (25% of wells), atrazine (5% of wells), and acetochlor (3% of wells).[9] The occurrence of pesticides in groundwater is more common in agricultural regions, although it can occur anywhere pesticides are stored or applied.

Very little information exists about pesticides in groundwater in Oconto County.[10] More information is needed regarding pesticides especially in areas near agriculture and where nitrate levels are elevated.

Arsenic
While there are some human sources of arsenic, the source of most arsenic in groundwater is naturally occurring arsenic in bedrock and glacial deposits. Of 203 water samples analyzed for arsenic in Oconto County, 96 have detectable arsenic and 17 samples (8%) are greater than the recently reduced safe drinking water standard of 10 parts per billion (ppb).[11] Most private wells in the county have unknown arsenic levels. In the Village of Suring Municipal Well #2 was taken off line in October 2006 because the three samples collected from the well in 2006 and analyzed for arsenic had levels at 13-14 ppb.[12] This well cannot be used unless emergency conditions arise. The Village installed Well #3 with arsenic removal equipment and will blend water from Well #1 and Well #3 to stay below the standard.[13] More information is needed to identify the extent of arsenic in the county and help people who may have elevated levels of arsenic to improve their drinking water quality.

Other potential groundwater contaminants originating from land uses
The following three groups of chemicals have the potential to contaminate groundwater.

Volatile organic compounds (VOCs) are a group of common industrial and household chemicals that evaporate, or volatilize, when exposed to the air. Sources of VOCs include a variety of everyday products such as gasoline, fuel oil, solvents, degreasers, and dry cleaning solutions. When chemicals containing VOCs are spilled or disposed of on or below the land surface some of the chemicals can be carried down into the groundwater where they may pose a threat to nearby wells. Some VOCs are quite toxic while others pose little risk. Health risks vary depending on the type of VOC, but effects of long-term

[9] Agricultural chemicals in Wisconsin groundwater. Final report May 2002. DATCP
[10] Of ~30 samples recorded in the WI DNR groundwater retrieval network and the Central Wisconsin Groundwater Center database, the majority showed undetectable levels of triazine.
[11] Data from WI DNR groundwater retrieval network. The new safe drinking water standard for arsenic went into effect on January 23, 2006. Based on health study results, the USEPA lowered the standard from 50 to 10 ppb.
[12] WI DNR groundwater retrieval network and Central Wisconsin Groundwater Center.
[13] Personal communication with Robert Barnum, WDNR, 12/20/06.

exposure can include cancer, liver damage, spasms, and impaired speech, hearing and vision.[14] VOC contamination of groundwater and soils is included in Figure 9.

Pharmaceuticals and personal care products. The list of pharmaceuticals is long and includes such medications as tranquilizers, pain killers, antibiotics, birth control, hormone replacement, lipid regulators, beta blockers, anti-inflammatories, chemotherapy, antidiabetics, seizure control, veterinary drugs, antidepressants and other psychiatric drugs. There is a related category of chemicals referred to as "personal care products" that includes cosmetics, perfumes, soaps, sunscreens, insect repellants and so forth. The volume of pharmaceuticals and personal care products entering the environment each year is about equal to the amount of pesticides used.

In 2000 the U.S Geological Survey conducted a nationwide assessment of drugs in streams and groundwater. They picked locations likely to be contaminated, but found pharmaceuticals in about 60% of groundwater samples. Sources of discharge of pharmaceuticals to the environment include wastewater treatment plants, septic systems, landfills, sludge and manure spreading and livestock feedlots. Why be concerned about traces of chemicals that were designed to be consumed? We're only beginning to understand the health effects. Because of the low concentrations, any effects are likely to appear only after years of exposure. A real concern is that some of the drugs are endocrine disruptors. Endocrine glands, such as the thyroid, pituitary or thymus send hormones, such as adrenaline, estrogen or testosterone to specific cells stimulating certain responses. There are hundreds of different hormones and they are messengers that regulate a multitude of normal biological functions, such as growth, reproduction, brain development and behavior. The delivery of hormones to various organs is vital and when the delivery, timing or amount of hormone is upset, the results can be devastating and permanent. Chemicals that are similar to hormones ("hormone mimics") can fit onto the receptor sites on the target cells and either block the real hormones or trigger abnormal responses in the cells. Scientific studies have indicated links between endocrine disruptors and reproductive disorders, immune system dysfunction, certain types of cancer, congenital birth defects, neurological effects, attention deficit, low IQ, low sperm counts and early onset of puberty in girls.[15]

Chloride at levels greater than 10 parts per million (ppm) usually indicate contamination by septic systems including from regeneration of water softeners, road salt, fertilizer, animal waste or other wastes. Chloride is not toxic in concentrations typically found in groundwater, but some people can detect a salty taste at 250 ppm. Levels of chloride that are above what is typical under natural conditions indicate that groundwater is being affected and extra care should be taken to ensure that land use activities do not further degrade water quality.[16]

[14] Kevin Masarik, Central Wisconsin Groundwater Center.
[15] *Drugs in Our Water?* by Ed Morse, Wisconsin Rural Water Association, October 2005.
[16] Kevin Masarik, Central Wisconsin Groundwater Center.

Sources of potential contaminants

Groundwater contaminants can come from a wide variety of sources. This report does not deal with these in detail, but does provide some references for further investigation.

Landfills

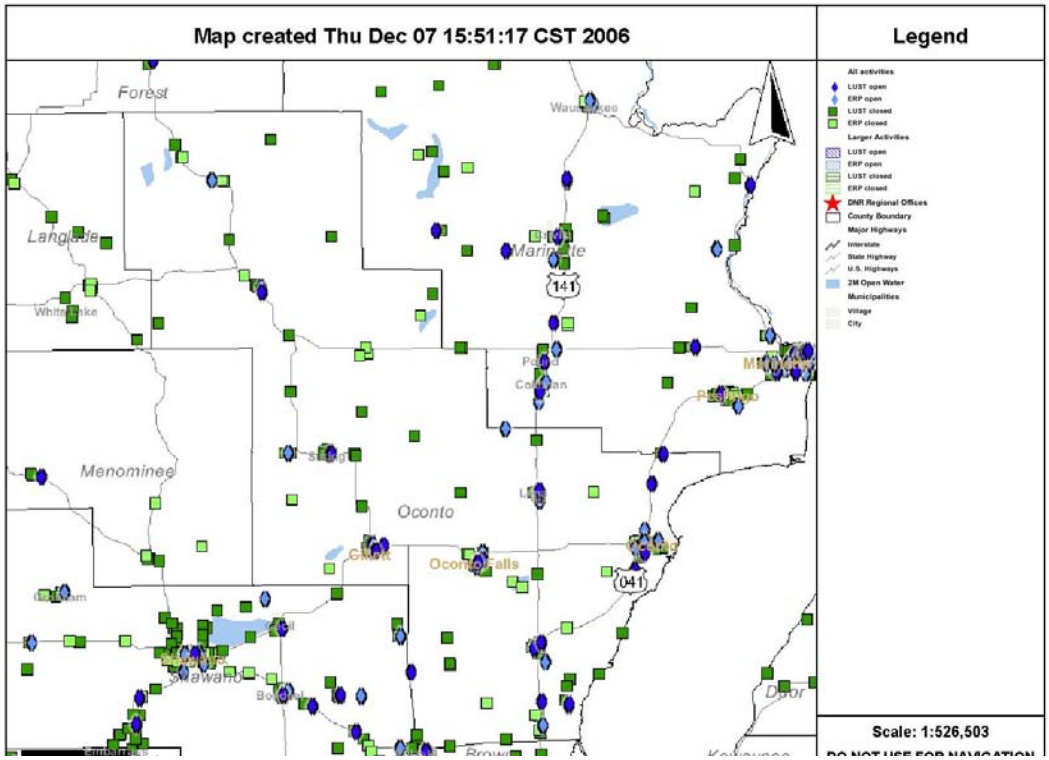
No solid waste landfills are licensed in Oconto County for 2006.[17] The county does have 89 facilities listed in the registry of waste disposal sites that includes active, inactive, and abandoned sites where solid or hazardous wastes were known, or likely to have been disposed. The inclusion of a site on the Registry does not mean that environmental contamination has occurred, is occurring, or will occur in the future. The Registry is intended to serve as a general informational source for the public, and State, and local officials, as to the location of waste disposal sites in Wisconsin. The registry is at http://dnr.wi.gov/org/aw/rr/archives/pubs/RR108.pdf

Hazardous substances

Properties that were or are contaminated with hazardous substances can be found using the DNR's Bureau for Remediation and Redevelopment Tracking System (BRRTS). This system includes contaminated sites, including spills, leaking tanks, Superfund sites, etc. Figure 9 shows the BRRTS map of contaminated sites in Oconto County. There are 23 open leaking underground storage tank (LUST) sites (royal blue diamonds in Figure 9) that have contaminated soil and/or groundwater with petroleum, which includes toxic and cancer causing substances. However, given time, petroleum contamination naturally breaks down in the environment. In the county there are 17 open environmental repair (ERP) sites (turquoise diamonds in Figure 9) which are sites other than LUSTs that have contaminated soil and/or groundwater. Examples include industrial spills or dumping, buried containers of hazardous substances and closed landfills that have caused contamination. More information for the sites on Figure 9 is available at http://botw.dnr.state.wi.us/botw/Welcome.do

[17] http://dnr.wi.gov/org/aw/wm/faclists/WisLic_SWLandfills.pdf

Figure 9: BRRTS map



Wells to be constructed on or near properties shown on the map in Figure 9 may require special well construction features. Residual soil contamination may need to be treated or disposed of if excavated, and should be avoided during well construction. Precautions may be needed during excavation, or for construction on such properties due to residual contamination. Some of these sites have deed restrictions or land use controls associated with them.

Agriculture

Oconto County has three concentrated animal feeding operations (CAFOs), all dairies. They are Dads Farms Inc. (Suring address), Suring Community Dairy LLC (Suring address) and Zahns Farms LLC (Gillett address).[18] By definition, these facilities each have greater than 1000 animal units. Other potential groundwater contaminants from agriculture include fertilizers and pesticides. Large amounts of nitrogen fertilizers are used when fields are planted in continuous corn, and can leach into groundwater as nitrates.

Superfund Sites

Oconto County has no Superfund sites.[19]

[18] Wisconsin's WPDES Permitted Animal Feeding Operations (map) http://www.dnr.state.wi.us/ORG/WATER/WM/nps/ag/cafo_map.pdf

[19] Superfund Sites in Wisconsin http://dnr.wi.gov/org/aw/rr/archives/pubs/RR005.pdf

Groundwater quantity

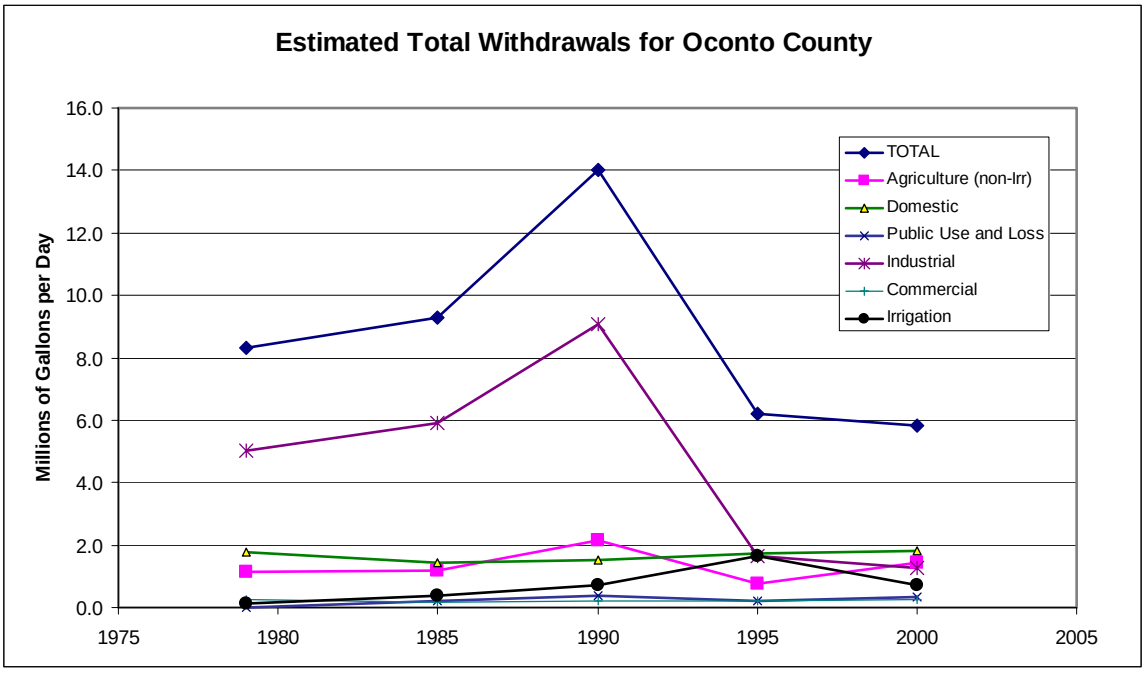
Despite relatively abundant precipitation in Wisconsin, some regions of the state have falling groundwater levels (southeast, Fox cities and Dane County). In some areas of Wisconsin, but not documented in Oconto County, lowered groundwater levels due to a combination of drought and increased water usage have caused portions of streams to go dry.

Water use

Figure 10 shows water use in Oconto County from 1979-2000.[20] Notable trends include:

- Total water use increased from 1979-1990 and then decreased from 1990-1995.
- The largest water users were industrial users which use both groundwater and surface water. Their use also accounted for the majority of the rise and fall in water use. This may be due to the closings of the Oconto Falls paper mill pulp plant and the plywood company in Mosling.[21]

Figure 10: Water use



High capacity wells

There are 76 permitted high capacity wells in Oconto County. These wells belong primarily to municipal utilities, farms, golf courses, cheese plants and bottling plants.[22]

USGS monitoring well

[20] Water use data and graph created by Charles Dunning and Cheryl Buchwald, U.S. Geological Survey.
[21] Oconto County Zoning Office.
[22] DNR Drinking Water System: High Capacity Wells http://prodoasext.dnr.wi.gov/inter1/hicap$.startup

The groundwater level in one U.S. Geological Survey monitoring well in Oconto County, located near Bonita has varied within about a three-foot range from 1985-2005 with no defined trend.[23] This well is shallow at 46 feet deep and is located near a river and dam which stabilizes water levels compared to surrounding areas.

Dry wells

Of more than 7,000 well that have been drilled since 1988, 147 wells indicated that the reason for constructing the well was to replace an existing well that had gone dry or was not able to produce enough water to meet the household water demands. The majority of the dry wells that needed replacement happened to be driven point wells. Driven point wells are generally shallower than drilled wells and are more susceptible to fluctuations in the water table during dry years. Driven point wells generally do not have the same pumping capacity as a drilled well and may not have been adequate to meet any increases in water use. In addition, driven points are also more likely to become plugged or encrusted over time which reduces yield and can lead to water quantity problems for well owners. It appears from this information that the well replacement was due more to the type of the original well than any overall water quantity concerns in Oconto County.

Groundwater quantity conclusions

Based on current water use that is less than 1979 water use and monitoring well data, it is unlikely that groundwater quantity issues will be a major concern for Oconto County. However, groundwater is a local resource and changes in land use which decrease recharge or large increases in water use could result in localized water quantity issues.

Geology and aquifers

This section provides a broad look at geology and soils in Oconto County based on generalized statewide maps. Local geology and soils may vary. The county may donsider more detailed investigation of local geology for land use planning purposes.

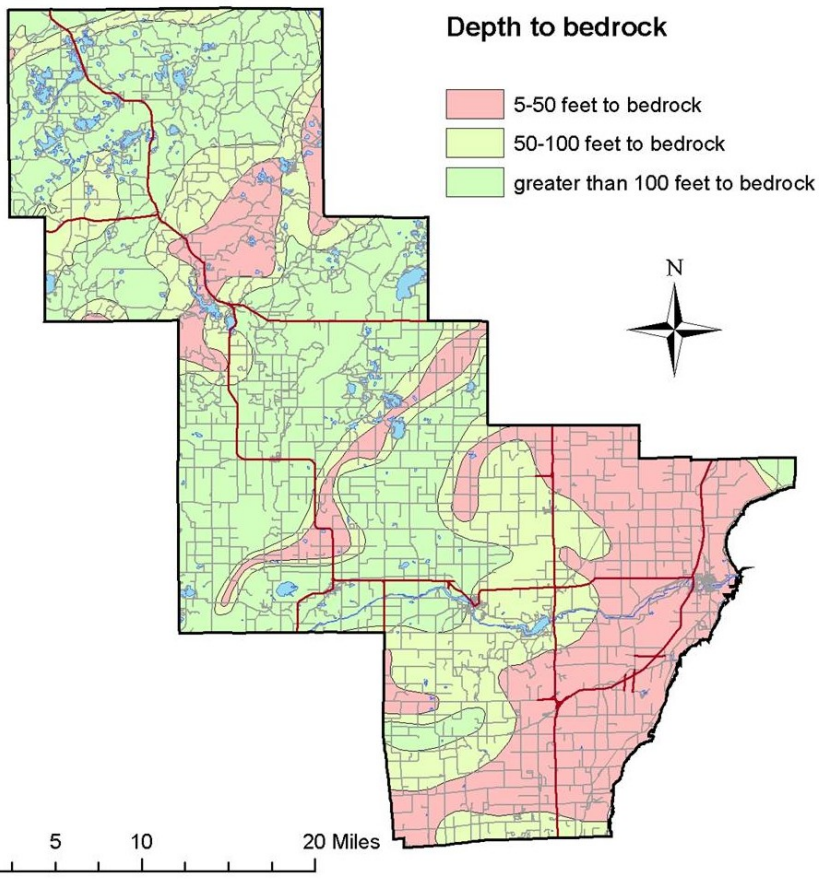
Groundwater is the water that occupies the spaces in between soil particles and rocks below the earth. Aquifers are water bearing geologic formations that contain groundwater. Geological formations have different physical and chemical properties which affect the quality of groundwater as well as its storage and transport.

Glaciers covered Oconto County during the Ice Age that ended about 10,000 years ago. These glaciers left behind thick deposits of sand, gravel, till (a mixture of sand, gravel, silt, and clay), and lake sediment over most of the county. These deposits cover the bedrock.

[23] Monitoring well location and hydrograph at http://wi.water.usgs.gov/public/gw/HISTORICAL/OC-0179.html

Depth to bedrock
See Figure 11 for the depth to bedrock in Oconto County.

Figure 11: Depth to bedrock



Glacial deposits

Glacial deposits are the soil and loose rocks located between the surface of the land and the bedrock. In Oconto County glacial deposits generally consist of lake deposits (clay, silt, and sand) near Green Bay, and a mix of till (mixture of sand, silt, clay, cobbles, and boulders) and outwash (sand and gravel) in the remainder of the county as shown in Figure 12.

Figure 12: Glacial deposits

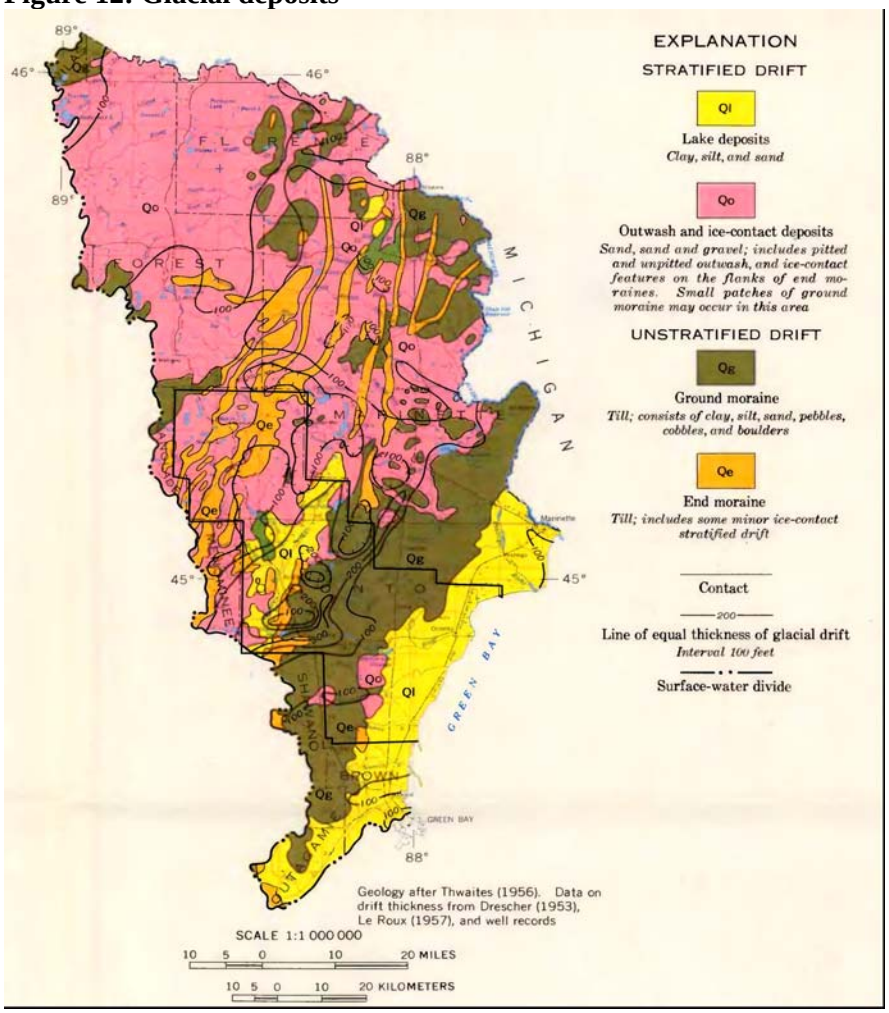


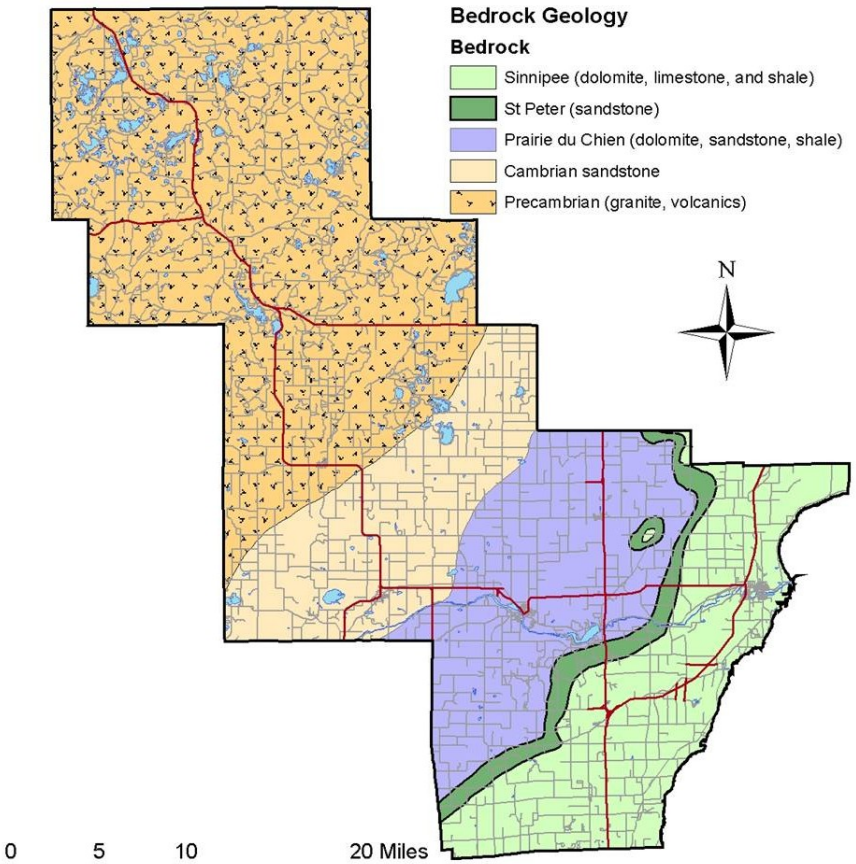
Figure 12 is from Oakes and Hamilton, and includes the entire Menominee-Oconto-Peshtigo River basin.[24] We currently do not have a glacial map for all of Oconto County. Attig and Ham prepared a detailed glacial map for the northern part of the county.[25]

[24] Oakes, E.L., and L.J. Hamilton, 1973. Water resources of the Wisconsin-Menominee-Oconto-Peshtigo River Basin. US Geological Survey, Hydrologic Atlas HA-470.

[25] Attig, J.W., and N.R. Ham. 1999. Quaternary geology of Northern Oconto County, Wisconsin. Wisconsin Geological and natural History Survey, Bulletin 97. 13 p and 1 map

Bedrock geology
Oconto County straddles the boundary between Paleozoic sedimentary rocks and the much older PreCambrian rocks of the Canadian Shield.

Figure 13: Bedrock geology



As shown in Figure 13, moving northwest from the shore of Green Bay, the sedimentary bedrock units are the Sinnipee dolomite, St Peter sandstone, Prairie du Chien Group (dolomite and sandstone), and Cambrian sandstone. West of the Cambrian sandstone lie a series of PreCambrian crystalline rocks such as granite, basalt, and rhyolite.

Sedimentary rocks form good aquifers, while crystalline rocks do not generally form good aquifers because in these rocks groundwater occurs mostly in cracks and fractures.

Aquifers
Sand and gravel forms an important shallow aquifer in Oconto County, especially in the north part of the county. In contrast, bedrock aquifers are present only in the south part of Oconto County.

Money spent on cleanup

Money spent by Petroleum Environmental Cleanup Fund Award (PECFA)
The PECFA program was created in response to enactment of federal regulations requiring release prevention from underground storage tanks and cleanup of existing contamination from those tanks. PECFA is a reimbursement program returning a portion of incurred remedial cleanup costs to owners of eligible petroleum product systems including home heating oil systems.[26]

As of December 12, 2006, $12,497,907 has been reimbursed by the PECFA fund to cleanup petroleum contaminated sites in Oconto County. This works out to $332 per resident in the county, which is significantly higher than the statewide average of $264 per resident. Of the 111 sites in Oconto County in the PECFA database, 22 sites remain open.[27]

Nitrate removal systems
As of 2005, over 20 municipal water utilities in Wisconsin have spent reducing nitrate concentrations in municipal water systems. None of the water utilities in Oconto County have needed to reduce nitrate levels.[28]

Groundwater Goals and Policies

So now that you've read about groundwater susceptibility, quality, quantity and geology in Oconto County, what next? Is there additional information you want to include about groundwater in your comprehensive plan? And more importantly, how do you use this information in your plan to lead to on-the-ground actions?

A recent study of how 79 Wisconsin communities have addressed groundwater in their comprehensive plans provides the following recommendations:

- Increase citizen involvement to heighten the priority of groundwater in local communities
- Hire local government staff and consultants that value groundwater
- Provide education about the costs of groundwater contamination and depletion
- Provide education to help plan writers better interpret and use groundwater information
- Improve the accessibility of groundwater data to plan writers
- Provide funding to support further groundwater studies

The complete results of the study which includes five case studies about communities who are protecting or cleaning up their groundwater are available at http://www.uwsp.edu/cnr/landcenter/groundwater/index.html

[26] http://commerce.wi.gov/ER/ER-PECFA-Home.html
[27] Wisconsin Department of Commerce
[28] Kevin Masarik and WDNR

To move toward action, we recommend that the county involve as many people and interests as possible to develop groundwater goals and policies. Plans are as strong as the people who are involved in creating them. The more people who are involved and believe in the plan, the more people who will help make it happen.

Goals

Goals describe what you want to accomplish. Here are some example groundwater goals. Use these as starting points to develop goals that fit Oconto County.

- Protect groundwater quality in private and municipal wells in the county.
- Determine what pesticides are being used and where. Test wells in these areas for pesticides and their metabolites.
- For pesticides with established drinking water standards, keep concentrations below the drinking water standard.
- For nitrates, keep concentrations below the drinking water standard of 10 parts per million.
- Avoid human-caused lowering of the county's lakes, streams, wetlands, and groundwater.

Policies

Policies describe courses of action used to ensure plan implementation and to accomplish goals. Often one goal will have two or more policies listed under it, which help achieve that goal. For instance, if a community goal is "protect groundwater quality," two associated policies could be "develop a manure management ordinance" and "adopt wellhead protection ordinances for each municipal well."

Existing policies to protect groundwater in Oconto County

The following policies are in place to protect groundwater quality in Oconto County:

1) Wellhead protection plans and ordinances – Wellhead protection plans are developed to achieve groundwater pollution prevention measures within public water supply wellhead areas. A wellhead protection plan uses public involvement to delineate the wellhead protection area, inventory potential groundwater contamination sources and manage the wellhead protection area. All new municipal wells are required to have a wellhead protection plan. A wellhead protection ordinance is a zoning ordinance that implements the wellhead protection plan by controlling land uses in the wellhead protection area.[29] The table below summarizes which water utilities in Oconto County have wellhead protection plans and ordinances.[30]

[29] Wisconsin Wellhead Protection Program Summary
http://www.dnr.state.wi.us/org/water/dwg/gw/whp/WHP-sum.html
[30] Ed Morse, Wisconsin Rural Water Association, personal communication 10/31/06.

Water system	Wellhead protection plan	Wellhead protection ordinance
Gillett	In progress	No
Lena	In progress	No
Oconto	No	No
Oconto Falls	No. Plan to start in 2007.	No
Suring	Yes	Yes. They plan to revise and update it.

2) Animal waste storage ordinance – In 2001 Oconto County adopted an animal waste management ordinance that applies to all unincorporated areas of the county (areas outside of city and village boundaries). The intent of the ordinance is to protect the groundwater and surface water resources of Oconto County by regulating:

1. Permitting of Storage Facilities
2. Nutrient Management practices
3. Enforcement of the following prohibitions
4. No overflow of manure storage structures
5. No unconfined manure stacking (piling) within water quality management areas (adjacent to stream banks, lakeshores, and in drainage channels.)
6. No direct runoff from feedlots or stored manure to waters of the state.
7. No unlimited livestock access to waters of the state where high concentrations of animals prevent adequate sod cover maintenance.
8. Permit new and expanding feedlots
9. Required removal of feed piles.[31]

The local governments in Oconto County may also have additional policies for groundwater protection in place. Common approaches to protect groundwater in rural areas include:

- Wellhead protection plans and ordinances
- Offering educational opportunities and incentives for groundwater-friendly types of agriculture such as nutrient management planning, rotational grazing and integrated pest management
- Zoning ordinances separating housing from land uses likely to contaminate groundwater and/or providing standards to contain potential contaminants
- Subdivision ordinances providing adequate space for private sewage systems and/or encouraging community sewage treatment systems

Below is a fairly expansive list of potential groundwater policies sorted into 11 categories.[32] Choose, modify and develop new policies that will help achieve your county

[31] Oconto County Animal Waste Management Ordinance
http://www.co.oconto.wi.us/upload/images/LCD/OrdinanceTotal.pdf

goals. *A draft list of recommended groundwater policies developed specifically for Oconto County was developed by the authors of this report and is included on page 2 of this document.* Once you have developed a list of groundwater policies for the county with input from as many local people as possible, see the recommendations after the list for next steps.

[32] Webster, Bobbie; Tang, ChinChun; Markham, Lynn and Chuck Dunning. 2005. Comprehensive Planning in Wisconsin: Are Wisconsin Communities Planning to Protect Their Groundwater? 2005. Center for Land Use Education and U.S. Geological Survey.

1	Water supply
1.1	Long-term planning to determine if enough water is available for future development
1.2	Water conservation measures
1.3	Quantity standards for new or existing high capacity wells
2	Wellhead protection
2.1	Wellhead protection plan
2.2	Identify potential contaminant sources
2.3	Adopt a wellhead protection ordinance that prohibits uses with the potential to contaminate municipal wells or prescribes BMPs for these uses
2.4	Identify and/or protect areas for new municipal wells
2.5	Well construction standards (quality)
2.6	Seal unused wells
2.7	Limits on new development and/or uses allowed in groundwater recharge areas if recharge areas are separate from the wellhead protection zone
3	Stormwater management
3.1	Stormwater plan
3.2	Promote infiltration - limit impervious surfaces and/or encourage raingardens
3.3	Treatment of stormwater runoff to remove contaminants before discharge to ground or surface water.
4	Agricultural practices
4.1	Incentives for groundwater-friendly crops allowed in designated areas
4.2	Nutrient management plans
4.3	Integrated pest management
4.4	Education and incentives for rotational grazing
4.5	Manure management ordinances
5	Waste management
5.1	Wastewater plan (facilities)
5.2	Group septic system standards
5.3	Locate new development or specific types of new development in areas with sewer service
5.4	Encourage advanced wastewater treatment systems. Local communities are not allowed to require more protective standards than COMM 83, but may encourage them.
5.5	Hazard waste collection - Clean Sweep or other programs

5.6	Landfills siting - located and designed to protect surface and groundwater
5.7	Urban service or sewer service areas
6	Land Conservation
6.1	Land acquisition to protect groundwater
6.2	Limit road salt use (usually sodium chloride = NaCl) or use alternative forms of salt to decrease groundwater contamination
6.3	Encourage/require low groundwater impact land covers such as forest/woods, prairie, native vegetation (MFL, CRP, CREP, EQIP, local programs)
6.4	Conservation subdivision standards that require a portion of the land to be maintained in low groundwater impact land cover.
6.5	Encourage conservation easements that protect groundwater through maintaining native vegetation or other means
7	Development Restriction/land regulation
7.1	Large lot sizes to protect groundwater for areas with private on-site wastewater disposal systems
7.2	Limit/prevent new residential development in areas with contaminated groundwater. Land division ordinances may require test results demonstrating the groundwater is suitable for human consumption before a lot split is approved.
7.3	Encourage land uses that have the potential to pollute groundwater to locate in areas with already contaminated groundwater
7.4	Limit residential and commercial fertilizer and pesticide use (one option is through limiting lawn area)
8	Educational programs
8.1	Drinking water testing program
8.2	Other groundwater monitoring program
8.3	Groundwater Guardian program
8.4	Other groundwater education program
9	Remediation
9.1	A contingency plan for immediate cleanup to avoid/mitigate groundwater contamination
9.2	Long-term groundwater clean up (brownfields)
10	Intergovernmental cooperation
10.1	Coordination on any of these issues with other local governments
11	Mining
11.1	Water quality measures
11.2	Water quantity measures

Next steps

After local people tweak the list of recommended groundwater policies at the beginning of the document as they see best for the county we recommend the following steps:

Prioritize the policies. The best way of prioritizing is to develop a systematic approach based on the item's importance, its dependency on other actions and consequently the timing of implementation.

Identify a responsible party for each policy. To ensure that policies are ultimately put in place, it is recommended that a responsible party be identified for each policy, program or other initiative your county expects to complete. Identifying responsible parties has two big benefits: there is a person or organization to take ownership of the action and make sure it is completed; and it helps manage workload so that too many responsibilities are not placed on too few people. Responsible parties may include volunteer organizations, civic groups, commissions, boards, consultants, and other stakeholders.

Consider "milestone dates." It is important to set realistic timeframes for implementation of the items. For regular business items, such as reviewing development proposals, you may include an "ongoing" timeline. However, broad timelines are generally not very useful for specific, one-time types of activities such as preparing an ordinance. When figuring out appropriate milestone dates for completion of tasks, you will need to take into consideration funding and length of time to accomplish the activity. You should also consider how much public input is necessary and whether the recommended activity will be controversial to implement. These all add to total length of a particular activity and the timeline should reflect those considerations. It is important to realize that these milestone dates will likely change as the plan is implemented and updated.[33]

We hope that this summary of groundwater data and potential groundwater goals and policies is helpful. The most important steps are to begin the conversation about groundwater in your community and to get started on a few actions to take care of it for future generations.

Report prepared by the interagency team of:

- Ken Bradbury, Wisconsin Geological and Natural History Survey
- Jamie Broehm, Oconto County Assistant Planner
- Cheryl Buchwald, U.S. Geological Survey
- Charles Dunning, U.S. Geological Survey
- Dave Hart, Wisconsin Geological and Natural History Survey
- Dave Johnson, Wisconsin Department of Natural Resources
- Dave Lindorff, Wisconsin Department of Natural Resources
- Lynn Markham, Center for Land Use Education
- Kevin Masarik, Central Wisconsin Groundwater Center
- Ed Morse, Wisconsin Rural Water Association

[33] Adapted from *Implementation Guide*. Center for Land Use Education. 2006