COUNTY OF EAU CLAIRE
EAU CLAIRE, WISCONSIN
"NOTICE OF PUBLIC MEETING"

In Accordance with the provisions of Chapter 19, subchapter IV, Wisconsin Statutes, NOTICE IS HEREBY GIVEN of the following public meeting:

THE GROUNDWATER ADVISORY COMMITTEE

WILL MEET ON TUESDAY JULY 17TH, 2018 TIME: 5:00 P.M.

PLACE: EAU CLAIRE COUNTY COURT HOUSE Room 302

721 OXFORD AVENUE EAU CLAIRE, WI 54703

OPEN SESSION

AGENDA

1. Call to order by Chair
2. Confirmation of Compliance with Open Meeting Law
3. Public Comment Period
4. Review/Approval of June 18, 2018 meeting minutes.
5. Report by Sub- Committee on Groundwater Report/Discussion/Action
   -Draft Outline Reviewed
   -Priority Recommendations
6. Approval of Draft Report for Submission to Planning and Development and County Board/Discussion/Action
7. Next Meeting Date (Aug __, 2018)
8. Items for the Next Agenda
9. Adjourn

PLEASE NOTE: *Upon reasonable notice, efforts will be made to accommodate the needs of individuals with disabilities through sign language, interpreters or other auxiliary aids. For additional information or to request the service, contact the County ADA Coordinator at 839-4710, (Fax:) 839-1669 or 839-4735, tty: use Relay (711), or by writing to the ADA Coordinator, Human Resources, Eau Claire County Courthouse, 721 Oxford Avenue, Eau Claire, WI 54703.*

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COUNTY OF EAU CLAIRE

EAU CLAIRE, WISCONSIN
GROUNDWATER ADVISORY COMMITTEE

MEETING MINUTES – June 19, 2018
EAU CLAIRE COUNTY COURTHOUSE, Room 302
720 – 2ND AVENUE, EAU CLAIRE, WI 54701

MEMBERS PRESENT: James Dunning, Heather Deluka, Nancy Coffey, Mary Kenosian, Glory Adams, Sarah Vitale, Sham Anderson (arrived at 5:07 pm)

MEMBERS ABSENT: Anna Mares, Jennifer Eddy

STAFF PRESENT: Audrey Boerner and Matt Steinbach (Eau Claire City-County Health Dept.); Chris Straight (West Central WI Regional Planning Commission); Liz Fagen and Greg Leonard (Eau Claire County Land Conservation)

OTHERS PRESENT: Beth Ivankovic

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1. **Call to order by Chair**
   The meeting was called to order by Chair pro tempore Dunning at 5:02 pm. A quorum was present.

2. **Confirmation of Compliance with Open Meeting Law**
   Dunning confirmed compliance with the open meetings law.

3. **Public Comment Period**
   Beth Ivankovic encouraged the committee to move forward with the State of the Groundwater report that is being drafted. She also asked about the possibility of a Confined Animal Feeding Operation ordinance based on soil type with enforcement authority, high capacity well ordinance, an outline of who has responsibility for groundwater protection, and mapping of environmentally sensitive areas.

4. **Review/Approval of April 24, 2018 minutes**
   ACTION: Motion by Adams/Anderson to approve the April 24, 2018 minutes as presented. Motion carried, 7-0-0.

5. **Report by Sub- Committee on Groundwater Report/Discussion/Action**
   The draft of the State of the Groundwater in Eau Claire County as prepared by the ad-hoc committee was reviewed. Dunning wondered if the basics of groundwater principals should be included as an appendix, fact sheet, a short section, or referenced to a web link. Also discussed to potentially be included in the report were wastewater irrigation, septage and sludge spreading, locations of sand mines, sensitive areas for groundwater protection, bedrock elevation, and sand and gravel deposits. The degree of accuracy of all the data sources will need to be referenced. The ad-hoc committee will work on incorporating the discussed topics.
   (Anderson left the meeting, 6:15 pm).

6. **GW Committee Priority Recommendations on Draft Report/Discussion/Action**
Priority recommendations for the report were discussed. Recommendations will be based on items in the following table.

UNDERSTANDING GROUNDWATER	PROTECTING	VALUING / EDUCATION

• Define and map Environmental Sensitive Areas (ESAs) and constraints (ie lot size, land use regs)
• Continue well testing and increase the number of tested wells
• Need additional groundwater sample data
• Understand polyacrylamide concerns
• Create flow model including flow, depth, recharge to better understand sustainability (climate impacts) and susceptibility
    o Potential grans for updating model
	• Explore how to consider water quality/quantity as part of subdivision plat review (land use regs/policies)
	• Explore county regulatory options RE: high cap wells
	• Increase the number of farmers with Nutrient Management Plans
	    o Increase cost share
	    o Continue planning assistance
	    o Increase face-to-face
	    o TRM grants
	    o 5+ acres of lawn
	• Explore citation authority for LCD – NR 151 – Farming/CAFO Ordinances
		• Checklist or fact sheet for homebuyers/builders/realtors
		• Share water testing results with public in a form that is accessible
		• Complete website with theory or principles of groundwater (Appendix in report)
		• Partner with towns to education public on how to keep water safe and the importance of residential well testing
		• Clarify regulatory responsibility and roles
		    o What can local government do?
		    o Local government tool kit

7. **Projected Planning and Development/Land Conservation Budget and grant Requests/Discussion/Action**
Leonard discussed that submitted as a capital budget project was a request for groundwater study. The report will help support this request and any potential grants pursued.

8. **Report on Testing Surveys from City-County Health Department**
This item was tabled until a later date.

9. **Next Meeting Date**
The next meeting date will be July 17, 2018 at 5:00 pm in the Eau Claire County Courthouse, Health Department room TBD.

10. **Items for the Next Agenda**
Review and discussion of the State of the Groundwater report will be the main item for the next meeting.

11. **Adjourn**
Dunning adjourned the meeting at 6:38 p.m.

Respectfully Submitted,

Greg Leonard
Land Conservation Manager

Note: all internal references need to be checked. Foot notes also need to be double checked.

2018 State of Groundwater in Eau Claire County

ABSTRACT

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Glossary of Abbreviations

CCL – Contaminant Candidate List

DNR – Department of Natural Resources

EPA – Environmental Protection Agency

gpd – gallons per day

MCL – maximum contaminant level

mg/L – milligrams per liter

NN wells – Non-transient, non-community

ppb – parts per billion

SDWA – Safe Drinking Water Act

TN wells – Transient, non-community

UCMR – Unregulated Contaminant Monitoring Rule

WICCI – Wisconsin Initiative on Climate Change Impacts

REPORT PURPOSE & SCOPE

This report, entitled *State of Groundwater in Eau Claire County - 2018,* was drafted by the Eau Claire County Groundwater Advisory Committee with assistance from staff and advisors to the committee. The Groundwater Advisory Committee includes members of the County Board, Board of Health, the Towns Association, Wisconsin Department of Natural Resources, and citizen members including a member with expertise in hydrogeology. Staff members and advisors are from the Eau Claire County Planning and Development Department, Eau Claire County Land Conservation Division, Eau Claire City-County Health Department, and West Central Wisconsin Regional Planning Commission.

Though the report focuses on Eau Claire County, the Groundwater Advisory Committee recognizes the fact that as a natural resource, our groundwater does not follow political boundaries. As such, information when describing areas will be described by watershed areas, as groundwater flow generally determines surface water flow. Watershed boundaries provide the best identifiable areas for descriptions.

This report is a summary of existing groundwater information and gaps where more information is needed. Topics include general groundwater information, land use trends potentially influencing groundwater, groundwater quality and quantity, and the potential influence of climate change.

The report scope is limited to locally known groundwater issues and contaminants.

Additional supplemental information is included within the appendices.

It should be understood this report in not inclusive of all that is known, or unknown, about our groundwater resource, but is a starting point to better appreciate one of our precious natural resources.

I. Eau Claire County's Groundwater

A. General Information[1]

Include a reference to web material here for further general information on groundwater.. Chris to do, or add as an appendix

1. Occurrence

An aquifer is an underground layer of permeable or fractured material that can store, transmit and supply water. In Eau Claire County, groundwater is found in sandstones of the Cambrian age and in unconsolidated deposits of sand and gravel within glacial drift. The sand and gravel aquifer is not a continuous rock unit, as is the sandstone bedrock aquifer, but occurs as outwash deposits and valley alluvium. The sand and gravel aquifer is usually much shallower than the sandstone aquifer and is sometimes referred to as the upper aquifer. In the Chippewa River Valley, sand and gravel deposits can be more than 200 feet over bedrock. The sandstone (or 'lower') aquifer generally underlies much of the county, except in areas of Precambrian undifferentiated igneous and metamorphic bedrock. The sand and gravel aquifer is generally found overlaying bedrock (Appendix A Figure 1 – depth to bedrock).

[1] Most of this information was originally reported in the 1994 Eau Claire Groundwater Management Plan, http://www.co.eau-claire.wi.us/home/showdocument?id=11566)

The sandstone aquifer can provide an available supply of water for municipal water supplies, whereas the sand and gravel aquifer is suited to individual domestic water supplies (Appendix A Figure 2 – Water Table Elevation). The hydrologic conditions of these aquifers can influence their use as water supplies. The rock formations of Cambrian sandstone can yield more than 1,000 gallons of water per minute while sand and gravel deposits may yield up to 500 gallons per minute or more.

2. Recharge and Discharge

Recharge is the input of water to an aquifer system, and discharge is the output of that system. Topography influences recharge, such that recharge is often lower on steep slopes when compared to a flat plain. Recharge also occurs through rock fractures and exposed rock outcrops. Groundwater is discharged naturally by springs and into wetlands, streams, lakes and as a result, the Chippewa and Eau Claire River systems (including their tributaries) are major discharge areas for Eau Claire County groundwater. Wells pumping water from the aquifer is another form of discharge.

3. Movement

The movement of groundwater is generally influenced by gravity, from high areas where recharge occurs to lower areas where discharge occurs. In areas of greater local topographic relief (differences in elevation), the impact of gravity on groundwater movement is greater. Groundwater movement is also influenced by well pumping. In some parts of the state, for example, municipal wells have changed regional groundwater flow toward the wells instead of natural discharge areas. Changes in water table elevation, regional flow, and the interface of upper and lower aquifers can be monitored to help identify potential problems before they become serious.

The natural rate of groundwater movement through sandstone is relatively slow, only a few inches to feet per day. The regional groundwater flow in Eau Claire County is generally from east to west for areas east of the Chippewa River, and generally west to east for areas on the west side of the Chippewa River (Appendix A Figure 2 – Water Table Elevation). Local flow may vary, as smaller tributaries flow toward larger drainage systems. For example, Coon Fork Creek in eastern Eau Claire County flows north toward the Eau Claire River.

4. Water Levels

In Eau Claire County, the depth to the water table below the land surface varies from 0 feet where water is at the surface (wetlands, lakes, or rivers) to over 250 feet (Appendix A Figure 2 - Water Table Elevation). The shape of the water table generally mimics topography. The depth to the water table is affected by topography, the amount and frequency of precipitation, permeability of subsurface materials, and well pumping.

5. Susceptibility of Groundwater to Pollutants

The US Geological Survey defines "susceptibility of groundwater to pollutants" as the ease with which a contaminant can be transported from the land surface to the water table.[2] There are several

[2] USGS. 2007. Eau Claire County Groundwater Report. https://wi.water.usgs.gov/gwcomp/find/eauclaire/index_full.html

characteristics that are factors in the degree to which groundwater is susceptible, including depth to bedrock, type of bedrock, soil characteristics, depth to water table, and characteristics of surficial deposits. Surficial land use also plays a role in groundwater susceptibility, as areas that are intensely developed (crops, livestock, housing development, etc.) can be sources of contamination of groundwater (Appendix A Figure 3 – Soils of Eau Claire County, Wisconsin and the Ability to Attenuate Contaminants).

In addition, the characteristics of an aquifer are important in how it can attenuate pollutants entering the groundwater. A sandstone aquifer composed of coarse to fine grained material has many small openings which can help to transmit pollutants, or dilute pollutants due to more rapid groundwater movement. Aquifers of more fine-grained materials may more readily slow pollutant transport. In addition, some aquifers have bacterial communities that may readily breakdown contaminant substances. Fractures and joints in bedrock aquifers can permit rapid vertical flow of pollutants into deeper aquifers. Heavy drawdown from pumping wells have also been known to cause water from the upper aquifer to leak into a lower aquifer system, causing cross-contamination between two aquifers.

Due to the highly permeable nature of many of the soil and aquifer materials in Eau Claire county, there is at least a moderate risk for contamination throughout much of the county. The areas more likely to be highly susceptible are the areas near surface water (because groundwater and surface water are connected), and where the subsurface materials are very coarse and groundwater is near the surface.

B. Eau Claire County Land Use Trends Potentially Influencing Groundwater

1. Residential Land Use

Eau Claire County's population is projected to grow from about 102,340 in 2017 to 111,610 residents in 2040.[3] For domestic use alone, this growth will result in about 159 million gallons per year being withdrawn based on current rates of about 47 gallons per person per day. This would be a 2% to 4% increase over estimated current withdrawals in the County (see Section E).

In 2016, the County had an overall population density of 161.4 persons per square mile, much higher than the 105 persons per square mile for the State of Wisconsin. Residential land use accounts for over 21 percent of assessed land in the County. Over 32 percent of all residential-improved parcels and over 83 percent of all residential assessed acreage in Eau Claire County is located in the unincorporated towns. Overall, the towns are projected to experience the highest growth (+15%), though the City of Eau Claire will grow most in terms of population numbers (+5,924 residents). The largest rates of increase are expected in the Town of Clear Creek, Town of Pleasant Valley, Town of Union, and the City of Altoona. Given these trends, the number of private wells for drinking water is expected to continue to increase.

Residential land use can pose risks to groundwater. For example, an estimated 20% of private septic systems in the Eau Claire River Watershed are failing.[4] Damaged well casings, improper disposal of household chemicals (e.g., motor oil, antifreeze paint, fertilizers, herbicides), pet waste, lack of backflow prevention, and abandoned wells all increase the threat of contamination.

[3] Based on Wisconsin Department of Administration official population estimates and projections.
[4] Eau Claire River Watershed Strategy Technical Memorandum, July 5, 2016

2. Commercial and Industrial Land Use

Commercial land use accounts for nearly two percent of assessed land in the County with manufacturing accounting for roughly 0.5%. Over 80 percent of all commercial parcels, and over 56 percent of commercial assessed acreage, in Eau Claire County are located in the cities of Eau Claire and Altoona alone. Similarly, over 50 percent of manufacturing parcels, and over 27 percent of manufacturing assessed acreage, are located in these same two cities. If not properly planned for and managed, commercial and industrial land uses can impact groundwater due to potential hazard materials used (see Section D.vi.), large rates of withdrawals (see Section E.ii.), and large amounts of hardscape (e.g., parking lots, roofs) that do not allow the infiltration of water. Activities that substantially modify key groundwater recharge areas or encroach upon the groundwater table, such as mining and cranberry bogs, require special attention due to elevated groundwater risks. There are currently eight non-metallic mining operations in Eau Claire County with one additional facility proposed, currently covering 324 acres (Figure 4 – Eau Claire County Sand & Gravel Mines).

3. Agriculture and Forest Land Use

The most prevalent land uses in Eau Claire County are agriculture and forest. In fact, almost 45 percent of the assessed land in the County is considered agriculture and over 21 percent is forest or agricultural forest. In addition, over 13% (56,000 acres) of the County is public, tax-exempt forest and other public resource lands as mentioned previously. As seen in Appendix A Figure 5, much of the eastern portion of the County is forested with the majority of agricultural land located in the central and southern portions of the County.

Over 5 percent of the County is assessed as "undeveloped". When including the acres of public natural resource lands, over 75 percent of the County is agricultural, forest, wetlands, surface waters, or is

otherwise undeveloped.

According to UW-Extension's Value & Economic Impact Brochure for Eau Claire County (2014), agriculture provided 4,641 jobs, or 6.3 percent, of the County's workforce of 73,590. Agriculture also accounts for $324.6 million, or 6.2 percent, of the County's total income. However, certain agricultural trends do pose risks to our groundwater. The number of high capacity wells for irrigation and larger livestock operations have been increasing in the County as discussed later in Section E. ii.

Agricultural land use has also changed within the past 100 years in Eau Claire County. Perennial hay crops, which allow greater infiltration, have been decreasing, and annual row crops have been increasing over the past 60 years. This shift in agricultural systems, along with changes in fertilizer types, and weed and pest management, further impact groundwater quantity and quality. Agricultural Best Management Practices, such as Nutrient Management Planning[AB1], can help protect both surface and groundwater, yet only about 25% of cropland fields have a formally developed nutrient management plan.

C. Water Testing and Programming

1. Municipal Drinking Water

Municipal and other than municipal systems (mobile home parks, condominium/apartment buildings, and sub-divisions that share a well) are required to test per SDWA (Safe Drinking Water Act) requirements. This includes inorganic compounds, synthetic organic compounds, volatile organic compounds, radionuclides, lead and copper on a three-year basis or more frequently if any contaminant is of concern. [AB2]Bacteria is tested at least monthly and the number of samples is based on population size (example: as few as one sample or as many as 70 per month). Additional sampling may be required depending upon treatment systems that are installed. In addition, the Health Department collects municipal water samples to test for coliform bacteria and residual chlorine from Altoona, Augusta, Fairchild, and Fall Creek. These samples are collected twice a month from various locations in each municipality as required by the safe drinking water law.

2. Private Drinking Water

The Eau Claire County Sanitary Code requires that all premises intended for human occupancy shall be provided with an adequate supply of water that is safe and acceptable to drink. Free testing for private water supplies serving families with newborn infants is offered for arsenic, fluoride, lead, copper, bacteria, and nitrate through the Eau Claire City-County Health Department. The Health Department's lab also offers testing on new wells and well water after the pump is installed to ensure the supply is safe for consumption. Private well owners may also have samples analyzed for these contaminants for a small fee at the Health Department. If a test indicates unsafe drinking water, recommendations are made by environmental health specialists to correct the water supply.

The WI DNR additionally conducts field inspections of well drillers and pump installs to ensure code requirements are followed and responds to home owner concerns of water quality changes and issues.

3. Other Public Water Supplies

The two other types of public water supplies are transient- and non-transient, non-community systems (TN and NN respectively). NN systems are a public water system that regularly supplies water to at least 25 of the same people at least six months per year, but not year-round. Some examples are schools, factories, office buildings, and hospitals which have their own water systems. NN systems are regulated by the WI DNR similarly to other-than-municipal systems except that they have less frequent bacteria sampling (quarterly) and do not sample for radionuclides. TN water systems are individual water supply systems that serve 25 or more different people 60 or more days of the year, and are not year-round residents. The population makeup using the water supply is ever changing. This would include facilities such as restaurants, motels, campgrounds and service stations. Since 1989, the Health Department has been given authority by the Wisconsin Department of Natural Resources to administer the portions of the Wisconsin well code that govern transient non-community water systems. TN systems must be sampled for bacteria and nitrate annually. Action is initiated when problems with water safety or the condition of the system are encountered. Facilities with bacteriologically unsafe results are required to discontinue use of their water for drinking and food preparation until corrective actions were taken and follow-up samples test safe.

4. Groundwater Programming in Eau Claire County

The goal of the Eau Claire City-County Health Department's drinking water protection program is to assure that the public is provided a safe water supply that is protected from organic and inorganic chemical contamination and communicable diseases. Appendix C includes a summary of groundwater protection regulations and ordinances applicable to Eau Claire County.

Through the drinking water protection program, staff promote the testing of private water wells for contaminants, review and issue well permits to assure proper location of new wells, require abandonment of unused wells, and conduct inspections of existing wells to assess their risk of becoming contaminated. They also provide consultation and work with the public to correct their drinking water problems and on measures they can take to prevent contamination of their well. In addition, they also provide drinking water testing for contaminants such as fecal coliform bacteria, organic chemicals, nitrate, pesticides, lead, and copper; conduct epidemiological investigations of suspected and confirmed waterborne illness cases and outbreaks; and participate with the County Groundwater Advisory Committee to implement groundwater protection initiatives.

Regulations for public water systems contained in the SDWA are over seen by the WI DNR as they are granted primacy by the US Environmental Protect Agency (EPA). The DNR is responsible for ensuring that public water systems adhere to sampling requirements, system correction, follow up of MCL (maximum contaminant level) violations, customer notifications of drinking water information, regular inspections, enforcement action for code violation and response to customers complaints. More specifics on following types of water supplies are found below.

D. Groundwater Quality in Eau Claire County

1. General Condition (pH, hardness, etc.)

The Health Department has conducted limited sampling in the county for pH, a measure of groundwater acidity. The average concentration of pH samples from the health department is 6.5 (but has been recorded as low at 4.9), making it more acidic than pH neutral water of 7. The more acidic water tends to be on the northern and eastern halves of the county. Acidic water causes corrosion of copper piping, leaded solder and leaded fixtures, which is considered a risk to personal health. Testing of water hardness in public water supplies since 2008 indicate an average hardness of 68 mg/L with the highest value at 267 mg/L (this includes treated and untreated water values). The use of water softeners and iron filters is common when in geologic formations deeper than the sand and gravel to mitigate water hardness issues. Water hardness is not a health concern.

Nutrients (Nitrate & Phosphorous)

Nitrate is a widespread, highly mobile contaminant of groundwater, especially common in heavy agricultural areas. Potential sources of nitrate contamination include agricultural or lawn fertilizer applications, onsite wastewater systems, animal feedlots and barnyards, and septage or sludge disposal. One of the most common water tests at the Health Department is for nitrate. Nearly 4,500 wells in the county have been tested, but approximately 4500 wells remain untested. Pregnant women and infants have the highest risk for adverse health effects from high concentrations of nitrate in drinking water. Some studies also suggest poorer pregnancy outcomes among livestock that drink water high in nitrate. In addition, the presence of elevated nitrate may serve as an indicator of potential contamination by other compounds. Since nitrate contamination originates at or near the surface, shallow wells are more likely to be contaminated or become contaminated sooner than deeper wells. The public health enforcement standard (MCL) for nitrate in drinking water is 10 mg/L (1 mg/L is equivalent to 1 part per million), and the preventative action limit (level at which action is recommended but health effects are not likely) is 2 mg/L.

As shown in Appendix A Figure 6, the majority of nitrate data available is from the western half of the county. The watersheds with the highest nitrate averages are Muddy and Elk Creek, and Lower Eau Claire River. The eastern side of the county has only a few nitrate samples, as much of this area is forested and the population is lower density. Approximately 1 in 2 wells sampled have nitrate that exceeds naturally occurring concentrations (generally2 mg/L). Nearly 1 in 20 wells that have been sampled exceed the health-based standard for nitrate.

Phosphorus (P) is a naturally occurring nutrient found in sedimentary rock, soil, manure, commercial fertilizers and wastewater discharges. Phosphorus loading can cause intense eutrophication events in surface water in which excessive nutrient input stimulates an explosive growth of algae, producing algal blooms that deplete the oxygen content of lake waters, leading to toxic conditions that have strong negative impacts on aquatic life and adjacent communities (Smith et al., 1999). Phosphorus-laden runoff from farm fields, barnyards, suburban lawns, urban areas and wastewater treatment plant discharge has been implicated in contamination of surface water throughout Wisconsin. These eutrophication events have been implicated in significant degradation of surface water quality across the state.

While the impact of phosphorus nutrient loading to the surface water system is well-known, the mechanics and physiochemistry of phosphorus transfer in the groundwater system is much more poorly understood. It has been previously assumed that phosphorus in groundwater was relatively immobile and was therefore of minimal ecological concern (Holman et al., 2008). Phosphorus tends to adsorb onto soil and sediments within the shallow subsurface and is not readily transported in groundwater, so P concentration in groundwater is typically quite low (Holman et al., 2008). However, ongoing water chemistry studies at UW-Eau Claire document highly elevated phosphorus levels in several regional aquifers across western Wisconsin, and suggest phosphorus is mobile and becoming concentrated in groundwater reservoirs.

A multidisciplinary approach has been used to assess the spatial and temporal distribution of phosphorus, and to constrain potential natural and human-contributed sources. Ongoing chemical analyses have documented differences in concentrations of phosphorus in geology, surface water, and groundwater. Surface water concentrations commonly exceed the Wisconsin surface water limit of 100 ppb, while groundwater concentrations are far higher (10 to >1000 ppb) in the Mt. Simon and Wonewoc

Formations. Evidence to date suggests that phosphorus concentrations in the Mt. Simon formation may be elevated due to anaerobic conditions releasing P from the sandstone. The Wonewoc Formation does not exhibit the same anaerobic conditions as the Mt. Simon, suggesting excessive concentrations of phosphorus that exceed absorption capacity. The source of P in both aquifers is still unconfirmed. More analysis is required to determine the source, fate, and transport of P in groundwater in western Wisconsin.

2. Coliform Bacteria

The Health Department also regularly tests for bacterial contamination, which tends to be a point-source issue. Not all coliform bacteria pose a health risk, but it may signal the presence of feces or sewage waste that has contaminated the well. In the last 10 years, over 16,800 bacteria sample tests have been taken at public water supplies in Eau Claire County. Of those samples, 612 (~3.6%) were total coliform positive while only one (~0.0059%) was *E. coli* positive. Disinfection, such as chlorination, is a standard practice for the treatment of bacterial pollution, but may not address the source of the contamination.

Coliform bacteria have been found in wells across Eau Claire County (Appendix A Figure 7). The highest densities of positive coliform tests are in areas with high residential density, such as in subdivisions and developments bordering the cities of Eau Claire and Altoona, in the towns of Union, Washington, Pleasant Valley, and Seymour.

Unlike other areas of the state, Eau Claire County does not have karst topography, which can lead to higher occurrences of e. coli positive bacteria samples. Karst topography is landscape underlain by dolomite and some limestone, and is characterized by underground cracks, fissures and sinkholes. Most of Eau Claire's bacteria positive samples are coliform. Typical causes of bacteria positive wells are mostly related to well/system maintenance and upkeep. This includes cracked and loose well caps, and broken conduit that provide an easy pathway for insects to enter the well. Poor system maintenance could include cross connections to dirty water, dead end lines and uncleaned treatment equipment (filters and softeners). Naturally occurring biofilms in the aquifer are common as well. Septic system maintenance (proper setbacks, regularly scheduled inspections and pumping) is still important to reduce the risk of *E. coli* contamination.

3. Metals

Lead and copper, as mentioned previously, are more easily leached from household plumbing and distribution systems when the water is acidic, along with other factors. Both contaminants have serious health effects in humans.Of 1,221 lead and copper samples (Eau Claire County public water supplies since 2008) the average copper level is 343 ug/L, with 18,400 ug/L as the highest sample result and 47 samples above the Action Level of 1,300 ug/L. The average lead level was 2.79 ug/L with the highest sample at 180 ug/L and 34 samples above the action level of 15 ug/L. All public water supply lead or copper action level exceedances (the concentration of a contaminant at which action is required, similar to an MCL) are followed up on by WI DNR staff and the public water supply. Systems then employ some combination of corrosion control recommendations and additional sampling until results are consistently below the action level.

Iron and manganese are often tied together in that if one is high, the other is likely to be as well. Iron is considered an aesthetic contaminant that is a nuisance but not harmful to human health. Excessive amounts are hard on fixtures and could result in iron bacteria issues. Manganese is considered a nuisance at lower levels but at higher levels can be considered to have health effects. A number of public systems in Eau Claire County are above the level (0.3 mg/L for iron and 0.05 mg/L manganese) where aesthetic issues are noticed (toilet bowl staining, taste, and odor) for both iron and manganese. Iron samples collected at Eau Claire County public water supplies since 2008 have shown an average of 0.173 mg/L iron, with the highest value of 5.1 mg/L. Manganese at these systems is at an average of 0.045 mg/L with the highest value of 1.83 mg/L. Most of the systems with higher levels of iron and manganese install a softening or filtering system (various kinds) to bring the values below the aesthetic levels described above.

4. Atrazine

Atrazine is a herbicide, or weed killer, that has been used on corn and other crops for many years in Wisconsin. Today, atrazine use is restricted and prohibited in some areas. This is because atrazine and its metabolites, substances formed as it breaks down in the environment, have been found to enter Wisconsin's groundwater from use on farm fields, spills or improper disposal.

At low levels in drinking water, atrazine does not cause immediate sickness or health problems. However, if people drink water for many years that contains 3 parts per billion or more of atrazine or its metabolites, they may develop cardiovascular, reproductive, or other health problems. This 3 ppb level is called an "enforcement standard," which means that if found it at that level, Wisconsin may move to prohibit its use in the area where found. This is done by changing an administrative rule, ATCP 30, or through administrative order.

The U.S. Environmental Protection Agency classified atrazine as "not likely to be carcinogenic"; that is, it is unlikely to cause cancer.

a) Restrictions On Use In Wisconsin

Wisconsin regulations restrict atrazine use beyond federal product label restrictions. It is important to remember that many products contain atrazine, even if it is not part of their name. These restrictions apply to all products that have atrazine as an ingredient.

Restrictions on use:

- Apply only between April 1 and July 31
- All handlers and applicators must be certified
- Use only on agricultural row crops and in forestry
- Record on the day of application for each field treated and keep records of the following parameters for 3 years:
    - Applicator's name
    - Farmer's name and address if different from applicator
    - Field location

- Date and time of application
- Brand name of product
- Manufacturer of EPA registration number of product
- Application rate
- Size of area treated
- Location where the product was loaded into the sprayer

b) Application Rate Restrictions

Application rates depend on soil texture and prior use of atrazine on the field:

Soil Texture	Atrazine used on field last year	Atrazine not used on field last year
Coarse (at least 25 percent sand, loamy sand or sandy loam)	¾ pound active ingredient atrazine per acre per year	¾ pound active ingredient atrazine per acre per year
Medium/fine soils (loam, silt, silt loam, sandy clay loam, silty clay loam, sandy clay, silty clay, clay, peat, muck	1 pound active ingredient atrazine per acre per year	1½ pound active ingredient atrazine per acre per year

c) Atrazine Prohibition Areas in Eau Claire County

Eau Claire County currently has two Atrazine Prohibition Areas designated by the State of Wisconsin. These areas are the result of either spills or over application to fields in the past. These areas of atrazine prohibition are illustrated in Figures 8, 9, and 10 (Appendix A).

5. Other Hazardous Materials and Toxic Chemicals (e.g., VOCs)

There are many types of hazardous materials and toxic chemicals that pose a threat to groundwater. For example, the EPA toxic chemical list has 595 chemicals in 32 categories for which any releases or emissions must be reported.[5] There is also no single definition or list for what constitutes a hazardous material or substance. For example, the EPA has specific definitions for hazardous substances, extremely hazardous substances, toxic chemicals, and hazardous wastes, while U.S. Department of Transportation and OSHA have slightly different definitions and risks, and these lists are always changing. At any one time, the EPA has an average of 300 new chemicals under review that are being proposed for commerce.[6]

The following is provided as an overview of the potential risks in Eau Claire County:

[5] U.S. Environmental Protection Agency. https://www.epa.gov/toxics-release-inventory-tri-program/tri-listed-chemicals

[6] U.S. Environmental Protection Agency. https://www.epa.gov/reviewing-new-chemicals-under-toxic-substances-control-act-tsca/statistics-new-chemicals-review

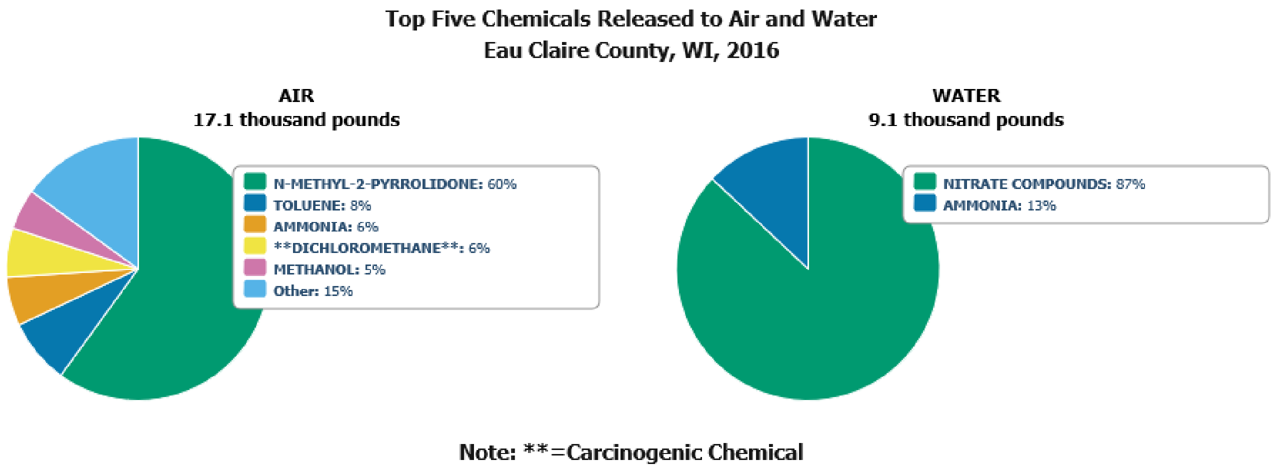
- Eau Claire County has 24 Extremely Hazardous Substance (EHS) Planning Facilities that have one or more extremely hazardous substance or chemical in such quantities that they are required to provide plans to the County's Local Emergency Planning Committee (LEPC) for review. All of these facilities are located in the City of Eau Claire, except 2 in Altoona, 2 in Fall Creek, 1 in Cleghorn, and 1 in the Town of Union. An additional 31 Reporting Facilities store or use one or more than 300 extremely toxic chemicals on site and must provide an annual report to the LEPC and local fire departments. All but 3 of the Reporting Facilities are located in the City of Eau Claire and about one-half of these facilities were educational institutions.[7]

- Two locations in Eau Claire County were previously on the Superfund National Priority List due to severe contamination that posed a risk to human health or the environment.[8] The Eau Claire Municipal Well Field had elevated levels of volatile organic compounds (VOCs) in the mid-1980s due to a nearby industry. While some VOCs are natural, most VOCs in the environment come from gasoline, solvents, paints, refrigerants, cleaners, pesticides, and other human activity. VOCs can have very serious health consequences, including cancer, harming the liver and kidneys, and nervous system disorders. The clean-up has been completed and water levels at the wells are currently in compliance. .

  Soil, surface water, and groundwater contamination from various VOCs were discovered at the Waste Research Reclamation site in the 1980's. Long-term remediation at the site continues and activities/uses are restructured. In 1993, the site was moved from the Superfund program to the Resource Conservation and Recovery Act (RCRA) program and deleted from the National Priorities List.

- In 2016, Eau Claire County had 12 facilities that released significant amounts of one or more toxic chemicals into the environment and required reporting by the EPA.[9] Releases include any toxic chemicals spilled, discharged, injected or otherwise released into the air, land, water, or underground. Most of these releases are permitted; not accidental. About 65% of the on-site releases were airborne, while the remaining releases were into surface waters as reflected in the charts below.

[7] EHS & Tier Two Reporting facilities lists maintained by Eau Claire County Emergency Management and Wisconsin Emergency Management.
[8] U.S. Environmental Protection Agency. https://cumulis.epa.gov/supercpad/CurSites/srchsites.cfm
[9] U.S. Environmental Protection Agency. https://www.epa.gov/toxics-release-inventory-tri-program



Note: Trend graphs were created using the 2001 core chemicals/industries list.

- The Wisconsin Bureau for Remediation & Redevelopment Tracking System tracks hazardous materials spills. As reflected in the table below, the number of reported spills has been decreasing. The large decrease in the number of leaking underground storage tanks (LUSTs), typically containing petroleum, is a primary factor in this trend. Over 2/3 of recent events are spills that are generally cleaned-up immediately or within 60-90 days. Environmental repair (ERP) and LUST sites typically pose greater risk to groundwater contamination or health and may require costly and lengthy clean-up efforts. The map on the following page shows that the majority of these sites are located within the cities and villages. Fifteen LUST and fifteen ERP sites are currently open with analysis, remediation, or active monitoring underway.

BRRTS Records for Eau Claire County – 1978 thru 2017 report dates[10]

Activity	1978-1999		2000-2017	
Spills	373	44.1%	271	67.6%
Leaking Underground Storage Tanks	250	29.6%	20	5.0%
Environmental Repair (non-LUST)	62	7.3%	26	6.5%
No Action Required Discharge	158	18.7%	75	18.7%
Removed from Database	2	0.2%	1	0.2%
Abandoned Container	1	0.1%	8	2.0%
Totals	**846**	**100%**	**401**	**100%**
Average Reports per Year	**40.3**		**23.5**	

- Landfills and historic waste sites also have the potential to contaminate groundwater, especially if built prior to more current regulations in the 1980's. The map on the following page shows the location of known landfills in Eau Claire County and includes the 1,200 foot buffer area for each landfill in which a WDNR variance approval is required prior to construction of a water supply well. The map also includes one WDNR-designated special well casing depth area in the Town of Washington associated with a closed paper sludge waste site. In this area, any new water supply

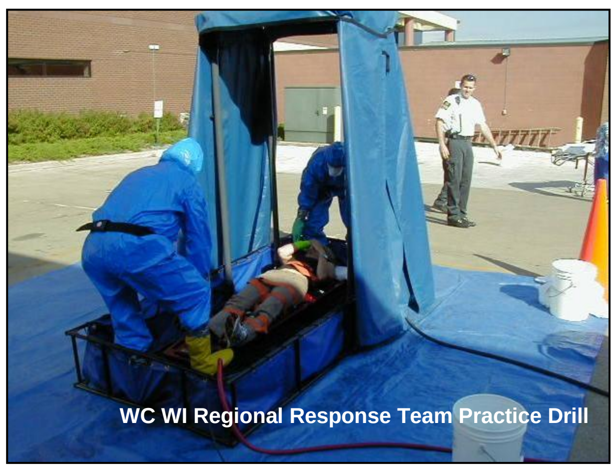
[10] Wisconsin Department of Natural Resources, WDNR BRRTS on the Web, http://dnr.wi.gov/topic/Brownfields/wrrd.html

well shall be sampled upon completion and tested for volatile organic compounds (VOC's) to determine required casing depth prior to use.

- Wells used for public drinking water must report water test results to the WDNR, including municipal or small community systems, churches, restaurants, and other public gathering places. Since January 2014, there were 64 reports for 19 public water systems that exceeded EPA Maximum Contaminant Levels (MCL).[11i] For some systems, the contaminant only exceeded the MCL in one test. The contaminants were:
  - Cooper (24 reports)
  - Lead (13 reports)
  - Nitrate (22 reports)
  - Radium (4 reports)

The location of facilities and spills are an important factor. Contamination risks are elevated in areas of high groundwater or near existing wells. For instance, County Groundwater Committee members expressed the importance of evaluating and monitoring the groundwater impacts of industrial sand mining operations. This is due to the possibility of increased dissolved metals (arsenic, aluminum, lead) in groundwater and the common use of polyacrylamides (acrylamide is a probable carcinogen) during processing at locations with high capacity wells, especially when close to wetlands or extraction sites. While facilities using large amounts of the most toxic substances are tracked and monitored, the improper containment, storage, or disposal of chemicals and substances in smaller amounts can also pose contamination risks.

It is important to note that the during the 2018 update of the Eau Claire County Multi-Hazard Mitigation Plan, transportation-related hazardous materials spills were most frequently mentioned by communities and responders as a larger concern compared to fixed facilities. This was largely due to the uncertainty of what types and quantities of chemicals and hazardous materials are being transported by highway or rail through the County and the potential for such a release to occur anywhere along major transportation routes. As a positive, the Eau Claire/Chippewa Falls Fire Departments are home to one of only two Type I Regional HazMat Response Teams in the State of Wisconsin. The Type I Team has the highest level of training and equipment to respond to a chemical, biological, or radiological emergency.



WC WI Regional Response Team Practice Drill

6. Emerging Contaminants (e.g., road salt, pharmaceuticals)

[11] Wisconsin Department of Natural Resources. WDNR Drinking Water System. https://prodoasext.dnr.wi.gov/inter1/pws29$.startup

There are a number of substances that have been identified in groundwater that have not historically been considered contaminants, but there is increasing evidence of their presence in the groundwater and potential negative impact to health. Some emerging contaminants have only recently become able to be detected due to new technology, as others emerged due to a change in use or disposal practice. Types of emerging contaminants include pharmaceuticals, personal care products (detergent, shampoo, non-prescription medication), viruses, and pesticides. As technology and understanding of the subsurface improve, additional pollutants may be considered emerging.

In 2016, the UW-Eau Claire and the Health Department began a joint project to better understand the potential source of nitrate by sampling for emerging contaminants indicating human wastewater (septic) and agricultural influence. By early 2018, 108 samples from private wells in Eau Claire County had been collected and analyzed. The majority of wells tested did not have any of these indicator contaminants present. However, 17 wells tested positive for herbicides or herbicide breakdown products. In addition, four wells tested positive for caffeine, and two wells for carbamazepine (prescribed for epilepsy and nerve pain). All indicators were detected at levels below 1 part per billion. These results indicate that human wastewater from septic tanks has impacted private well water in a small number of samples. The full study report is available from the Health Department.

EPA uses the Unregulated Contaminant Monitoring Rule (UCMR) program to collect data for contaminants suspected to be present in drinking water, but that do not have health-based standards set under the Safe Drinking Water Act (SDWA). Every five years EPA develops a new list of UCMR contaminants, largely based on the Contaminant Candidate List (CCL). The DNR administers this rule and ensures that the larger communities follow through with appropriate sampling. The City of Eau Claire is included in the sampling pool. During the 2015 sampling period, The City of Eau Claire sampled for the contaminants shown in the tables below. The sample results showed detects for the following 21 contaminants: vanadium, strontium, PFOS, PFOA, PFNA, PFHxS, PFHpA, PFBS, molybdenum, HCFC-22, Halon 1011, cobalt, chromium-6, chromium, chloromethane, chlorate, bromomethane, 1,4-dioxane, 1,3-butadiene, 1,2,3-trichloropropane, 1,1-dichloroethane.

Radon and other radioactive substances enter groundwater through interaction with the rock and soils. In Wisconsin, these substances are most commonly found in northern counties with higher amounts of granite rock and sand or gravel derived from granite rocks. Though radon gas is known to exist in soils in Eau Claire County, testing of radon gas in groundwater is limited. Other radioactive substances are required to be tested in community public water systems.

UCMR 3 Chemical Contaminants and Methods

Contaminant	Contaminant Full Name	CAS[1] Number	Method ID	Method Name	Monitoring Requirement
1,2,3-trichloropropane	1,2,3-trichloropropane	96-18-4	524.3	Volatile Organic Compounds	AM
1,3-butadiene	1,3-butadiene	106-99-0	524.3	Volatile Organic Compounds	AM
Chloromethane	methyl chloride	74-87-3	524.3	Volatile Organic Compounds	AM
1,1-dichloroethane	1,1-dichloroethane	75-34-3	524.3	Volatile Organic Compounds	AM
Bromomethane	methyl bromide	74-83-9	524.3	Volatile Organic Compounds	AM
HCFC-22	chlorodifluoromethane	75-45-6	524.3	Volatile Organic Compounds	AM
Halon 1011	bromochloromethane	74-97-5	524.3	Volatile Organic Compounds	AM
1,4-dioxane	1,4-dioxane	123-91-1	522	Synthetic Organic Compound	AM
Vanadium	vanadium	7440-62-2	200.8	Metals	AM
Molybdenum	molybdenum	7439-98-7	200.8	Metals	AM
Cobalt	Cobalt	7440-48-4	200.8	Metals	AM
Strontium	Strontium	7440-24-6	200.8	Metals	AM
Chromium	total chromium	N/A	200.8	Metals	AM
Chromium-6	chromium-6	18540-29-9	218.7	Chromium-6	AM
Chlorate	Chlorate	14866-68-3	300.1	Oxyhalide Anion	AM
PFOS	perfluorooctanesulfonic acid	1763-23-1	537	Perfluorinated Compounds	AM
PFOA	perfluorooctanoic acid	335-67-1	537	Perfluorinated Compounds	AM
PFNA	perfluorononanoic acid	375-95-1	537	Perfluorinated Compounds	AM
PFHxS	perfluorohexanesulfonic acid	355-46-4	537	Perfluorinated Compounds	AM
PFHpA	perfluoroheptanoic acid	375-85-9	537	Perfluorinated Compounds	AM
PFBS	perfluorobutanesulfonic acid	375-73-5	537	Perfluorinated Compounds	AM
17β-estradiol	estradiol	50-28-2	539	Hormones	SS
17α-ethynylestradiol	ethinyl estradiol	57-63-6	539	Hormones	SS
Estriol	16-α-hydroxyestradiol	50-27-1	539	Hormones	SS
Equilin	Equilin	474-86-2	539	Hormones	SS
Estrone	Estrone	53-16-7	539	Hormones	SS
Testosterone	testosterone	58-22-0	539	Hormones	SS
4-androstene-3,17-dione	4-androstene-3,17-dione	63-05-8	539	Hormones	SS

[1]Chemical Abstract Service

UCMR 3 Microbiological Contaminants and Methods

Contaminant	Method ID	Method Name	Monitoring Requirement
Enteroviruses	EPA 1615A	Enterovirus cell culture	PST
Enteroviruses	EPA 1615B	Enterovirus RT-qPCR	PST
Noroviruses	EPA 1615C	Norovirus genogroup I with RT-qPCR primer set A	PST
Noroviruses	EPA 1615D	Norovirus genogroup I with RT-qPCR primer set B	PST
Noroviruses	EPA 1615E	Noroviruses genogroup II	PST
Total coliforms	SM 9223B	Colilert®	PST
E.coli	SM 9223B	Colilert®	PST
Enterococci	ASTM D6503-99	Enterolert®	PST
Aerobic spores	SM 9218	Aerobic endospores	PST
Somatic phage	EPA 1602	Bacteriophage	PST
Male specific phage	EPA 1602	Bacteriophage	PST

Field Name	Definition
MonitoringRequirement	AM: Assessment Monitoring (List 1)
	SS: Screening Survey (List 2)
	PST: Pre-Screen Testing (List 3)

* United States Environmental Protection agency. January 2016. The Third Unregulated Contaminant Monitoring Rule (UCMR 3): Data Summary.

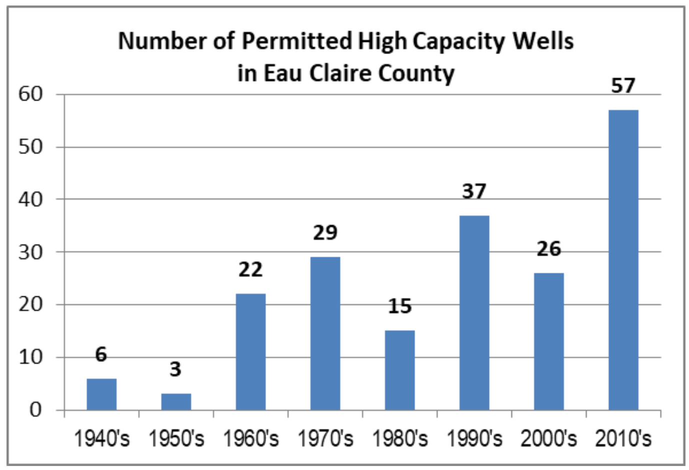
E. Groundwater Quantity and Use

1. Groundwater Availability and Usage

No current study or model is available providing a clear understanding of groundwater availability and geographic differences in groundwater quantity in Eau Claire County. Groundwater contributes nearly all of the water supply in Eau Claire County used for domestic, commercial, industrial, and agricultural purposes, including all municipal drinking water supplies and private potable wells. It is likely that somewhere between 5.0 to 6.5 billion total gallons of groundwater are withdrawn in Eau Claire County annually, with 80-85% of this withdrawal occurring through high-capacity wells.[12] Approximately 800-900 million gallons of groundwater is withdrawn from smaller, non-reporting wells (not high capacity wells) in Eau Claire County each year.[13] It is important to note that while demand continues to increase as population and development increases, conservation efforts have been effective in reducing the demand in many homes and businesses. For example, residential water use peaked at 61 gallons per day/person in 1990 and has declined slowly to about 47 gpd/person in 2014.[14] The following are some highlights from the Eau Claire Groundwater Use data discussed and cited in Appendix B:

2. Low-Capacity Private Wells

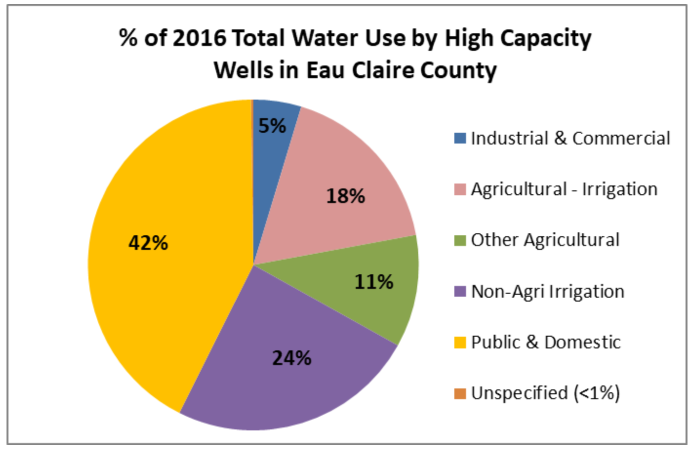
- There are roughly 9,000 smaller private wells in Eau Claire County. Approximately 25% of Eau Claire County residents receive their drinking water from a smaller, low-capacity private well. Water use for low-capacity private wells is not tracked.
- An robust study on the water supply sources for these smaller wells and any geographic variations across the County has not been completed. As discussed previously in Section II.A., a range of factors can influence susceptibility to contamination, including the depth of the aquifer from which groundwater is being drawn (i.e., static water level).



3. Municipal, Agricultural, Industrial, and Other High Capacity Wells

[12] Based on estimates of low-capacity private wells and high capacity wells identified and cited in Appendix B.
[13] Ibid.
[14] Center for Land Use Education—University of Wisconsin-Stevens Point and UW-Extension. Wisconsin Land Use Megatrends—Water. Summer 2014.

- High capacity well use is regulated and tracked under Wisconsin law.



- The number of permitted high capacity wells in the County has been increasing.
- About 42% of groundwater withdrawals by high capacity wells in the County are for public and domestic uses (e.g., drinking water, fire protection). About 28% is for agriculture and 24% is for non-agricultural irrigation.
- Appendix B includes maps showing the distribution of high capacity wells in Eau Claire County. Not surprisingly, the highest concentrations are nearest the County's population centers.

F. Potential Influence of Climate Change on Groundwater

Analysis of historical data shows that groundwater and surface water resources are intimately linked to local and regional climate conditions. And regardless of the debate over the causes of climate change, there is clear evidence that Wisconsin's climate is changing significantly.

a) a. Our Changing Climate

The 2003 report entitled *Confronting Climate Change in the Great Lakes Region* published by the Union of Concerned Scientists and the Ecological Society of America projected that by 2030, summers in Wisconsin may resemble those in Illinois overall, in terms of temperature and rainfall. By 2100, the summer climate will generally resemble that of current-day Arkansas, and the winter will feel much like current-day Iowa.

To further document these climate changes and explore their impacts on our State, the Wisconsin Initiative on Climate Change Impacts (WICCI) was formed as a collaborative effort of the University of Wisconsin and the Wisconsin Department of Natural Resources. Much of the information in this section is adapted from the WICCI effort.

The following are some of the key climatic trends being experienced in Eau Claire County according to the WICCI analysis (www.wicci.wisc.edu):

1. Eau Claire County's average temperatures are rising and are projected to continue to rise. **Figure 12 (Appendix A)** shows that the annual average temperature in Eau Claire County increased between 1.5º F and 4.0º F between 1950 and 2006, with the greatest increases in the City of Eau Claire area. Between 1980 and 2055, annual average temperatures are projected to increase by about 6.5º F in the County, with the winter average temperatures increasing by 8.5º F.
2. Eau Claire County is projected to have more extreme heat events. **Figure 13** (Appendix A) shows that the number of days projected to be 90º F or greater will increase by 18-26 days in Eau Claire County between 1980 and 2055.
3. Eau Claire County is experiencing more annual precipitation than in the past. The County is expected to get even wetter in the future with a significant seasonal and geographic variation to the

precipitation. **Figure 14** (Appendix A) shows that the annual average precipitation has increased in Eau Claire County over the past fifty years overall, with the greatest increases in the southeastern portions of the County. **Figure 15** (Appendix A) shows that changes in summer precipitation have not been decreasing like many areas to the north. Overall, WICCI projects Eau Claire County's annual average precipitation to increase by 1.5 inches per year between 1980 and 2055.

4. Heavy precipitation events are expected to increase in Eau Claire County. Currently, the region experiences heavy precipitation events of two or more inches about ten times per decade (once every year). Eau Claire County is projected to experience about two additional heavy precipitation events per decade by 2055. However, based on the frequency of heavy rainfall events over the past 5-10 years, this projection may be underestimated.

5. Between 2000 and 2013, the region experienced a series of agricultural droughts. Many farmers suffered crop losses and some seepage lakes and spring-fed streams were impacted. The Governor declared a State of Emergency and/or U.S. Secretary of Agriculture declared an agricultural disaster, which included Eau Claire County, on six different occasions (2003, 2005, 2006, 2007, 2009, 2012) with some drought impacts impacting crop yields over multiple years. It is uncertain if this "spurt of droughts" was related to climate change, since a drought year hasn't been experienced since 2013. If weather patterns return to longer-term trends, severe drought conditions can be expected to occur every four to five years on average (1 to 2 drought years per decade) in Eau Claire County.[15]

b) Potential Climate Change Impacts to Groundwater Supply

Overall, groundwater quantity has not been a significant concern in the County, though groundwater levels fluctuate seasonally due to weather patterns. For instance, during the 1976-1977 drought years, some area shallow private wells dried up. It is not certain how Eau Claire County's groundwater supply (and quality) will be influenced by climate change:

- Initially, groundwater recharge is likely to increase due to the increased precipitation.
- Recharge will likely be offset, in part, by increased evapotranspiration due to the higher temperatures and longer growing season. As time goes on, higher temperatures and increased precipitation have the potential to exceed the added recharge from increased precipitation, resulting in lower groundwater levels overall. Changes in land use and land management may also influence recharge.
- The amount of recharge will also be influenced by how and when the precipitation occurs. While increased winter precipitation is projected, warmer temperatures may result in more rain and less snow. Heavy rainfall events and fast snow melts can result in increased runoff and less infiltration,

[15] Eau Claire County Multi-Hazard Mitigation Plan. May 2018 draft

especially if the ground is frozen. Warmer summer and fall seasons as well as longer growing seasons can decrease recharge due to increase evaporation and plants using more soil moisture as soils dry out earlier in the year.

- If recharge is decreased over time, contaminants and dissolved solids in the groundwater can become more concentrated. Conversely, rapid recharge or large seasonal variance in recharge can make the groundwater more susceptible to contamination.

Projecting the potential impacts is complicated and will vary based on many factors. For example, sandy soils and areas of the County where the groundwater table is shallow will be the most impacted by the above trends. Localized groundwater flooding (i.e., groundwater table rises above ground level) may occur due to increases in winter precipitation and heavy rainfall events. In addition, the future warmer, wetter winters could result in more icy roads, which increase the potential for contamination from chlorides. Contamination can also occur due to the inundation of drinking water wells during heavy rainfall events or due to increased microbial activity as water temperatures rise in areas of shallow groundwater.

c) Potential Climate Change Impacts to Groundwater Demand

With population growth and new development, the demands on our groundwater are increasing. Climate change will exacerbate this demand in three primary ways:

- Longer growing seasons without significant increased precipitation during summer months could lead to increased reliance on agricultural irrigation systems, especially in areas of sandier or droughty soils. The region may already be experiencing this impact as reflected in the previously discussed increase in the number of high capacity wells.
- Increased growing seasons could also result in land use changes and more land being put into crop production, which, in turn, has the potential to increase the use of nutrient and pesticide applications.
- Groundwater withdrawals for municipal systems would also likely increase due to elevated summer temperatures and a "longer summer season."

Most of our existing planning models, standards, best practices, and infrastructure are based on historic events and do not fully accommodate the above mentioned climatic trends. Good soil health best management practices and drought-tolerant plant varieties or types of crops could help offset some of these impacts. While improvements to water conservation have occurred, more effort may be needed to encourage rural and urban water conservation. It is also important to promote integrated water management by planning water use in a manner that: (i.) considers natural systems (e.g., watersheds, the entire water cycle) as well as site-specific vulnerabilities; (ii.) are based on long-term projections of supply and demand that reflect recent trends; and (iii.) by tying water use, management, and related policy to land use and economic growth forecasts.

II. Priority Recommendations

Dress this up to fit here. ***Critical Information Gaps:*** *(a) More information is needed on flow and quantity for…. Flow and quantity must be understood prior to being able to collect information and allow for site- or project-specific analysis. (b) Additional time is needed to evaluate the compatibility of the Tinker Model to the more recent approach in Chippewa County. Once this evaluation is complete, a specific groundwater flow model approach for Eau Claire County needs to be identified.*

may present this in a table format with columns for timelines, lead parties, resources, etc. for each recommendation

A. Understanding our Groundwater – Testing, Monitoring, and Modeling Recommendations

- Continue Public Health well testing with greatest focus on subwatershed that….
- Update the Tinker flow model. Is this model compatible with the Chippewa County approach? What State or USGS resources are available.

B. Protecting our Groundwater – Planning, Policies, and Program Recommendations

- expand this report?
-

C. Valuing our Groundwater – Educational and Civic Governance Recommendations

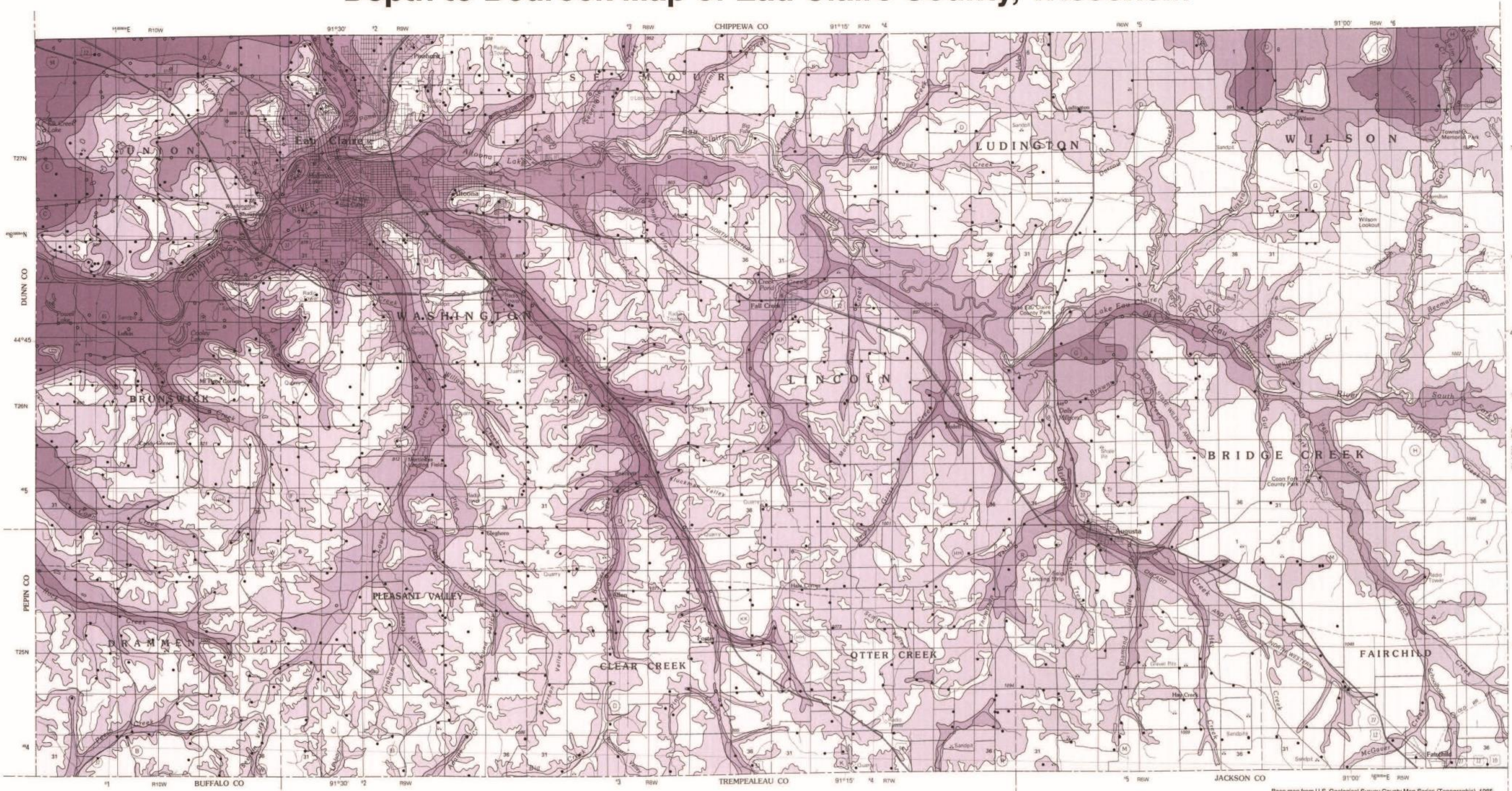
- complete and maintain the County's groundwater webpage
- pursue EPA environmental education, private foundation or other educational grant dollars to do....

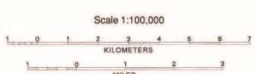
APPENDIX A – FIGURES

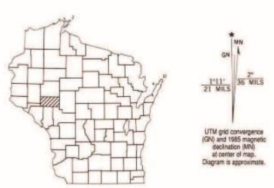
(note to be inserted about the accuracy of all the maps)

Figure 1 – Depth to Bedrock Map of Eau Claire County, Wisconsin

Depth to Bedrock Map of Eau Claire County, Wisconsin







Cartography by D.L. Patterson and D.C. Endrizzi

D.M. Johnson, 1993

Miscellaneous Map 37

A product of the Eau Claire County Groundwater Resource Investigation, a joint project of the Wisconsin Geological and Natural History Survey and the Eau Claire County Board of Supervisors.

Depth to bedrock categories

- 0–5 ft — bedrock at or near the land surface
- 5–25 ft — bedrock often exposed in roadcuts, streambeds, and excavations
- 25–50 ft — bedrock usually intersected by water wells and other borings
- 50–100 ft, 100+ ft — bedrock intersected only by deep drillholes
- approximate depth to bedrock, in feet below land surface
- ∘ well that does not intersect bedrock • well that intersects bedrock

In Eau Claire County, bedrock is composed almost entirely of Cambrian sandstone, siltstone, and small amounts of shale. The Mount Simon Formation of the Elk Mound Group is the most extensively exposed unit. Cambrian rock is absent in the stream valleys of the northeast, where Precambrian basement rock is exposed, and is up to more than 250 feet thick in the southwest part of the county. In the hills of southern Eau Claire County, the Mount Simon is overlain by younger Cambrian sandstone, dolomite, and shale of the Elk Mound Group (the Eau Claire and Wonewoc Formations), the Tunnel City Group, and the St. Lawrence and Jordan Formations of the Trempealeau Group. The strata dip gently to the southwest.

Surficial deposits in Eau Claire County, which are up to 200 feet thick in the Chippewa River valley and absent in places in upland areas where bedrock occurs at the surface, consist primarily of residuum and materials of glacial and alluvial origin. Three glacial episodes have deposited surficial materials in Eau Claire County: the pre-Illinois, Illinois, and Wisconsin (oldest to youngest) (Baker, 1984). Pre-Illinois lake sediment of the Kinnickinnic Member of the Pierce Formation was deposited in lakes that were dammed by ice that blocked the westward drainage of the Chippewa River and its tributaries; this material is absent in the uplands of the north and southwest and where it has been eroded. A red sandy till deposited in the northeastern part of the county during the Illinois Glaciation and derived from the Superior Basin is included in the River Falls Formation. During the Wisconsin Glaciation, the Laurentide Ice Sheet advanced into the northeastern corner of the county, where it deposited till and outwash.

Since glaciation, slope processes have reworked the glacial sediment as well as residual materials on bedrock. This reworking of sediment has resulted in the accumulation of colluvial deposits at the base of slopes. Figure 1 shows a cross section of a typical stream valley and the relationship of the bedrock to surficial deposits.

The depth to bedrock map presented here provides a general guide to the thickness of surficial materials. It is based on well records, the Eau Claire County soil survey (Soil Conservation Service, 1977), and field observations. The distribution of surficial deposits combined with the effects of erosion and mass wasting can cause significant differences in the depth to bedrock over short distances. Because of local complexity, this map should be used only as a guide to the general thickness of the materials. Detailed site-specific investigations, including drilling, are necessary to verify local conditions.

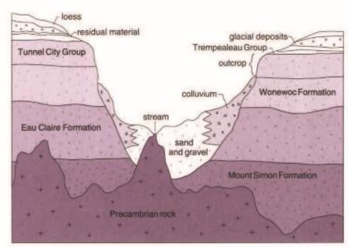


Figure 1. Cross section of typical stream valley.

Sources of information

Baker, R.W., 1984, Pleistocene history of west-central Wisconsin: Wisconsin Geological and Natural History Survey Field Trip Guide Book 11, 76 p.

Brown, B.A., 1988, Bedrock geology of Wisconsin, west-central sheet: Wisconsin Geological and Natural History Survey Map 88-7, scale 1:250,000.

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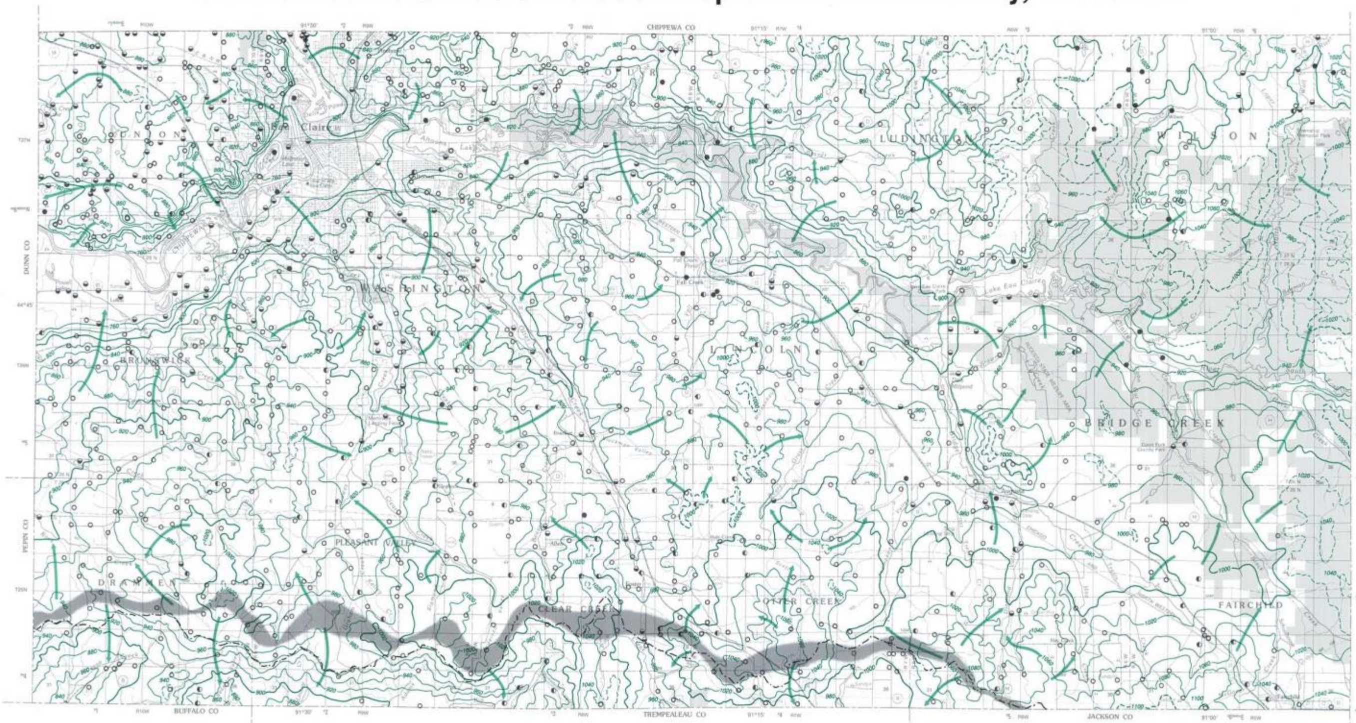
James M. Robertson, Director and State Geologist

Figure 2 – Generalized Water-Table Elevation Map of Eau Claire County, Wisconsin

Generalized Water-Table Elevation Map of Eau Claire County, Wisconsin



M.A. Muldoon
1992

Introduction

This map is part of the Eau Claire County Groundwater Resource Investigation, a joint project of the Wisconsin Geological and Natural History Survey and the Eau Claire County Board. The purpose of this project was to compile and interpret hydrogeologic data for Eau Claire County. The resulting information can be used by Eau Claire County's soil-and-water-resource and land-use planners.

The water cycle

Gravity and solar energy play active roles in a continuous water recycling process called the *water cycle* (fig. 1).

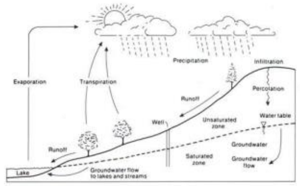


Figure 1. *The water cycle.*

Water falling on the land surface can flow downhill as overland *runoff*, evaporate, transpire through plants, or infiltrate into the ground. As this infiltrating water seeps downward through rock or soil, it travels through pore spaces and open cracks or fractures in the subsurface material. When these pores and cracks are completely filled with water, the material is said to be *saturated*.

The *water table* marks the top of this saturated zone, where hydraulic pressure in the pores is equal to atmospheric pressure. *Groundwater* is the water contained in the saturated zone below the water table. The amount of infiltrating precipitation partly determines the position, or elevation, of the water table, which fluctuates seasonally, and from one year to another. Above the water table, pores and cracks are partly or completely filled with air and partly filled with water, and the material is said to be *unsaturated*.

Gravity moves groundwater slowly through pore spaces; eventually, the groundwater discharges to a well, the land surface, or a water body where solar energy evaporates some of it into the atmosphere, thus continuing the water cycle.

In Wisconsin, the water cycle generally operates with 30 to 32 inches of precipitation during an average year, from which about 75 percent (22 to 26 inches) returns to the atmosphere by evapotranspiration. The remainder either flows over the land surface and collects in surface-water bodies or infiltrates into the ground as *recharge* to the groundwater system. The ratio of overland runoff to groundwater recharge varies considerably around the state, depending upon factors such as topography, soil type, vegetative cover, rainfall intensity, and individual farming and general land-use practices.

Movement of groundwater and surface water

A saturated subsurface material that yields sufficient water to a well is called an *aquifer*. *Permeability* is a measure of the relative ease with which water can flow through an aquifer; it is dependent on the nature of the materials through which the water is flowing. Large pores or fractures in the subsurface can hold more water than small ones, but in order for water to flow effectively, these pores or fractures must be interconnected.

Groundwater can move as rapidly as several feet per day in porous sands and sandstones, or as slowly as less than 1 inch per year in clay or in unfractured crystalline rock. For example, sandy soils and sandstones frequently have relatively large pore spaces that are well connected with each other, allowing water to move more easily than it can in clayey soils that have small, poorly connected pores. Rocks such as crystalline granite commonly have few fractures that are poorly connected; as a result they commonly have low permeability and transmit little water. However, no matter how rapidly or slowly the groundwater flows, its natural direction of movement is in response to gravity, from upland recharge areas (where water infiltrates into the subsurface) to lowland discharge areas (lakes, rivers, springs, and seeps). Discharge areas are often associated with surface-water bodies, so groundwater has a significant role in the development and environmental health of lakes, streams, and wetlands. Wells also function as groundwater-discharge points.

A *surface-water divide* is a line of separation, commonly a ridge or narrow tract of high ground that divides the surface waters that flow naturally into one basin from those that flow naturally into a different basin. It is a line across which no surface water flows. There is one major surface-water divide in Eau Claire County. North of the surface-water divide (which is located in southern Eau Claire County), the streams and rivers flow into the Eau Claire or Chippewa Rivers. These rivers come together near the city of Eau Claire and eventually flow into the Mississippi River. South of the surface-water divide, most streams flow into the Buffalo River, which is also a tributary of the Mississippi River.

A *groundwater divide* is similar to a surface-water divide, in that it is a ridge defined by contours of the water table. Shallow groundwater moves away from the divide in different (often opposite) directions. A groundwater divide does not necessarily coincide with a surface-water divide. The one major groundwater divide in Eau Claire County approximately coincides with the surface-water divide. Over much of central and southern Eau Claire County, discharge areas include north-flowing creeks that serve as tributaries to the Eau Claire River. In the northern part of the county, discharge areas include Fivemile, Sevenmile, Ninemile, Hay, and Muskrat Creeks and the North Fork of the Wolf River; these south-flowing streams are tributaries for the Eau Claire River. In the northwest corner of the county the Chippewa River and Dells Pond serve as groundwater discharge areas.

Contamination of groundwater

Because groundwater comes from precipitation that percolates down from the land surface, any water-soluble material or liquid that is put on or in the ground has the potential to be transported to the saturated zone. The unsaturated zone can be a good natural filter and may remove many harmful materials from the recharging water by a variety of physical and biological processes. In general, fine-grained materials are better able to attenuate contaminants; as a result, areas with thin or sandy soils over a rock aquifer or thin or sandy soils with a shallow water table are especially susceptible to groundwater contamination from land-use activities. Once a contaminant reaches the saturated zone, it has the potential to move with the groundwater and discharge to wells or surface-water bodies. Concentration of contaminants in the saturated zone can be reduced by the processes of dilution, adsorption onto fine-grained particles, and chemical breakdown.

Contamination that occurs today may not become evident for several or even hundreds of years because groundwater can move as slowly as a few inches per year. Once contaminated, groundwater is difficult to purify and may take many years, decades, or centuries to be cleaned by dilution, attenuation, and chemical breakdown of contaminants.

Data compilation and interpretation

Data were compiled by Julie Gassen, Lucy Buchan, Xiangxue Cheng, and David Johnson at a scale of 1:24,000, using U.S. Geological Survey quadrangles (7.5-minute series, topographic) as base maps. All available Wisconsin Geological and Natural History Survey geologic logs were plotted onto these base maps. The Wisconsin Department of Natural Resources well constructor's reports were examined and checked against each other, and the most representative, reliable, and useful data available for each section were plotted.

Data density varies considerably across Eau Claire County; the density ranges from few data points on county-owned lands (eastern part of the county and along the Eau Claire River) to at least one report per 1 to 2 square miles in inhabited parts of the county. A total of 1,028 well data points was used in constructing the water-table map.

Domestic wells are not ideal measuring points for determining water-table elevation. Most wells are open over long intervals and are completed far below the top of the saturated zone. Domestic wells provide good estimates of water-table elevation in areas where groundwater flow is more horizontal than vertical and poor estimates in areas where groundwater flow is more vertical than horizontal. To determine whether vertical groundwater flow was significant, water levels were compared for wells of different depths. Over much of Eau Claire County, wells completed at different depths had similar water levels; however, in some areas, vertical groundwater gradients seemed significant. In those areas, the wells with the shallower open intervals were assumed to provide the closest estimate of the elevation of the water table, and data from the deeper wells were not used.

Well constructor's reports provide measurements taken at different times of the year and in different years. Because of the seasonal variations in water levels as well as changes in water levels with depth, a water level determined from a well constructor's report was not used as an exact data point. Instead, the water level was considered to be part of a range of values. The elevations of springs, groundwater seepage areas (such as wetlands), lakes that intersect the water table, and rivers were used as data points in most areas.

The bedrock geology of Eau Claire County consists of Precambrian crystalline rock (commonly referred to as granite) overlain by a thick sequence of Cambrian sandstones with minor amounts of shale (Brown, 1988). Pleistocene deposits (thin in most places) consist of till deposited prior to the late Wisconsin; these deposits have been eroded from much of the county. Evidence of these early glaciations is sparse except in the northeast part of Eau Claire County (Cates and Madison, 1989). The latest advance of the glaciers terminated north and northeast of Eau Claire County; however, water from the melting ice followed the Chippewa River drainage and deposited thick sand and gravel sequences. Although the geology is complex, the water table closely mimics topography, suggesting good hydraulic connections between the Cambrian sandstone and the surficial deposits. The shallow groundwater system appears to be a single unconfined aquifer at the scale of this water-table map (1:100,000).

Many wells in Eau Claire County are completed in sandstone (71%) or a mixture of sandstone and shale (9%). The sand and gravel aquifer is used in places (17% of the wells), and a few wells are completed in granite or sandstone and granite (3%).

Limitations of the map

This map depicts, in a general way, the direction of shallow groundwater flow, which is primarily perpendicular to lines of equal water-table elevation. "Shallow" refers to depth below the water table, and not to depth below the land surface. The accuracy of the interpretation varies throughout the study area, increasing with greater data density and decreasing with greater hydrogeologic complexity. The water-table elevation lines are solid where enough data are available to locate the lines with a reasonable degree of confidence (within ±0.3 mile on the map). The lines are dashed where data are less abundant or where hydrologic conditions are more complex and their locations are considered to be accurate to within ±0.7 mile on the map. In the areas where a question mark appears on the map, such as the tops of hills, data are insufficient to interpret water-table elevation.

It was beyond the resources of this study to field-check the locations and water levels given on the Department of Natural Resources well constructor's reports that were used to construct this map. This map is a summary of available water-level data for Eau Claire County. It is intended for use at the published scale of 1:100,000 but should *not* be considered definitive for site-specific applications.

References

Brown, B.A., 1988, Bedrock geology of Wisconsin, west-central sheet: Wisconsin Geological and Natural History Survey Regional Map Series (Map 88-7), scale 1:250,000.

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Base map from U.S. Geological Survey County Map Series (Topographic), 1985.

Scale 1:100,000

Explanation

- average elevation of water table in feet, solid where considered accurate within ±0.3 mile on the land surface; dashed where considered accurate within ±0.7 mile on the land surface; 20-ft contour interval. Datum is mean sea level.
- ? elevation of water table unknown; insufficient data
- surface-water divide
- groundwater divide, approximately located
- general direction of shallow groundwater flow
- county-owned land and Wisconsin Department of Natural Resources Wildlife Refuge

Geologic materials contributing water to well (All geologic information is taken from Department of Natural Resources Well Constructor's reports on file at the Wisconsin Geological and Natural History Survey.)

- ○ sandstone
- ◐ sandstone and shale
- ◒ sand and/or gravel
- ● granite or granite and sandstone

Data have not been field checked. Water-level elevation data were generalized from information collected over a period of approximately 50 years.

Sources of data

U.S. Geological Survey quadrangles (7.5-minute series, topographic; 1972-84) were used to determine surface-water and well-water elevations

Water-level observation wells from the Groundwater Level Monitoring Network operated and maintained by the U.S. Geological Survey and Wisconsin Geological and Natural History Survey

Wisconsin Department of Natural Resources well constructor's reports (1936-87)

Wisconsin Geological and Natural History Survey published and unpublished geologic logs (1896-1988)

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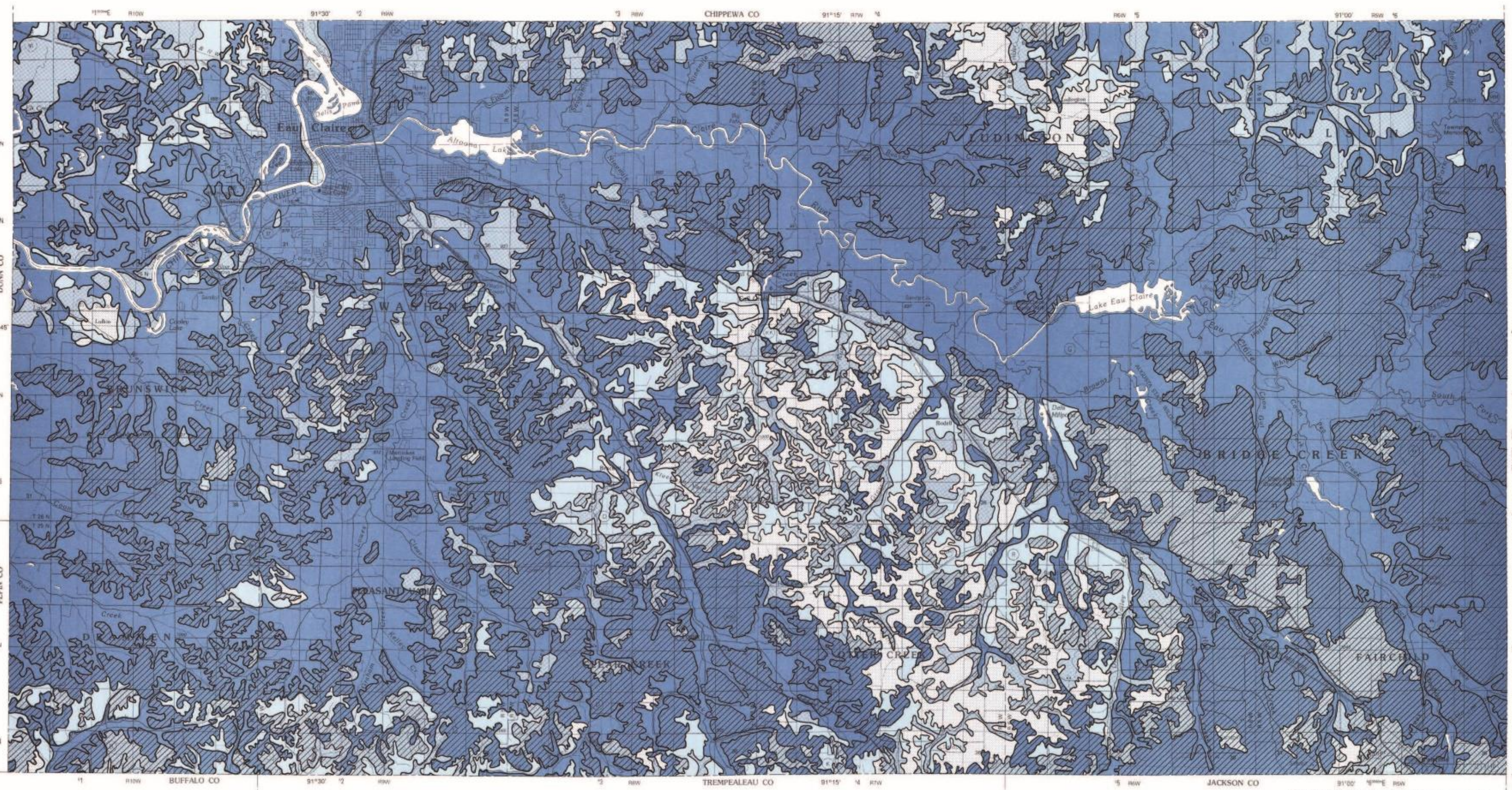
Cartography by K. Campbell Roushar

Miscellaneous Map 35

Figure 3 – Soils of Eau Claire County, Wisconsin, and Their Ability to Attenuate Contaminants

SOILS OF EAU CLAIRE COUNTY, WISCONSIN, AND THEIR ABILITY TO ATTENUATE CONTAMINANTS



K.J. Cates
and F.W. Madison

1989

Introduction

Soils usually compose only the upper 2 to 4 feet of unconsolidated materials at the earth's surface. Soils are the basis of agricultural production; they provide the foundation for buildings and roads; if properly used, they aid in the treatment and recycling of wastes from homes, from the production of livestock and poultry, and from municipal and industrial sewage treatment plants. Soil characteristics (depth, texture, and permeability) are among the most significant factors that determine the rate and extent of groundwater recharge and the degree of natural protection against contamination. Land characteristics such as slope, vegetation type, and type of rock will, in conjunction with the soil, determine the overall potential of the environment to protect groundwater.

Glaciers moved across most of Eau Claire County tens or hundreds of thousands of years ago, leaving behind characteristic deposits of till (a poorly sorted mixture of sand, silt, clay, and boulders) and outwash (sand and gravel carried off the ice by meltwaters). Subsequent erosion and other geomorphic processes have removed many of these deposits; consequently, evidence of these early glaciations is sparse at the modern land surface, except in the northeastern part of the county where soils are formed in glacial till.

Although the last glacier to invade Wisconsin terminated north and northeast of Eau Claire County, its influence on the modern landscape was significant. Water from the melting ice moved through the county, following the Chippewa River drainage system and leaving behind extensive coarse-textured (sand-sized) alluvial deposits. Fine, silt-sized particles were carried great distances until the flow of the water slowed enough to allow deposition of these materials. Following the disappearance of the ice, these fine particles were picked up by the wind and deposited to varying depths on the land surface. Many of the modern soils in Eau Claire County formed in this silty material, which is called loess.

Many factors influence the type of soil that develops in an area: the parent material from which the soil formed, relief, climate, natural vegetation, drainage, and the time that the soil has had to form. Although the early glaciers modified the landscape in the county, relatively steep areas are common and soil erosion is a continuing problem. In some parts of Eau Claire County, the loess has been eroded and soils formed in residuum of the sandstone bedrock. Bedrock, either sandstone or shale, is within 5 feet of the land surface over about 164,000 acres (nearly 40% of the county).

For mapping, classification, and interpretive purposes, soils are grouped into soil series on the basis of similar physical and chemical characteristics, type of parent material, and arrangement of horizons or layers. A grouping of individual soils based solely on physical and chemical characteristics is required to evaluate the potential of soils for attenuating contaminants. An evaluation system was developed to assess those soil properties that play a role in the attenuation of potential groundwater contaminants resulting from land-use activities.

Capacity of soils to attenuate contaminants

Attenuation is a series of complex processes, all of which are not clearly understood. During attenuation, the soil holds essential plant nutrients for uptake by agronomic crops, immobilizes metals that might be contained in municipal sewage sludge, or removes bacteria contained in animal or human wastes. The soil is an integral part of the natural protection of groundwater from surface-applied contaminants.

However, the natural purification capacity of the soil, like that of any other natural resource, is limited; sometimes soils that retain contaminants become contaminated. Cleaning contaminated soil can be as difficult as cleaning contaminated groundwater. The evaluation system presented here must be looked upon as a supplemental planning tool only, as a time- and cost-saving guide for preliminary screening of the county for areas sensitive to the impact of normal land-use activities. This soil-potential map does not replace the need for detailed on-site investigations. It does, however, reduce the number of areas to be studied in detail by identifying the areas of best and least attenuation potential. Local details have been generalized to fit the mapping scale, which cannot accommodate small, local variations in soil characteristics.

This system evaluates the ability of the soil solum (the A and B horizons) to attenuate potential contaminants resulting from activities above or within the soil zone. The soil-attenuation capacity is considered here only in general terms and is not contaminant-specific. Different contaminants may behave differently--some may be completely eliminated by soil organisms, some may be used by plants, some may be adsorbed on soil particles, and some may eventually pass through the soil solum unchanged.

Physical and chemical characteristics to establish soil ratings

For assessing soil potential for attenuation of contaminants in Eau Claire County, seven physical and chemical characteristics were selected for each soil series and were given weighted values (table 1). Values assigned to each characteristic were determined subjectively, with 1 being the poorest and 10 the best attenuation potential. These values were summed, and soils with total point scores within certain ranges were grouped into four soil associations, which, in turn, reflect different attenuation potentials (table 2). Soil associations consist of two or more dissimilar series that occur on the landscape in a regularly repeating pattern.

Information needed for this assessment was taken entirely from the Eau Claire County soil survey. All soil series mapped in the county were ranked on the basis of their characteristics in a natural state. Man-induced changes, such as tiling and ditching, may affect the attenuation potential of a particular soil. In those instances where alteration has been extensive, a reassessment may be required. Areas in the county where the bedrock is within 5 feet of the surface are indicated on the map. Even though the rock may be covered with 2 to 4 feet of soil materials that have good capacity for contaminant attenuation, the proximity of the bedrock to the land surface still limits subsurface and surface land-use activities.

Soil attenuation potential

Slightly more than 72 percent of the land area (298,940 acres) in Eau Claire County is covered with soils that have the least potential for contaminant attenuation. Even though they are well drained, the coarse texture of deep, sandy soils such as Menahga and Plainfield series allows water to move through them very rapidly, thus minimizing contact between the percolating waters and soil particles and reducing contaminant attenuation. Boone and Plainbo soils form in 20 to 40 inches of sandy residuum from sandstone bedrock; Elkmound soils have 10 to 20 inches of loamy materials over platy sandstone. Ludington and Humbird soils develop in residuum from interbedded sandstones and shales. Many of these shallow, residual soils form on steep slopes and are not well suited for any type of land use.

Soils with marginal potential for contaminant attenuation include those formed in up to 30 inches of silty materials over sandstone (Veedum, Norden, Gale) and in similar thicknesses of loamy materials over sandstone (Hixton, Northfield) or outwash (Meridian, Lows, Dells). In their subsurface horizons, some of these soils display morphological features that indicate periods of saturation. Presence of a saturated zone within the soil solum interrupts the attenuation processes and may allow contaminants to be introduced into the groundwater.

Soils with good potential to attenuate contaminants cover 33,310 acres (about 8% of the county). These soils have formed in 20 to 40 inches of loess over sandstone (Gale) or loess over outwash (Meridian). Seaton soils have developed in deep silt (>48 inches) and normally would be considered to have the best attenuation potential. However, in Eau Claire County Seaton soils that occur on steep slopes and have been moderately or severely eroded are ranked as having only good attenuation potential. Erosion removes the topsoil, thus affecting infiltration of water into the soil--a key part of the attenuation process. These soils are well suited for a variety of land uses, including agriculture, but must be managed carefully to control erosion.

About 25,000 acres in the county are covered with soils having the best potential for contaminant attenuation. These are soils such as Seaton and Mt. Carroll, which are formed in deep silt (>48 inches). Maximum attenuation occurs when water percolates slowly through the soil solum and contact between contaminants and soil particles is maximized. Well structured, medium-textured surface horizons that enhance infiltration and deep, finer-textured subsoils are characteristic of the soils in this association. These soils are well suited to all types of land-use activities.

This map shows the distribution of soils in Eau Claire County on the basis of their potentials for contaminant attenuation. Soils with bedrock within 5 feet of the land surface are found throughout the county. Soils with special management requirements dominate the county. Deep, flat-lying sandy soils lend themselves well to irrigated agriculture but, because of their limited ability to attenuate contaminants, must be carefully managed to avoid nutrient and pesticide movement to the groundwater. Soils on steep slopes are often shallow and are not suited to land uses other than forestry. Deeper soils on steep slopes can be used in a variety of ways but must be carefully managed to reduce erosion.

Table 1. Ranking system for evaluating the attenuation potential of soils

Physical/chemical characteristics	Classes	Weighted values
Texture[1] of surface (A) horizon	l, sil, scl, si	9
	c, sic, cl, sicl, sc	6
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials, and all textural classes with coarse fragment class modifiers	1
Texture[1] of subsoil (B) horizon	c, sic, sc, si	10
	scl, l, sil, cl, sicl	7
	lvfs, vfsl, lfs, fsl	4
	s, ls, sl, organic materials, and all textural classes with coarse fragment class modifiers	1
Organic matter content[2]	Mollisols	8
	Alfisols	5
	Entisols; Inceptisols; Spodosols	3
	Histosols; Aquic suborder; and Lithic, Aquollic, and Aquic subgroups	1
pH-Surface (A) horizon	≥6.6	6
	<6.6	4
Depth of soil solum (A + B horizons)	>40 in.	10
	30-40 in.	8
	20-30 in.	3
	<20 in.	1
Permeability[3]-subsoil (B) horizon	very low	10
	moderate	8
	high	4
	very high	1
Soil drainage class	well drained	10
	well to moderately well drained	7
	moderately well drained	4
	somewhat poorly, poorly, and very poorly drained; and excessively well drained	1

[1] Soil textural classes: l = loam, sil = silt loam, scl = sandy clay loam, si = silt, c = clay, sic = silty clay, cl = clay loam, sicl = silty clay loam, sc = sandy clay, lvfs = loamy very fine sand, vfsl = very fine sandy loam, lfs = loamy fine sand, fsl = fine sandy loam, s = sand, ls = loamy sand, sl = sandy loam.

[2] Based on the ordinal, subordinal, or subgroup levels of the soil classification system; soils are assigned a lower number if they are wet or less than 20 inches thick over bedrock; see county soil survey report.

[3] Based on the particle-size class at the family level of the soil classification system, type, and grade of structure, and consistence; see soil profile descriptions and classification table in county soil survey report.

Attenuation Potential

- Best
- Good
- Marginal
- Least
- Bedrock within 5 feet of surface

SCALE 1:100 000

KILOMETRES 1 0 1 2 3 4 5

MILES 1 0 1 2

Wisconsin Geological and Natural History Survey Map 89-6

Cartography by K. Campbell Roushar

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Table 2. Soil series in Eau Claire County listed by attenuation potential

	Least potential	Marginal potential	Good potential	Best potential
Sum of weighted values	0-30	31-40	41-50	51+
	Adrian Alluvial land, sandy* Alluvial land, wet* Arland, eroded† Au Gres Billett Boone-Plainbo complex Burkhardt Chetek Eleva Elkmound Elm Lake Fairchild-Merrillan complex Fall Creek Friendship Gotham Houghton Ludington-Humbird complex Markey Menahga Morocco Newson Northfield, eroded† Northfield, steep† Plainbo Plainfield River wash* Sparta Terrace escarpments, sandy* Trempe Ume Vilas	Arland Cable Caryville Curran Dells Dunnville Ettrick Gale, eroded† Gale, steep† Hiles Hiles-Kert complex Hixton, eroded† Kert Lows Marshan Meridian, eroded† Meridian, moderately well drained† Norden Northfield Orion Otter Shiffer Veedum Vesper	Arenzville Dakota Fall Creek, moderately well drained variant Gale Hixton Meridian Seaton, steep, eroded† Seaton, moderately well drained† Tell	Mt. Carroll Otterholt Pillot Seaton Seaton, eroded† Seaton, benches† Whitehall, deep variant
Acreage	298,940	57,290	33,310	24,742
Percent of total land area	72.2	13.8	8.0	6.0

* Undifferentiated land type
† Soil phase

Figure 4. Locations of Sand and Gravel Mines within Eau Claire County, Wisconsin

Figure 5. Eau Claire County Land Cover

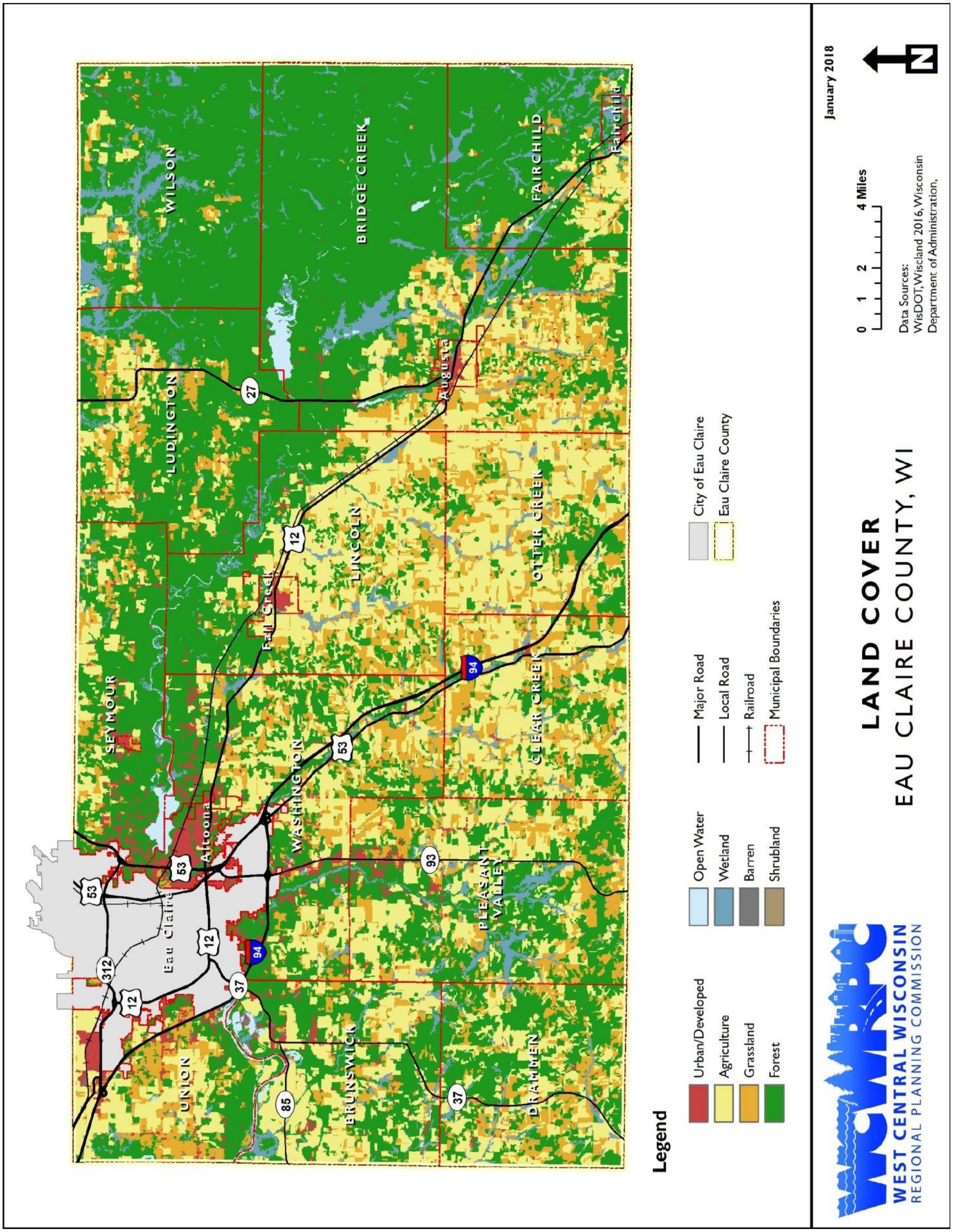


Figure 6 – Nitrates

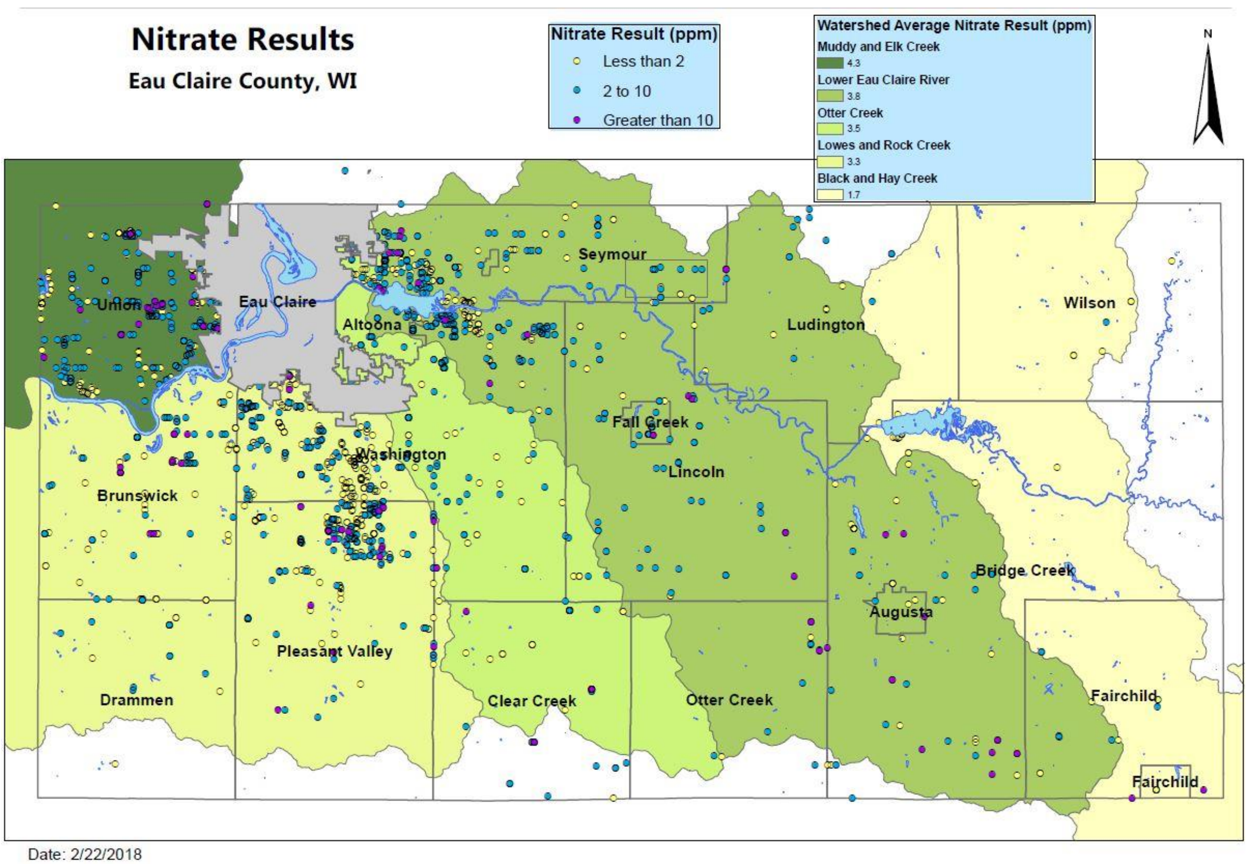


Figure 7 – Coliform

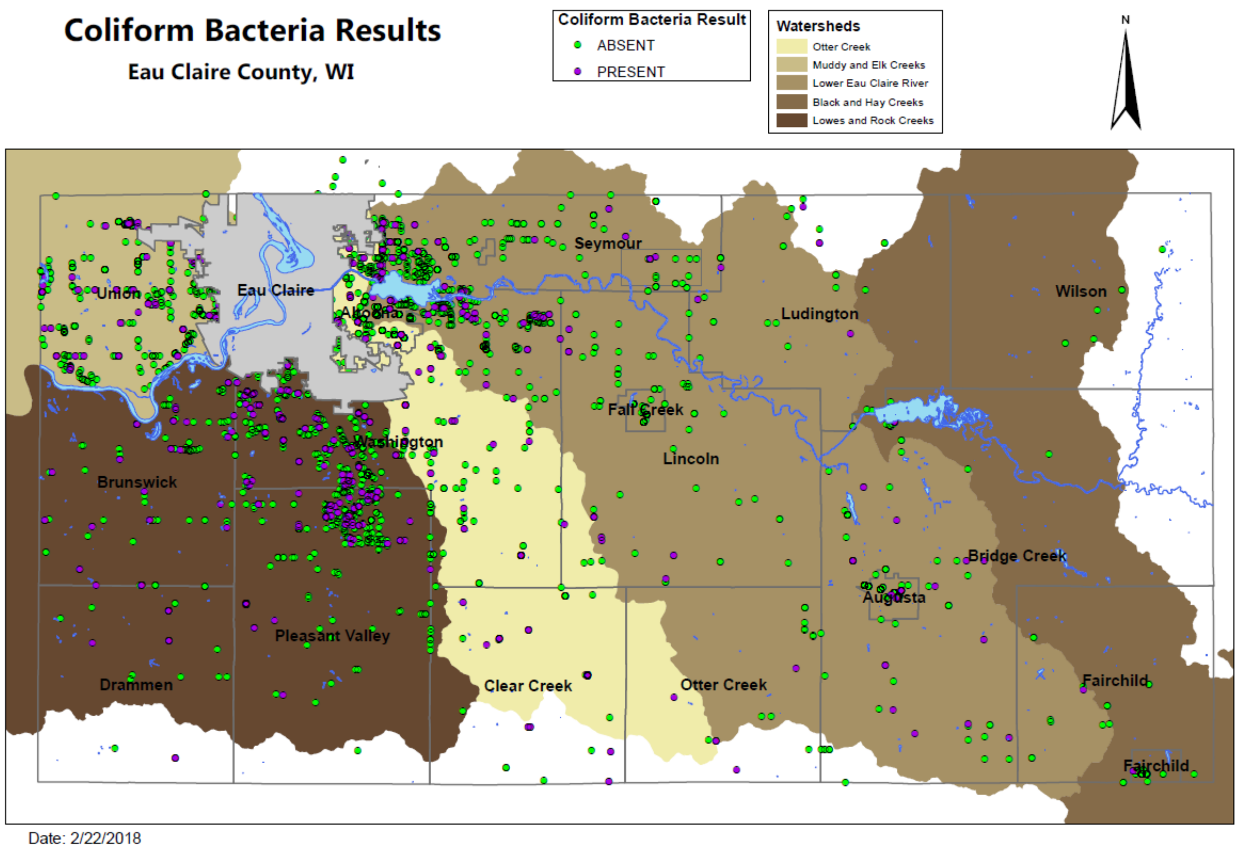


Figure 8 - Atrazine Prohibition Areas in Eau Claire County

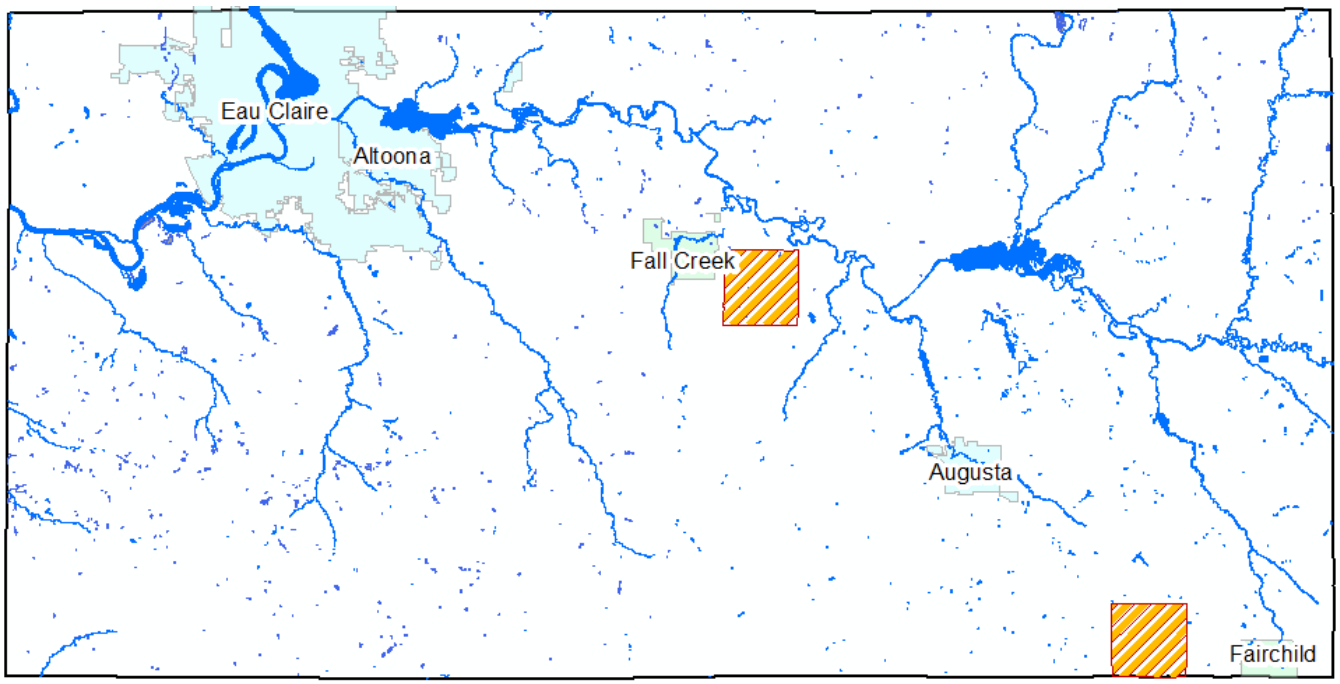


Figure 9 – Atrazine Prohibition area outside of Fall Creek, WI.

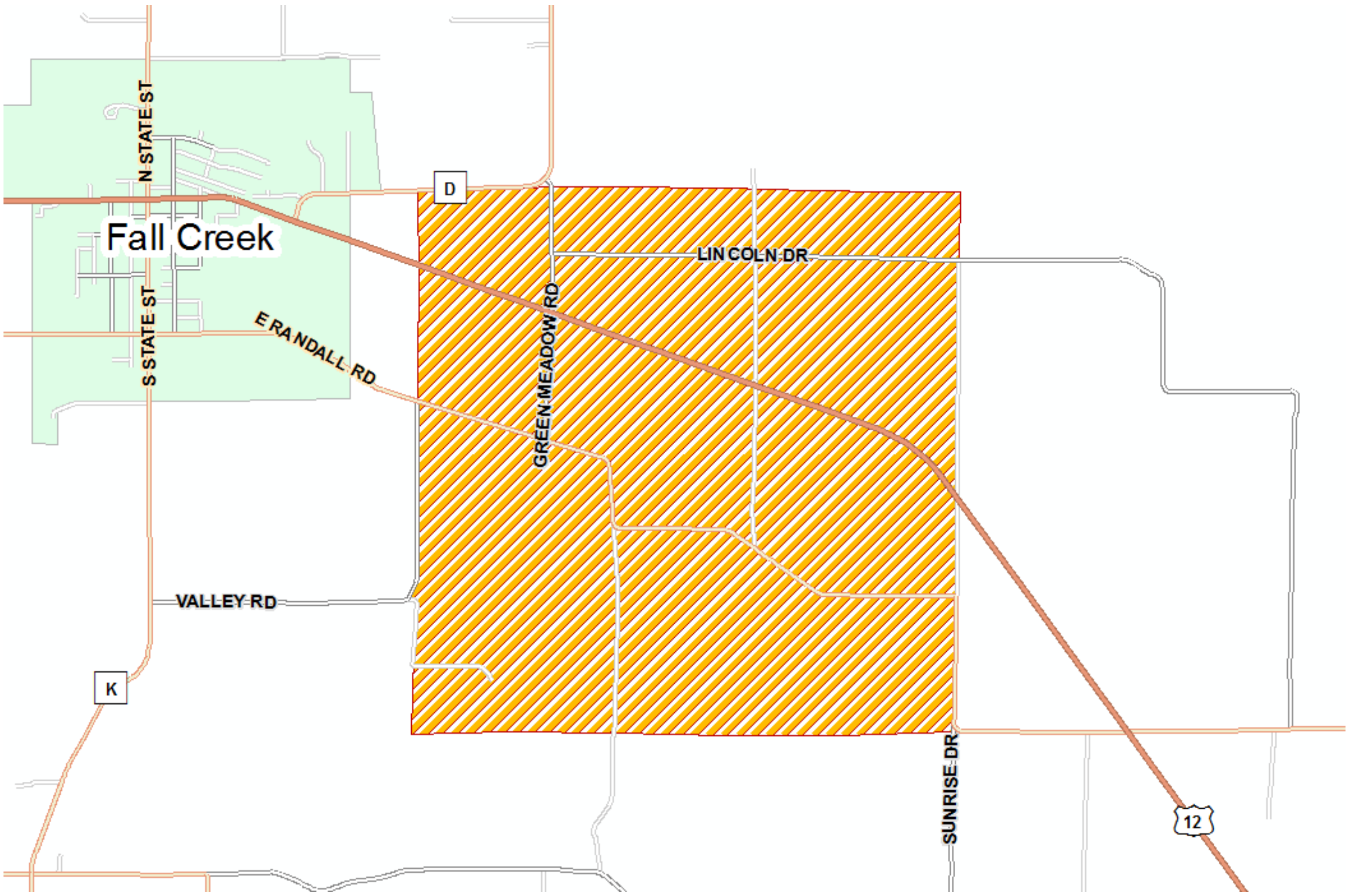


Figure 10 – Atrazine Prohabition Area outside of Fairchild, WI.

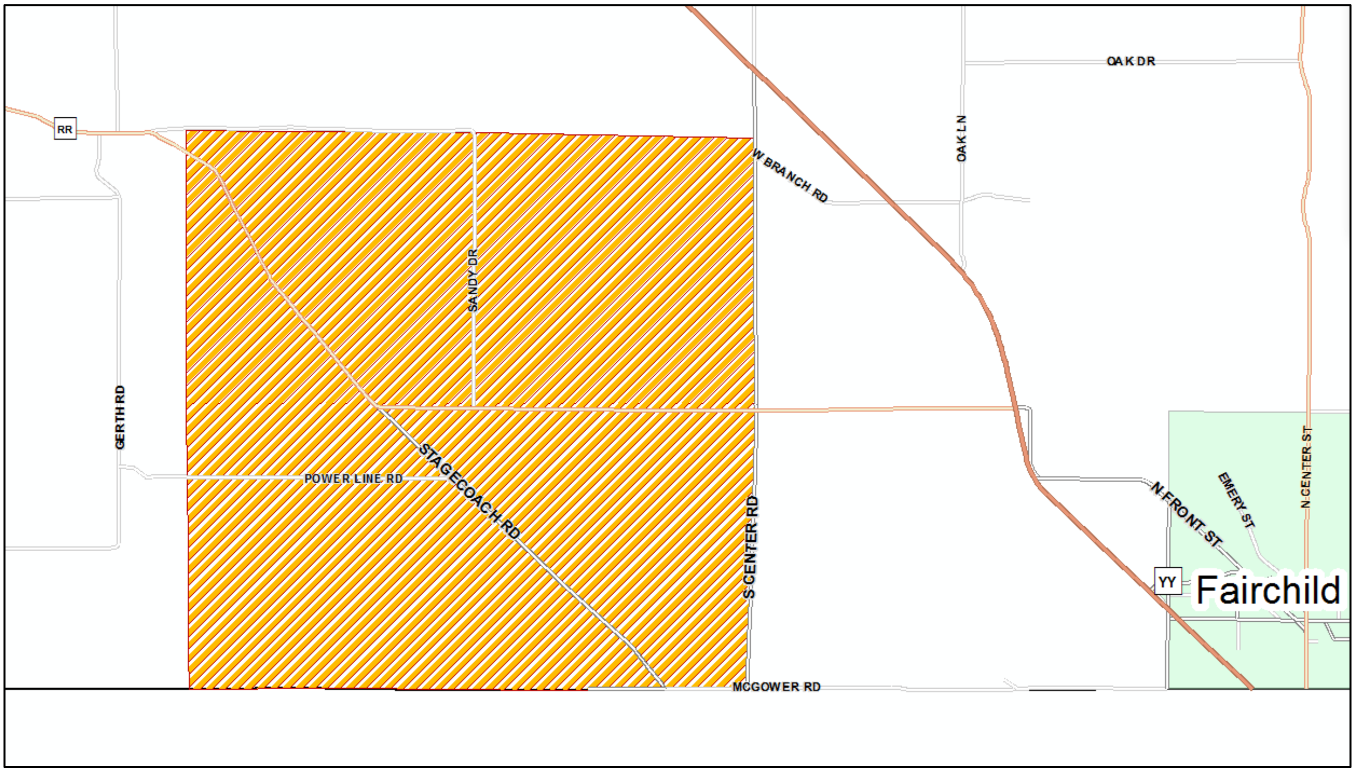


Figure 11 – Landfills and Hazardous Materials Spills, Eau Claire County

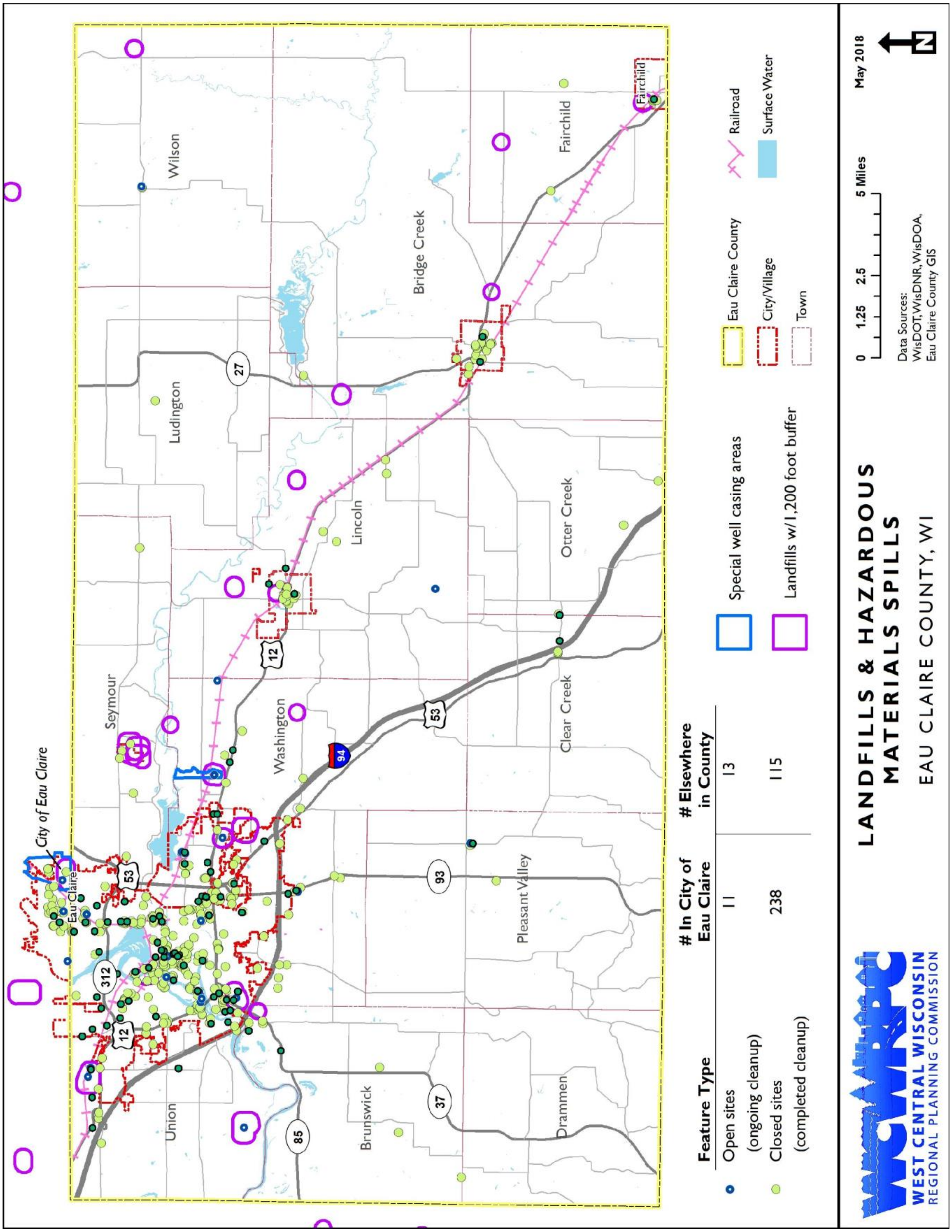


Figure 12 – Wisconsin Temperature Change

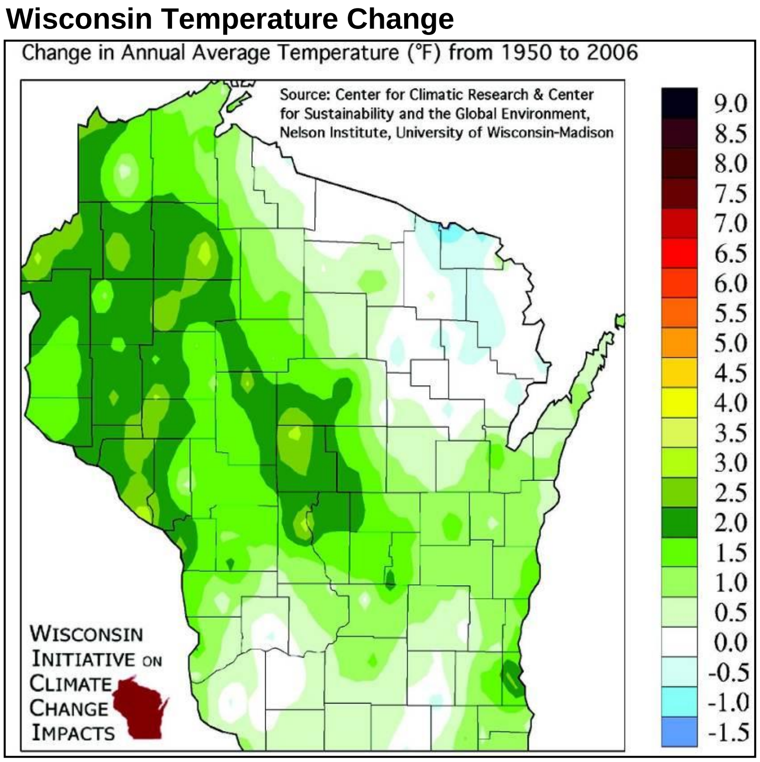
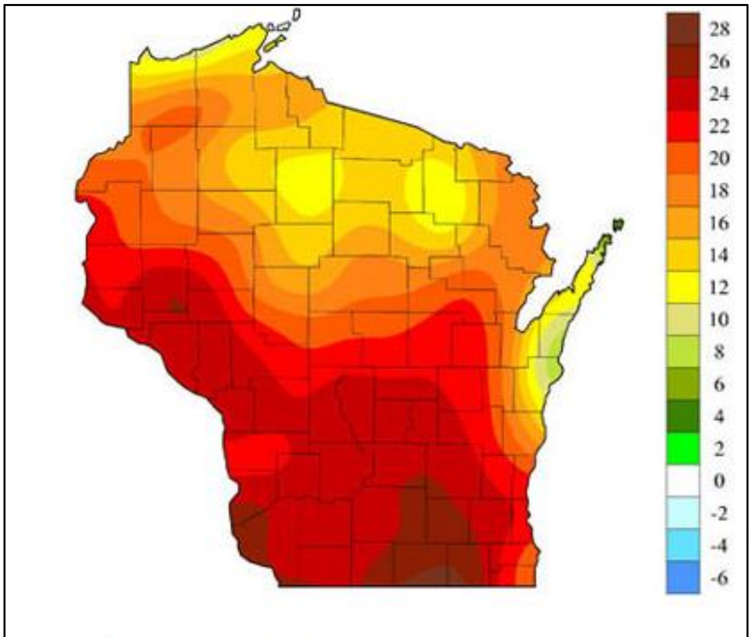


Figure 13 – Change in # of 90+ Degree Days

Change in # of 90+ Degree Days



Projected Change in the Frequency of 90°F Days Per Year from 1980 to 2055

Figure 14 – Wisconsin Precipitation Change

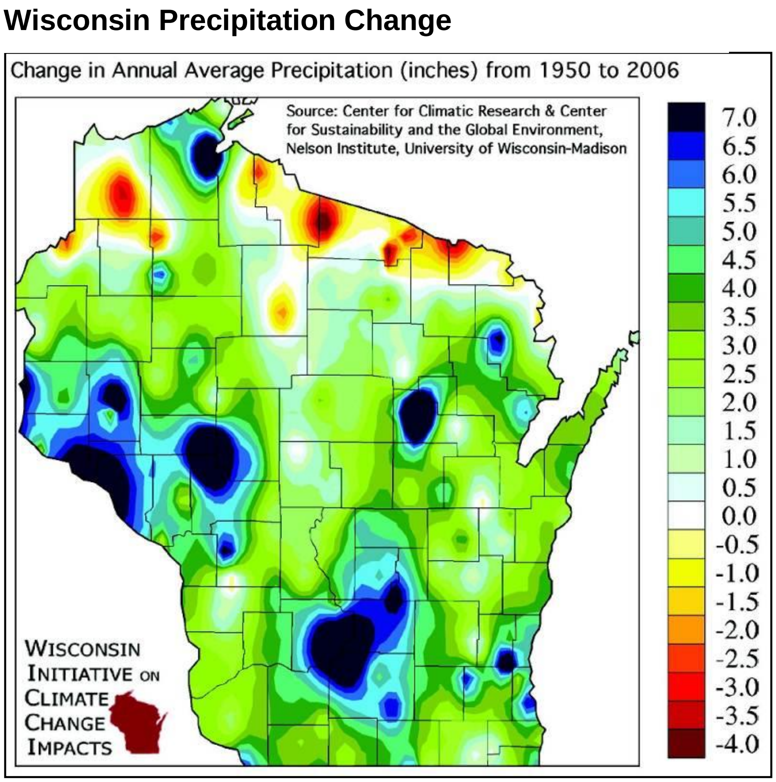
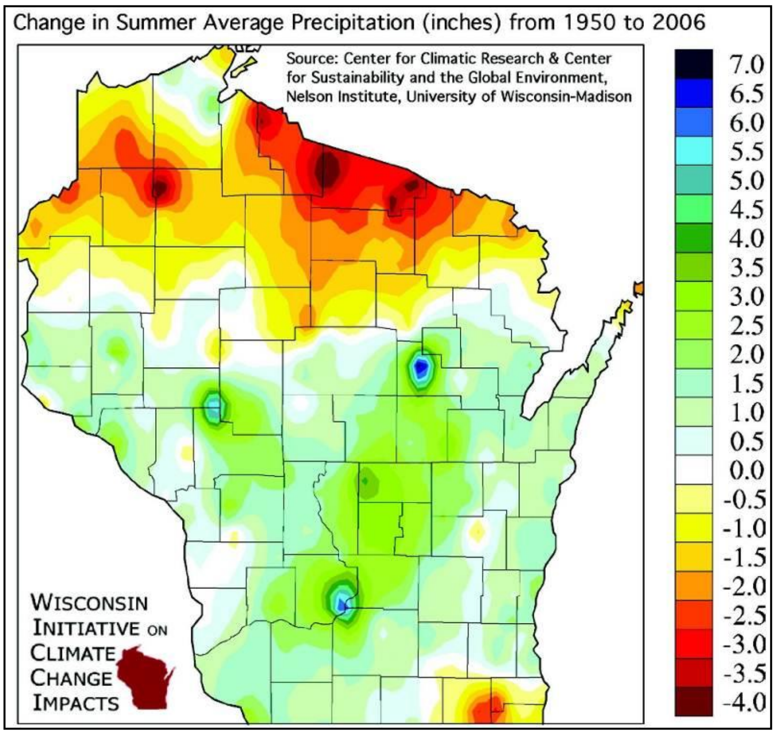


Figure 15 – Wisconsin Summery Precipitation Change

Wisc. Summer Precipitation Change



Section III. Priority Recommendations

<table>
<tr>
<td>UNDERSTANDING GROUNDWATER

Define and map Environmental Sensitive Areas (ESAs) and constraints (ie lot size, land use regs)
Continue well testing and increase the number of tested wells
Need additional groundwater sample data
Understand polyacrylamide concerns
Create flow model including flow, depth, recharge to better understand sustainability (climate impacts) and susceptibility

Potential grans for updating model

</td>
<td>PROTECTING

Explore how to consider water quality/quantity as part of subdivision plat review (land use regs/policies)
Explore county regulatory options RE: high cap wells
Increase the number of farmers with Nutrient Management Plans

Increase cost share
Continue planning assistance
Increase face-to-face
TRM grants
5+ acres of lawn

Explore citation authority for LCD – NR 151 – Farming/CAFO Ordinances

</td>
<td>VALUING / EDUCATION

Checklist or fact sheet for homebuyers/builders/realtors
Share water testing results with public in a form that is accessible
Complete website with theory or principles of groundwater (Appendix in report)
Partner with towns to education public on how to keep water safe and the importance of residential well testing
Clarify regulatory responsibility and roles

What can local government do?
Local government tool kit

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