

Door County Well Monitoring Program - Fall 2019 Summary

UW Oshkosh
Environmental Research and Innovation Center

December 9th and 10th, 2019

Program Goals

- Provide continued education on water resources in Door County, WI
- Provide avenue for residents and guests to have the most accurate information on their drinking water quality
- Provide reliable information to guide county resources for the protection and maintenance of drinking water resources
- Be proactive with respect to drinking water resources, rather than reactive
- Create a groundwater water quality database for Door County
- Establish trends in groundwater data over time



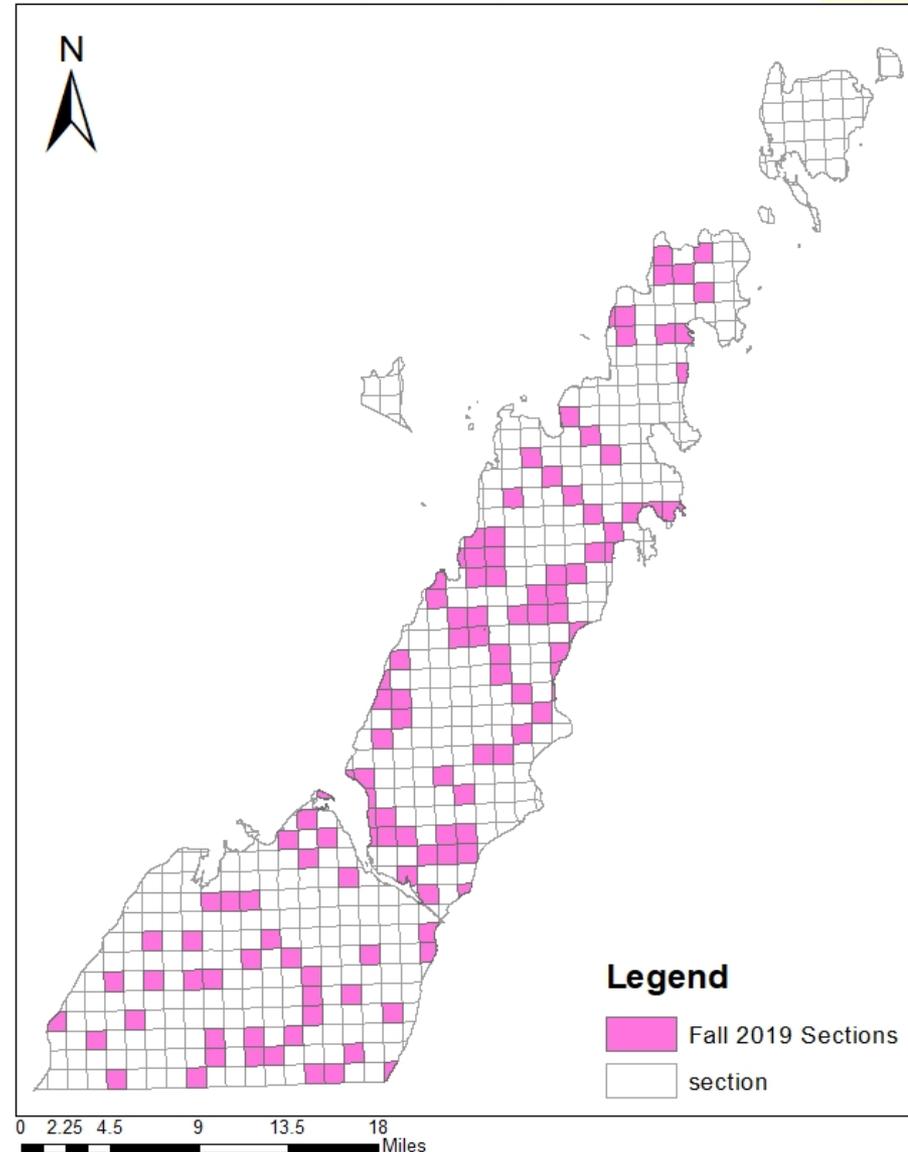
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Department of Engineering
Technology

Door County Well Study: Fall 2019



- Target is at least one well per section (square mile) of Door County
- Spatially distributed data to look for trends and relationships
 - Soil type
 - Depth to bedrock
 - Water table depth
 - Land use



What do my results mean?

Bacteria

- Tested for Coliform and *E. coli*
- Negative or 0: no bacteria present in the sample, safe to drink
- Positive or any #: bacteria present in the sample, unsafe to drink

Nitrate

- ND: nitrate was not detected in the sample
- Between 0-10 mg/L: nitrate was detected in the “safe” range
- Over 10 mg/L: nitrate was detected over the “safe” range

What do my results mean?

Arsenic

- ND: arsenic was not detected in the sample
- Between 0-10 $\mu\text{g}/\text{L}$: arsenic was detected in the “safe” range
- Over 10 $\mu\text{g}/\text{L}$: arsenic was detected over the “safe” range

What do my results mean?

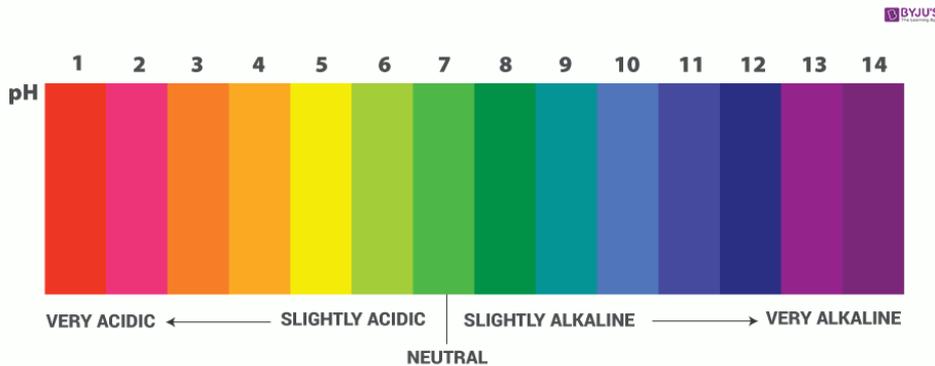
Cumulative

- pH: measure of the acid-base balance. Carbon dioxide concentration and an increase in temperature can decrease the pH of water.
- Iron: a metal element that makes up about 5% of the earth's crust. It is not considered hazardous to health.
- Hardness: water's ability to react with soap and produce a lather. Caused by ions such as calcium and magnesium. It is not considered hazardous to health.
- Alkalinity: water's ability to neutralize acids. Can be affected by natural deposits in the earth and industrial practices. It is not considered to be hazardous to health.

What do my results mean?

Cumulative

- pH



- Iron: Recommended level is less than 0.3 mg/L

- Hardness

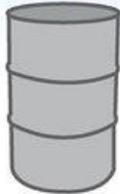
Water Hardness Scale		
Grains/Gal	mg/L & ppm	Classification
Less than 1	Less than 17.1	Soft
1 – 3.5	17.1 - 60	Slightly Hard
3.5 - 7	60 - 120	Moderately Hard
7 - 10	120 - 180	Hard
Over 10	Over 180	Very Hard

- Alkalinity: Recommended level is between 75-200mg/L

How much is one part per ...

million (ppm)

milligrams/liter (mg/L)



= three drops added to a
42-gallon barrel

billion (ppb)

micrograms/liter ($\mu\text{g/L}$)



length = 35 feet, diameter = 8 feet

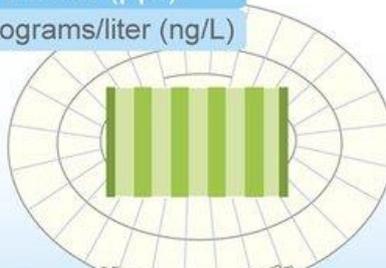
= one drop added to
a large tanker truck

quadrillion (ppq)

picograms/liter (pg/L)

trillion (ppt)

nanograms/liter (ng/L)



= ten drops added to the Rose Bowl
(filled with water)

= two teaspoons added to the
Great Salt Lake of Utah



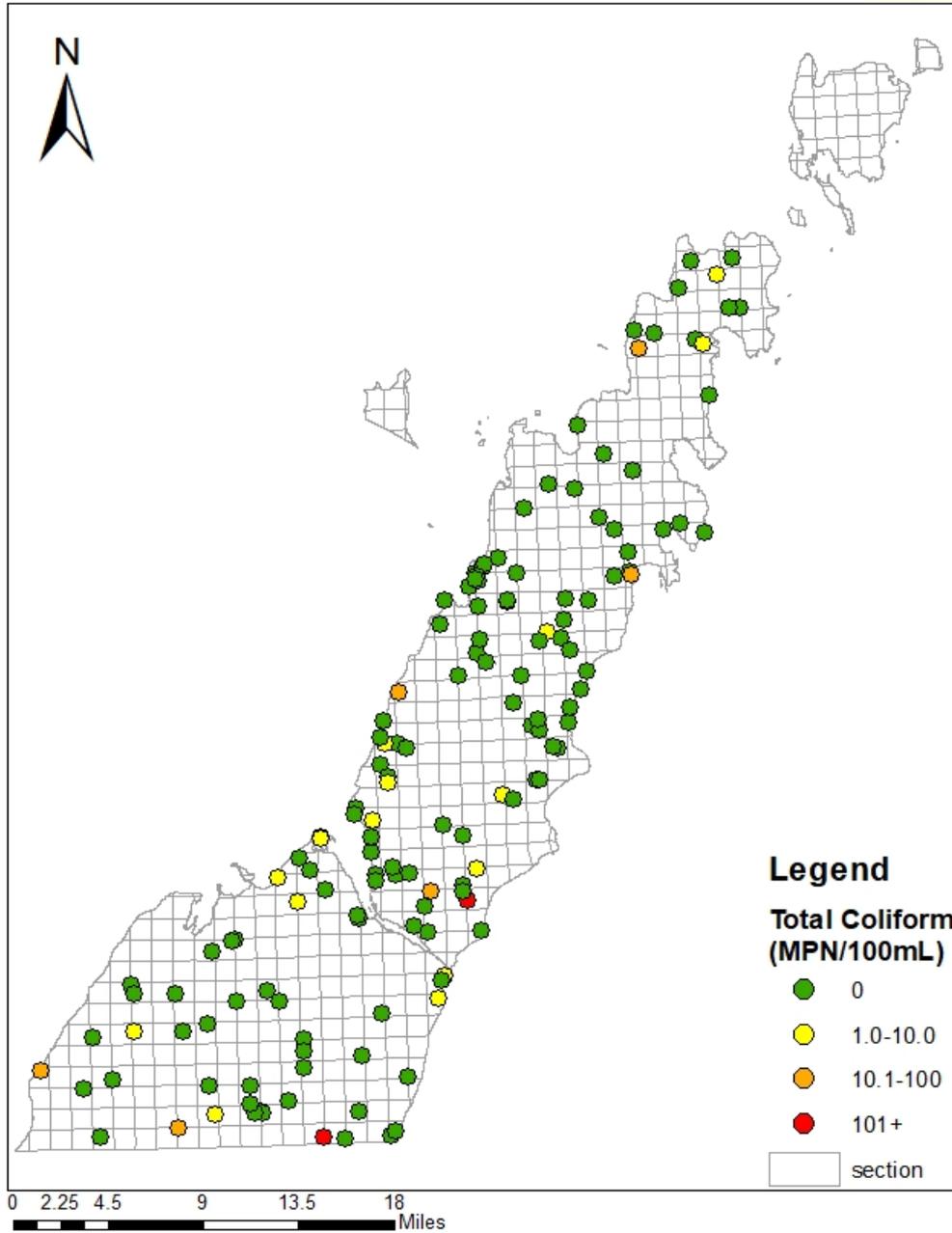
2019 Results

Fall 2019 Sampling Results

Coliform

Coliform Result (MPN/100 mL)	# Samples	% Samples
0	125	84
1-10	15	10
10-100	6	4
100+	2	1
n=148		

Door County Total Coliform Results: Fall 2019

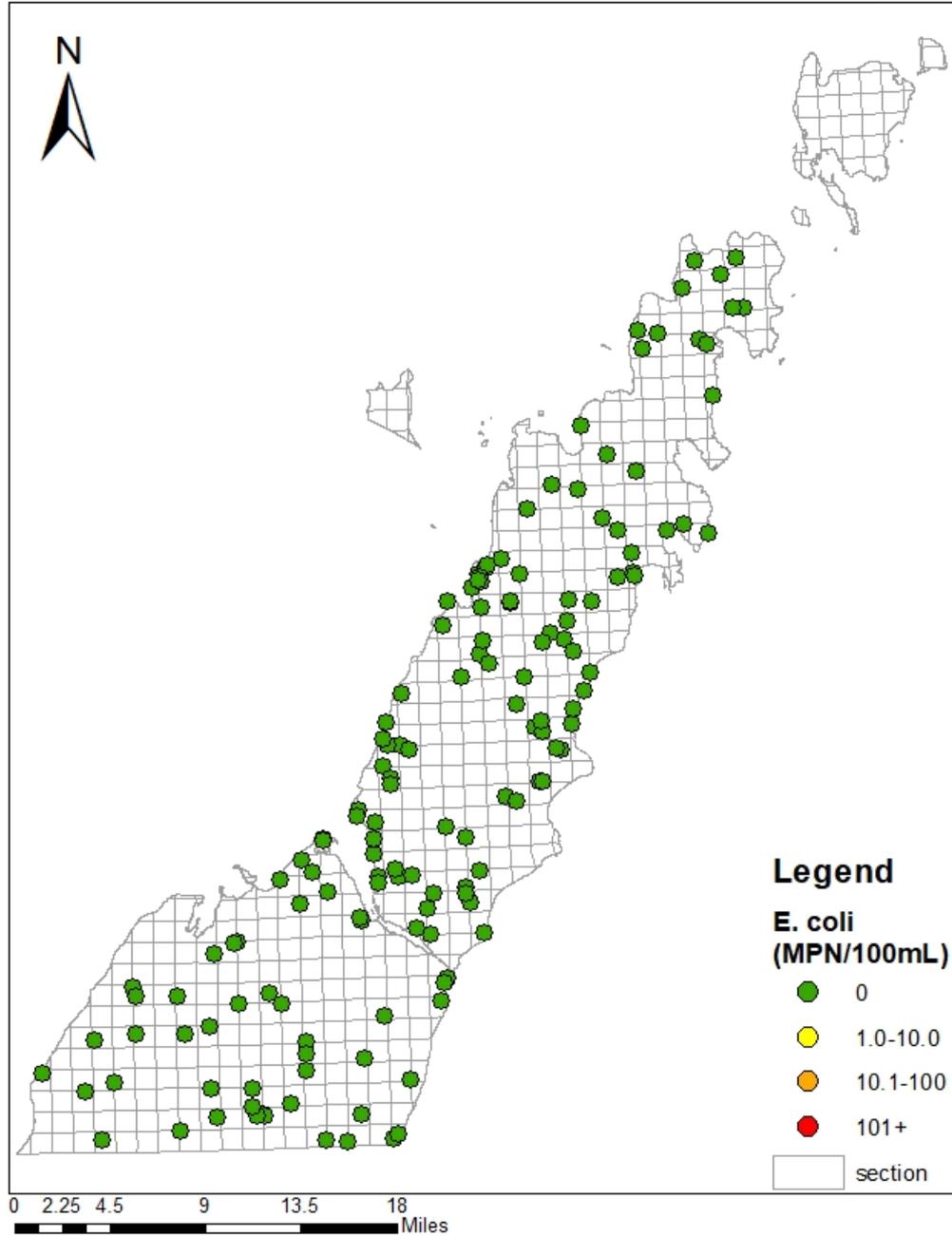


Fall 2019 Sampling Results

E coli

<i>E coli</i> Result (MPN/100 mL)	# Samples	% Samples
0	148	100
1-10	0	0
10-100	0	0
100+	0	0
n=148		

Door County E. coli Results: Fall 2019

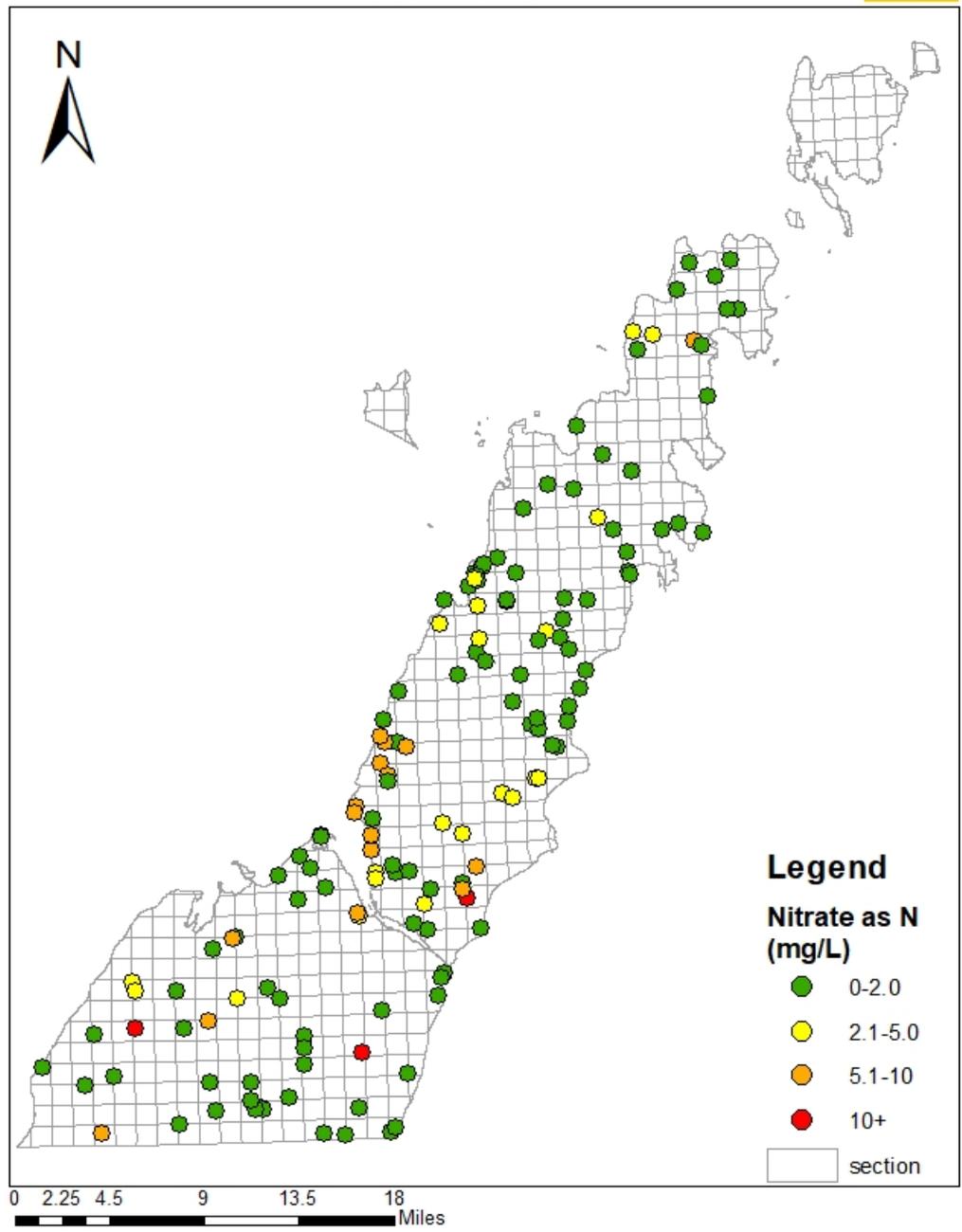


Fall 2019 Sampling Results

Nitrate

Nitrate Result (mg/L)	# Samples	% Samples
Less than 2	104	71
2-5	23	16
5-10	16	11
10+	3	2
n=146		

Door County Nitrate Results: Fall 2019

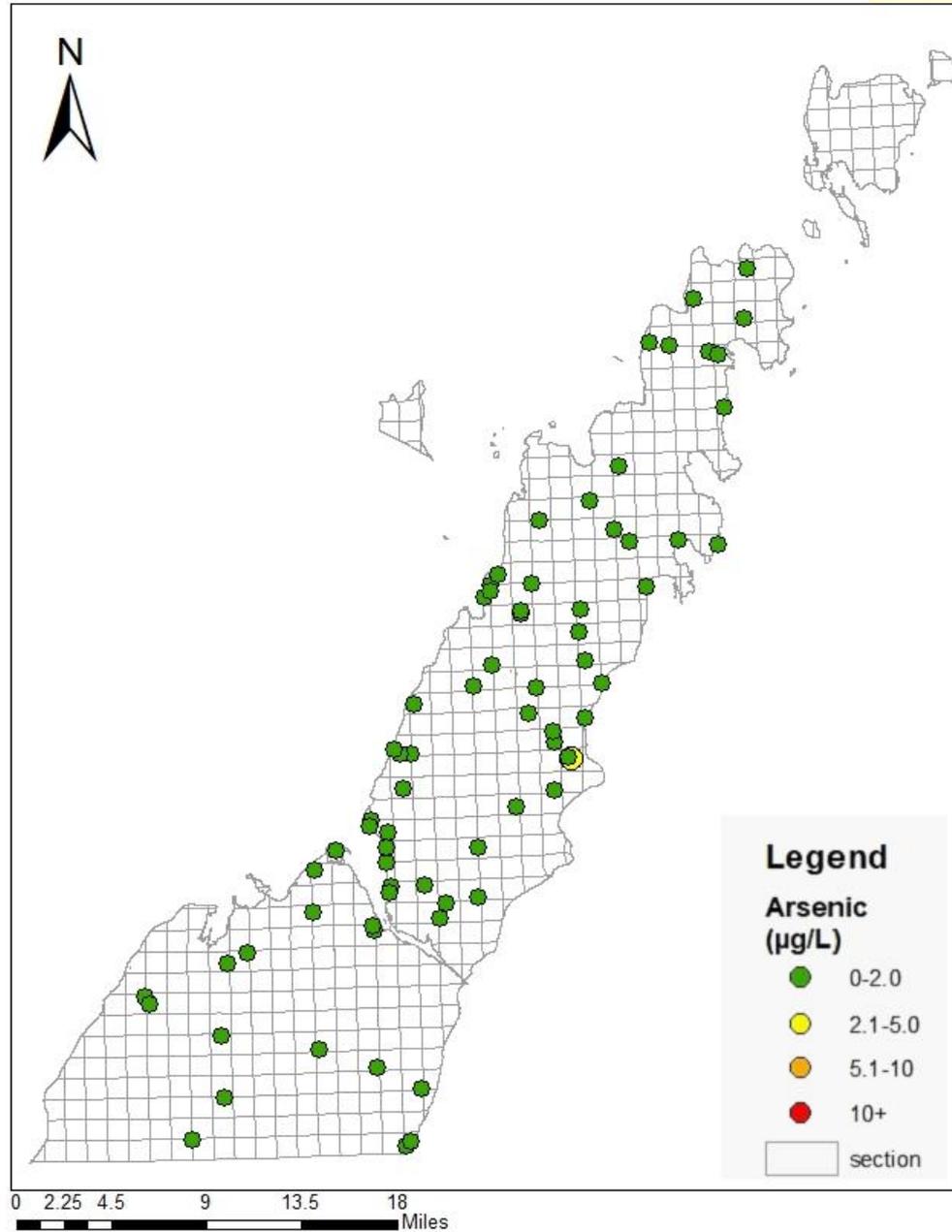


Fall 2019 Sampling Results

Arsenic

Arsenic Result ($\mu\text{g/L}$)	# Samples	% Samples
Less than 2	70	99
2-5	1	1
5-10	0	0
10+	0	0
n=71		

Door County Arsenic Results: Fall 2019



Previous County-Wide Efforts

Water Quality Standard	2019 Door County Results	Previous Door County Results*	Wisconsin**
Total Coliform (> 0 MPN/100 ml)	16%	12-23%	17%
<i>E. coli</i> (> 0 MPN/100 ml)	0%	2-10%	5%
Nitrate (> 10 mg/L)	2%	1-3%	10%
Arsenic (> 10 µg/L)	0%	3%	4%

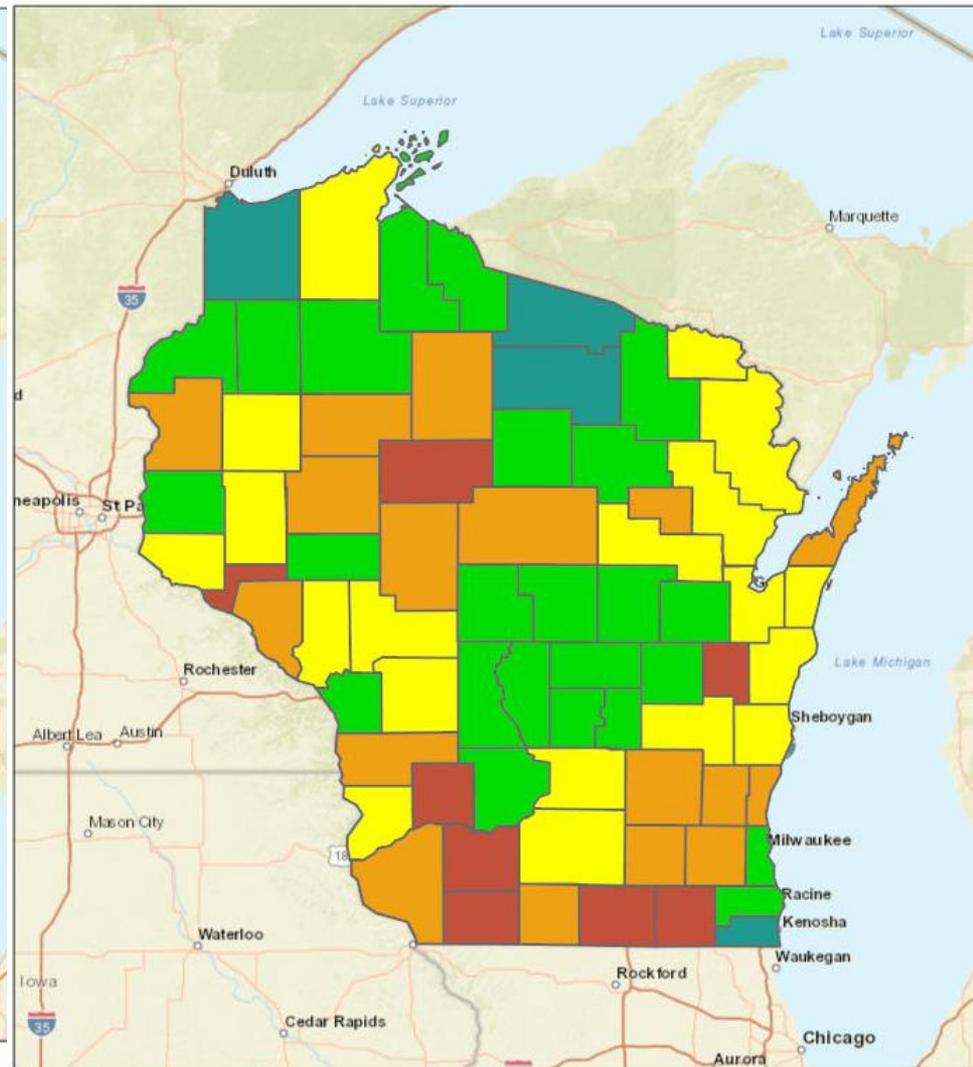
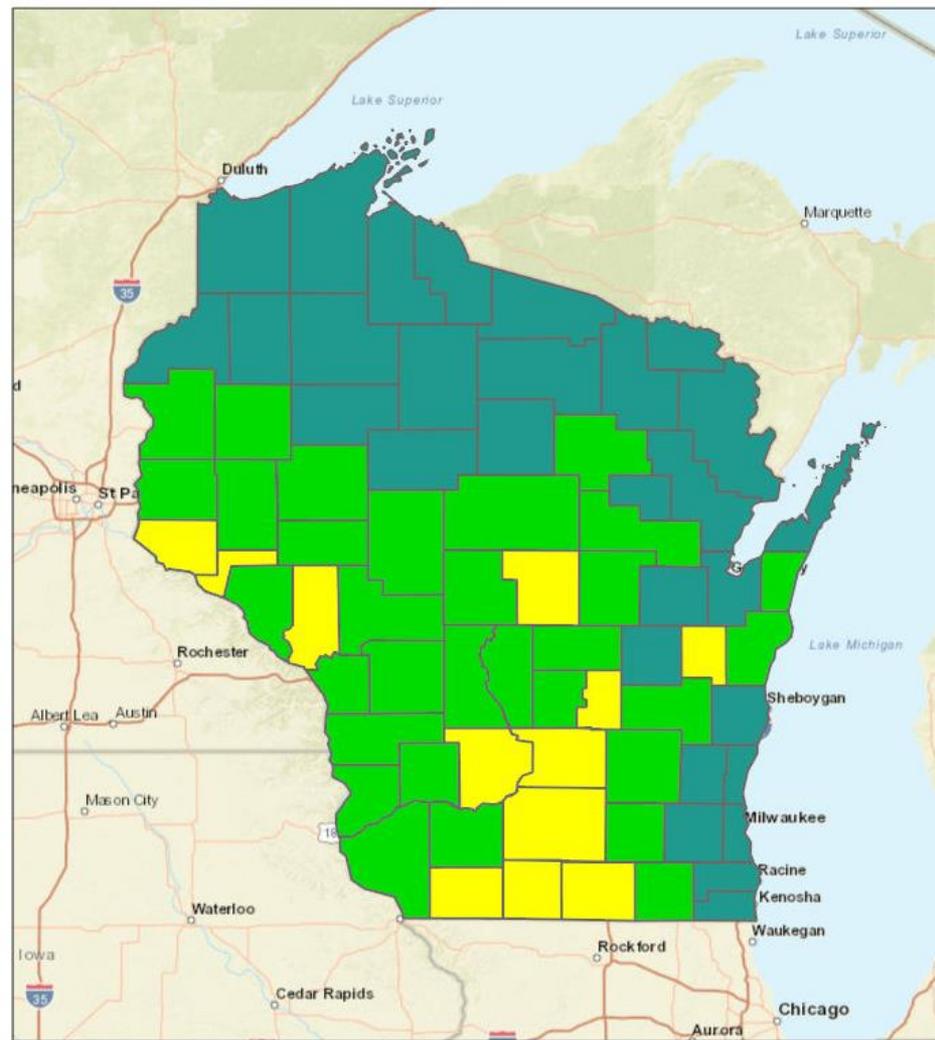
*Data derived from UWSP Well Viewer, UWO 2015 (480 samples) & 2016 (392 samples) community program, 2011-2015 UWEx Private Well Program (582 samples)

**Data derived from the Wisconsin Groundwater Coordinating Council Report & UWSP Well Viewer

Statewide Private Well Data

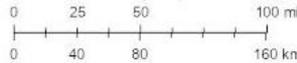
Average Nitrate

% Positive Bacteria



November 26, 2019

1:4,622,324



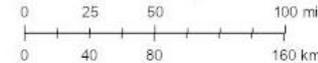
Nitrate - mg/l N - Average by County

- ... 2.0 mg/l as N
- 2.1 - 5.0
- 5.1 - 10.0

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P,
 Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (I
 NGCC), (c) OpenStreetMap contributors, and the GIS User Commu

November 26, 2019

1:4,622,324



Bacteria - Percent - Positive by County

- 5.1% - 10%
- 10.1% - 15%
- 15.1% - 20%
- 20.1% - 25%
- 25.1% ...

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, ...



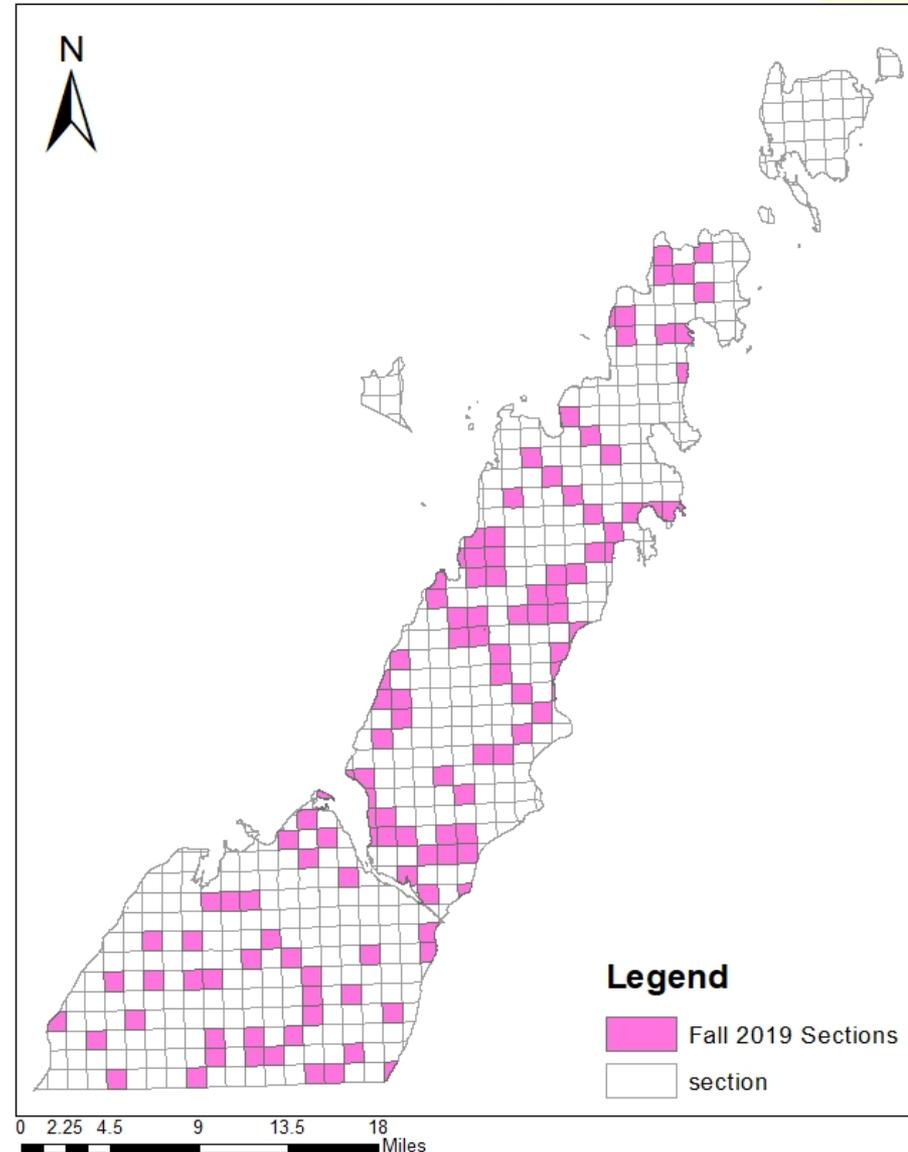
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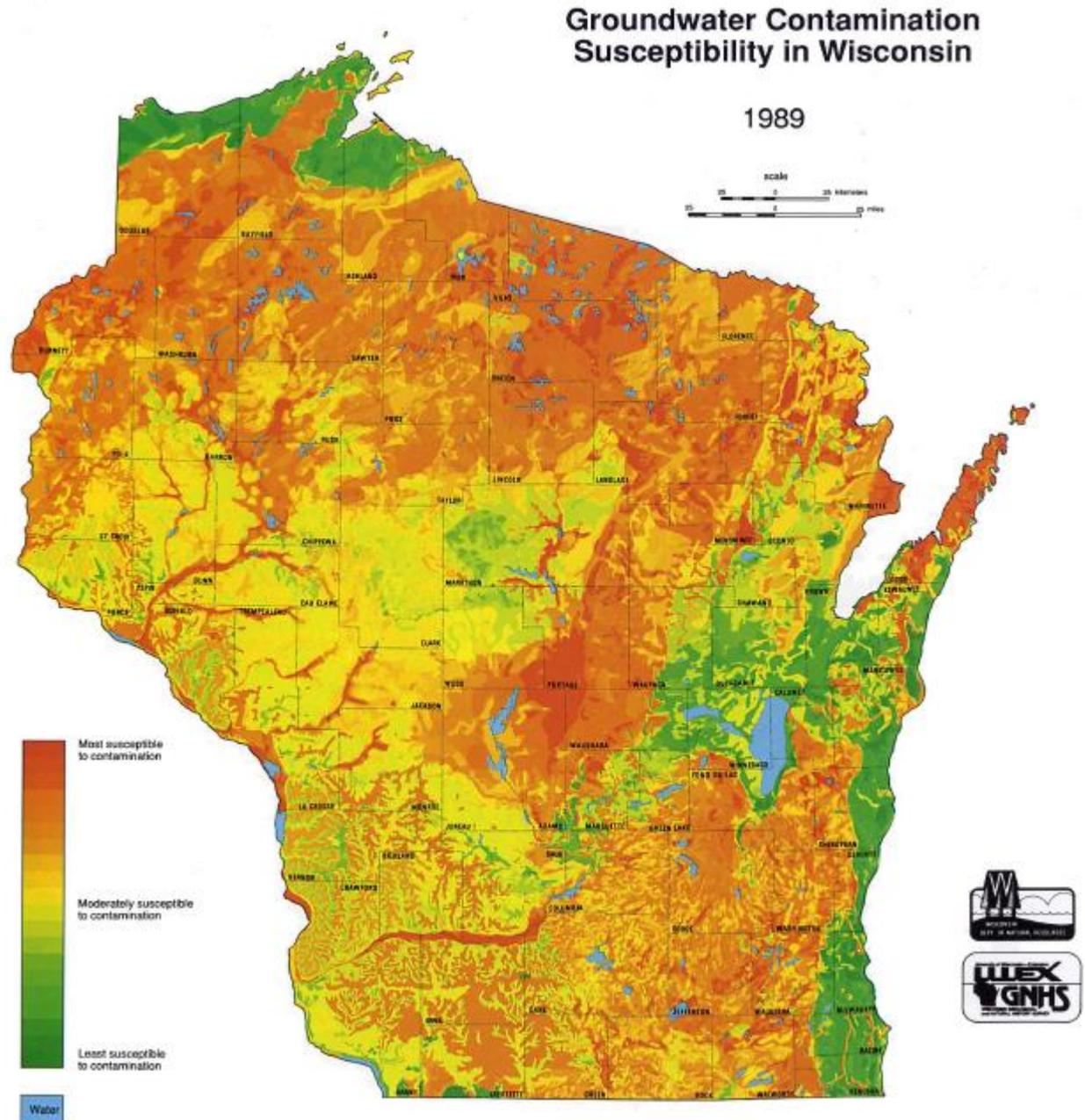
Karst Geology & Groundwater Quality



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- Based on factors such as: bedrock depth, soil type, depth to water table, etc.



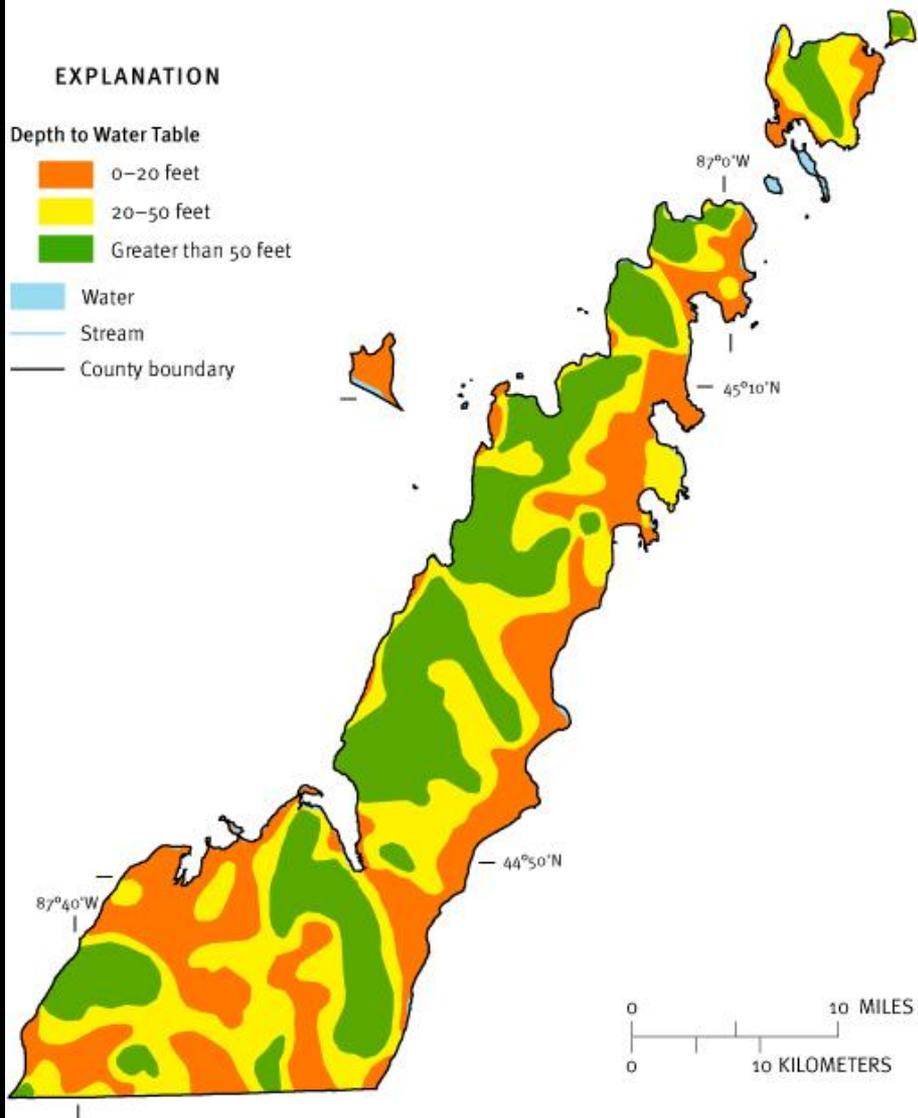
Door County – Depth to Water Table

EXPLANATION

Depth to Water Table

- 0–20 feet
- 20–50 feet
- Greater than 50 feet

- Water
- Stream
- County boundary



This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, <http://wi.water.usgs.gov/gwcomp/>

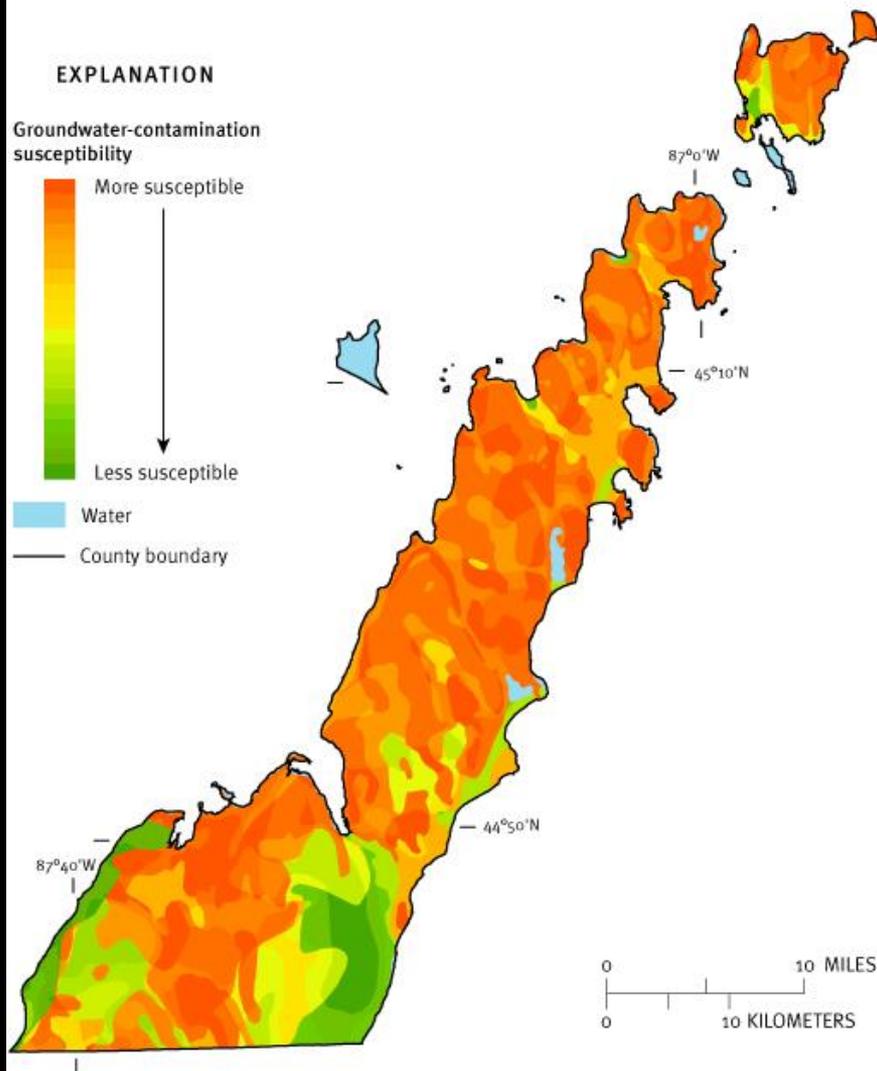
Door County – Groundwater-Contamination Susceptibility Analysis

EXPLANATION

Groundwater-contamination susceptibility

- More susceptible
- Less susceptible

- Water
- County boundary

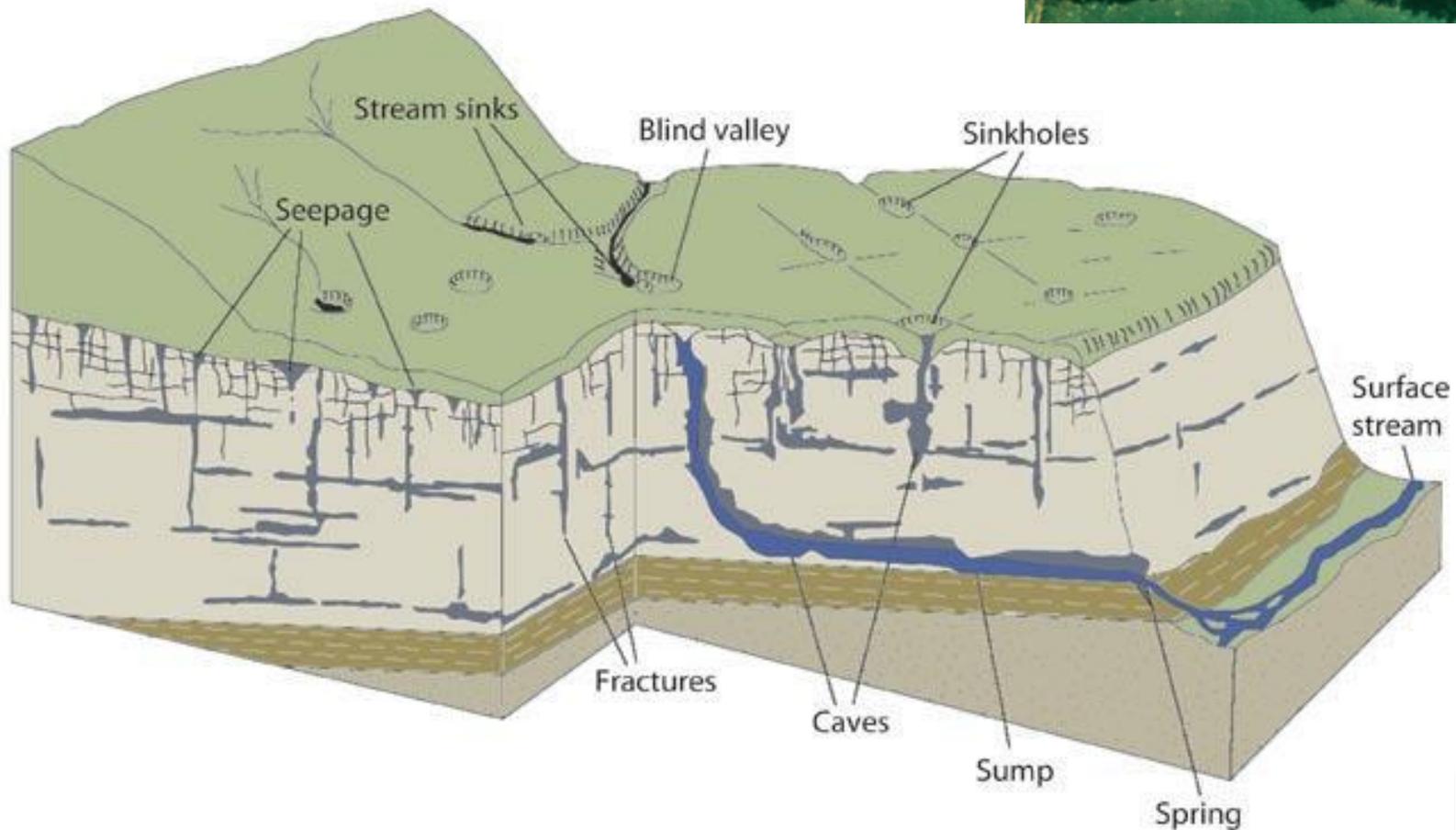


This groundwater-contamination susceptibility map is a composite of five resource characteristic maps, each of which was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2007, <http://wi.water.usgs.gov/gwcomp/>

Karst Geology and Impact on Well Water



U.S. Karst Map

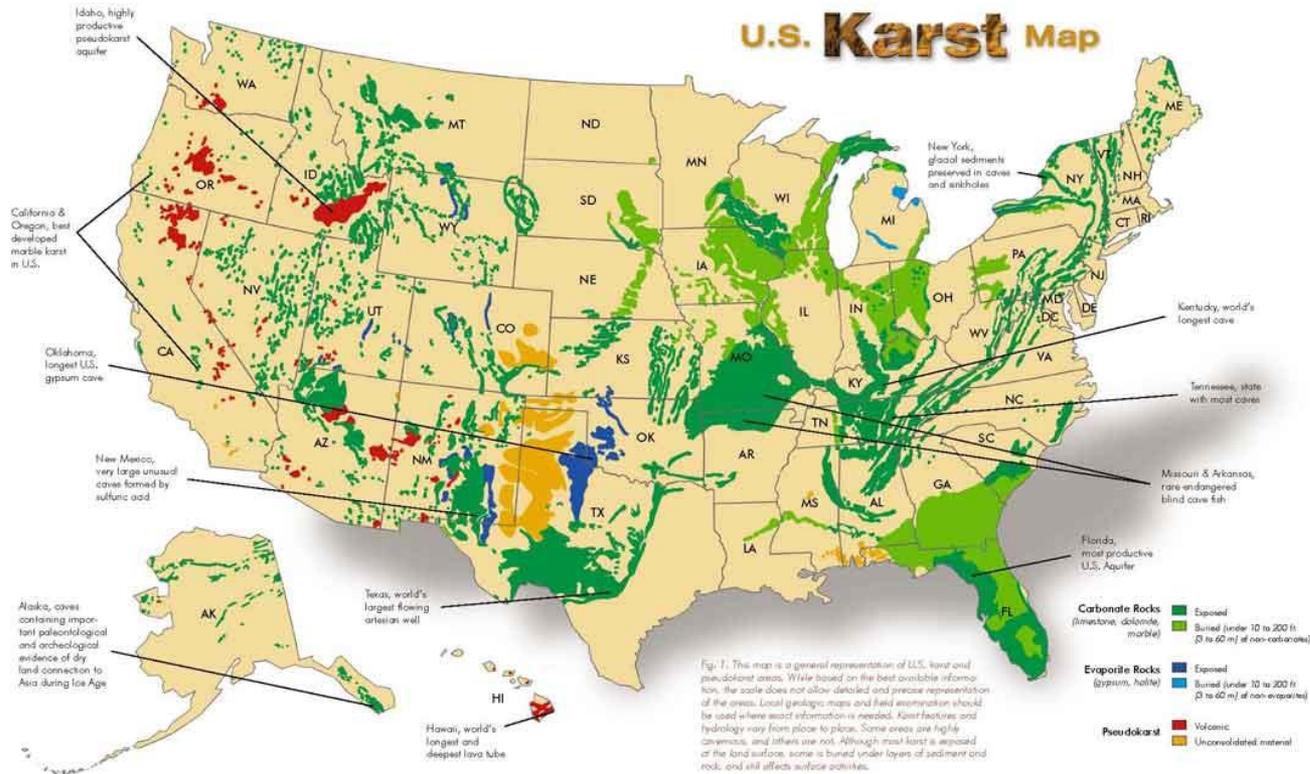
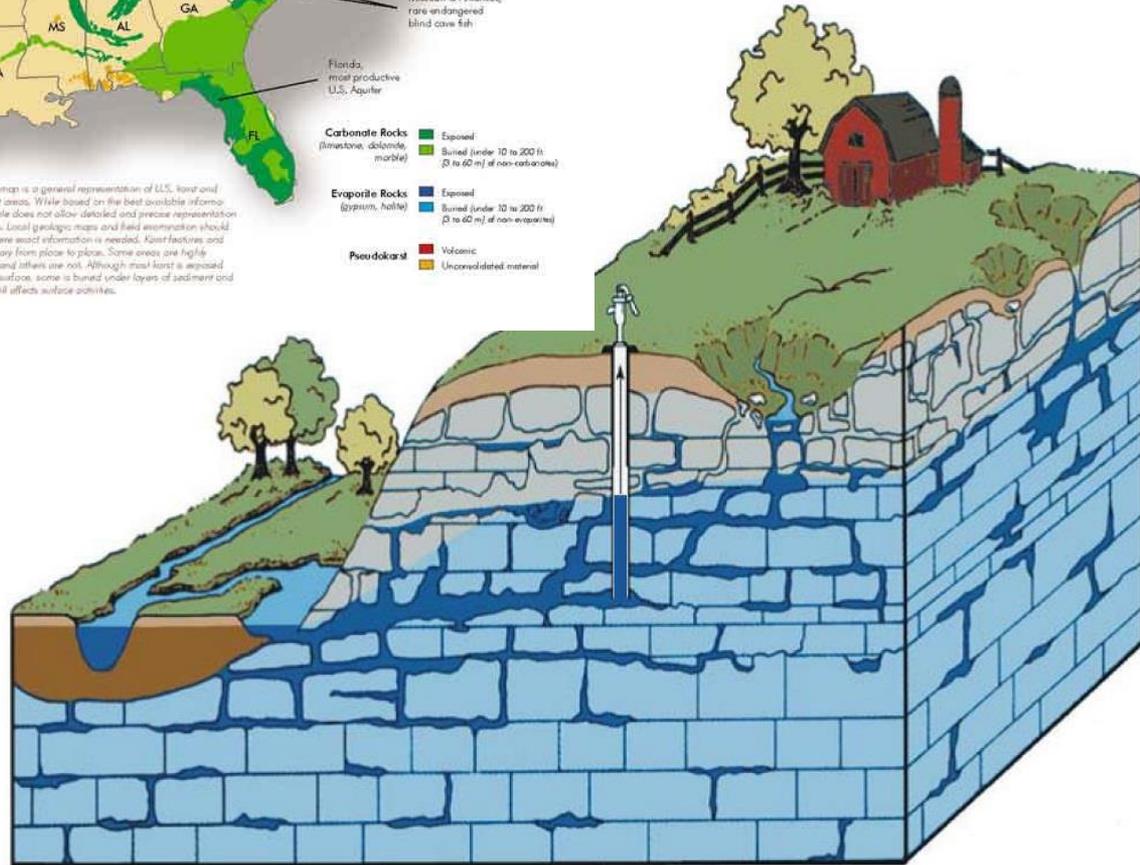


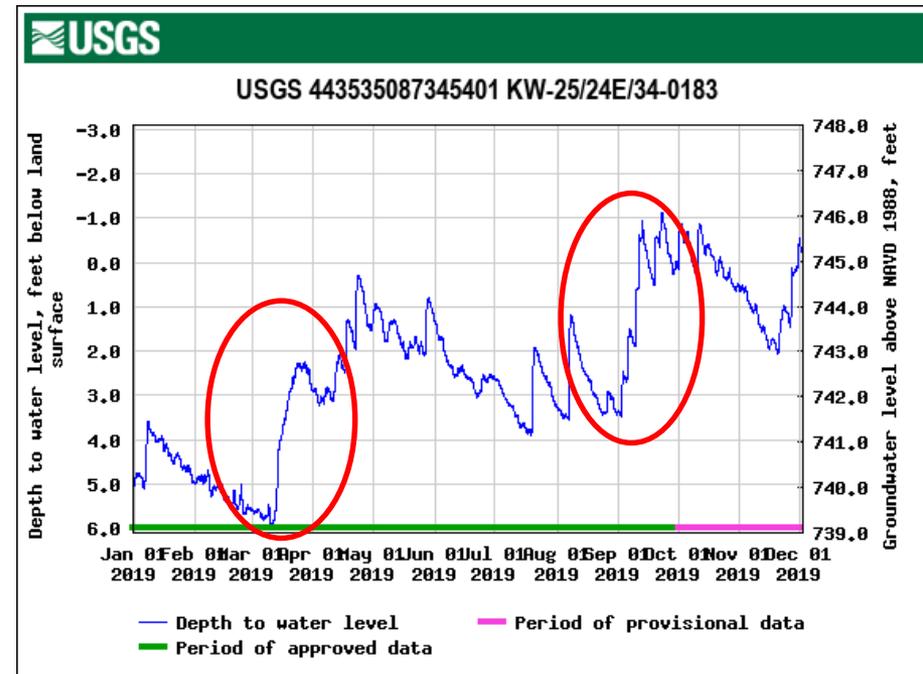
Fig. 1. This map is a general representation of U.S. karst and pseudokarst areas. While based on the best available information, the scale does not allow detailed and precise representation of the areas. Local geologic maps and field observation should be used where most information is needed. Karst features and hydrology vary from place to place. Some areas are highly cavernous, and others are not. Although most karst is exposed at the land surface, some is buried under layers of sediment and rock, and still affects surface activities.





Groundwater Recharge

- Samples are collected in a narrow window of time (~30 hours) - **Why?**
 - Weather conditions
 - Groundwater conditions – dry period or recharge?
 - Greater effect with karst geology



Bacteria

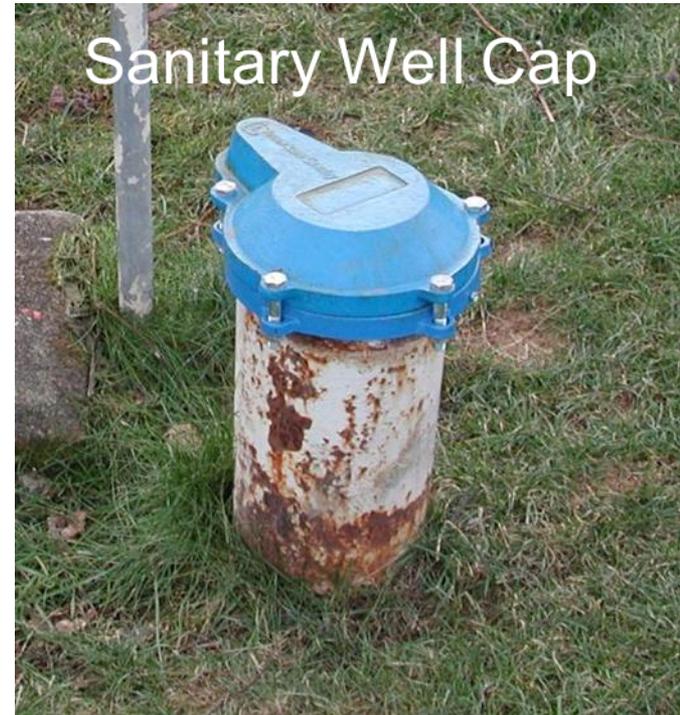
- Feces contains millions of microorganisms/gram
- Pathogens (disease-causers) usually found in low numbers
- Pathogens are usually more difficult to identify in the lab than indicator organisms
- Pathogens can be bacteria (*E.coli*), viruses (Norovirus), or protozoans (*Cryptosporidium*)
- We look for fecal indicator organisms that “indicate” that a recent contamination has occurred (and that pathogens also are likely present)

Positive Bacteria Result

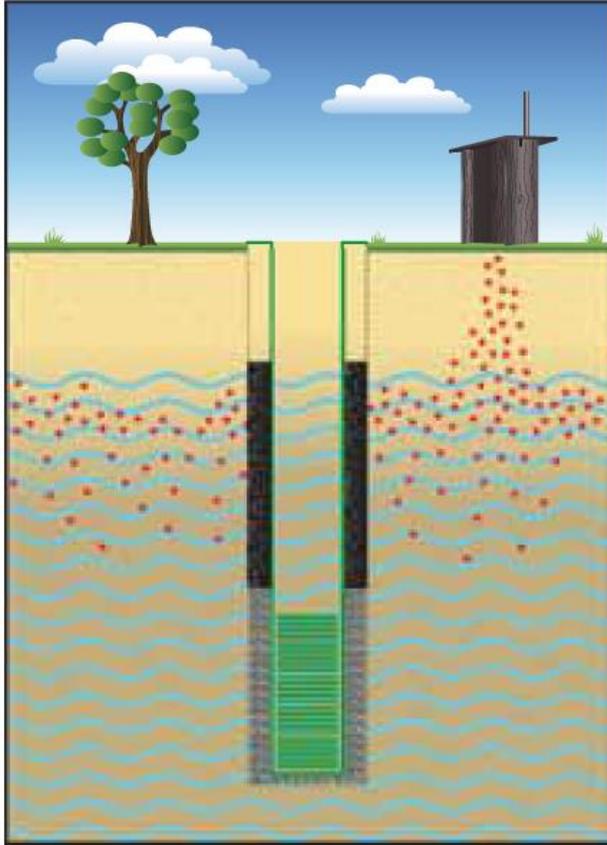
- Sources
 - Improperly constructed well
 - Older or damaged well
 - Distribution system issue (cracked pipe, dead end, etc)
 - Outside source of bacteria (agriculture, animal waste, human waste)



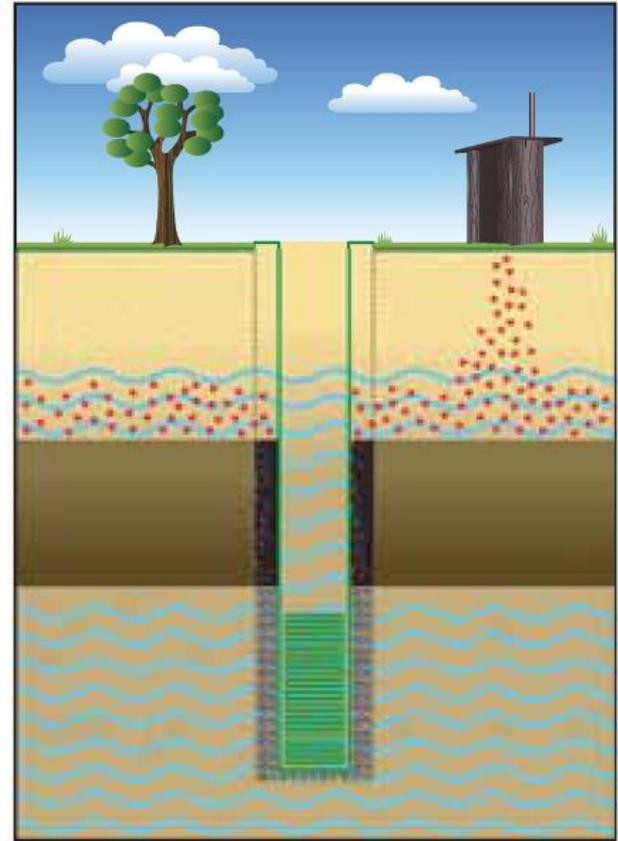
Positive Bacteria Result



Properly Constructed Wells

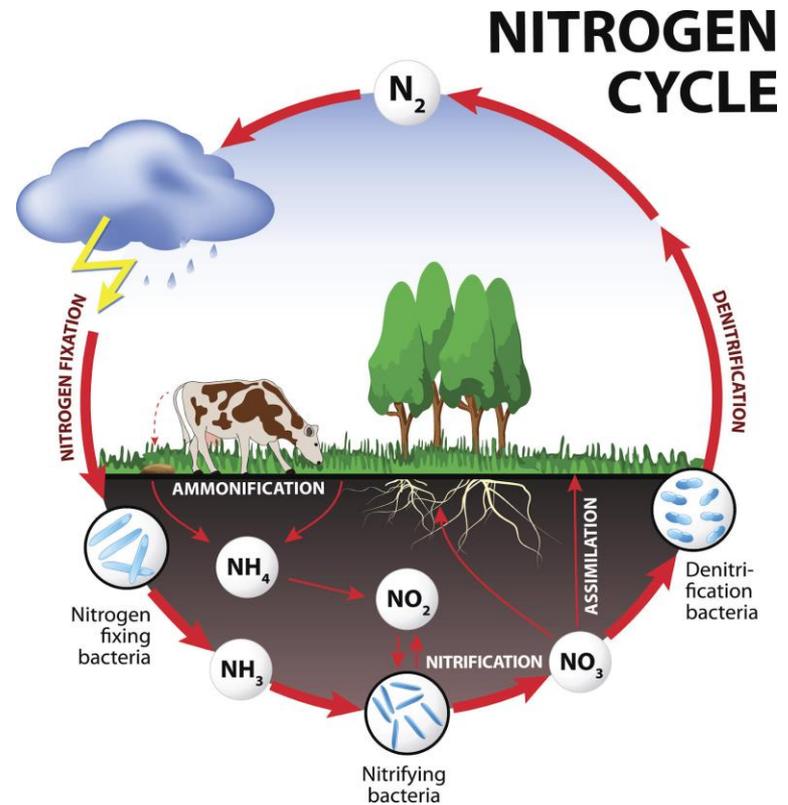


Single Aquifer Sanitary Seal

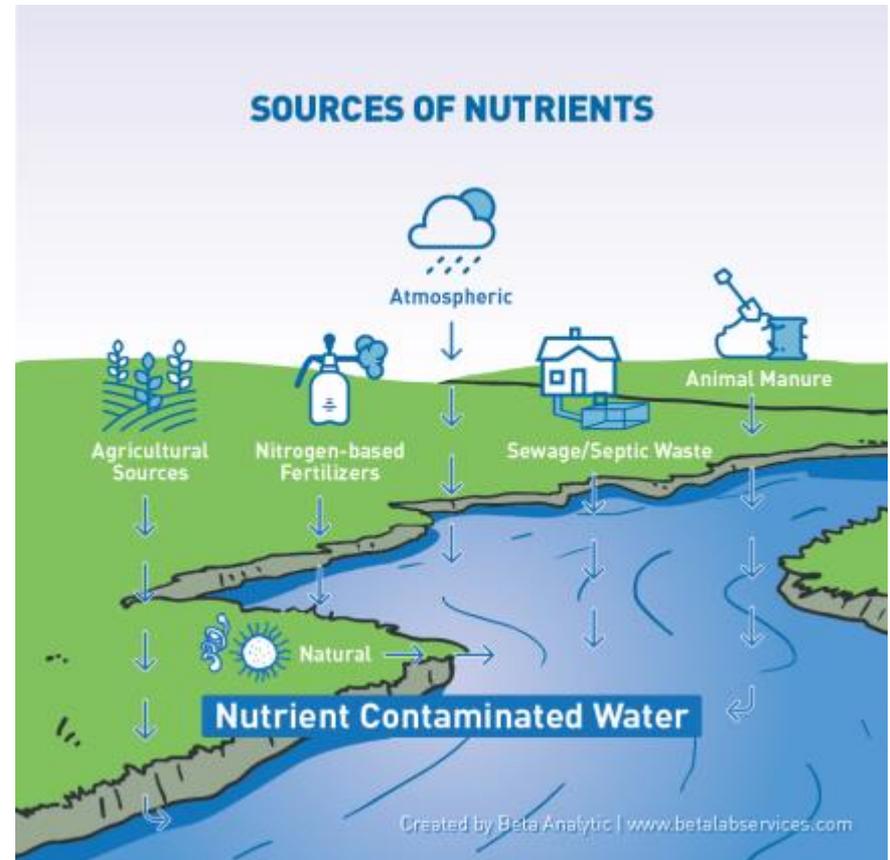


Multiple Aquifer Sanitary Seal

- Formed when nitrogen from ammonia or other sources combines with oxygen in water
- Soluble in water – runoff

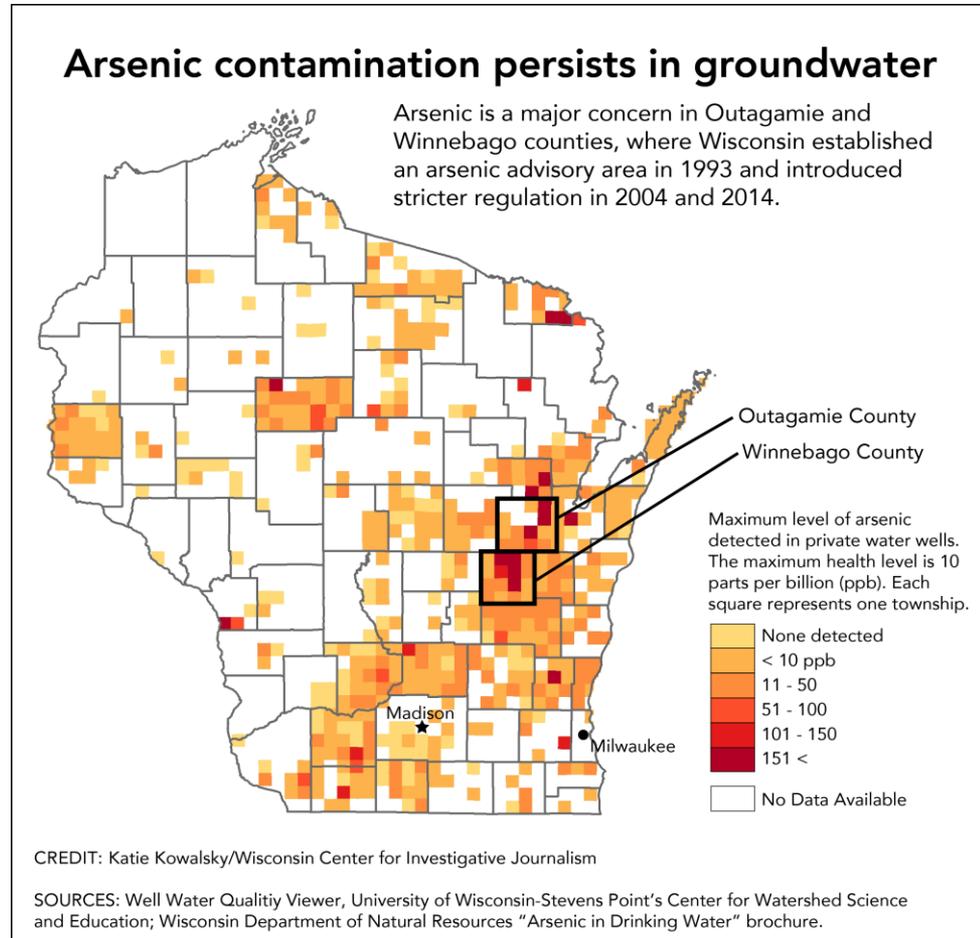


- Sources
 - Agriculture (manure and/or fertilizer)
 - Sewage/Septic
 - Animal waste
 - Atmospheric (trace amounts)
 - Lawn care (fertilizer)
 - Very low naturally occurring nitrate



Arsenic

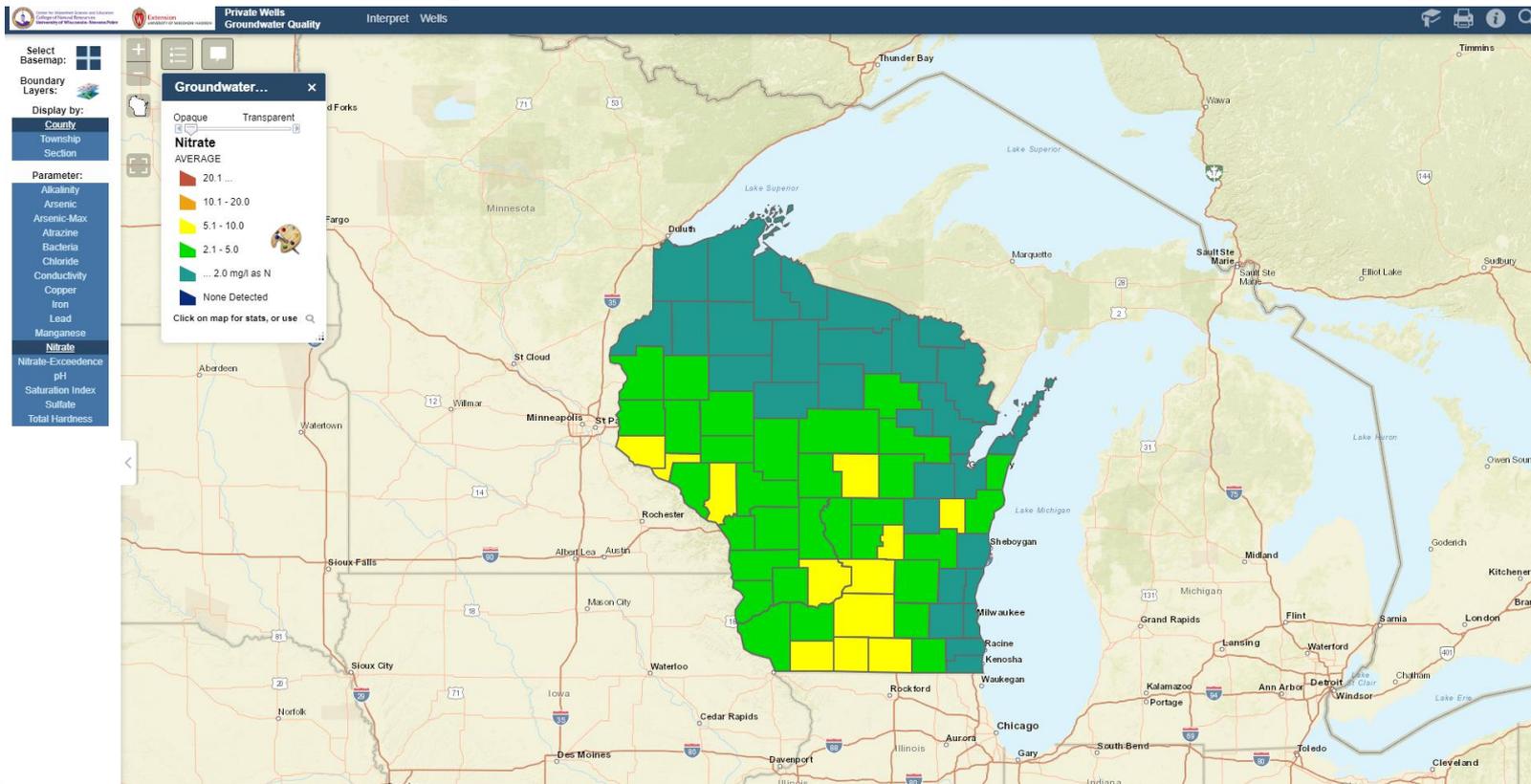
- Sources
 - Most naturally occurring in bedrock
 - Lead arsenate pesticides were used in orchards from 1890s-1960s (binds to soil, does not usually migrate into groundwater)



Where is the data going?

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Technology

- UWSP Well Water Data Viewer <https://www.uwsp.edu/cnr-ap/watershed/Pages/WellWaterViewer.aspx>



Further Research & Plans

- 2020 – targeted sampling in spring, summer, and fall
- Recruiting same volunteers for 2020 plus additional wells in other sections across county
- Continuation as a long-term study in future years will require additional funding

Take Home Messages

- Karst geology makes Door County groundwater highly vulnerable to contamination
- Sample your well annually for bacteria and nitrate, or more often if changes or problems observed
- Results from fall 2019 are consistent with previous sampling efforts in Door County and statewide
- Repeated sampling in 2020 will help identify seasonal changes in groundwater quality

Resources

- Door County Public Health
- Door County Soil and Water Dept
- WI DNR
- Presentation available online at uwosh.edu/eric

Thank you!
We can't do this
without you!