2016
Chippewa County Groundwater Quality Inventory

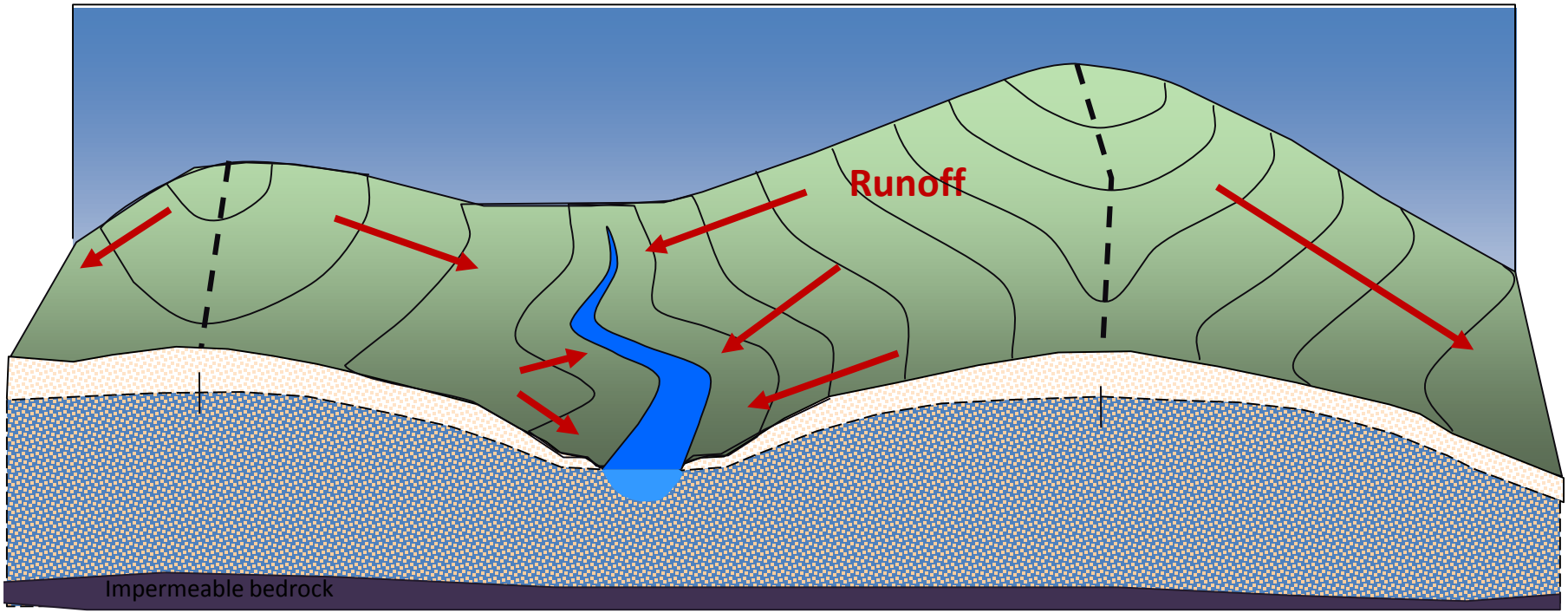
University of Wisconsin-Stevens Point
College of Natural Resources

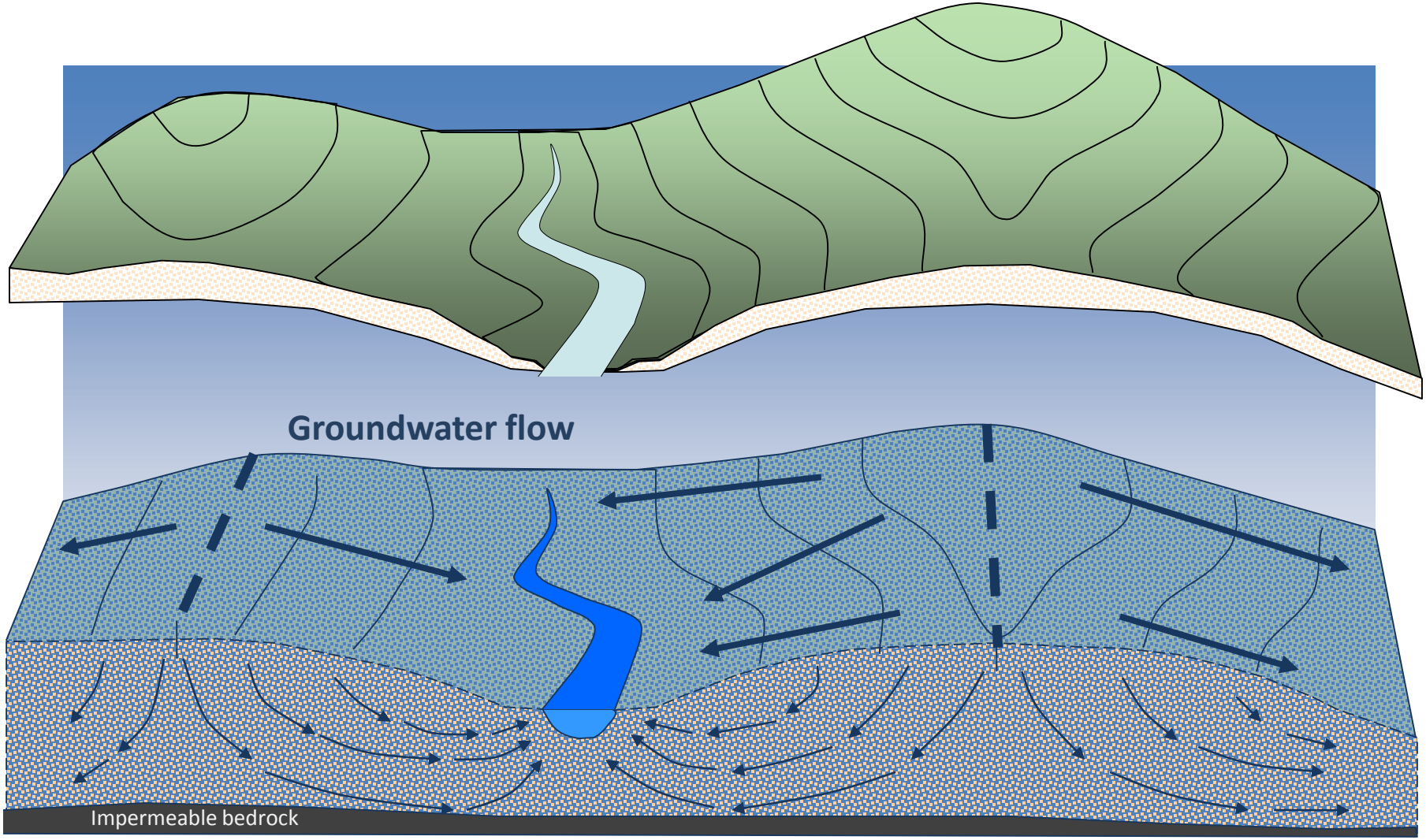
UW Extension
University of Wisconsin-Extension

Chippewa County
"Stewardship for Sustainability"
Land Conservation and Forest Management

CHIPPEWA COUNTY
Public Health
Prevent. Promote. Protect.

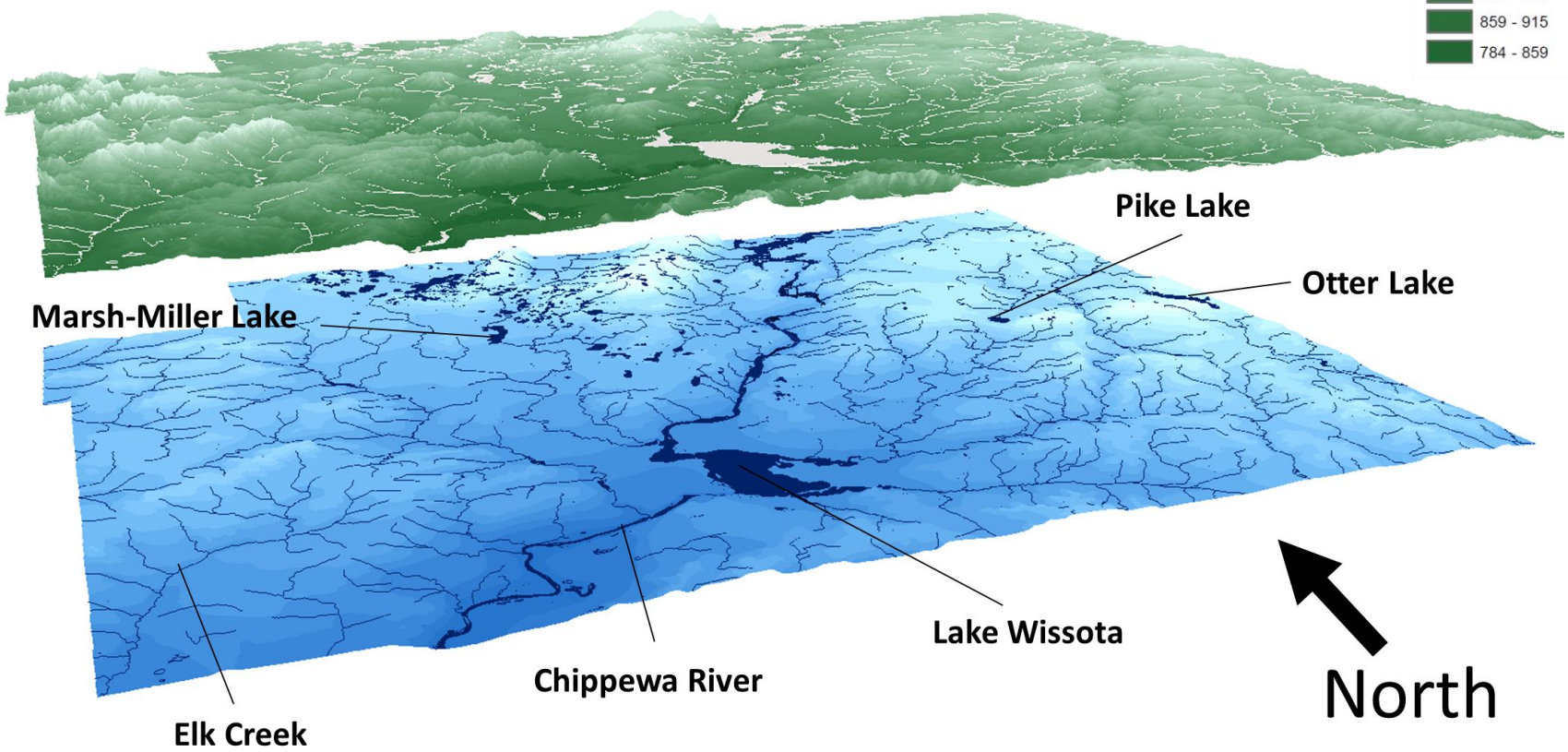
Through the University of Wisconsin-Extension, all Wisconsin people can access University resources and engage in lifelong learning, wherever they live and work.

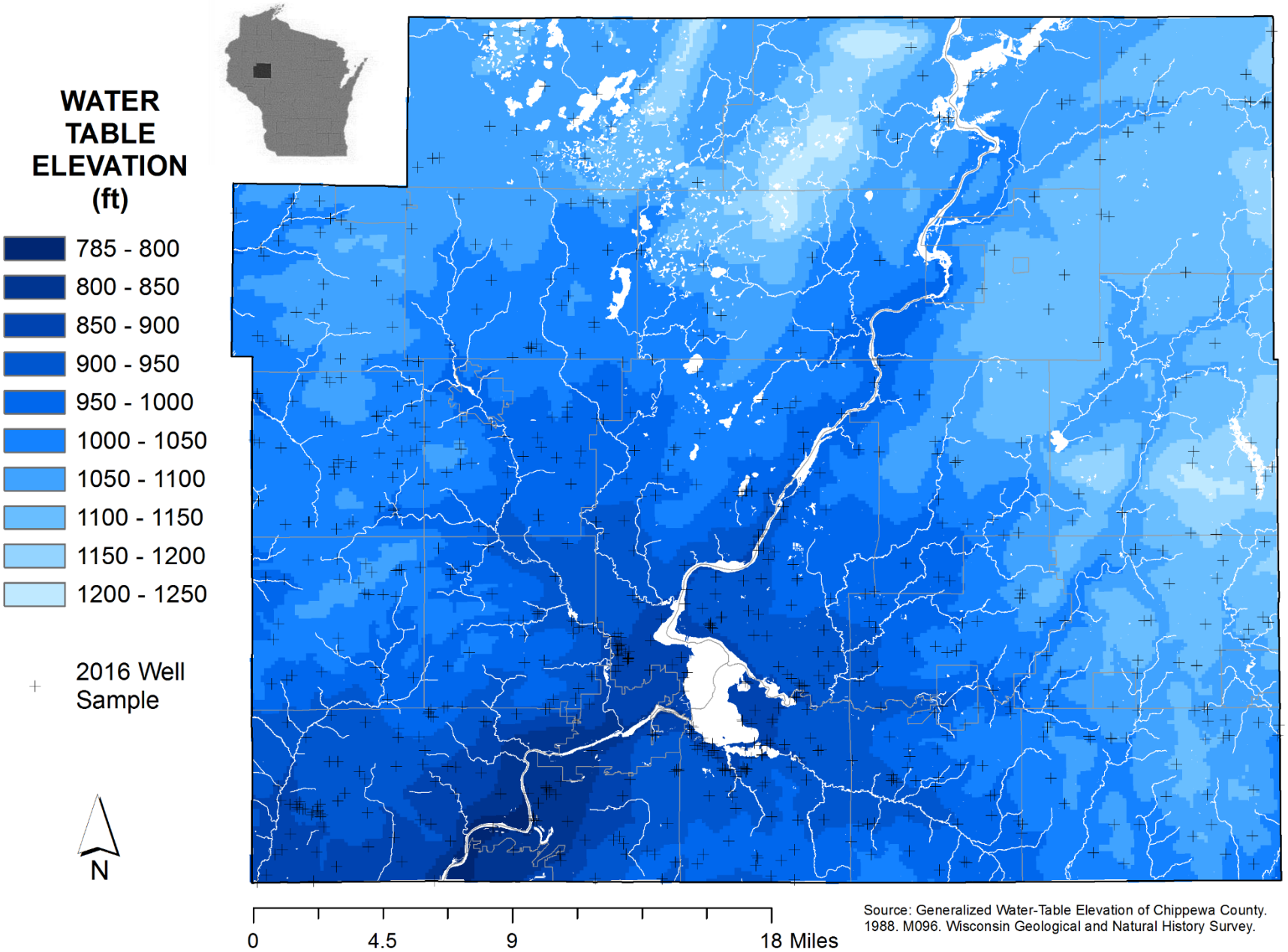

Runoff
Impermeable bedrock


Groundwater flow
Impermeable bedrock

Chippewa County Water Table

Land Surface Elevation (ft)	Water Table Elevation (ft)
1410 - 1532	1,197 - 1,252
1325 - 1410	1,169 - 1,196
1272 - 1325	1,149 - 1,168
1233 - 1272	1,125 - 1,148
1200 - 1233	1,099 - 1,124
1171 - 1200	1,074 - 1,098
1145 - 1171	1,050 - 1,073
1118 - 1145	1,024 - 1,049
1089 - 1118	994 - 1,023
1059 - 1089	965 - 993
1026 - 1059	937 - 964
990 - 1026	911 - 936
951 - 990	887 - 910
915 - 951	854 - 886
859 - 915	817 - 853
784 - 859	781 - 816





Source: Generalized Water-Table Elevation of Chippewa County. 1988. M096. Wisconsin Geological and Natural History Survey.

General Groundwater Flow Direction

0 0.125 0.25 0.5 Miles

N W E S

Legend

Well Water Table

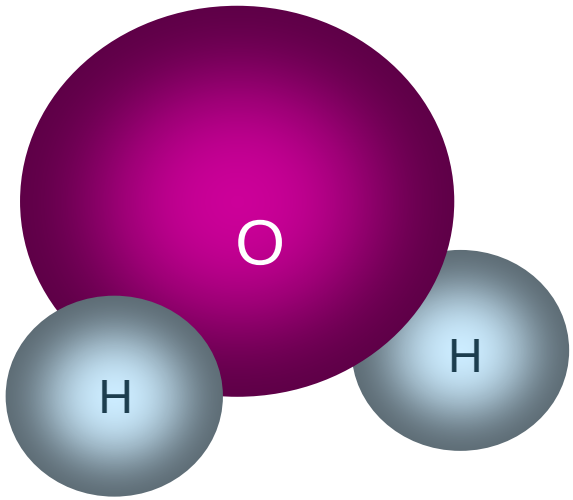
The black arrows show generalized groundwater flow direction in the area near your well. Groundwater flows perpendicular to the groundwater elevation lines and moves from high areas (hills) to low areas (streams,rivers). In general, residential wells impacted by land use are usually the result of those activities occuring within a roughly 1/2 mile distance from a well.

Disclaimer: This map is for educational purposes only. Groundwater flow is a best guess based on currently available information.

Cartography by Sean Piette

water basics

- "Universal Solvent"
- Naturally has "stuff" dissolved in it.
  - Impurities depend on rocks, minerals, land-use, plumbing, packaging, and other materials that water comes in contact with.



What did we test for?

Health Related

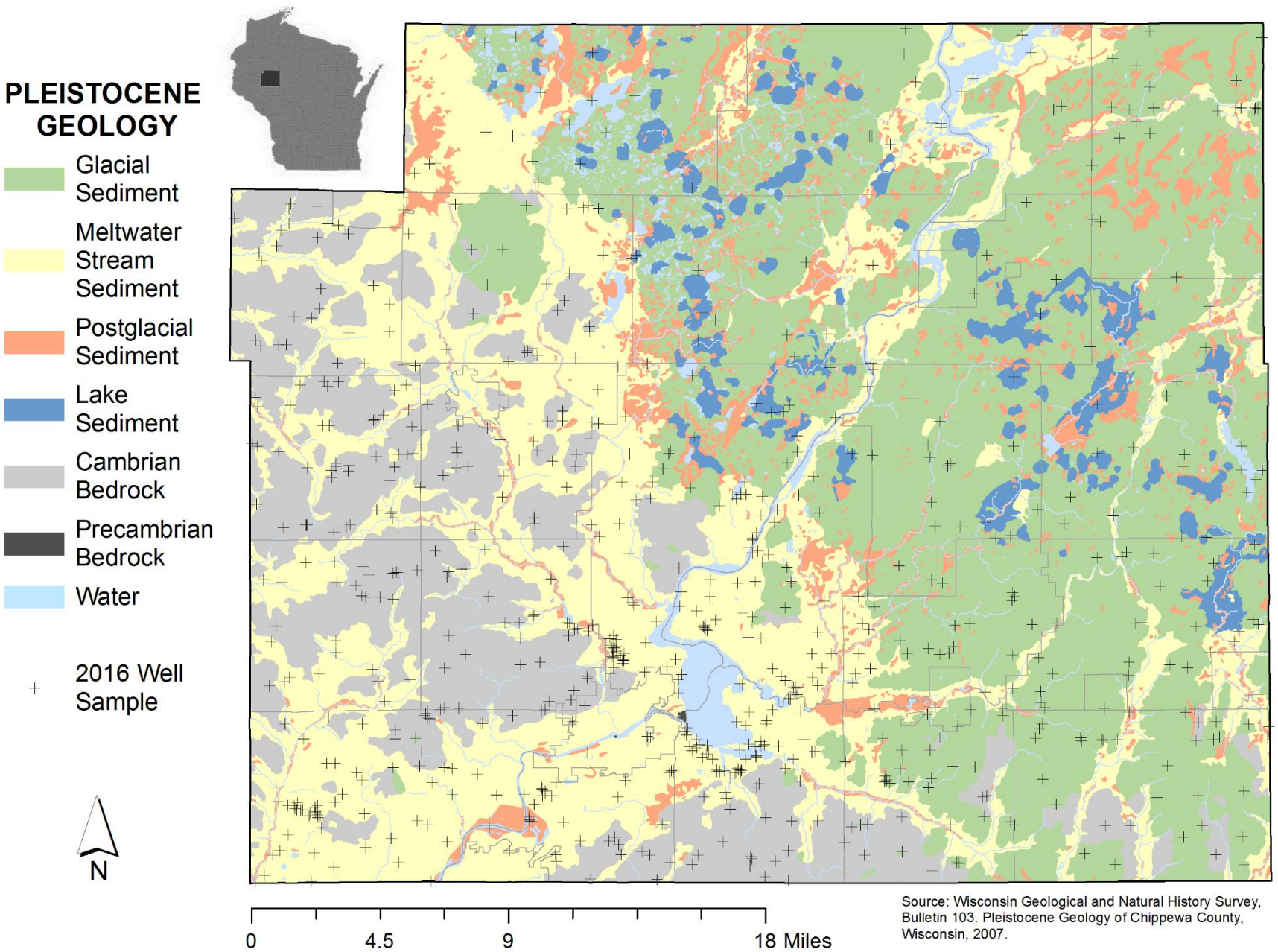
- Nitrate
- Arsenic
- Copper
- Lead
- Manganese
- Sulfate
- Sodium
- Zinc

Aesthetic (taste, color, odor)

- Hardness
- Iron
- Manganese
- Chloride

Overall Water Quality

- pH
- Conductivity
- Alkalinity
- Calcium
- Magnesium
- Phosphorus

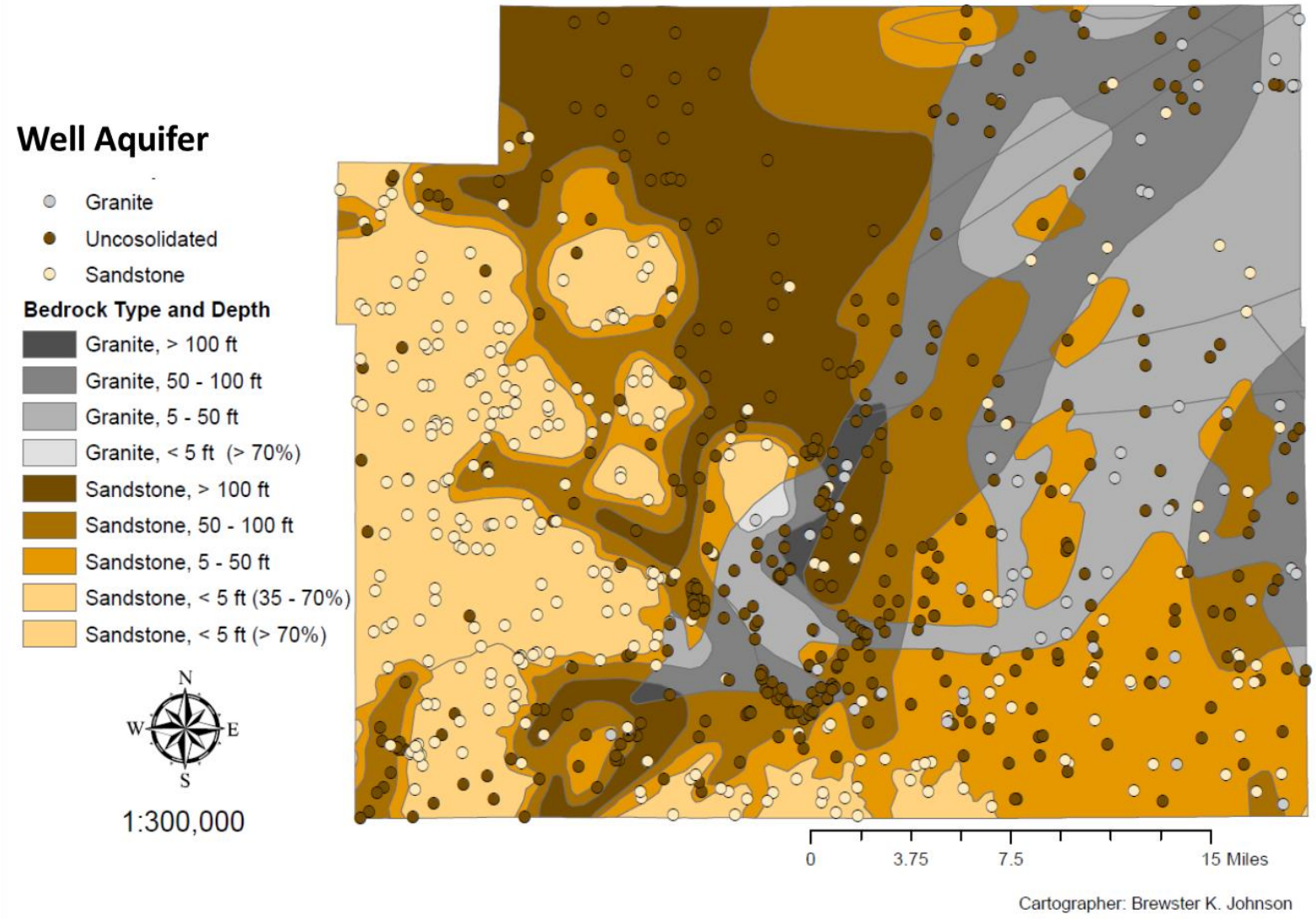


Source: Wisconsin Geological and Natural History Survey, Bulletin 103. Pleistocene Geology of Chippewa County, Wisconsin, 2007.

2016 water quality by Pleistocene geology category

Analyte	Cambrian (n=170)					Glacial Sediment (n=207)					Meltwater Stream Sediment (n=360)				
	Mean	StDev	Median	Min	Max	Mean	StDev	Median	Min	Max	Mean	StDev	Median	Min	Max
Alkalinity (mg/L as $CaCO_3$)	**28**	34	**16**	2	268	**121**	73	**137**	5	358	**48**	42	**32**	4	289
Arsenic (mg/L)	**<0.003**	0.001	**<0.003**	<0.003	0.005	**<0.003**	0.001	**<0.003**	<0.003	0.008	**<0.003**	0.001	**<0.003**	<0.003	0.007
Calcium (mg/L)	**15.8**	9.0	**15.0**	<0.2	50.4	**37.3**	24.8	**36.3**	<0.2	207.7	**22.2**	15.3	**20.7**	<0.2	139.5
Chloride (mg/L)	**18.6**	18.2	**12.8**	0.9	102.2	**35.6**	118.4	**11.8**	0.8	1520	**27.3**	41.7	**14.2**	0.6	451
Conductivity (umhos/cm)	**168**	109	**139**	26	759	**359**	399	**302**	29	5220	**222**	156	**192**	31	1561
Iron (mg/L)	**0.066**	0.345	**0.055**	<0.004	4.092	**0.427**	1.106	**0.032**	<0.004	6.963	**0.495**	2.061	**0.019**	<0.004	22.1
Magnesium (mg/L)	**5.2**	4.2	**4.2**	<0.2	31.7	**13.8**	10.3	**13.2**	<0.2	87.9	**7.8**	5.7	**7.0**	<0.2	43.7
Manganese (mg/L)	**0.025**	0.088	**0.005**	<0.002	0.014	**0.166**	0.325	**0.010**	<0.002	1.849	**0.138**	0.572	**0.005**	<0.002	7.17
Nitrate (mg/L)	**5.9**	4.7	**5.0**	<0.1	29.6	**3.6**	4.3	**1.9**	<0.1	18.1	**6.4**	6.3	**4.8**	<0.1	34.9
Phosphorus (mg/L)	**0.359**	0.333	**0.301**	<0.004	1.813	**0.080**	0.135	**0.040**	<0.004	1.334	**0.126**	0.203	**0.028**	<0.004	1.11
pH (standard units)	**6.3**	0.7	**6.18**	406	9.78	**7.2**	0.7	**7.36**	5.17	8.31	**6.8**	0.5	**6.70**	5.48	8.87
Potassium (mg/L)	**4.5**	14.9	**2.1**	<0.2	167.9	**1.6**	1.4	**1.2**	<0.2	9.7	**1.5**	2.2	**1.2**	<0.2	38.4
Sulfate (mg/L)	**9.9**	6.3	**8.2**	0.8	37.1	**10.8**	8.0	**9.5**	<0.2	58.6	**7.8**	4.7	**6.9**	<0.2	31.9
Total Hardness (mg/L as $CaCO_3$)	**61**	37	**56**	<4	211	**150**	103	**147**	<4	881	**88**	61	**80**	<4	529

Chippewa County Well Aquifer Classification

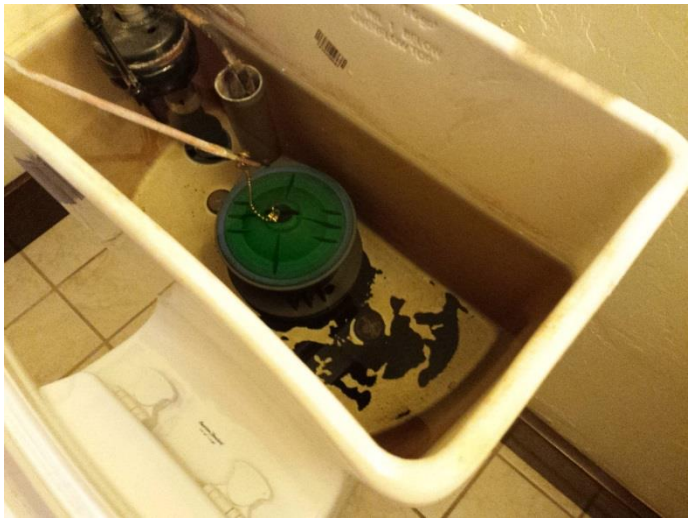


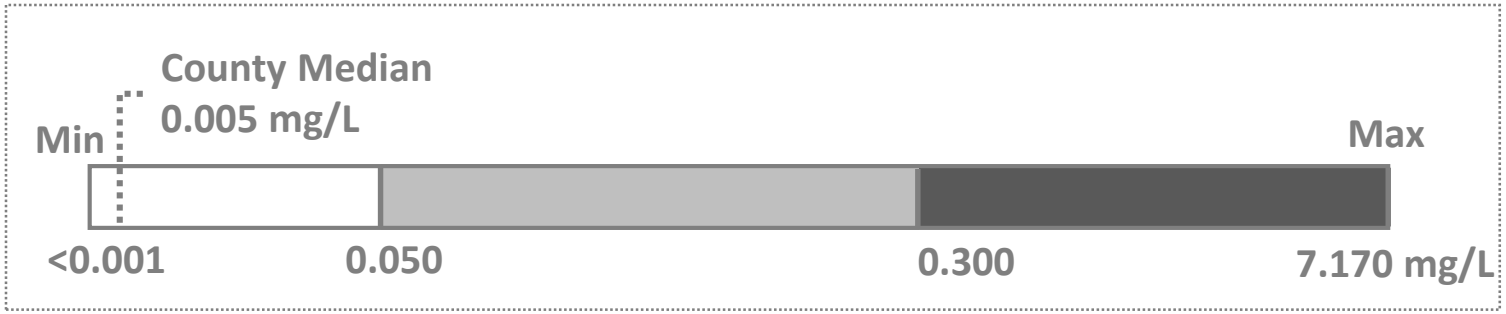
2016 water quality by Chippewa County aquifer classification

Analyte	Granite (n=49)		Sand and Gravel (n=212)		Sandstone (n=193)	
	Mean	StDev	Mean	StDev	Mean	StDev
Alkalinity (mg/L as $CaCO_3$)	**147**	77	**68**	57	**42**	54
Arsenic (mg/L)	**<0.003**	0.002	**<0.003**	0.002	**<0.003**	0.002
Calcium (mg/L)	**44.0**	24.0	**26.3**	16.2	**17.9**	13.1
Chloride (mg/L)	**37.6**	55.1	**30.8**	47.8	**17.3**	19.8
Conductivity (umhos/cm)	**406**	234	**265**	167	**176**	122
Iron (mg/L)	**0.505**	0.966	**0.678**	2.506	**0.097**	0.386
Magnesium (mg/L)	**16.3**	9.1	**9.3**	6.0	**5.9**	5.1
Manganese (mg/L)	**0.140**	0.213	**0.235**	0.799	**0.040**	0.137
Nitrate (mg/L)	**2.6**	3.6	**5.6**	6.6	**5.1**	4.7
Phosphorus (mg/L)	**0.055**	0.114	**0.086**	0.160	**0.296**	0.293
pH (standard units)	**7.45**	0.65	**6.94**	0.57	**6.46**	0.67
Potassium (mg/L)	**2.4**	1.2	**1.4**	1.1	**3.5**	13.7
Sulfate (mg/L)	**11.0**	9.9	**13.0**	5.1	**9.4**	6.0
Total Hardness (mg/L as $CaCO_3$)	**177**	97	**103**	64	**69**	52

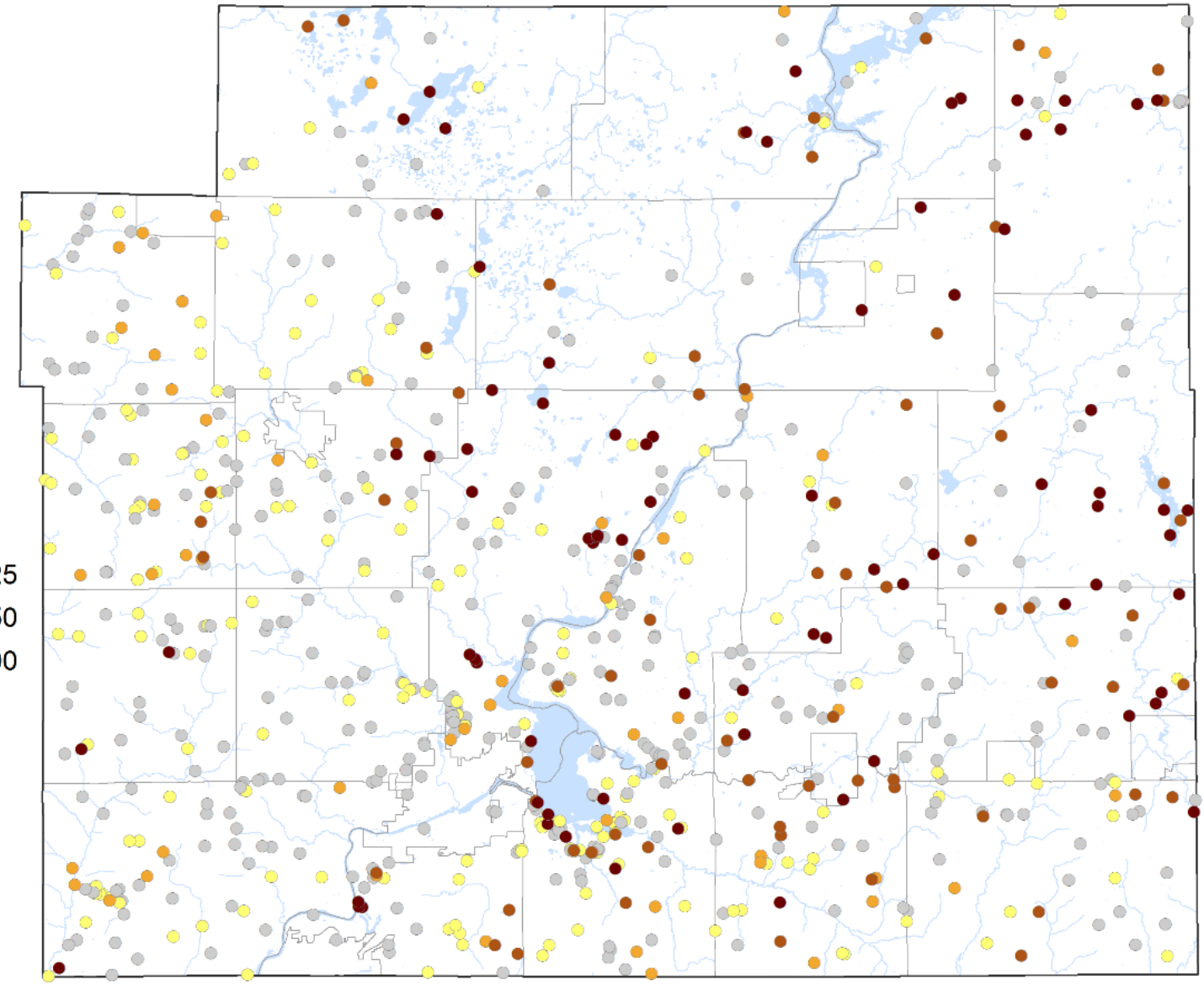
Manganese

- Naturally occurring
- Aesthetic Level: 0.050 mg/L
  - Causes black/brown precipitate and possible staining on fixtures
- Health Advisory Level: 0.300 mg/L
  - Long-term exposure may harm the nervous system





Health considerations | Aesthetic concerns | Likely land use impacts | No health or aesthetic concerns



MANGANESE (mg/L)

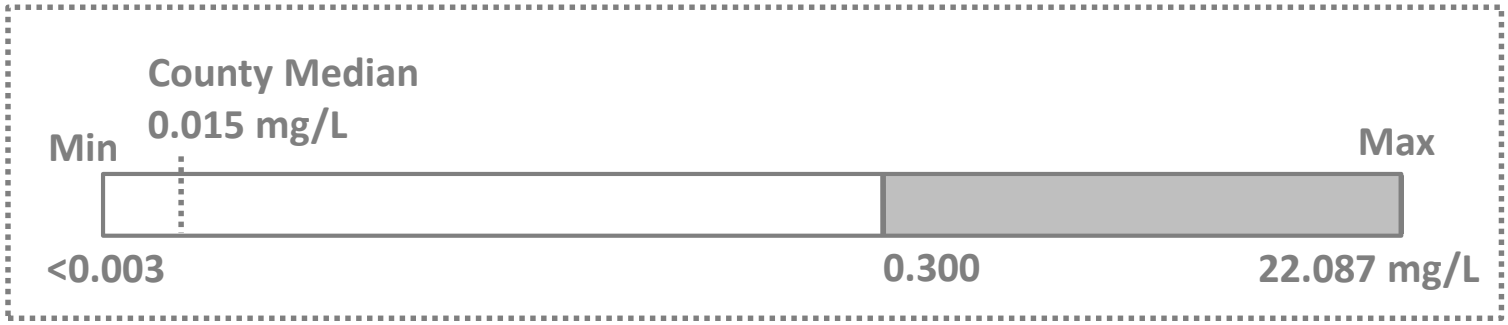
- < 0.005
- 0.006 - 0.025
- 0.026 - 0.050
- 0.051 - 0.300
- > 0.300

N

0 4.5 9 18 Miles

Iron

- Naturally occurring in soils and rock
- Aesthetic Level: 0.300 mg/L
  - Taste
  - Reddish-brown staining of sinks, showers, toilets and laundry
- Treatment:
  - Oxidation or Iron Filters
  - Water softeners



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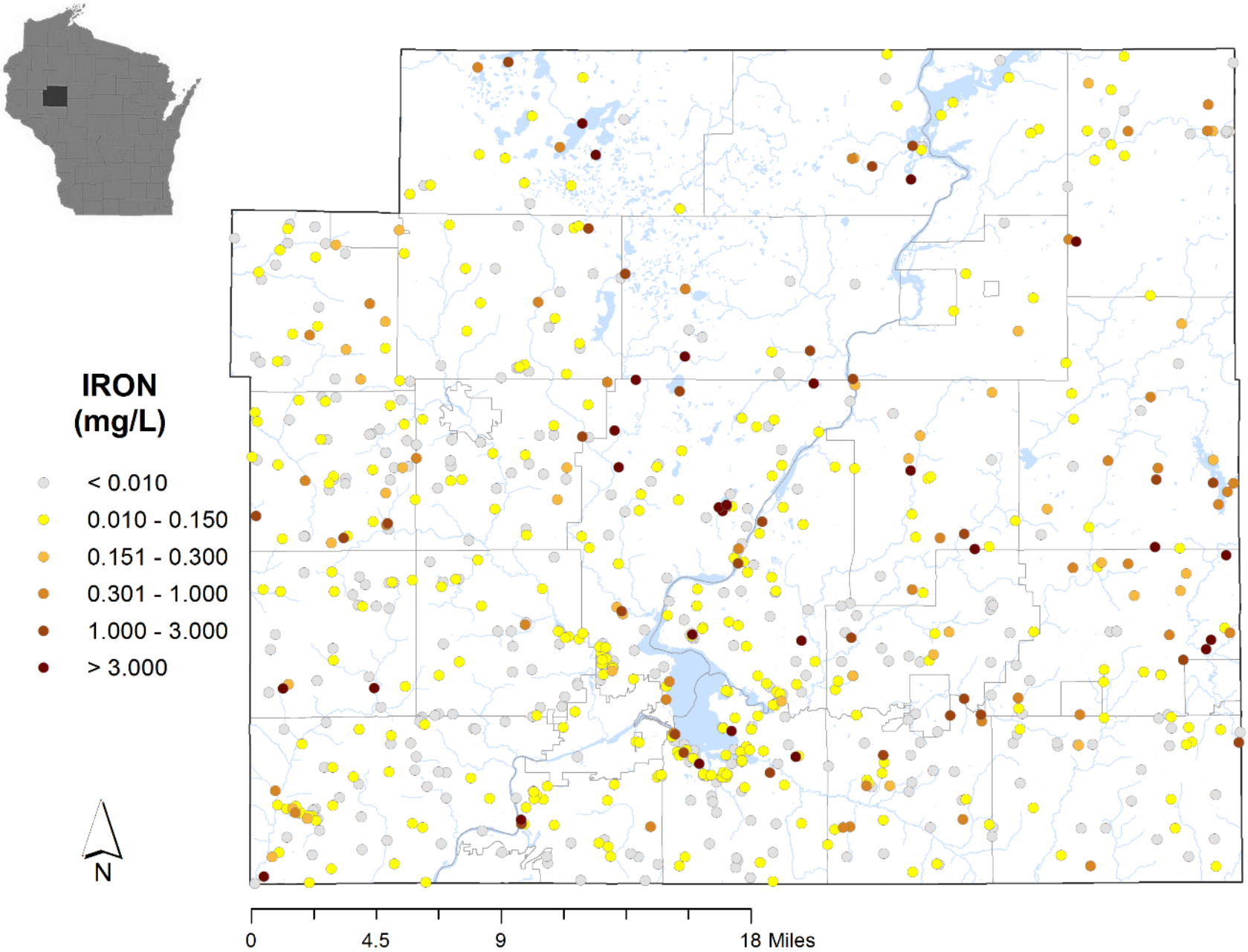
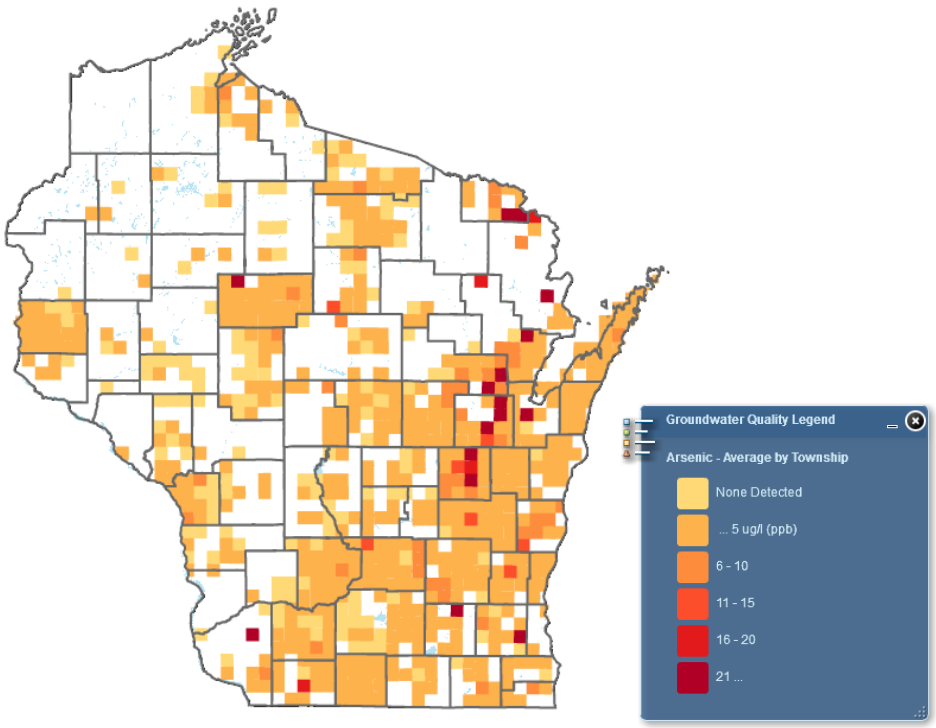
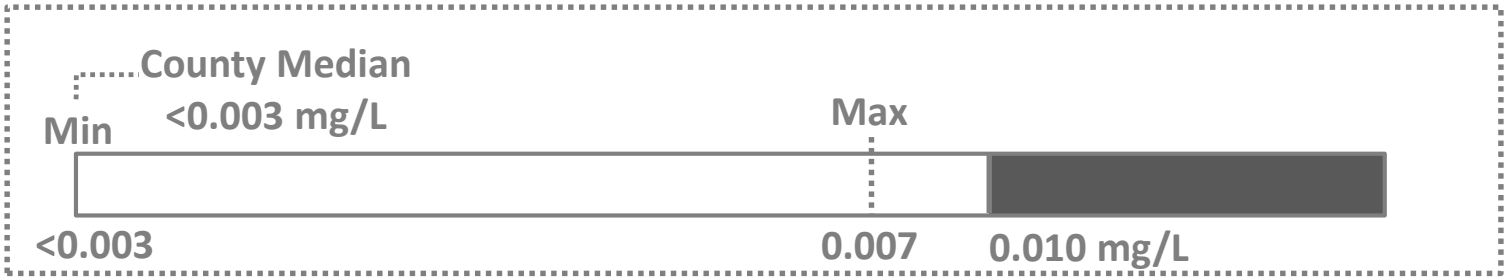
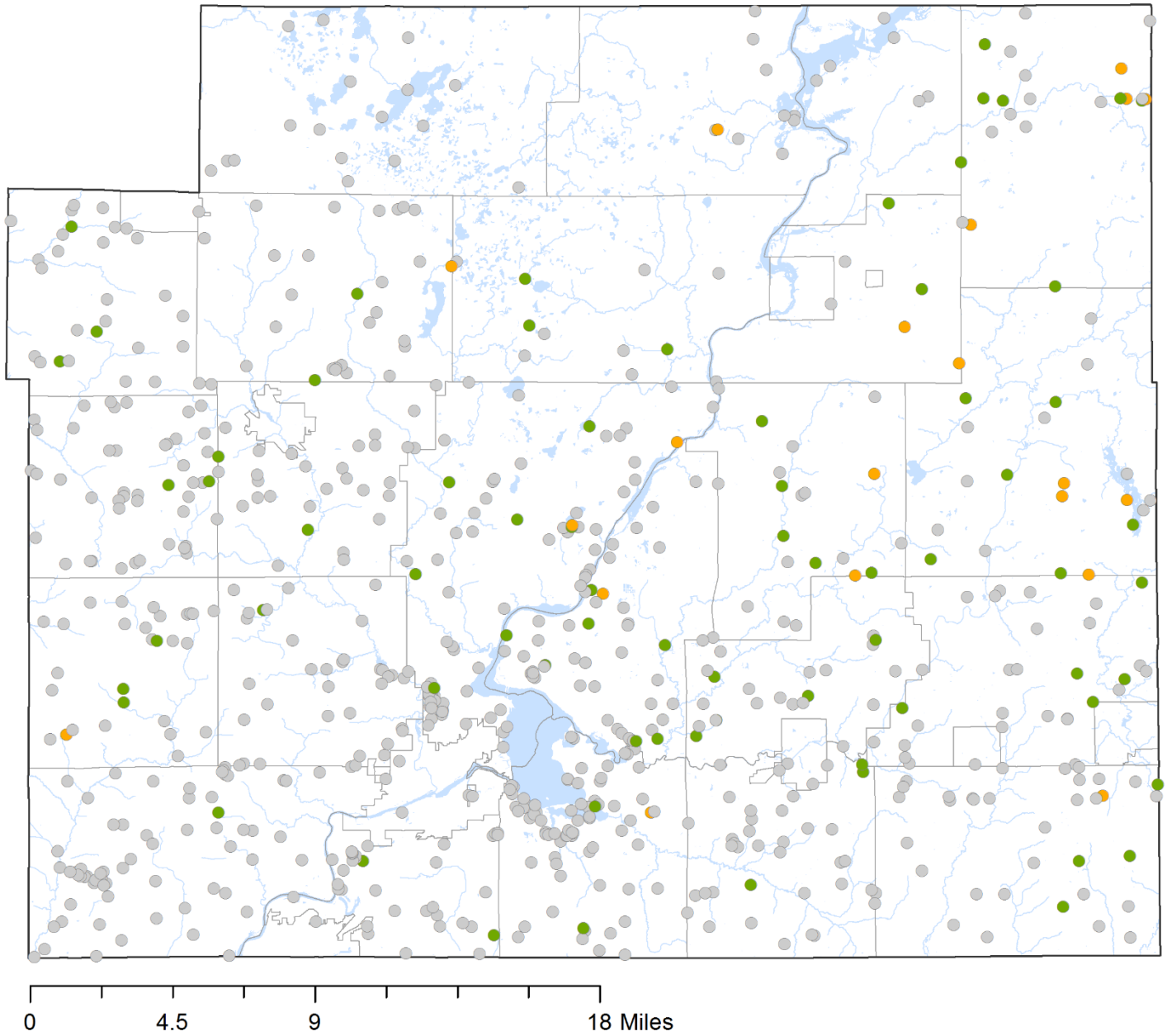

IRON
(mg/L)
< 0.010
0.010 - 0.150
0.151 - 0.300
0.301 - 1.000
1.000 - 3.000
> 3.000
N
0
4.5
9
18 Miles

Arsenic

- Naturally occurring in soils or other geologic materials
- Health Standard: 0.010 mg/L
  - Long-term consumption may increase the risk of certain cancers
- Treatment: Reverse osmosis, distillation (drinking water)



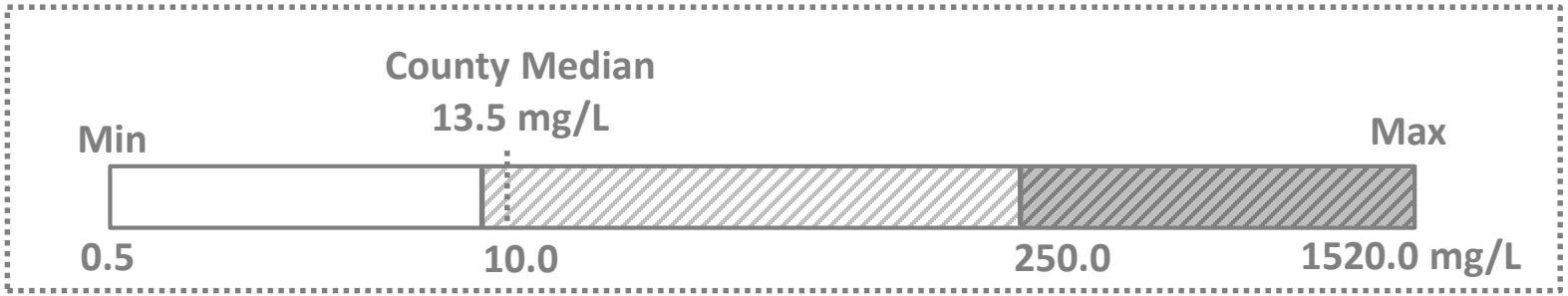


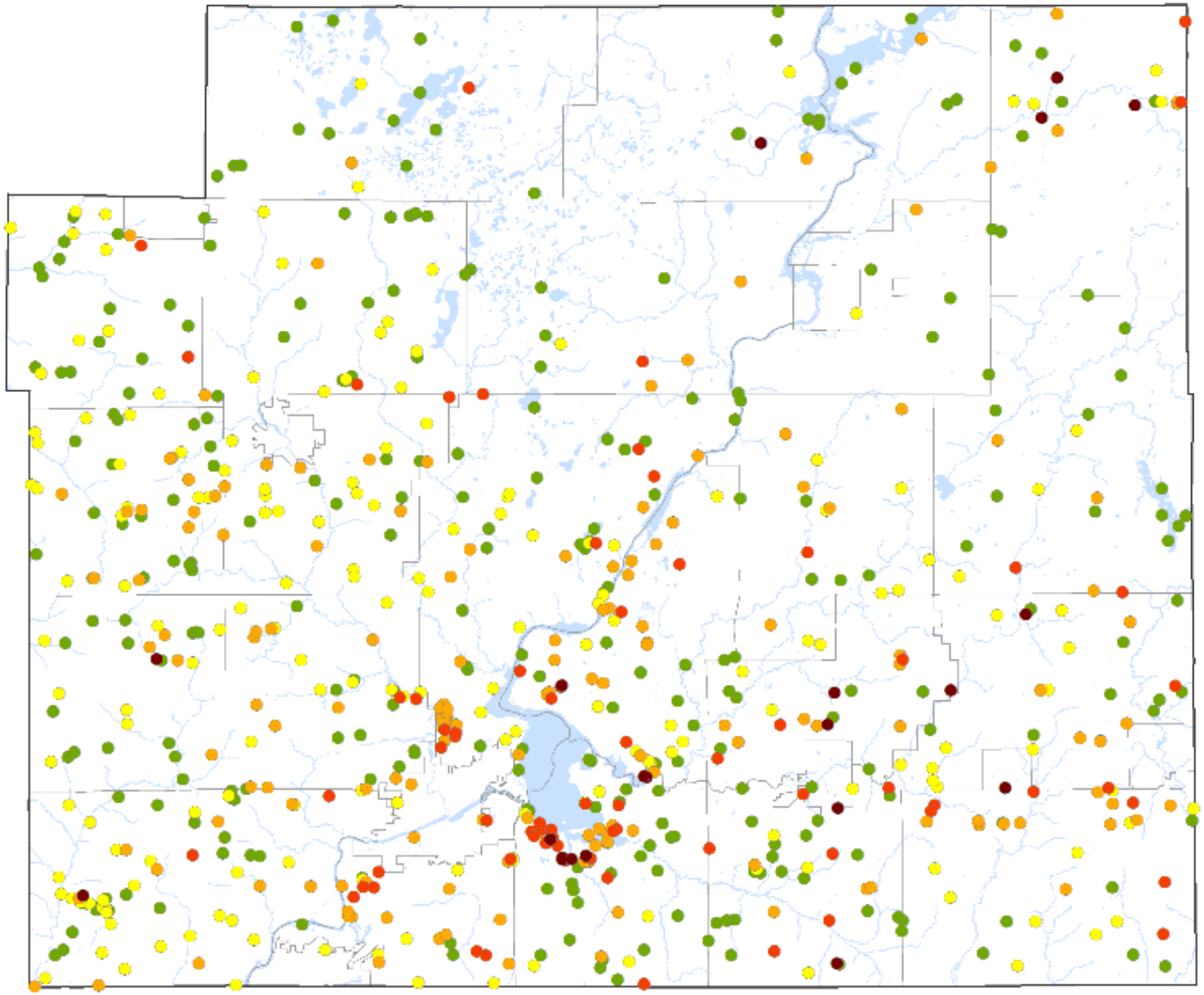

ARSENIC
(mg/L)
< 0.003
0.004 - 0.005
0.006 - 0.010
> 0.010
N
0
4.5
9
18 Miles

Chloride

- Natural levels generally <10 mg/L
- Elevated levels associated with:
  - Fertilizers, septic system effluent, road salt
- Aesthetic Level: 250 mg/L
  - Salty taste
  - Corrosion of some metals

Photo: PBS Newshour





CHLORIDE (mg/L)

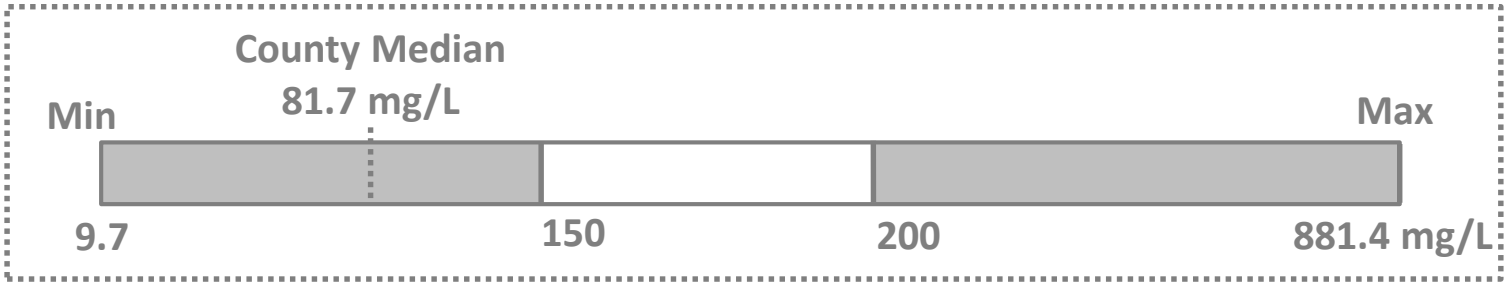
- Less than 10
- 11 - 20
- 21 - 50
- 51 - 100
- Greater than 100

N

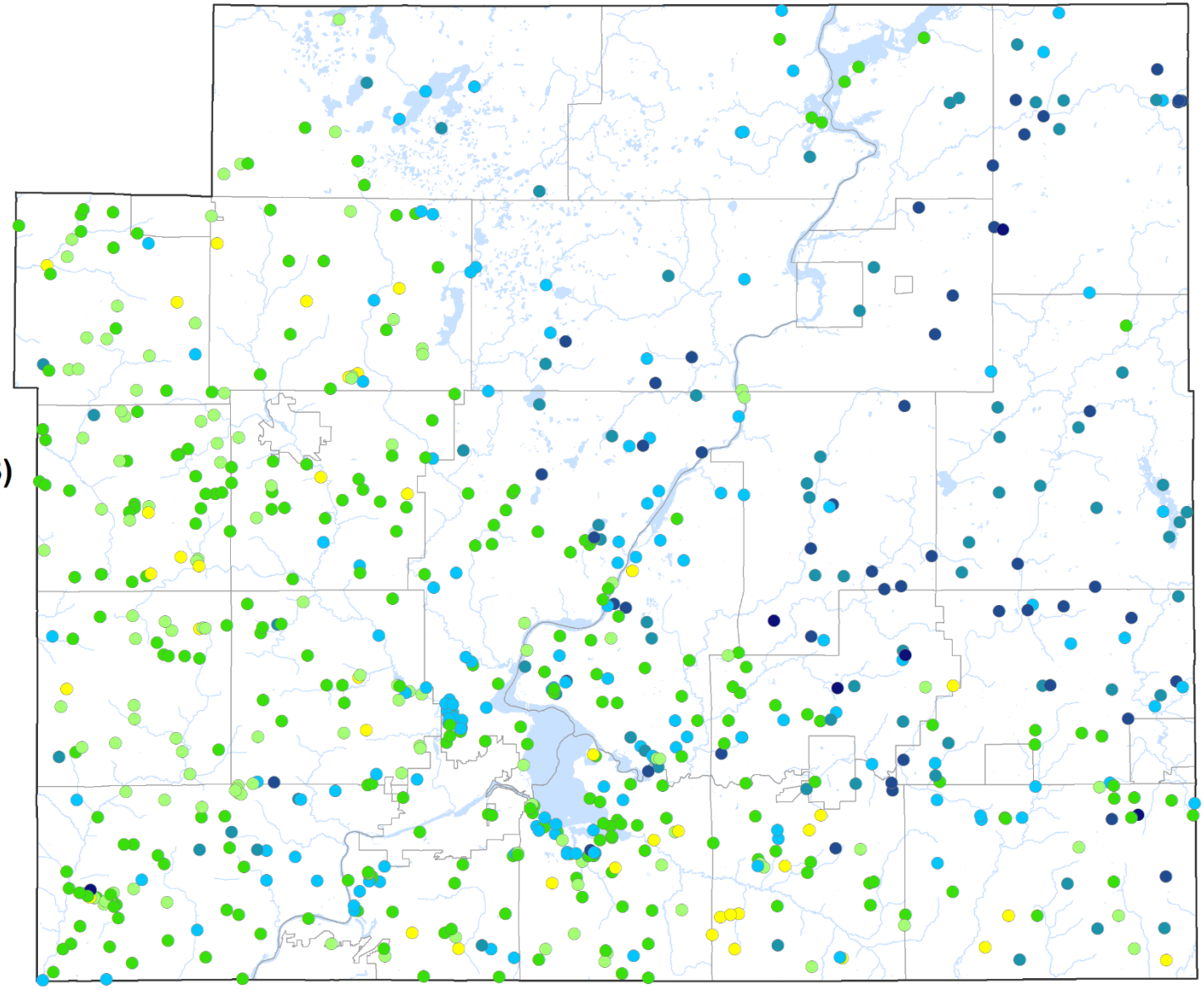
0 4.5 9 18 Miles

Hardness

- Measure of calcium and magnesium
- Naturally occurring from dissolution of limestone or dolomite in rocks/soil
- Aesthetic Problems:
  - Greater than 200 mg/L
    - Scale deposits on fixtures/pipes/water heaters
    - Treatment: Water softener
  - Less than 150 mg/L
    - Soft water that tends to be more corrosive
    - Treatment: Acid-neutralizer



Health considerations | Aesthetic concerns | Likely land use impacts | No health or aesthetic concerns



TOTAL HARDNESS (mg/L as CaCO3)

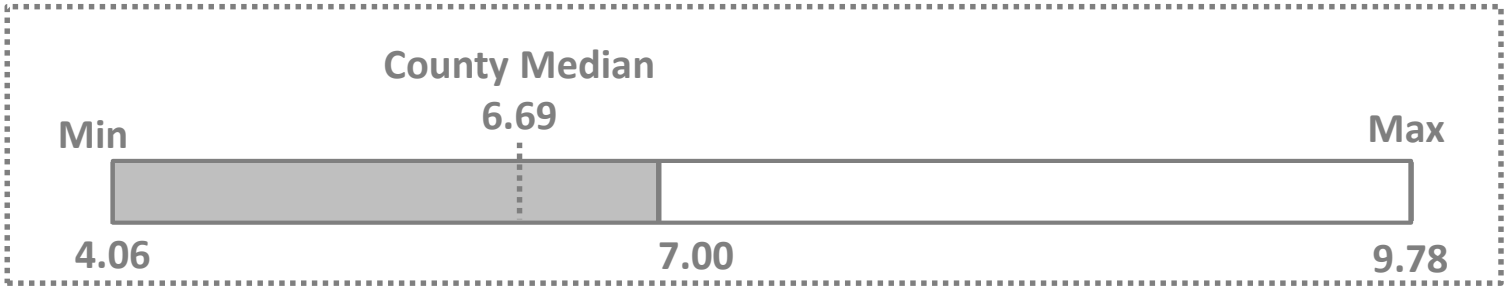
- < 25
- 26 - 50
- 51 - 100
- 101 - 150
- 151 - 200
- 201 - 300
- > 300

N

0 4.5 9 18 Miles

pH

- Measure of acidity
- Levels less than 7.0 are:
  - More likely to cause corrosion
  - More likely to result in elevated levels of lead/copper if found in plumbing system
- Treatment: Acid-neutralizer



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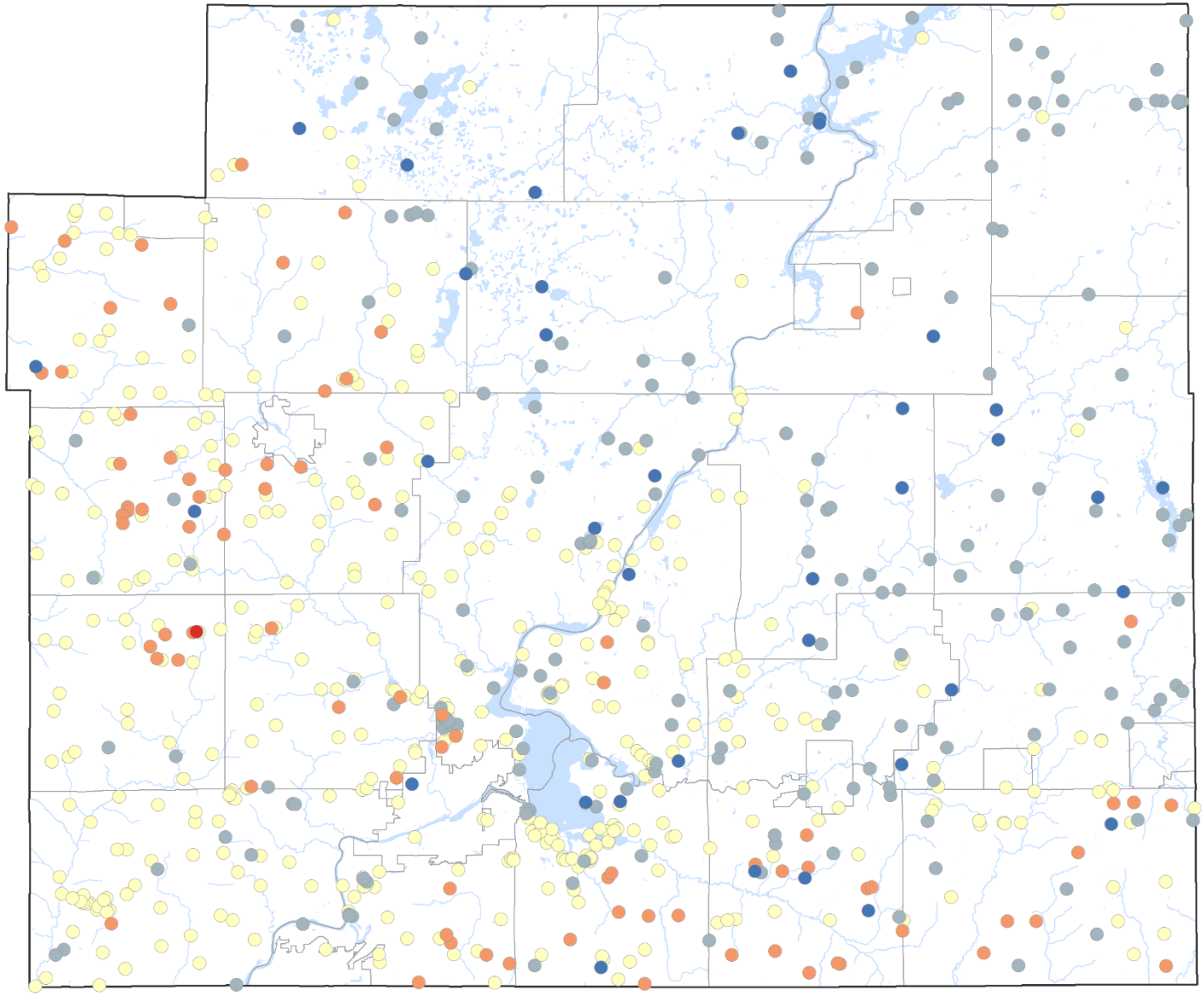
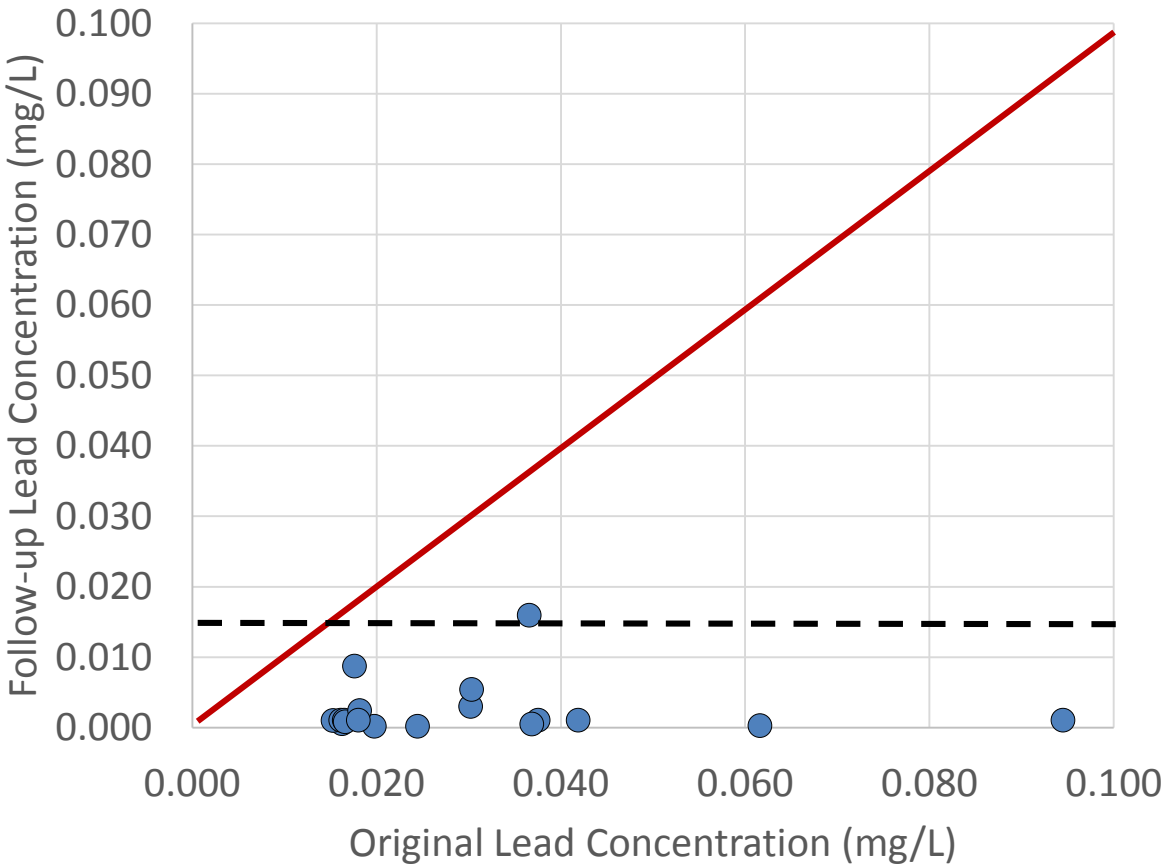

pH
< 5.00
5.00-6.00
6.01-7.00
7.01-8.00
> 8.00
N
0
4.5
9
18 Miles

Lead

- Sources: Lead solder, lead pipes, brass fixtures, stabilizer in materials used to make some hoses.
- Health Standard: 0.015 mg/L
  - Lead may damage the brain, kidneys, nervous system, red blood cells, reproductive system.
- Treatment: Run water for 1-2 minutes prior to using for drinking or cooking

Retesting of elevated lead samples

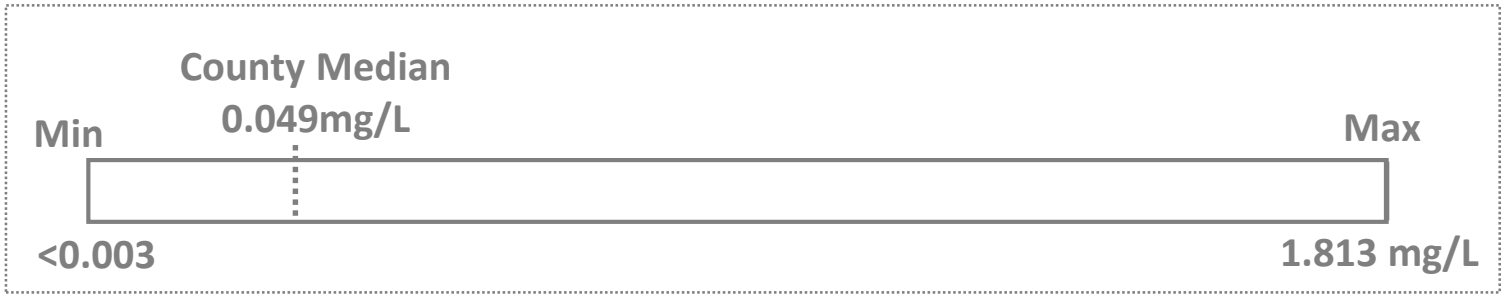
Original	Follow-Up
0.042	<0.002
0.016	<0.002
0.485	0.004
0.015	<0.002
0.016	<0.002
0.018	0.009
0.095	<0.002
0.354	<0.002
0.020	<0.002
0.030	0.003
0.017	<0.002
0.038	<0.002
0.062	<0.002
0.017	<0.002
0.024	<0.002
0.661	<0.002
0.018	0.002
0.018	<0.002
0.037	<0.002
0.037	0.016
0.030	0.005



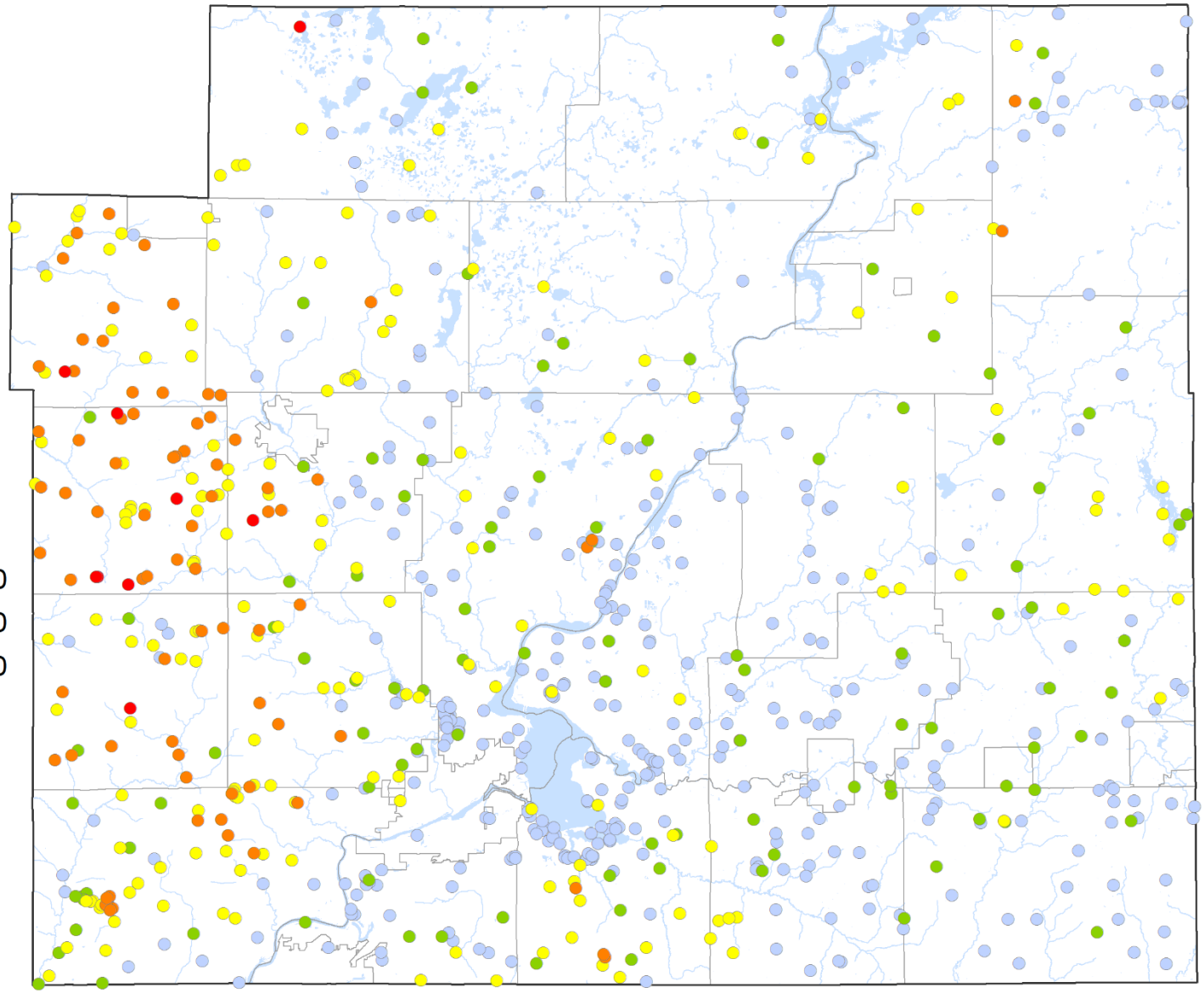
Phosphorus

- Naturally low in groundwater
- Elevated levels may result from dissolution of phosphorus rich minerals
- Not a common test for well or drinking water
- Concern for surface water quality- contributes to eutrophication
  - soil & P fertilizer runoff

Algae bloom on Wisconsin's Lake Tainter. (photo: Peg McAloon)



Health considerations | Aesthetic concerns | Likely land use impacts | No health or aesthetic concerns



PHOSPHORUS (mg/L)

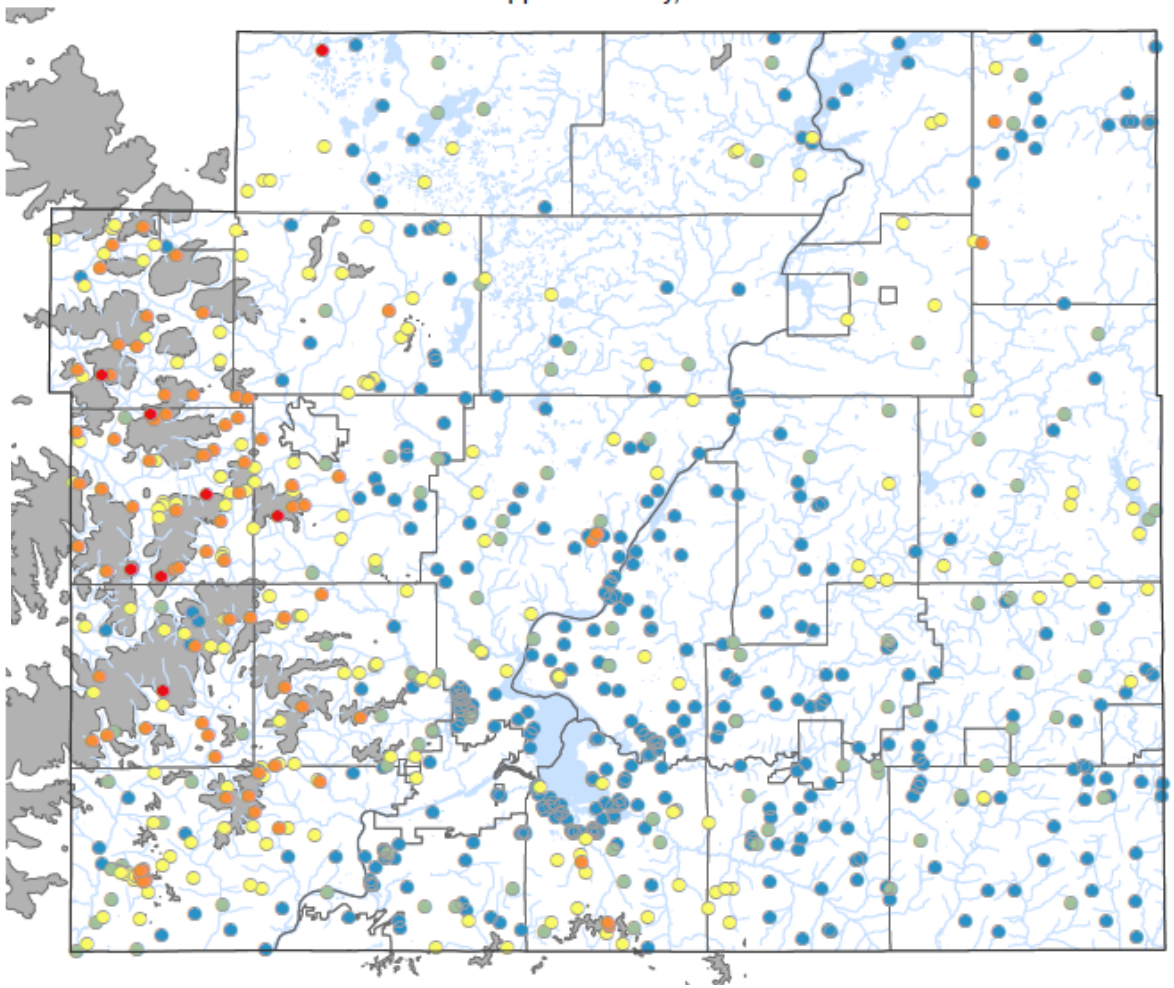
- < 0.050
- 0.050 - 0.100
- 0.101 - 0.500
- 0.501 - 1.000
- > 1.000

N

0 4.5 9 18 Miles

2016 Phosphorous & Intersection with Wonewoc and Tunnel City

Chippewa County Groundwater Quality Inventory 2016
Chippewa County, WI



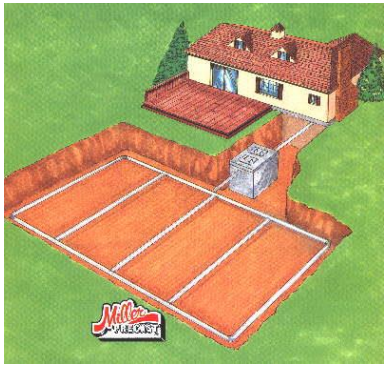
Phosphorus (mg/L)

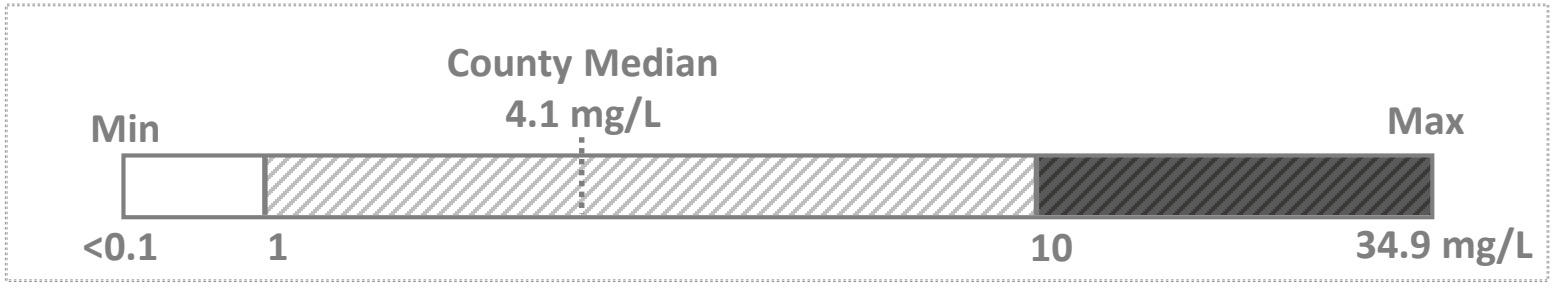
- < 0.05
- 0.05 - 0.1
- 0.11 - 0.5
- 0.51 - 1.0
- > 1.0

Wonewoc and Tunnel City

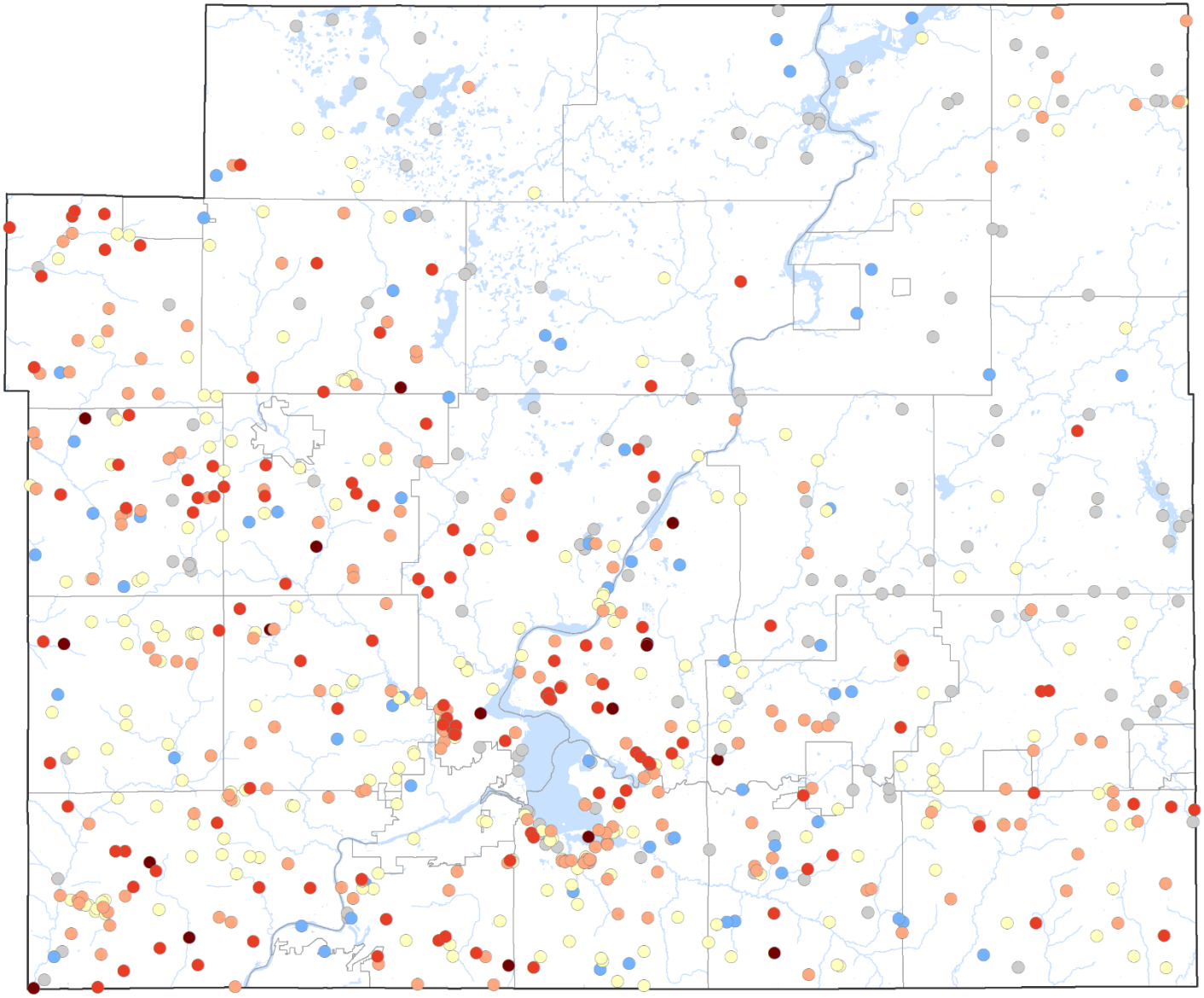
Nitrate

- Natural levels in groundwater < 1 mg/L
- Elevated levels associated with:
  - Fertilizers, manure/bio-solid applications, septic system effluent
- Health Standard: 10 mg/L
  - Methemoglobinemia, birth defects, miscarriages, thyroid function
  - Greater than 10 mg/L should <u>not</u> be used by infants, pregnant women or those trying to become pregnant. Everyone else avoid long-term consumption.
- Treatment: Reverse osmosis, distillation, or anion exchange (drinking water only)

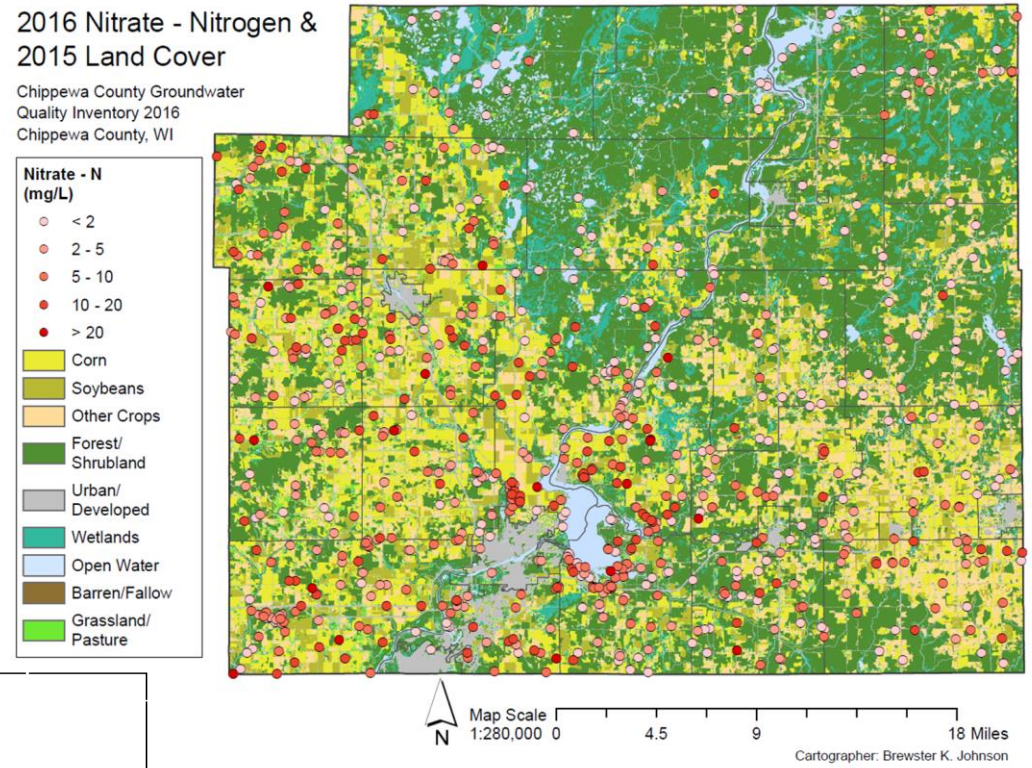


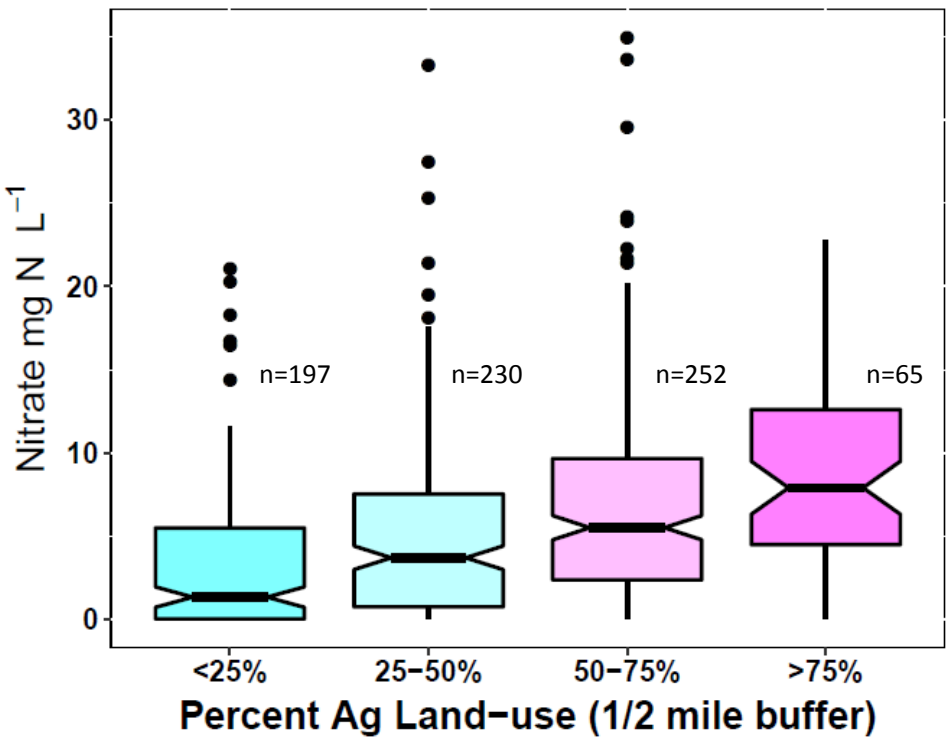


Health considerations | Aesthetic concerns | Likely land use impacts | No health or aesthetic concerns


NITRATE-NITROGEN (mg/L)
< 0.1
0.2 - 1.0
1.1 - 5.0
5.1 - 10.0
10.1 - 20.0
> 20.0
N
0
4.5
9
18 Miles

Chippewa County: Nitrate by % Agriculture





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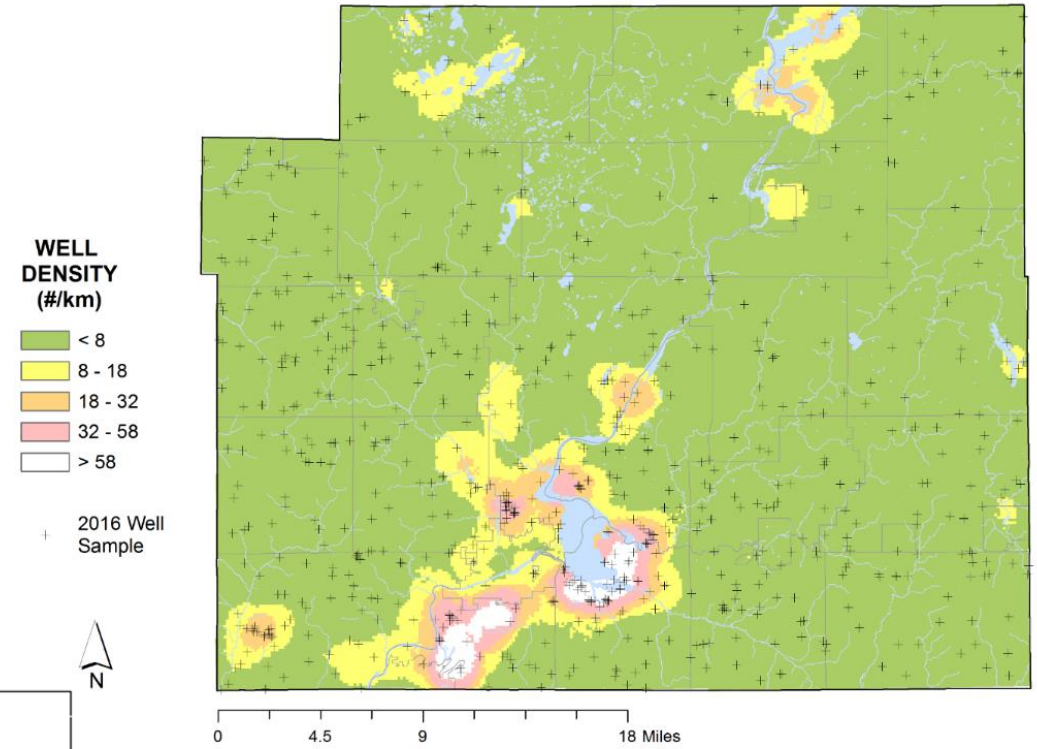
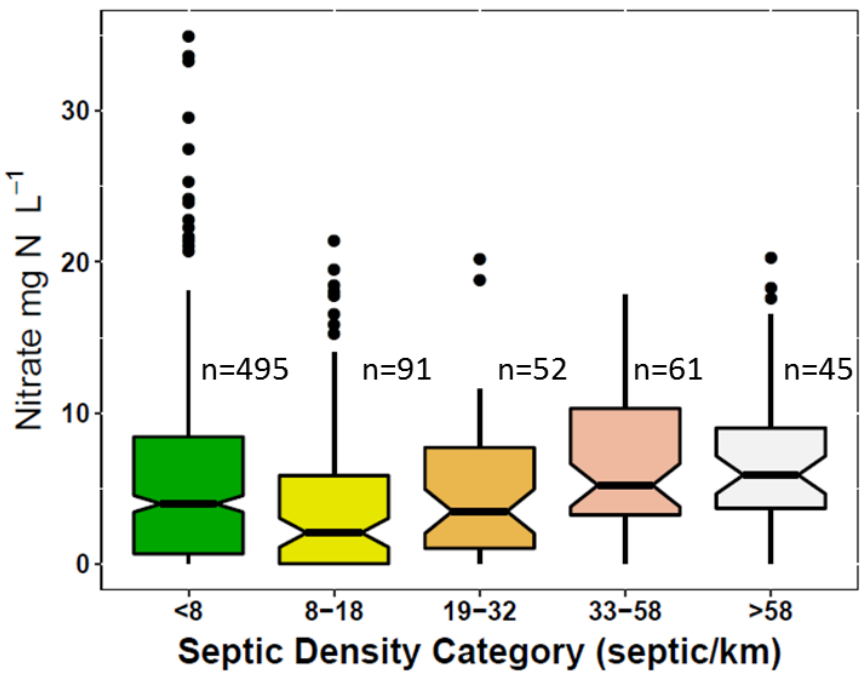
Chippewa County: Nitrate and septic system density





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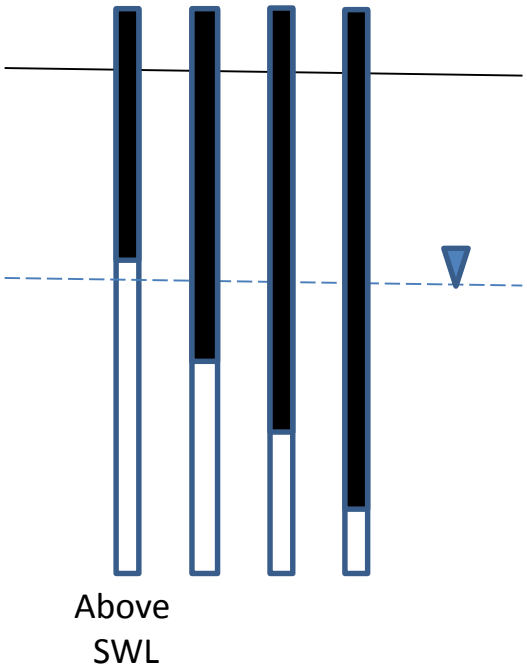
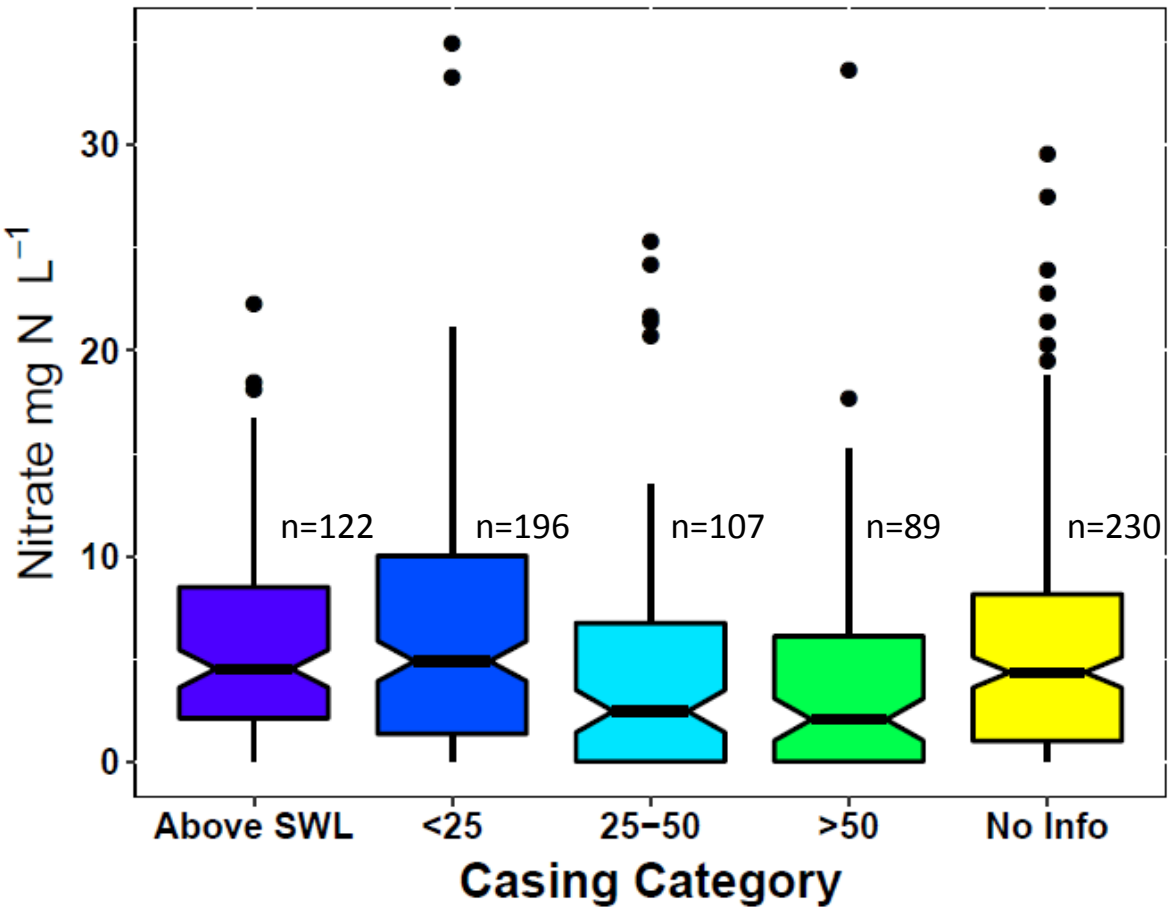
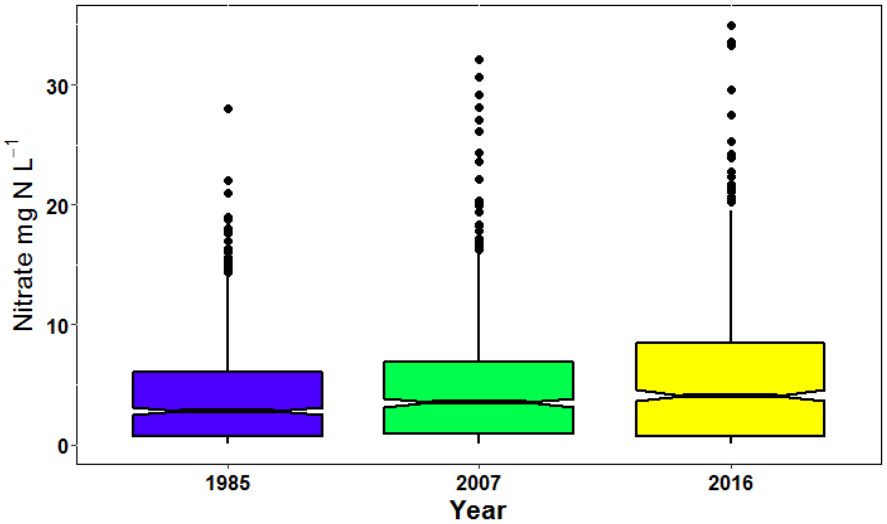
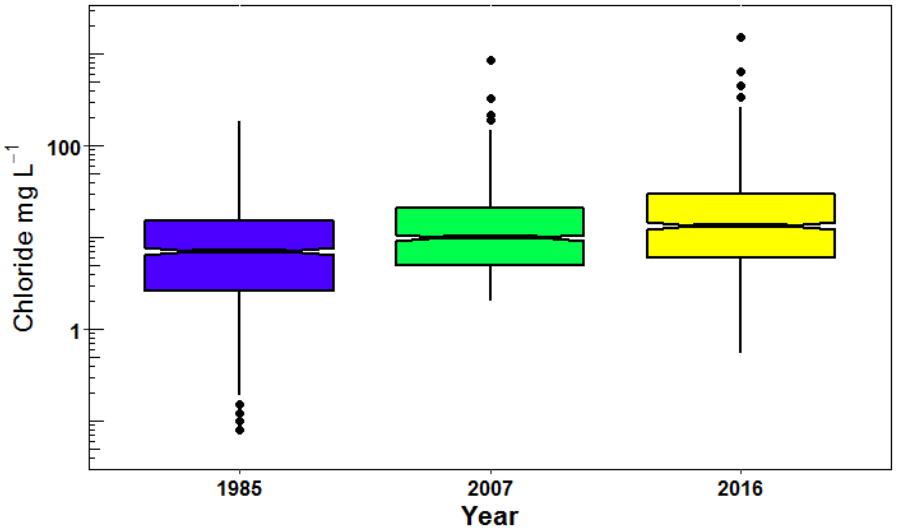
Casing depth and nitrate





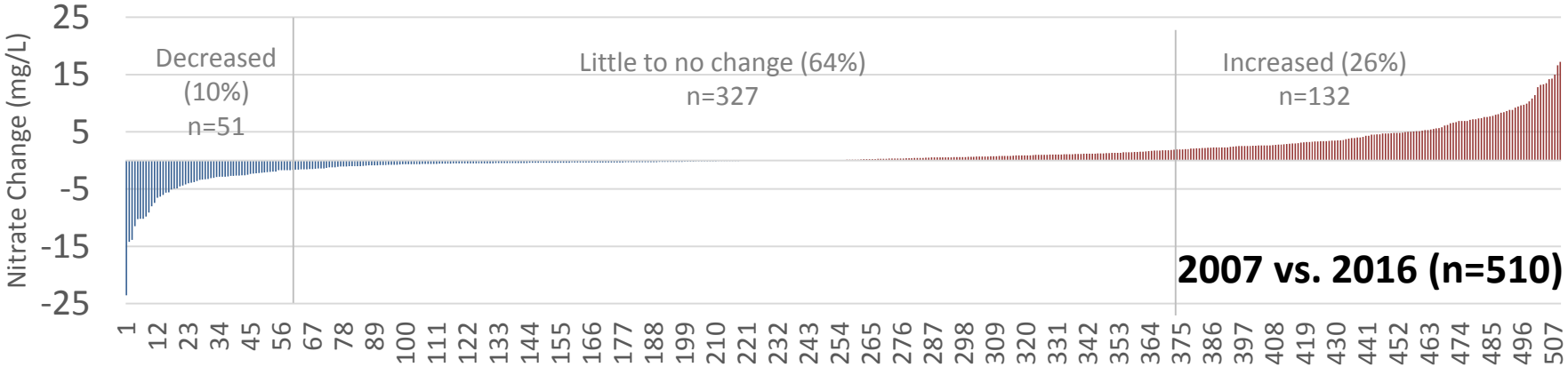
Water quality changes over time (1985, 2007, 2016)
All samples

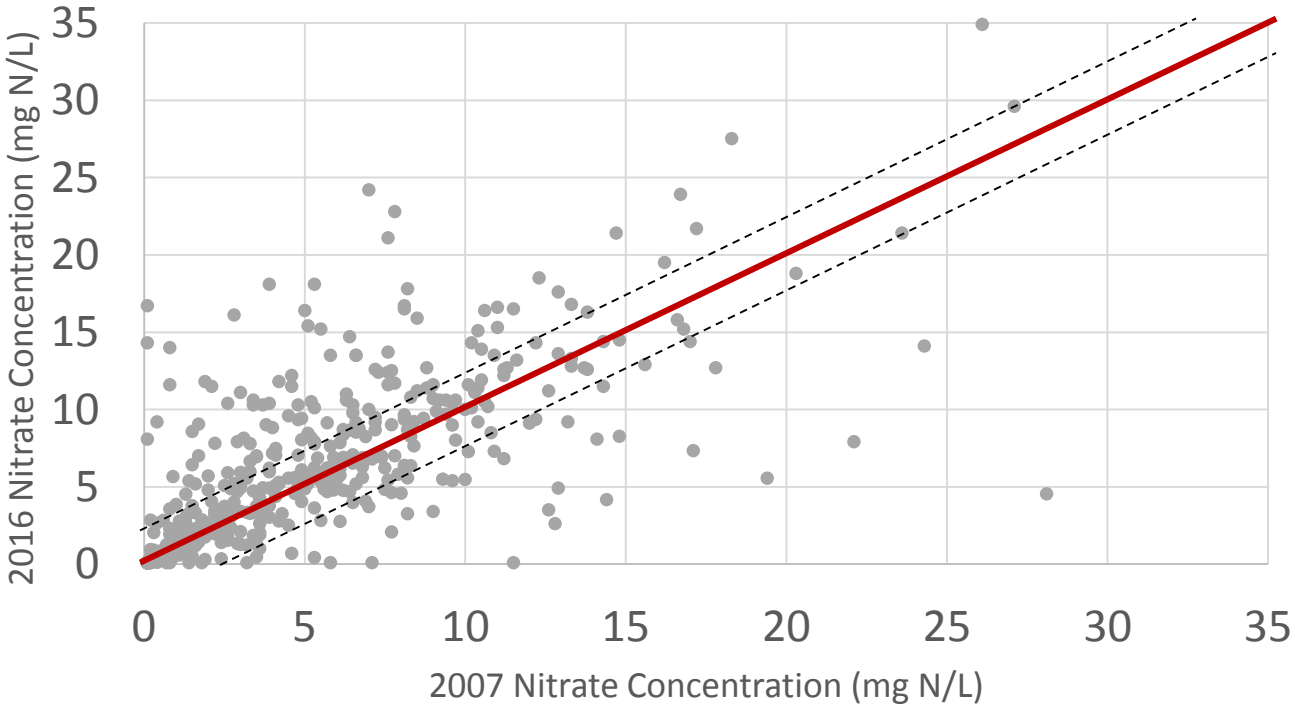




	n	Nitrate-Nitrogen (mg/L)					Chloride (mg/L)				
		Median	Mean	StDev	Min	Max	Median	Mean	StDev	Min	Max
1985	715	2.8	4.2	4.4	<0.1	28.0	6.8	10.7	13.7	<1	182
2007	800	3.5	4.7	4.8	<0.1	32.1	10.0	19.0	38.7	<1	858
2016	744	4.1	5.5	5.6	<0.1	34.9	13.5	27.6	69.6	0.5	1520

Comparing nitrate concentrations over time





Year	Nitrate Average (mg N/L)	Greater than 10 mg/L
1985	4.2	11.3%
2007	4.7	12.3%
2016	5.5	18.3%

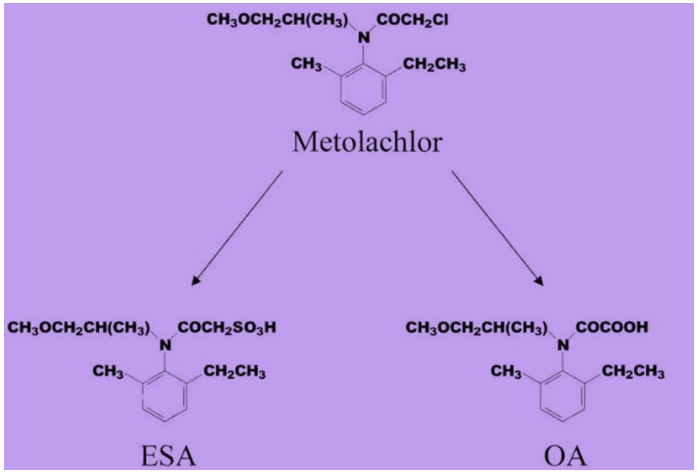
Nitrate Source Analysis

- Nitrate was a primary focus of this groundwater quality inventory.
- Sixty wells were chosen for additional testing to determine the source(s) of nitrate.

What did we look for?

- Two major sources of nitrate contamination:
  - Agricultural Practices
  - On-site waste treatment systems (septic)

What did we look for?



- Agricultural Practices
  - Pesticide Metabolites (breakdown products)
  - Metolacholor, alachlor and acetochlor metabolites
    - Mobile in groundwater
    - Unique to agricultural practices
    - Established testing method
  - Wisconsin Department of Agriculture Trade and Consumer Protection – Groundwater Exceedance Survey:

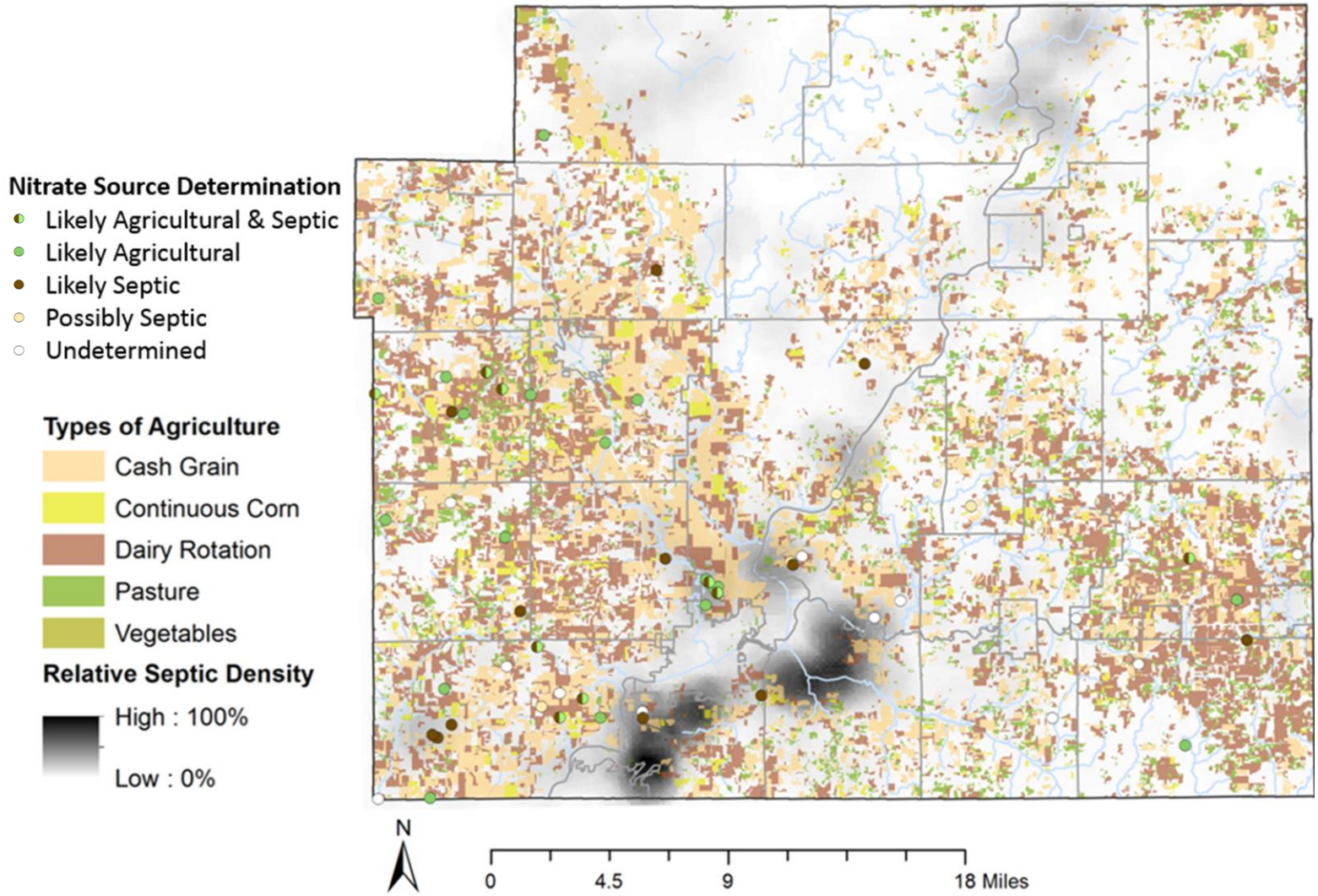
    "The <u>two most commonly detected pesticide metabolites</u> in the 2012 Targeted Sampling project were **metolachlor ethanesulfonic acid** (ESA) and **alachlor ESA**, which were detected in over 50 percent of the wells sampled. Metolachlor ESA and alachlor ESA were also the most common pesticide metabolites in the 2007 statewide survey, with approximately 21.6 percent of the wells having detectible concentrations."

What did we look for?

- On-site waste treatment systems (septic)
  - Unique to human use
    - Food products (caffeine, artificial sweeteners)
    - Pharmaceuticals
  - Reported in literature
  - Stable, mobile in subsurface environment
  - Good instrumental response

Well Selection

- Wells for follow-up nitrate source analysis (NSA) were selected based on these criteria:
  - Only wells with a Wisconsin Unique Well Number were considered.
  - Wells with nitrate-N concentrations less than 2 mg/L are near background levels of nitrate and therefore not considered for NSA.
  - An Inverse Distance Weighting tool in ESRI ArcMap was used to assign density values categorizing septic density criteria.
  - 32 had concentrations between 2 and 10 mg/L.
  - 28 wells had nitrate-N concentrations higher than 10 mg/L.
    - Two of these had nitrate–N concentrations greater than 20 mg/L.


Nitrate Source Determination
Likely Agricultural & Septic
Likely Agricultural
Likely Septic
Possibly Septic
Undetermined
Types of Agriculture
Cash Grain
Continuous Corn
Dairy Rotation
Pasture
Vegetables
Relative Septic Density
High : 100%
Low : 0%
N
0
4.5
9
18 Miles

Results of Nitrate Source Analysis

Tracers Detected	Nitrate-N (mg/L)			N
	Mean	Median	Range	
Both agricultural & septic tracers	11.8	12.2	3.6 – 32.4	15
At least one agricultural	10.3	9.1	4.9 – 17.8	13
More than one septic	8.3	8.4	2.2 – 15.3	13
Only one septic tracer	8.8	8.4	3.4 – 14.7	6
No tracers detected	7.9	5.2	2.1 – 21.7	13

Comparing nitrate concentrations and the detection of chemical indicators:

- The greatest mean, median and overall nitrate concentrations were detected in wells with both tracers.
- The mean nitrate concentration for wells with at least one agricultural tracer but no septic tracers was above the drinking water standard of 10 mg/L.
- Four wells without detects of either tracers had nitrate above 10 mg/L. Further investigation is needed to determine the source of contamination in these areas.

What does this mean?

- There are established WI Public Health Standards for Alachlor ESA and Metolachlor ESA + OA.

Analyte	WI Public Health Standard (parts per billion)	Highest Concentration in Chippewa County Study (ppb)
Alachlor ESA	20	2.62
Alachlor OA	No standard	Not detected
Metolachlor ESA	1300	4.10
Metolachlor OA		0.21

What does this mean?

- There are NO established Public Health Standards for pharmaceuticals. The WI Division of Public Health has determined a Health Advisory Level for the antibiotic sulfamethoxazole.

Analyte	WI Public Health Standard (parts per billion)	Highest Concentration in Chippewa County Study (ppb)
Acesulfame	No standard	3.209
Sucralose	No standard	2.053
Caffeine	No standard	0.021
Paraxanthine	No standard	0.020
Sulfamethoxazole	100	0.251

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