

Groundwater and Drinking Water Education Program Columbia County

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Center for Watershed Science and Education



Center for Watershed Science and Education
College of Natural Resources
University of Wisconsin-Stevens Point



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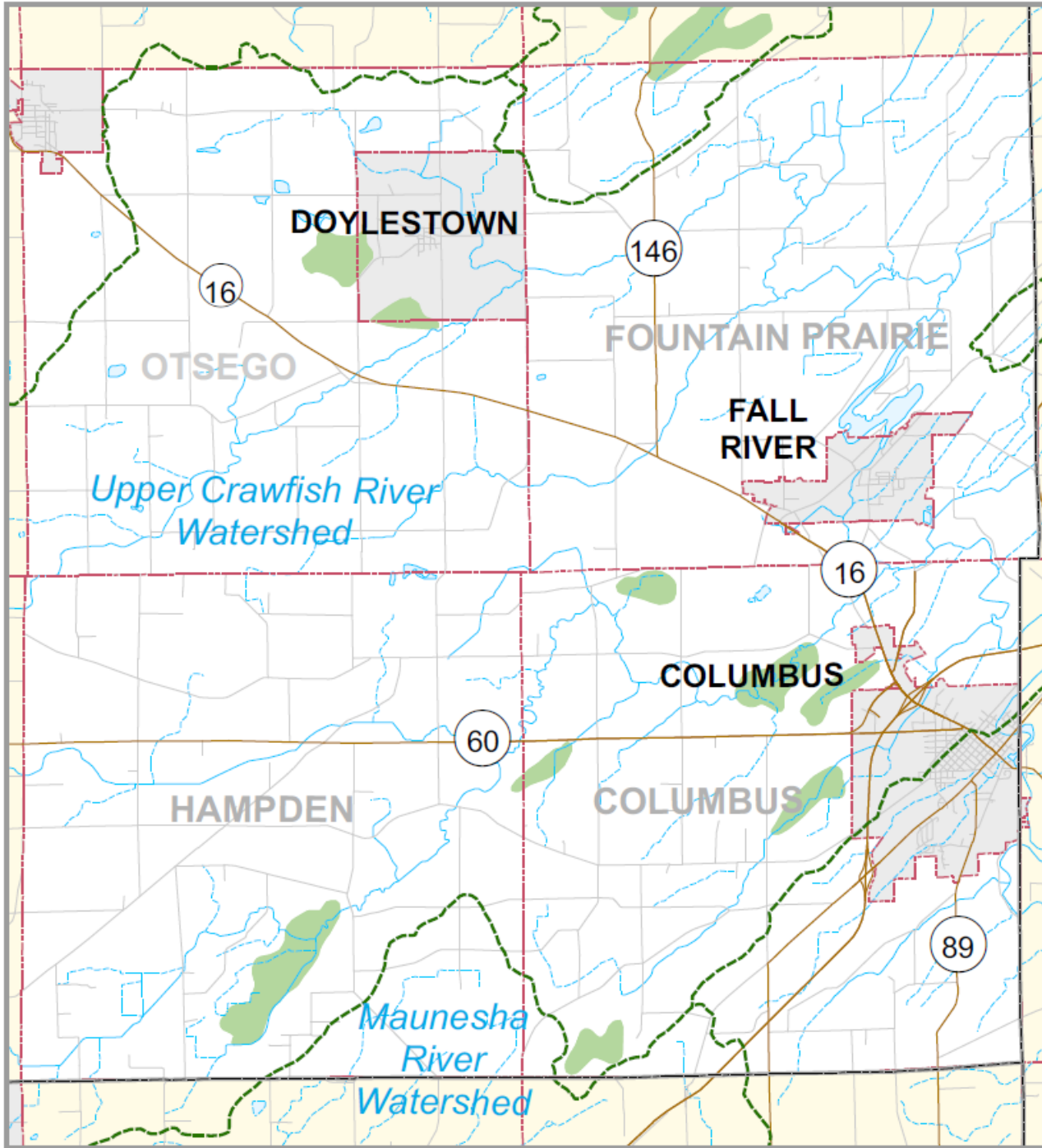
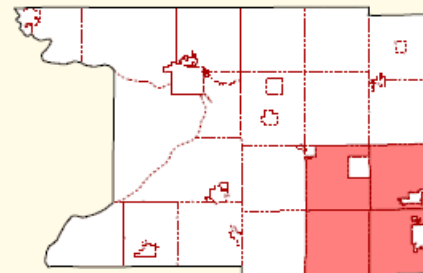
Today's presentation

- Groundwater Basics: Where does my water come from
- Well Construction
- What do my individual test results mean?
- General groundwater quality in Columbia County
- Improving your water quality

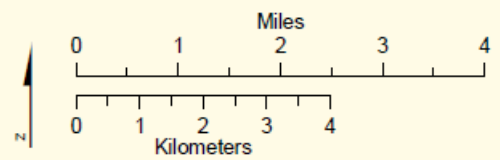


Towns of Columbus, Fountain Prairie, Hampden, and Otsego

Columbia County, September 2019



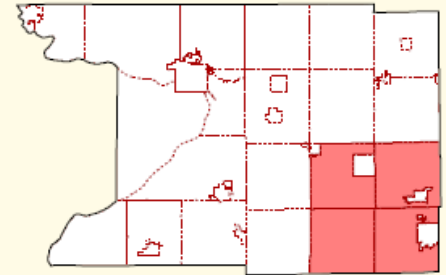
- Watershed Boundary
- Streams
- Lakes/Reservoirs
- Wetlands
- State/US Highways
- Other Roads
- Town Boundaries
- Municipalities



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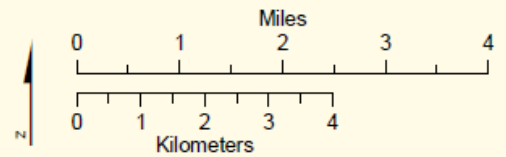
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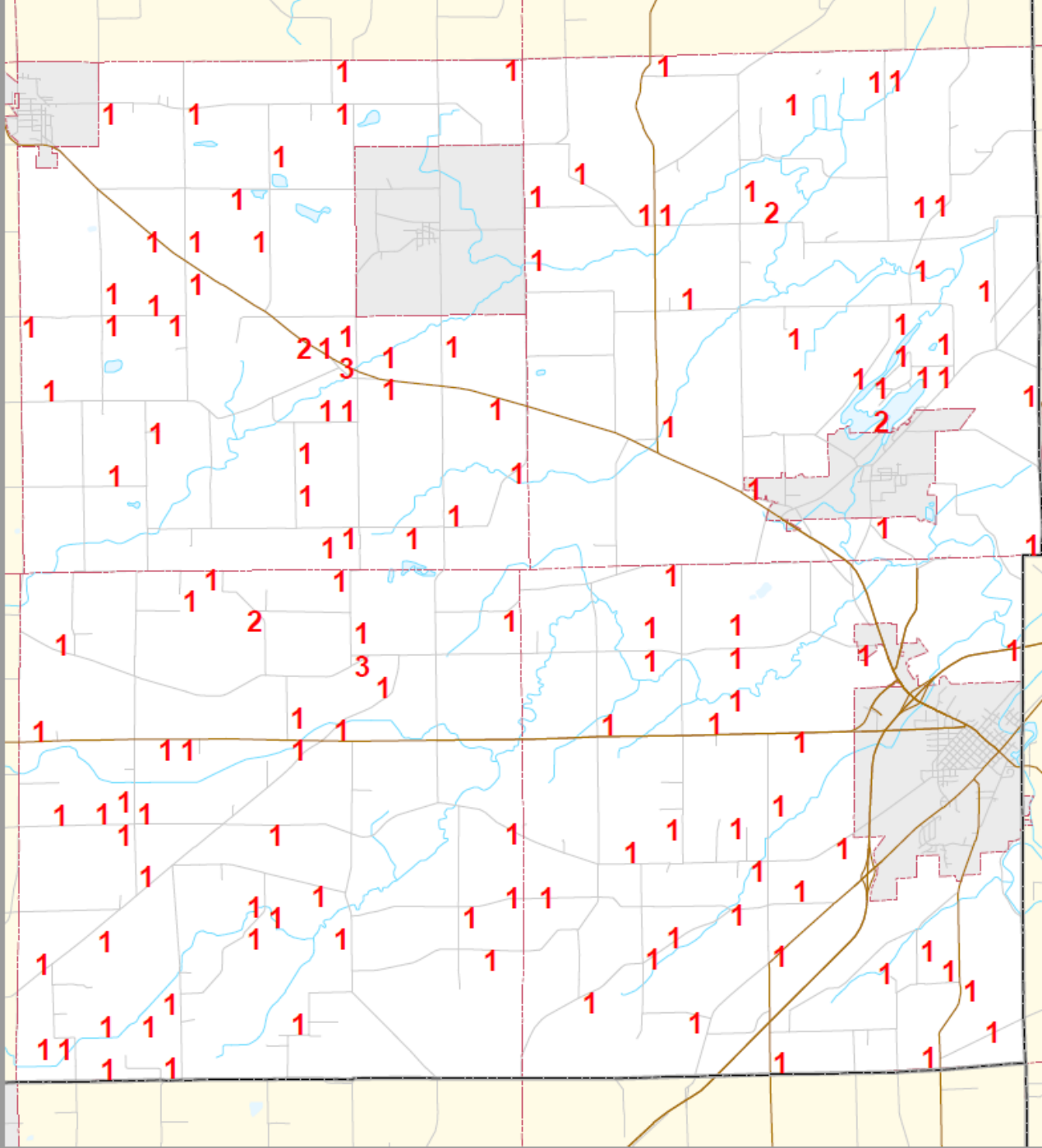


SAMPLE DISTRIBUTION

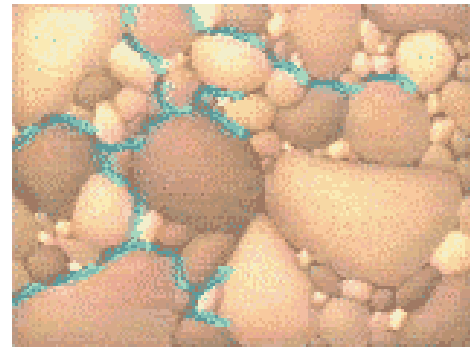
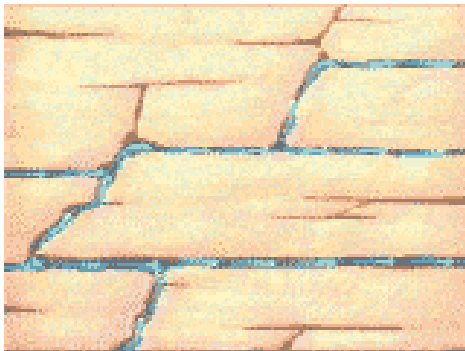
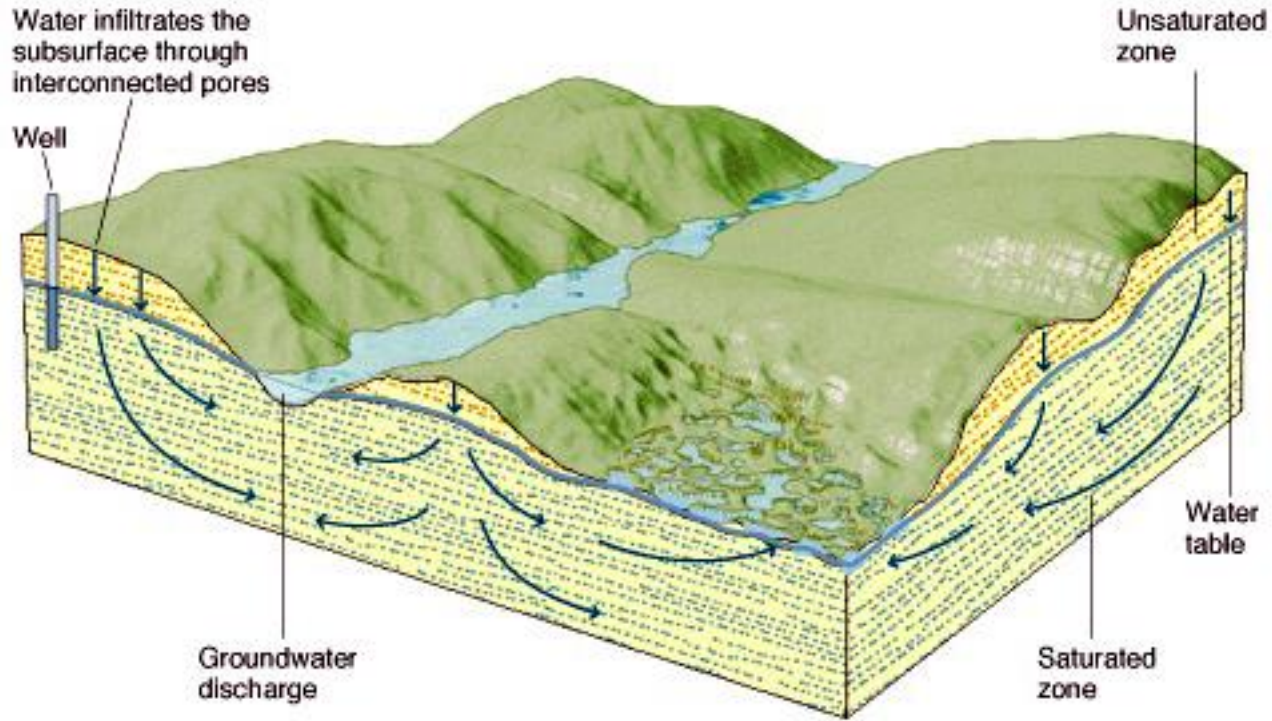
NUMBER OF SAMPLES
per 1/4 1/4 SECTION



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Groundwater Movement

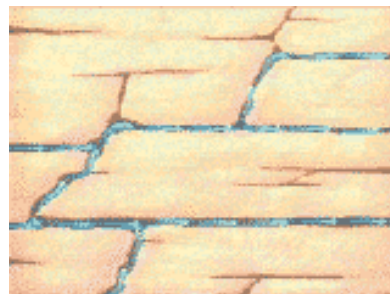


Aquifers: Our groundwater storage units

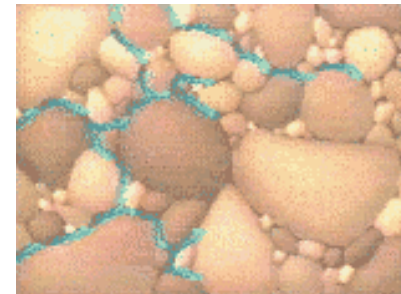
Aquifers are geologic formations that store and transmit groundwater.

The aquifer properties determine how quickly groundwater flows, how much water an aquifer can hold and how easily groundwater can become contaminated. Some aquifers may also contain naturally occurring elements that make water unsafe.

Wisconsin's geology is like a layered cake. Underneath all of Wisconsin lies the Crystalline bedrock which does not hold much water. Think of this layer like the foundation of your house. All groundwater sits on top of this foundation. Groundwater is stored in the various **sandstone, dolomite and sand/gravel** aquifers above the **crystalline bedrock** layer. The layers are arranged in the order which they formed, oldest on the bottom and youngest on top.

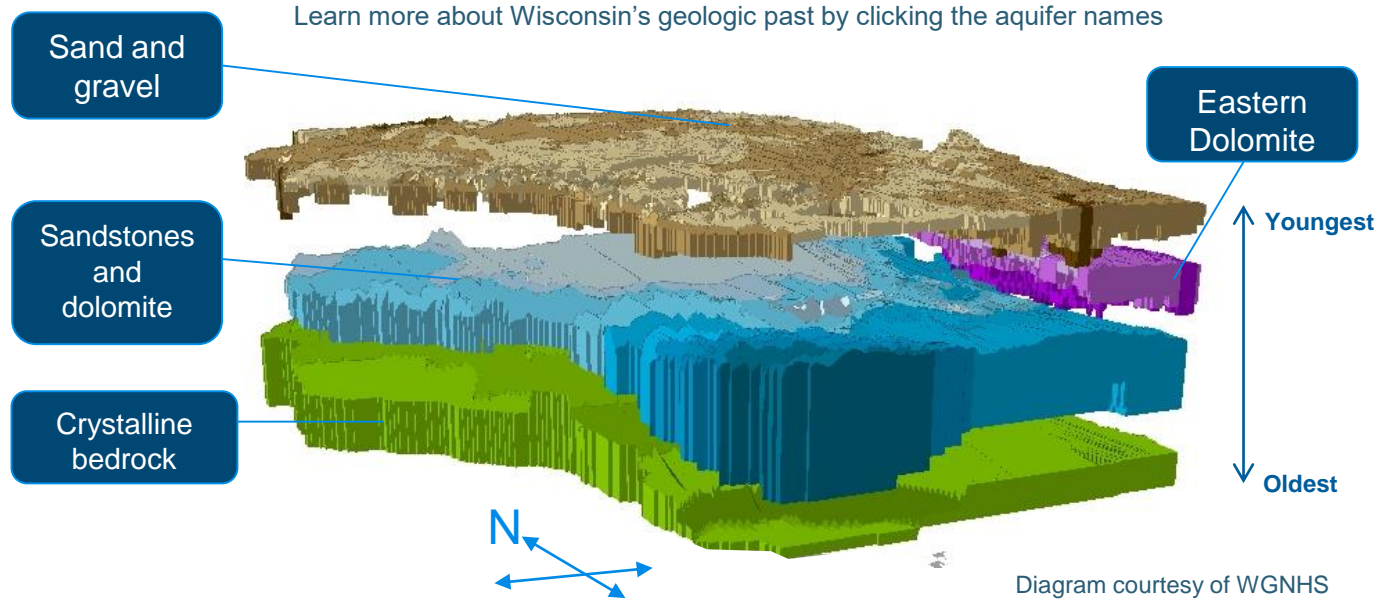


Water and contaminants can move quickly through cracks and fractures.



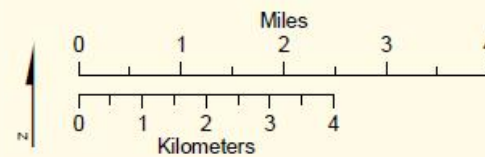
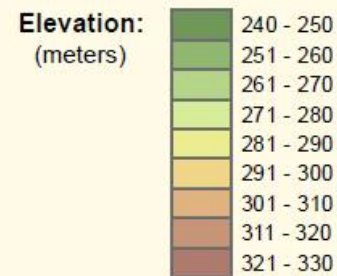
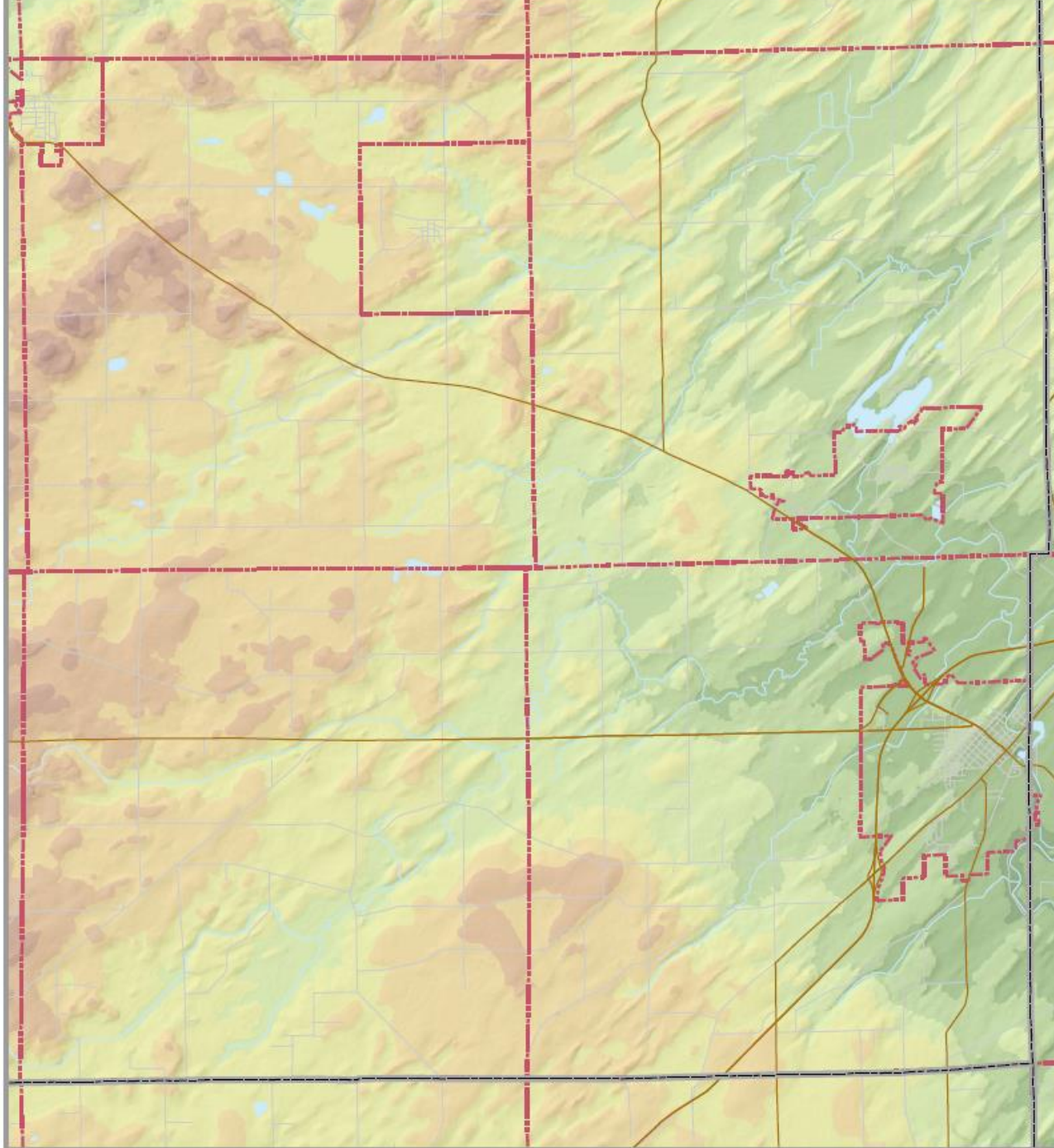
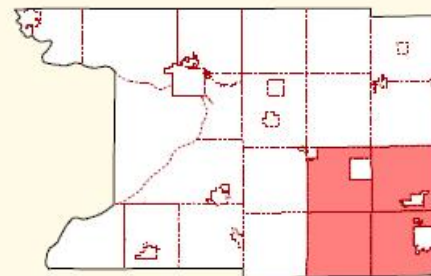
Water moving through tiny spaces in between sand particles or sandstone moves slower and allows for filtration of some contaminants.

Learn more about Wisconsin's geologic past by clicking the aquifer names



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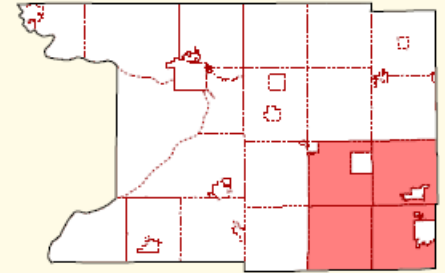
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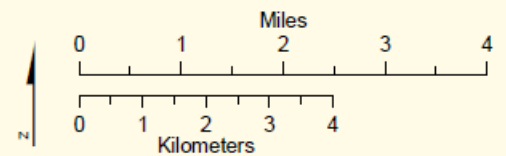
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Depth to Bedrock:

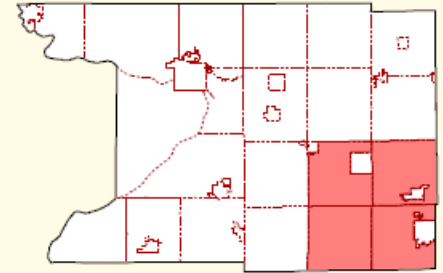
- within 5 ft - more than 70% of area
- within 5 ft - 35 to 70% of area
- 5 to 50 ft
- 50 to 100 ft
- greater than 100 ft







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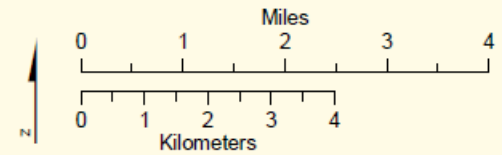
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Bedrock Units:

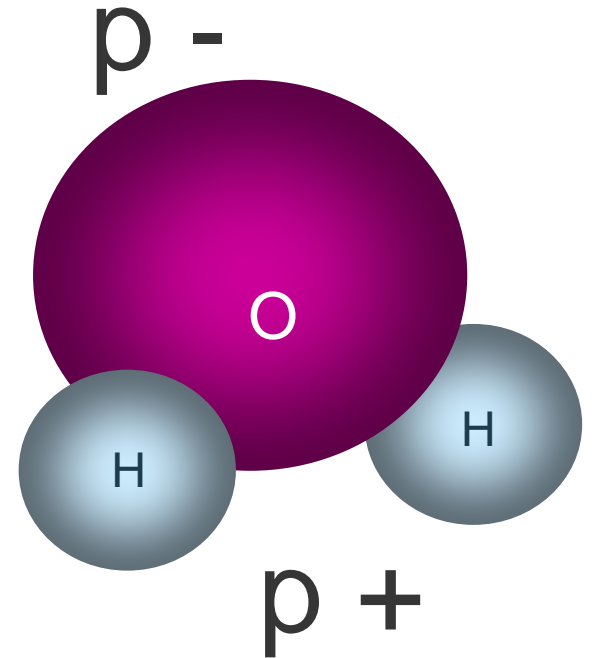
-  Cambrian Sandstone
-  Galena-Platteville Dolomite
-  Prairie du Chien Dolomite
-  St Peter Sandstone



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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.
- Can also treat water to take “stuff” out



Interpreting Drinking Water Test Results

Tests important to health:

- Bacteria
- Sodium
- Nitrate
- Copper
- Lead
- Triazine
- Zinc
- Sulfate
- Arsenic

Tests for aesthetic (taste,color,odor) problems:

- Hardness
- Iron
- Manganese
- Chloride

Other important indicator tests:

- Saturation Index
- Alkalinity
- Conductivity
- Potassium

Red = human-influenced **Blue** = naturally found

Health Concern Categories

Acute Effects

- Usually seen within a short time after exposure to a particular contaminant or substance.

(ex. Bacteria or viral contamination which may cause intestinal disease)

Chronic Effects

- Result from exposure to a substance over a long period of time.
- Increase risk of developing health complications later in life.

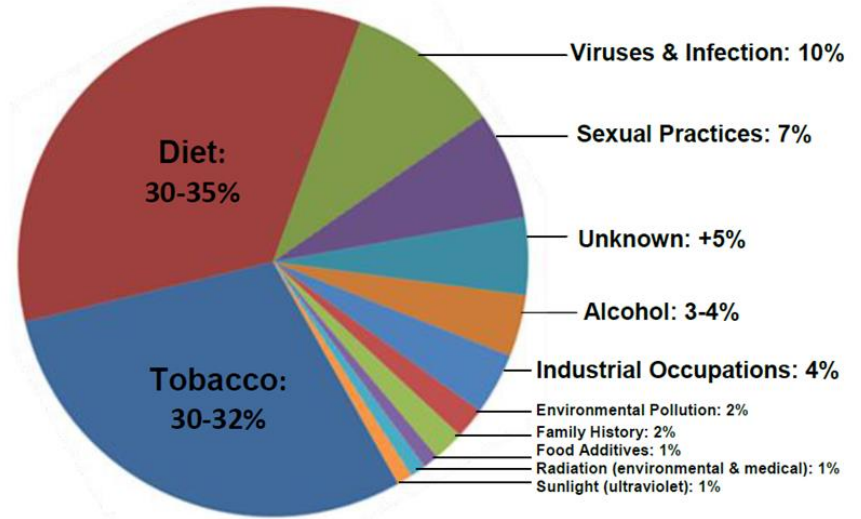
(ex. Arsenic or pesticides can increase the risk of developing certain cancers)



Chronic related health concerns are generally about risk management

National Cancer Risk Factors with Percentages

Adapted from *Everyone's Guide to Cancer Therapy*



| | |
|--|---|
| Being struck by lightning | 0.16 in 1,000 chance. |
| 0.010 mg/L of arsenic in drinking water. | 3 out of 1,000 people likely to develop cancer. |
| 2 pCi of indoor radon level. | 4 out of 1,000 people likely to develop lung cancer. ¹ |
| 2 pCi of indoor radon combined with smoking. | 32 out of 1,000 people could develop lung cancer. ¹ |

Drinking water quality is only one part of an individual's total risk.

¹<http://www.epa.gov/radon/healthrisks.html>

Private vs. Public Water Supplies

Public Water Supplies

- Regularly tested and regulated by drinking water standards.

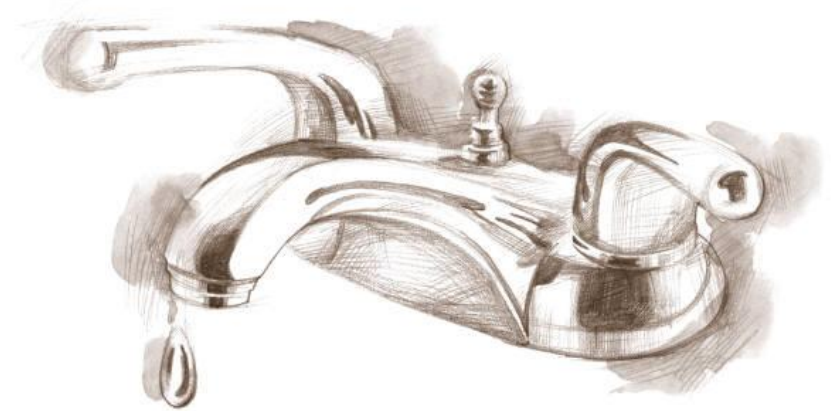
Private Wells

- Not required to be regularly tested.
- Not required to take corrective action
- Owners must take special precautions to ensure safe drinking water.



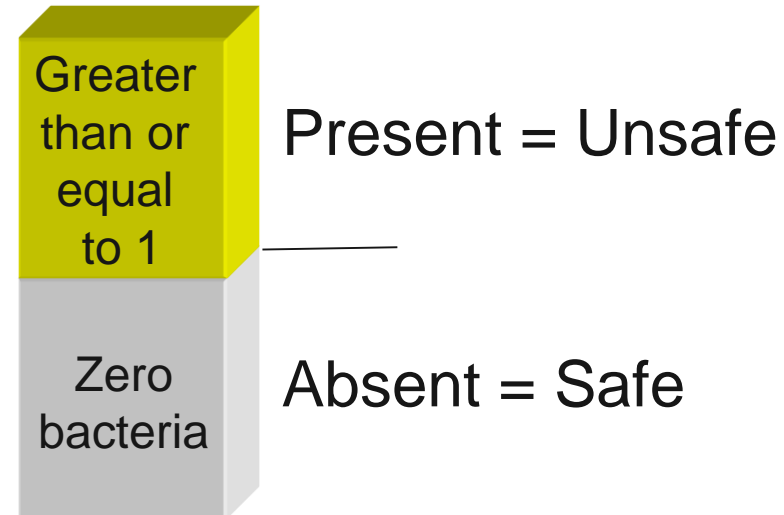
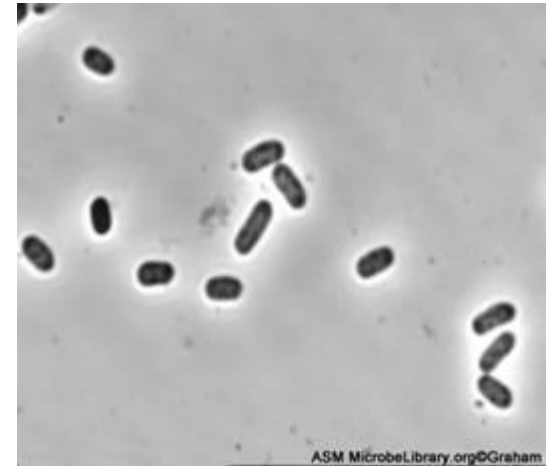
Why do people test their water?

- Installed a new well
- Change in taste or odor
- Buying or selling their home
- Plumbing issues
- Want to know if it's safe to drink.



Coliform bacteria

- Generally do not cause illness, but indicate a pathway for potentially harmful microorganisms to enter your water supply.
 - Harmful bacteria and viruses can cause gastrointestinal disease, cholera, hepatitis
- Well Code: “Properly constructed well should be able to provide bacteria free water continuously without the need for treatment”
- Recommend using an alternative source of water until a test indicates your well is absent of coliform bacteria
- Sources:
 - Live in soils and on vegetation
 - Human and animal waste
 - Sampling error



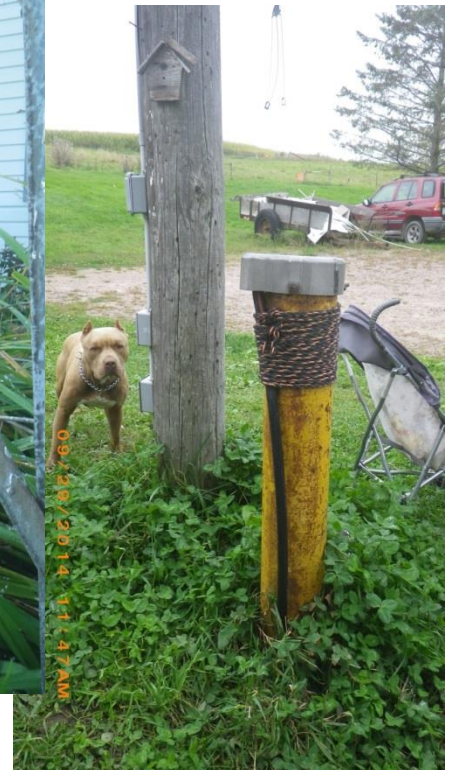
If coliform bacteria was detected, we also checked for e.coli bacteria test

- Confirmation that bacteria originated from a human or animal fecal source.
- E. coli are often present with harmful bacteria, viruses and parasites that can cause serious gastrointestinal illnesses.
- Any detectable level of E.coli means your water is unsafe to drink.

Information Sources: United States Department of Health and Human Services – Centers for Disease Control and Prevention (www.cdc.gov) and United States Environmental Protection Agency (www.epa.gov)

| Contaminants | Sources | Symptoms |
|---|--|--|
| BACTERIA | | |
| <p><i>Escherichia coliform (E. coli)</i> <i>Salmonella</i> <i>Campylobacter</i> <i>E. coli O157</i> (Requires a special water test for detection. Causes similar, but more serious illness than other E.coli strains. Requires medical treatment.)</p> | <ul style="list-style-type: none"> • Infected human and animal feces • Manure • Septic systems • Sewage | <ul style="list-style-type: none"> • Gastrointestinal illness • Low-grade fever • Begins 12 hrs - 7 days after exposure |
| <p><i>Leptosporidia</i></p> | <ul style="list-style-type: none"> • Urine of livestock, dogs and wildlife • Manure | <ul style="list-style-type: none"> • High fever, severe headache and red eyes • Gastrointestinal illness • Begins 2-28 days after exposure |
| MICROSCOPIC PARASITES | | |
| <p><i>Cryptosporidia</i> <i>Giardia</i></p> | <ul style="list-style-type: none"> • Infected human and animal feces • Manure • Septic systems • Sewage | <ul style="list-style-type: none"> • Gastrointestinal illness • Begins 2-14 days after exposure |
| VIRUSES | | |
| <p>Norovirus</p> | <ul style="list-style-type: none"> • Infected human feces and vomit • Septic systems • Sewage | <ul style="list-style-type: none"> • Gastrointestinal illness • Low-grade fever & headache • Begins 12-48 hrs after exposure |
| CHEMICALS | | |
| <p>Nitrate</p> | <ul style="list-style-type: none"> • Fertilizers • Manure • Bio-solids • Septic systems | <p>Methemoglobinemia or "Blue Baby Syndrome" – No documented cases in Door County, but elevated nitrate levels in well water may indicate risk of contamination by additional pathogens.</p> |
| <p>Atrazine (trade-name herbicide for control of broadleaf and grassy weeds)</p> | <p>Estimated to be most heavily used herbicide in the U.S. in 1987/89, with its most extensive use for corn and soybeans in the Midwest, including WI. In 1993, it became a restricted-use herbicide nationally. U.S. EPA set a max. contaminant level (MCL) at 3 parts per billion for safe drinking water.</p> | <p>Short-term exposure above the MCL may cause: congestion of heart, lungs and kidneys; low blood pressure; muscle spasms; weight loss; damage to adrenal glands.</p> <p>Long-term exposure above MCL may cause: weight loss, cardiovascular damage, retinal and some muscle degeneration; cancer.</p> |

Well Construction

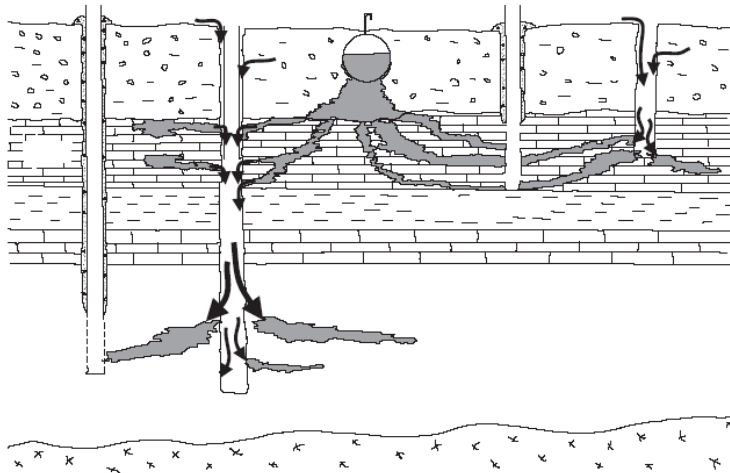


Photos courtesy of: Matt Zoschke

Other things to look for....



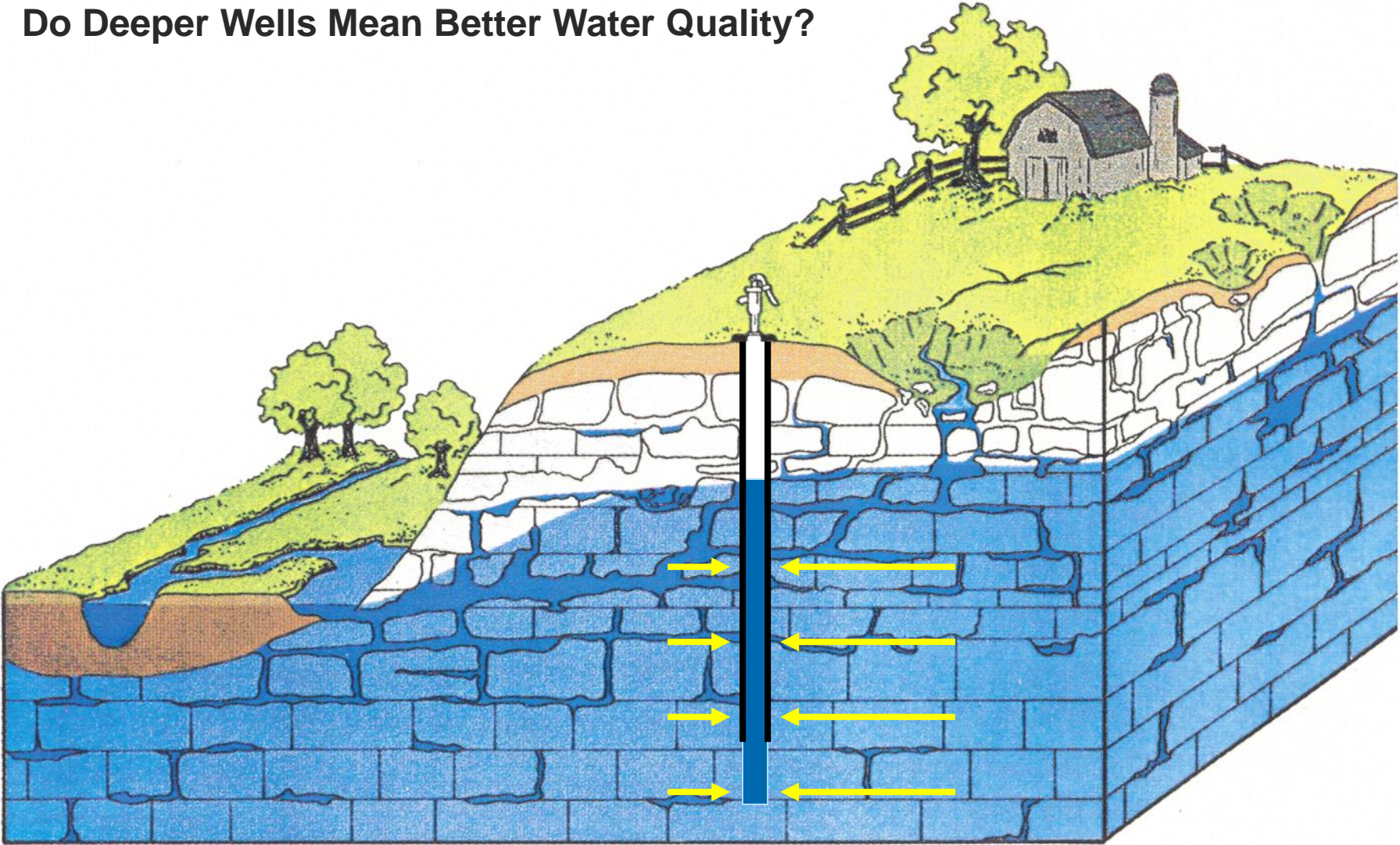
AQUIFER CONTAMINATION THROUGH IMPROPERLY ABANDONED WELLS



Source: Adapted from DiNovo and Jaffe, 1984.



Do Deeper Wells Mean Better Water Quality?



What should I do if coliform bacteria was present?

1. Use alternative source of water for drinking
2. Retest
3. Try to identify any sanitary defects
 - Loose or non-existent well cap
 - Well construction faults
 - A nearby unused well or pit
 - Inadequate filtration by soil
4. Disinfect the well
5. Retest to ensure well is bacteria free.

➤ *For reoccurring bacteria problems the best solution may be a new well or if new well is unlikely to remedy the problem because of geology, may seek approval for treatment.*

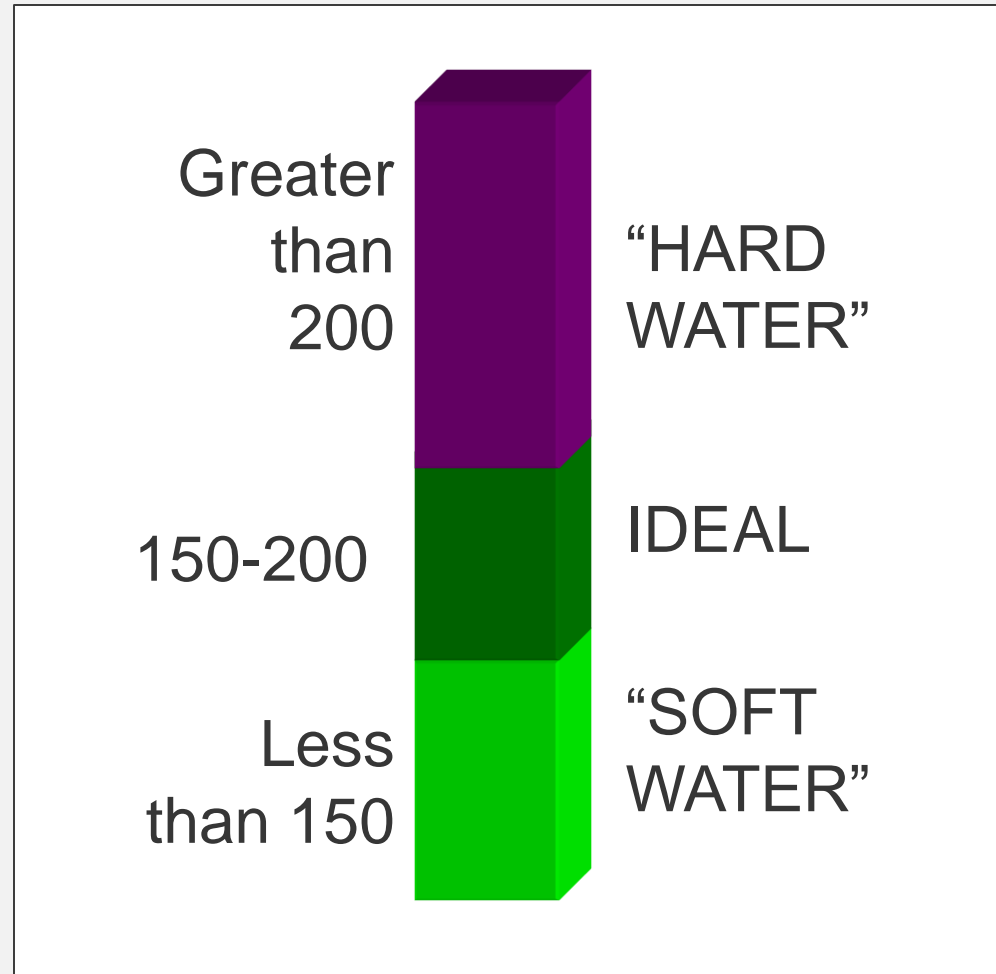


Rock and Soil Impacts on Water Quality

Tests for Aesthetic Problems

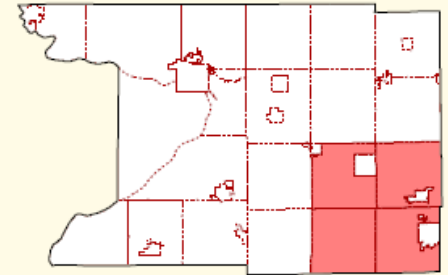
Hardness

- Natural (rocks and soils)
- Primarily calcium and magnesium
- Problems: scaling, scum, use more detergent, decrease water heater efficiency



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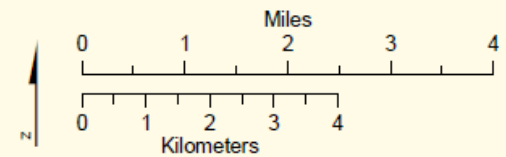
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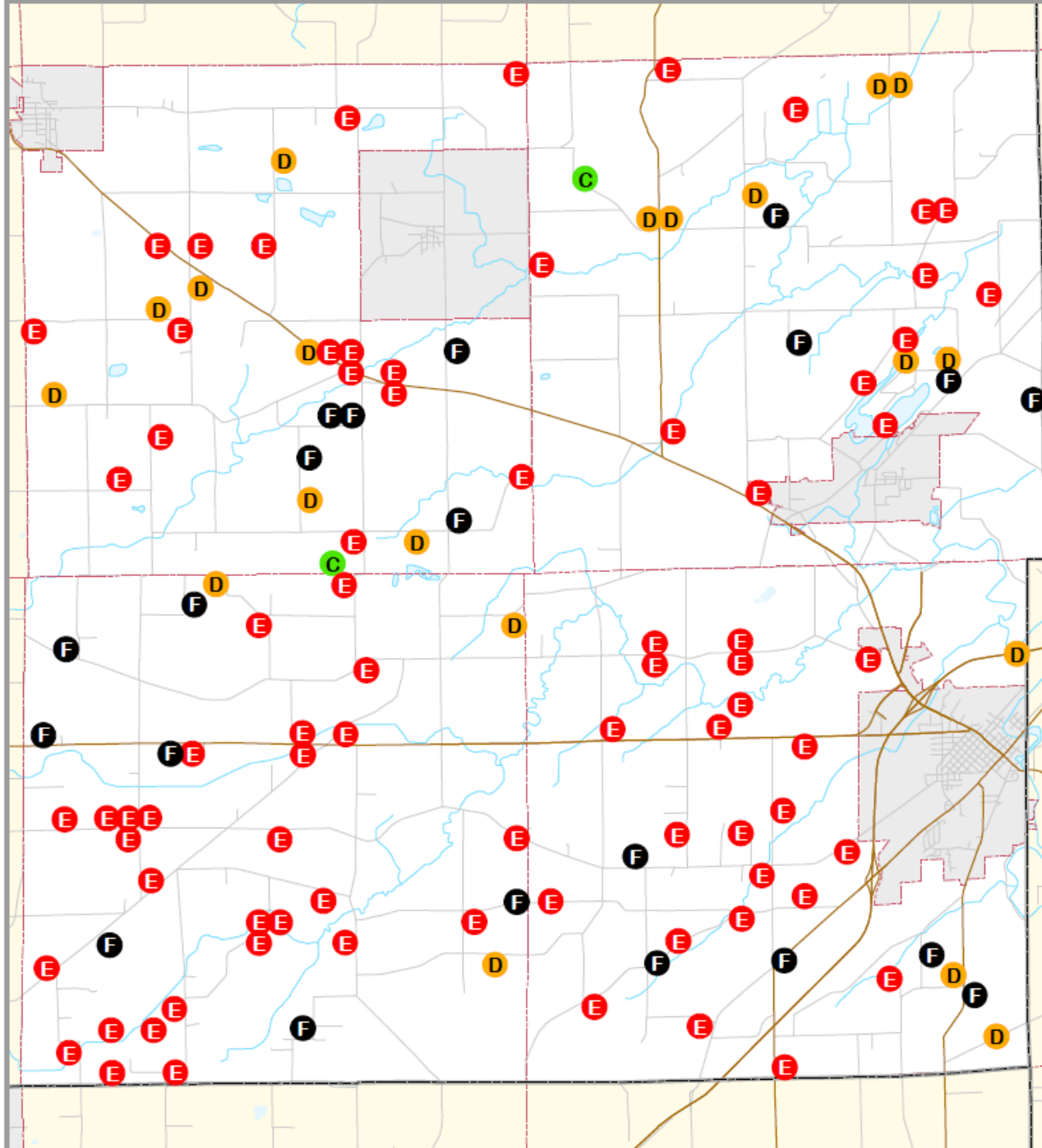
TOTAL HARDNESS (ppm CaCO₃)

| | | | |
|----------|-----------|----|------|
| A | ... 50 | 19 | 13 % |
| B | 51 - 100 | 0 | 0 % |
| C | 101 - 200 | 2 | 1 % |
| D | 201 - 300 | 21 | 14 % |
| E | 301 - 400 | 83 | 55 % |
| F | 401 ... | 26 | 17 % |

Mapped value is the average for the 1/4 1/4 section
Treated samples not mapped



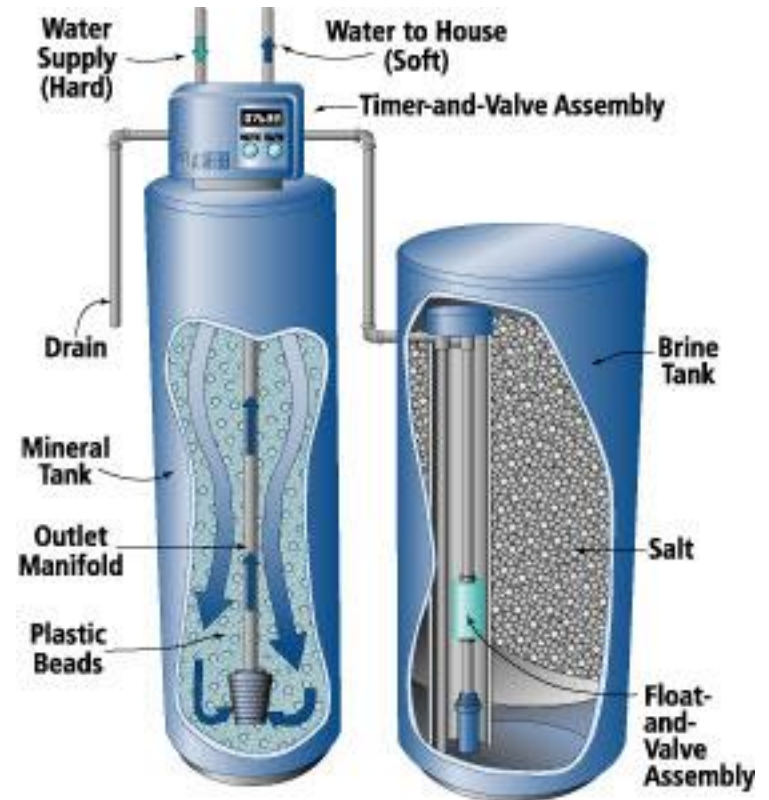
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Water Softening

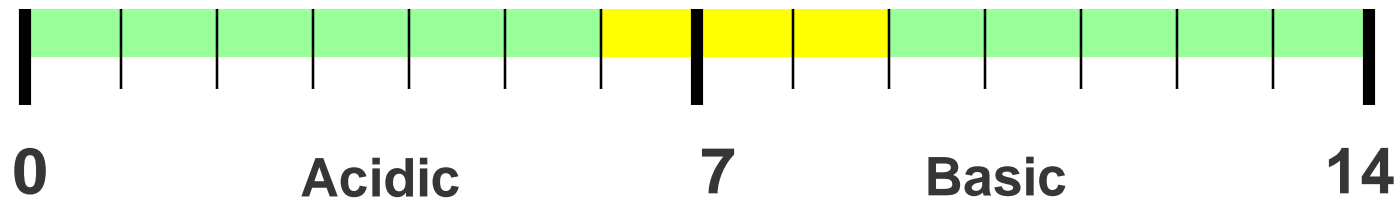
Water softeners remove calcium and magnesium which cause scaling and exchange it for sodium (or potassium).

- Negative: Increases sodium content of water.
- Suggestions:
 - Bypass your drinking water faucet.
 - Do not soften water for outdoor faucets.
 - If you are concerned about sodium levels – use potassium chloride softener salt.



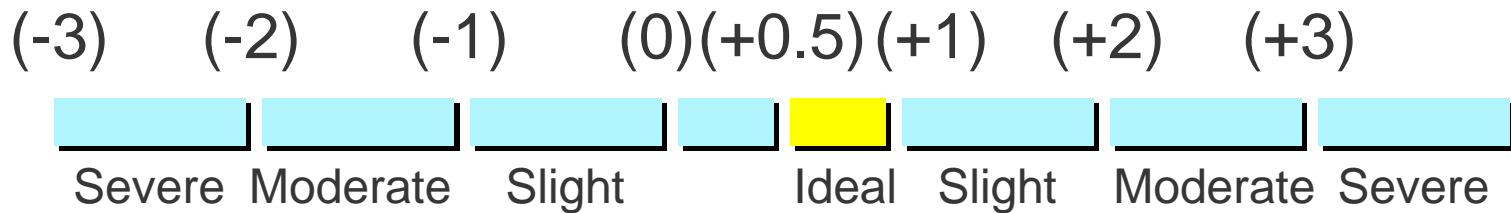
Tests for Overall Water Quality

- **Alkalinity** – ability to neutralize acid
- **Conductivity** –
 - Measure of total ions
 - can be used to indicate presence of contaminants (~ twice the hardness)
- **pH** – Indicates water's acidity and helps determine if water will corrode plumbing



Tests for Overall Water Quality

Saturation Index



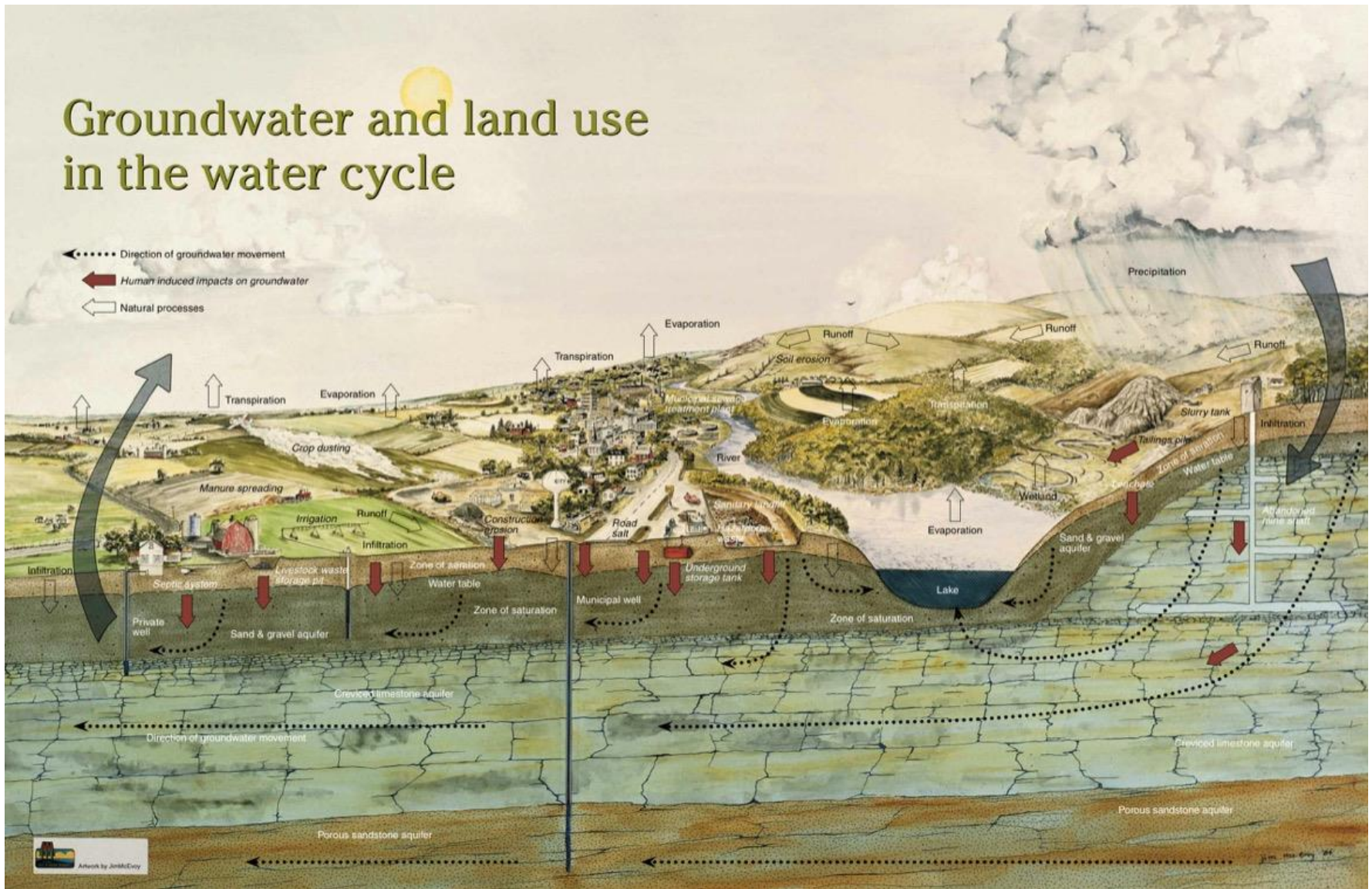
Corrosion occurs



Scaling occurs



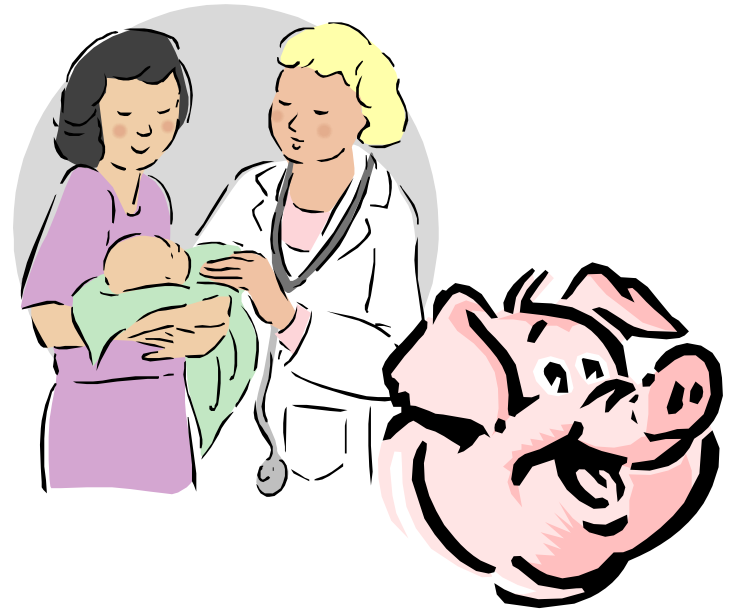
Groundwater and land use in the water cycle



Nitrate-Nitrogen

Health Effects:

- Methemoglobinemia (blue baby disease)
- Possible links to birth defects and miscarriages (humans and livestock)
- Indicator of other contaminants



Sources:

- Agricultural fertilizer
- Lawn fertilizer
- Septic systems
- Animal wastes



Test Important to Health

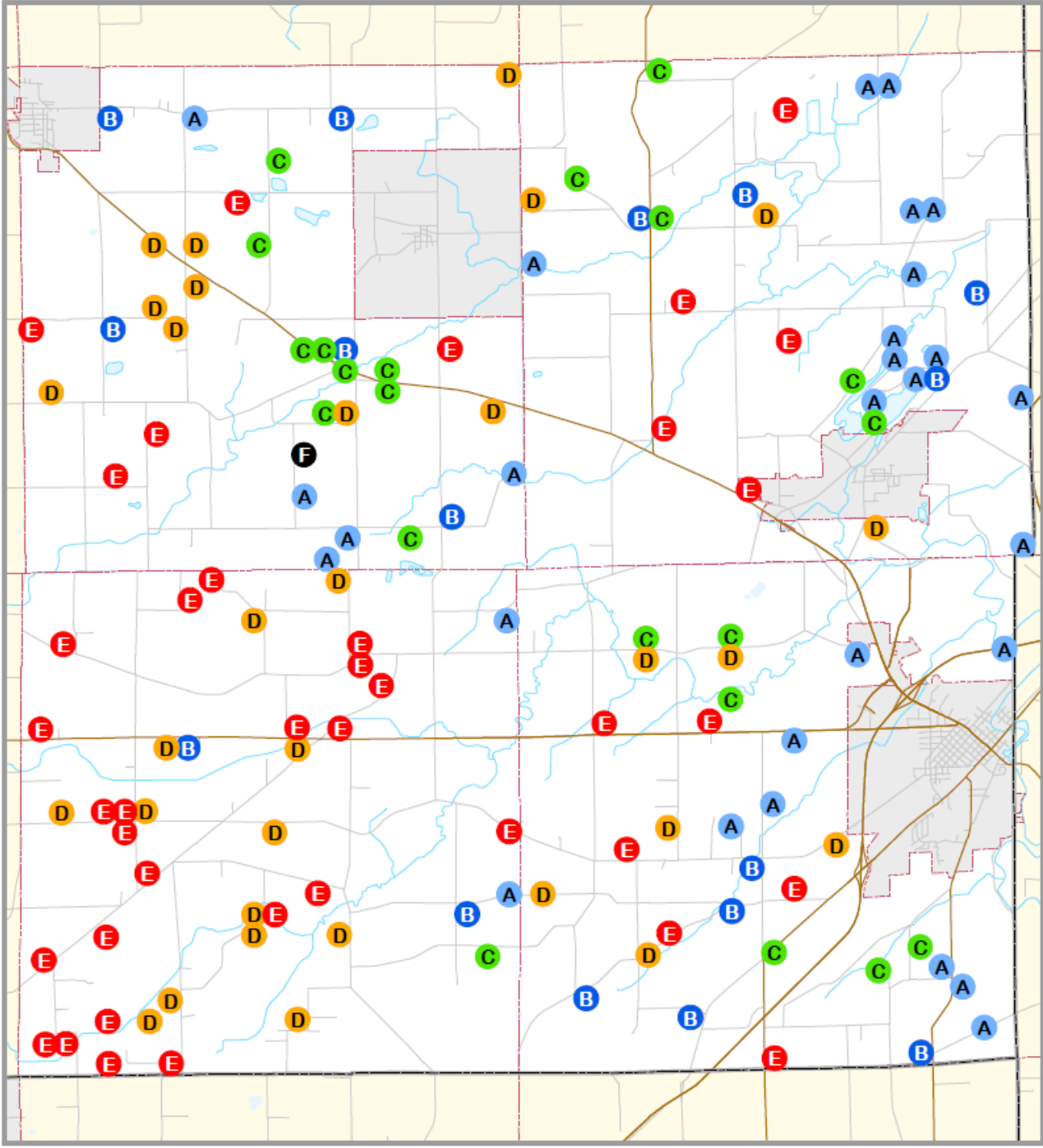
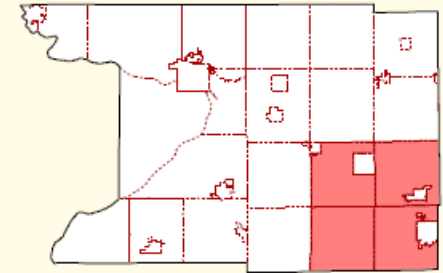
Nitrate Nitrogen

- **Greater than 10 mg/L**
Exceeds State and Federal Limits for Drinking Water
- **Between 2 and 10 mg/L**
Some Human Impact
- **Less than 2.0 mg/L**
“Transitional”
- **Less than 0.2 mg/L**
“Natural”



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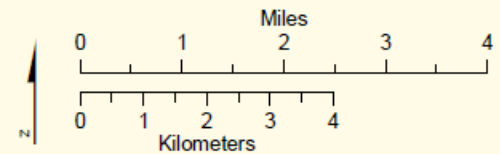
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NITRATE-NITRITE (ppm N)

| | | | |
|---|---------------|----|------|
| A | None Detected | 28 | 19 % |
| B | ... 2.0 | 20 | 13 % |
| C | 2.1 - 5.0 | 25 | 17 % |
| D | 5.1 - 10.0 | 33 | 22 % |
| E | 10.1 - 20.0 | 43 | 28 % |
| F | 20.1 ... | 2 | 1 % |

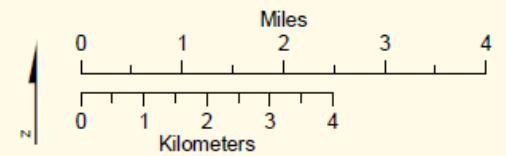
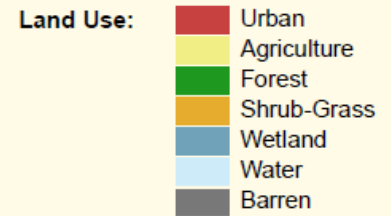
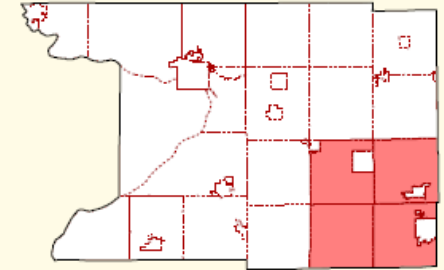
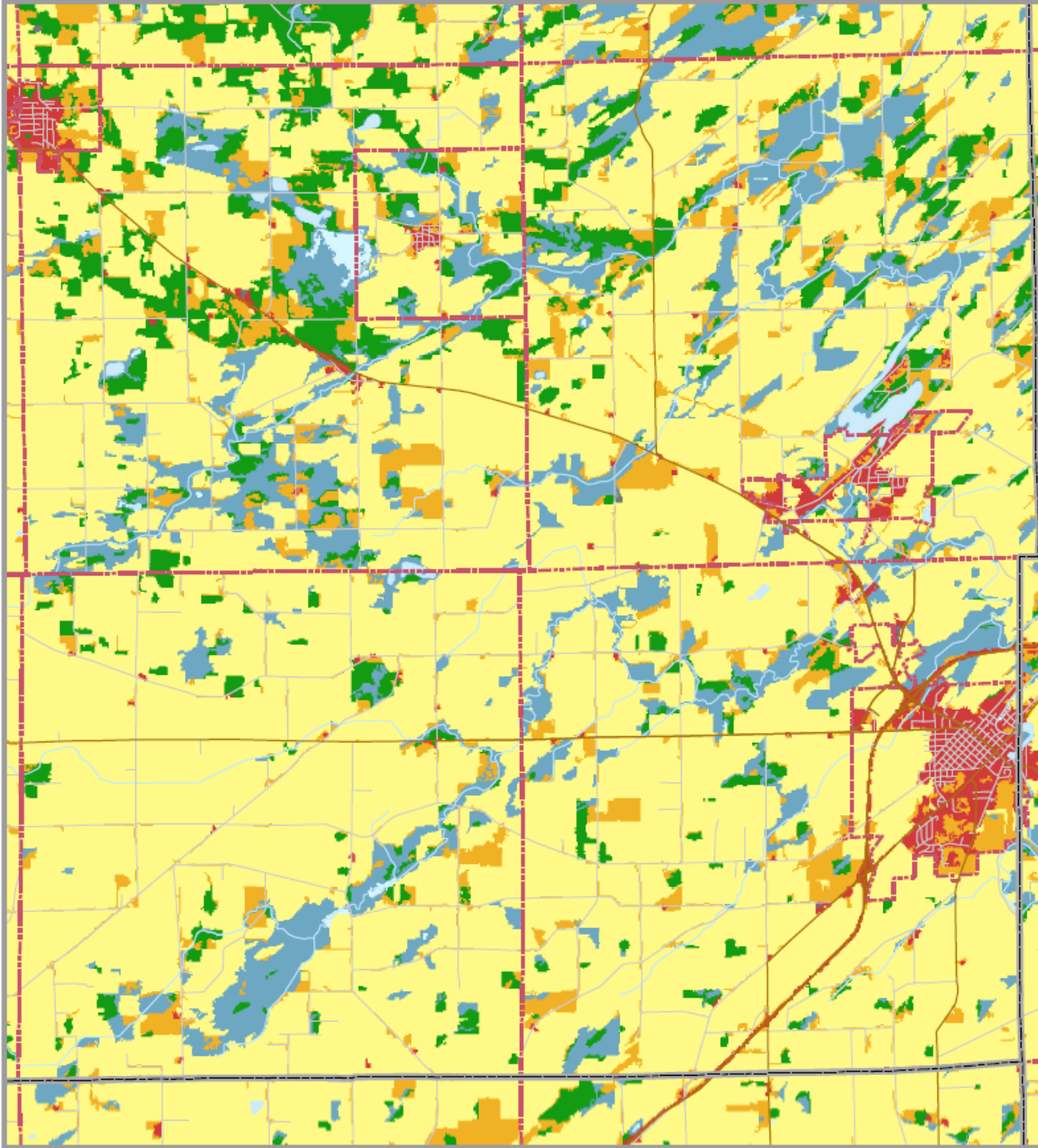
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Treated samples not mapped



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What can I do to reduce my nitrate levels?

Solution:

- **Eliminate contamination source or reduce nitrogen inputs**

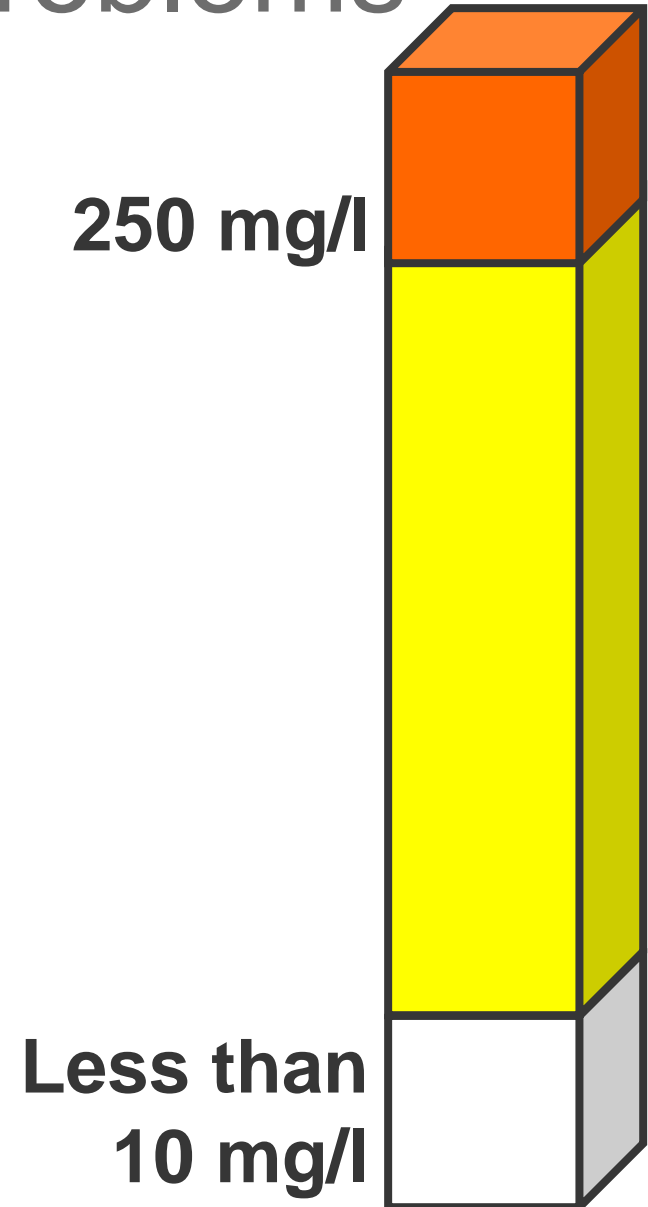
Short term:

- **Change well depth or relocate well**
- **Carry or buy water**
- **Water treatment devices**
 - **Reverse osmosis**
 - **Distillation**
 - **Anion exchange**

Tests for Aesthetic Problems

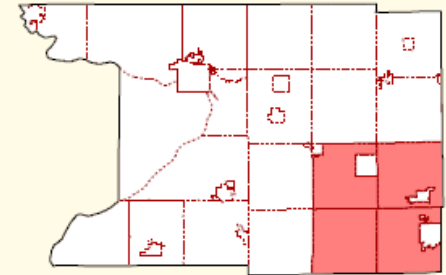
Chloride

- Greater than 250 mg/l
 - No direct effects on health
 - Salty taste
 - Exceeds recommended level
- Greater than 10 mg/l may indicate human impact
- Less than 10 mg/l considered “natural” in much of WI
- **Sources:** Fertilizers, Septic Systems and Road Salt



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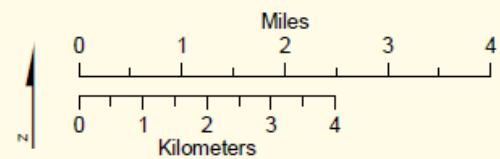
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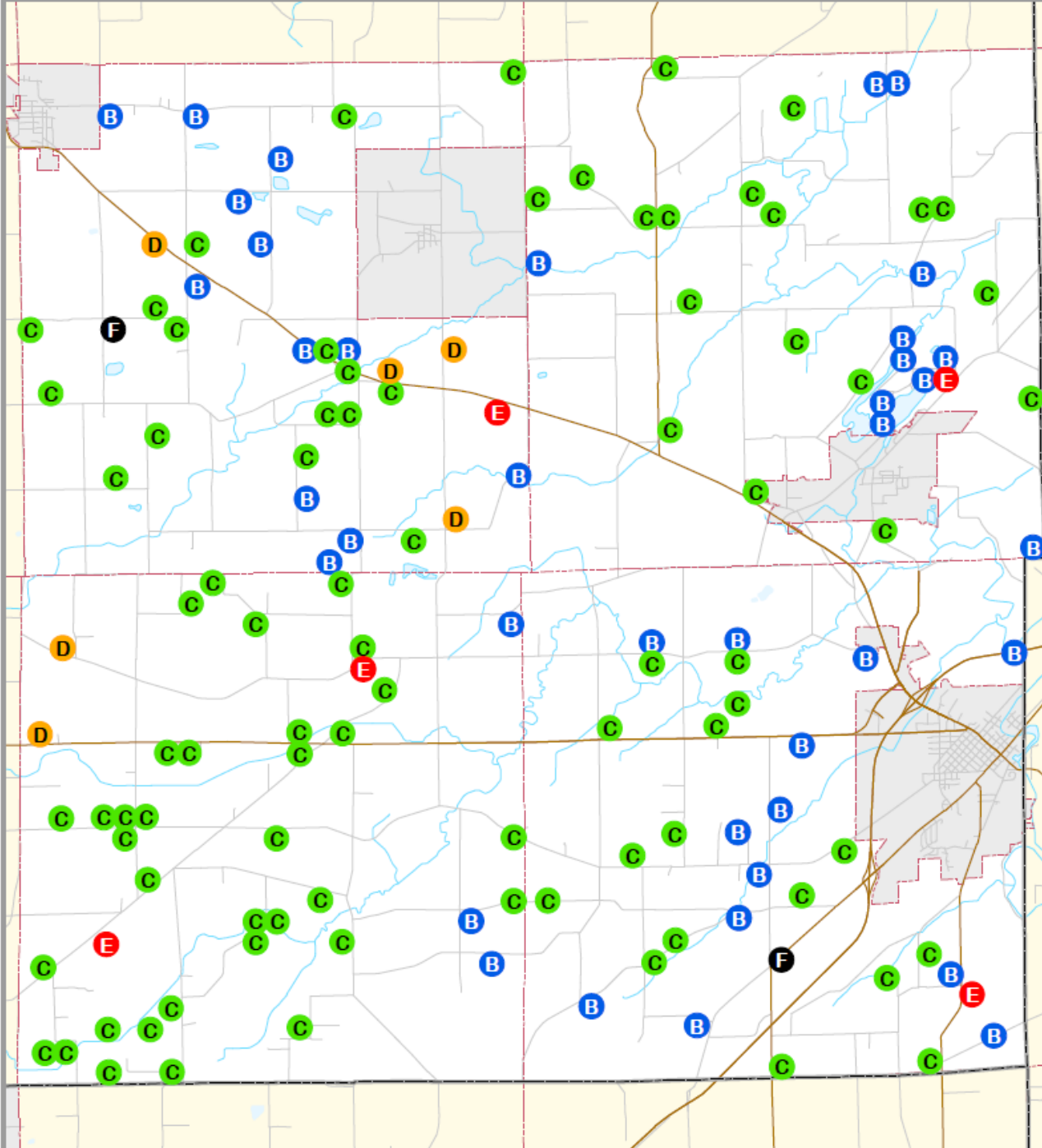
CHLORIDE (ppm)

| | | |
|------------------------|----|------|
| A None Detected | 0 | 0 % |
| B ... 10 | 45 | 30 % |
| C 11 - 50 | 88 | 58 % |
| D 51 - 100 | 11 | 7 % |
| E 101 - 200 | 4 | 3 % |
| F 201 ... | 3 | 2 % |

Mapped value is the average for the 1/4 1/4 section
Treated samples not mapped



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Test Important to Health

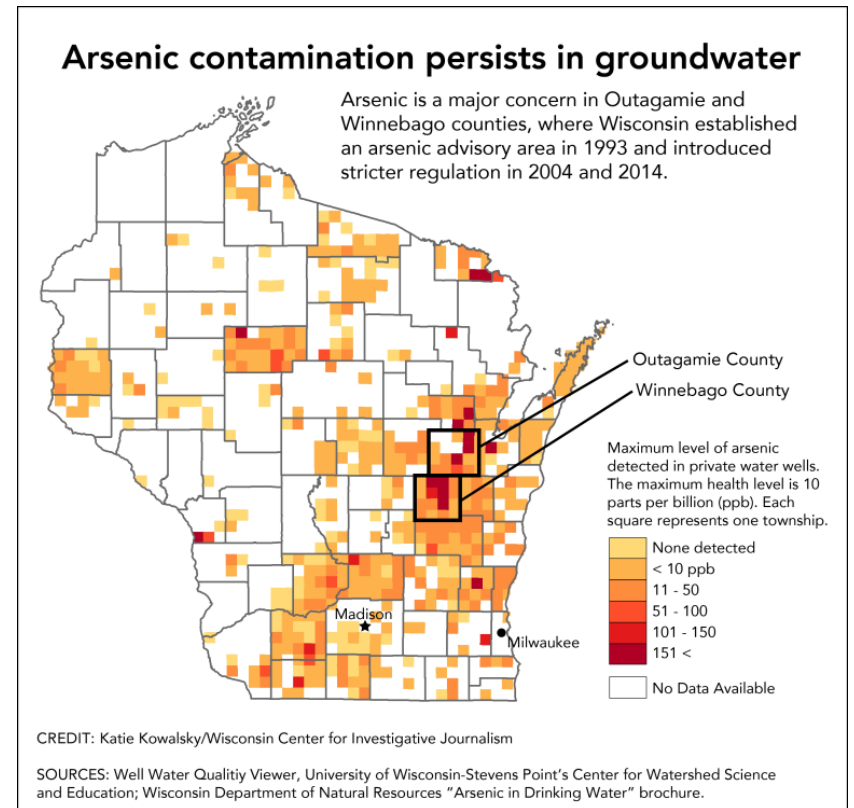
Arsenic

Sources: Naturally occurring in mineral deposits

Standard: 0.010 mg/L (10 ppb)

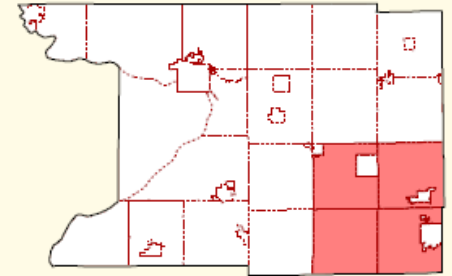
Health Effects:

- Increased risk of skin cancers as well as lung, liver, bladder, kidney, and colon cancers.
- Circulatory disorders
- Stomach pain, nausea, diarrhea
- Unusual skin pigmentation



Towns of Columbus, Fountain Prairie, Hampden, and Otsego

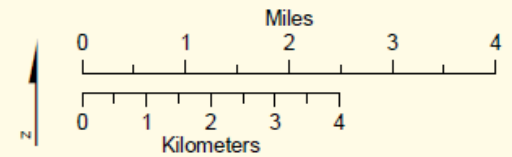
Columbia County, September 2019



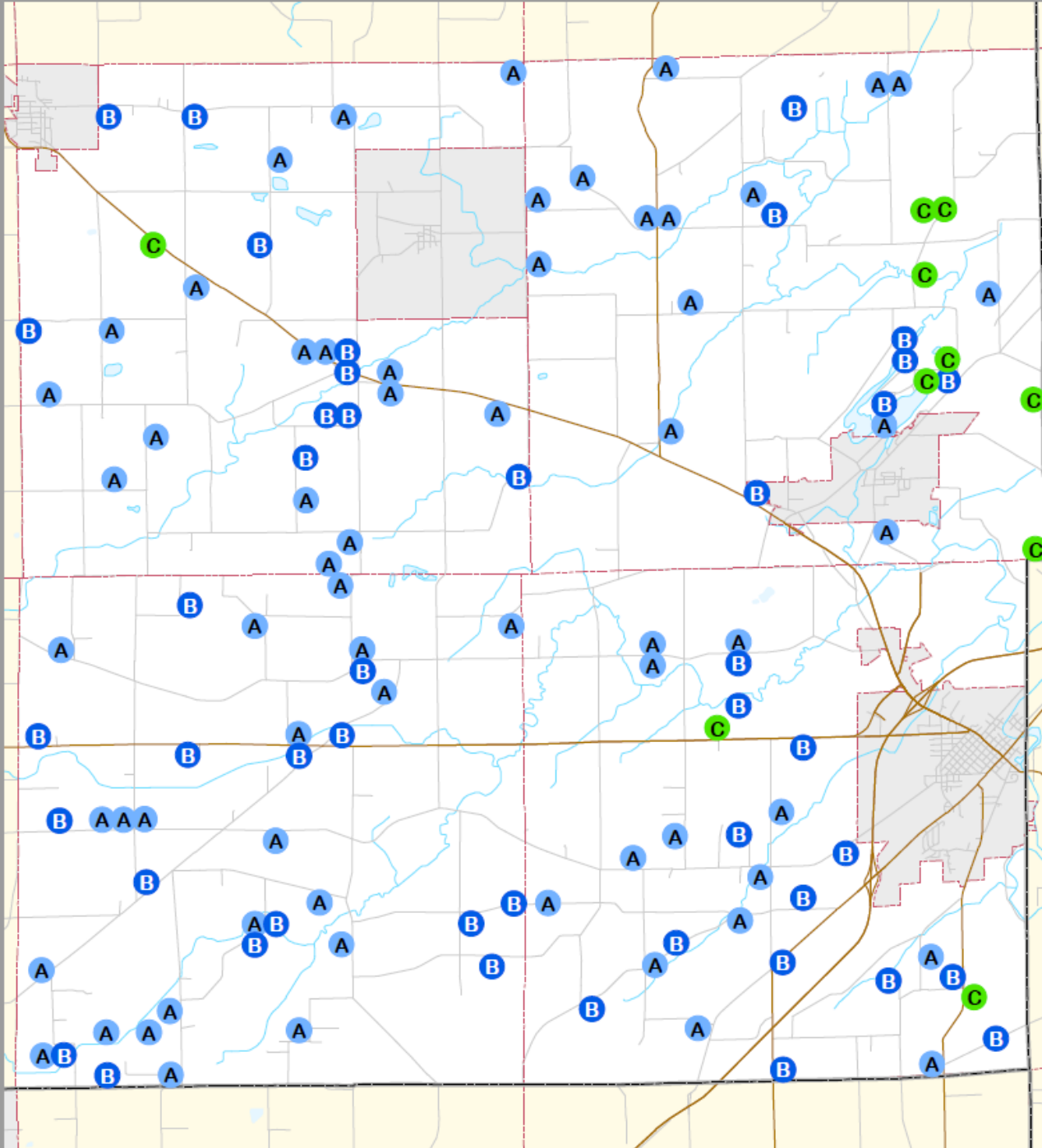
ARSENIC (mg/l)

| | | | |
|----------|---------------|----|------|
| A | None Detected | 69 | 54 % |
| B | ... 0.010 | 48 | 38 % |
| C | 0.011 - 0.050 | 11 | 9 % |
| D | 0.051 - 0.100 | 0 | 0 % |
| E | 0.101 - 0.150 | 0 | 0 % |
| F | 0.151 ... | 0 | 0 % |

Mapped value is the average for the 1/4 1/4 section
Treated samples not mapped



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Tests for Aesthetic Problems

Iron

- Natural (rocks and soils)
- May benefit health
- Red and yellow stains on clothing, fixtures

- If iron present, increases potential for iron bacteria
 - Slime, odor, oily film



**Greater
than 0.3
mg/L**

**Less
than 0.3 mg/L**

**Aesthetic
problems
likely**

Test Important to Health

Copper

- **Sources:** Copper water pipes
- **Standard:** Less than 1.3 mg/L is suitable for drinking

Health Effects:

- Some copper is needed for good health
- Too much may cause problems:
 - Stomach cramps, diarrhea,
 - vomiting, nausea
 - Formula intolerance in infants



Test Important to Health

Lead

Sources: Lead solder joining copper pipes (pre-1985) or brass fixtures

Standard: 0.015 mg/L (15 ppb)

Health Effects:

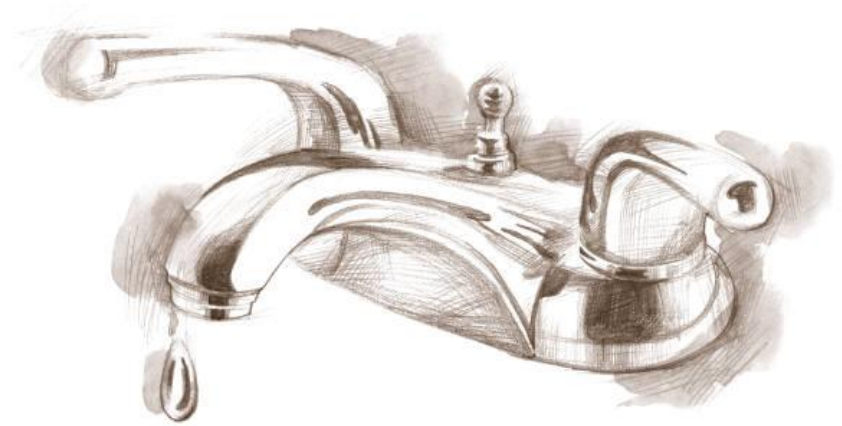
- Young children, infants and unborn children are particularly vulnerable.
- Lead may damage the brain, kidneys, nervous system, red blood cells, reproductive system.



Lead and Copper

Solutions:

- Allow water to run for a minute or two before using for drinking or cooking
or
- Use a treatment device, but generally not necessary



Pesticides in Drinking Water

- Pesticides include: insecticides, herbicides, fungicides and other substances used to control pests.
- Health standards usually only account for parent compound.
- Parent compounds breakdown over time.
- Little research into health effects from the combination of chemicals..
- **Most frequently detected pesticides in Wisconsin:**
 - Alachlor* and its chemical breakdown products
 - Metolachlor and its chemical breakdown products
 - Atrazine** and its chemical breakdown products
 - Metribuzin
 - Cyanazine and its chemical breakdown products.



Tests Important to Health

DACT Screen

Sources: Triazine pesticides (mainly atrazine used on corn crops)

DACT Screen: Only measures the diaminochlorotriazine (DACT) residue levels of triazine type pesticides (atrazine, simazine, propazine, cyanazine, etc)

Specific to diaminochlorotriazine (DACT), does not account for parent compound or other breakdown components

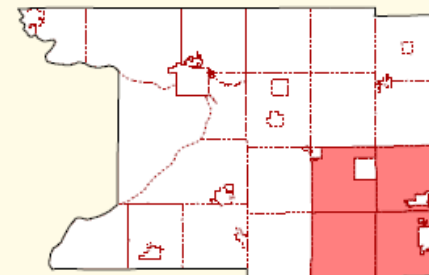
Drinking water limit:

- **3 ppb of total atrazine** (*atrazine + the 3 breakdown components*)



Towns of Columbus, Fountain Prairie, Hampden, and Otsego

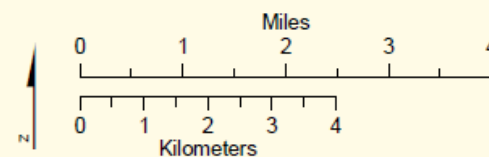
Columbia County, September 2019



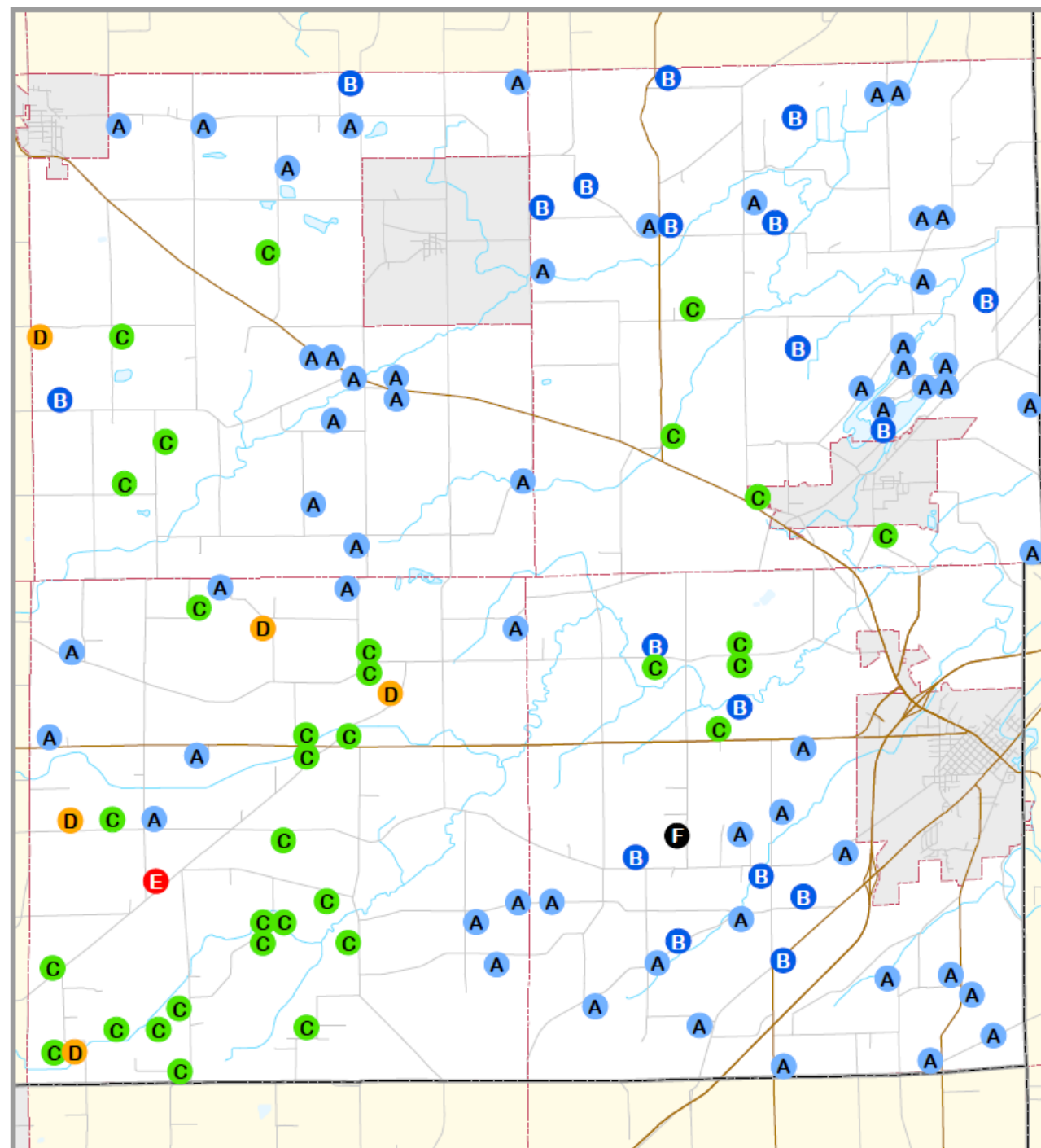
DACT (ug/l)

| | | |
|------------------------|----|------|
| A None Detected | 60 | 50 % |
| B ... 0.3 | 21 | 18 % |
| C 0.4 - 1.0 | 32 | 27 % |
| D 1.1 - 2.0 | 5 | 4 % |
| E 2.1 - 3.0 | 1 | <1 % |
| F 3.1 ... | 1 | <1 % |

Mapped value is the maximum for the 1/4 1/4 section
Treated samples not mapped



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Improving water quality

➤ Long-term improvements

- Eliminate sources of contamination

➤ Short-term improvements

- Repair or replace existing well
- Connect to public water supply or develop community water system
- Purchase bottled water for drinking and cooking
- Install a water treatment device
 - Often the most convenient and cost effective solution

understanding water treatment

- **Advantages:**

- + Reduce level of contaminants and other impurities
- + Improve taste, color and odor

- **Disadvantages:**

- Require routine maintenance.
- Can require large amounts of energy.
- Testing is often the only way to know it is functioning properly for most health related contaminants.

- **Cautions:**

- Treatment methods often selective for certain contaminants
- Multiple treatment units may be necessary
- Treatment may also remove beneficial elements from water in the process.



Where do you go from here: Recommended next steps

- Test well annually for bacteria, or if water changes color or clarity.
- Consider testing annually for nitrate, particularly if your levels are approaching 10 mg/L.
- If your nitrate level was greater than 5 mg/L consider testing for pesticides
- If you haven't checked for arsenic consider testing.
- If arsenic was present, test again in 15 months to see if levels have changed significantly.

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- **Columbia County Health Department**
- **Towns of Columbus, Fountain Prairie, Hampden, and Otsego**



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