Groundwater and Well Water Education Program
Douglas County
Today’s presentation

- Groundwater Basics: Where does my water come from
- Well Construction
- What do my individual test results mean?
- General groundwater quality in Douglas County
- Improving your water quality
Wisconsin has 3 major basins

- Lake Superior Basin
- Mississippi River Basin
- Lake Michigan Basin
Groundwater Movement

Water infiltrates the subsurface through interconnected pores

Well

Groundwater discharge

Saturated zone

Unsaturated zone

Water table
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.
“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

<table>
<thead>
<tr>
<th>Tests important to health:</th>
<th>Tests for aesthetic (taste, color, odor) problems:</th>
<th>Other important indicator tests:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bacteria</td>
<td>• Hardness</td>
<td>• Saturation Index</td>
</tr>
<tr>
<td>• Sodium</td>
<td>• Iron</td>
<td>• Alkalinity</td>
</tr>
<tr>
<td>• Nitrate</td>
<td>• Manganese</td>
<td>• Conductivity</td>
</tr>
<tr>
<td>• Copper</td>
<td>• Chloride</td>
<td>• Potassium</td>
</tr>
<tr>
<td>• Lead</td>
<td></td>
<td></td>
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<tr>
<td>• Triazine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Zinc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Sulfate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Arsenic</td>
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</tr>
</tbody>
</table>

**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.

<table>
<thead>
<tr>
<th>Being struck by lightning</th>
<th>0.16 in 1,000 chance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.010 mg/L of arsenic in drinking water.</td>
<td>3 out of 1,000 people likely to develop cancer.</td>
</tr>
<tr>
<td>2 pCi of indoor radon level.</td>
<td>4 out of 1,000 people likely to develop lung cancer.¹</td>
</tr>
<tr>
<td>2 pCi of indoor radon combined with smoking.</td>
<td>32 out of 1,000 people could develop lung cancer.¹</td>
</tr>
</tbody>
</table>

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

¹http://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.

[Image: https://www.wisconsinwatch.org/2013/05/22/20-years-after-fatal-outbreak-milwaukee-leads-on-water-testing/]

[Image: Private well surrounded by leaves and vegetation]
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.
Well Construction

Photos courtesy of: Matt Zoschke
Other things to look for....
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

<table>
<thead>
<tr>
<th>Hardness Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 200</td>
<td>“HARD WATER”</td>
</tr>
<tr>
<td>150-200</td>
<td>IDEAL</td>
</tr>
<tr>
<td>Less than 150</td>
<td>“SOFT WATER”</td>
</tr>
</tbody>
</table>
Douglas County
February & October 2018

TOTAL HARDINESS (ppm CaCO3)

- A ... 50  
  - 35  22%
- B 51 - 100  
  - 51  32%
- C 101 - 200  
  - 40  25%
- D 201 - 300  
  - 3   2%
- E 301 - 400  
  - 9   6%
- F 401 ...  
  - 19  12%

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**

(-3)  (-2)  (-1)  (0)(+0.5)(+1)  (+2)  (+3)

Severe  Moderate  Slight  Ideal  Slight  Moderate  Severe

Corrosion occurs  Scaling occurs
Soil

Land-use activity that pollutes groundwater.

Because groundwater moves, wells located far from the contamination source can sometimes be polluted from activities not directly surrounding the well.
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
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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Test Important to Health

UNSAFE - for infants and pregnant women; everyone should avoid long term consumption.

“NATURAL”
Douglas County
February & October 2018

NITRATE-NITRITE (ppm N)

- **A**: None Detected 141 90%
- **B**: 0.0 - 2.0 13 8%
- **C**: 2.1 - 5.0 2 1%
- **D**: 5.1 - 10.0 1 <1%
- **E**: 10.1 - 20.0 0 0%
- **F**: 20.1 - 30.0 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

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
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
ARSENIC (mg/l)

- **A**: None Detected 130 82%
- **B**: ... 0.010 26 16%
- **C**: 0.011 - 0.050 2 1%
- **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
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

Less than 0.3 mg/L

Greater than 0.3 mg/L

Aesthetic problems likely
Douglas County
February & October 2018

IRON (mg/l)

- A: None Detected (31 samples, 20%)
- B: ... 0.300 (94 samples, 59%)
- C: 0.301 - 1.000 (17 samples, 11%)
- D: 1.001 - 2.000 (4 samples, 3%)
- E: 2.001 - 5.000 (7 samples, 4%)
- F: 5.001 ... (5 samples, 3%)

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

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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.

http://ourbetterhealth.org/category/pets/
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
Sulfate

If your level is:

Greater than 500 mg/L
- May contribute to low milk production and butterfat production in dairy cows.

Greater than 250 mg/L
- May cause a laxative effect particularly in people not accustomed to consuming water at this level.

Less than 250 mg/L
- Not likely to be a concern at these levels.

General Information:
Naturally occurring in groundwater in some parts of Wisconsin.

Health Concerns:
Concentrations over 250 mg/L may give water an off taste and cause diarrhea in people not accustomed to consuming the water. Sulfate over 500 mg/L may lower milk production and butterfat production in dairy cows.

Additional Information:
Sulfate is not the same as hydrogen sulfide.
Douglas County
November 2019

SULFATE (mg/l)

<table>
<thead>
<tr>
<th>Class</th>
<th>Range</th>
<th>Count</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>None Detected</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>B</td>
<td>...25</td>
<td>58</td>
<td>76 %</td>
</tr>
<tr>
<td>C</td>
<td>26 - 50</td>
<td>10</td>
<td>13 %</td>
</tr>
<tr>
<td>D</td>
<td>51 - 75</td>
<td>0</td>
<td>0 %</td>
</tr>
<tr>
<td>E</td>
<td>76 - 100</td>
<td>1</td>
<td>1 %</td>
</tr>
<tr>
<td>F</td>
<td>101 ...</td>
<td>7</td>
<td>9 %</td>
</tr>
</tbody>
</table>

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Treated samples not mapped

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Tests for Aesthetic Problems

Manganese

- Natural (rocks and soils)
- Aesthetic issues: taste, odor, color (black staining or precipitates)
- Health Advisory Level: 0.300 mg/L

Many years of exposure to high levels of manganese can cause harm to the nervous system. A disorder similar to Parkinson’s disease can result. This type of effect is most likely to occur in the elderly. The federal health advisory for manganese is intended to protect against this effect.
Douglas County
November 2019

MANGANESE (mg/l)

- A: None Detected 16 21%
- B: 0.050 36 47%
- C: 0.051 - 0.300 18 24%
- D: 0.301 - 0.500 5 7%
- E: 0.501 - 1.000 0 0%
- F: 1.001 ... 1 1%

Mapped value is the average 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
Where do you go from here: Recommended next steps

- Test well annually for bacteria, or if water changes color or clarity.
- If levels are elevated, test again in 15 months for nitrate.
- If you detected arsenic, considering testing every 5 – 10 years to see if levels are changing.
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