Town of Saratoga
Community Drinking Water Program

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

- Groundwater Basics: Where does my water come from
- Well Construction
- What do my individual test results mean?
- General groundwater quality in the Town of Saratoga.
- Improving your water quality
What is groundwater?

Rainfall or snowmelt that infiltrates into the subsurface will eventually reach a point where all the empty spaces in either the soil or rock are completely filled with water. This area is sometimes referred to as the saturated zone.

The water in the saturated zone is our groundwater. Groundwater is always moving very slowly through the interconnected pores and fractures in the rock beneath the land surface.

Groundwater typically flows from recharge areas, to discharge areas. Discharge areas occur in areas where the top of the saturated zone (the water table) intersects the land surface. Rivers, streams, lakes, springs and wetlands are all examples of groundwater discharge features.

Your well extends down past the water table and removes groundwater from the surrounding aquifer. Most private wells access groundwater that recharged within ¼ to ½ mile of the well.

Groundwater is the area below the land surface where all the cracks and spaces between soil and rock are completely filled with water. Aquifers are simply the water bearing geological formations that hold our groundwater. Groundwater in fractured rock aquifers will move much more quickly than water in a sandstone or sand and gravel aquifer.
What is a Watershed?

A watershed is the land area where water originates for a particular river or stream. Some of the water will reach the surface water body from overland flow, much of it however will come from groundwater that recharged somewhere within the watershed. Large regional watersheds are made up of many small local watersheds that are tributaries of a larger river system.

Figure by Kevin Masarik, CWSE
Wisconsin’s Watersheds

Wisconsin has three major watersheds or drainage basins. Rivers in the Lake Michigan Watershed are indicated by blue lines, rivers in the Lake Superior Watershed are indicated by orange lines, and rivers in the Mississippi River Watershed are indicated by green lines.

These three watersheds are further subdivided into the watersheds that you see below, represented by the different colors.
Groundwater flows from recharge areas to discharge areas (streams, rivers, lakes and wetlands). It is responsible for providing a large percentage of the water in Wisconsin’s surface waters. The water table is not flat and changes in groundwater elevation are often similar to changes in the land surface elevation. Groundwater can often be determined by locating the nearest river or stream and assuming that the water is traveling to that discharge feature.
Groundwater flow direction based off of water table elevation map
What happens when we have more rain?

- Impermeable bedrock
- Local groundwater flow
- Regional groundwater flow
What happens when we have more rain?

- More infiltration
- Groundwater levels rise
- More water in rivers, lakes and streams
- *Seasonal and Climatic Implications*
What happens when we have less rain?
What happens when we have less rain?

- Less infiltration
- Groundwater levels start to go down
- Less water in rivers, lakes and streams
- *Seasonal and Climatic Implications*
Types of Wells

Drilled Well

Driven Point Well
Do Deeper Wells Mean Better Water Quality?
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
What are the Health Concerns?

- **Acute Effects** – Usually seen within a short time after exposure to a substance.
  (ex. Bacteria or viral contamination which may cause intestinal disease)

- **Chronic Effects** – Results from exposure to a substance over a long period of time.
  (ex. Arsenic or pesticides can increase the chance of developing certain types of cancer)
# Understanding Risk…?

<table>
<thead>
<tr>
<th>Event</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dying from a lightning strike.</td>
<td>0.013 in 1,000 chance.</td>
</tr>
<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>Dying in a car accident.</td>
<td>4 in 1,000 chance.</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.

¹[http://www.epa.gov/radon/healthrisks.html](http://www.epa.gov/radon/healthrisks.html)
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.
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.
No one test tells us everything we need to know about the safety and condition of a water supply.
1 mg/l = 1000 parts per billion (ppb)
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

- Sanitary water supply should not contain any coliform bacteria

- 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

Present = Unsafe
Absent = Safe
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.

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**Contaminants** | **Sources** | **Symptoms**
---|---|---
**BACTERIA**
*Escherichia coli* *(E. coli)*  
*Salmonella*  
*Campylobacter*  
*E. coli 0157* (Requires a special water test for detection. Causes similar, but more serious illness than other E.coli strains. Requires medical treatment.)
- Infected human and animal feces  
- Manure  
- Septic systems  
- Sewage
- Urine of livestock, dogs and wildlife  
- Manure
- High fever, severe headache and red eyes  
- Gastrointestinal illness  
- Begins 2-28 days after exposure

**MICROSCOPIC PARASITES**
*Cryptosporidia*
- Infected human and animal feces  
- Manure  
- Septic systems  
- Sewage
- Gastrointestinal illness  
- Begins 2-14 days after exposure

*Giardia*
- Infected human feces and vomit  
- Septic systems  
- Sewage
- Gastrointestinal illness  
- Low-grade fever & headache  
- Begins 12-48 hrs after exposure

**VIRUSES**
*Norovirus*
- Infected human feces and vomit  
- Septic systems  
- Sewage
- Gastrointestinal illness  
- Low-grade fever  
- Begins 12-48 hrs after exposure

**CHEMICALS**
*Nitrate*
- Fertilizers  
- Manure  
- Bio-solids  
- Septic systems
- 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.

*ATRazine*  
*(trade-name herbicide for control of broadleaf and grassy weeds)*
- 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 1999, 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.
- 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.  
- Long-term exposure above MCL may cause: weight loss, cardiovascular damage, retinal and some muscle degeneration; cancer.
Some Common Pathways for Bacteria to Enter Your Water System
Comm 82.40(8)(e)2., Wisconsin Administrative Code prohibits the installation of a yard hydrant with a below ground discharge. The code reads:

“Stop and waste-type control valves may not be installed underground.”

This type of hydrant, with a below ground discharge is popular because of the ease of operation and the relative low cost.

The plunger (control valve) is located below the frost line. When the handle is lifted water enters the riser and flows through the head. A drain at the same level as the plunger allows water in the riser and the head to drain each time the handle is lowered. This draining action prevents freezing temperatures from causing the water in the hydrant riser or head to expand and burst the device. If a hose connected to the hydrant without a hose connection vacuum breaker were submerged in a barrel, the entire contents of the barrel could be siphoned through the drain port and could contaminate the groundwater or even your drinking water supply.

If you have further questions, please check the Commerce website at: http://commerce.wi.gov/SB/SB-PlumbingProgram.html

or, contact your local plumbing inspector

or, contact one of the consultants listed

What does an approved yard hydrant look like?

There’s no “one” answer for a code-compliant yard hydrant. Many manufacturers produce models that are code compliant. When you buy a hydrant, make sure that it has an approved hose connection vacuum breaker and does not include an underground drain.

And if you install a hose connection vacuum breaker on a yard hydrant make sure you loosen it during the winter to prevent freezing conditions from bursting the hydrant.

If you find a model that you have questions about, contact the department or your local plumbing inspector.

<table>
<thead>
<tr>
<th>District #</th>
<th>Name</th>
<th>Phone / fax</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tim Joyce</td>
<td>608-235-0555 / 608-283-7454</td>
</tr>
<tr>
<td>2</td>
<td>Tom Braun</td>
<td>715-540-5387 / 608-283-7455</td>
</tr>
<tr>
<td>3</td>
<td>Don Orenus</td>
<td>715-584-2007 / 608-283-7452</td>
</tr>
<tr>
<td>4</td>
<td>Don Hough</td>
<td>715-634-4804 / 608-283-7451</td>
</tr>
<tr>
<td>5</td>
<td>Ryan Boebe</td>
<td>608-412-3998 / 608-283-7449</td>
</tr>
</tbody>
</table>
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.
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
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.
Town of Saratoga
Wood County
November 2012

TOTAL HARDNESS (ppm CaCO3)

<table>
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<tr>
<th>Category</th>
<th>Value</th>
<th>Percentage</th>
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<tr>
<td>A</td>
<td>... 50</td>
<td>25</td>
</tr>
<tr>
<td>B</td>
<td>51 - 100</td>
<td>36</td>
</tr>
<tr>
<td>C</td>
<td>101 - 200</td>
<td>14</td>
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<tr>
<td>D</td>
<td>201 - 300</td>
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<tr>
<td>E</td>
<td>301 - 400</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>401 ...</td>
<td>0</td>
</tr>
</tbody>
</table>

Mapped value is the average unless otherwise indicated. Treated samples not mapped.
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
Land Use and Water Quality

Well pumping water
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”*

**Test Important to Health**

![Bar chart showing nitrate levels and their implications for health.](chart.png)

**UNSAFE** - for infants and pregnant women; everyone should avoid long term consumption.
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
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
  “Natural” in much of WI
Tests for Aesthetic Problems

Iron

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

- Potential for iron bacteria
  - Slime, odor, oily film

Aesthetic problems likely

0.3 mg/L

0
Copper

- Sources: Copper water pipes
- Standard: 1.3 mg/L

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

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

- Run water until cold before drinking.
- Use a treatment device.
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
Pesticides in Drinking Water

- 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 WI:
- 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.

* WI public health groundwater standard for breakdown component Alachlor ESA.
** WI public health groundwater standard is for the total chlorinated atrazine residue.
Tests Important to Health

**DACT Screen**

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

- **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*
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.
Before investing in treatment....

- Always have water tested at a certified lab before investing in water treatment.
  - Know the types and amounts of chemicals you would like removed.

- Choose a device that has been approved by the Wisconsin Department of Commerce.
  - Ask for a copy of the approval letter.
    - or
  - Check the agency’s Drinking Water Treatment Product Approval website:
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 pesticides, you may want to perform a more extensive and accurate pesticide analysis.
Next Steps

➢ Test for known or potential contaminants in your neighborhood
  - Gasoline?
  - Pesticides?
  - Solvents?

Check for known contamination sites in Wood County at:
http://dnr.wi.gov/org/aw/rr/gis/index.htm
Thanks to the following for helping sponsor this program:

- Town of Saratoga
- Wood County UW-Extension
- Wood County Health Department

For more information contact:
Kevin Masarik
Center for Watershed Science and Education
800 Reserve St.
Stevens Point, WI 54481
715-346-4276
kmasarik@uwsp.edu

www.uwsp.edu/cnr-ap/watershed