Perspectives from My 25 Years of Wisconsin Water Quality Research

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Study occurrence, transport, and health effects of human pathogens in the environment

Special focus on water quality and waterborne infectious disease

Research often located in Upper Midwest, but communications and relevance are worldwide
1. Takeaways from Wisconsin-based research
   • Derived from peer-reviewed scientific findings
   • Publications available upon request

2. Recommendations for improving Wisconsin’s water quality
   • Derived from experience, collaborations, and scientific literature
   • Opinions expressed are mine and do not represent policies or recommendations from USDA or USGS
Septic systems are responsible for contamination of groundwater with human fecal wastes and are linked with disease transmission.
Kewaunee County: More septic systems around a private well means greater risk for contamination by human fecal microbes.

![Graph showing the probability of detection of human fecal microbes in relation to the number of drain-field septic systems within 750 feet.](image)

Model accounts for the effects of:
- Rainfall total previous 2 days
- Depth to groundwater previous 14 days
- Depth to bedrock
Septic systems can be responsible for groundwater-borne disease outbreaks

Eau Claire: Sports club well water contaminated by norovirus from old septic system

Door County: Restaurant well water contaminated by norovirus from new septic system
- 229 people ill
- 6 people hospitalized

Norovirus Outbreak Caused by a New Septic System in a Dolomite Aquifer

by Mark A. Borchardt¹, Kenneth R. Bradbury², E. Calvin Alexander Jr.³, Rhonda J. Kolberg⁴, Scott C. Alexander⁵, John R. Archer⁶, Laurel A. Braatz⁷, Brian M. Forest⁸, Jeffrey A. Green⁹, and Susan K. Spencer⁹
Central Wisconsin: Mismanaged septic holding tanks are linked with infectious diarrhea in children

- For every additional holding tank per square mile, children living in the same area had an 8% increase in viral diarrhea

- For every additional holding tank per 40 acres, children living in the same area had a 22% increase in bacterial diarrhea
Agricultural activities contaminate groundwater with livestock manure and nitrate
Kewaunee County: More crop land around a private well means greater risk for contamination by high nitrate

Model accounts for the effects of:
- Distance to nearest cropped field
- Distance to manure lagoon
- Depth to bedrock

<table>
<thead>
<tr>
<th>Color</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Probability of detection</td>
</tr>
<tr>
<td>Red</td>
<td>95% confidence interval</td>
</tr>
<tr>
<td>Green</td>
<td>State-wide average (7%)</td>
</tr>
</tbody>
</table>
Kewaunee County: Private wells located farther from manure storage are less likely to be contaminated with coliform bacteria.

Model accounts for the effects of:
- Distance to nearest agricultural field
- Area of cropped fields within 750 feet of well
- Depth to bedrock

- Blue line: Probability of detection
- Red line: 95% confidence interval
- Green line: State average (~20%)
Municipal groundwater supplies are contaminated with human pathogens. There is elevated risk for acute gastrointestinal illness when groundwater is not disinfected.
La Crosse, Madison: Sanitary sewers can leak and contaminate municipal wells, even very deep wells, with human pathogens.


14 Rural Wisconsin Communities: Non-disinfected community groundwater supplies cause illness

- Disinfection is not required for groundwater-supplied drinking water.
- About 14% of acute gastrointestinal illnesses in communities that do not practice disinfection is from their drinking water.
Lake Michigan beaches and urban waterways of southeastern Wisconsin are contaminated with human pathogens.


Key Takeaway 5

800,000 households in Wisconsin rely on private wells. Many wells exceed health standards for drinking water quality.
**Wisconsin Private Well Data**

<table>
<thead>
<tr>
<th></th>
<th>Wells sampled</th>
<th>Total coliform</th>
<th><em>E. coli</em></th>
<th>NO$_3$ – N &gt; 10 ppm</th>
<th>Total coliform or NO$_3$ – N &gt; 10 ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kewaunee 1</td>
<td>316</td>
<td>21%</td>
<td>0.4%</td>
<td>7%</td>
<td>26%</td>
</tr>
<tr>
<td>Kewaunee 2</td>
<td>400</td>
<td>22%</td>
<td>1%</td>
<td>7%</td>
<td>28%</td>
</tr>
<tr>
<td>Southwest WI 1</td>
<td>301</td>
<td>34%</td>
<td>4%</td>
<td>16%</td>
<td>42%</td>
</tr>
<tr>
<td>Southwest WI 2</td>
<td>539</td>
<td>16%</td>
<td>2%</td>
<td>15%</td>
<td>27%</td>
</tr>
<tr>
<td>Statewide 1997</td>
<td>534</td>
<td>23%</td>
<td>3%</td>
<td>7%</td>
<td>-</td>
</tr>
<tr>
<td>Statewide 2013</td>
<td>3838</td>
<td>18%</td>
<td>-</td>
<td>10%</td>
<td>-</td>
</tr>
<tr>
<td>Statewide 2017</td>
<td>401</td>
<td>-</td>
<td>-</td>
<td>8%</td>
<td>-</td>
</tr>
</tbody>
</table>

*a* Information on the quality of water found at community water systems and private wells. United States GAO/RECD-97-123, June 1997


Kewaunee County: Depth to Bedrock Affects Nitrate Contamination of Private Wells

High nitrate: exceeds health standard \( N-\text{NO}_3^- > 10 \text{ ppm} \)
Key Takeaway 6

Kewaunee County: Well construction is not as important as surrounding land use in private well contamination.

Model accounts for the effects of:
Depth to bedrock

Data restricted to casing depths between 40 and 200 feet
1. Takeaways from Wisconsin-based research

2. Recommendations for improving Wisconsin’s water quality
Resources for Specific Recommendations for Improving Wisconsin’s Water Quality

Published in 2017 by the Wisconsin Land and Water Conservation Association, available at https://wisconsinlandwater.org/programs/food-land-water-project

Published in 2019 by Wisconsin’s Greenfire, available at https://wigreenfire.org/
Recommendations for Improving Wisconsin’s Water Quality

1. Connecting science to policy
2. Practices and studies
3. Funding
Connecting Science to Policy

Bridging the Gap

Science & Data

Policy & Decisions
Connecting Science to Policy

Diagram: Bridging the gap between Science & Data and Policy & Decisions.
Connecting Science to Policy

➢ Systematic reviews:
  • A new tool for environmental management
  • Derived from medical research methods
  • Structured methods synthesize existing scientific evidence
  • Addresses specific question, problem, or policy
  • More information at The Collaboration for Environmental Evidence https://www.environmentalevidence.org/
Connecting Science to Policymakers

- Create opportunities for policymakers and water quality scientists to interact
- Topic based interactions, e.g., Wisconsin Family Impact Seminars, developed by Karen Bogenschneider at UW-Madison
- Casual interactions, e.g., Office Hours at the Capitol, sponsored by the La Follette School for Public Affairs
Establish statewide, scientifically robust groundwater quality monitoring to assess trends and identify beneficial practices

Determine effective setback distances between contamination sources and wells/surface waters using scientific studies

Treatment is not the first option for drinkable private well water
Recommendations continued…

Practices and Studies

➢ Look to the country of Denmark for practices for reducing high nitrate in the Central Sands groundwater.
➢ Multiple publications in the literature on Denmark’s efforts.

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Trend Reversal of Nitrate in Danish Groundwater - a Reflection of Agricultural Practices and Nitrogen Surpluses since 1950

Environ. Sci. Technol. 2011, 45, 228-234

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Recommendations continued…

Funding

➢ Enhance state and university laboratory water quality testing capabilities
➢ Fund counties to support scientific studies to address their local water quality issues
➢ Ensure adequate research funding for the Joint Solicitation for Groundwater Research administered by the State Groundwater Coordinating Council
Minnesota Clean Water, Land, and Legacy Amendment Fund

Hold statewide referendum whether Wisconsin, like Minnesota, should add 0.375% sales tax to fund improvements in water quality, wildlife habitat, parks, and the arts.

https://www.pca.state.mn.us/sites/default/files/lrp-f-3sy18.pdf
Preventing It from Hitting the Fan…

Working together Wisconsin scientists and policymakers can:

➢ Identify research priorities
➢ Generate ideas
➢ Test potential solutions

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