

**Environment and Natural Resources Trust Fund  
2020 Request for Proposals (RFP)**

---

**Project Title:**

**ENRTF ID: 086-B**

Groundwater Microbiology Phase 2: Private Wells

---

**Category:** B. Water Resources

**Sub-Category:**

---

**Total Project Budget: \$** 499,196

**Proposed Project Time Period for the Funding Requested:** June 30, 2023 (3 yrs)

**Summary:**

The proposed study will generate critically important knowledge on the microbiological quality of private wells throughout Minnesota, identify risk factors, and provide sound guidance for protecting public health.

**Name:** Raymond Hozalski

**Sponsoring Organization:** U of MN

**Job Title:** Professor

**Department:** Civil, Environmental, and Geo- Engineering

**Address:** 500 Pillsbury Drive SE  
Minneapolis MN 55455

**Telephone Number:** (612) 626-9650

**Email** hozal001@umn.edu

**Web Address:** \_\_\_\_\_

---

**Location:**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

---

**Alternate Text for Visual:**

Pathogens in water from private wells pose a health risk for many Minnesotans.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____ %



**PROJECT TITLE:** *Groundwater Microbiology Phase 2: Private Wells*

## **I. PROJECT STATEMENT**

This project will investigate private groundwater wells for microorganisms known to make people sick. Recent alarming reports out of Wisconsin have shown that many private drinking water wells are contaminated with pathogenic microorganisms, nitrate (from fertilizer use), or both. For example, 42% of private wells sampled in 3 Southwestern WI counties were contaminated with fecal coliform bacteria and/or nitrate. The source of the fecal contamination is likely both septic systems and agricultural operations (e.g., cattle and dairy farms). The Karst-type geology that is prevalent in SW WI is also found in SE Minnesota, suggesting that similar contamination is also likely in our state. This is particularly concerning because more than 1 million Minnesotans use private wells as their primary source of residential water. The proposed study will generate critically important knowledge on the microbiological quality of private wells throughout Minnesota, identify risk factors, and provide sound guidance for protecting public health.

In a nearly completed LCCMR project, we quantified a variety of mostly bacterial pathogens in 16 public groundwater systems throughout MN. The results from this study showed that groundwaters supplying public water systems in MN are largely free of enteric pathogens (i.e., pathogens associated with human or animal fecal material that cause gastrointestinal issues after being ingested). While these results are comforting, they are likely not indicative of the thousands of private wells throughout MN. Private wells are often shallower than public supply wells and private wells are rarely tested for pathogens. Our LCCMR research showed that total bacteria concentrations tended to be lower in older water obtained from deeper wells and greater in younger water obtained from shallower wells. This result along with the WI study suggests that many Minnesotans – i.e., those who directly consume water (i.e., without any treatment) from relatively shallow private wells- could be at risk of exposure to pathogens.

The proposed research will inform the extent of this potential pathogen and nitrate exposure problem by characterizing and quantifying all of the bacteria, some viruses, and nitrate in water from private wells, including the direct quantification of many known disease-causing organisms. We predict that water from private wells in Minnesota will more frequently contain unsafe levels of pathogens and nitrate than water from public supply wells, especially in areas in SE MN where Karst geology and impacts from agriculture and septic systems overlap. Our secondary hypothesis is that the enteric pathogen levels in water from private wells will correlate with chemical indicators of groundwater quality, such as nitrate and tritium. The specific goals are to:

1. Quantify and characterize the microorganisms in water from private wells around the state
2. Attempt to link the microbiological data to conventional or chemical water quality indicators, including nitrate and tritium, and to well depth
3. Disseminate the information gained from this work to stakeholders by working with the Minnesota Department of Health, Minnesota Rural Water Association, and by presenting at state meetings.

This research would compliment recent efforts by the MDH to quantify pathogenic viruses in Minnesota's public groundwater supplies, our recent LCCMR-funded project on bacteria in public groundwater supplies, and a recent state report showing increased nitrate contamination of water supplies.

## **II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1 Title:** *Characterize microbial communities in Minnesota's groundwater obtained from private wells*

**Description:** Samples will be collected from up to 100 private wells around the state. We will work with the MRWA and the MDH to identify possible participants and to solicit their involvement. We plan to collect 3 samples from each well at different times of the year. We will then characterize the microorganisms in these samples using next-generation DNA sequencing technology. We will use quantitative PCR (qPCR) to quantify the presence of specific pathogenic microorganisms (e.g., *Salmonella*, *Legionella*, *E. coli*) known to cause disease in humans as well as crAssphage, a viral marker of human fecal contamination (i.e., as opposed to



**Environment and Natural Resources Trust Fund (ENRTF)  
2020 Main Proposal Template**

animal). Finally, we will use software that is freely available to University researchers to statistically analyze the data and correlate our microbiological data to other water quality data (see Activity 2).

**ENRTF BUDGET: \$235,548.**

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Sample collection and Genomic DNA extractions</i>	December 31, 2022
2. <i>Next-Generation DNA sequencing</i>	December 31, 2022
3. <i>Quantification of specific microorganisms</i>	December 31, 2022
4. <i>Data Analysis</i>	April 30, 2023

**Activity 2 Title:** *Analyze the groundwaters for conventional water quality parameters and correlate with microbiological data.*

**Description:** At the same time that we collect samples for microbiological analysis, we will also collect samples for analysis of conventional water quality parameters including: temperature, pH, chloride, and nitrate. We will also measure tritium, as a measure of water age and aquifer vulnerability. We will also quantify fecal coliforms, *E. coli*, and *Enterococcus* spp. using cultivation-based methods.

**ENRTF BUDGET: \$133,145.**

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Sample collection, water quality analyses</i>	December 31, 2022
2. <i>Statistical Analysis</i>	April 30, 2023

**Activity 3 Title:** *Disseminate research results to stakeholders.*

**Description:** The first two activities will significantly improve our knowledge of the microbiological safety of groundwater from private wells in MN and identify well characteristics that suggest higher risk. The final activity will be to disseminate these results at local conferences (e.g., MN Section of the American Water Works Association Annual Conference), to the stakeholders (e.g., rural residents) by working with the MDH and the MRWA, and to the scientific community via open-access publications. Outreach activities could be used to inform well owners in higher risk regions of the state and/or with certain well characteristics to consider alternatives to protect their health such as: (1) pathogen testing, (2) install a point-of-use treatment system, (3) drill new well, or (4) drink bottled water.

**ENRTF BUDGET: \$130,503.**

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Presentations at in-state scientific conferences (on-going/continuous)</i>	June 30, 2023
2. <i>Meetings with stakeholders to disseminate results (on-going/continuous)</i>	June 30, 2023

**III. PROJECT PARTNERS AND COLLABORATORS:**

The project team will be led by Drs. Raymond Hozalski and Timothy LaPara (University of Minnesota, Department of Civil, Environmental, & Geo-Engineering) who are experts in water treatment and microbiology. The team also will include one post-doc and several undergraduate student researchers, MDH, and MRWA.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

The long-term goal of the proposed research is to protect the public health of Minnesotans served by groundwater resources. The results from this work could be used to identify regions where MDH should focus attention on additional well water testing and on outreach activities to make sure private well owners are adequately informed of the risks and their options for reducing risk to acceptable levels.

**V. SEE ADDITIONAL PROPOSAL COMPONENTS:**

**A. Proposal Budget Spreadsheet**

Attachment A:  
 Environment and Natural Resources Trust Fund  
 M.L. 2020 Budget Spreadsheet



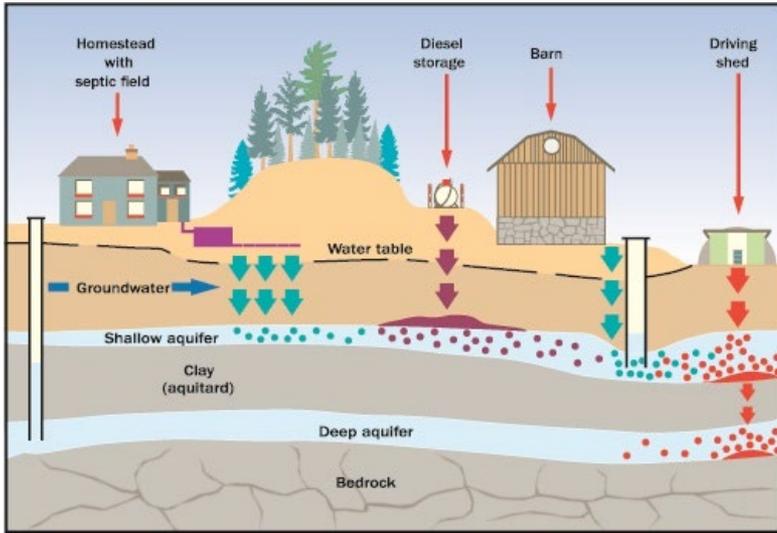
Legal Citation:  
 Project Manager: Raymond M. Hozalski  
 Project Title: Groundwater Microbiology Phase 2: Private Wells  
 Organization: University of Minnesota  
 Project Budget: \$499,196  
 Project Length and Completion Date: 3 years, June 30, 2023  
 Today's Date: April 5, 2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
<b>BUDGET ITEM</b>			
<b>Personnel (Wages and Benefits)</b>	\$ 409,196	\$ -	\$ 409,196
Raymond Hozalski, Professor (74% salary, 26% benefits); 10% FTE for three years; project			
Timothy LaPara, Professor (74% salary, 26% benefits); 10% FTE for three years; project supervision,			
Postdoctoral research associate (80% salary, 20% benefits); 100% FTE for 36 months; sample			
Undergraduate Researchers (100% salary, 0% benefits), paid hourly. Sample collection and			
<b>Professional/Technical/Service Contracts</b>			
University of Minnesota Genomics Center: droplet digital PCR, DNA sequencing and other tasks	\$ 30,000	\$ -	\$ 30,000
Tritium analysis at the University of Waterloo			
<b>Equipment/Tools/Supplies</b>			
Lab supplies (DNA/RNA extraction kits; Reagents for PCR and DNA sequencing)	\$ 30,000	\$ -	\$ 30,000
<b>Capital Expenditures Over \$5,000</b>			
	\$ -	\$ -	\$ -
<b>Fee Title Acquisition</b>			
	\$ -	\$ -	\$ -
<b>Easement Acquisition</b>			
	\$ -	\$ -	\$ -
<b>Professional Services for Acquisition</b>			
	\$ -	\$ -	\$ -
<b>Printing</b>			
	\$ -	\$ -	\$ -
<b>Travel expenses in Minnesota</b>			
In-state travel for sample collection and discussions with stakeholders	\$ 20,000	\$ -	\$ 20,000
<b>Other (Open access fees for peer-reviewed journal papers)</b>			
	\$ 10,000	\$ -	\$ 10,000
<b>COLUMN TOTAL</b>	\$ 499,196	\$ -	\$ 499,196

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
<b>Non-State:</b>		\$ -	\$ -	\$ -
<b>State: U of MN (In-kind; Indirect costs not charged to project)</b>	Secured	\$ 269,566	\$ -	\$ 269,566
<b>In kind:</b>		\$ -	\$ -	\$ -

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
<b>Current appropriation:</b>		\$ -	\$ -	\$ -
<b>Past appropriations:</b>		\$ -	\$ -	\$ -

# Groundwater Contamination Sources



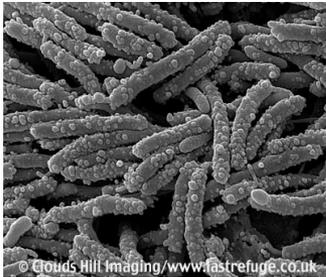
<http://www.omafr.gov.on.ca/english/engineer/facts/15-045.htm>



<http://pixshark.com/happy-person.htm>



Point of use treatment system



Pathogens/chemicals



Clean water



ENRTF ID: 086-B  
<http://pixshark.com/happy-person.htm>

## **Project Manager Qualifications and Organization Description**

### **Dr. Raymond M. Hozalski**

Professor, Environmental Engineering, Department of Civil, Environmental, and Geo-Engineering, University of Minnesota

B.ChE., Chemical Engineering, 1990, Villanova University, Villanova, PA.

M.S., Environmental Engineering, 1992, The Johns Hopkins University, Baltimore, MD.

Ph.D., Environmental Engineering, 1996, The Johns Hopkins University, Baltimore, MD.

Dr. Hozalski will serve as project manager and be responsible for overall project coordination. He is an internationally known expert in water treatment and has been conducting research in that area for over 25 years. He has worked on numerous applied research projects in collaboration with Minnesota drinking water utilities over the past 20 years. He has published more than 70 articles in top environmental engineering and science journals and currently serves on the U.S. Environmental Protection Agency's Science Advisory Board Drinking Water Committee.

### **Timothy M. LaPara**

Professor, Department of Civil, Environmental, and Geo- Engineering, University of Minnesota

B.S.C.E., Civil Engineering, 1995, University of Notre Dame, Notre Dame, IN

Ph.D., Civil Engineering, 1999, Purdue University, West Lafayette, IN

Dr. Timothy LaPara will also be responsible for overall management of the proposed project. Dr. LaPara's research is focused on the role of municipal and industrial wastewater treatment plants in preserving environmental quality and in protecting public health. His research has a strong interdisciplinary nature, stemming from his unique background in both environmental engineering and microbiology.

### **Organization Description**

The University of Minnesota (UMn) is one of the largest, most comprehensive, and most prestigious public universities in the United States ([http://www1.umn.edu/twincities/01\\_about.php](http://www1.umn.edu/twincities/01_about.php)). The laboratories and offices of the PI and co-PI and/or at UMn core facilities contain all of the necessary fixed and moveable equipment needed for the proposed studies.