



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-364

Proposal Title: Evaluating Coronavirus and Other Microbiological Contamination of Drinking Water Sources from Wastewater

Project Manager Information

Name: Timothy LaPara

Organization: U of MN - College of Science and Engineering

Office Telephone: (612) 624-6028

Email: lapar001@umn.edu

Project Basic Information

Project Summary: With detection of coronavirus in human feces, there are urgent concerns about microbiological contamination of drinking water sources by wastewater. We will investigate this contamination, identify sources, and evaluate solutions.

Funds Requested: \$699,000

Proposed Project Completion: 2023-06-30

LCCMR Funding Category: Water Resources (B)

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

A previous LCCMR project allowed us to investigate the microbiological quality of twenty public water systems (PWSs) supplying groundwater to Minnesota residents. In an ongoing project, we are investigating the microbiological quality of PWSs supplying treated surface water. The research proposed herein expands on those projects by including a state-wide investigation of private wells and by sampling surface and groundwater PWSs to analyze for SARS-CoV-2 (a.k.a. COVID-19). We will also attempt to identify the contamination sources and to offer potential solutions to this contamination by making well placement recommendations and by partnering with a small Minnesota business (AquaMedix; Eden Prairie, MN) that produces point-of-use treatment filters.

Groundwater is generally believed to be an abundant source of safe and high-quality water. In recent years, however, research performed by the Minnesota Department of Health and others has shown that groundwater can be contaminated with disease-causing microorganisms, including numerous viruses (e.g., norovirus) and protozoa (e.g., *Cryptosporidium parvum*). The presence of these microorganisms indicates that some groundwaters are being contaminated by wastewater, possibly from septic systems and leaky sanitary sewers. This raises serious concerns that SARS-CoV-2, known to be present in human feces of infected persons, could potentially enter groundwater.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

Our proposed solution to the problem is three-pronged. First, we will further document the microbiological contamination of groundwater by collecting water samples from both public and private wells. This work is necessary to confirm the limited work done to date by the Minnesota Department of Health (i.e., their work needs to be validated by an independent laboratory); our work also will expand on the previous work by considering private wells (which have yet to be studied and are more likely to be susceptible to contamination) and by looking for SARS-CoV-2. Second, we will attempt to identify the various sources of microbiological contamination by analyzing a range of inorganic and organic chemical fingerprints that have origins of septic tanks, animal wastes, and hospital wastes. With information on potential sources and their locations relative to the wells, we plan to develop recommendations for future well placements to minimize the risk of contamination. And third, we will test a potential treatment solution for the problem of microbiological contamination of groundwater by partnering with AquaMedix (Eden Prairie, MN), who will provide state-of-the-art in-home water filtration units that are designed to remove the microbiological contaminants of concern.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Groundwater is undeniably one of Minnesota's most precious environmental resources. It is an abundant and high-quality source of water for drinking, for bathing, and for numerous other uses. Groundwater, however, can be contaminated with microorganisms that can make people sick (especially viruses, like SARS-CoV-2 and norovirus). This project will first focus on investigating the extent of contamination in both public and private water supplies. We will then identify the likely sources of this contamination, allowing us to make recommendations regarding well placement to minimize the risk of contamination in the future. Finally, we will investigate in-home treatment technologies by partnering with a Minnesota company (AquaMedix), such that we will offer a potential treatment solution to Minnesotans when the source of contamination cannot be identified and ameliorated or the costs of amelioration (e.g., drill a new well) are prohibitive.

Activities and Milestones

Activity 1: Investigate public and private well water for microbiological contamination by viruses, bacteria, and protozoa.

Activity Budget: \$233,000

Activity Description:

University of Minnesota personnel will identify volunteer partners (i.e., public water supplies and private well owners, to remain anonymous) from whom we will collect large-volume (> 200 gallons) water samples. We will concentrate the microorganisms in these samples and then analyze for harmful microorganisms using state-of-the-art assays that target genes (RNA and DNA) specific to the dangerous microbes. We will spend the first two years of the study period collecting, processing, and analyzing well water samples. Much of the sample collection, which is a labor-intensive process, will be performed by undergraduate students to help reduce project costs (while simultaneously providing a stellar research experience for our students). The genetic analyses for harmful microorganisms will be performed by either a graduate student or a post-doctoral research associate.

Activity Milestones:

Description	Completion Date
Sample collection and processing	2022-06-30
Quantification of different microorganisms from samples	2022-12-31
Data Analysis and Report Preparation	2023-06-30

Activity 2: Identify potential sources of microbiological contamination of groundwater

Activity Budget: \$233,000

Activity Description:

Once sites with microbially contaminated groundwater have been identified, it is crucial to understand where and how the pathogens are entering the groundwater so that we can minimize the risk of future contamination (i.e., so-called wellhead protection).

To identify the source or sources of contamination, we will generate multiple lines of evidence by analyzing organic and inorganic chemicals that are source fingerprints and conservative (i.e., do not degrade). First, we will measure the concentrations of inorganic ions (e.g., chloride, bromide, sodium, and potassium) as well as the concentrations of nitrate and organic carbon. These data will be used to differentiate among different waste sources. For example, we will use the sodium to potassium ratio to differentiate waste from septic tanks (i.e., human) from animal-derived sources. Second, we will analyze for specific organic chemicals, including a stilbene-type fluorescent whitening agent widely used in household laundry detergents, the artificial sweeteners sucralose and acesulfame, and an iodinated X-ray contrast media compound widely used in hospital CT scans. These data will allow us to further refine our identification of likely waste sources. Lastly, we will measure tritium as an indicator water age and aquifer vulnerability.

Activity Milestones:

Description	Completion Date
Sample collection and quantification of organic and inorganic chemicals from samples	2022-12-31
Data Analysis and Report Preparation	2023-06-30
Statistical analysis of correlating pathogen occurrence with potential sources	2023-06-30

Activity 3: Validate that in-home water filtration systems can protect against microbiological contamination of groundwater

Activity Budget: \$233,000

Activity Description:

This activity will build upon the results of the first project Activity. In the first year of the project, we will identify numerous water systems (both public water supplies and private wells) that are contaminated with harmful microorganisms. At one of the public water systems, we will recruit 5 volunteer residences where we will install in-home water filtration units from AquaMedix. Similarly, we will recruit 5 private wells with microbiological contamination and install in-home water filtration units in these homes. We will then collect water samples before and after the filters to investigate whether in-home filtration can resolve the health risks posed by microbiological contamination of groundwater.

Activity Milestones:

Description	Completion Date
Install in-home water filtration units	2021-05-31
Collected and analyze water samples after intervention	2022-12-31
Data Analysis and Report Preparation	2023-06-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Brady Benson	Aquamedix	Aquamedix will provide some guidance on in-home water treatment technologies. We will purchase and install these technologies to test their effectiveness.	No
Boya Xiong	University of Minnesota	co-Project Manager	Yes
Raymond M. Hozalski	University of Minnesota	co-Project Manager	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

The results of this project will be disseminated directly to participating public water supplies and private well owners. We also will disseminate our research results broadly through presentations at local (e.g., the annual conference Minnesota-section of the American Water Works Association), national, and international conferences. We also will publish our results in the open-access, peer-reviewed literature; this will enable LCCMR staff to publicize our research without any concerns with respect to copyright. We also will ask the University of Minnesota and/or MDH to produce press releases of our results, as appropriate.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Evaluate Emerging Pathogens in Lakes, Rivers, and Tap Water to Keep Drinking Water Safe	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 04f	\$325,000
Improving Drinking Water for Minnesotans through Pollution Prevention	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04f	\$345,000
Triclosan Impacts on Wastewater Treatment	M.L. 2014, Chp. 226, Sec. 2, Subd. 03c	\$380,000
Wastewater Treatment Process Improvements	M.L. 2016, Chp. 186, Sec. 2, Subd. 04k	\$398,000
Bacterial Assessment of Groundwater Supplies Used for Drinking Water	M.L. 2016, Chp. 186, Sec. 2, Subd. 04f	\$299,000

Project Manager and Organization Qualifications

Project Manager Name: Timothy LaPara

Job Title: Professor

Provide description of the project manager's qualifications to manage the proposed project.

Dr. LaPara has worked at the University of Minnesota since 2000 in the Department of Civil, Environmental, and Geo-Engineering. His research primarily focuses on the microbiology of drinking water and of municipal wastewater treatment. He has authored or co-authored 65 manuscripts published in the peer-reviewed technical literature. According to the Web of Science, his research has been cited more than 2,500 times by other peer-reviewed research publications.

Organization: U of MN - College of Science and Engineering

Organization Description:

The University of Minnesota is one of the largest, most comprehensive, and most prestigious public universities in the United States (http://www1.umn.edu/twincities/01_about.php). The laboratories directed by the project managers contain the majority of the equipment needed to perform the proposed project, including centrifuges, pumps, water meters, analytical balances, and a real-time PCR machine. The University of Minnesota also has “core facilities” that offer additional equipment, which can be used by University researchers “at cost.” For this project, the core facility that is most germane is the University of Minnesota Genomics Center (UMGC; <http://genomics.umn.edu>). UMGc offers state-of-the-art DNA sequencing capabilities, numerous real-time PCR machines, droplet digital PCR machines, and experts available for consultation on an as-needed basis.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Timothy LaPara		Project Manager			27%	0.24		\$56,773
Raymond Hozalski		Co-Project Manager			27%	0.48		\$118,072
Boya Xiong		Co-project manager			27%	0.12		\$19,562
Post-doctoral research associate		Perform experiments, analyze data			20%	3		\$187,699
Graduate Research Assistant		Perform analyses, analyze data			44%	1.5		\$149,645
Undergraduate research assistant		Undergraduate students will be used to help collect samples, process these samples, etc. These are labor-intensive activities.			0%	84		\$67,249
							Sub Total	\$599,000
Contracts and Services								
University of Minnesota Genomics Center	Internal services or fees (uncommon)	UMGC provides at-cost access to state-of-the-art molecular/genetic equipment (e.g., next-gen DNA sequencing, droplet digital PCR), supplies, and technical expertise.				0		\$8,000
Masonic Cancer Center	Internal services or fees (uncommon)	This is an analytical biochemistry laboratory that provides access to numerous pieces of analytical equipment (e.g., GC-MS-MS) at-cost to University researchers. This facility will help us analyze specific chemicals of concern in groundwater.				-		\$5,000
Department of Earth and Environmental Sciences	Internal services or fees (uncommon)	This laboratory provides access to analytical equipment at-cost to University researchers. This facility would be used to quantify cations and anions in groundwater.				-		\$5,000
Analytical Laboratory	Professional or Technical Service Contract	We will need to send samples to a commercial laboratory to quantify the levels of tritium in the collected water. These tritium levels are used to determine the "age" of the water.				-		\$2,000

							Sub Total	\$20,000
Equipment, Tools, and Supplies								
	Tools and Supplies	Membrane filtration units	Used to collect high volume water samples					\$10,000
	Tools and Supplies	DNA extraction kits	Extract and purify DNA from groundwater samples					\$10,000
	Tools and Supplies	Expendable reagents for quantitative polymerase chain reaction	These reagents are needed to quantify genes linked to specific organisms					\$10,000
	Tools and Supplies	Miscellaneous chemicals, laboratory supplies (e.g., glassware)	Numerous chemical reagents will need to be purchased to collect samples, process these samples, analyze the samples, and preserve the samples.					\$10,000
	Tools and Supplies	In-home treatment units	To test the ability of in-home treatment units to improve the microbiological quality of drinking water					\$5,000
							Sub Total	\$45,000
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Use of personal vehicles and/or vehicles rented from the University's fleet services	We will need to travel to different locations to collect groundwater samples.					\$23,000
	Conference Registration Miles/ Meals/ Lodging	MN-section of the American Water Works Association	We will try to present our results at the MN-section of the American Water Works Association.					\$2,000
							Sub Total	\$25,000

Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Publication	Page charges for publication	Most journals now allow "open access" publication, which effectively means that the authors retain the copyright of their published work. This would allow LCCMR staff to circulate our research manuscripts without concern or restrictions imposed by copyright laws.					\$4,500
	Printing	Poster printing	We will likely present our research in poster form, at local/University conferences and at the MN-section of the American Water Works Association.					\$500
							Sub Total	\$5,000
Other Expenses								
		Equipment repair	We will heavily use pre-existing laboratory equipment to perform this project. This equipment routinely needs repair and maintenance.					\$5,000
							Sub Total	\$5,000
							Grand Total	\$699,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
In-Kind	The University of Minnesota incurs indirect costs equal to 55% of the modified total direct costs. These costs are not charged to LCCMR.	Indirect costs (lights, overhead, support personnel, etc).	Secured	\$354,824
			Non State Sub Total	\$354,824
			Funds Total	\$354,824

Attachments

Required Attachments

Visual Component

File: [608d475d-6b5.pdf](#)

Alternate Text for Visual Component

Groundwater is a precious resource that is often used as a supply for drinking water (both public and private water supplies). Although groundwater is typically assumed to be free of microbiological contamination, it often contains microorganisms that can make people sick. Our drinking water infrastructure is very robust and it properly protects public health, but the consumption of untreated groundwater could lead to illnesses among Minnesotans.

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

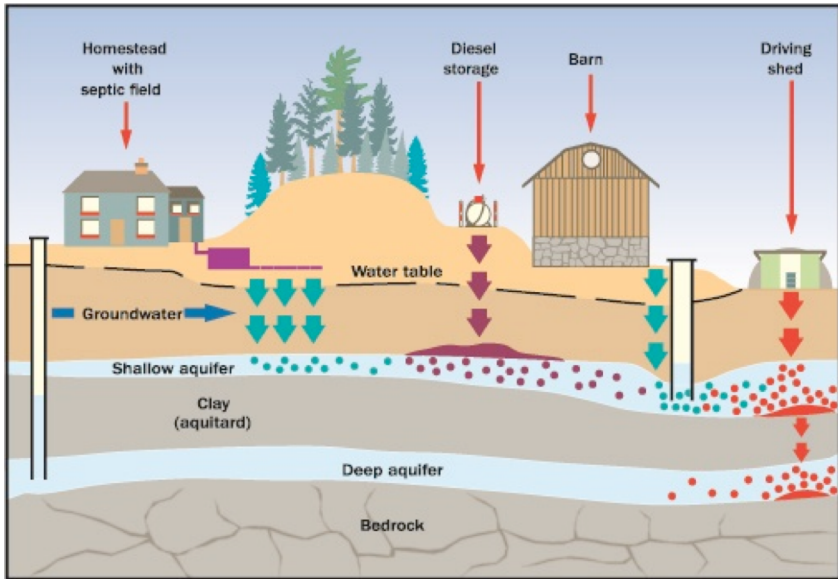
Does your project include research?

Yes

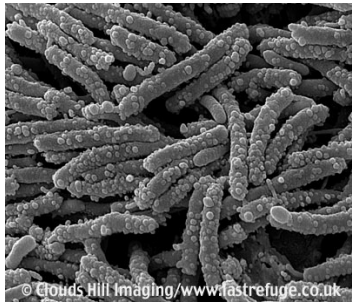
Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Groundwater Contamination Sources



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



Pathogens/chemicals



Clean water



Point of use treatment system



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



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

