Environment and Natural Resources Trust Fund

M.L. 2021 Approved Work Plan

General Information

ID Number: 2021-364

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: July 21, 2021

Project Title: Evaluating Coronavirus And Other Microbiological Contamination Of Drinking Water Sources From Wastewater

Project Budget: $594,000

Project Manager Information

Name: Timothy LaPara

Organization: U of MN - College of Science and Engineering

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Project Reporting

Date Work Plan Approved by LCCMR: July 20, 2021

Reporting Schedule: January 1 / July 1 of each year.

Project Completion: June 30, 2024

Final Report Due Date: August 14, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 04g

Appropriation Language: $594,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to survey public and private wells to identify sources of and evaluate solutions to microbiological contamination of drinking water sources by wastewater, including from the virus that causes COVID-19.

Appropriation End Date: June 30, 2024

Narrative

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.

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.

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

Activities and Milestones

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

Activity Budget: $198,000

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. We hope to partner with ~20 public water supplier and ~60 private well owners. Our plan is to collect 3-6 replicate samples from each volunteer participant (240-480 total samples). We will test for more than 20 different microbial pathogens, including adenovirus, norovirus, SARS-CoV-2, Legionella, Giardia lamblia, Cryptosporidium parvum, E. coli, and Mycobacterium avian. Results will be immediately shared with well owners (public or private) in an informal manner.

Activity Milestones:

Description	Completion Date
Sample collection and processing	June 30, 2022
Quantification of different microorganisms from samples	December 31, 2022
Data Analysis and Report Preparation	June 30, 2023

Activity 2: Identify potential sources of microbiological contamination of groundwater

Activity Budget: $198,000

Activity Description:
We will identify the source or sources of contamination at 5 sites identified in Activity 1 as "contaminated". 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. Results will be immediately shared with well owners (public or private) in an informal manner as well as formally as part of our dissemination plan.

Activity Milestones:

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

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

Activity Budget: $198,000

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	May 31, 2022
Collected and analyze water samples after intervention	December 31, 2022
Data Analysis and Report Preparation	June 30, 2023

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

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
The results of this project will be disseminated directly to the participating public water supplies and private well owners. We will also disseminate our research results broadly through presentations at local (e.g., the annual conference of the Minnesota-section of the American Water Works Association), national, and international conferences. We also will publish our results in the peer-reviewed literature in the open-access format; 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. We will appropriately acknowledge the Minnesota Environment and Natural Resources Trust Fund during all dissemination activities through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENTRF Acknowledgment Guidelines

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
Triclosan Impacts on Wastewater Treatment	M.L. 2014, Chp. 226, Sec. 2, Subd. 03c	$380,000
Bacterial Assessment of Groundwater Supplies Used for Drinking Water	M.L. 2016, Chp. 186, Sec. 2, Subd. 04f	$299,000
Wastewater Treatment Process Improvements	M.L. 2016, Chp. 186, Sec. 2, Subd. 04k	$398,000
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

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Undergraduate research assistant		Undergraduate students will be used to help collect samples, process these samples, etc. These are labor-intensive activities.			0%	1.5		$37,180
Graduate Research Assistant		Perform analyses, analyze data			44%	1.26		$129,255
Post-doctoral research associate		Perform experiments, analyze data			20%	3		$193,330
Boya Xiong		Co-project manager			27%	0.12		$19,562
Raymond Hozalski		Co-Project Manager			27%	0.24		$62,608
Timothy LaPara		Project Manager			27%	0.24		$56,773
							Sub Total	**$498,708**
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	In-home treatment units	To test the ability of in-home treatment units to improve the microbiological quality of drinking water. The cost will include the price of the filter ($50-$100 each) as well as the cost of installation (~$400-$450 each). We will install 10 of these systems.					$5,000
	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	Expendable reagents for quantitative polymerase chain reaction	These reagents are needed to quantify genes linked to specific organisms					$10,000
	Tools and Supplies	DNA extraction kits	Extract and purify DNA from groundwater samples					$10,000
	Tools and Supplies	Membrane filtration units	Used to collect high volume water samples					$10,000
							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.					$18,292

	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	**$20,292**
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	**$594,000**

Classified Staff or Generally Ineligible Expenses

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

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	$302,241
			Non State Sub Total	**$302,241**
			Funds Total	**$302,241**

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....

Optional Attachments

Support Letter or Other

Title	File
Peer review addendum (Final)	4a513a6e-dca.docx
Background Check Form	bb8757ae-67a.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

I have modified the budget by reducing some of funds requested for faculty salary (esp. for Prof. Hozalski), for the graduate research assistant (cutting this appointment from 50% to 25% in the first year), and for undergraduate researchers. I also reduced our travel budget slightly. MARCH 22, 2021: I updated the work plan per the suggestions of LCCMR staff to include additional details.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the UMN Policy.

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

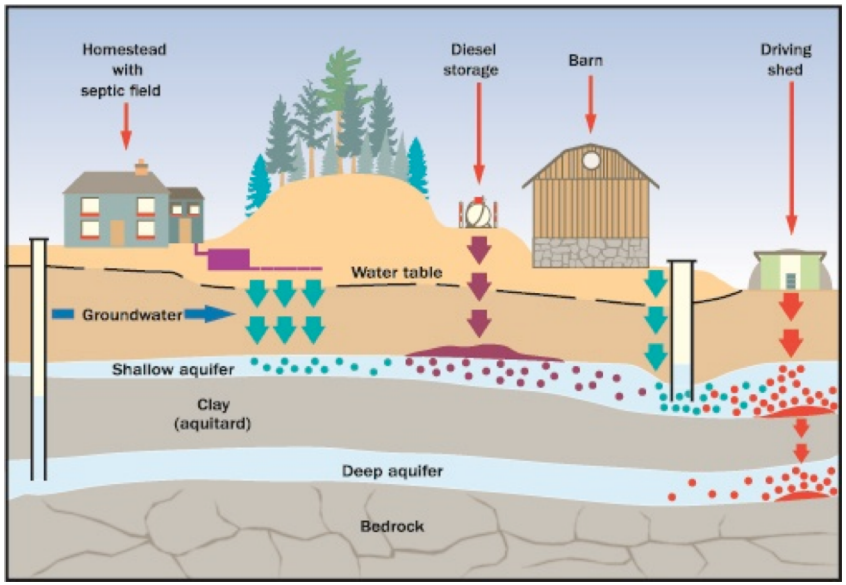
Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Groundwater Contamination Sources

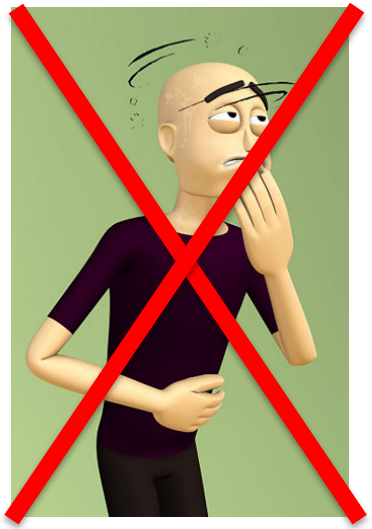


http://www.omafra.gov.on.ca/english/engineer/facts/15-045.htm

Pathogens/chemicals

Point of use treatment system

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



Clean water

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