



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-385

Proposal Title: Mapping Hotspots of Antibacterial Resistance in Minnesota's Waters

Project Manager Information

Name: Satoshi Ishii

Organization: U of MN - College of Biological Sciences

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Project Basic Information

Project Summary: This project will identify the antibiotic resistance hotspots and hot moments in Minnesota's surface waters and provide a decision support tool for water managers.

ENRTF Funds Requested: \$190,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Small Projects (G)

Secondary Category: Water (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.

Many Minnesotans enjoy and benefit from Minnesota's waters; however, some watersheds do not meet water quality standards and are therefore included in the impaired list. Bacteria contamination is one of the major causes of impairment of Minnesota's waterways across the state, making the water unsafe for swimming and other recreational activities. Currently, Minnesota Pollution Control Agency (MPCA) monitors the levels of fecal contamination by using fecal indicator bacteria (FIB) such as fecal coliforms and *Escherichia coli* (*E. coli*). While FIB monitoring is practical and convenient, it cannot detect the occurrence of pathogens and antibiotic resistance genes (ARGs), contaminants of emerging concern. Measuring ARGs and pathogens is not included in the regular work of MPCA, and therefore, our understanding of the occurrences and sources of ARGs and antibiotic-resistant pathogens in Minnesota waterways is largely limited.

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

The overall goal of this project is to improve water quality and protect public health by identifying the hotspots and hot moments of ARGs in Minnesota waters and sharing the data with the public and stakeholders. To achieve this goal, the following three activities are planned. In Activity 1, we will measure 48 ARGs by using a state-of-the-art high-throughput gene quantification tool developed by the Ishii lab. We will leverage the archived DNA samples (n >1000) previously collected from six watersheds across Minnesota with varying land-use patterns (urban, agricultural, and forested environments). We already have basic water quality parameters, *E. coli*, pathogens, and microbial source tracking marker data with these samples. In Activity 2, we will combine all of these data to identify the hotspots and hot moments of the occurrence of ARGs and propose potential sources of ARGs. In Activity 3, we will share the results with the public and stakeholders by creating an interactive webtool to show the ARG hotspots and hot moments.

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?

The specific outcomes are (1) the levels of ARGs in urban, agricultural, and natural watersheds in Minnesota, (2) hotspots and hot moments of ARG occurrence and their potential sources, and (3) interactive map to show the ARG hotspots and hot moments. These outcomes will be used to establish strategies to improve Minnesota's water quality and protect public health.

Activities and Milestones

Activity 1: Measure ARGs in >1,000 water samples collected in MN

Activity Budget: \$94,000

Activity Description:

The objective of this activity is to measure 48 ARGs in >1,000 water samples collected from various watersheds in Minnesota. We will leverage the archived DNA samples previously collected from six watersheds in Minnesota with varying land-use patterns (urban, agricultural, and forested environments). We already have basic water quality parameters, E. coli, pathogens, and microbial source tracking marker data with these samples. We will first organize the sampling sites and associated metadata. DNA samples stored will be used for the state-of-the-art high-throughput gene quantification tool developed in the Ishii lab.

Activity Milestones:

Description	Approximate Completion Date
List of samples and associated metadata	December 31, 2027
Quantity of ARGs obtained	June 30, 2028

Activity 2: Identify the hotspots and hot moments of the occurrence of ARGs

Activity Budget: \$70,000

Activity Description:

We will combine the ARG data obtained in Activity 1 with the water quality, E. coli, pathogen, and microbial source tracking marker data obtained previously. Spatiotemporal dynamics of ARGs and other marker genes will be analyzed. In particular, the impacts of land-use patterns, precipitation, and other environmental factors (temperature, etc.) on the occurrence of ARGs will be analyzed. Statistical modeling will be used to clarify the relationship among these data. These analyses will lead to the identification of the hotspots and hot moments of the ARG occurrence. By analyzing the co-occurrence of ARGs, pathogens, and microbial source tracking markers, we will propose potential sources of ARGs.

Activity Milestones:

Description	Approximate Completion Date
Clarify the relationship between land use patterns and the occurrence of ARGs	December 31, 2028
Identify the hotspots and hot moments of the ARG occurrence	December 31, 2028
Identify potential sources of ARGs	June 30, 2029

Activity 3: Create an interactive map to show the ARG hotspots and hot moments

Activity Budget: \$26,000

Activity Description:

We will create an interactive webtool to show the ARG hotspots and hot moments on a map. Users can zoom in/out and select the ARG and pathogen of interest to see their distribution on the map. The webtool will be available to the public and stakeholders. We will host a webinar to explain how to use it. The instructions and recorded video will be also uploaded to the project website. In addition, we will disseminate the results through presentations and publications, which will be freely available to the public.

Activity Milestones:

Description	Approximate Completion Date
Interactive map to show the ARG hotspots and hot moments	June 30, 2029
Project report and presentation	June 30, 2029

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.

We will create a project webpage to share the interactive map and disseminate the project results. In addition, we will present our results at the Minnesota Water Resources Conference and produce scientific manuscripts in open-access journals. The Environment and Natural Resources Trust Fund will be acknowledged in the publications, presentations, and other media per the ENRTF Acknowledgment Guidelines. The ENRTF logos and signage will appear on the project webpage.

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 work be funded?

The data will be shared with MPCA so that they can use it for future decision-making. The proposed work aligns with the goal of the Minnesota One Health Antibiotic Stewardship Collaborative (MOHASC) (see attached letter of support). The longer-term benefit of this work will be refining environmental management plans and regulations by government agencies like MPCA, MDH, and MDA. Additionally, the improvement of microbiological water quality will provide economic benefits to state and local communities through fewer beach closures, ecosystem services, and a reduction of health costs due to waterborne illnesses.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Advanced Biofilter for N2O Removal	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 07d	\$325,000
Highly Efficient Nutrient Removal Technology for Agricultural Drainage	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 04o	\$453,000

Project Manager and Organization Qualifications

Project Manager Name: Satoshi Ishii

Job Title: Professor

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

Satoshi Ishii is a Professor at the BioTechnology Institute and the Department of Soil, Water, and Climate at the University of Minnesota. Dr. Ishii's research focuses on environmental microbiology and biotechnology, including water quality and public health microbiology. He has over 20 years of experience working on the detection of waterborne pathogens and antibiotic resistance. Dr. Ishii has managed multiple projects related to the proposed subject, some of which were done in collaboration with the Minnesota Pollution Control Agency and local watershed management organizations.

Organization: U of MN - College of Biological Sciences

Organization Description:

The University of Minnesota is the main research and graduate teaching institution in the state of Minnesota. The BioTechnology Institute provides advanced research, training, and university-industry interaction in biological process

technology. In the Department of Soil, Water, and Climate, we seek to improve and protect the quality of soil, air, and water resources in natural and managed ecosystems, through research, teaching, and extension.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Satoshi Ishii		Project manager			27%	0.16		\$37,200
Postdoctoral Research Associate		Perform experiments and analyze data for Activity 1, 2, and 3			21%	1.5		\$120,000
Research Associate		Develop a webtool for Activity 3			27%	0.03		\$3,800
							Sub Total	\$161,000
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Reagents and consumables for high-throughput qPCR	Necessary to quantify various ARGs in the water samples					\$24,000
							Sub Total	\$24,000
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Trips and registration fees to present our research results at MN Water Resources Conference (\$500/person x 2 researchers)	To disseminate the results					\$1,000
							Sub Total	\$1,000

Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Publication	Open access publication fee	Necessary to make our results publicly available					\$4,000
							Sub Total	\$4,000
Other Expenses								
							Sub Total	-
							Grand Total	\$190,000

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				
In-Kind	University of Minnesota	The University of Minnesota is not allowed to charge the State of Minnesota its typical overhead rate of 54% of the total modified direct costs. We are listing our unrecoverable indirect cost as in-kind contribution.	Secured	\$103,976
			State Sub Total	\$103,976
Non-State				
			Non State Sub Total	-
			Funds Total	\$103,976

Total Project Cost: \$293,976

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [e520a930-379.pdf](#)

Alternate Text for Visual Component

To clarify the occurrence of antibiotic-resistant pathogens in Minnesota's waterways, a high-throughput antibiotic resistance gene (ARG) detection tool will be used. The results will be visualized using an interactive webtool to show the ARG hotspots and hot moments on a map....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
MPCA letter of support	d95e9d81-2fc.pdf
U of M proposal approval letter	c5d9a310-2b1.pdf
MOHASC letter of support	098a01c8-f81.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they 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 understand the UMN Policy on travel applies.

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

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?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing \$10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care,

treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Lori Nicol, University of Minnesota

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A