



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-144

Proposal Title: Microgeographic Impact of Antibiotics Released from Identified Hotspots

Project Manager Information

Name: Randall Singer

Organization: U of MN - College of Veterinary Medicine

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Project Basic Information

Project Summary: We will evaluate the impact of antibiotics released from hotspots identified in our previous project to surface waters in Minnesota using field, laboratory, and modeling approaches to ultimately inform interventions.

Funds Requested: \$598,000

Proposed Project Completion: 2024-06-30

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.

Antimicrobial resistance (AMR) threatens public health, animal health, and ecosystem health. Antibiotic use in hospitals, long-term care facilities, and animal husbandry operations (point sources) play a major role in AMR emergence. Discharges and runoff from these point sources enter the natural environment, in some cases after going through a treatment system at the point source itself or at a wastewater treatment plant. More than 50% of the antibiotic compounds used at the point source may be released unchanged or as an active metabolite into the environment. Antibiotic residues are found in the surface waters nearby the point sources. We still do not fully understand how far these residues can be transported, how long they remain in the water, and how they vary depending on the antibiotic use at the point sources. It is imperative to understand these issues to establish appropriate mitigation strategies at the point source to minimize the impact to human, animal, and ecosystem health.

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.

To fill in the important knowledge gaps that are needed to establish interventions to combat the impact of AMR on health-related outcomes, we propose to assess the influence of specific point sources on the dissemination of antibiotics in surface waters spatially and temporally. We will choose these point sources based on our previous large-scale footprint model of the entire state of Minnesota established with previous ENRTF support. By evaluating specific point sources (i.e. hospitals, wastewater treatment plants, animal husbandry operations) at a micro-geographical scale and over time, we will be able to correlate antibiotic prescription data throughout the year with environmental concentrations of antibiotic residues. We will be collecting field samples following our refined methodology from our previous project, as well as conducting laboratory experiments to fully understand factors such as degradation and association with particulates in the water column, which are critical variables to include in modeling efforts. Our models will ultimately indicate what type of interventions are needed at these point sources to minimize the impact of antibiotics on human, animal, and ecosystem health.

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?

We will generate data that correlates the impact of specific point sources with the dissemination of antibiotics into the environment both temporally and spatially. That information will allow improvement of waste management interventions at each one of the point sources studied, and better mitigation strategies to decrease the spread of antibiotics and AMR into the environment.

Activities and Milestones

Activity 1: Point source data collection and modeling of antibiotic residues on surface waters

Activity Budget: \$322,500

Activity Description:

We will select point sources in specific watersheds in Minnesota that represent hospitals, wastewater treatment plants, and animal husbandry operations. This selection will be based on our previously developed footprint model for the entire state, which highlighted hotspots of antibiotic levels in surface waters in relation to point sources. We will collect data on antibiotic use and on waste management practices at these sources. This information will be provided leveraging the Minnesota One Health Antibiotic Stewardship Collaborative, as well as through collaborations that spearheaded from our previous ENTRF funded projects. Using these data and results from Activity 2, we will develop geospatial and hydrological models to predict the dissemination of antibiotic residues from the point sources over time and over space in the watersheds of interest. We will also conduct epidemiological analyses to correlate antibiotic use and waste management practices with the field measurements for the antibiotic residues (Activity 2). Finally, we will integrate all results into a user-friendly interface to be used by managers at the point sources to visualize their impact into the watershed. That interface will also allow us to model intervention strategies and assess how the antibiotic emission levels change based on different treatment scenarios.

Activity Milestones:

Description	Completion Date
Identify specific point sources within a watershed based on previous state wide footprint model	2021-08-31
Data collection on antibiotic use and waste management practices at the identified point sources	2021-12-31
Development of user-friendly interface	2024-06-30
Geospatial and hydrological modeling using data from Activity 2	2024-06-30
Epidemiological analyses	2024-06-30

Activity 2: Field measurements downstream of point sources and laboratory transformation studies

Activity Budget: \$275,500

Activity Description:

Once point sources are identified, the levels emitted into the environment and any seasonal variations need to be quantified with field measurements. Based on information collected in Activity 1, up to 10 sites that cover different sources (e.g., hospitals, wastewater treatment plants, animal husbandry operations) will be selected. For three of these sites, monthly sampling from April to October will be conducted (upstream, at the discharge point, and five locations downstream). For the other seven sites, quarterly sampling will be performed. To fully understand the persistence of antibiotics in aquatic systems and fully parameterize models (Activity 1), information about degradation rates of different compounds is needed. Relevant removal processes include transformation by sunlight, degradation by bacteria, and sorption to settling particles. While degradation by bacteria seems counter-intuitive, at subtherapeutic levels, bacteria can degrade antibiotics. For the targeted compounds, a literature review will be conducted to compile relevant rate constants. Because biodegradation rates will be affected by season and the native microbial community and sorption will be affected by the type and load of particles present, experiments will be needed to obtain rate constants relevant to Minnesota. Experiments for sunlight degradation will be used to fill in literature gaps.

Activity Milestones:

Description	Completion Date
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Literature review of transformation rates	2022-07-31
Photolysis studies	2022-12-31
Sorption studies	2023-07-31
Field measurements of antibiotic levels over distance from point sources (monthly sites)	2023-10-31
Biodegradation studies	2024-05-31
Field measurements of antibiotic levels over distance from point sources (quarterly sites)	2024-05-31

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Amy Kinsley	University of Minnesota	Co-Investigator	Yes
Amanda Beaudoin	Minnesota Department of Public Health	Co-Investigator	No
Kristine Wammer	University of St. Thomas	Co-Project Manager	Yes
Irene Bueno	University of Minnesota	Co-Project Manager	Yes
William Arnold	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?

Our project will define relationships between essential activities (e.g., healthcare, wastewater treatment, animal agriculture) and the maintenance and proliferation of AMR in Minnesota's natural environment. The long-term goal is to develop scientific and risk-based guidance in human, animal, and environmental health for the mitigation of AMR in the natural environment. Our approach will also be useful to explore other biologically active chemicals in Minnesota's environment, such as hormones and endocrine disruptors. Results will be shared at local conferences, in open-access scientific publications, by publicly available final report, and through the Minnesota One Health Antibiotic Stewardship Collaborative.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Mapping Antibiotic Resistance in Minnesota to Help Protect Environmental, Animal, and Human Health	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 04h	\$750,000
Benign Design: Environmental Studies Leading to Sustainable Pharmaceuticals	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04b	\$415,000
Determining Influence of Insecticides on Algal Blooms	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04a	\$350,000
Antibiotics and Antibiotic Resistance Genes in Minnesota Lakes	M.L. 2014, Chp. 226, Sec. 2, Subd. 03e	\$300,000
Solar Driven Destruction of Pesticides, Pharmaceuticals, Contaminants in Water	M.L. 2014, Chp. 226, Sec. 2, Subd. 03a	\$291,000
Assessing Techniques for Eliminating Contaminants to Protect Native Fish and Mussels	M.L. 2016, Chp. 186, Sec. 2, Subd. 04d	\$287,000
Assessment of Household Chemicals and Herbicides in Rivers and Lakes	M.L. 2017, Chp. 96, Sec. 2, Subd. 04a	\$236,000
Assessing Neonicotinoid Insecticide Effects on Aquatic and Soil Communities	M.L. 2016, Chp. 186, Sec. 2, Subd. 04e	\$400,000

Project Manager and Organization Qualifications

Project Manager Name: Randall Singer

Job Title: Professor

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

Dr. Randall Singer will be responsible for overall project coordination. He will co-lead the geospatial modeling, a subject about which he has been researching and teaching for 20 years. He will coordinate the sampling activities of the project with the other project managers. He has led several large field studies requiring extensive coordination of sampling activities. This includes the study of antibiotics in the waterways of Chile, an activity that added extra challenges to project management (such as conducting the entire project in Spanish, a language in which Dr. Singer is fluent). Dr. Singer has been studying antibiotic-related issues for more than 20 years; he has focused on the environmental dissemination of antibiotics for 18 years. For the past several years he has been developing an approach for building a geospatial model to predict the environmental loading of antibiotics and antibiotic resistance and how to relate these predictions to environmental health impacts. In 2000 he was awarded the Presidential Early Career Award for Scientists and Engineers by President Clinton for his work on antibiotic resistance. Between 2006 and 2010 he served on the U.S. Delegation to the CODEX Task Force on Antimicrobial Resistance; this Task Force was renewed in 2017, and Dr. Singer was again invited to serve as a member. Dr. Singer has spoken twice to the U.S. House of Representatives on this topic. He served as a voting member of the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria between 2015 and 2019 and organized two full symposia for this Council on antibiotic resistance in the environment. In February 2020 he was invited to speak to the Council on the work he is conducting on his current LCCMR project on modeling the environmental dimension of antibiotics in Minnesota's waterways.

Organization: U of MN - College of Veterinary Medicine

Organization Description:

The University of Minnesota - College of Veterinary Medicine affects the lives of animals and people every day through educational, research, service, and outreach programs. We are dedicated to the education of future and current veterinarians and biomedical scientists and the discovery of new knowledge and skills. The college's faculty is nationally and internationally recognized for teaching and research excellence. Signature research includes infectious disease, genomics, comparative medicine, raptor conservation, public health, epidemiology and dairy, swine, and avian medicine. The college embraces the "One Health" concept, which aims to transform new knowledge into better health for animals, people, and the environment. The college also plays an important role in the health of the community by assuring food safety, conducting biomedical research, preventing zoonotic diseases, and enhancing our physical and psychological well-being through the care of companion animals and the protection of Minnesota's wildlife natural resources.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Randall Singer		Project Manager			27%	0.15		\$36,000
William Arnold		Co-Project Manager			27%	0.12		\$35,750
Irene Bueno		Co-Project Manager and Geospatial Modeler			20%	3		\$271,500
Amy Kinsley		Co-Investigator			27%	0.06		\$9,000
Graduate Student		Perform field measurements/laboratory experiments			43%	1.25		\$127,250
Undergraduate		Assist with field sampling/laboratory experiments and literature review			0%	0.5		\$17,500
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Undergraduate		Assist with field sampling/laboratory experiments and literature review			0%	0.5		\$17,500
							Sub Total	\$532,000
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Laboratory consumables, including solvents, standards, gloves, vials, columns	For processing of field samples and conducting laboratory experiments					\$23,000
	Tools and Supplies	Mass spectrometry time	Instrument fees for analysis of ~500 samples					\$30,000
							Sub Total	\$53,000
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								

							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Mileage for sample collection	To get water samples from selected sites					\$3,000
	Conference Registration Miles/ Meals/ Lodging	Conference fees	To present results and local conferences					\$1,000
							Sub Total	\$4,000
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Conference fees	To present results and local conferences	X				\$3,000
							Sub Total	\$3,000
Printing and Publication								
	Publication	Open access fees for peer-reviewed journals	To disseminate results to the scientific community and the general public					\$6,000
							Sub Total	\$6,000
Other Expenses								
							Sub Total	-
							Grand Total	\$598,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	Conference fees	This project is developing methodology that is of interest to the broader scientific community. It is important to present the results of this project at scientific conferences outside of Minnesota. This budget item reflects some of the costs associated with presenting the results at high profile scientific conferences.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Waived facilities and administrative costs	The University of Minnesota is waiving the income normally generated from extramural research grants that contribute Facilities and Administrative (F&A). The current full rate is 55% of direct costs.	Pending	\$322,025
			State Sub Total	\$322,025
Non-State				
			Non State Sub Total	-
			Funds Total	\$322,025

Attachments

Required Attachments

Visual Component

File: [f57b8e5a-5d4.pdf](#)

Alternate Text for Visual Component

Antibiotic residues are found in surface waters near hotspots like hospitals or animal farms. We still need to understand how far these residues can be transported, how long they remain in water, and how they vary depending on the antibiotic use at the source. As shown in the image, this project will 1) select hotspots identified from the antibiotic footprint model of Minnesota developed in the previous ENRTF funded project, 2) collect field measurements over time upstream and downstream from the hotspot, as well as conduct laboratory transformation studies to assess how antibiotics change depending on different environmental factors, 3) build a geospatial and hydrological model informed by the data collected previously, and 4) integrate the model into a user-friendly interface for managers to use at the hotspots with the goal of reducing the release of antibiotics into the environment.

Optional Attachments

Support Letter or Other

Title	File
Letter of support for Dr. Amanda Beaudoin	1a49a93c-da8.pdf
UMN SPA Cover Letter	2ecdd62e-310.pdf

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?

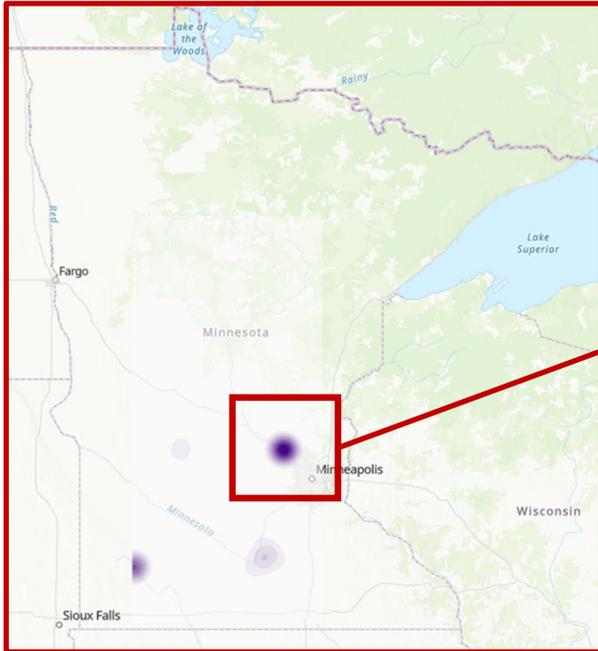
Yes

Does the organization have a fiscal agent for this project?

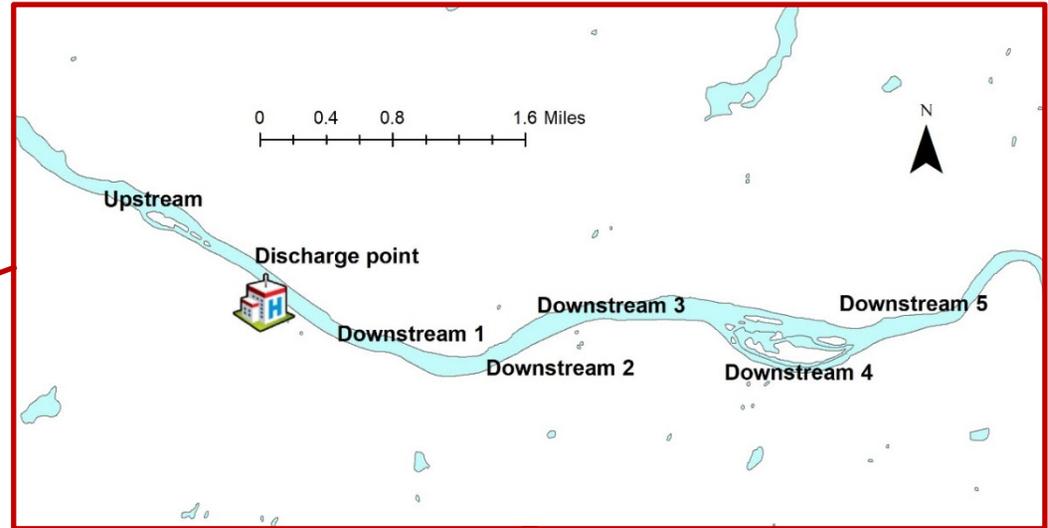
Yes, Sponsored Projects Administration

Microgeographic Impact of Antibiotics Released from Identified Hotspots

1. Hotspots identified in previous grant



2. Field measurements in different seasons & Laboratory transformation studies



4. Develop user-friendly interface



3. Geospatial and hydrological modeling

