Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-442

Proposal Title: Technology and Education to Address Water Quality Monitoring Challenges

Project Manager Information

Name: Junaed Sattar

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: This project creates a robotic sensor system, with multiple pods retrieved by an autonomous underwater vehicle, to assess water quality among Minnesota's watersheds.

ENRTF Funds Requested: $729,000

Proposed Project Completion: June 30, 2029

LCCMR Funding 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.

Ensuring clean water is vital for both human health and environmental sustainability, yet consistent and accessible water quality data remains difficult to obtain. Monitoring consistently across areas, particularly remote ones, is challenging due to limited accessibility, extreme weather, and seasonal changes. Significant logistical effort, while transporting and maintaining equipment, is required while contending with a lack of real-time data transmission options in remote locations. Also, radio frequencies are ineffective for long-distance, high-bandwidth communication underwater, further complicating continuous monitoring. Even with recent advancements in robotics and smart sensors, skilled personnel are required for sensor deployment, calibration, and maintenance, increasing costs and operational complexity. However, autonomous underwater vehicles (AUVs) combined with multi-probe water quality sensors offer a scalable, cost-effective alternative, and augments productivity of domain experts. These systems can improve data collection frequency, reduce manual labor, and enhance decision-making in water resource management. In an era of shrinking budgets and workforce limitations, leveraging robotic systems presents a transformative opportunity. Yet, successful transformation depends on public trust, stakeholder engagement, and demonstrating the reliability and effectiveness of AUV-based monitoring solutions.

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.

To address these challenges, we will (1) design and implement an AUV-assisted water quality monitoring system, (2) support ongoing monitoring efforts with strategic deployments, and (3) refine a reusable framework for assessing public acceptance of robotic water monitoring. Our proposed AUV-based system will autonomously transport and deploy static sensor pods at designated locations within watershed areas. These pods, with long-life batteries and multi-probe water quality sensors, will collect continuous data resting on the bottom of the waterbody. After an expert-informed predetermined period, the pods will automatically surface, enabling retrieval by the AUV or personnel. The AUV will extract the data, ensuring seamless, long-term, and cost-effective monitoring of remote or hard-to-reach water bodies. Deployments will align with the Minnesota Pollution Control Agency's 10-year watershed monitoring schedule, optimizing integration with existing programs. We will collaborate with local partners to strategically position the pods and develop outreach materials supporting sustainable monitoring aligned with One Watershed, One Plan priorities. Public acceptance is critical to the success of this system. To address this, we will implement a targeted questionnaire assessing public perceptions, acceptability, and response to robotic water monitoring. These insights will be integrated into planning and communications, informing adoption decisions and implementation.

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?

Efficient, acceptable, and accessible water quality monitoring methods enhance water conservation and protect our water supply. By creating a technology-assisted solution to water quality monitoring, particularly for remote, hard-to-reach locations, and assessing public preference for such a system, we aim to achieve: 1) an augmented and more comprehensive water quality monitoring effort, 2) a greater understanding of water quality dynamics, 3) a refined and centralized information dashboard for organizational decision making and public consumption, and 4) informed implementation plans considering public sentiment.

Activities and Milestones

Activity 1: Develop static underwater sensor pods and AUV deployment mechanism

Activity Budget: $350,052

Activity Description:
This activity will develop a cost-effective, scalable, and environmentally low-impact underwater sensor pod system for long-term water quality monitoring in remote and hard-to-access locations. Designed for minimal human intervention, the sensor pods will function as stationary monitoring units, prioritizing reliability, durability, and energy efficiency. Each cylindrical pod will feature corrosion-resistant housing, a passive buoyancy system with a ballast release mechanism for controlled surfacing, and a weighted bottom for stable, upright positioning. Powered by Lithium-ion or alkaline battery packs, the pods will operate for one to two weeks, depending on sampling frequency. A low-power microcontroller will manage data collection, optimizing energy efficiency. The pods will be equipped with a suite of water quality sensors, including temperature, dissolved oxygen (DO), pH, and nutrients (e.g., nitrate, phosphate). Data will be stored on internal SD cards or flash memory for later retrieval. For cost-effective deployment, the AUV will release the pods via a gravity-based drop from a rack, while retrieval will rely on a passive buoyancy release mechanism. In challenging conditions, RFID or LED beacons may assist the AUV in locating and recovering surfaced pods.

Activity Milestones:

Description	Approximate Completion Date
Create a prototype of submersible sensor pods, equipped with multi-parameter water quality probes	June 30, 2027
Create mechanism for deployment and retrieval of sensor pods using a low-cost open source AUV	March 31, 2028
Initial deployment of sensor pods with AUV in selected watershed	July 31, 2028
Water quality data collection, retention, and transmission to the data dashboard for partner support activities	December 31, 2028
Refined deployment of sensor pods with AUV in selected watershed	June 30, 2029

Activity 2: Public acceptance of robotic pod systems for water quality monitoring

Activity Budget: $198,038

Activity Description:
This activity seeks to understand public preferences for, acceptability of, and response to the use of a robotic system for water quality monitoring. Once public perceptions are understood, they can be integrated into planning and communications about technically-assisted monitoring and management. Given the lack of knowledge regarding the acceptance of using robots in public spaces, we will build on initial work that addressed attitudes toward robots in public spaces overall and will implement a questionnaire among a representative sample of residents in each watershed to explore the acceptability of a robot system. A representative sample will be purchased and an online questionnaire implemented in each watershed. Data will be cleaned and descriptively analyzed to understand public preferences, acceptability and responses to the robots, exploring differences by water values and place identity. Initial results will be shared with local partners to inform their adoption decisions and statewide to inform discussions of robotic-assisted monitoring efforts.

Activity Milestones:

Description	Approximate Completion Date
Pre-tested questionnaire among watershed residents for immediate and long-term use	May 31, 2027
Baseline public acceptance levels of robotic sensor system to monitor water quality	March 31, 2028

Presentations, meetings, and reports to share information and address public interests and concerns for adoption	June 30, 2029

Activity 3: Support partners in ongoing water-quality monitoring efforts

Activity Budget: $180,910

Activity Description:

In this activity, we will work with local partners to assist in ongoing water quality monitoring by deploying the AUV and sensor pods over two field seasons (April-November). In the first field season, we will work directly with partners to deploy pods in areas of interest. In the second season, our partners will deploy the system independently with technical support if needed. To enhance the impact of the monitoring process, we will refine a data visualization dashboard to incorporate geospatial tracking of sensor pod placement and retrieval locations. This will improve documentation and communication of data collection processes across the study area. The dashboard will also be adapted to display key environmental parameters, such as dissolved oxygen (DO) and nutrient levels. To support the expansion and application of our work, we will develop technical resources, including a website and a series of instructional videos on building and using an AUV-assisted water quality monitoring system. Additionally, we will collaborate with project partners to explore new technologies, applying these tools to assess ecosystem health and translate our findings into meaningful scientific insights.

Activity Milestones:

Description	Approximate Completion Date
Dataset of sensor pod locations and water quality metrics	March 31, 2027
Refined data visualization dashboard	March 31, 2028
Technical support materials (website and videos)	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Amy Kinsley	The University of Minnesota Twin Cities	Aquatic epidemiologist investigating effects of water quality on aquatic life and human well-being. Will be assisting in enhancing the impact of the monitoring process with a data visualization dashboard, which will aid local partners in ongoing water quality monitoring tasks.	Yes
Ingrid Schneider	The University of MInnesota Twin Cities	Focusing on the human dimensions of natural resource management, in partnership with national forests, parks, and state natural resource agencies. Will be investigating the public acceptance of robotic pod systems for water quality monitoring.	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 work be funded?

The proposed system will deliver an affordable, scalable solution for continuous water quality monitoring in Minnesota's lakes and watersheds. Implementation will involve AUV-assisted deployment of sensor pods at multiple sites, with detailed documentation of pod designs, collected datasets, a data dashboard, and deployment protocols for easy replication. By project completion, successful demonstrations will validate the approach and assess its public acceptability. To sustain and expand efforts, the team will seek federal grants, industry partnerships, and state funding to support long-term monitoring, technology refinement, and broader deployment across the region, ensuring lasting impact on water resource management.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Water Quality and Robots: Experientially Educating Minnesotan Youth	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 05s	$353,000

Project Manager and Organization Qualifications

Project Manager Name: Junaed Sattar

Job Title: Associate Professor

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

Junaed Sattar is an Associate Professor, Department of Computer Science, University of Minnesota Twin Cities, and the founding director of the Minnesota Interactive Robotics and Vision Laboratory, at the Minnesota Robotics Institute. Dr. Sattar manages a team of 9 graduate and 6 undergraduate students, conducting research in Field and Marine Robotics. He creates novel systems and methods to enable robust autonomous behavior for outdoor robots, particularly those that operate in the aquatic domain, towards environmental preservation and human well-being. He and his group have extensive experience designing, building, and operating robotic platforms for outdoor use, and these systems have seen significant applications in the lakes and rivers of Minnesota, and also in the Caribbean Sea for marine life inspection tasks. Dr. Sattar possesses expertise in robot localization, visual perception and object detection, and multi-robot coordination and collaboration, all in the context of field and outdoors robotics, in environments that are often fraught with significant challenges for robots to reliably exhibit such capabilities. These are important and relevant experiences and skills required for the successful completion of the proposed project for a number of reasons. Firstly, the proposed research will involve the construction of underwater self-sustaining pods containing multiple water quality sensors

deployed by autonomous surface vehicles (ASVs). These pods need to be deployed for reasonable periods of time to collect representative water quality data, so robust construction and power independence are necessary. Secondly, the deployment and retrieval of such sensors require novel mechanisms to be designed for existing AUVs like LoCO. Dr. Sattar's expertise in addressing these issues in robotic sensor construction, and his experience in deploying pragmatic robotic systems in a variety of open water bodies such as lakes and oceans make him suitable to lead this project.

Organization: U of MN - College of Science and Engineering

Organization Description:
The Minnesota Robotics Institute (MnRI) at the College of Science and Engineering is made up of researchers pushing the frontiers of robotic locomotion and perception in the land, air, and water across a vast array of domains including Precision Agriculture, Environmental Monitoring, Underwater Communication & Collaboration, Swarm Robotics, Social Robots, and Robot Perception. The Interactive Robotics Laboratory (http://irvlab.cs.umn.edu), as part of the MnRI, conducts research in underwater robotics motivated by the needs of environmental assessment, conservation biology, water quality assessment, and coral reef mapping and monitoring. The IRVLab specializes in cutting-edge perceptual computing for robotics applications in degraded visual conditions, and rugged robotic device construction, among others. Robotic field trials are a core part of the IRVLab's mission to invent robotics-driven solutions to a number of real-world problems. Outreach across the state as part of the research is a core agenda of the lab's work, as evidenced by robot trials in diverse locations, from Lake Superior in Duluth to Lake Byllesby in Cannon Falls. Students are exposed to the latest innovations in autonomous outdoor systems, and often are creating such innovations themselves, becoming well-equipped to face the challenges in the 21st-century economy in Minnesota and beyond.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Junaed Sattar - PI		Overseeing the project			26.8%	0.24		$73,313
Amy Kinsley - Co-PI		Co-Investigator for overseeing the project			26%	0.3		$55,466
Ingrid Schneider - Co-PI		Co-Investigator for overseeing the project			26%	0.12		$28,114
Post-Doc Associate - TBD		Researcher			21%	1.5		$124,679
Graduate Research Assistant -TBD		Student Researcher			43%	2.25		$353,576
Undergraduate Research Assistant		Student Researcher			0%	0.72		$12,486
							Sub Total	**$647,634**
Contracts and Services								
TBD	Service Contract	Panel for Survey Sample				-		$24,000
							Sub Total	**$24,000**
Equipment, Tools, and Supplies								
	Equipment	Robot sensors/pod building	Robotic Platform and Maintenance of it					$40,000
	Tools and Supplies	Consumables such as wires, batteries, etc.	Building and repairing of the robotic platform					$5,348
							Sub Total	**$45,348**
Capital Expenditures								

							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Other	Travel to Research site such as watershed sites	Research					$12,018
							Sub Total	**$12,018**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$729,000**

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				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $729,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 9120229c-cb3.pdf

Alternate Text for Visual Component

The visual demonstrates a rendering of an underwater robot deploying sensor pods at the bottom of a lake, and a schematic of the proposed water quality sensor being used, along with the project title and investigator's names....

Supplemental Attachments

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

Title	File
UMN_LoCO_AUV_On_A_Reef	cf53e793-953.pdf
Budget and Justification	e961518a-6d1.pdf
Sponsored Project Administration Authorization Letter	a5339931-350.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?

Yes

Does the organization have a fiscal agent for this project?

No

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:

Resha Tejpaul & Daniel Hegland, U of M College of Science & Engineering.

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

Yes, I understand