Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-447

Proposal Title: Cheap Portable Sensor to Detect PFAS in Water

Project Manager Information

Name: Tianhong Cui

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: We propose to develop a cheap, accurate, and ease-to-use sensor for detection of PFAS in water. It can be used for natural water monitoring and drinking water detection of PFAS.

ENRTF Funds Requested: $369,000

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.

PFAS are human-made chemicals found in many industrial and consumer products because they repel water and oil. However, these chemicals do not break down easily and build up in the environment, especially in water sources. Over time, this can harm ecosystems and pose serious health risks to people. Exposure to PFAS has been linked to problems such as developmental and reproductive issues, thyroid disorders, weakened immune function, and liver damage. PFAS contamination in drinking water and natural water bodies is a growing concern. Detecting these chemicals currently requires laboratory tests like liquid chromatography-mass spectrometry (LC-MS), which are highly accurate but expensive, slow, and require specialized equipment. This makes regular testing difficult, especially in areas with limited resources or where quick results are needed. This proposal aims to develop an affordable, portable sensor for rapid PFAS detection. This new tool will allow on-site testing, reducing the need for costly lab analysis and speeding up contamination assessments. By making PFAS detection more accessible and efficient, this innovation will improve environmental monitoring and help protect public health by enabling faster responses to pollution.

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.

We plan to develop an affordable, portable sensor that can quickly detect PFAS in water. The sensor will use laser-induced graphene (LIG) and molecularly imprinted polymers (MIPs). LIG creates a conductive and porous surface that improves sensitivity, while MIPs help the sensor accurately recognize PFAS molecules. This design will allow real-time, on-site testing without needing expensive lab equipment. Funding will support two main efforts. First, we will design, build, and test the sensor in the lab, making sure it is sensitive, accurate, and easy to use. This step will focus on improving how LIG and MIPs work together and testing the sensor with controlled PFAS samples. Second, we will connect the sensor to a portable electrochemical testing kit and conduct field tests in Minnesota lakes and rivers. These real-world tests will help us identify and fix any performance issues, ensuring the sensor is ready for practical use. Our goal is to create a reliable, easy-to-use tool for PFAS monitoring. By making testing more accessible and affordable, this sensor will help detect contamination early, protect water quality, and support public health efforts.

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?

This project will help protect Minnesota's water by making PFAS detection more affordable and portable. With easier access to testing, contamination can be identified and addressed more quickly, reducing long-term environmental harm. The project will help safeguard aquatic ecosystems, protect wildlife from PFAS exposure, and ensure cleaner water for public use. Data from Minnesota's lakes and rivers will support informed policy decisions and cleanup efforts. This sensor provides a practical and scalable way to expand PFAS monitoring, improving the state's ability to manage and reduce contamination effectively.

Activities and Milestones

Activity 1: Design, fabricate, and test an affordable, accurate, and easy-to-use sensor for detecting PFAS in water in a laboratory setting

Activity Budget: $184,000

Activity Description:
The first activity of the project focuses on designing, fabricating, and testing a highly sensitive sensor based on laser-induced graphene (LIG) for PFAS detection in the lab. This phase begins by optimizing the fabrication process for LIG electrodes, adjusting factors including laser power, scan speed, and electrode shape to improve conductivity, stability, and surface area for better electrochemical sensing. The electrodes' structures and electrical properties will be analyzed to ensure strong performance. Next, molecularly imprinted polymers (MIPs) will be created for different PFAS compounds. This involves using electropolymerization, where monomers form selective binding sites around PFAS molecules. The process will be tuned by adjusting factors including monomer-to-template ratio, polymerization time, and cycle number to enhance selectivity. Finally, the sensor's performance will be tested in the lab by measuring its ability to detect various PFAS compounds, developing calibration curves, and evaluating response time, stability, and repeatability. These results will help refine the sensor before moving on to real-world field testing.

Activity Milestones:

Description	Approximate Completion Date
Design, fabrication, and evaluation of highly sensitive sensors based on laser-induced graphene for electrochemical performance	June 30, 2027
Design, synthesis, and evaluation of molecularly imprinted polymers for selective detection compoundsof various PFAS	June 30, 2028
Characterization, evaluation, refinement, and optimization of portable PFAS sensors in the laboratory	June 30, 2029

Activity 2: Integration of the sensor with a portable electrochemical measurement kit, followed by field testing, refinement, and optimization in real-world conditions

Activity Budget: $185,000

Activity Description:
The second activity focuses on integrating the PFAS sensor with a portable electrochemical measurement kit for real-world use. This step ensures the sensor is practical for field deployment and works effectively in different water environments. First, the sensor will be connected to a portable electrochemical workstation, allowing for on-site PFAS detection. Its performance will be tested with real water samples from Minnesota lakes and rivers, optimizing it for different environmental conditions. A standardized detection process will be developed to ensure accurate and consistent results across various water sources. Next, field tests will be conducted using the portable detection kit, incorporating wireless data transmission for real-time monitoring. These tests will assess sensor stability, response time, and accuracy in natural settings, guiding improvements for better reliability and durability. Finally, we will analyze the collected data and collaborate with environmental agencies and policymakers in Minnesota. The findings will provide insights into PFAS contamination trends, helping to refine monitoring strategies and strengthen the sensor's role in long-term environmental protection and policy decisions.

Activity Milestones:

Description	Approximate Completion Date
Integration PFAS sensors with a portable workstation and a standardized protocol for accurate on-site detection	June 30, 2027

Field testing and optimization of PFAS sensors using a portable measurement kit in Minnesota waters	June 30, 2028
Data analysis and system evaluation of PFAS sensors in Minnesota waters with stakeholders	June 30, 2029

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?

This project will develop portable field and laboratory testing kits for PFAS detection in water, with patents filed to support commercialization. Findings will be shared through publications, conferences, and collaborations with industry and environmental agencies to encourage adoption. The University of Minnesota and Cui's lab will continue supporting development through the NSF Regional Innovation Engine, which has an initial $15 million investment over two years and potential for up to $145 million over eight years. This water technology initiative will drive further advancements, optimization, and real-world deployment.

Project Manager and Organization Qualifications

Project Manager Name: Tianhong Cui

Job Title: Professor

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

Dr. Tianhong Cui is a Distinguished McKnight University Professor at the University of Minnesota. He is a Professor in Department of Mechanical Engineering and an Affiliate Senior Member of the graduate faculty in Department of Electrical and Computer Engineering. He joined the faculty of the University of Minnesota in 2003. He is a Fellow of the American Society of Mechanical Engineering. He is also a member of the European Academy of Sciences and Arts. Dr. Cui is an international leading expert on micro sensors and advanced manufacturing. He has 380 archived publications in scientific journals and prestigious conferences and 10 US patents. He is the founding Executive Editor-in-Chief for a Nature journal, Microsystems & Nanoengineering. He has received awards including the STA & NEDO Fellowships in Japan, the Alexander von Humboldt Fellowship in Germany, the Richard & Barbara Endowed Chair and the Distinguished McKnight University Professorship from the University of Minnesota, the Blaise Pascal Chair Visiting Professorship in France (named after famous French scientist Blaise Pascal), the Distinguished Visiting Fellowship from the Royal Academy of Engineering and the Global Chair at the University of Bath in UK, a recent JSPS faculty fellowship at the University of Tokyo, and numerous best paper awards. Most recently Dr. Cui has received two NSF grants on micro-chemical sensors for detection of water pollutants.

Dr. Cui will serve as the PI and project manager, responsible for overseeing the project, all reports, and deliverables. He will supervise one PhD assistant to work on design, fabrication, and characterization of the proposed sensors for detection of PFAS in water. He will hold weekly meetings and daily technical discussions with his advisee to ensure good progress in this proposed work. Dr. Cui and his PhD student will also be responsible for field tests and assessment of the proposed PFAS sensor.

Organization: U of MN - College of Science and Engineering

Organization Description:

All programs in the College of Science and Engineering at the University of Minnesota are ranked among the top 25 in the nation by U.S. News. The Department of Mechanical Engineering is recognized as one of the leading programs in the country, serving as a hub for education, research, and innovation. This project will be conducted at the University of Minnesota in the Technology Integration & Advanced Nano/Microsystems Laboratory (TIAN Lab), located in the Mechanical Engineering Building. Directed by Professor Cui, the TIAN Lab is equipped with state-of-the-art fabrication and characterization tools, enabling the design, production, and analysis of PFAS detection sensors. Professor Cui and his PhD assistant will use these facilities to develop and test the sensors. Some fabrication will take place at the Minnesota Nano Center, a premier facility for nanoscience and applied nanotechnology research. The Center maintains advanced

equipment, enforces strict safety protocols, and provides training for researchers. Supported by the state, the NSF's NNCI program, and industry partnerships, the Center offers academic users significantly reduced rates—often less than half of the actual operational cost.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Tianhong Cui		Principal Investigator			26.79%	0.24		$89,299
Graduate Research Assistant		Research Assistant			43.01%	1.5		$186,769
							Sub Total	**$276,068**
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Silicon wafers, polymer substrates, graphene, chemicals, and components for testing set-up	Materials and supplies for various items required to fabricate and characterize the PFAS sensor					$29,932
							Sub Total	**$29,932**
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travels in Minnesota	Sampling and field tests in Minnesota waters					$13,500
							Sub Total	**$13,500**
Travel Outside Minnesota								

							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Scientific Services - University Of Minnesota Nano Center	Scientific Service at the University of Minnesota's Minnesota Nano Center and the Characterization facility. Fabrication and characterization costs of the PFAS detectors in central facilities					$49,500
							Sub Total	**$49,500**
							Grand Total	**$369,000**

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	Unrecovered F&A calculated at 54% MTDC	Support of ME Facilities where research will be conducted.	Secured	$169,212
			Non State Sub Total	**$169,212**
			Funds Total	**$169,212**

Total Project Cost: $538,212

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 621eaf3b-7ad.pdf

Alternate Text for Visual Component

Comparision of the current and proposed technologies...

Supplemental Attachments

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

Title	File
Proposal Submission Authorization Letter	f2a9512c-e50.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?

Yes

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

Yes

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

No

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:

Josh Gates <gates191@umn.edu>

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