Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-454

Proposal Title: Fungal-Amended Biofiltration System for Enhanced Remediation of Water

Project Manager Information

Name: Jiwei Zhang

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Basic Information

Project Summary: This project aims to discover a resilient, high-performing fungal species that can amend a versatile nature-based biofiltration system to boost the efficacy of pollutant treatment in Minnesota waters.

ENRTF Funds Requested: $414,000

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.

Minnesota's major rivers and more than 12,000 lakes require cost-effective filtration systems to address the increasing pollutants threatening water quality and ecosystems dependent on these water bodies. As urban expansion and climate change lead to greater runoff, there is a pressing need for more efficient practices to manage the rising pollutant levels entering our waters. While existing best management practices (BMPs), such as biofiltration and iron-enhanced sand filters, effectively remove certain pollutants like phosphorus, they fall short when faced with complex situations involving various types of pollutants. Therefore, there is a demand for alternative water filtration systems that can enhance treatment efficacy and preserve Minnesota's water resources.

Fungal organisms have demonstrated an ability to remediate toxic organics and fecal pollutants, yet there are limited studies on their application in water filtration systems. No comprehensive analyses of fungi have been conducted to explore their adaptation to the unique environmental conditions of Minnesota's water. Furthermore, there has yet to be research identifying high-efficiency fungal species suitable for contaminated water treatment in northern climates. Although the potential exists for fungal methods to be utilized in water treatment, significant research gaps remain regarding the development of fungal mycelium amendments in water infiltration systems.

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 propose identifying resilient, high-performing fungal organisms that can be integrated into a nature-based water filtration system, thereby providing a sustainable and reliable method for enhanced contaminant removal from impacted waters. The research will leverage the robust remediating capacity of fungal machinery to advance water filtering/retention systems. Thus, it aligns with LCCMR-Water Priorities, which focuses on developing innovative practices to prevent and tackle water issues in Minnesota.

To achieve our objectives, we will address an important research gap by generating scientific information on using fungal mycelium amendments in biofiltration systems. We will develop a comprehensive fungal database to identify species that thrive in Minnesota’s unique wastewater conditions by systematically assessing and ranking their phenotypes. These phenotypic evaluations will focus on targeting environmentally regulated organics and inorganics. The selected fungal species will then be validated for their effectiveness in removing a diverse array of pollutants through tube tests using artificial waters. Using the most effective fungi identified, we will design an innovative fungal-amended water filtering system and assess its performance in purpose-built media columns. We anticipate that this research will yield crucial information on fungal phenotypes and advance the development of new technologies for remediating and preserving Minnesota’s water.

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?

- Recommendations for fungi species based on location and contaminated water environments.
- Recommendations for fungi species based on target pollutants.
- Sourcing information for recommended fungal species.
- Biofiltration design recommendations like mixing ratio, maintenance, longevity, etc.
- Recommendations for additional research and/or the need for a field-scale pilot project.

Activities and Milestones

Activity 1: Project Management and Design

Activity Budget: $34,000

Activity Description:
Project management will include initiating agreements, designing and implementing the proposed research, tracking the progress of deliverables, preparing invoices, training graduate students/postdoctoral researchers, reporting to LCCMR, and forming a Technical Advisory Panel for this project. A basic Quality Assurance Project Plan (QAPP) will be created before samples and measurements are taken. Our team will combine the expertise of water and wastewater treatment science and engineering (Dr. Nigel Pickering at Geosyntec) and fungal remediation (Asst. Prof. Dr. Jiwei Zhang at U of Minnesota, PI). Meetings will be organized among team members every month to discuss the project's progress and for troubleshooting.
To initiate the project, we will summarize the issue of chemicals of emerging concerns (CECs) in Minnesota's waters via collaboration among all PIs. This approach will capitalize on using the publically available database to create metadata of water pollutants that include the following: fecal bacteria, agricultural tile drainage (e.g., nitrate and phosphate), pharmaceutical and personal care products (PPCPs), pesticide and herbicide (e.g., glyphosate), polycyclic aromatic hydrocarbons (PAHs), halogenated chemicals (e.g., PFAS, PCBs), plasticizers, and other man-made chemicals. This objective will document the typical CECs and identify key pollutants for evaluating fungal phenotypes.

Activity Milestones:

Description	Approximate Completion Date
Project initiation	July 31, 2026
CEC metadata in Minnesota's waters	December 31, 2026
Year 1 report and research plan revision	June 30, 2027
Year 2 report and research plan revision	June 30, 2028
Final data compilation and project write-up	June 30, 2029

Activity 2: Screening Remedial Phenotypes of Fungal Species for Cold-Climate Pollutant Conditions

Activity Budget: $100,000

Activity Description:
In this task led by Zhang lab, we will focus on testing fungi distributed in Minnesota and Midwest for their hardiness and ability to remediate pollutants under Minnesota's contaminated water environmental conditions. We plan to use species from cold-climate fungal collection centers, such as Minnesota Fungal Collections, Forest Product Laboratory Fungal Collections at USDA, and other Fungal Collections of Midwest states. This fungal library, which is comprised of hundreds of species, will allow us to do large-scale screening. We will perform rapid screenings using plate assays at cold (15°C) and normal (25°C) temperatures and with a selection of the key water pollutants identified above. The growth of fungal mycelia under test conditions will be scored and ranked for documenting the distinct phenotypic features that cope well in the Minnesota environment and also process the key chemicals. Triplicate cultures will be used for each treatment to allow statistical calculation with student's t-tests and ANOVAs. We expect to create a database demonstrating fungal resilience to cold conditions and mycoremediation potential for crucial contaminants. The database will guide us in selecting chemicals for the next task. Fungal species that can cause invasive/pathogenic issues will be eliminated from the continued analysis.

Activity Milestones:

Description	Approximate Completion Date
Collect the required fungal species library	October 31, 2026
Conduct large-scale fungal phenotypic tests	April 30, 2027
Screen the fungal species for water remediation	June 30, 2027
Create and publish fungal database of hardy, high-remediation phenotypes	December 31, 2027

Activity 3: Assessing Fungal Capacity for Wastewater Pollutant Removal

Activity Budget: $150,000

Activity Description:
This task will perform a more detailed analysis at Zhang's lab to evaluate fungal mycelia's capacity to remove pollutants from the state's water. We will use the selected fungal species to perform tube tests to measure their capacities in removing 10-20 prioritized CEC pollutants. The tubes will contain the living fungal system dosed with artificially contaminated water containing target pollutants at typical concentrations. We will assess the removal rates by measuring the residual concentrations after fungal treatment using standard methods. For instance, PAHs and PCBs will be monitored by GC/MS (US-EPA 610) and PFAS by LC/MS or 19F NMR using the facilities of Dr. Zhang's department, anions (e.g., chloride, nitrite, nitrate, sulfate, and phosphate) and metals by a Thermo Scientific Integrion HPIC system at the U of M Research Analytical Laboratory (https://ral.cfans.umn.edu/), and fecal bacteria by the 16S amplicon-based qPCR. If no singular fungal species works for all pollutants, we will optimize the species selection criteria by weighting the importance of the pollutants. Fungal transformation products will be monitored to ensure the selection of environmentally friendly species. We expect to discover fungi with great potential to remediate water pollutant environments in real-world situations.

Activity Milestones:

Description	Approximate Completion Date
Conduct tube tests for monitoring the fungal removal rates of CECs	October 31, 2027
Conduct chemical analysis to quantify the fungal removal rates of CECs	December 31, 2027
Select fungal species for constructing the meso-column water filtration systems	March 31, 2028

Activity 4: Testing Fungal-Amended Wastewater Biofilters

Activity Budget: $130,000

Activity Description:
The objective of this task, led by Dr. Nigel Pickering, is to test the ability of the selected fungal species in a mycelium-amended filtering system designed to remove pollutants in various contaminated waters. Soil columns will represent a vertical slice of a biofilter. We will use polyvinyl chloride pipe to create laboratory-scale columns. Columns will be top-fed by a multi-head peristaltic pump from a large common mixing tank and have a bottom sampling port. Column design will reflect retention times for typical biofilters. Column media will be created using a pre-grown/established live mycelial matrix incorporated into a mix that will include typical sand and compost ratios. Various mixing ratios of the mycelium to biofilter mix will be evaluated for pollutant removal. Columns for all treatments will be at least replicated. An estimated annual volume of the contaminated water will be used. Repeated pulses of wastewater will be applied to the columns to simulate contamination events until the desired total water depth has been applied. Columns will be dosed with synthetic contaminated water containing the same array of pollutants as the previous task. The difference between inlet and outlet concentration will yield pollutant removal efficiency.

Activity Milestones:

Description	Approximate Completion Date
Construct the water filtration columns	March 31, 2028
Establish fungal species in the water filtration columns	July 31, 2028
Test the performance the fungal-amended filtering system	February 28, 2029
Disseminate results from the fungal-amended water filtration techniques	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Nigel Pickering	Geosyntec, LCC.	Develop and test the fungal-amended biofiltration columns	Yes
Research Analytical Laboratory	University of Minnesota	Chemical analysis of water pollutants	No

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?

Incorporating fungal amendments to create new, cocktail-media filtration systems could enhance the protection of Minnesota's major watersheds and over 12,000 lakes. If this project is successful, the findings and related engineering methods will benefit water resource professionals and wastewater permit holders in Minnesota and beyond. This initiative will promote emerging applied research, enable more informed decision-making, and support the implementation of innovative technologies for treated contaminated waters.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
PFAS Fungal-Wood Chip Filtering System	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 08f	$189,000

Project Manager and Organization Qualifications

Project Manager Name: Jiwei Zhang

Job Title: Assistant Professor

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

Our team, led by Dr. Jiwei Zhang at U of Minnesota and Dr. Nigel Pickering at Geosyntec, has a wealth of experience in managing cross-disciplinary projects, designing and conducting wet lab experiments, managing and reporting data, and can ensure the accomplishment of the proposed research at high-quality levels.

Dr. Zhang is currently an assistant professor in the Department of Bioproducts and Biosystems Engineering, with a promotion to tenure and an associate professor position expected in Fall 2025. His research focuses on investigating and utilizing the biodegradation capabilities of fungal species for environmental engineering to sustain and conserve local and national environments. Dr. Zhang oversees a certified BSL1 lab at the U of Minnesota designed to culture and manipulate fungal species used in this research. The lab has created the SOPs required for this project, and the instruments are well-maintained and calibrated periodically.

Dr. Pickering is a technical consultant for this project and works as a Senior Water Resources Engineer at Geosyntec Consultants, Inc. He will lead the development and testing of fungal-amended filtration columns designed to improve pollutant treatment in Minnesota waters. His involvement will connect our fundamental laboratory research with potential practical applications in the field.

Relevant to project management, each partner, collaborator, and subgroup's roles have been clearly defined, and we have thoroughly estimated the feasibility of each task. We have also integrated tiered strategies with alternative means to achieve goals. We plan to use an open group format, with uniform data handling, hands-on involvement of students/postdocs and team members in collaboration, and sharing results transparently via presentations and data. Specific quality assurance and quality control (QA/QC) plans are made for the research.

Overall, this project is an important step in researching valuable fungal resources, and our proposal is poised for high-quality, mission-relevant discoveries.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Organization Description:
The College of Food, Agricultural, and Natural Resource Sciences (CFANS) is one of seventeen colleges and professional schools at the University of Minnesota. The Department of Bioproducts and Biosystems Engineering of CFANS, where Dr. Zhang serves as a faculty member, is organized to discover and teach solutions for the sustainable use of renewable resources and the enhancement of the environment. The missions of CFANS align well with this proposal, and the facilities, equipment, and other resources owned by the College and Department will ensure the success of this project.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Assistant Professor		PI; Manage project; Supervise students/postdocs; Conduct the proposed research			26.8%	0.3		$45,600
Graduate Student Assistant		Assist PI in carrying out project; RA salaries, fringe/benefits, and tuition fees			45.5%	3		$179,500
							Sub Total	**$225,100**
Contracts and Services								
Geosyntec; Dr. Nigel Pickering	Service Contract	Lead the development and testing of fungal-amended filtration columns designed to improve pollutant treatment in Minnesota waters. The itemized budget for Geosyntec is attached to this proposal in "Attachments."				1.5		$156,095
							Sub Total	**$156,095**
Equipment, Tools, and Supplies								
	Tools and Supplies	Laboratory supplies and tools in year 1, including a PC for CEC metadata analysis ($1000), chemicals, fungal medium, dishes, flasks, and other lab consumables for performing fungal tests on wastewater pollutants.	Materials to set and perform laboratory procedures for culturing, screening, laboratory scale testing, and analysis of fungal phenotypes on various wastewater pollutants.					$8,940
	Tools and Supplies	Laboratory supplies in year 2, including chemicals, dishes, flasks, and other lab consumables for growing fungi, and analytic services, molecular reagents, and HPLC/LC-MS for testing fungal removal of wastewater pollutants using the lab-scale sorption tests.	Materials and analytical service for the lab-scale tests for monitoring fungal capacities in removing wastewater pollutants.					$10,935
	Tools and Supplies	Laboratory supplies and tools in year 3, including PVC shelving, PVC piping, peristaltic pumps and tubing, and buckets required for setting up the wastewater filtration columns and sample analysis to monitor the performance of the fungal-amended columns.	Materials and analytical services for the lab-scale tests for testing the performance of the fungal-amended wastewater filtration columns in removing pollutants. Both the Zhang's and Pickering's groups will build a					$9,930

			similar setup to synergize efforts and accelerate the progress.					
							Sub Total	**$29,805**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
							Sub Total	**-**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Publication fee in professional journals at Year 2; A large-scale phenotypic tests for screening the fungal capacities to remove wastewater pollutants.	Write-up and publish the research findings					$1,500
	Publication	Publication fee in professional journals at Year 3; A fungal-amended cocktail filtration system for wastewater treatment.	Write-up and publish the research findings					$1,500
							Sub Total	**$3,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$414,000**

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	Waived UMN overhead	Waived UMN overhead	Secured	$195,235
			Non State Sub Total	**$195,235**
			Funds Total	**$195,235**

Total Project Cost: $609,235

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 0f0d314a-c02.pdf

Alternate Text for Visual Component

This project aims to conduct large-scale tests on fungal phenotypes to screen and validate their capabilities in removing water pollutants. The findings will be used to integrate fungal mechanisms into a water filtration system, thus developing a new treatment technique that enhances pollutant remediation in contaminated waters in Minnesota....

Supplemental Attachments

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

Title	File
UMN authorization letter for submission_2026_454	0d8c4a93-fb4.pdf
Audit	a03cd273-10b.pdf
Subrecipient Commitment Form_Geosyntec	13586ef9-758.pdf
Letter Of Intent_Geosyntec	e93ffecf-fa7.pdf
Itemized budget for Geosyntec services led by Dr. Nigel Pickering	72e2a615-2c4.docx

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?

N/A

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:

Wendy Moylan; 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

Yes, I understand