



# Environment and Natural Resources Trust Fund

M.L. 2024 Approved Work Plan

## General Information

**ID Number:** 2024-189

**Staff Lead:** Noah Fribley

**Date this document submitted to LCCMR:** June 6, 2024

**Project Title:** Preventing PFAS and Microplastics Contaminants across Minnesota

**Project Budget:** \$656,000

## Project Manager Information

**Name:** Roger Ruan

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

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## Project Reporting

**Date Work Plan Approved by LCCMR:** June 20, 2024

**Reporting Schedule:** June 1 / December 1 of each year.

**Project Completion:** June 30, 2027

**Final Report Due Date:** August 14, 2027

## Legal Information

**Legal Citation:** M.L. 2024, Chp. 83, Sec. 2, Subd. 08k

**Appropriation Language:** \$656,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to help stop the flow of per- and polyfluoroalkyl substances (PFAS) and microplastics contaminants into Minnesota's environment by developing strategies and technologies to manage solid waste streams on site. This appropriation is subject to Minnesota Statutes, section 116P.10.

**Appropriation End Date:** June 30, 2027

## Narrative

**Project Summary:** This project helps Minnesota entities that directly or indirectly cause PFAS and microplastics contamination stop the flow of the contaminants by developing strategies to manage solid waste streams.

**Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.**

As PFAS and plastic products bring benefits to our daily life, the risks of them ending up contaminating land and water has grown significantly. Environmental contamination of PFAS and microplastics in our living environment is currently a widespread issue of concern, posing a great threat to human and ecological health. It was reported that microplastic particles can be absorbed across membranes in the human body and found in human blood and PFAS compounds have been detected above the recommended attention limits in food. Most studies focus on removing the PFAS and microplastics from soils and water, but very little research data or practical solution currently exists on how to stop the continuous flow of these contaminants into our environment. As documented in the literature and reports, the major sources of PFAS and microplastics contamination in drinking water, groundwater, soils, and air include industrial sites, landfills, and wastewater treatment plants. Unfortunately, we don't know how to effectively mitigate them by securing the major source in Minnesota. This project will guide us to proactively dispose of waste streams which play a vital role in releasing PFAS and microplastics in a way that intercepts the migration of environmental contaminants.

**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.**

PFAS and microplastics usually get into lands, rivers, and lakes mainly due to improperly disposal of PFAS/microplastics-containing waste streams. Minnesota waste managers have an immediate need of techniques and equipment to mitigate the effect of PFAS/microplastics-containing waste streams on the environment. This project will focus on developing an advanced mobile catalytic microwave-assisted pyrolysis (cMAP) system to achieve effective treatment of specific waste streams and minimize the environmental impacts under real-world conditions. First, we will secure partnerships with local fire training sites, industrial sites, materials recovery facilities, landfills, and wastewater treatment plants to identifying the source of PFAS and microplastics across Minnesota. The next activity will test the feasibility of treating various waste streams in the lab by developing the bench-top scale cMAP system and highly effective catalysts and examine how the contaminants evolve during this process. The optimal design and parameters will be used to construct a 200 kg/day mobile pilot-scale cMAP system for demonstration and the preliminary techno-economic analysis and life cycle assessment will be conducted to verify the feasibility.

**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 give the scientific knowledge through this exploratory research and understanding of: 1) how to effectively treat PFAS/microplastics containing solid wastes through catalytic microwave-assisted pyrolysis technology and demonstrate a pilot-scale system to verify the commercial feasibility; and 2) how to conduct preliminary techno-economic analysis and life cycle assessment for the proposed technology, based on the obtained data from this project. The objective of this proposed research is to help state-wide entities cleanly dispose of their PFAS/microplastics-containing solid wastes to prevent environmental contamination and protect the state's water resource, aquatic lives, and human safety.

## 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

## Activities and Milestones

### Activity 1: Laboratory investigation of treating PFAS/microplastics-containing solid wastes

**Activity Budget:** \$200,000

#### Activity Description:

Initially, we will work with our industry partners to collect various types of solid wastes from their sites. We will evaluate and characterize the samples of feedstock, in terms of the compositions of the feedstock and levels and types of contamination in the feedstock. In the first year, we will also develop an advanced cMAP system for converting solid wastes into solid, liquid and gas products. Any operating issues with the lab-scale system will be resolved. Optimal process conditions, including pyrolysis/catalysis temperatures and loading of catalyst, will be established for maximizing the quality of desirable products. The fate and transport of PFAS and microplastics during the cMAP will be assessed in detail. Specifically, an understanding of fluorine migration into final products will be obtained through an analysis of fluorine occurrence form by liquid chromatography-tandem mass spectrometry (LC-MS/MS) and mass spectrometry (MS). On the other hand, we will also evaluate the microplastics concentration in the biochar, bio-oil, and pyrolytic gases, although we believe they will be completely degraded into short chain hydrocarbons in the high temperature process. Furthermore, several strategies, including enhancing porosity and adjusting acidic properties, could be implemented in developing new catalysts with improved performance.

#### Activity Milestones:

Description	Approximate Completion Date
Collection and characterization of solid wastes	December 31, 2024
Develop an advanced cMAP system	December 31, 2024
Conduct solid waste pyrolysis studies and catalyst development	September 30, 2025
Analyze the fate and transport of PFAS and microplastics	June 30, 2026

### Activity 2: Developing a mobile demonstration pilot-scale cMAP system that will enable verification of the PFAS/microplastics-containing solid wastes treatment

**Activity Budget:** \$334,000

#### Activity Description:

In this activity, a 200 kg/day pilot-scale system will be constructed and demonstrated. This pilot cMAP system will be installed on a trailer which can be hauled by a truck, so the system can be demonstrated at a specific site. In this activity, related technical issues with the 200 kg/day system to be built will need to be addressed, including potential polymer melting and blockage at the feeding tube, insufficient mixing of the ball bed, and complete separation of pyrolytic vapor from ash and char before entering the catalytic reactor. This pilot-scale cMAP system will be used to 1) confirm the feasibility of treating PFAS/microplastics-containing solid wastes at a larger throughput; 2) improve the treatment efficiency and minimize the environmental impacts under real-world conditions; 3) determine product yield, quality, pollutants/greenhouse gas emissions, and energy consumption for the subsequent techno-economic analysis and life cycle assessment.

#### Activity Milestones:

Description	Approximate Completion Date
Construction of a 200 kg/day mobile pilot-scale cMAP system	September 30, 2026
Pilot system improvement and demonstration	March 31, 2027

### Activity 3: Conducting preliminary techno-economic analysis and life cycle assessment for the proposed technology

**Activity Budget:** \$122,000

**Activity Description:**

In this activity, we will design end-to-end conversion process and build the simulations to generate mass and energy balances and information about energy consumption and operational costs for a preliminary techno-economic analysis. Pollutants and greenhouse gas emissions will be determined by measuring primarily fluorine-containing compounds, CO<sub>2</sub> and CH<sub>4</sub> released during the operation of the pilot system at a specific site. This information will serve as preliminary life cycle assessment inputs in this activity. In addition, the potential impact of organic gases and aerosols emitted by the system on air quality will be evaluated with continuous monitoring and point measurements.

**Activity Milestones:**

Description	Approximate Completion Date
Generate information for a preliminary techno-economic analysis	March 31, 2027
Monitor pollutants and greenhouse gas emissions for preliminary life cycle assessment	March 31, 2027
Final Report on this project with outreach materials	June 30, 2027

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Paul Chen	University of Minnesota	Co-PI	No
David Brummel and Michael Reed	Ramsey/Washington Recycling & Energy	R&E will support the project by supplying various waste feedstock samples and sharing input, feedback and subject matter expertise of soil waste management systems throughout the project.	No

## 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.**

The dissemination plan for this project serves a threefold objective: seeking input from relevant industries, raising awareness about the issues and potential solutions, and educating stakeholders on the project's findings. Key stakeholders include managers of industrial sites, landfills, and wastewater treatment plants dealing with PFAS and microplastics-containing waste, environmental mitigation and restoration entities, state environmental control agencies, students, and researchers.

- To raise awareness, we will engage in effective communication with stakeholders and the general public through various channels. These include hosting Zoom brief meetings, maintaining an informative project website, and delivering presentations at meetings organized by trade groups and professionals. We will tailor our communication to cater to both technical and non-technical audiences, ensuring that everyone gains valuable insights into the project's significance.
- To educate stakeholders, we will design and disseminate public information about the demonstration project. This information will be accessible and understandable for diverse audiences. We will actively encourage participation from various entities, including UMN outreach centers, waste management firms, and other interested parties. Throughout the project duration, we will warmly welcome stakeholder visits to the project site, allowing them to witness progress firsthand.
- A final demonstration will take place on UMN's St. Paul campus, with advance announcements sent to stakeholders, including LCCMR members and staff, to maximize participation and impact.
- For technical findings, we will present at relevant conferences and publish in peer-reviewed journals. By sharing our discoveries, we aim to foster behavioral changes among stakeholders and the general public, motivating them to take action in preventing the spread of PFAS and microplastics by stopping the flow of contaminants.
- Throughout all dissemination activities, we will duly acknowledge the Environment and Natural Resources Trust Fund's support. The trust fund logo or attribution language will be appropriately included on project print and electronic media, publications, signage, and other communications and outreach materials. This acknowledgment demonstrates our gratitude and ensures transparency in our funding sources.

## 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 long-term goal of this work is development of a cost-effective and practical mobile pilot-scale cMAP system that meets the needs of environmentally friendly treating specific waste streams and the environmental needs of Minnesotans. We will communicate with policy makers (e.g. MPA, EPA), Metropolitan Council Environmental Services, and managers of fire training/fire response sites, industrial sites, landfills, and wastewater treatment plants, who are

interested in curbing PFAS and microplastics contaminants, to educate them through presentations, understand their practical concerns, gain their inputs, and collaborate with them on pilot projects, and foster a long-term relationship.

### Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Methods to Destroy PFAS in Landfill Leachates	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 04a	\$200,000

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Professor/faculty		PI - 2.5 weeks summer salary - direct all research, analysis, admin and personnel			36.8%	0.15		\$41,371
Professor/faculty		Co-PI - contract faculty - co-direct all aspects of project - supervise post doc and student			36.8%	0.48		\$72,087
Graduate Research Assistant		One researcher to conduct experiments, analysis, education			47%	3		\$162,682
Post Doc Researcher		Conduct research and analysis			25.7%	3		\$215,166
							<b>Sub Total</b>	<b>\$491,306</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	-
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Purchase of lab and miscellaneous supplies, including feedstock, catalysts, chemicals, consumable supplies for analytical instruments, gloves, masks, PPE	For running experiments and operating conversion systems, chemical and physical analyses					\$27,922
	Equipment	Components for fabrication of a small pilot system including reactor vessel, insulation materials, magnetrons, heating devices, control, motors, mixer, feeder, valves, etc. The procurement of individual equipment components for constructing the small pilot system will not exceed \$5,000 per item.	To fabricate a small pilot system for extensive testing, cost and emission analysis, and demonstration					\$134,000
							<b>Sub Total</b>	<b>\$161,922</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-



<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	12 one-day 2-person trips, 100 miles each round trip (\$0.655/mile), meals @\$50/person	Visits to waste management sites, feedstock collection and transport					\$2,772
							<b>Sub Total</b>	<b>\$2,772</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$656,000</b>

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

## Attachments

### Required Attachments

#### *Visual Component*

File: [f50d512a-08a.pdf](#)

#### *Alternate Text for Visual Component*

Environmental contamination of PFAS and microplastics in our living environment is currently a widespread issue of concern, posing a great threat to human and ecological health. The schematic highlights the research approach of this project. We propose to remove PFAS and microplastics across Minnesota by reducing their sources....

### Supplemental Attachments

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

Title	File
Support letter from Ramsey/Washington Recycling & Energy	<a href="#">65cd4582-532.pdf</a>
2022 Audit	<a href="#">93261535-b00.pdf</a>
Authorization	<a href="#">98bffa13-22e.pdf</a>
Support letter from Clean Water Action Minnesota	<a href="#">9e0d8aab-3b7.pdf</a>
Research Addendum revised 2024-189_final	<a href="#">77940339-5ea.pdf</a>

### Difference between Proposal and Work Plan

#### *Describe changes from Proposal to Work Plan Stage*

We have requested a reporting schedule on January 1st and July 1st of each year, and we will prepare the progress report biannually as requested.

## Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

**Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?**

N/A

**Do you agree travel expenses must 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 agree to the UMN Policy.

**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