Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-184

Proposal Title: Microplastics from Paint Chips: Impact on Contaminant Transport

Project Manager Information

Name: Lee Penn

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: Paint chips release microplastics into the environment. We propose to determine how microplastics from paint chips impact the fate and transport of contaminants of concern in Minnesota waters.

Funds Requested: $471,000

Proposed Project Completion: June 30 2025

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.

Plastic pollution is a growing environmental problem. Microplastics are tiny pieces of plastics that have broken off bigger plastic objects (e.g., clothing, bags) or were added to products (e.g., paints). Paint chips shed from objects like boats, docks, and hockey boards, and microplastics can then be released from those paint chips into their surroundings. We propose to study how microplastics from paint chips can serve as vehicles to transport contaminants of concern (COCs) within the environment.

Microplastics pose a major threat to our environment for three reasons. First, organisms, on land and in water, eat microplastics, and those microplastics can severely disrupt digestion, sometimes even resulting in death. Second, microplastics can absorb contaminants (e.g., pesticides, drug molecules). This makes microplastics potential vehicles for transporting and delivering contaminants to organisms that eat those microplastics. Third, microplastics may act as reservoirs for contaminants of concern (COCs) in the environment. Two types of COCs are important to consider: molecules used in fabricating plastics (e.g., plasticizers) and molecules absorbed from the plastic's surroundings (e.g., pesticides, herbicides, drug molecules). How much and which COCs are carried by microplastics in water has not been studied in the environment, and not at all in Minnesota.

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.

Here, we propose to examine how microplastics released from paint chips impact the fate and transport of COCs in Minnesota waters. We propose to do this by:

- Determining how much microplastic is released from paint chips using paint chips prepared from paints commonly used on structures like hockey boards and boats and paint chips collected from Lake Nokomis, where hockey boards were installed during winter 2020-2021.
- Determining how much and which COCs are taken up by microplastics commonly found in paints
- Determining how paint chips continue to break down under environmental conditions (e.g., exposure to light, agitation, and lake water)
- Modeling the fate and transport of COCs, in order to learn how things change with the presence of paint chips

Major Results Expected:
Determination of how much and which COCs are taken up by common microplastics commonly found in paints. Improved understanding of how microplastics change the fate and transport of COCs in Minnesota Waters, which will lead to better predictions about environmental impact.

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?

The results from this project will enable the State of Minnesota to better predict the impact of environmental contamination with chemicals and microplastics and develop better approaches to prevention and remediation. In addition, the team will give open scientific presentations and publish scientific papers addressing the above objectives.

Activities and Milestones

Activity 1: Lab Studies to Determine Impact of Aging on Release of Microplastics from Paint Chips

Activity Budget: $235,500

Activity Description:
We will perform a series of lab-based experiments in order to determine how paint chips break down and release microplastics to their environment. We will use lab-prepared paint chips using paints commonly used on docks, hockey boards and skating rinks, and boats as well as paint chips collected from the main beach area of Lake Nokomis, where hockey boards were installed during the winter of 2020-2021 and substantial deposition of paint chips on the lake bottom was observed. Initial experiments will use the lab-prepared paint chips in order to refine methods, since the amount of paint collected from Lake Nokomis is limited. The paint chips will be added to batch reactors containing purified or natural lake water. Experimental variables include exposure to light, which is known to accelerate the breakdown of plastics and other materials, and agitation, which is common due to wave action and/or flow in natural waters. The release of microplastics from the paint chips will be monitored using several techniques. These techniques include light scattering to detect the presence of particles in the water and combined microscopy and spectroscopy to identify particles released into the water.

Activity Milestones:

Description	Completion Date
Quantify release of microplastics from lab-prepared paint chips	July 31 2023
Identify microplastics released from lab-prepared paint chips	July 31 2023
Quantify release of microplastics from paint chips collected from Lake Nokomis	December 31 2023
Identify microplastics released from lab-prepared paint chips	December 31 2023

Activity 2: Quantify Uptake of COCs by Microplastics Common in Paints

Activity Budget: $141,300

Activity Description:
We will combine select COCs and the types of microplastics found in paints in batch experiments. Target COCs include plasticizers (e.g., per- and polyfluoroalkyl substances (PFAS), polychlorinated biphenyls (PCBs)) and current-use organochlorine pesticides. Target microplastics include polyurethanes, polyesters, polyacrylates, polystyrenes, and epoxies. Particles will be introduced to glass containers of aqueous solutions with known amounts of COCs, allowed to equilibrate for 24 hours on a wrist-action shaker, filtered, and analyzed for COCs in both the water and microplastic. How much COC is taken up by each plastic will be calculated. Solutions will be prepared using both purified water and natural water collected from Lake Nokomis or the Mississippi River.

Next, we will perform batch experiments using the paint chips in order to determine how much of the COCs absorb into the microplastic particles and whether the presence of the COCs changes how microplastics are released from the paint chips. Both the lab-based and field-based paint chips will be introduced to glass containers of aqueous solutions with known amounts of COCs, allowed to equilibrate for varying amounts of time on a wrist-action shaker. Batch reactor contents will be filtered, and both the solids and the liquid will analyzed for COCs.

Activity Milestones:

Description	Completion Date
Determine uptake of COCs into the microplastics commonly found in paints	July 31 2024
Determine uptake of COCs into paint chips	December 31 2024
Determine how aging in the presence of COCs changes release of microplastics from paint chips	December 31 2024

Activity 3: Model Impact of Microplastic Common in Paints on Fate and Transport of COCs

Activity Budget: $94,200

Activity Description:
Results from Activities 1 and 2 will be used in a model designed to predict the fate and transport of COCs associated with microplastics. The model will be designed to predict the fate and transport of COCs associated with microplastics released from paint chips. Modeling the fate and transport of COCs associated with microplastics will build on sediment transport models that account for buoyant and non-bouyant microplastics.

The results from modeling will impact the design of additional laboratory experiments, and the results from those experiments will be used to improve the models. This will enable us to strengthen the utility of both the experimental and model results. Combined, results will elucidate how paint chips impact the fate and transport of both the particles and the COCs they contain in Minnesota waters.

Activity Milestones:

Description	Completion Date
Estimate the mass of particles added to natural waters from paints	June 30 2025
Determine the amounts of COCs released from paint-based microplastics to natural waters	June 30 2025
Identify how microplastics from paints impact the fate and transport of contaminants of concern	June 30 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Matt Simcik	University of Minnesota - Twin Cities School of Public Health	Dr. Simcik is in the Division of Environmental Health Sciences in the School of Public Health. Dr. Simcik is an expert in the fate and transport of organic contaminants in the environment. Dr. Simcik will serve as primary supervisor to the lab manager and the graduate assistant.	Yes
Prof. Melissa Mauer Jones	University of Minnesota – Duluth (UMD)	Prof. Mauer Jones is studying how microplastic particles form from larger pieces of plastic. We will partner with her research group in characterizing the microplastic particles generated from our batch described in activity 1.	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 be funded?

The results of this project will be disseminated to the Minnesota Pollution Control Agency through presentations to the agency and to the greater scientific community through presentations at national meetings and through the peer reviewed literature. In addition, the investigators will seek funding from both national and state-level sources, and results from this work will be incorporated into those proposals.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Solar Cell Materials from Sulfur and Common Metals	M.L. 2014, Chp. 226, Sec. 2, Subd. 08a	$494,000

Project Manager and Organization Qualifications

Project Manager Name: Lee Penn

Job Title: Professor

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

Dr. Lee Penn will lead the project and work closely with Dr. Matt Simcik in coordinating experiments and field sampling geared towards improving understanding of the effect that microplastics have on the fate and transport of contaminants of concern in Minnesota waters. They will co-advise two graduate students. The post-doctoral research will serve as a mentor towards the graduate student.

Dr. R. Lee Penn will be the primary project manager. Dr. Penn is a Full Professor in the Chemistry Department at the University of Minnesota and an expert in particles in the environment. Dr. Penn is also on the graduate faculty of the Water Resource Sciences Program and in the Department of Earth Sciences. Dr. Penn will be responsible for project and data management and will serve as primary supervisor to one of the Graduate Assistants.

Dr. Matt F. Simcik will be the secondary Project Manager. Dr. Simcik is an Associate Professor in the Division of Environmental Health Sciences in the School of Public Health at the University of Minnesota. Dr. Simcik is also on the graduate faculty of the Civil, Environmental and Geoengineering Department and the Water Resource Sciences Program. Dr. Simcik is an expert in the fate and transport of organic contaminants in the environment. Dr. Simcik will serve as primary supervisor to the lab manager and the second Graduate Assistant.

Organization: U of MN - College of Science and Engineering

Organization Description:
The University of Minnesota College of Science and Engineering brings together the University's programs in engineering, physical sciences, mathematics and computer science into one college. Because of this unique structure, the college is uniquely positioned to provide the vision, leadership, and intellectual capital that underwrite interdisciplinary progress in the 21st Century. The college is ranked among the top academic programs in the country. The college includes 12 academic departments offering a wide range of degree programs at the baccalaureate, master's, and doctoral levels.

Researchers within the College of Science and Engineering are on the leading edge of finding ways to solve some of the world's greatest problems by developing new forms of environment-friendly energy and products, new medical devices, digital and electronic technologies, and a strong national infrastructure. The college has collaborations with the University of Minnesota’s world-renowned medical school, locally-based companies such as 3M and Medtronic, as well as universities around the globe.
Partnerships with the private sector nurture the work of College of Science and Engineering faculty and students. Input from leading companies helps shape the college's curriculum, ensuring that students' skills match industry needs. In return, the college offers a wealth of resources to help businesses succeed.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Lab Manager		Manage PI lab operations			25.4%	0.24		$17,300
Principal Investigator		Supervise graduate student; perform electron microscopy on samples; co-lead sample collection in the field; evaluate data and design experiments.			36.5%	0.3		$69,780
Co-Principal Investigator		Supervise graduate student;lead sample collection in the field; evaluate data and design experiments.			36.5%	0.3		$78,368
Graduate Research Assistant (Beginner)		Design and execute experiments and sample collection; characterize standard and field samples of polymer fibers.			45.01%	1.5		$148,319
Graduate Research Assistant (Advanced)		Co-advised and working in close collaboration with members of each PI's research group; Design and execute experiments and sample collection; quantify absorption of contaminants in standard and field samples of polymers.			22.91%	1.5		$105,809
							Sub Total	**$419,576**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Model contaminant compounds	Model contaminant compounds					$4,000
	Tools and Supplies	long glass column, six small lasers for light scattering measurements	Supplies for paint chip aging experiments					$4,000
	Tools and Supplies	Supplies for Materials Characterization	microscopy and spectroscopy for polymer characterization before and after use in batch experiments and for characterization of samples collected from the field; microscopy slides and stubs, conductive glue and paste, standards					$2,000

	Tools and Supplies	General Chemical Supplies	salts, water purification cartridges, glass containers					$10,000
	Tools and Supplies	Filters	Filters for removal of microplastics from experimental and natural waters					$12,000
	Equipment	Two Wrist Action Shakers	Gentle agitation shakers designed to simulate the back and forth motion of the human wrist, ideal for suspension cell culture, media prep, and storage.					$8,000
							Sub Total	**$40,000**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel to/from field site	Travel to/from field sites for sample collection; travel to/from University of Minnestoa - Duluth for collaborative meetings, sample collection, and experiments					$1,424
							Sub Total	**$1,424**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Technical Services	User fees for instrumentation (microscopy and spectroscopy for					$10,000

			polymer characterization) at the University of Minnestoa - College of Science and Engineering's Characterization Facility ($3k/yr)					
							Sub Total	**$10,000**
							Grand Total	**$471,000**

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	University of Minnesota	The investigators will also devote 1% time per year in-kind ($9,089 3 year total).	Potential	$14,814
In-Kind	University of Minnesota	In-kind Overhead for administrative and operational expenses that will support the research described within this application.	Potential	$191,969
			Non State Sub Total	**$206,783**
			Funds Total	**$206,783**

Attachments

Required Attachments

Visual Component

File: 41cc3b8d-898.pdf

Alternate Text for Visual Component

Paints can release microplastics into the environment, and microplastics may contain chemicals of concern (COCs). Microplastics pose a major threat to our environment. The schematic shown here highlights some of the places we find microplastics contamination (water, lake sediment, plant materials, fish, animals, and more). We propose to study how microplastics from paints can serve as vehicles to transport contaminants of concern (COCs) within the environment....

Optional Attachments

Support Letter or Other

Title	File
Letter of Intent-SPA	70557510-8ff.docx

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

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?

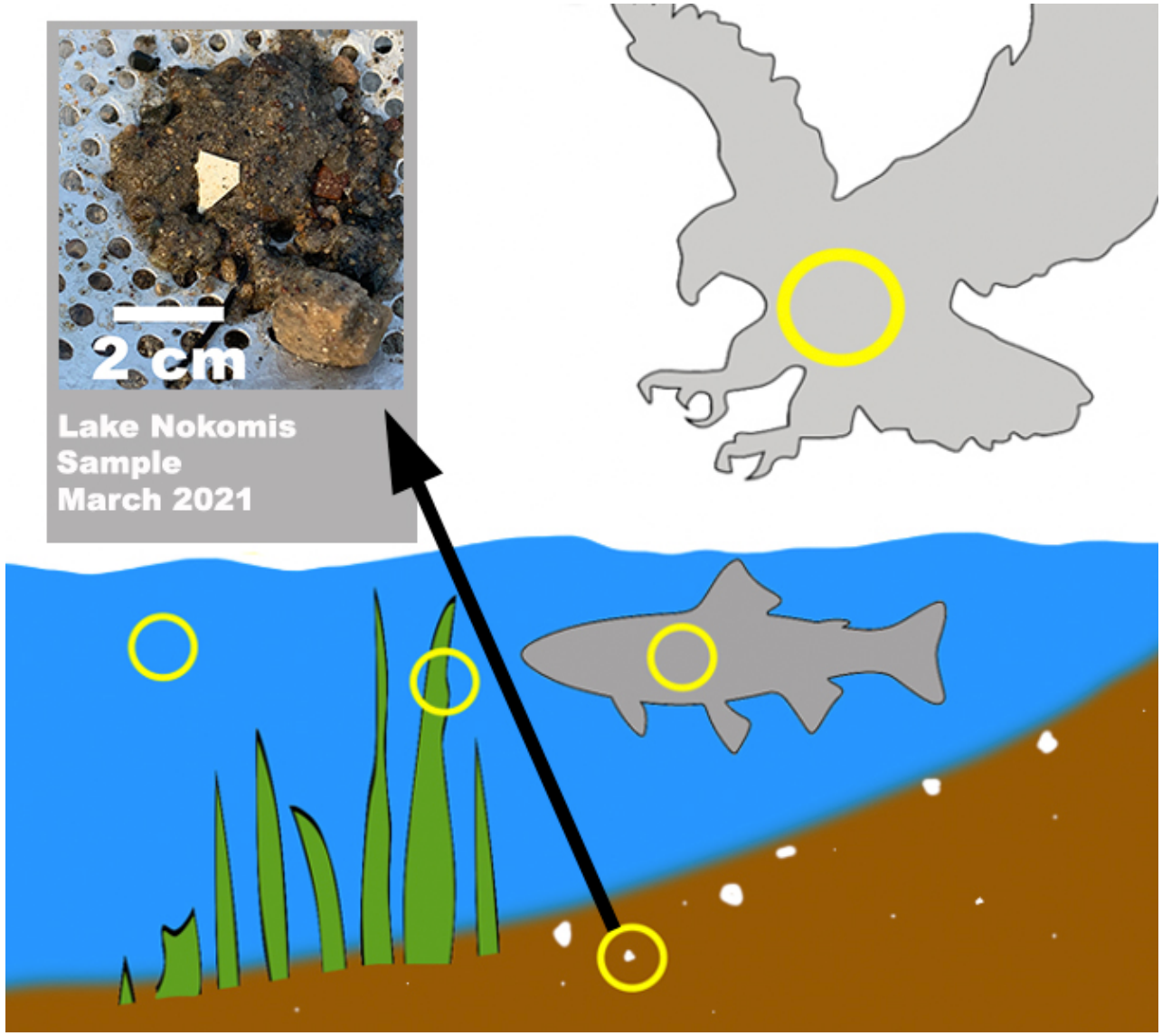
Yes, Sponsored Projects Administration

Microplastics from Paint Chips: Impact on Contaminant Transport

Project Managers:

R. Lee Penn
Chemistry
UMN

Matt Simcik
School of Public Health
UMN



Microplastics are ubiquitous and may contain chemicals of concern (COCs). Microplastics pose a major threat to our environment. We propose to study how microplastics from paint chips can serve as vehicles to transport contaminants of concern (COCs) within the environment.