



## Environment and Natural Resources Trust Fund

### 2022 Request for Proposal

#### General Information

**Proposal ID:** 2022-124

**Proposal Title:** Developing a Novel Biodegradable Plastic to Replace Polyethylene

#### Project Manager Information

**Name:** Brett Barney

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

**Office Telephone:** (612) 562-3061

**Email:** bbarney@umn.edu

#### Project Basic Information

**Project Summary:** Our project seeks to develop a novel biodegradable plastic produced by microbes that is naturally biodegradable and can serve as a replacement for polyethylene.

**Funds Requested:** \$172,000

**Proposed Project Completion:** June 30 2024

**LCCMR Funding Category:** Small Projects (H)

**Secondary Category:** Methods to Protect, Restore, and Enhance Land, Water, and Habitat (F)

#### 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

## Narrative

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

Plastic pollution of our air, water and lands is a direct result of poor waste management practices and an ever growing desire by consumers and manufacturers for the convenience of plastic products. Most plastics are engineered in a manner that makes them resistant to biodegradation, resulting in the longevity of these wastes in our environment. We are currently working on a separate project funded by LCCMR to identify microbes and microbial communities that are capable of degrading problematic plastics such as polyethylene and polystyrene. In this project, we propose to develop a new material that shares many of the same features and characteristics of polyethylene, the primary component in high and low density polyethylene (HDPE and LDPE), two major classes of plastics used in packaging. Our work would balance the chemical resistance of polyethylene, while incorporating characteristics that would make this plastic more amenable to biodegradation by natural organisms found throughout the environment. This material would have beneficial features compared to current bioplastics such as PolyLactic acid (PLA), and would provide manufacturers and the public with an alternative to polyethylene conventional plastics.

**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.**

Our laboratory has been working on biosynthetic routes to commodity materials for more than a decade. Much of this work is focused on various lipids and oils derived from microbes and algae. We are also interested in natural polymers that could substitute for conventional plastics. Polyethylene is chemically one of the simplest polymers, developed in the 1930s, and produced at levels greater than 100 million tons annually, accounting for over one third of the entire plastics market. In a sense, polyethylene is simply a very long oil, similar to waxes, that has grown long enough that it behave as a very strong solid. Our laboratory works to better understand fundamental biochemical reactions that result in the production of novel oils, and has recently found evidence to support the production of new chemical monomers that could be used to create an oil-based polymer that could be used to synthesize a whole new class of bioplastics with a strong potential for biodegradation and which could also replace polyethylene. These studies are preliminary, but the potential to develop a new class of biodegradable plastic could be truly transformative and a game changer in relation to the environmental pollution from plastics.

**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?**

We will demonstrate the productions of a new class of bioplastics derived from microbes with a high potential for recycling or biodegradation and with the goal of replacing plastics such as polyethylene. We will yield sufficient quantities of these plastics to fully characterize the material properties in comparison with conventional polyethylene, and also study the potential for biodegradation to assure that these materials will not have the same long-term environmental issues associated with traditional plastics.

## Activities and Milestones

### Activity 1: Develop New Bioplastic Replacement for Polyethylene.

**Activity Budget:** \$172,000

**Activity Description:**

This project will focus on demonstrating the potential to produce sufficient quantities of a novel biologically-derived polymer to serve as a replacement for polyethylene. The polymer will differ from conventional oil-based polyethylene through a novel chemical structure that is amenable to biodegradation by a range of natural enzymes found in the environment. Once sufficient amounts of this improved bioplastic have been produced, we will characterize the material to compare the characteristics to current polyethylene plastics, and also test the ability for this material to degrade in conventional composting systems.

**Activity Milestones:**

Description	Completion Date
Demonstrate production of sufficient bioplastic quantities for characterization studies.	January 31 2023
Characterize physical properties of new bioplastic and compare to polyethylene.	November 30 2023
Demonstrate potential to scale-up production of bioplastics.	December 31 2023
Determine potential to biodegrade new bioplastic under standard composting conditions.	April 30 2024

## 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?**

This work is currently in the conceptual phase, though preliminary studies show a strong potential for success. Results would be disseminated through research publications and products might be brought to market through University of Minnesota Research and Development Initiatives. The PI has patented other processes in the past, and would work with the UMN Commercialization Office to bring new products to market. Additional funding is being sought through several other Federal funding sources including the Department of Energy, and potentially through the Environmental Protection Agency and the National Science Foundation, and potentially through interested manufacturers.

## Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Transformation of Plastic Waste into Valued Resource	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04j	\$225,000

## Project Manager and Organization Qualifications

**Project Manager Name:** Brett Barney

**Job Title:** Associate Professor

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

Dr. Brett Barney (PI) has been a professor with the Department of Bioproducts and Biosystems Engineering at the University of Minnesota since 2009. Dr. Barney's laboratory works with enzymes involved in important biological processes, including polymer biodegradation and production. Dr. Barney has 30 years of experience in both basic and applied research in both academia and industry, including experience managing projects and laboratories in a range of settings. Previous research funding has come from the Legislative-Citizen Commission on Minnesota Resources (LCCMR), the National Science Foundation (NSF), the United States Department of Agriculture (USDA), the United States Department of Energy (DOE), the Defense Advanced Research Projects Agency (DARPA), Minnesota's Discover, Research and Innovation Economy (MnDRIVE) and the Initiative for Renewable Energy and the Environment (IREE). His industry experience was related to the production of biomedical devices that utilized a wide range of different plastics, and he teaches a course at the University of Minnesota related to recycling, which includes extensive materials related to the problems of plastics and their effects on the environment.

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

**Organization Description:**

The Bioproducts and Biosystems Engineering Department serves as a core department combining Agricultural Engineering, Biological Engineering and Environmental and Ecological Engineering. The University of Minnesota provides a range of facilities and sufficient laboratory space to perform each of the activities described in this proposal. UMN Sponsored Projects Administration (SPA) is the entity authorized by the Board of Regents to manage project agreements with the LCCMR program.

## Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
<b>Personnel</b>								
Principal Investigator		Lead PI - conduct project - summer salary only			36.5%	0.04		\$7,063
Graduate Student		Researcher			45%	1		\$99,634
2 Undergraduate students		research - 2 students @ 720 hrs per year each			0%	0.7		\$33,102
							<b>Sub Total</b>	<b>\$139,799</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Lab supplies	General Laboratory Chemicals, Media, and Reagents (\$400 per month) and Kits for Performing Routine Molecular Biology (\$400 per kit), Analytical Reagents, DNA Synthesis of Primers (\$100 per month), Liquid Nitrogen for Strain Storage (\$400 per year). All estimations are based on historical records for similar projects.					\$32,201
							<b>Sub Total</b>	<b>\$32,201</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	<b>-</b>
<b>Acquisitions and Stewardship</b>								

							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
							<b>Sub Total</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>	\$172,000

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

### Optional Attachments

#### *Support Letter or Other*

Title	File
Institutional Approval to Submit	<a href="#">08784080-6b8.pdf</a>
Visual Component	<a href="#">cb8ac19c-59f.docx</a>

## 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?**

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

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