Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-121

Proposal Title: Biochar-Based Materials and Pollution Mitigation along Roadsides

Project Manager Information

Name: Emilie Snell-Rood

Organization: U of MN - College of Biological Sciences

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Project Basic Information

Project Summary: This research will produce recommendations for how to use biochar-based materials along roadsides to mitigate pollution and sequester carbon, facilitating the use of timber and agricultural waste in ecological restoration.

ENRTF Funds Requested: $823,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Resiliency (A)

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.

Road networks represent some of our most critical infrastructure. However, roads also generate substantial pollution, especially along high traffic roads. Roadside rights-of-way present an opportunity to reduce pollutant effects, for instance through the construction of stormwater ponds or vegetation buffers. This proposal explores the use of a plant waste product, "biochar," in roadside restoration to mitigate pollutants and store carbon. Biochar is produced when biological material is heated at high temperatures under low oxygen. Biochar has been offered as a method of sequestering carbon from plant waste: when crop residues or dead trees are turned to biochar, about half of that carbon is immobilized, relative to letting it rot naturally. Biochar offers a range of other benefits, such as water retention, improved soil structure, and pollutant binding. Biochar has extensive networks of microscopic pores that can trap pollutants, potentially preventing their movement through the ecosystem. This research explores the ecological and economic potential of biochar use along roadsides to mitigate pollutants, restore habitats, and store carbon.

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.

This work tests the potential of biochar to mitigate pollution along roadsides. We have recently developed biodegradable biochar-based plasters for ecological restoration, for weed control and binding of soil metal contamination. This work explores the potential of these biochar materials to mitigate roadside pollution. Minnesota has over 130,000 miles of roads, which are the source of heavy metal, microplastic, and salt pollution. Conversion to electric cars is expected to increase microplastic and metal pollution through faster tire wear and increased metal content of cars. Traffic noise is an additional concern in some parts of the state. We will test how biochar-based plasters could be applied along roadsides, either on vertical surfaces (sound-walls) or on the ground during revegetation after construction. This research will test the efficacy of these materials in binding roadside pollutants (heavy metals and tire wear particles) and the impacts on the roadside plant community. We will also explore the potential of biochar plasters to mitigate traffic noise if applied to sound walls. We focus on biochar from agricultural and timber waste streams and model the impact on carbon sequestration and the bioeconomy through a life cycle analysis.

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 work will produce recommendations for how biochar can be used along roadsides to mitigate heavy metal and microplastic pollution. Results are applicable to a wide range of restoration efforts, such as areas of legacy metal pollution in mining regions. The use of biochar in restoration has additional benefits in terms of sequestration of carbon in plant waste. The use of plant waste to make biochar has the potential to create economic demand on agricultural and timber waste products as biochar is integrated into the Minnesota bioeconomy.

Activities and Milestones

Activity 1: Developing biochar plaster recipes and application methods

Activity Budget: $142,514

Activity Description:
In this activity, we will develop clay plaster mix designs and application methods for use of biochar plaster on vertical surfaces. Due to its durability and air entrapment in its microporous structure, biochar will add beneficial properties of porosity while being insulative. We will build on pilot data from biochar plasters on horizontal surfaces, initially starting with at least a dozen mix designs that vary the amount and type of biochar, clay, sand and water. Across all mix designs, we will contrast the performance of biochars from two feedstocks (wood waste, buckthorn; agricultural waste, oat hulls). Additionally, we will experiment with biochar preparation process that includes grinding the dry biochar to various fine particulate sizes (between 2mm and 75 microns) for testing plaster water demand without losing durability and strength. Using a 3D clay printer, we will experiment with different internal densities and test for effects on thermal conductivity and moisture response. We will experiment with application and adherence to two typical sound wall substrates. Lastly, we will vary plaster thickness, surface textures and patterns, to test for effects on sound absorption (Activity 4). Finally, we will do lab testing of degradation over time (see also Activity 2).

Activity Milestones:

Description	Approximate Completion Date
Lab testing of 12 recipes (2 biochars) on vertical surfaces	December 31, 2027
Experimenting with plaster application methods	December 31, 2028
Lab plaster degradation tests	June 30, 2029

Activity 2: Biochar plaster absorption of pollutants in the lab and field

Activity Budget: $269,328

Activity Description:
In this activity, we will use lab and field approaches to test the performance of different biochar-based plasters in their ability to capture roadside pollutants. Data from Activity 1 will inform the choice of three biochar recipes and three application methods for the two focal feedstocks (18 total combinations). In lab assays, we will apply artificial “road dust” to containers with either vertical or horizontal treatments of the biochar plasters. Our artificial pollutant mixture will contain tire particles sifted to simulate the particle range of road dust, along with sodium chloride, sand, and copper chloride (to simulate copper wear from cars, as electric cars contain 183 lbs/car). A subset of plasters will be tested in simulated weathering conditions to test performance in artificial rain, UV and temperature swings. We will complement lab studies with field studies along three roadside sites that vary in traffic volume, with vertical and horizontal biochar plaster replicates spread three distances from the roadside, left in place for at least six months (see visual). Across these experiments, we will use measures of contaminants in both the plasters, wastewater that has passed through the plasters, and adjacent surfaces to measure the pollutant capacity of the materials.

Activity Milestones:

Description	Approximate Completion Date
Develop lab test box and locate field plots	December 31, 2026
Lab and field setup of weathering tests	December 31, 2027
Lab tests of pollutant absorption	December 31, 2028
Lab tests of pollutant extraction from biochar	June 30, 2029
Lab tests of biochar plaster weathering	June 30, 2029

Field tests of biochar plaster weathering	June 30, 2029

Activity 3: Effects of biochar plaster on roadside soils and plant communities

Activity Budget: $173,701

Activity Description:
In this activity, we will evaluate how biochar-based plasters mitigate pollution in roadside plant communities. We expect that biochar-based plasters will degrade over a 1-2 year time period, slowly working their way into roadside soils. We will test whether biochar incorporation into the soil reduces pollutant bioavailability to roadside plants, and the potential benefits of incorporating plants into the biochar plaster itself. First, we will couple field measurements of biochar plaster degradation (plots from Activity 2) to get an idea of the time course and particle size of degradation. Second, based on these data, we will use greenhouse manipulations to test the susceptibility of roadside plants to uptake of heavy metal pollutants captured by biochar, making soil mixes that incorporate components of the biochar plaster. We will grow plants in pots inoculated with roadside plasters and roadside soil, using plant uptake of heavy metals as an indicator of the bioavailability of these pollutants in the biochar mixture versus the soil (as a control). Finally, we will test whether inoculation of biochar-plasters with fast-growing moss slows the rate of degradation of these plasters and increases the capture rate of pollutants.

Activity Milestones:

Description	Approximate Completion Date
Greenhouse experiment with plant-pollutant uptake	October 31, 2027
Greenhouse experiment with moss-biochar mixtures	October 31, 2028
Field sampling of plants for metal uptake measurements	October 31, 2028
Pollutant measurement of all plant samples	June 30, 2029

Activity 4: The potential of biochar plasters to mitigate sound pollution along roadsides

Activity Budget: $175,007

Activity Description:
In this activity, we will begin to explore other possible benefits of biochar-plasters in roadsides. We predict that the increased surface area of the plasters, especially for certain application methods, will absorb sound from traffic noise. We will partner with the Orfield laboratories in Minneapolis to measure the acoustic performance of at least 30 recipe-application combinations using frequencies that simulate traffic noise. We predict that application methods with more airspace and higher biochar content, will have the greatest sound pollution impact. Additionally, we will work with spatial modelers within the Minneapolis-St Paul Urban Long-term Ecological Research program to begin to map areas of greatest road traffic sound pollution risk in the greater Twin Cities metro area. For these same samples, we will also run a set of light experiments to measure heating and cooling rates of the plasters and light absorption to ensure any recommendations will not have negative impacts on urban heat islands, and to explore the possibility of mitigation of light pollution.

Activity Milestones:

Description	Approximate Completion Date
Make biochar plaster samples for sound testing	December 31, 2027
Sound testing of biochar plasters	December 31, 2028
Light and temperature testing of the same plasters	December 31, 2028
Spatial modeling of noise pollution	June 30, 2029

Activity 5: Life cycle assessment of roadside biochar plasters

Activity Budget: $62,450

Activity Description:

Biochar holds great promise in reducing our carbon footprint, but in order to determine if there are net gains in carbon storage or improvements to other environmental performance indicators, a full life cycle assessment (LCA) is necessary. In this activity, partners at the Natural Resources Research Institute will conduct an LCA to identify and quantify the potential environmental impacts of manufacturing and using the new biochar plasters with respect to climate change, energy demand, water use, human health, and resource use, compared to competing alternatives. The LCA will use inventory data from previous research by the project team as well as from laboratory and field experiments conducted in the proposed project, and will consider different plaster recipes, raw materials, application methods, and locations of use. Upon completion, we will present a Design Summary describing the most sustainable plaster recipe(s) for potential use in Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Life cycle inventory of the entire biochar plaster manufacturing process	June 30, 2027
LCA model of entire biochar plaster manufacturing and application process	December 31, 2027
Life cycle impact assessment to determine potential environmental impacts of biochar plaster manufacturing and application	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Malini Srivastava	University of Minnesota - Twin Cities	co-PI	Yes
Lee Penn	University of Minnesota - Twin Cities	Senior Personnel	Yes
Boya Xiong	University of Minnesota - Twin Cities	Senior Personnel	Yes
Matt Aro	University of Minnesota - Duluth	Senior Personnel	Yes
Daniel Stanton	University of Minnesota - Twin Cities	Collaborator	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?

The findings of this research will be implemented through existing collaborations with relevant organizations. Results will be communicated through the Minnesota Biochar Initiative, which includes ties to biochar production facilities at the City of Minneapolis. We will rely on existing connections to the Minnesota Department of Transportation and Minnesota Pollution Control Agency to communicate of our findings, for instance through annual meetings with contacts at each agency. If additional research is needed, we will seek funding from federal agencies (e.g., NSF, EPA, USDA) and other sources (e.g., MPCA, MnDoT, UMN).

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Pollinator Plantings and the Redistribution of Soil Toxins	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 08e	$610,000
Karner Blue Butterfly Insurance Population Establishment in Minnesota	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 08b	$405,000

Project Manager and Organization Qualifications

Project Manager Name: Emilie Snell-Rood

Job Title: Professor

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

Project leader Snell-Rood has extensive experience managing large research projects with conservation applications. Over the last decade, she has led three grants to study roadsides as habitat for pollinators (ENRTF, MnDoT, NRRB) and three grants to study urban pollutants and pollinator habitat (ENRTF, UMN, NSF). In past ENRTF research on roadside habitat for pollinators, she coordinated research across ten collaborators; this work resulted in over a dozen publications, with results informing roadside restoration in Minnesota and beyond. In current ENRTF research (concluding June 2025), Snell-Rood is coordinating research across over a dozen collaborators on urban heavy metal and

microplastic contamination. This research has resulted in five publications to date, with another five forthcoming. Snell-Rood is co-lead of the Minneapolis-St Paul Urban Long-Term Ecological Research Program (MSP-LTER), funded through the National Science Foundation, managing a large collaborative of researchers interested in urban contaminants and habitat restoration. As part of this effort, she regularly communicates with the Minnesota Pollution Control Agency and community partners, especially in areas with high lead pollution. Snell-Rood's expertise lies in ecology, animal development, biodiversity, and behavior in human-dominated environments affected by nutrient and toxin stressors. She has worked on butterflies, bees, beetles, flies, birds, mammals, and a range of plants used by pollinators. Her lab at UMN currently houses four PhD students, three postdocs, and five undergraduate research assistants. A full list of scientific publications can be found on google scholar -- https://scholar.google.com/citations?user=s-pbFU8AAAAJ&hl=en&oi=ao

Organization: U of MN - College of Biological Sciences

Organization Description:
This project brings together expertise from across the University of Minnesota-Twin Cities and Duluth campuses. Project personnel are housed within the College of Biological Sciences, the College of Design, the College of Science and Engineering, and the Natural Resources the School of Public Health (UMN-Duluth). Together, our team has expertise in roadside habitats, ecotoxicology, environmental contaminants, environmental health, soil chemistry, earthen materials in architecture, life cycle analysis, and natural resources. Across the labs involved, we have space, facilities, and experience for the proposed experiments, lab and field testing, and analyses described in the proposal. Our team already communicates regularly through monthly zoom meetings of the MSP-LTER, the Urban Metals and Microplastics Collaborative, and small group meetings. Grant support will be provided through each college at UMN represented on the project.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Emilie Snell-Rood		Principal Investigator			26.8%	0.18		$47,098
Malini Srivastava		co-PI			26.8%	0.12		$31,839
Matt Aro		Senior Personnel			26.8%	0.45		$51,280
Lee Penn		Senior Personnel			26.8%	0.06		$19,065
Boya Xiong		Senior Personnel			26.8%	0.06		$13,423
Project Manager/Lab Technician		Project Manager/Lab Technician			26.8%	3		$277,167
Graduate Student Research Assistant		Graduate Student Research Assistant			44.3%	2.19		$187,840
Undergraduate Research Assistant		Undergraduate Research Assistant			0%	2.4		$88,308
							Sub Total	**$716,020**
Contracts and Services								
Orfield Labs	Service Contract	Testing sound absorption of different plasters				0.05		$10,000
QBIC labs (Northwestern University)	Service Contract	heavy metal processing (plants) ICP-MS				0.1		$10,000
UMN-RAL facility	Internal services or fees (uncommon)	heavy metal processing (soils) ICP-OES				0.15		$10,000
UMN-Plant Growth Facilities	Internal services or fees (uncommon)	fees for greenhouse space for soil and plant testing in Activities 2 and 3				0.3		$8,000

LCA software virtual server hosting	Service Contract	Required fees for LCA testing for Activity 5				0.3		$8,280
							Sub Total	**$46,280**
Equipment, Tools, and Supplies								
	Equipment	Spectrophotometer	for light measurements of biochar to estimate light absorption and heating potential					$10,000
	Equipment	Mixing and printing equipment for plasters	equipment needed to mix and 3D print clay biochar plasters in College of Design					$12,050
	Tools and Supplies	lab and field supplies for making and testing biochar plasters	includes materials themselves (biochar, clay, sand), mixing devices for field, boxes for testing, reagents for extractions, lab expendables (gloves, pipets), glassware, filters and supplies for microplastics extractions					$23,860
	Equipment	Velocity tester	for plaster testing in College of Design					$3,500
							Sub Total	**$49,410**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Other	Travel to field sites for Activities 2 and 3 (estimated 20+ trips, 10-30 miles round-trip depending on the site)	To install and monitor roadside plots					$2,000
	Other	Travel to/from UMD-UMN-TC, 2 trips per year, 306 miles	For in-person visits to sites and for lab testing to coordinate across Activity 5 and other activities (Aro travel to UMN-TC)					$1,290

							Sub Total	**$3,290**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Publication fees for resulting publications	Fees for publishing resulting publications, open access whenever possible					$8,000
							Sub Total	**$8,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$823,000**

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	UMN-Indirect Costs	University of Minnesota overhead	Secured	$400,000
Cash	National Science Foundation (MSP-LTER)	Provides support to PI and other participants on the "contaminants team" studying heavy metals and microplastics in the Twin Cities, in addition to providing additional support for data management, spatial mapping, site selection/monitoring, and supplies.	Secured	$200,000
Cash	UMN-Institute on the Environment Impact Goals	Provides funding (through 2026) for protocol development for microplastic monitoring on roadside and garden soils in the Snell-Rood lab.	Secured	$50,000
			Non State Sub Total	**$650,000**
			Funds Total	**$650,000**

Total Project Cost: $1,473,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: f0142bfb-63c.pdf

Alternate Text for Visual Component

Image of biochar plaster applied to the ground and image of where biochar plaster tests will be placed on roadsides....

Supplemental Attachments

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

Title	File
UMN SPA approval to submit	e7acbaa8-00b.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?

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

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:

Launa Shun -- University of Minnesota -- shunx001@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

Yes, I understand