

**Environment and Natural Resources Trust Fund**

# 2022 Request for Proposal

## **General Information**

**Proposal ID:** 2022-077

**Proposal Title:** Biochar Soil Amendment to Improve Urban Tree Survival

## **Project Manager Information**

**Name:** Eric Singsaas

**Organization:** U of MN - Duluth - NRRI

**Office Telephone:** (218) 788-2648

**Email:** esingsaa@d.umn.edu

## **Project Basic Information**

**Project Summary:** We will demonstrate opportunities to turn waste wood from dying trees into biochar to supplement soils for urban tree plantings. Biochar stores carbon and helps to improve sapling establishment.

**Funds Requested:** $397,000

**Proposed Project Completion:** June 30 2027

**LCCMR Funding Category:** Air Quality, Climate Change, and Renewable Energy (E)

## **Project Location**

**What is the best scale for describing where your work will take place?** Region(s): Metro, NE,

**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.**

This proposed project builds upon the City of Minneapolis resolution to incorporate regenerative agriculture and biochar as a climate resilience solution by expanding its application to improve tree planting along streets. Minneapolis has made a city-wide commitment to achieve a low carbon economy. As part of this commitment, the city has adopted a resolution supporting the use of biochar as a carbon negative solution; one that sequesters carbon absorbed by trees and other plants into the soil for the long term. Biochar is a high-carbon material made from waste biomass that can sequester carbon while also improving many properties of soils.   
  
The introduction of invasive pests such as the Emerald Ash Borer is creating a vast surplus of dead and dying trees in Minnesota that could be disposed of by converting into biochar. There is an opportunity to leverage some of the properties of biochar to help improve tree survival in the city. When processed correctly, urban tree biochar can be turned into a soil amendment that increases aeration and water percolation in compacted soils, and also adsorbs pollutants such as lead, road salt, and polycyclic aromatic hydrocarbons, thereby alleviating many stresses on urban trees.

**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.**

The proposed work will demonstrate the conversion of insect-killed trees into a biochar that improves urban soil properties and then demonstrate its application to improve new tree establishment in the metro area. To understand the influence of biomass input and processing parameters on biochar properties, we will produce a variety of biochars at different temperature and residence time conditions to estimate the yield of char, then measure fixed carbon content, porosity, extractives, and cation exchange capacity of the biochar in the laboratory to understand the relationship between input biomass, processing conditions, and biochar properties.  
  
To assess the impact of biochar on tree survival, we will select 2 biochars and up to 3 tree species that have low establishment success in Minnesota to conduct a common plot study investigating the practical impact of biochar on urban tree establishment and survival.   
  
To demonstrate the impact of biochar in a real urban environment, we will work with the Minneapolis Park and Recreation Board and Hennepin County forestry crews to incorporate biochar into neighborhood tree planting.

**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:  
Provide data on processing conditions and properties to guide small producers on producing biochar from insect-damaged tree wastes.  
Provide information on the relationship between biochar properties and performance in urban forestry.   
Provide information on how to use biochar to improve establishment and survival of trees that had previously been difficult to establish in Minnesota cities.   
Establish biochar incorporation methods for urban tree-planting crews.  
Disseminate information on production and use of biochar to other cities around Minnesota to help find markets for waste wood.

## **Activities and Milestones**

### **Activity 1: Produce, test, and characterize biochar for urban soils experiments**

**Activity Budget:** $158,810

**Activity Description:**This activity will focus on first determining the optimal processing conditions for ash trees and then scale-up of biochar production for the plot and field experiments.   
  
The properties of different biochars can vary substantially depending on many factors, including the input biomass, processing temperature, residence time, and post treatment conditions. Since many studies of biochar application in soils provide little information beyond the processing temperature, there is little guidance right now for municipalities and companies interested in producing biochar to develop a biochar industry that suits their needs.   
  
This research activity will address this information gap. We will start with lab-scale processing of sample biomass from invasive species-threatened tree biomass (e.g., black ash, green ash, balsam fir) and use designed experiments to characterize the relationship between processing conditions and physical/chemical properties of the biomass.   
  
Using the bench-scale experiments as guidance, we will decide upon two types of biomass to use for activities 2 and 3, and select conditions to make as much as 5 tons of biochar under each condition at the NRRI Biomass Conversion Laboratory. These biochars will be analyzed to verify their physical/chemical properties and shipped to St. Paul for the plot and field studies.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Complete pilot production of 2 biochar types for pilot study | March 31 2023 |
| Understanding of processing condition impacts on biochar properties | May 31 2023 |
| Complete pilot production of biochar for city tree planting | September 30 2023 |

### **Activity 2: Plot study the impact of biochar on new urban tree candidate species survival in Minnesota’s climate**

**Activity Budget:** $103,904

**Activity Description:**The objective of this activity is to determine the value of biochar to trees planted in Minnesota without the possible confounding factors associated with the urban street-side environment. We will select three species that have low establishment success rates in Minnesota and therefore are not commonly planted today, and study them in research plots on the U of M campus using research plots.   
  
We will plant 90 trees from three selected species purchased from a nursery that supplies trees to Minnesota’s cities. These will be planted in outdoor plots with two types of biochar produced at the NRRI Biomass Conversion Laboratory (activity 1) and control (no biochar) using a nested factorial experimental design. After tree establishment, we will monitor them over the course of the study period for survival, growth in diameter, height, and general health.   
  
The outcome of this activity will be a report on the relationship between biochar properties and species on the survival and growth of trees in Minnesota’s climate.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Complete planting of plot study on St. Paul campus | June 30 2023 |
| Complete growth and survival measurements | December 31 2026 |

### **Activity 3: Demonstrate biochar soil supplementation to improve survival of new tree varieties in neighborhoods**

**Activity Budget:** $134,286

**Activity Description:**The objective of this activity is to demonstrate the application of biochar to street tree planting in urban environments, and to assess the impact of biochar on tree survival and vigor.   
  
We will select three species of trees in consultation with the municipal and county urban foresters , and apply two types of biochar with controls. The experimental trees will be planted at sites selected randomly throughout the city of Minneapolis in coordination with city tree planting crews. University students will be present to mix biochar into the soil for backfill with the planting crews. Trees will be GPS tagged for monitoring over the course of the study. Twice per year, student crews will measure the GPS tagged trees for survival and vigor, as well as record growth in diameter and height.   
  
The main outcome of this activity will be a report on the relationship between biochar properties and species on the survival and growth of trees. A secondary outcome of this work will be to familiarize city tree planting crews and neighbors with biochar and its role in carbon sequestration as part of the city’s climate strategy.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Complete installation of neighborhood trees in Minneapolis | October 31 2023 |
| Complete field measurements on city trees | May 31 2027 |
| Communication and dissemination of information to municipal leadership and citizens | June 30 2027 |
| Final report | June 30 2027 |

## **Project Partners and Collaborators**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Organization** | **Role** | **Receiving Funds** |
| Eric North | University of Minnesota Twin Cities | Co-PI | Yes |
| James Doten | City of Minneapolis - Health | Supervisor of urban biochar applications. | 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?**This project will run for five years in order for crews to get sufficient data on urban tree establishment and survival that is relevant and actionable by cities and biochar producers alike. At the end of the project per open we will have both experimental and field demonstration results that are sufficient to encourage cities to budget for biochar incorporation into their tree planting plans. This will allow cities to work with private industry to produce biochar from municipal tree wastes for the urban forestry markets.

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

|  |  |  |
| --- | --- | --- |
| **Name** | **Appropriation** | **Amount Awarded** |
| Expand Materials Reuse and Recycling Jobs Program | M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 05k | $800,000 |
| Forest and Bioeconomy Research | M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 03q | $2,200,000 |

## **Project Manager and Organization Qualifications**

**Project Manager Name:** Eric Singsaas

**Job Title:** Research Director

**Provide description of the project manager’s qualifications to manage the proposed project.**Dr. Singsaas is the Director for Materials and Bioeconomy at the University of Minnesota’s Natural Resources Research Institute. He is a plant physiologist and biochemist who studies biological hydrocarbon production and forest product utilization. He has a B.A. in Biology and Chemistry from Concordia College, Moorhead, MN and a Ph.D. in Botany and Plant Biochemistry from the University of Wisconsin – Madison. From 2001-2015 Eric was professor of biology at the University of Wisconsin – Stevens Point, where he co-developed the Wisconsin Institute for Sustainable Technology to foster the development of a bioeconomy based around use of renewable natural resources. Since 2016 he has led development of bioeconomy programs at the University of Minnesota's NRRI. He has published research in the fields of plant stress physiology and plant-environment interactions, as well as biomass processing and biofuels technology development. He holds several patents in biorefinery and biofuels technology.

**Organization:** U of MN - Duluth - NRRI

**Organization Description:**The Natural Resources Research Institute (NRRI) is an applied research and economic development engine for the University of Minnesota research enterprise. NRRI employs over 130 scientists, engineers and technicians to deliver on its mission to deliver integrated research solutions that value our resources, environment and economy for a sustainable and resilient future. NRRI collaborates broadly across the University system, the state and the region to address the challenges of a natural resource based economy. NRRI researchers have extensive experience in managing large, interdisciplinary projects. NRRI’s role is as an impartial, science-based resource that develops and translates knowledge. Projects include characterizing and defining resource opportunities, minimizing waste and environmental impact, maximizing value from natural resources and maintaining/restoring ecosystem function. The NRRI's Materials & Bioeconomy research group is focused on developing new and innovative uses of Minnesota’s ag and forest biomass, residuals, and other waste products to create new opportunities for the state through applications of chemical, biological, and materials science principles. We work closely with the NRRI Biomass Conversion Laboratory to scale-up process technologies for pilot and demonstration-scale projects.

## **Budget Summary**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Category / Name** | **Subcategory or Type** | **Description** | **Purpose** | **Gen. Ineli gible** | **% Bene fits** | **# FTE** | **Class ified Staff?** | **$ Amount** |
| **Personnel** |  |  |  |  |  |  |  |  |
| Eric Singsaas |  | Principal Investigator |  |  | 26.7% | 0.25 |  | $49,539 |
| Eric North |  | Co-Principal Investigator |  |  | 26.7% | 0.4 |  | $72,607 |
| Brian Barry |  | Materials Scientist to lead characterization |  |  | 26.7% | 0.25 |  | $32,670 |
| Sergiy Yemets |  | Chemist |  |  | 26.7% | 0.1 |  | $7,164 |
| Oleksiy Kacharov |  | Chemist - biochar analysis |  |  | 26.7% | 0.1 |  | $6,575 |
| Oksana Kolomitsyna |  | Chemist - Biochar characterization |  |  | 26.7% | 0.1 |  | $6,791 |
| Matthew Young |  | Research Engineer - Biochar production and applications |  |  | 24.1% | 0.25 |  | $21,797 |
| Jeff Kinkel |  | Engineer - Biomass conversion |  |  | 26.7% | 0.08 |  | $11,640 |
| Patrick Casey |  | Technical staff - biomass conversion |  |  | 24.1% | 0.08 |  | $6,969 |
| Robert Hietala |  | Technical staff - Biomass conversion |  |  | 24.1% | 0.08 |  | $5,254 |
| Student Researcher - Undergraduate |  | Field research assistant |  |  | 0% | 1.25 |  | $39,000 |
| Student Researcher - Undergraduate |  | Field research assistant |  |  | 0% | 1.25 |  | $39,000 |
| Temp Casual |  | Environmental Intern |  |  | 7.4% | 0.2 |  | $7,113 |
| Temp Casual |  | Environmental Intern |  |  | 7.4% | 0.2 |  | $7,113 |
|  |  |  |  |  |  |  | **Sub Total** | **$313,232** |
| **Contracts and Services** |  |  |  |  |  |  |  |  |
| Twin Ports Testing | Professional or Technical Service Contract | Ultimate and Proximate analysis of biochar made for this project. |  |  |  | - |  | $11,165 |
| Trailer rental | Professional or Technical Service Contract | Rental of live bottom trailer to deliver wood chips from Minnesota timber company to Biomass Conversion Laboratory |  |  |  | - |  | $8,120 |
| University of Minnesota Plot Fees | Internal services or fees (uncommon) | Plot rental on St. Paul campus for outdoor tree experiments. |  |  |  | - |  | $4,246 |
| Data plan | Professional or Technical Service Contract | Annual data plan for tablet computers used to log and locate experimental trees across the city. |  |  |  | - |  | $901 |
|  |  |  |  |  |  |  | **Sub Total** | **$24,432** |
| **Equipment, Tools, and Supplies** |  |  |  |  |  |  |  |  |
|  | Tools and Supplies | Nursery trees, 270 | Trees as experimental subjects; for 90 for plot experiment (St Paul campus) and 180 for field (Minneapolis city streets) experiments. |  |  |  |  | $33,750 |
|  | Tools and Supplies | Biomass - wood chips, approx. 50 tons | Obtain chipped wood from ash or other tree species threatened by invasive pests from local tree harvest company. |  |  |  |  | $5,075 |
|  | Tools and Supplies | Laboratory chemicals and supplies | Chemicals and consumables needed for physical and chemical analysis of biochar samples. |  |  |  |  | $963 |
|  |  |  |  |  |  |  | **Sub Total** | **$39,788** |
| **Capital Expenditures** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Acquisitions and Stewardship** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Travel In Minnesota** |  |  |  |  |  |  |  |  |
|  | Miles/ Meals/ Lodging | Day trips between Duluth and Minneapolis - 9 trips annually for periods 1-2 and 3 trips annually for periods 3-5. | Duluth personnel to supervise research, meet with staff, and disseminate results. Minneapolis personnel to supervise biochar production. |  |  |  |  | $5,773 |
|  | Other | Travel within Minneapolis - based on motor pool vehicle rate of $58/day for local use, average of 30 days per summer. | Student and technical staff for tree planting, data collection and monitoring. |  |  |  |  | $8,700 |
|  |  |  |  |  |  |  | **Sub Total** | **$14,473** |
| **Travel Outside Minnesota** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Printing and Publication** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Other Expenses** |  |  |  |  |  |  |  |  |
|  |  | Costs for shipping biochar | Costs for shipping biochar from Coleraine to Minneapolis using a trucking or freight service. |  |  |  |  | $5,075 |
|  |  |  |  |  |  |  | **Sub Total** | **$5,075** |
|  |  |  |  |  |  |  | **Grand Total** | **$397,000** |

### **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 unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs. | Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs) | Secured | $218,350 |
|  |  |  | **Non State Sub Total** | **$218,350** |
|  |  |  | **Funds Total** | **$218,350** |

## **Attachments**

### **Required Attachments**

#### ***Visual Component***

File: [6e979e76-a16.pdf](https://lccmrprojectmgmt.leg.mn/media/map/6e979e76-a16.pdf)

#### ***Alternate Text for Visual Component***

Visual depiction of converting dead or dying trees to biochar for soil amendment and its benefits to soil and trees: Increased soil carbon, improved soil physical properties, improved soil chemical properties, improved biological properties....

### **Optional Attachments**

#### ***Support Letter or Other***

|  |  |
| --- | --- |
| **Title** | **File** |
| UMD Sponsored Projects Transmittal Letter | [5c1c6fbb-b00.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/5c1c6fbb-b00.pdf) |
| Letter of Support – Minneapolis | [17d475ec-598.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/17d475ec-598.pdf) |

## **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