Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-422

Proposal Title: Innovative Air Treatment for Wildlife and Livestock Protection

Project Manager Information

Name: Min Addy

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

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Project Basic Information

Project Summary: The non-thermal plasma and microwave air treatment systems eliminate viruses, aerosol, harmful gases, and odors with zero emission, protecting wild bird populations and livestock from airborne pollutants and zoonotic disease.

ENRTF Funds Requested: $850,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Fish and Wildlife (D)

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.

Minnesota, a leader in poultry production, faces serious risks from airborne disease transmission and pollutant emissions that can harm both farmed and wild species. Since 2022, the highly pathogenic avian influenza (HPAI) outbreak has caused the death of over 166 million birds in the U.S. In Minnesota, the Raptor Center tested 2,462 wild birds and found 225 positive cases, the most recent on January 9, 2024. The virus directly threatens Minnesota's wild waterfowl populations, and with 70 confirmed human cases of H5 bird flu in the U.S. as of April 2024, concerns about cross-species transmission are rising. Beyond disease risks, poultry farms release ammonia (NH_3) and hydrogen sulfide (H_2S), which degrade air and water quality, harm fish populations, and disrupt wetland ecosystems. Conventional ventilation systems rely on negative pressure, failing to address these environmental and biosecurity risks. This allows the airborne pathogens and pollutants, such as viruses, aerosols, and harmful gases smaller than 0.3 micrometers, spreading unchecked.

This project addresses these challenges by developing and pilot-testing an electrified, in-situ, and sustainable air treatment technologies that continuously remove airborne pathogens and chemical pollutants, ensuring biosecurity for both farmed and wild species, and protecting Minnesota's natural ecosystems.

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.

We propose an advanced air treatment system that utilizes non-thermal plasma (NTP) and microwave (MW) technology to safeguard natural ecosystems from airborne pollutants and disease transmission. Unlike conventional filtration, it operates continuously with minimal maintenance, reducing contaminants that threaten vulnerable local wildlife.

NTP generates a partially ionized gas through a strong electric field, rapidly decomposing airborne contaminants into reactive species like radicals, free ions, and reactive oxygen species. Our previous research demonstrates its effectiveness in inactivating airborne pathogens and decompose harmful gases like NH_3 and H_2S. This not only prevents the spread of avian influenza to wild bird populations and reduces zoonotic spillover risks, but also limits nitrogen deposition in lakes and wetlands that can harm fish habitats. The MW system operates with low energy and zero-emission. Its core reactor features SiC foam filters embedded with zeolite and catalytic materials (TiO_2, CuO). SiC-based foams improve heating rate and energy efficiency, their porous structure enables efficient contaminant adsorption with minimal pressure drop. Microwave irradiation ensures rapid pathogen disinfection and odor decomposition.

By limiting airborne disease transmission, protecting wild birds and aquatic ecosystem, and reducing the poultry operation's environmental footprint, this project supports long-term conservation and resiliency in Minnesota's natural resources.

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 a direct environmental benefit by reducing the spread of airborne diseases from poultry facilities to wild bird populations, lowering the risk of avian influenza outbreaks that could threaten Minnesota's migratory waterfowl and other vulnerable species. Capturing harmful NH_3 and H_2S at the source prevents their release into the atmosphere, reducing nitrogen pollution that threatens fish populations. By mitigating airborne pollutants, this project supports wetland conservation efforts and protects species that depend on clean air and water. The system provides a zero-emission solution aligning with Minnesota's long-term environmental conservation goals while ensuring biosecurity in poultry operations.

Activities and Milestones

Activity 1: Develop and Test the Performance of MW and NTP Modules

Activity Budget: $220,000

Activity Description:

Preliminary results demonstrate a 2.7 log reduction of bioaerosols at room temperature. Effective air treatment is achieved with exit temperatures below 60°C, which can be further reduced through heat sink recycling. This research will optimize key parameters such as zeolite loading, humidity, temperature, and residence time, while exploring the integration of microwave-responsive catalysts like TiO2 and CuO into zeolites to enhance disinfection and odor removal.

Our NTP module will utilize dielectric-barrier discharge (DBD) reaction vessels in a coaxial tubular design. Air enters through one end of the DBD vessel, passing through the plasma discharge region where ionization generates reactive species capable of disinfecting airborne pathogens or converting harmful gases into benign forms. Treated gas exits the DBD vessel free of hazardous byproducts. Key parameters, including applied voltage, discharge gap, air flow rate, and electrode materials, significantly influence the treatment efficiency of the DBD reactor. We will conduct experiments testing different configurations of the DBD reactor under varying conditions to optimize its performance.

Activity Milestones:

Description	Approximate Completion Date
Develop the MW module and test the disinfection ability	December 31, 2026
Develop NTP module and test the disinfection performance	December 31, 2026
Test MW process parameters and integrate catalysts into zeolites to improve MW air treatment performance	June 30, 2027
Test and optimize DBD configurations for maximum disinfection and harmful gas transformation	June 30, 2027

Activity 2: Process Modeling, Optimization, and AI-Driven Control for Scaling Up the NTP and MW Module

Activity Budget: $250,000

Activity Description:

This activity focuses on utilizing data from lab-scale tests to develop models for scaling up the NTP and MW air treatment systems. Key parameters like module dimensions, airflow rate, contaminant concentrations, temperature, and power consumption will be incorporated. AI-driven sensors will be integrated to monitor system performance, particularly gases such as NH_3 and H_2S. Pathogen level analysis will be conducted in collaboration with Prof. Zheng's lab. AI algorithms will analyze this data to refine process parameters, predict system behavior, and recommend adjustments to maximize performance while minimizing energy use.

Various test conditions, including air temperature, disinfection efficiency, flow rate, and energy consumption, will be analyzed to establish correlations between critical parameters and assess the feasibility of scaling up. Advanced computational modeling tools will simulate and optimize performance, including breakdown voltage that trigger plasma discharge, ionization processes, and reactive species generation for the NTP module, the heat distribution and airflow patterns within the SiC foam structure during treatment for the MW module.

By applying these models, we will predict real-world system behavior and identify optimal configurations for scaling. This will guide the development of a prototype treatment unit for on-farm small pilot testing in subsequent research phases.

Activity Milestones:

Description	Approximate Completion Date
Data collection and modeling for MW reactors completed	December 31, 2027
Data collection and modeling for NTP reactors completed	December 31, 2027
Scale-up parameters will be determined for the optimized MW configuration	June 30, 2028
Scale-up parameters will be determined for the optimized NTP configuration	July 31, 2028

Activity 3: Pilot-Scale Experiments with Air Dynamic Modeling

Activity Budget: $380,000

Activity Description:

The developed prototype units will be taken to a poultry barn in West Central Research and Outreach Center (WCROC) for pilot-scale testing and demonstration. Prototype units will be integrated into electricity generation sources and mounted at different places, and data on the destruction and removal of airborne contaminants and air flow profiles will be constantly monitored at different spots in the farmhouse. For this activity, the strategy to place prototype units according to the internal configuration of the barn will be thoroughly investigated. Computational fluid dynamics (CFD) tools such as Ansys will be applied to simulate the ventilation and hazard removal performance within the barn. The final decision will consider criteria including air contents distribution, treatment capacity, energy consumption, and operation costs to optimize the compatibility between MW and NTP modules and other facilities such as the air filtration units. Stakeholders will be brought to the demo site to view the system and operation.

Activity Milestones:

Description	Approximate Completion Date
Small pilot-scale test/demonstration system design completed	August 31, 2028
Small pilot-scale test/demonstration system fabricated and tested	December 31, 2028
Simulation of the pilot scale test condition completed	April 30, 2029
The field test/demonstration system will be demonstrated in WCROC to the stakeholders	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Zheng Xing	Department of Veterinary and Biomedical Sciences, UMN	Co-PI	No
Roger Ruan	Department of Bioproducts and Biosystems Engineering, UMN	Co-PI	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?

After pilot testing, the project will transition to full-scale implementation through collaboration with poultry producers, conservation organizations, and regulatory agencies. Performance data will be shared via publications, workshops, and policy forums, ensuring alignment with Minnesota's conservation and biosecurity goals. Future funding will be secured from USDA, DOE, and public-private partnerships, with support from the University of Minnesota's commercialization office for intellectual property and licensing. Beyond poultry farms, the system can be deployed in wildlife rehabilitation centers, fisheries, and wetland projects to prevent disease transmission, reduce nitrogen pollution, and enhance ecosystem resilience, establishing Minnesota as a leader in sustainable agricultural innovation.

Project Manager and Organization Qualifications

Project Manager Name: Min Addy

Job Title: Research Associate Professor

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

Dr. Addy is a Research Associate Professor in the Bioproducts and Biosystems Engineering Department at the University of Minnesota. She has over 20 years of research experience in waste reduction, biomass-to-biofuel conversion, and renewable energy. Her research focuses on microwave-assisted pyrolysis for converting woody biomass, plastics, and other waste materials into high-value fuels and chemicals. She has also worked extensively on gasification and pyrolysis of waste, microalgae cultivation for wastewater treatment and biofuel production, and anaerobic digestion for animal manure treatment and biogas generation. In addition to her work in waste conversion and biofuels, Dr. Addy has expertise in air quality control, particularly in the use of non-thermal plasma and microwave technologies for nitrogen fixation and air disinfection. Her research also extends to food safety, where she has explored the application of intense pulsed light to inactivate harmful bacteria and other pathogens in various food products, including non-fat dry milk, wheat flour, and almonds.

Dr. Addy has published over 100 peer-reviewed journal articles and four book chapters. She has also taught Renewable Energy Technologies and Food Process Engineering for more than 10 years. She has extensive knowledge of advanced air purification techniques involving plasma and microwave technologies, as well as innovative methods for repurposing decommissioned wind turbine components through chemical processes. She has successfully led multidisciplinary research projects and mentoring multiple students. With extensive project management experience, she has coordinated research teams, overseen experimental design, and ensured the successful execution of proposed projects.

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

Organization Description:
The Center for Biorefining is a University of Minnesota research center affiliated with the College of Food, Agricultural and Natural Sciences and helps coordinate the University efforts and resources to conduct exploratory fundamental and applied research and provide education on science and technology for environment protection and circular economy; stimulate collaboration among the University researchers, other public sector investigators, and private investigators involved in biobased production technology development; promote technology transfer to industries; and foster economic development in rural areas. The Center's research programs are founded by DOE, USDA, DOT, DOD, LCCMR, IREE, Xcel Energy, and other federal and state agencies, NGOs, and private companies. The Center is equipped with state of the arts analytical instruments, and processing facilities ranging from bench to pilot scale.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Lead PI Addy - .85 FTE dependent on grant funds		Direct and oversee all research and personnel			36.6%	0.45		$45,663
Co-PI Ruan summer salary only		direct specific area of research and personnel			36.6%	0.15		$45,568
Co-PI Xing - contract based faculty		direct specific area of research			36.6%	0.21		$45,341
Post doctoral student		Oversee work in lab			25.9%	2.25		$188,900
lab technician - position dependent on grant funds		analysis in Xing lab			36.6%	0.3		$26,812
Post doctoral student		Oversee work in Xing lab			25.9%	2.25		$168,235
							Sub Total	**$520,519**
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Equipment	Miscellaneous parts, including microwave power supply/magenetron, plasma reactor, ceramic sleeve, roots blower, mixing shaft, nitrogen balancing and pressure regulating system, metal expansion joint, condensation system, and product tank,	for building the benchtop and small pilot scale catalytic microwave-assisted processing system					$54,451

	Tools and Supplies	1. Chemicals and materials for bench-top experiments and small pilot scale system operation, including catalysts, reagents for synthesizing various zeolites, SiC materials 2. Consumable lab supplies for lab experiments including gloves, masks, filters, etc	to conduct the research accurately and safely					$43,030
	Equipment	Components including mirowave-assisted reactor vessel, plasma generators, insulation materials, magnetrons, control, motors, mixer, feeder, valves, etc.	fabrication of a pilot-scale demonstration system for catalytic NTP air filtration modules					$230,000
							Sub Total	**$327,481**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	tbd	outreach and demo of air treatment system					$2,000
							Sub Total	**$2,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$850,000**

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				
			Non State Sub Total	-
			Funds Total	-

Total Project Cost: $850,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: bac2ce95-8e3.pdf

Alternate Text for Visual Component

Illustration of air sanitation units using catalytic NTP and low-temperature MW treatments to eliminate airborne pathogens, harmful gases, and odors. Treated air is either recirculated or exhausted. The preliminary results show E. coli bioaerosol reduction and specific energy input variations under different temperatures and zeolite loading on SiC foams....

Supplemental Attachments

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

Title	File
Letter of Authorization to Submit	045d001f-f57.pdf
Audit	42acf897-c48.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?

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

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Wendy Moylan, Juer Liu, University of Minnesota

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

N/A