Environment and Natural Resources Trust Fund

2025 Request for Proposal

General Information

Proposal ID: 2025-089

Proposal Title: Plasma System for PFAS Remediation: Integration and Validation

Project Manager Information

Name: Tom Slunecka

Organization: Plasma Blue, LLC

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Project Basic Information

Project Summary: Develop and validate a commercially viable 50 gph upwardly scalable liquid-phase plasma reactor system to eradicate PFAS from drinking water from common sources resulting in CaF2 and H2O.

ENRTF Funds Requested: $1,032,000

Proposed Project Completion: June 30, 2027

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.

Per- and poly-fluoroalkyl substances (PFAS) are a group of anthropogenic chemicals which have been used in the production of fire-fighting foams, stain repelling agents, fluoropolymers, pesticides, paints, and medicines for decades. These chemicals are not biodegradable and can bioaccumulate, resulting in deleterious conditions for humans and ecological systems. At relatively low concentrations, PFAS could lead to serious health conditions such as kidney and testicular cancers, liver damage, immunotoxicity, neurotoxicity, and abnormal thyroid hormone levels. PFAS standards for drinking water have been suggested as 4 ppt for each by state and federal agencies.

Removing PFAS from drinking water is a priority issue facing government and industry. Current ex-situ technologies (sorption, reverse osmosis, nanofiltration) remove and concentrate PFAS from water with very low PFAS concentrations. The technologies do not destroy PFAS, requiring PFAS destruction technologies or land application. Current PFAS destruction methods (advanced oxidation processes (AOPs) such as UV/H2O2, Fenton reaction, zero-valent iron and photochemical) have yielded mixed results at the

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.

Impending regulations and the serious health and ecological effects of PFAS make developing commercially viable destruction technologies and systems an urgent focus. To complicate matters, PFAS does not degrade naturally and is still required in certain critical applications. The liquid-phase plasma reactor at the heart of a system that we propose using for PFAS destruction was developed at the University of Minnesota Southern Research and Outreach Center verified and scaled up to 10 gph with a 99% or greater efficacy rate under LCCMR Project 2022-265.

The next logical step is to scale up the reactor throughput further (50 gph) and develop a commercially viable treatment system capable of meeting a 4 ppt PFAS standard. Necessary system components that will need to be designed, tested, calibrated and added to the system are: 1) a pre-treatment concentrating module; 2) a post-treatment CaF2 precipitation module offering added value; and 3) an argon gas collector for PFAS concentrations requiring its use. The scalable prototype commercial system will then be optimized, validated and demonstrated.

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 specific outcomes of this project are to further scale up the liquid phase plasma reactor for PFAS destruction to a 50 gph flow-through level (upwardly scalable), optimize operating parameters and verify its efficacy. Secondly, pre- and post-treatment modules will be designed, optimized, verified and incorporated into a PFAS water treatment device that can be used to destroy PFAS from city, well and gray water to meet the likely EPA and MDH standard of 4 ppt.

Activities and Milestones

Activity 1: Verify the efficacy of the liquid phase plasma reactor over a range of PFAS contamination levels and subsequent CaF2 recovery.

Activity Budget: $242,000

Activity Description:
A bench-top system with a CaF2 precipitator will be constructed. Five PFAS concentrations ranging from low to high, simulating what would be expected in bottled water, city water, well water, gray water, and industrial wastewater, will be prepared in the lab. Tests will determine the optimum operating parameters for PFAS treatment for each level of contamination at the benchtop scale. Operating parameters will include reactor configuration, treatment time, energy use, need for including a gas (air, argon or other) in the reactor flow stream, number of passes through the reactor to achieve the desired standard, operating cost estimates, and CaF2 precipitate analysis. Off-gas analysis will be done for up to 3 contamination levels.

Activity Milestones:

	Description	Approximate Completion Date
1.	Add CaF2 precipitator to the bench-top PFAS eradication unit	October 31, 2025
2.	Develop operating parameters for different PFAS concentrations	March 31, 2026
3.	Off-gas analyses	June 30, 2026

Activity 2: PFAS removal system scale-up to 50 gph throughput and validation of efficacy

Activity Budget: $350,000

Activity Description:
The scale up from a PFAS destruction benchtop system including CaF2 precipitator to one that will handle a 50 gph flow-through capacity will be completed. A suitably sized CaF2 precipitator will be incorporated into the PFAS eradication system. The scaled-up PFAS removal system will be tested with 3 of the PFAS concentrations tested in the lab. Operating parameters will include reactor configuration, treatment time, energy use, need for including a gas (air, argon or other) in the reactor flow stream, number of passes through the reactor to achieve the desired 4 ppt standard, operating cost estimates and CaF2 precipitate analysis. Pretreatment concentrator and gas recapture modules will be fitted to the system.

Activity Milestones:

	Description	Approximate Completion Date
1.	Scale up to 50 gph and add CaF2 precipitator of appropriate scale	December 31, 2025
2.	Develop operating parameters for 3 PFAS contamination levels	June 30, 2026
3.	Add additional pre- and/or post-treatment modules	October 31, 2026

Activity 3: Construct a benchtop PFAS treatment system and validate the efficacy of the technology specifically for city, well and gray water.

Activity Budget: $210,000

Activity Description:
City water, well water and gray water will be sourced from 5 locations each. Water from each source will be analyzed for PFAS concentration, dissolved elemental constituents, and particulate matter composition and size. Laboratory tests will

lead to determining optimum operating parameters for each source, the effects and fates of minerals in the flow-through stream, the effects and fates of organic matter in the flow-through stream, whether additional pre- or post-treatment modules are necessary (filtration or precipitation) and will determine when and if a gas addition to the reactor flow stream (air, argon or other) is necessary for optimum results. Off-gases will be characterized for no gas and gas options if necessary. Analyses of the precipitate will be conducted to characterize and quantify compounds formed. Bench scale system energy use and operating costs will be estimated.

Activity Milestones:

	Description	Approximate Completion Date
1.	Locate sources and acquire sufficient quantities of water and analyze	June 30, 2026
2.	Develop optimum operating conditions	November 30, 2026
3.	Identify fate of minerals and organic matter	February 28, 2027
4.	Off-gas analysis	June 30, 2027

Activity 4: Test and validate the efficacy of the 50 gph system specifically for city water, well water and gray water applications.

Activity Budget: $230,000

Activity Description:
Water sourced from one location representing each of 3 sources as in Activity 3 will be used to develop system operating parameters and to validate the efficacy of the large-scale liquid plasma PFAS destruction system. Tests will lead to verification of the optimum operating parameters for each source. If additional pre- or post-treatment modules are necessary they will be incorporated into the system.

Activity Milestones:

	Description	Approximate Completion Date
1.	Test and validate the system for tap water	February 28, 2027
2.	Test and validate the system for well water	March 31, 2027
3.	Test and validate the system for gray water	April 30, 2027
4.	Demonstrate the PFAS destruction system to potential users	June 30, 2027

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Shaobo Deng	University of Minnesota, Southern Minnesota Research and Outreach Center	The University of Minnesota will be responsible for all lab-scale testing and evaluation, including the concept testing of pre- and downstream units (PFAS concentrator, Argon gas collector, and CaF2 precipitator) and system optimization for different water sources.	Yes

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 purpose of this project is to scale up and integrate the plasma reactor into a system for PFAS destruction and recovery of valuable chemicals. The resulting 50 gph unit will be demonstrable and upwardly scalable. At any time in the research and development process, interested governmental or NGO could begin working on the incorporating a commercial scale unit into their particular situation. Essentially, the results of this work will attract investors for technology implementation.

Project Manager and Organization Qualifications

Project Manager Name: Tom Slunecka

Job Title: Chief Executive Officer

Provide description of the project manager's qualifications to manage the proposed project.
Tom Slunecka has been the chief executive officer of Minnesota Soybean since August of 2012. Since then, he has overseen the creation of several new non-profit and for-profit entities, including Plasma Blue, and the Soy Innovation campus and also the creation of Ag Management Solutions, which focuses on providing services to ag associations and the businesses they manage. He currently serves as CEO of AMS.

Before joining Minnesota Soybean, Slunecka had a long history in the biofuels and agriculture industry. Throughout his career, he has launched several products, services and companies, many of which are still relevant today. His previous experience includes serving as executive director of the Ethanol Promotion & Information Council, Omaha, Neb., and vice president of marketing for the National Corn Growers Association, St. Louis. In addition, Slunecka worked with the Urban Air Initiative and Phibro Animal Health where he was vice president of marketing for PhibroChem, a specialty supply company focused on ethanol and animal agriculture in New Jersey.

Starting with New Jersey-based American Cyanamid, Tom has successfully blended the corporate urgency of return on investment with the day-to-day needs of members and policy makers for the industry.

Tom is a native of South Dakota and holds a Bachelor of Science degree in Agriculture Business from South Dakota State University in Brookings. Tom and his wife, Robyn, have three sons, Wyatt, William and Jack.

Organization: Plasma Blue, LLC

Organization Description:
Plasma Blue, LLC is a for-profit new biodiesel process company, currently owned by the Minnesota Soybean Research & Promotion Council. Plasma Blue, LLC is based on a revolutionary new technology, that will allow the biofuels industry to

better utilize renewable sources of energy, such as wind and solar, in the conversion of sustainably-grown feedstocks to oil. This farmer-driven technology is affordable and provides plants with an option for quick expansion with existing infrastructure or for new plants considering what technology would best fit their situation.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
PI-Tom Slunecka		Principal Investigator-Overall Project Management			10%	0.5		$75,800
Engineer-Seg Niebuhr		Design, build, and test modules			10%	0.5		$112,650
Lab Technician-Wyatt Slunecka		Lab technician and work.			10%	1		$53,450
							Sub Total	**$241,900**
Contracts and Services								
University of Minnesota	Sub award	The University of Minnesota will be responsible for all lab-scale testing and evaluation, including the concept testing of pre- and downstream units (PFAS concentrator, Argon gas collector, and CaF2 precipitator) and system optimization for different water sources.				1.2		$260,203
Forrest Izuno	Professional or Technical Service Contract	Dr. Izuno will work with the University of Minnesota inventor of the plasma-in-liquid reactor and Plasma Blue scientists and engineers to design and verify a system that will destroy PFAS in drinking water while ensuring environmental integrity. He will assist in experimental design, data management, report development, and outreach events.				0.2		$60,000
BioCognito LLC, Nathan Danielson	Professional or Technical Service Contract	BioCognito help clients bring new industrial biotechnologies to market. For the Plasma Blue effort, BioCognito will be working to identify those niches that are the best fit for plasma-based degradation of PFAS containing water. This effort will consider how to best deploy right-sized solutions based on need and infrastructure.				0.2		$40,000
TBD	Professional or Technical Service Contract	Additional consultation and help with the design, build, and testing of new modules.				1		$97,250

TBD	Professional or Technical Service Contract	External Laboratory Service-Off-gas, PFAS, and Precipitate Analyses				1		$122,550
							Sub Total	**$580,003**
Equipment, Tools, and Supplies								
	Tools and Supplies	Chemicals, analysis kits, glassware, tools and personal protection supplies	Equipment to conduct lab experiments with the new modules.					$35,000
	Equipment	PFAS Concentrator Module	When low levels of PFAS are in the water, we would actually be better off concentrating PFAS to a level that can still be treated with one or two passes through the reactor. Basically, we'd bubble gas through the water to be treated. PFAS adheres to the gas bubbles and concentrates at the top of the water column. We'd then pull water off the top of the column and pass it through the reactor. This should give us process efficiency. This would be pretreatment.					$10,000
	Equipment	Plasma Blue Reactor Module	The core of the system is the Plasma Blue plasma in liquid reactor.					$110,000
	Equipment	CaF Precipitator Module	The treated water that passes through the reactor will have fluorine molecules in it. We will pass the fluid over a chemical precipitation bed to create CaF2, a marketable product that also ensures the absence of fluorine in the treated water. Post treatment.					$10,000
	Equipment	Argon Gas Collector Module	If we need to pass argon gas into the flow stream, we will need to collect gas so it does not go to the atmosphere...Argon is very expensive so we can collect and reuse. Further, the fewer chemicals we put out into the atmosphere the better.					$10,000
							Sub Total	**$175,000**

Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	4-6 trips, 1-2 people.	Source water and complete demonstrations.					$17,597
							Sub Total	**$17,597**
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	1-2 trips, 2 people, airfare, lodging, and registrations	Biofuels conference, TBD					$17,500
							Sub Total	**$17,500**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$1,032,000**

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: $1,032,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 8f751ff0-4e3.docx

Alternate Text for Visual Component

Flow chart of water through the PFAS plasma retractor....

Financial Capacity

Title	File
Financial Capacity Note	f7699f30-69a.pdf

Supplemental Attachments

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

Title	File
Forrest Izuno - (BIO)	2eb7b2b7-475.docx
BioCognito, LLC - Nathan Danielson (BIO)	a56cd271-a5b.doc
Plasma Blue, LLC - Seg Niebuhr (BIO)	63c99f5b-135.docx
FY24 LCCMR U of M Proposal Budget	938a8ecf-7df.xlsx
Fy24 LCCMR U of M Scope of Work	43be0e75-333.docx
U of M Sub-award Approval Letter	71fd94f8-805.pdf
Plasma Blue, LLC -Patent Disclosure	ae71ff7a-2ad.docx
Non-State Entity Resolution Letter	0325b9cb-4ad.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

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?

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:

Adam Sorensen, Ag Management Solutions, LLC