



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-382

Proposal Title: Evaluating Landfill Leachate PFAS Reduction Utilizing Engineered Wetlands

Project Manager Information

Name: Mark St. Lawrence

Organization: St. Louis County

Office Telephone: (218) 749-0647

Email: stlawrencem@stlouiscountymn.gov

Project Basic Information

Project Summary: This project will focus on development, implementation, and evaluation of a semi-passive, demonstration-scale engineered wetland treatment system with integrated outflow-filtration for reducing PFAS and other landfill leachate contaminants of interest.

Funds Requested: \$895,000

Proposed Project Completion: 2024-03-31

LCCMR Funding Category: Water Resources (B)

Project Location

What is the best scale for describing where your work will take place?

Region(s): 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.

St. Louis County's Regional Landfill (Landfill) is the only Municipal Solid Waste (MSW) landfill in northeast Minnesota. Leachate from the Landfill is spray irrigated on adjacent fields. PROBLEM: Current and emerging [Per- and polyfluoroalkyl substances (PFAS)] contaminants of interest (CoI) in Landfill leachate have come under increased scrutiny and management requirements. More importantly, cost effective leachate transport-for-treatment options no longer exist for Landfill operators within 150-175 miles. OPPORTUNITY: Published research concludes that removal of these CoI via transfer and / or transformation pathways by microbes, hydrosols, and aquatic plants is possible. During July-October 2019, a County-funded microcosm-scale Engineered Wetland Treatment System (EWTS) was developed based on published EWTS criteria to remove and reduce contaminants in Landfill leachate. Overall PFAS and nitrogen concentrations decreased between inflow and outflow during the 2019 WTS evaluation; additional refinement of a County-funded microcosm hybrid EWTS will occur during 2020. Therefore, a critical OPPORTUNITY exists to test a demonstration-scale hybrid EWTS to better define its efficacy for reducing PFAS and other CoI in Landfill leachate. With a more targeted approach, a more representative and effective hybrid EWTS may be developed for reducing and preventing CoI such as PFAS from release into surface water and groundwater resources.

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.

A unique and urgent opportunity exists to develop and use a semi-passive form of leachate treatment to remove current and emerging CoI; specifically, PFAS. Conclusions from previous research using an EWTS for this purpose concluded that 1) >50% overall PFAS concentration was removed; and, using Landfill leachate, 2) approximately 68% PFOS and 20% PFOA reduction was achieved using the County-funded microcosm-scale EWTS during 2019; ammonia, TKN, and nitrate-nitrite removal was >70%; and other regulated and unregulated CoI concentrations also decreased. Based on available published and non-published data, design of effective EWTS for Landfill leachate treatment is possible. Additional County-funded EWTS research will be completed during 2020. A hybrid-EWTS (EWTS with outflow filtration) will be designed based on published EWTS criteria and 2019 data, and tested for effective reduction/removal of current and emerging CoI. LCCMR 2021 funds will allow development of a larger demonstration-scale system based on effective hybrid-EWTS technology developed during 2020 for understanding CoI fates, movements, and reductions in Landfill leachate. Development of this hybrid EWTS for removal of CoI from Landfill leachate will reduce and prevent these contaminants from entering critical surface water and groundwater 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?

1) Use data and information obtained during 2019 and 2020 testing to develop and evaluate an effective semi-passive, hybrid EWTS to reduce and prevent landfill leachate CoI from release into surface water and groundwater resources; 2) evaluate specific EWTS-outflow filtration technology efficacy; 3) evaluate EWTS-outflow filtration technology life-expectancy; and 4) disseminate information obtained throughout the course of this research via appropriate research symposia and publications, and to other County landfills for leachate treatment needs.

Activities and Milestones

Activity 1: Activity 1: Design, construct, and initiate (flood) demonstration-scale hybrid EWTS, with follow-up outflow-filtration integration design

Activity Budget: \$472,405

Activity Description:

Based on 2019 and 2020 microcosm-scale EWTS data, and current published literature, the proposed semi-passive demonstration-scale hybrid EWTS will be designed, constructed, planted, and initiated (flooded). EWTS hydraulic retention time will be targeted at 12-14 days. A titanium dioxide-coated UV radiation-mediated photocatalysis chamber, targeting additional organic material and potentially PFAS degradation in EWTS outflow, will be constructed. Initial leachate chemical characterization and volume and flow rate(s) predictions will be completed; and additional laboratory-scale granular activated carbon column testing will be completed, data from which will inform demonstration-scale EWTS outflow-filtration specifics (e.g., more intensely targeting suspended solids and organic carbon removal within the EWTS if needed). Preparations for efficacy and efficiency testing during 2022 and 2023 growing seasons will be completed. Quarterly and other progress and accomplishment reporting requirements to LCCMR and County personnel will be completed.

Activity Milestones:

Description	Completion Date
Design and construct hybrid EWTS for landfill leachate treatment.	2021-11-30
Complete additional granular activated carbon column filtration testing.	2021-12-31
Complete maintenance for overwinter storage of hybrid EWTS components.	2021-12-31
2021 Quarterly and other progress and accomplishment reporting to LCCMR and County personnel.	2021-12-31

Activity 2: Activity 2: Complete 2022 growing season efficacy and efficiency evaluation of complete demonstration-scale hybrid EWTS

Activity Budget: \$205,592

Activity Description:

The initial growing season for the demonstration-scale hybrid engineered EWTS evaluation will begin following spring 2022 thaw. The EWTS status will be assessed; plant growth will be evaluated; and Landfill leachate inflow will begin when appropriate. Information from 2019 and 2020 testing will inform any adjustment of system dynamics in an effort to improve overall efficacy. EWTS outflow will be exposed to UV radiation in a titanium dioxide-coated photocatalysis chamber targeted at additional organic matter, and potentially PFAS, degradation prior to filtration. Final EWTS outflow, and follow-up filtration outflow, samples will be used to 1) determine overall system efficacy and efficiency throughout 2022; and 2) guide any adjustments to the complete hybrid EWTS dynamics. EWTS hydrosol and plant samples will be used to determine fate and movement of contaminants of interest within the EWTS. The 2022 growing season data will be used to guide decision-making focused on improving intended system function for the 2023 growing season; with the ultimate data quality objective of potential development of a larger, field-scale hybrid EWTS for treatment/removal of landfill leachate contaminants of interest.

Activity Milestones:

Description	Completion Date
Assess spring 2022 status of demonstration-scale hybrid EWTS.	2022-05-31
Initiate leachate inflow to EWTS; prep for outflow filtration processes.	2022-06-30

5/18/2020

Complete 2022 efficacy, efficiency, filtration life-expectancy evaluation of hybrid EWTS.	2022-12-31
Complete maintenance to prep hybrid EWTS for overwinter.	2022-12-31
Complete quarterly and other reporting to LCCMR and County personnel.	2022-12-31

Activity 3: Activity 3: Complete 2023 growing season efficacy and efficiency evaluation of complete demonstration-scale hybrid EWTS

Activity Budget: \$217,003

Activity Description:

The 2022 growing seasons’ data will be used to guide decision-making focused on improving intended system function for the 2023 growing season. The EWTS status will be assessed; plant growth will be evaluated; and Landfill leachate inflow will begin when appropriate. Information from 2022 testing will inform any adjustment of system dynamics in an effort to improve overall efficacy. EWTS outflow will continue to be exposed to UV radiation in a titanium dioxide-coated photocatalysis chamber targeting additional organic matter, and potentially PFAS, degradation prior to filtration. Scheduled EWTS outflow samples, and filtration process outflow samples, will be used to 1) determine overall system efficacy and efficiency throughout 2023; and 2) guide any adjustments to system dynamics. EWTS hydrosol and plant samples will be used to determine fate and movement of contaminants of interest. Ultimately, 2022 and 2023 hybrid EWTS data will be used for evaluation of field-scale hybrid EWTS applicability for treatment/removal of landfill leachate contaminants of interest. In concurrence with the overall data quality and use objectives, data obtained during 2023 will be used for a focused evaluation of this hybrid-EWTS for potential field-scale development for mitigation of contaminants of interest in Landfill leachate.

Activity Milestones:

Description	Completion Date
Assess condition of the Hybrid EWTS; complete pre-irrigation season maintenance prior to initiating EWTS inflow.	2023-05-31
Initiate leachate inflow to EWTS; prep for outflow filtration processes.	2023-06-30
Complete maintenance to prep hybrid EWTS for overwinter.	2023-12-31
Complete final LCCMR and County reporting, and final evaluation of hybrid EWTS leachate treatment efficacy.	2024-03-31

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Rick Crum, P.G.	Northeast Technical Services, Inc.	Mr. Richard Crum will serve as the Project Manager for Northeast Technical Services, Inc., personnel associated with specific roles on this project.	Yes
Paul Eger, Ph.D.	Global Minerals Engineering / Northeast Technical Services, Inc.	Dr. Paul Eger is experienced with water resource management and constructed wetland treatment system design. Dr. Eger's primary responsibility will be to review the EWTS functional design in terms of targeting removal of specific contaminants of interest.	Yes
O'Niell Tedrow, M.S.	Northeast Technical Resources, Inc.	O'Niell is experienced with freshwater toxicology, water resource management, and pilot-scale constructed wetland treatment system design. He will primarily be responsible for designing, maintaining, and evaluating the efficacy and efficiency of the demonstration-scale EWTS.	Yes
Jonathan Novak, E.I.T.	Northeast Technical Services, Inc.	Jonathan will primarily be involved with designing, initiating, integrating, and maintaining filtration processes receiving outflow from the demonstration-scale EWTS. Additional responsibilities will be associated with field and lab report data quality review, and data entry and management in an online-accessible database with GIS integration.	Yes
Jacob Crispo, P.E.	Northeast Technical Services, Inc.	Jacob will primarily be responsible for construction oversight, inspection, and certification of the EWTS. Specifically, verification and certification of structural internal and external berm construction materials and integrity, liner integrity, and placement of internal berms, weirs, leak detection features, and other internal water depth- and flow- regulation structures.	Yes
Jordan Erickson	Northeast Technical Services, Inc.	Jordan's experience is focused on environmental engineering. Her primary responsibility will be working with Jacob during the design, construction, inspection, and certification processes associated with the EWTS.	Yes
Karissa Vosen	Northeast Technical Services, Inc.	Karissa's primary responsibility will be associated with field and lab report data quality reviews, and data entry and management in an online-accessible database with GIS integration.	Yes
Nick Joelson	Northeast Technical Services, Inc.	Nick holds a MN Class D wastewater operator's license, HAZWOPER certification, MN Type V Basic (spray irrigation) certification, MN Waste Disposal Facility Inspector Certification, and responsible for seasonal operation/maintenance of existing landfill leachate spray-irrigation system. He will be responsible for periodic EWTS inspections above and beyond current responsibilities.	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 be funded?

Primary costs for implementing the demonstration-scale hybrid-EWTS will be incurred during 2021. Once initiated, the demonstration-scale system will be maintained through 2023 for efficacy evaluation. Based on the feasibility and efficacy evaluation, funding for development of a field-scale hybrid EWTS will be pursued. Data obtained will be used to guide integration of the demonstration-scale EWTS into a full-scale hybrid-EWTS for Landfill leachate treatment prior to spray irrigation. St. Louis County will maintain and use the EWTS for leachate storage and supplemental leachate pre-irrigation treatment while pursuing field-scale development funding.

Project Manager and Organization Qualifications

Project Manager Name: Mark St. Lawrence

Job Title: Director, St. Louis County Environmental Services

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

Mark St. Lawrence, Director, will be the primary contact for the St. Louis County Environmental Services Department "Environmental Services" for this project. Assisting Mark will be Dave Fink, Deputy Environmental Services Director. Dave has academic degrees focusing on Limnology and Freshwater Resources. David began as a County Planner (2001), advancing to Program Administrator (2014) and Deputy Director (2019). During this time, he has managed and evaluated multiple pilot- and field- scale project initiatives focused on more efficient and effective reduction of current and emerging contaminants of interest in landfill leachate. These projects have resulted in successfully reducing overall leachate nitrogen concentration, allowing the continuation of land application of leachate from the Landfill, the County's preferred leachate treatment option; the option of transport of Landfill leachate to a wastewater treatment facility no longer exists. Through strict adherence of Environmental Services' land application requirements, the department has successfully managed leachate onsite, preventing release of leachate into surface water and groundwater resources. During the past 10 years, Dave has partnered with local water resource scientists and engineers at Northeast technical Services, Inc., to accomplish these projects; some of which are part of an ongoing effort to reduce and prevent release of nitrates and other emerging contaminants of interest. Recently, Dave directed initial County-funded microcosm-scale engineered wetland treatment system (EWTS) research during 2019, which focused on reducing leachate PFAS and other contaminants of interest. Successes achieved from the 2019 effort resulted in County-funded development of an improved, 2020 hybrid-EWTS research design (EWTS with follow-up outflow filtration) that focuses on replicating 2019 results, and evaluating and refining the hybrid-EWTS in an effort to specifically target reducing levels of contaminants in Landfill leachate. Current efforts pursuing semi-passive hybrid-EWTS technology for Landfill leachate treatment are a direct result of Dave's initiative.

Organization: St. Louis County

Organization Description:

St. Louis County Environmental Services manages MSW, recycling, demolition waste, special wastes, household hazardous waste, and leachate management programs within the County's Solid Waste Management Area. MSW collected at 19 County canister sites and five transfer stations is hauled to the County Regional Landfill for disposal. Environmental Services is funded through an Enterprise Fund; primary revenues generated from Landfill tipping and property assessed service fees. The department's progressive nature has resulted in successful leachate treatment projects briefly described in the 'Project Manager Qualifications' section. Environmental Services has contracted with Northeast Technical Services, Inc., (NTS) an environmental science and engineering company, to design, maintain, and evaluate efficacy of the department's leachate treatment management projects. Their 2019 microcosm-scale EWTS achieved removal of multiple leachate contaminants of interest, including PFAS. NTS will be contracted to design, construct, implement, maintain, and evaluate the proposed demonstration-scale hybrid-EWTS. County personnel will participate in all aspects of the leachate treatment and management research projects. NTS maintains direct ties with academic and industry specialists in passive, semi-passive, and active water treatment processes; and design and use of EWTS for mitigation of contaminants of interest in industry-influenced waters.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
							Sub Total	-
Contracts and Services								
Northeast Technical Services, Inc. (NTS)	Sub award	For 27 years, NTS has collaborated with St. Louis County Environmental Services to provide overall landfill engineering, operation, and environmental compliance. Contract amount for proposed EWTS evaluation will be \$340,000: expert personnel (in collaborator section), field and sampling/monitoring consumables, travel, conference attendance, lab analyses, and report printing.				1.64		\$340,000
							Sub Total	\$340,000
Equipment, Tools, and Supplies								
							Sub Total	-
Capital Expenditures								
		Holding tanks	Hold leachate between individual treatment steps within demonstration-scale hybrid EWTS.					\$7,500
		Pumps, fittings, valves, flow meter, and level switches.	Connect and maintain flow between individual treatment steps within the demonstration-scale hybrid EWTS					\$15,500
		Engineered Wetland Treatment System	Primarily, the EWTS will function as a series of reactors for targeted transfers and transformations of contaminants of interest in Landfill leachate; secondarily, the EWTS will function as additional Landfill leachate containment for pre-irrigation treatment. Funds requested will be					\$315,000

			used specifically for EWTS excavation, construction, with allocation of some funds to NTS personnel for final EWTS prep, such as inspection and certification, leveling of substrate, planting, obtaining internal / external elevations.					
		Granular activated carbon (GAC) columns and activated carbon exchanges	Granular activated carbon columns will be used as the final leachate treatment step targeted at removal of PFAS.					\$40,000
							Sub Total	\$378,000
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
							Sub Total	-
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Electrician	Complete electrical distribution network to components of the hybrid EWTS; specifically, high voltage availability for pumps and filtration assembly processes.					\$20,000
		Filtration skid placement	Anticipated cost (\$1,000 in 2022 and \$1,000 in 2023) for placement of the rental micro-filtration skid.					\$2,000

		Rental micro-filtration skid	Approximately \$75,000 (2022) and \$80,000 (2023); \$155,000 total for rental of a micro-filtration skid for particulate material filtration prior to granular activated carbon filtration.					\$155,000
							Sub Total	\$177,000
							Grand Total	\$895,000

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	St. Louis County Deputy Environmental Services Director (David Fink) personnel time commitment.	David will serve as project coordinator, will be one of two primary County contacts, and will be available to visit the site as required for project updates and briefings.	Secured	\$10,000
In-Kind	St. Louis County Environmental Services (2021, 2022, and 2023)	St. Louis County will provide a staff colleague when possible for EWTS monitoring. This will be accomplished by St. Louis County personnel providing time and effort outside the normal respective position descriptions to monitor and assist with functional maintenance throughout the project duration. The staff time equates to an approximate \$22,769 value to the project.	Secured	\$22,769
In-Kind	St. Louis County Environmental Services	Cover costs associated with travel and conference attendance for purposes of information dissemination.	Secured	\$1,500
In-Kind	St. Louis County Environmental Services Director (Mark St. Lawrence) personnel time commitment	Mark will be one of two primary County contacts, and will be available for various project requirements, and progress updates and briefings.	Secured	\$10,000
In-Kind	St. Louis County Environmental Services (Steve Pellinen) personnel time commitment.	Steve will be an additional County contact, and will be available to assist with project needs onsite, and will be a primary contact for onsite project assistance.	Secured	\$10,000
In-Kind	St. Louis County Auditor's office (Cindy Palm - Financial Analyst)	Cindy will be a County Auditor's contact as a Fiscal Agent representative	Secured	\$10,000
In-Kind	Northeast Technical Services, Inc., will donate an YSI Pro-Plus with Quad Cable field meter for the duration of this project; and a Hach field kit for measuring turbidity.	This field meter will be used to measure the characteristics of leachate at specific locations within the system pathway from inflow to the EWTS to the outflow of the final filtration process: temperature, pH, dissolved oxygen, and conductivity. Oxidation-reduction potential may be added as a sensor capability. The Hach field kit will be used to measure turbidity at the same locations as other field measurements. These data will be critical for verifying EWTS outflow suitability as inflow to micro- and activated carbon- filtration assemblies.	Secured	\$4,500
			Non State Sub Total	\$68,769
			Funds Total	\$68,769

Attachments

Required Attachments

Visual Component

File: [2bd80310-113.pdf](#)

Alternate Text for Visual Component

This hybrid engineered wetland treatment system (EWTS) is specifically designed to promote transfers and transformations of contaminants of interest. Specifically, nitrogen species, phosphorus, aqueous organic carbon, and total suspended solids are targeted for removal in the EWTS. The TiO₂-UV photocatalysis reactor is designed to target additional organic carbon degradation, with a potential benefit of PFAS degradation. The micro-filtration component is designed to remove additional suspended solids, with the potential for additional organic carbon removal, prior to granular activated carbon filtration. Granular activated carbon filtration is included as a final polishing step to specifically remove PFAS. Final hybrid EWTS outflow will be returned to the leachate treatment pond from which it was originally obtained.

Board Resolution or Letter

Title	File
Board Resolution	89ef981a-f4b.pdf

Optional Attachments

Support Letter or Other

Title	File
MPCA Letter of Support	84e85f09-395.pdf
City of Virginia Letter of Support	ea7f13a9-491.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

Yes

Does the organization have a fiscal agent for this project?

No

Evaluating Landfill Leachate PFAS Reduction Utilizing Engineered Wetlands

- *Enhances existing landfill leachate treatment process to target contaminants of interest*
- *Safer and more cost effective than other treatment options (transporting offsite, reverse osmosis, etc.)*
- *Semi-passive treatment*
- *No concentrated waste outflows generated*
- *Minimal energy and operator input required*



