# Environment and Natural Resources Trust Fund

2022 Request for Proposal

## General Information

**Proposal ID:** 2022-286

**Proposal Title:** Emerging PFAS Contaminant Mitigation Using Hybrid 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 result in the design, implementation, and evaluation of an innovative method for protection of water resources and mitigation of emerging water contaminants in landfill leachate; specifically, PFAS.

**Funds Requested:** $501,000

**Proposed Project Completion:** December 31 2024

**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.**

Landfill leachate poses environmental risks to surface and groundwater because of its high pollutant load and must be decontaminated or remediated before disposal, typically via transport to a municipal wastewater treatment plant (WWTP), or pre-treated prior to spray-irrigation. Alternative treatment methods are increasingly necessary due to capacity challenges and recent PFAS concerns at WWTPs, increased cost-of-transport, and the need for removal of emerging contaminants of concern such as PFAS (per-and polyfluoroalkyl substances). St. Louis County's Regional Landfill is the only Municipal Solid Waste landfill in northeast Minnesota, serving a population of 80,000 increasing seasonally to 110,000 (summer). Leachate is currently irrigated on adjacent fields following pre-treatment. Cost effective transport-for-treatment does not exist. Concerns about PFAS alter the management requirements for spray irrigation and substantially increase pre-treatment costs. An innovative approach to leachate treatment was explored July-Oct 2019 by creating a small-scale Engineered Wetland Treatment System (EWTS) designed to remove and reduce contaminants. A small-scale hybrid EWTS was tested in 2020, resulting in substantial decreases in PFAS, nitrogen, and manganese. The next step is testing larger, demonstration-scale hybrid EWTS to better quantify decreases of PFAS and other contaminants of interest to prevent release into surface 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.**

To develop, refine, and evaluate an innovative semi-passive form of leachate treatment using an EWTS in combination with post wetland treatments throughout multiple consecutive growing seasons. Small-scale hybrid EWTS testing during 2019 and 2020 provided very encouraging results, prompting Environmental Services to propose upgrading its research to demonstration-scale. Small-scale single-season use of a hybrid EWTS during 2020 resulted in ≥90% PFAS with health risk limits (PFOS, PFOA, PFHxS, PFBS, PFBA), >90% ammonia, and ~90% manganese removals. The proposed system would include five, approximately 6-meter x 2.5-meter reactor cells in series, followed by EWTS-outflow treatment intended for additional organic carbon and PFAS removal. It is well documented that the right combination of plants and soils within a wetland system can act as a natural filter but additional treatment is needed to effectively decrease specific pollutants in leachate such as PFAS. Specifically, with this proposed system, fates, movements, and decreases of contaminants, specifically PFAS, in leachate will be closely studied. This will result in reducing and preventing leachate contaminants from entering critical surface- and ground- water resources. Should this project provide the results we anticipate, its application could be extended to landfills throughout Minnesota.

**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 proposal addresses 5 of the 10 priority areas of concern identified in the recently released "Minnesota's PFAS Blueprint:" to measure PFAS effectively and consistently, prevent PFAS pollution to surface- and ground-water resources, protect ecosystem health, reduce PFAS exposure from fish and game consumption, and manage PFAS in waste. The overall outcome: design and develop an effective alternative leachate treatment method other than, or prior to, wastewater treatment facility disposal. Additional outcomes include 1) evaluate onsite hybrid EWTS design criteria for effective and cost-efficient PFAS removal throughout multiple consecutive seasons; and 2) evaluate EWTS-outflow treatment efficacy and life expectancy.

## Activities and Milestones

### Activity 1: Activity 1: Year One (2022) Design, Permit, and Build Semi-Passive Leachate Treatment System

**Activity Budget:** $181,600

**Activity Description:**
Based on previous small-scale EWTS data, and current published literature, the proposed semi-passive demonstration-scale hybrid EWTS will be designed, constructed, planted, and initiated. Initial leachate chemical characterization, and volume and flow rate calculations, will be completed. Additional EWTS outflow treatment steps will be designed and constructed. Preparations for growing-season efficacy and efficiency testing during 2023-2024 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 hybrid EWTS for landfill leachate treatment. | August 31 2022 |
| Complete additional EWTS outflow treatment steps construction. | December 31 2022 |
| Complete maintenance for overwinter storage of hybrid EWTS components. | December 31 2022 |
| Complete yearly and other reporting throughout 2022 to LCCMR and County personnel. | December 31 2022 |
| Construct hybrid EWTS. | December 31 2022 |

### Activity 2: Activity 2: Year Two (2023) Hybrid EWTS Testing and Evaluation

**Activity Budget:** $162,800

**Activity Description:**
Two complete growing seasons will be used to more thoroughly evaluate a hybrid EWTS for this purpose. The initial complete growing season for the demonstration-scale hybrid EWTS evaluation will begin following spring thaw 2023. EWTS status will be assessed; plant growth will be evaluated; and Landfill leachate inflow will begin when appropriate. Information from previous testing will inform any adjustment of system dynamics in an effort to improve overall efficacy. EWTS outflow will be exposed to additional treatment targeting suspended solids, organic carbon, and PFAS. EWTS outflow, and additional-treatment outflow, samples will be used to determine overall system effectiveness throughout 2023, and to guide any adjustments to increase efficacy. EWTS soil and plant samples will be used to determine fate and movement of contaminants of interest within the EWTS. 2023 growing season data will be used to guide decision-making focused on improving intended system function for the 2024 growing season; with the ultimate data quality objective of potential development of a larger, field-scale hybrid EWTS for treatment/removal of leachate contaminants of interest.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Initiate leachate inflow to EWTS; prep for outflow treatment processes. | June 30 2023 |
| Assess spring 2023 status of demonstration-scale hybrid EWTS and complete reporting requirements. | July 31 2023 |
| Complete initial outflow treatment process life-expectancy evaluations. | December 31 2023 |
| Complete yearly and other reporting throughout 2023 to LCCMR and County personnel. | December 31 2023 |

### Activity 3: Activity 3: Year Three (2024) Hybrid EWTS Testing and Evaluation

**Activity Budget:** $155,600

**Activity Description:**
EWTS status will be assessed; plant growth will be evaluated; and leachate inflow will begin when appropriate for the second of two complete growing season evaluations. Information from 2023 testing will inform any adjustment of system dynamics in an effort to improve overall efficacy. EWTS outflow will continue to be exposed to additional treatment targeting removal of suspended materials, organic carbon, and PFAS; and will be adjusted if needed in an effort to improve effectiveness. EWTS outflow samples, and additional-treatment outflow samples, will be used to determine overall system effectiveness throughout 2024 and guide any adjustments to increase efficacy. EWTS soil and plant samples will be used to determine fate and movement of contaminants of interest. Ultimately, 2023-2024 hybrid EWTS data will be used for evaluation of field-scale hybrid EWTS feasibility for treatment/removal of landfill leachate contaminants of interest.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Assess spring 2024 status of demonstration-scale hybrid EWTS. | May 31 2024 |
| Initiate leachate inflow to EWTS; prep for outflow treatment processes. | June 30 2024 |
| Complete yearly and other reporting throughout 2024 to LCCMR and County personnel. | July 31 2024 |
| Complete maintenance for overwinter storage of hybrid EWTS components. | December 31 2024 |
| Complete final reporting and hybrid EWTS evaluation. | December 31 2024 |

## Activity 4: Activity 4: Education and Outreach

**Activity Budget:** $1,000

**Activity Description:**
As an Adjunct Instructor at Vermilion Community College (VCC), Dr. Tedrow will coordinate with other VCC Instructors and involve students in relevant Degree programs throughout the duration of this project. Despite the majority of the work being completed during summer months, sufficient time will exist during late-spring and early- / mid- autumn for student involvement. Specifically, students in the Water / Wastewater Treatment and Watershed Science Programs will have the opportunity to visit, tour, and ask questions about this project as a whole. Due to the uniqueness of this project (novel applications of typical water treatment processes to a landfill leachate treatment scenario), the opportunity to involve students in relevant Degree Programs from a local Community College is unmatched. This opportunity will not exist without LCCMR financial assistance. Students will learn first-hand (i.e., 'hands-on experience') the importance of preventing PFAS pollution, limiting PFAS from drinking water, protecting overall ecosystem health, and managing PFAS in wastes. The latter is critical - keep PFAS out of landfills, and we can avoid additional energy- and cost- intensive treatment needs. The culmination of this will be pursuit of an open forum to distribute project details, information, results, and other specifics.

**Activity Milestones:**

| Description | Completion Date |
|---|---|
| Fall 2022 site visit. | December 31 2022 |
| Spring 2023 site visit. | May 31 2023 |
| Fall 2023 site visit. | December 31 2023 |
| Spring 2024 site visit. | May 31 2024 |
| Fall 2024 site visit. | December 31 2024 |

## Project Partners and Collaborators

| Name | Organization | Role | Receiving Funds |
|---|---|---|---|
| O'Niell Tedrow, Ph. D. | Northeast Technical Services, Inc. and Vermilion Community College | As a water resources scientist, Dr. Tedrow's primary role will be functional design and evaluation of the proposed hybrid EWTS. As an Adjunct Instructor, he will involve students with this project to the extent possible individually and in collaboration with other VCC instructors; and will assist with public forum coordination. | Yes |
| Paul Eger, Ph. D. | Global Minerals Engineering | Dr. Eger will work with Dr. Tedrow on functional design of the proposed hybrid engineered wetland treatment system. | Yes |
| Rick Crum, P.G. | Northeast Technical Services, Inc. | Mr. Crum will serve as the Project Manager for Northeast Technical Services, Inc., and Global Minerals Engineering personnel associated with roles on this project. | Yes |
| Jonathan Novak, E.I.T. | Northeast Technical Services, Inc. | Jonathan will primarily be involved with designing, initiating, integrating, and maintaining EWTS-outflow treatment processes. Additional responsibilities will be associated with field and lab report data quality review, and data 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 any certification(s) of the EWTS. Specifically, verification of structural integrity, reactor cell liner integrity, and other engineering specifics. | 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. As a field scientist, Jordan will assist with EWTS monitoring and characterization requirements. | Yes |
| Karissa Vosen | Northeast Technical Services, Inc. | Karissa's primary responsibility will be associated with field and lab report data quality reviews, and data 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 is 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?**

Results from this proposed study will be used to develop and refine an innovative field-scale hybrid EWTS for protection of water resources, and effective and efficient removal of emerging water contaminants (e.g., PFAS) from leachate prior to spray irrigation. Funding for which will likely be pursued through grants and County enterprise and environmental trust funds. Additionally, results from this proposed study may be used to inform effective and efficient onsite leachate treatment strategies for other landfills throughout Minnesota.

## Project Manager and Organization Qualifications

**Project Manager Name:** Mark St. Lawrence

**Job Title:** Environmental Services Director

**Provide description of the project manager's qualifications to manage the proposed project.**
Mark St. Lawrence, St. Louis County Environmental Services (ES) Director, will be the Project Manager for this project. Assisting Mark will be Dave Fink, ES Deputy Director. Dave has academic degrees focusing on Limnology and Freshwater Resources. Dave began as a County Planner (2001), advancing to Program Administrator (2014) and Deputy Director (2019), and has managed evaluations of multiple pilot- and field- scale project initiatives focused on more efficient and effective reduction of current and emerging contaminants of interest (CoI) in landfill leachate, such as nitrogen and PFAS. ES has partnered with local water resource scientists and engineers at Northeast Technical Services, Inc. (NTS), for the past 10 years to accomplish these projects; some of which are part of an ongoing effort to decrease and prevent release of nitrogen, PFAS, and other CoI into surface- and ground- water resources. These projects have resulted in successfully reducing the overall leachate nitrogen concentration, allowing continued land application of leachate, the County's preferred leachate treatment option (the option of efficient leachate transport-for-treatment to a wastewater treatment facility no longer exists). During 2019 and 2020, ES contracted with NTS to design and evaluate hybrid engineered wetland treatment systems for removal of nitrogen and PFAS. Data from these evaluations indicate effective PFAS (~50-90%; PFOS, PFOA, PFHxS, PFBS. PFBA), nitrogen (~80-100%), and manganese (>80%) removal. Through strict adherence to land application regulations, and proactive approaches to increased efficacy and efficiency of leachate treatment, ES has successfully managed leachate onsite, preventing release into surface- and ground- water resources.

**Organization:** St. Louis County

**Organization Description:**
St. Louis County Environmental Services (ES) manages municipal solid waste (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 (Landfill) for disposal. Leachate collected from the Landfill is treated for nitrogen and VOC's in two lined settling ponds prior to spray-irrigation; the County's preferred method of leachate disposal versus pass-through at a WWTP. ES 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. ES has contracted with Northeast Technical Services, Inc., (NTS), a local environmental science and engineering company, to design, maintain, and evaluate efficacy of ES leachate management and treatment projects. NTS maintains direct ties with academic and industry specialists in semi-passive and active water treatment processes, and will be contracted to design, construct, implement, maintain, and evaluate the proposed demonstration-scale hybrid EWTS. County personnel will participate in all aspects of this demonstration-scale leachate treatment and management research project.

## 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) | Professional or Technical Service Contract | NTS maintains a contract with SLC ES for landfill leachate management and treatment, and will provide expertise for designing, constructing, managing, and evaluating the hybrid EWTS: $262,000 includes personnel (collaborator section), electrician contract, sampling and routine hybrid EWTS maintenance / upkeep consumables, and all leachate, substrate and plant testing/characterization. | | X | | 1.5 | | $326,000 |
| | | | | | | | **Sub Total** | **$326,000** |
| **Equipment, Tools, and Supplies** | | | | | | | | |
| | Equipment | Flow meter(s) (up to 4 flow meters). | To regulate flow between the leachate holding pond, EWTS, and EWTS-outflow treatment process(es) (round to $3,000). | | | | | $3,000 |
| | Equipment | Level switchgear (up to 10 switches). | The level switchgear will be used during initiation of batch-treatment of EWTS-outflow, when needed, between the EWTS and EWTS-outflow treatment processes. | | | | | $1,000 |
| | Equipment | Pumps (up to 4 pumps). | The pumps will be used to transfer leachate between the leachate holding pond, the EWTS, and EWTS-outflow treatment processes. | | | | | $4,000 |
| | Equipment | Piping and pipe-fittings. | Piping and pipe-fittings will be used in the construction of conveyance / transfer pathways between the leachate holding pond, the EWTS, and EWTS-outflow treatment processes. | | | | | $4,000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Equipment | Valves | Valves will be used for adjustment and regulation of flow between the leachate holding pond, the EWTS, and EWTS-outflow treatment processes. | | | | | $3,000 |
| | Tools and Supplies | EWTS cell substrate. | A mixture of multiple substrate types will be used in each of the five (5) EWTS reactor cells. | | | | | $10,000 |
| | Tools and Supplies | Wetland plants. | Specific plants will be purchased for each planted EWTS reactor cell. The total requested is for purchase of plants during 2022 (initial planting), and additional plants during 2023-2024 for any replanting requirements: $9/tray; 100 trays per cell; 4 cells; 2022 planting, and 2023-2024 re-planting (2.5 years' worth of planting total). | | | | | $9,000 |
| | | | | | | | **Sub Total** | **$34,000** |
| **Capital Expenditures** | | | | | | | | |
| | | Transfer and Holding Tanks. | Contain leachate between treatment process steps (2x5000 gal.: $7,000; 1x500 gal.: $500); rounded to $8,000. | | | | | $8,000 |
| | | Five (5) dumpster containers up to 50-yard capacity. | These five (5) dumpster containers will be used as demonstration-scale wetland reactor cells ($7,500 each --> round to $40,000 total). | | | | | $40,000 |
| | | Granular activated carbon containers, with yearly carbon refresh. | This will be a final PFAS removal step in the overall process (2 columns at $11,000 = $22,000; 2 carbon refreshes at $9,000 = $18,000). | | | | | $40,000 |
| | | EWTS Outflow Pre-GAC Treatment. | Removal of dissolved organic carbon in EWTS outflow prior to use of granular activated carbon filtration for final PFAS removal. | | | | | $50,000 |
| | | | | | | | **Sub Total** | **$138,000** |
| **Acquisitions and Stewardship** | | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | **Sub Total** | **-** |
| **Travel In Minnesota** | | | | | | | | |
| | Miles/ Meals/ Lodging | We anticipate VCC student involvement in this project will be as follows: six (6) trips; 120 miles round trip; two vehicles; at $0.575 per mile = $828; round to $1,000. | These site visits from VCC will be scheduled for each fall and spring throughout the duration of the project, plus one visit for other faculty to become familiar with the project, and the work site for course planning purposes. | | | | | $1,000 |
| | Conference Registration Miles/ Meals/ Lodging | Travel to conference location, lodging, meals (per diem): $500 per person (two total) total for each of two conferences. | We anticipate two personnel to participate in at least two conferences to disseminate available data. | | | | | $2,000 |
| | | | | | | | **Sub Total** | **$3,000** |
| **Travel Outside Minnesota** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| **Printing and Publication** | | | | | | | | |
| | Publication | Report distribution | All reports for this proposal are expected to be electronically distributed; therefore, no printing fees are expected for this project. | | | | | - |
| | | | | | | | **Sub Total** | **-** |
| **Other Expenses** | | | | | | | | |
| | | | | | | | **Sub Total** | **-** |
| | | | | | | | **Grand Total** | **$501,000** |

## Classified Staff or Generally Ineligible Expenses

| Category/Name | Subcategory or Type | Description | Justification Ineligible Expense or Classified Staff Request |
|---|---|---|---|
| **Contracts and Services** - Northeast Technical Services, Inc. (NTS) | Professional or Technical Service Contract | NTS maintains a contract with SLC ES for landfill leachate management and treatment, and will provide expertise for designing, constructing, managing, and evaluating the hybrid EWTS: $262,000 includes personnel (collaborator section), electrician contract, sampling and routine hybrid EWTS maintenance / upkeep consumables, and all leachate, substrate and plant testing/characterization. | Northeast Technical Services, Inc. (NTS) is a local Science and Engineering Firm, which has maintained a contract with St. Louis Env. Services (SLCES) for approx. 20 years to manage landfill leachate onsite. NTS' rates to SLCES are typically ~20% less than market, has a history of pro-bono work for SLCES, is within 5 miles of the project site, and is distinctly familiar with the facilities. During summer 2019 and 2020, SLCES contracted with NTS scientists to design, build, and evaluate small-scale EWTSs which were successful at removing PFAS, nitrogen, and manganese. This proposed project would be an addition to this existing contract for NTS scientists to continue development, refinement, and evaluation for multiple consecutive growing seasons of this leachate treatment strategy based on their previous EWTS design; and would ensure critical professional jobs are retained on Minnesota's Iron Range.<br>This is a single source contract.<br>**This is a single source contract.** |

## Non ENRTF Funds

| Category | Specific Source | Use | Status | Amount |
|---|---|---|---|---|
| **State** | | | | |
| | | | **State Sub Total** | **-** |
| **Non-State** | | | | |
| In-Kind | St. Louis County Environmental Services (Steve Pellinen) personnel time commitment. | Steve will be an additional County contact, 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 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 | $8,000 |
| In-Kind | St. Louis County Auditor's office (Cindy Palm - Financial Analyst) | Cindy will be the County Auditor's primary contact related to fiscal activity. | Secured | $10,000 |
| In-Kind | St. Louis County Environmental Services Director (Mark St. Lawrence) | Mark will be one of two primary County contacts, and will be available for various project requirements, and progress updates and briefings. | Secured | $12,000 |
| In-Kind | St. Louis County Environmental Services (2022, 2023, and 2024) | St. Louis County will provide a maintenance worker to assist with EWTS monitoring on an as-needed basis. This will be accomplished by St. Louis County personnel providing time and effort outside the normal respective position description to monitor and assist with functional maintenance throughout the project duration. | Secured | $20,000 |
| 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. | The 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 | $4,750 |
| | | | **Non State Sub Total** | **$64,750** |
| | | | **Funds Total** | **$64,750** |

# Attachments

## Required Attachments

### *Visual Component*

File: 034ef1b6-2c1.pdf

### *Alternate Text for Visual Component*

LEFT: The three charts forming the left column show successful removal of PFAS when compared to MDH Health Based Values (HBVs) during small-scale hybrid engineered wetland treatment system (EWTS) testing in 2020.

RIGHT: Proposed demonstration-scale hybrid EWTS testing to verify and validate PFAS removal efficiency and efficacy. This demonstration-scale hybrid (EWTS) is specifically designed to promote transfers and transformations of contaminants of interest based on published data and 2020...

### *Board Resolution or Letter*

| Title | File |
|---|---|
| St. Louis County Board Resolution Authorizing Proposal Submittal to LCCMR | 16480725-7af.pdf |

## Optional Attachments

### *Support Letter or Other*

| Title | File |
|---|---|
| Letter of Support - Vermilion Community College | fec71bbe-0c2.pdf |
| Letter of Support - MPCA | 0a7bf844-2b1.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?**

No

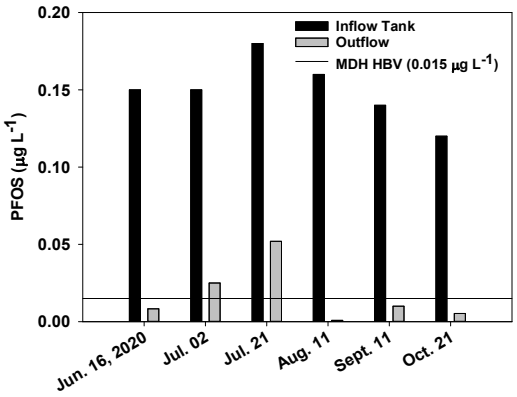
**Does the organization have a fiscal agent for this project?**

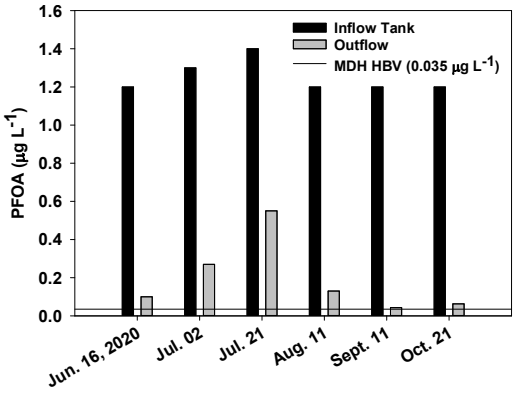
No

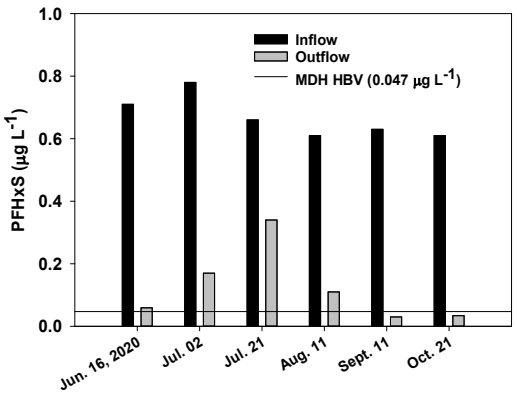
**(2022 LCCMR Proposal)**

## 2020 PFAS Treatment Results

***PFAS with MDH Health Based Value (HBV):***
***PFOS, PFOA, PFHxS, PFBS, PFBA***




*(Inflow PFBS, PFBA below MDH HBV)*

## Emerging PFAS Contaminant Mitigation Using Hybrid Engineered Wetlands

- ***Enhances existing landfill leachate treatment process to remove specific contaminants (PFAS, N)***
- ***Semi-passive treatment – minimal energy/operator input required***
- ***No concentrated waste streams generated***