



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2019 ENRTF Work Plan (Main Document)

Today's Date: August 9, 2018
Date of Next Status Update Report: March 1, 2020
Date of Work Plan Approval: June 5, 2019
Project Completion Date: June 30, 2022
Does this submission include an amendment request? ___

PROJECT TITLE: Improving Nitrogen Removal in Greater Minnesota Wastewater Treatment Ponds
Project Manager: Paige J. Novak
Organization: University of Minnesota
College/Department/Division: Department of Civil, Environmental, and Geo- Engineering
Mailing Address: 122 Civil Engineering Building, 500 Pillsbury Drive SE
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Location: Minneapolis, MN 55455 and McLeod or Sibley counties

Total Project Budget:	\$325,000
Amount Spent:	\$0
Balance:	\$325,000

Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04e

Appropriation Language: \$325,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to assess cold weather nitrogen cycling and different aeration methods to improve the efficacy of Minnesota's underperforming wastewater treatment ponds.

I. PROJECT STATEMENT:

In Minnesota there are over 1000 small communities with unmet wastewater management needs, ranging from no treatment to inadequate treatment. If inadequately treated, wastewater discharges can contain high concentrations of nitrogen species, including ammonia and nitrate. Ammonia can decrease the oxygen levels in the receiving water body and is also toxic to fish. Nitrate can eventually lead to eutrophication and can also contaminate groundwater supplies, rendering well water unsafe to drink. It is therefore important to treat, and thereby remove, these nitrogen species to protect surface and groundwater quality in greater Minnesota.

An option for treating wastewater in small communities is treatment ponds. In fact, there are currently more than 300 wastewater treatment pond systems that help serve the needs of Minnesota’s small communities. These systems are very simple to operate, relying on wind and surface transfer of air to help bacteria within the pond treat the nitrogen species present in the wastewater. The ponds are emptied periodically, according to guidelines from the Minnesota Pollution Control Agency, and are discharged to surface water such as creeks or streams.

Unfortunately, 23% of Minnesota’s ponds under-perform with respect to total nitrogen removal. Very little research has been conducted on wastewater treatment ponds to understand how they operate with respect to nitrogen removal and to understand how low oxygen levels and low temperature, both of which can occur in wastewater treatment ponds in Minnesota during the winter and spring months, impact bacterial nitrogen removal. If nitrogen cycling in pond systems was well understood, these systems could be managed more precisely. If needed, simple interventions such as adding oxygen and mixing the sediment of the pond could also be used to stimulate total nitrogen removal during times of poor performance, such as the winter and spring months.

We propose to study how pond systems operate with respect to nitrogen cycling under conditions of low oxygen and/or low temperature. This work will be performed at both the laboratory scale at the University of Minnesota and full scale with the assistance of project partner Minnesota Rural Water Association (MRWA). Subsequent laboratory research will focus on how simple interventions such as mixing and oxygen addition improve or change nitrogen cycling. Recommendations based on the laboratory work will be provided to MRWA, to assist in developing and field-testing improved nitrogen removal practices in the future. The overall goal of this research is to better understand nitrogen-cycling in wastewater treatment ponds, improving their management, so that they can serve as a well-operating solution for some of Minnesota’s 1000 small communities that need wastewater management.

II. OVERALL PROJECT STATUS UPDATES:

First Update March 1, 2020

Second Update September 1, 2020

Third Update March 1, 2021

Fourth Update September 1, 2021

Fifth Update March 1, 2022

Final Report between project end (June 30) and August 15, 2022

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 Title: Laboratory assessment of how nitrogen cycles during winter/spring months

Description:

Model pond reactors (5-liter) will be set up in the laboratory, containing sediment and/or water obtained from two wastewater treatment ponds: a well performing and poorly performing pond. Reactors will be operated to model pond conditions when the temperature is low and ice cover decreases the amount of oxygen that can reach the deeper regions of the pond. It is during these months that the nitrogenous compounds that can cause surface water and groundwater damage are thought to build up. Nitrogen removal and the types and quantities of bacteria that perform various nitrogen cycling steps will be measured to understand how cold temperatures and low oxygen impact these processes.

ACTIVITY 1 ENRTF BUDGET:

ENRTF Budget: \$184,109

Outcome	Completion Date
<i>1. Experiments performed at a variety of oxygen levels at low (2°C) temperature</i>	<i>7/31/20</i>
<i>2. Experiments repeated at 7°C</i>	<i>1/31/21</i>
<i>3. Experiments repeated at 12°C</i>	<i>6/31/21</i>

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ACTIVITY 2 Title: Full-scale pond assessment of nitrogen cycling during winter/spring

Description:

We will work with our project partner, the Minnesota Rural Water Association, to obtain samples from the same two ponds over time. Water-column samples will be taken for analysis of nitrogen species; temperature and oxygen concentrations will be measured by Minnesota Rural Water Association. Samples will be taken over time after wastewater loading during the winter and spring months when temperatures are expected to range from 2°C to 12°C and the ponds range from free-surface to ice-covered. Several samples will also be taken during the summer and fall months to serve as “warm water controls”. Samples of the water column and pond sediment will be taken to measure the nitrogen-cycling bacteria present in the samples.

ACTIVITY 2 ENRTF BUDGET:

ENRTF Budget: \$100,000

Outcome	Completion Date
<i>1. Sampling the oxidation ponds during winter and spring</i>	<i>6/30/21</i>
<i>2. Analysis of the bacteria present in pond samples</i>	<i>6/30/21</i>

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ACTIVITY 3 Title: Evaluation of simple methods (mixing and aeration) at the laboratory scale to stimulate total nitrogen removal during periods of low oxygen concentration and low temperature

Description:

Laboratory experiments will be performed to evaluate the effect of oxygen addition, via the solid and easily deployed “oxygen-release compound” (ORC®, Regenesis), and the effect of gentle sediment mixing via a paddle mixer. The effect of such simple stimulation methods on the transformation patterns of nitrogen species under conditions least favorable to nitrogen removal in the winter and spring will be determined.

ACTIVITY 3 ENRTF BUDGET:

ENRTF Budget: \$40,891

Outcome	Completion Date
<i>1. Evaluation of effect of ORC addition and mixing on nitrogen removal in the laboratory</i>	<i>3/30/22</i>
<i>2. Discussion of results with project partner to determine strategies for field assessment in the future</i>	<i>4/30/22</i>

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IV. DISSEMINATION:

Description:

The target audience for results from this research will be environmental engineers and scientists in academia, professionals in the area of wastewater treatment, city managers and other local government officials, and the Minnesota Pollution Control Agency. Results will be disseminated through scholarly publications in peer-

reviewed journals such as *Environmental Science and Technology* and *Environmental Science: Water Research and Technology*. Results from the research project will also be presented at regional conferences such as the *Conference on the Environment*. MRWA will disseminate the research findings in the quarterly Today magazine and monthly TA Times newsletter as needed. MRWA will participate in joint presentations with the University of Minnesota as needed to present the research findings. MRWA will also make research material available on the MRWA website as needed or deemed appropriate.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the [ENRTF Acknowledgement Guidelines](#).

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Second Update September 1, 2020

Third Update March 1, 2021

Fourth Update September 1, 2021

Fifth Update March 1, 2022

Final Report between project end (June 30) and August 15, 2022

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

Explanation of Capital Expenditures Greater Than \$5,000: N/A

Explanation of Use of Classified Staff: N/A

Total Number of Full-time Equivalent (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours for entire duration of project: 6,480	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: 1.04 FTE/yr
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Total Number of Full-time Equivalent (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Contract Personnel Hours for entire duration of project: N/A	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE: N/A
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VI. PROJECT PARTNERS:

A. Partners outside of project manager’s organization receiving ENRTF funding

Name	Title	Affiliation	Role
Minnesota Rural Water Association			Responsible for sampling in activity 2 and assisting with dissemination activities

B. Partners outside of project manager’s organization NOT receiving ENRTF funding

None

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

The proposed work fits into a larger research agenda at UMN on the development and evaluation of treatment technologies for water and wastewater. The proposed research expands the focus to outstate and rural infrastructure support, coordinating with several other proposals. **This research will also be coordinated with the Minnesota Pollution Control Agency’s (MPCA’s) work on the optimization of rural wastewater systems. The MPCA does not have the capacity to perform longer-term and well controlled experiments and this research will complement their work well.**

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted March 1 and September 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2022

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet

B. Visual Component or Map

C. Parcel List Spreadsheet: N/A

D. Acquisition, Easements, and Restoration Requirements: N/A

E. Research Addendum

Attachment A:

Environment and Natural Resources Trust Fund

M.L. 2019 Budget Spreadsheet

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Project Manager: Paige J. Novak

Project Title: Improving Nitrogen Removal in Greater Minnesota Wastewater Treatment Ponds

Organization: University of Minnesota

Project Budget: \$325,000

Project Length and Completion Date: 3 years, June 30, 2022

Today's Date: 8/9/18



ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	\$ 171,778	\$ -	\$ 171,778
Novak (PI, 2% time per year for three years, salary 75% of cost, fringe benefits 25% of cost). Project supervision, provide guidance on the reactor construction and operation. Total estimated cost is \$16,581. LaPara (PI, 2% time per year for three years, salary 75% of cost, fringe benefits 25% of cost). Project supervision, guidance on microbial analysis aspects of the project. Total estimated cost is \$12,674. Graduate student (50% time per year for three years, 57% salary, 32% tuition, 11% fringe benefits). Conducting laboratory experiments and analyzing samples collected from oxidation ponds by the Minnesota Rural Water Association. Total estimated cost is \$142,523.			
Professional/Technical/Service Contracts			
Minnesota Rural Water Association will work with us to take treatment pond samples and do chemical analysis in the field. A 25% engineer will be paid to perform this work. They will also help with disseminating findings through their outreach programs using staff time (25% FTE/year).	\$ 100,000	\$ -	\$ 100,000
Equipment/Tools/Supplies			
Laboratory supplies are budgeted including, but not limited to: kits for in-field nitrogen species analysis, chemicals for synthetic wastewater generation, materials to construct wastewater reactors, chillers to maintain low reactor temperatures, analysis needs such as standards, sample vials, columns and guard columns, supplies for culture-independent bacterial enumeration and identification; consumables such as gloves and solvents (\$13,333/yr). Additional funds budgeted for equipment repair and maintenance (\$3,200), and laboratory services (sequencing for confirmation of organism identity, \$8,000).	\$ 51,200	\$ -	\$ 51,200
Travel expenses in Minnesota			
Mileage charges to oxidation pond sites for sample collection, and pond water, wastewater, and pond sediment collection. Mileage will be reimbursed \$0.55 per mile or current U of M	\$ 2,022	\$ -	\$ 2,022
Other			
	\$ -	\$ -	\$ -
COLUMN TOTAL	\$ 325,000	\$ -	\$ 325,000

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:		\$ -	\$ -	\$ -
State:		\$ -	\$ -	\$ -
In kind: Novak and LaPara will provide unpaid time to the project (including 2% cost-share). Because the project is overhead-free, laboratory space, electricity, and other overhead costs are provided in kind. The University of Minnesota overhead rate is 54%.		\$ 175,500	\$ -	\$ 175,500

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
Current appropriation:		\$ -	\$ -	\$ -
Past appropriations:		\$ -	\$ -	\$ -

