Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)

Project Title: **ENRTF ID: 067-B**

Eliminating Nitrate in Drain Tile Runoff

Category: B. Water Resources

Sub-Category:

Total Project Budget: $ 398,623

Proposed Project Time Period for the Funding Requested: June 30, 2022 (3 yrs)

Summary:

To develop a technology to convert nitrate from drain tile discharge to nitrogen gas, thus providing low-cost treatment and helping the farm community protect water resources.

Name: John Gulliver

Sponsoring Organization: U of MN

Title: Professor

Department: College of Science and Engineering/St. Anthony Falls Laboratory

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Minneapolis MN 55414

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Visual indicating typical placement of device below a drain tile with outflow into a drainage ditch.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Eliminating Nitrate in Drain Tile Runoff

I. PROJECT STATEMENT

This project will develop a technology to convert nitrate from drain tile discharge to nitrogen gas in a cost-effective manner, thus providing low-cost treatment and helping the farm community protect water resources. The technology will filter drain tile discharge through a media that will retain the nitrate, releasing clean water to the receiving water body.

The release of nitrate through drain tiles is becoming a large issue for Minnesota water resources. In fact, most of the nitrate release is from drain tiles (Discovery Farms Minnesota, *2016 Year in Review*, 2017). The nitrate results in impairments in surface and groundwater bodies and is carried to the Gulf of Mexico where it creates a large dead zone due to hypoxia. Technology is therefore needed to minimize impacts from nitrate release.

We believe that we have a technology that will be cost-effective in reducing nitrate release from the drain tiles that are under most Minnesota farms, called a nitrate retention-denitrification facility. The technology involves rapid filtration, requiring a relatively small container, through a media that captures nitrate (Erickson et al., Abiotic Capture of Stormwater Nitrates with Activated Carbon, *Environmental Engineering Science,* 33(5), 354-363, 2016). This will concentrate the nitrate onto the media and allow the release of clean water to streams, rivers and groundwater. After the runoff subsides, the media will be designed to naturally become a denitrification facility, where anaerobic degradation converts the nitrate to harmless nitrogen gas. The media will then be nitrate-free again, and ready for the next rain-induced flow event and the retention of more nitrate, such that the media is self-rejuvenating.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Build Prototypes and Optimize Media Mix*

Prototypes of the nitrate retention-denitrification facility will be built and used to optimize the mix of media that will most successfully meet the conditions of low cost, fast filtration, nitrogen retention, support of denitrifying bacteria, denitrification and rejuvenation to begin the process again. We have been successful at nitrate retention and fast filtration with granular activated carbon (Erickson, et al. 2016). This process concentrates nitrate onto activated carbon, preparing it for the denitrification process. However, there are less expensive alternatives such as biochar that should also be considered. We will also consider a source of carbon to support denitrifying bacteria and test the denitrifying capabilities of various media. All tests will utilize synthetic drain tile discharge, designed to meet the important aspects of agricultural drain tile discharge.

ENRTF BUDGET: $198,000

Outcome	Completion Date
1. Interim report describing optimization process and the media believed to be best suited to meet the optimization criteria	*12/31/2020*

Activity 2: *Test Optimized Media Mixes in a Full-Scale Installation*

One or more media mixes determined to be optimal under activity 1 will be installed in one or more outdoor, full-scale nitrate retention-denitrification facilities, and subjected to flow and water quality typical of drain tile discharges. The purpose is to test whether the system is successful at meeting the conditions listed under activity 1 in the environment typical of agricultural drain tiles. Plans are to have the treatment system

approximately 16 ft^2 by 3 ft deep, with a discharge that is typical of agricultural drain tiles. Adjustments will be made to the treatment setup and to the media as required to optimize field performance.

ERNTF BUDGET: $200,623

Outcome	Completion Date
1. Report on the optimum media and facility arrangement to denitrify drain tile runoff	*6/30/2022*
2. Brochure with installation instructions for the denitrification facility	*5/31/2022*

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
John S. Gulliver	**Professor**	**University of Minnesota**	**PI- Project supervision**
Andrew J. Erickson	**Research Associate**	**University of Minnesota**	**Analysis and experimental supervision/operation**
Peter T. Weiss	**Visiting Professor**	**Valparaiso University**	**Analysis and report preparation**

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:

Once we have proven the system in a full-scale installation, the retention-denitrification facility will be ready for installation below agricultural drain tiles throughout Minnesota. We believe that installation at a number of Discovery Farms or other tile sites monitored by the Minnesota Department of Agriculture would demonstrate this retention-denitrification technology across the State of Minnesota. We intend to apply for funding from the Board of Soil and Water Resources, Minnesota Department of Agriculture and the U.S. Department of Agriculture to install and monitor the success of the retention-denitrification facilities.

V. TIME LINE REQUIREMENTS:

Three years are needed to complete the project to capture seasonality in the field sampling, target specific questions in the laboratory, and analyze the range of processes involved.

VI. SEE ADDITIONAL PROPOSAL COMPONENTS:

A. Proposal Budget Spreadsheet
B. Visual Component or Map
F. Project Manager Qualifications and Organization Description
G. Letter or Resolution

2019 Proposal Budget Spreadsheet

Project Title:

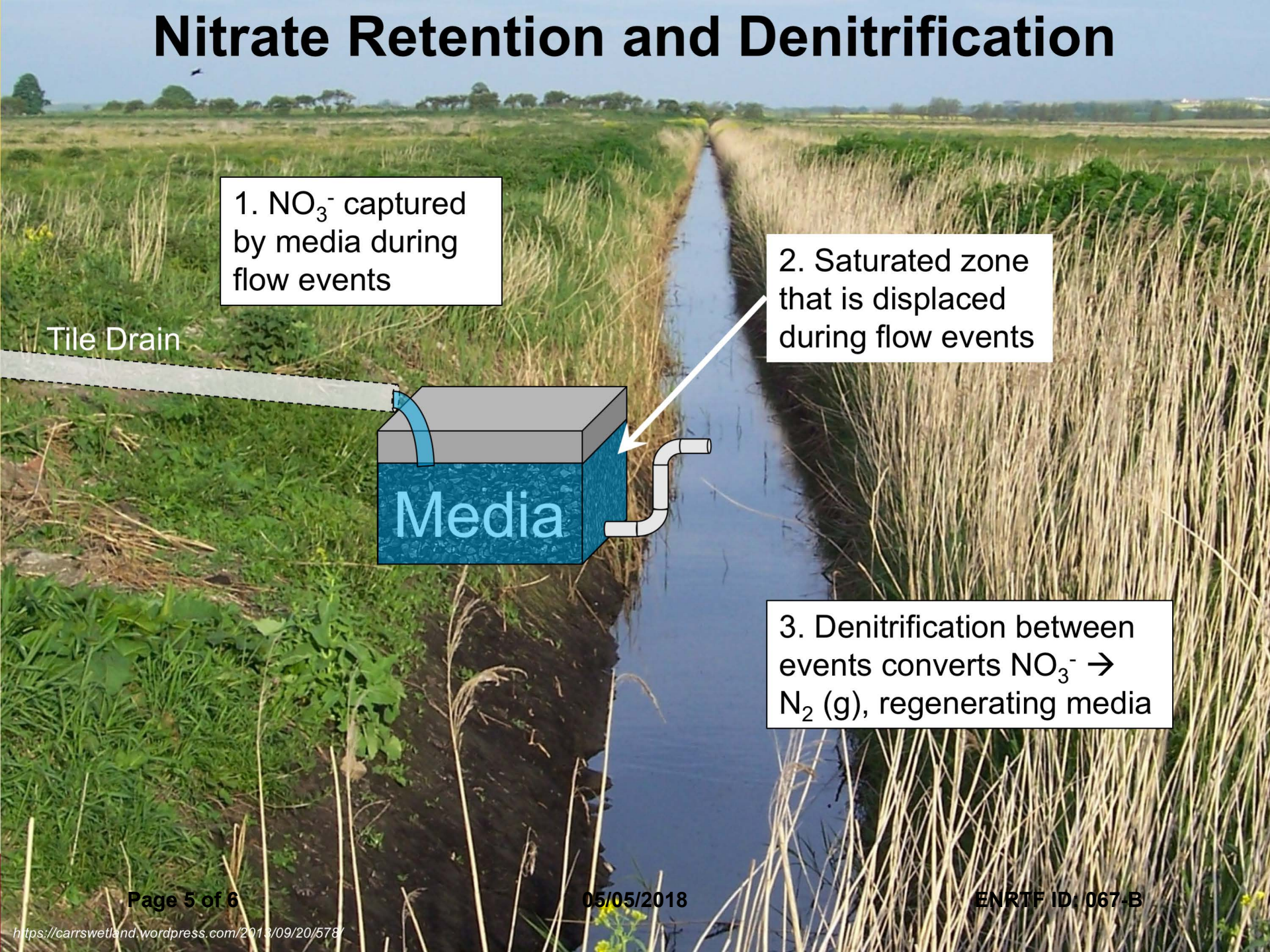
IV. TOTAL ENRTF REQUEST BUDGET *3* **years**

BUDGET ITEM Annual salary increase of 3% assumed)	**AMOUNT**
Personnel:	$ 303,976
Professor (J. Gulliver) Supervisory and Analysis, 8% time, 75% salary, 25% benefits, 3 years ($50,910)	
Research Associate (A. Erickson) Experiment supervision, data analysis, report writing, 20% time,75% salary, 25% benefits, 3 years ($58,146)	
Junior Scientist (A. Ketchmark) Construction of Experimental Apparatus (A. Ketchmark) 15% time, 78% salary, 22% benefits, 3 years ($26,325)	
Graduate Student, Laboratory Experiments, field experiments, sample analysis, data analysis and report writing, 50% appointment, 53% salary, 47% benefits, 3 years ($143,151)	
Junior Engineer Trainee/Undergraduate Research Assistant, laboratory sample collection, field sample collection, laboratory analysis, 33% time, 100% salary, 3 years ($25,444)	
Professional/Technical/Service Contracts:	$ 74,664
Visiting Professor (Peter Weiss) will be on-site 12 weeks each summer and work 1/2-time on the project. 13% time, 100% salary, 3 years ($74,664).	
Equipment/Tools/Supplies:	$ 18,981
Analytical laboratory services for gas, water and media analysis ($8,001).	
Supplies for field monitoring, sample collection, laboratory experiments, and sample analysis ($10,860).	
Printing and duplicating project needs ($120).	
Acquisition (Fee Title or Permanent Easements): N/A	$ -
Travel:	$ 1,002
Travel to attane meetings and conferences in Minnesota ($1,002)	
Additional Budget Items:	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 398,623

V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period:	$ -	
Other State $ To Be Applied To Project During Project Period:	$ -	
In-kind Services To Be Applied To Project During Project Period: Unrecovered IDC	$ 189,857	*Funded with project*
Past and Current ENRTF Appropriation:	$ -	
Other Funding History: 319 Grant from the U.S. Environmental Protection Agency through the Minnesota Pollution Control Agency	$ 300,000	*Completed*

Nitrate Retention and Denitrification



https://carrswetland.wordpress.com/2013/09/20/578/

Project Manager Qualifications & Organization Description

Dr. John S. Gulliver

Professor, Department of Civil, Environmental and Geo- Engineering, University of Minnesota

B.S. 1974	University of California, Santa Barbara (Chemical Engineering)
M.S. 1977	University of Minnesota (Civil Engineering)
Ph.D. 1980	University of Minnesota (Civil Engineering)

John Gulliver is a professor of civil, environmental and geo- engineering, performing his research at the St. Anthony Falls Laboratory. Much of his research, in conjunction with other faculty, involves the development of new technology for stormwater treatment and assessment of field performance of stormwater treatment practices, including the SAFL Baffle, which converts any sump into an effective sediment settling device, the Iron-Enhanced Sand Filter, which removes dissolved, as well as particulate phosphorus, and the MPD Infiltrometer, which can measure infiltration into soil accurately and effectively with minimal volume of water. He has investigated the retention of metals by bioretention media, the infiltration rates of various stormwater treatment practices, the impact of various types of impervious areas on runoff, and the impact of climate change on stormwater infrastructure. He is a co-author of the book, Optimizing Stormwater Treatment Practices: A Handbook of Assessment and Maintenance, published by Springer. Gulliver has expanding his interdisciplinary research into activities related to managing and treating urban runoff and publication of the practitioner-oriented newsletter, Stormwater Updates.

The St. Anthony Falls Laboratory (SAFL), an interdisciplinary fluids research and educational facility of the College of Science and Engineering at the University of Minnesota. SAFLs research is focused at the intersection of fluid dynamics with major societal challenges in energy, environment and health. SAFL integrates experiments in the laboratory and field with advanced computational tools and theory to obtain innovative, science-based solutions to real-world fluid-flow problems. SAFL serves as a resource for departments across the Twin Cities campus, the statewide University system, and the broader research community. The connections and collaborations reach across the country and all over the world, and SAFL partners with local, state and federal agencies; private consulting firms; businesses of many kinds; technical associations; and other educational institutions to expand knowledge and solve problems.