Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 058-B**

Preventing Lake and Stream Pollution from Stormwater Ponds

Category: B. Water Resources

Total Project Budget: $ 535,740

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

We will develop tools to cost-effectively identify stormwater ponds requiring rehabilitation, and to investigate and evaluate techniques to mitigate the lake and stream pollution that results from these ponds.

Name: John Gulliver

Sponsoring Organization: U of MN

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Minneapolis MN 55112

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

1) Runoff phosphorus is trapped in pond sediment, 2) phosphorus is released from sediment in failing ponds, 3) Increased phosphorus in pond outflows results in "pea soup" water in lakes.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

PROJECT TITLE: Preventing Lake and Stream Pollution from Stormwater Ponds

I. PROJECT STATEMENT

The goal of this project is to develop tools to cost-effectively identify stormwater ponds requiring rehabilitation, and to investigate and evaluate techniques to mitigate the pollution that can result from these ponds.

Why- Stormwater ponds that are not maintained properly can create pollution. Minnesota has 30,000+ stormwater treatment ponds that are used to improve water quality. While these ponds are effective for retention of solids, metals, oils and hydrocarbons, there is increasing evidence that many of these ponds are not working as intended to retain phosphorus, the primary cause of lake and stream algae blooms, due to sediment phosphorus release. The state currently has no means to accurately determine when and where ponds should be maintained (e.g. by removing contaminated sediments), or if they should continue to be used at all.

Background- Stormwater ponds are primarily designed to capture phosphorus, a critical pollutant in runoff. High levels of phosphorus affect not only pond water quality, but also that of the lakes or streams receiving the pond outflows, by causing harmful algal blooms that lead to poor water quality, fish kills, and degradation of lake and stream ecosystems. We know that ponds have high potential for pollution: 98 stormwater ponds surveyed in the Twin Cities area during 2010 - 2013 contained an annual average total phosphorus concentration of 0.5 mg/L, five times the 0.1 mg/L criterion set for aquatic and recreational waters. Recent studies have also shown that outflows from some ponds contain more phosphorus than the inflows into the ponds. Such ponds may be failing for several reasons: initial undersizing, reduced storage capacity from accumulated sediment over time, excessive phosphorus inputs from development or disturbance in their watersheds, or frequent low oxygen conditions. For the communities that own and operate the ponds, tools to assess these conditions and resulting pond phosphorus release, as well as potential maintenance strategies are lacking, but are necessary to improve water quality in lakes and streams receiving pond outflows. Our project will identify these factors for use in tools for pond management by cities, counties and watershed management agencies.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Identify Factors causing failure of ponds for phosphorus management **Budget: $223,968**

The goal of this activity will be to quantify the release of phosphorus (P) from the ponds by how watershed, climate, and pond characteristics influence pond P export to receiving waters. Pond water chemistry will be sampled intensively in ten ponds, with inflow and outflow of 3 of the ponds monitored continuously. Water samples will be collected from an additional 20 ponds during dry and wet periods, including winter, to investigate variability among ponds and the influence of season, pond age and weather on P release.

Outcome	Completion Date
1. Quantify phosphorus loading to and from monitored ponds	*12/31/2020*
2. Identify relationships between pond phosphorus and climate, season, pond size and age, and watershed factors	*6/30/2021*

Activity 2: Quantify phosphorus release from stormwater pond sediments **Budget: $201,603**

Activity 2 will determine the conditions that facilitate a release of phosphorus from pond sediments so that those conditions can be avoided or mitigated, and identify indicators of pond failure- threshold levels. Fifty intact sediment cores will be collected from 10 ponds, and used to measure the sediment release rate of phosphorus. Factors that control P release (e.g. dissolved oxygen, temperature and pond water chemistry) will be altered to match field conditions observed in ponds. Indicators of pond failure by high rates of P release will be identified and verified with the sediment cores.

Outcome	Completion Date
1. Quantify phosphorus flux from different pond sediments under various conditions	*10/31/2020*

2. Identify sediment characteristics and factors affecting phosphorus release/retention	*12/31/2020*

Activity 3: Develop tools and guidelines for maintaining stormwater ponds **Budget: $110,169**

The goal of this activity will be to develop a decision support tool based on previous work and the results of the field monitoring and laboratory experiments. The tool will be based on a model that will predict the relationship between pond attributes like age, design and size, watershed variables, phosphorus loading, and potential for phosphorus release for ponds across Minnesota. The results can be used to determine when ponds need to be dredged, and propose methods to control net phosphorus release from ponds.

Outcome	Completion Date
1. Develop a predictive model that can estimate phosphorus release potential for stormwater ponds in Minnesota	*4/30/2021*
2. Develop strategies for maintenance of stormwater ponds	*6/30/2021*

III. PROJECT STRATEGY

A. Project Team/Partners

- Dr. John Gulliver, PI, Professor, Department of Civil, Environmental and Geo- Engineering, UMN-Twin Cities,
- Dr. Jacques Finlay, co-PI, Associate Professor, Department of Ecology, Evolution, and Behavior, UMN-TC,
- Dr. Heinz Stefan, Professor Emeritus, Department of Civil, Environmental and Geo- Engineering, UMN-TC
- Dr. Ben Janke, Research Associate, St. Anthony Falls Laboratory, UMN-Twin Cities,
- Dr. Poornima Natarajan, Research Associate, St. Anthony Falls Laboratory, UMN-Twin Cities,

Input and advice from several agencies will be utilized to ensure that the goals of this research are met, and that the findings are useful to, and shared with, decision-makers in Minnesota. First, we have partnered with the Minnesota Pollution Control Agency (David Fairbairn) in a preliminary study of pond pollutant release. Second, we have enlisted the assistance of the Purgatory Creek Watershed District, who performed the initial research on pond phosphorus concentrations. Finally, we will seek advice from the members of the Stormwater Research Council, who participate and are involved in much of the stormwater research in Minnesota.

B. Project Impact and Long-Term Strategy

This project will improve water quality of Minnesota lakes and streams by providing guidance for pond maintenance, which requires improved understanding of factors and processes that influence phosphorus release (or retention) from ponds. The project will quantify the phosphorus release from stormwater ponds in Minnesota, and relate release to pond, watershed, season, and climate factors. Understanding environmental conditions that influence phosphorus release from sediments, which have been studied in lakes but are poorly understood in ponds, will be a major goal of the work.

An important outcome of the project is the development of maintenance guidelines that will minimize phosphorus loading from ponds to other water bodies. This will include developing tools that can predict the relationship between phosphorus release and pond or watershed characteristics, and provide guidance on when ponds require maintenance. These tools would help communities prioritize sediment removal or other treatment options, which are relevant also to other toxins trapped by ponds that are difficult to dispose of. The results will be valuable to a wide range of state, municipal and private entities managing stormwater ponds, and to those interested in restoring water quality of wetlands or shallow lakes in Minnesota.

C. Timeline Requirements

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

2018 Detailed Project Budget

Project Title: Preventing Pollution from Green infrastructure

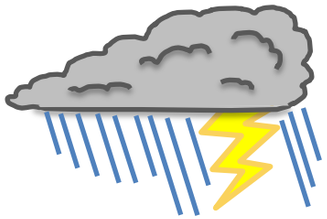
IV. TOTAL ENRTF REQUEST BUDGET 3 years

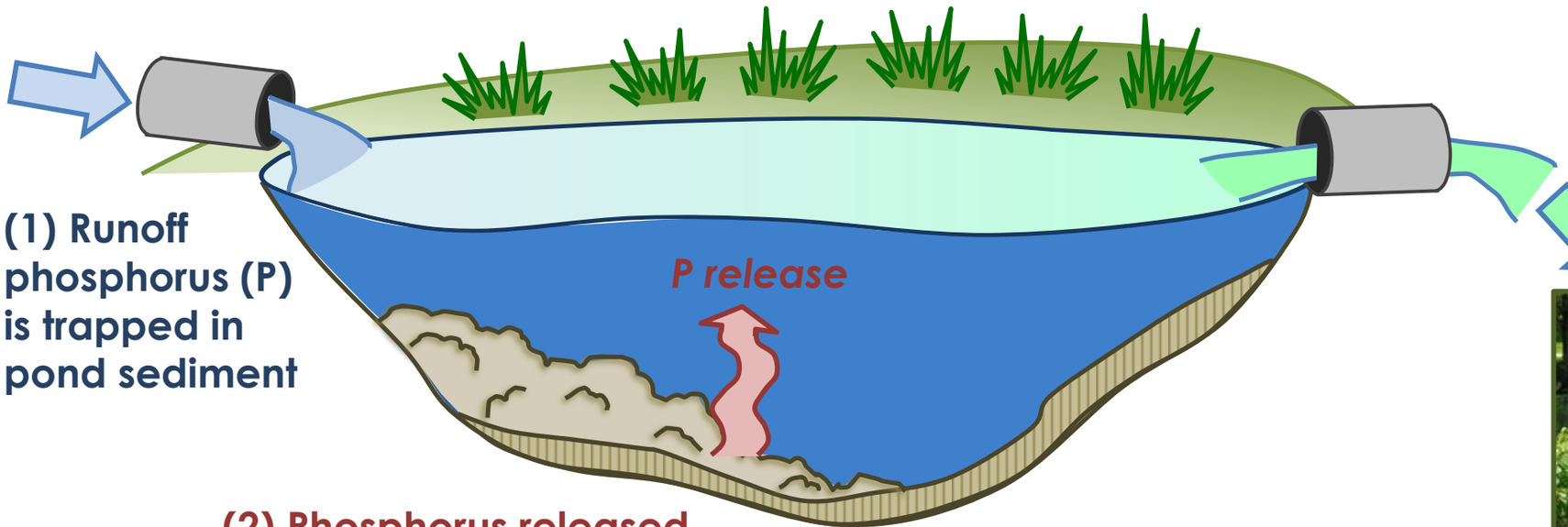
BUDGET ITEM *(Annual salary increase of 3% assumed.)*	**AMOUNT**
Personnel:	$ 444,868
Professor (J. Gulliver), Supervisory and Analysis, 4% time, 75% salary, 25% benefits, 3 years ($34,568).	
Professor (J. Finlay), Supervisory and Analysis, 4% time, 66% salary, 34% benefits, 3 years ($21,312).	
Research Associate (B. Janke), Field sampling and monitoring, data collection and analysis, 50% time, 75% salary, 25% benefits, 3 years ($129,043).	
Research Associate (P. Natarajan), Field sample collection, laboratory experiments, data collection and analysis, 26% time, 75% salary, 25% benefits, 3 years ($58,929).	
Graduate Student, Laboratory experiments, sample analysis, and data analysis, 26% appointment, 53% salary, 47% benefits, 3 years ($72,490).	
Junior Scientist (A. Ketchmark), Field sample collection and experimental apparatus, 3% time, 78% salary, 22% benefits, 3 years ($46,358).	
Junior Scientist (S. Rorer), Laboratory sample analysis, 16% time, 78% salary, 22% benefits, 3 years ($32,145).	
Junior Engineer Trainee/Undergraduate Research Assistant, Field sample collection and laboratory sample analysis, 62% time, 100% salary, 3 years ($50,023).	
Professional/Technical/Service Contracts:	$ 37,332
Visiting Professor (Peter Weiss) will be on-site 12 weeks each summer and work 1/4th-time on the project. 6% time, 100% salary, 3 years ($37,332).	
Equipment/Tools/Supplies:	$ 49,220
Analytical laboratory services for gas, water and sediment analysis ($8,000).	
Supplies for field monitoring, sample collection, laboratory experiments, and sample analysis ($40,860).	
Cellular data for remote data collection at field monitoring sites ($240).	
Printing and duplicating project reports ($120).	
Acquisition (Fee Title or Permanent Easements): *NA*	$ -
Travel:	$ 4,320
Travel: To sites to collect samples. 8000 miles @ $0.54/mi ($4,320)	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 535,740

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**
Unrecovered F&A at 54% MTDC	$ 277,093	*Secured*
Funding History/A	$ -	
Remaining $ From Current ENRTF Appropriation: *N/A*	$ -	

How Stormwater Ponds Can Pollute Lakes and Streams





(1) Runoff phosphorus (P) is trapped in pond sediment

(2) Phosphorus released from sediment in old or failing ponds

(3) Increased phosphorus in pond outflows

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 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.