

**Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 052-B

Enhanced Street Sweeping to Restore Nutrient-Impaired Lakes

Category: B. Water Resources

Total Project Budget: \$ 474,536

Proposed Project Time Period for the Funding Requested: 3 Years, July 2014 - June 2017

Summary:

We propose developing tools for Metro cities that could be used to evaluate the potential effectiveness and cost of using enhanced street sweeping to restore their nutrient-impaired lakes.

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Sponsoring Organization: U of MN

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Location

Region: Metro

County Name: Statewide

City / Township:

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



Environment and Natural Resources Trust Fund (ENRTF)

2014 Main Proposal

Project Title: *Enhanced Street Sweeping to Restore Nutrient-Impaired Lakes*

PROJECT TITLE: Enhanced Street Sweeping to Restore Nutrient-Impaired Lakes

I. PROJECT STATEMENT

Within the 7-county Metro region, 150 lakes have been designated as legally “impaired” by nutrient enrichment and only one has been restored. Our municipalities need new cost-effective approaches to restore their algae-choked, eutrophic lakes. In a nearly completed study of street sweeping in the City of Prior Lake, we have found that enhanced street sweeping can be an effective way to remove phosphorus (the key nutrient causing algae blooms in lakes) from streets before it enters storm drains and lakes (see Visual). **Enhanced street sweeping** employs more frequent street sweeping than cities generally do, with additional sweeping mainly in the spring and fall, when trees drop abundant debris (flowers, seeds, leaves) into streets. Three key findings motivate us to propose a broader study of enhanced street sweeping across the entire Metro:

- The quantity of phosphorus removed by sweeping increased as the tree canopy over the street increased
- More frequent sweeping increased the amount of phosphorus removed
- Street sweeping was very economical during the spring and fall, costing as little as \$20 per pound of phosphorus removed, compared with \$500 or more for stormwater ponds.

In a parallel study in the Capital Region Watershed District, we estimated that *half of stormwater phosphorus comes from phosphorus-rich tree leaves and other debris* that fall into streets and are washed into storm drains.

Here we propose a study to examine the potential effectiveness (in terms of cost and lake improvement) of enhanced street sweeping to restore nutrient-impaired lakes throughout the Metro region. We expect to find that enhanced street sweeping will be most effective in residential watersheds with lots of trees. Specifically, we will analyze the potential of enhanced sweeping to restore 15 nutrient-impaired Metro lakes with MPCA-approved restoration plans (7 in Hennepin, 3 in Ramsey, 3 in Dakota, and 1 each in Anoka and Carver Counties; see Visual). Outcomes will include:

- Maps showing quantities of phosphorus coming from tree debris monthly, street by street, for all cities in the Metro
- A simple methodology cities can use to identify the potential of enhanced street sweeping to restore nutrient-impaired lakes
- An economic evaluation tool to allow cities to identify the cheapest way to achieve lake restoration goals

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity #1: Create Maps of Phosphorus Inputs from Tree Debris for all Metro Streets. Budget: \$144,826

We will develop color-coded maps showing areas of potential phosphorus inputs from trees to streets and of phosphorus removal by various sweeping scenarios by combining our findings from the Prior Lake study with high-resolution tree cover maps for the entire Metro region. If the LCCMR proposal submitted by Marv Bauer is funded, our activity #1 could be reduced by about \$100,000.

Outcome	Completion Date
<i>Web-based maps showing potential phosphorus inputs from tree debris for streets throughout the Metro region, along with potential phosphorus removal rates that could be accomplished by various sweeping scenarios.</i>	<i>December 2015</i>

Activity #2: Determine the Potential for Enhanced Sweeping to Restore Lakes. Budget: \$280,790

We will evaluate the potential for enhanced sweeping to restore 15 lakes (a few are chains of lakes) in the Metro region that are currently nutrient impaired and have completed restoration plans (case study lakes). For each



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lake, potential phosphorus removal from the watershed by enhance sweeping will be quantified and compared to phosphorus removal by stormwater ponds and other BMPs, if present, using well-known models. We will then quantify the effect of reduced phosphorus inputs on lake clarity, accounting for internal phosphorus loading from sediments, and the expected lag time of lake response. We will use data from Activity #1, lake restoration plans, the Prior Lake study, cities and watershed districts, and a limited amount of new sampling in lakes.

Outcome	Completion Date
1. Findings showing the potential for enhanced sweeping to restore nutrient-impaired Metro lakes.	December 2016
2. A report on the methodology to determine circumstances where street sweeping will most likely be effective in improving water quality	December 2016 June 2017
3. Supporting workshops for public works departments.	

Activity #3: Determine the Lowest Cost to Achieve Phosphorus Reduction Goals. Budget: \$48,920

We will identify the best combinations of streets, months of the year, and frequencies for street sweeping within the watersheds of the case study lakes to achieve phosphorus reduction goals in the cheapest way possible. We will also incorporate various constraints of enhanced sweeping, based on interviews with local public works officials and lake managers. Activity #3 builds on findings from Activities #1 and #2.

Outcome	Completion Date
1. Estimates of lowest cost to achieve phosphorus reduction goals to wholly or partially restore the case study lakes using enhanced sweeping.	December 2016
2. A report on the economic methodology, to allow cities to conduct future evaluations.	June 2017

III. PROJECT STRATEGY

A. Project Team/Partners

The project will be led by Dr. Lawrence Baker (Dept. of Bioproducts and Biosystems Engineering) at the U of M. Drs. Joe Knight and Marv Bauer (Dept. of Forest Resources) will do much of the mapping work proposed in Activity #1. Drs. Sarah Hobbie and Jacques Finlay (Dept. of Ecology, Evolution, and Behavior) will contribute expertise on the movement of nutrients through urban landscapes for activities #1 and #2. Dr. Jay Coggins (Dept. of Applied Economics), will lead the economic analysis (Activity #3). Several cities and watershed districts will participate in a "Technical Advisory Group" that will meet twice per year (not paid by LCCMR funds).

B. Timeline Requirements

Activity #1 will be completed by December 2015. Research in Activity #2 will start in 2014 and be completed in Dec. 2016; outreach will continue through June 2017. Activity #3 research will start in mid 2015 and be completed by Dec. 2016, with a methodology manual to be completed in June 2017.

C. Long-Term Strategy and Future Funding Needs

Our proposed project is part of a long-term effort to increase the success of lake restoration using enhanced street sweeping. Data from Prior Lake project will inform the proposed LCCMR project, which in turn fill knowledge gaps to give "early adopter" cities confidence to move forward with enhanced sweeping projects. , We are also working with the City of St. Paul to plan a new enhanced sweeping experiment designed to compare quantities of stormwater phosphorus in two small, residential watersheds, one with enhanced sweeping and one with traditional sweeping. We anticipate that several other cities will also begin deliberate experimentation and implementation, guided in part by findings from the proposed LCCMR project.

2014 Detailed Project Budget

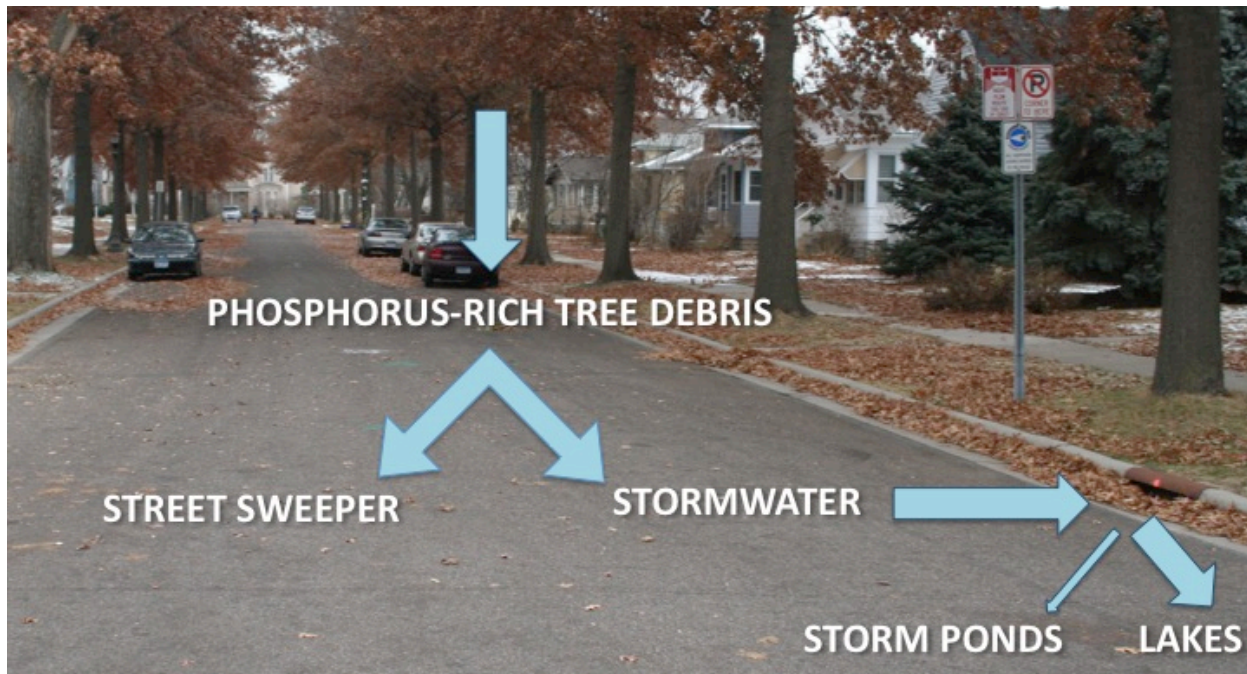
Project Title: Enhanced Street Sweeping to Restore Nutrient-Impaired Lakes

IV. TOTAL ENRTF REQUEST BUDGET 3 years

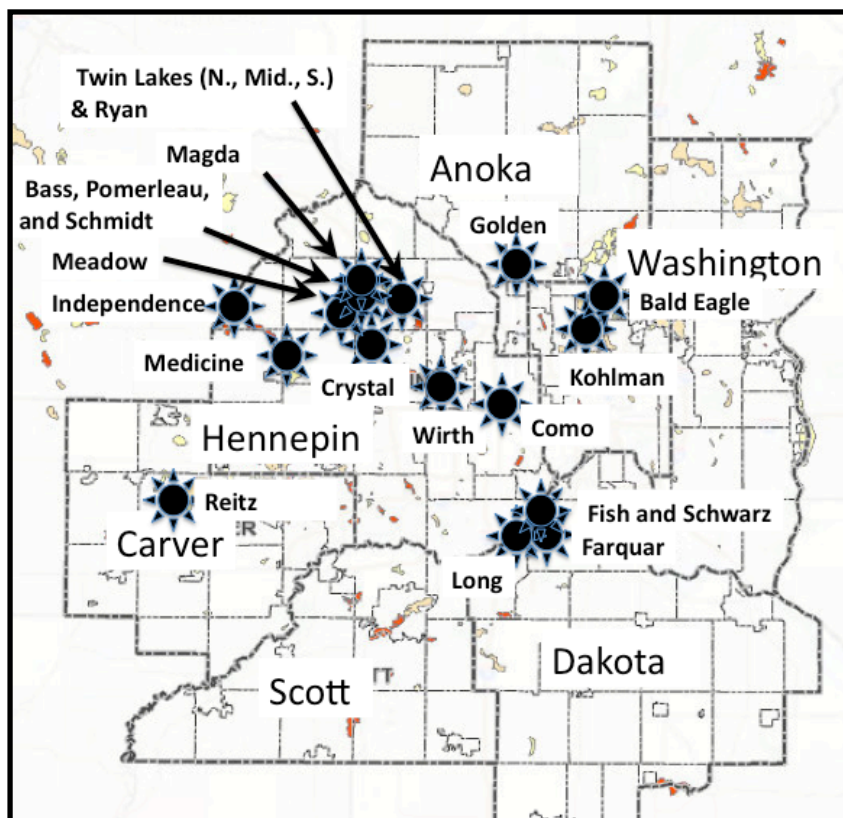
BUDGET ITEM (See "Guidance on Allowable Expenses", p. 13)	AMOUNT
Personnel:	\$ -
Faculty (all at 33.6% fringe)	
L. Baker (5 months)	\$ 64,477
J. Knight (0.5 months)	\$ 5,805
S. Hobbie (2.0 months)	\$ 30,202
J. Finlay (2 months)	\$ 25,794
J. Coggins (0.5 months)	\$ 7,773
Grad students (3.5 years, fringe at 81% (includes tuition)	142244
Civil service staff (2.0 year, 36.8% fringe)	161201
Undergraduates (0.25 years, 7% fringe)	6541
Contracts: N/A	\$ -
Equipment/Tools/Supplies:	\$ -
Acquisition (N/A)	\$ -
Travel: In-state travel to study sites + in-state conferences to present findings.	\$ 4,000
Additional Budget Items: <i>In this column, list any additional budget items that do not fit above categories. List by item(s) or item type(s) and explain how number was reached. One row per type/category.</i>	\$ -
Supplies: Acquisition of satellite imagery	\$ 15,000
Lab supplies	\$ 10,000
GIS license fees	\$ 1,500
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 474,537

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ Being Applied to Project During Project Period: NA	\$ -	NA
Other State \$ Being Applied to Project During Project Period: U of M indirect costs, at 52% of direct costs	\$ 218,922	NA
In-kind Services During Project Period:	\$ -	NA
Remaining \$ from Current ENRTF Appropriation (if applicable):	\$ -	NA
Funding History:	\$ -	NA



Rationale for Using Street Sweeping to Improve Lake Water Quality. Trees drop debris containing abundant phosphorus (flowers, seeds in spring; leaves in autumn) into streets. Without sweeping, phosphorus from tree debris moves into stormwater, where a fraction is trapped by stormwater ponds and other structural “best management practices”, at high cost. Much of the phosphorus ends up in lakes, where it fertilizes algae, reducing clarity. Enhanced street sweeping removes phosphorus at relatively low cost, preventing it from reaching lakes.



Map of Nutrient-Impaired Lakes with Approved Restoration Plans in the Metro Region. These lakes will be the focus of activities 2 and 3.

PROJECT MANAGER QUALIFICATIONS

Dr. Lawrence Baker, an environmental engineer, will be the project manager for the proposed project. He is a Research Professor in the Department of Bioproducts and Biosystems Engineering at the University of Minnesota with 30 years of research experience. In the past 10 years his research has focused on the flows of water and nutrients in urban ecosystems.

He is the principle investigator on two projects that provide databases that will be used in this proposed LCCMR project: the Prior Lake Street Sweeping Project (funded by EPA via MPCA) and the Twin Cities Household Ecosystems Projects (funded by the National Science Foundation). Dr. Hobbie is a co-PI on both of these projects. He also co-leads a closely related project, led by Dr. Sarah Hobbie and funded by the U of M's Institute on the Environment, that is examining "flowpaths" of nutrients in urban landscapes in St. Paul.

Regarding specific qualifications important for this project:

1. Project leadership. Dr. Baker has managed about 40 research projects from diverse sponsors, including the Minnesota Pollution Control Association, EPA, and the National Science Foundation. A hallmark of his research is his ability to develop solutions-oriented, multidisciplinary projects with strong public outreach.

2. Extensive writing. He has authored or co-authored more than 120 publications. In addition to journal articles and book chapters, he has contributed to numerous scientific assessment reports. He has written or contributed to guidance manuals and magazine articles for professional audiences (mainly engineers, planners, and water resource managers). He has also written many columns on environmental issues in the *Minneapolis Star and Tribune*, the *Minnesota Journal*, and other newspapers.

3. Public engagement. Dr. Baker organized two conferences on urban sustainability at the University of Minnesota (in 2010 and 2011) to bridge the gap between academics and sustainability professionals in Minnesota. He is also frequently invited to give public talks, seminars, and guest lectures. He and his colleagues (including Sarah Hobbie) have presented findings from the Prior Lake Street Sweeping Project to the Minnesota Water Resources Conference; public works departments at Prior Lake, Minneapolis, and St. Paul; the MPCA; and the Capital Region Watershed District. As part of the Prior Lake project, we are also developing an web-based interactive spreadsheet calculator tool to enable city public works departments to make planning-level decisions regarding adoption of enhanced street sweeping, and are developing a series of workshops for public works departments and public officials, to be held in mid-summer 2013. As a private citizen, Dr. Baker served on the Citizens League Water Policy Study Committee (2008-2009) and was Chair of Friends of the Sunrise River (2007-2010), named Outstanding River Community by Minnesota Waters in 2010.

Collaborators

Professors Marv Bauer and Joe Knight, both in the Department of Forest Resources at the U of M, and both experts in remote sensing, will lead Activity #1. Dr. Bauer is one of the leading remote sensing experts in the country; his work includes a well-known LCCMR project that used satellite imagery to estimate lake clarity for all of Minnesota's lakes. Professor Sarah Hobbie, (Dept. Ecology, Evolution and Behavior), an expert on soil and vegetation, together with Dr. Jacques Finlay (also a prof. in EEB), an expert on biogeochemistry, will co-lead Activity #2 with Dr. Baker. Dr. Jay Coggins (Department of Applied Economics at the U of M), who specializes in econometrics, will lead activity #3.