Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)

Project Title: **ENRTF ID: 044-B**

Salt Impacts to Minnesota Lakes, Rivers and Groundwater

Category: B. Water Resources

Total Project Budget: $ 497,276

Proposed Project Time Period for the Funding Requested: 3 years, July 2016 to June 2019

Summary:

This project will quantify the current water softening salt loads in Minnesota, assess alternative softening materials and methods and quantify the transport of de-icing and softening salt through the soil.

Name: John Gulliver

Sponsoring Organization: U of MN

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Minneapolis MN 55414

Telephone Number: (612) 625-4080

Email gulli003@umn.edu

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Picture of a road salting truck and household water softening units equals dead fish.

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

PROJECT TITLE: Salt Impacts to Minnesota Lakes, Rivers, and Groundwater

I. PROJECT STATEMENT

WHY – Salt Impacts the Environment. Minnesota uses an increasing amount of salt (sodium chloride) to de-ice our roads and soften our water. The sodium is trapped by the soil and other particles, but chloride will move through the soil to receiving water bodies or groundwater. We know from previous research that road salt is the dominant source of salt in the Twin Cities metro area, and salt is accumulating to toxic levels in many lakes and rivers. We know relatively little about salt sources in rural Minnesota, and how salt accumulates in soil and groundwater. We suspect that a high percentage of the chloride currently stays in the soil moisture and shallow groundwater, but how much in each and where is it going? How long does it take to get there? When will it impact our drinking water sources? How long until chloride concentrations in our lakes, rivers and groundwater are no longer toxic to fisheries?

Between 1991 and 2006 road salt use increased by 230%, with ramifications for future impairments. When water is softened to remove hardness, salt is used to regenerate the softener releasing chloride to septic systems and wastewater treatment plants (WWTPs). Monitoring to date has shown numerous WWTPs with discharge concentrations greater than limits for aquatic life. Greater Minnesota may have similar problems, given the prevalence of septic systems on lakes and streams. We need to address the impacts of our increased use of salt to water bodies in Minnesota because it is impractical and expensive to remove chloride after it is dissolved in water.

GOAL – This project will quantify the current water softening salt loads in Minnesota, assess alternative softening materials and methods and quantify the transport of chloride from de-icing and softening through the soil. This project will enable us to minimize the long-term impacts of de-icing and softening salt on the water bodies in Minnesota.

OUTCOMES – The outcome of this project is to enhance strategies that improve water quality by providing methods to reduce the chloride load from water softening and developing tools that predict salt movement through the soil. The methods and tools developed during this project will inform state, municipal and private entities using road and parking lot salt, municipal waste water treatment system operators, and thousands of rural communities and property owners with subsurface sewage treatment systems in Minnesota.

HOW –The project will be divided in three main activities as described below.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Estimate statewide sodium chloride use **Budget: $89,488**

This activity will determine the amount of chloride that is being used statewide to remove hardness from water, both by municipalities and in private homes, and the percent contribution of chloride from water softening. We will identify locations where chloride loads are likely to impact aquatic life.

Outcome	Completion Date
1. Conduct surveys in test markets outside of metropolitan area	*12/31/2016*
2. Estimate overall sodium chloride use for water softening	*6/30/2017*

Activity 2: Develop best management practices to reduce salt due to water softening **Budget: $173,710**

This activity will compare private and municipal softening, evaluate the efficiency of various private softening units, and evaluate units that do not use chloride for removal of hardness to develop a matrix of options. This research need is listed in the 2015 MPCA draft chloride management plan for the Twin Cities. The matrix will form the framework for private landowners, municipalities and watersheds to make smart decisions about reducing their chloride load when needed to protect aquatic life. This will include an economic assessment considering the effectiveness and cost of the system and the operation.

Outcome	Completion Date
1. Develop list of alternative methods to reduce sodium chloride use for water softening	*12/31/2017*
2. Evaluate capital and operational costs for alternatives	*6/30/2018*
3. Recommend best management practices	*12/31/2018*
4. Create framework for a tool to evaluate various alternatives	*6/30/2019*

Activity 3: Chloride transport through, and retention in, Minnesota soils **Budget: $234,078**

A number of field sites across Minnesota will be chosen for applying soil tests to measure the retention of chloride in soil moisture. Experiments will be performed to simulate continuous (septic) or seasonal chloride loading (snowmelt water), and rinsing (by infiltrating rainwater); conditions typically observed in Minnesota climates. Finally, a soil chloride model will be developed based on previous work and the results of the experiments.

Outcome	Completion Date
1. Identify soil properties that affect, and are indicators of, chloride retention in soils	*3/31/2017*
2. Quantify chloride retention capacity and lag time of release from soils	*8/31/2018*
3. Develop a predictive simulation model that can identify water quality impairments and mitigation strategies for road salt applications	*6/30/2019*

III. PROJECT STRATEGY

A. Project Team/Partners

- Dr. John Gulliver, PI, Professor, Department of Civil, Environmental and Geo- Engineering, UMN-Twin Cities,
- Ms. Sara Heger, co-PI, Extension Specialist, Water Resource Center, UMN-Twin Cities,
- Heinz Stefan, Professor Emeritus, Department of Civil, Environmental and Geo- Engineering, UMN- Twin Cities,
- Dr. William Herb, Research Associate, St. Anthony Falls Laboratory, UMN-Twin Cities,
- Mr. Andrew Erickson, Research Fellow, St. Anthony Falls Laboratory, UMN-Twin Cities,
- Dr. Peter T. Weiss, Visiting Professor, Valparaiso University, Valparaiso, IN,
- Ms. Connie Fortin, Fortin Consulting - Key knowledge from related work on developing BMPs for reduction of road salt use and related education,
- Mr. Andrew Ronchak, Minnesota Pollution Control Agency. State regulatory leadership coordinating issues related to WWTP discharge issues and the overall chloride management strategies underway at the MPCA,
- A graduate student will assist in the data collection and alternative analysis,
- An editor will assist with creating and editing documents for project dissemination.

Stefan's, Ronchak's and 75% of Gulliver's time on this project will be donated as in-kind to the project.

B. Project Impact and Long-Term Strategy

Understanding the relationships between salt usage and chloride in our lakes, streams and groundwater will allow regulators and water resource managers to reduce our chloride load strategically, which will protect the environment at minimum cost. The predictive tools developed with this project will be valuable to estimate future impacts of our current salt usage and potential salt reduction strategies.

C. Timeline Requirements

Three years are needed to complete the project due to the statewide analysis and the complexity of the range of issues to be evaluated.

2016 Detailed Project Budget

Project Title: Salt Impacts to Minnesota Lakes, Rivers and Groundwater

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM *(Annual salary increase of 3% assumed.)*	**AMOUNT**
Personnel: Professor (J. Gulliver), Supervisory and Analysis, 4% time, 75% salary, 25% benefits, 3 years**.**	$ 24,270
Personnel: Research Associate (S. Heger), Supervisory, data gathering and analysis related to water softeners, 30% time, 75% salary, 25% benefits, 3 years.	$ 83,372
Personnel: Research Associate (W. Herb), Analysis, 6% time, 75% salary, 25% benefits,3 years.	$ 17,133
Personnel: Editor, (C. Hansen), Proof and edit documents, 2.5% time, 78% salary, 22% benefits, 3	$ 3,826
Personnel: Research Fellow (A. Erickson), Field sample collection, laboratory experiments and Analysis, 50% time, 75% salary, 25% benefits,3 years.	$ 131,320
Personnel: Graduate Student, Data gathering and analysis related to water softeners, 50% appointment, 53% salary, 47% benefits, 3 years.	$ 109,700
Personnel: Junior Scientist (A. Ketchmark), Field sample collection and experimental apparatus, 4% time, 78% salary, 22% benefits, 3 years.	$ 6,557
Personnel: Junior Engineer Trainee, Field sample collection and laboratory experiments, 25% time, 100% salary, 3 years.	$ 19,287
Professional/Technical/Service Contracts: Contract with Connie Fortran to provide expertise and experience with data collection and analysis related to road salt and water conditioning.	$ 66,300
Professional/Technical/Service Contracts: Visiting Professor (Peter Weiss) will be on-site 12 weeks each summer and work 1/4-time on the project. 6% time, 100% salary, 3 years.	$ 29,111
Equipment/Tools/Supplies: Analytical laboratory charge for soils analysis.	$ 3,000
Equipment/Tools/Supplies: Misc. Supplies for experimental setup and analysis.	$ 2,000
Acquisition (Fee Title or Permanent Easements): *NA*	$ -
Travel: *To sites to collect samples. 2500 miles @ $0.56/mi*	$ 1,400
Additional Budget Items: *NA*	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 497,276

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 52% MTDC	$ 233,103	*Secured*
John S. Gulliver, In-kind time for supervision of project, 12% of appointment	$ 68,611	*Secured*
Andrew Ronchak, Staff from the Minnesota Pollution Control Agency will donate 5% his time to gather information regarding salt used and it's impacts related to septic systems and wastewater treatment plants.	$ 22,500	*Secured*
Funding History/A	$ -	
Remaining $ From Current ENRTF Appropriation: *N/A*	$ -	

Salt Impacts the Environment

Road Salt

(www.overtimepaylaws.org)

&

Softening Salt


(www.watergem.us)

=

Dead Fish


(www.poleshift2012.com)

John S. Gulliver, Ph. D., P. E.
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University of Minnesota
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January 2015

Professional Preparation

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

Appointments

3/98 – 6/07 Head, Department of Civil Engineering, University of Minnesota.
10/97-3/98 Acting Head, Department of Civil Engineering, University of Minnesota.
6/96 - present Professor, Department of Civil Engineering, University of Minnesota.
9/87 - 9/96 Associate Professor, Department of Civil Engineering, University of Minnesota.
9/81 - 9/87 Assistant Professor, Department of Civil Engineering, University of Minnesota.
6/80 - 9/81 Research Associate, St. Anthony Falls Hydraulic Laboratory, University of Minnesota**.**

Honors And Awards

Dave Ford Water Resources Award for Outstanding Achievement in Water Resources in Minnesota, Presented by the Planning Committee of the 2013 Water Resources Conference, 2013.

Resident Fellow, Institute on the Environment, University of Minnesota, 2012 – present

Minnesota Federation of Engineering and Science Technologist Societies Distinguished Engineer of the Year, 2012.

Center for Transportation Studies Partnership Award, 2011, for "Assessment and Recommendation for Operation of Standard Pumps as Best Management Practices for Stormwater Treatment." The award recognizes research projects that have resulted in significant impacts on transportation.

CTS Scholar, 2007 – present

Rickey Medal, 2003. American Society of Civil Engineers. Award given for a career of research and education related to hydroelectric energy.

Joseph S. and Rose T. Ling Professor of Civil Engineering, 1999 - 2009.

Fellow, American Society of Civil Engineers, 1995 - Present

Rickey Medal, 1990. American Society of Civil Engineers. Award given to the ASCE Technical Committee in recognition of contribution to "Civil Engineering Guidelines for Planning and Designing Hydroelectric Developments."

Selected Publications:

Five books authored or edited, including:

Erickson, A.J., P.T. Weiss and J.S. Gulliver, *Optimizing Stormwater Treatment Practices: A Handbook of Assessment and Maintenance*, Springer, New York, NY, 2013.

109 Peer reviewed journal articles, including:

Erickson, A.J., J.S. Gulliver and P.T. Weiss, Capturing Dissolved Phosphorus with Iron Enhanced Sand Filtration, *Water Research,* 46**(**9), 6601–6608, 2012.

Paus, K.H., J. Morgan, J.S. Gulliver, T. Leiknes and R.M. Hozalski, Assessment of the Hydraulic and Toxic Removal Capacities of Bioretention Cells after 2 to 8 Years of Service, *Water, Soil and Air Pollution*, 225 (1803), 2013.

Paus, K.H., J. Morgan, J. S. Gulliver, and R. M. Hozalski, Effects of Bioretention Media Compost Fraction on Toxic Metals Removal, Hydraulic Conductivity, and Phosphorous Release, *Journal of Environmental Engineering*, 140(10), 04014033, 2014.