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

Project Title: **ENRTF ID: 037-B**

Investigation of Road Salt Alternatives and Pavement Innovations

Category: B. Water Resources

Total Project Budget: $ 521,999

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

Summary:

We will investigate road salt alternatives and pavement innovations that will reduce or eliminate the flux of chloride from road salt into our lakes, streams and groundwater.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Flow chart showing activities with visuals.

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

PROJECT TITLE: Investigation of Road Salt Alternatives and Pavement Innovations

I. PROJECT STATEMENT

This project will investigate road salt alternatives and pavement innovations that will reduce or eliminate the high flux of chloride from road salt into our environment and thus improve the water quality of our lakes, streams and groundwater.

Road salt impacts water quality, and will be a primary 21st century pollutant of concern in northern regions. Minnesota annually uses ~90 lbs per person of road salt (sodium chloride) to de-ice our roads and parking lots. Most of the sodium is trapped by the soil, but chloride is washed off of the streets or will move through the soil to receiving water bodies. We know from previous research that salt is accumulating to toxic levels in many lakes, streams and shallow groundwater. In the Twin Cities metropolitan area, for example, there are already 26 impaired lakes, 23 impaired streams and 1 impaired wetland for chloride. There is a strong possibility that lakes in urban Minnesota will become unable to support some of their fresh water organisms. Road salt alternatives and pavement innovations have the potential to provide similar road friction conditions while having less impact on the environment. We need to investigate the cost-effective application of these alternatives and pavement innovations now, to prepare for the near-future when a substitute for road salt is desired and needed.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Synthesize past and current investigations and apply the results to water quality impacts in Minnesota. **Budget: $71,180**

Past and current investigations of road salt alternatives, pavement innovations and road friction studies will be reviewed. We will synthesize these investigations through a model to evaluate potential water quality impacts for road salt alternatives in Minnesota. We are aware that there are substantial research needs here and that sufficient information will not be available for all alternatives, but this review will limit duplication of effort and maximize progress towards essential knowledge gaps.

Outcome	Completion Date
1. Analyze water quality impacts in Minnesota for some alternatives	*12/31/2018*

Activity 2: Conduct friction tests on pavement cores to select promising techniques **Budget: $209,112**

Cores from several different pavement types will be treated with approximately 12 road salt alternatives and pavement innovations, and exposed to typical winter conditions in a cold room. The temperature, humidity, and ice cover will be controlled and varied to make direct comparisons between alternatives. One of several road friction testers will be selected for these experiments and used to measure road friction in these simulated winter conditions with pavement innovations and road salt alternatives. Ranking metrics will be developed based on cost and environmental impact of the alternatives, as well as road friction results for various simulated winter conditions.

Outcome	Completion Date
1. Laboratory road friction tests completed in various conditions for road salt alternatives	*10/31/2019*
2. Develop ranking metrics from cost and predicted road friction results for all alternatives	*12/31/2019*

Activity 3: Evaluate and field test most promising techniques in natural winter conditions **Budget: $241,706**

A field site will be selected to test the road friction of the 3 – 5 best overall road salt alternatives and pavement innovations under actual winter field conditions. The best alternatives will be selected using the metrics developed in Activity 2, which represent a combination of minimum environmental impact, maximum road friction for the recommended treatment and optimal cost of the treatment. Once selected, these alternatives will be applied to a paved surface in natural winter conditions to verify laboratory measurements of de-icing,

anti-icing, and road friction. These results will be combined with laboratory results (Activity 2) and insights from the synthesis (Activity 1) into a final report with recommendations for road salt alternatives and pavement innovations.

Outcome	Completion Date
1. Field test road surface friction for different road salt alternatives/pavement innovations	*4/30/2021*
2. Write report on laboratory and field test results	*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. Bruce Wilson, co-PI, Professor, Department of Bioproducts and Biosystems Engineering, UMN-TC,
- Dr. Heinz Stefan, Professor Emeritus, Department of Civil, Environmental and Geo- Engineering, UMN-TC,
- Dr. Peter T. Weiss, Visiting Professor, Valparaiso University, Valparaiso, IN,
- Ms. Brooke Asleson, Minnesota Pollution Control Agency. State regulatory leadership coordinating issues related to the overall chloride management strategies underway at the MPCA **(Not receiving LCCMR funds**),
- Ms. Connie Fortin, Fortin Consulting – Proposal participant - Key knowledge from related work on determining costs of road salt and related education,
- Mr. Andrew Erickson, Research Fellow, St. Anthony Falls Laboratory, UMN-Twin Cities.

B. Project Impact and Long-Term Strategy

The outcome of this project is to investigate and enhance strategies that improve water quality by evaluating road salt alternatives and pavement innovations to reduce the chloride load from road runoff. The methods and tools developed during this project will inform state, municipal and private entities using chloride –based salt on roads and parking lots. A feasibility matrix will be developed to summarize high level economic, environmental, time frame, implementation & maintenance challenges and benefits for alternate strategies.

A better understanding of road friction for road salt alternatives, combined with knowledge of environmental impacts and application and infrastructure costs will enable an improved decision-making process for public and private entities. City, county and MnDOT engineers will soon be making decisions about the best road salt alternative for their application. In addition, commercial entities are salting parking lots to reduce liability. This research could be used by the legislature to limit this liability if proper practices are used. The need for this research and the information it will generate is great, and the timing is urgent.

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 (Brooke Asleson) for many years on the impacts of road salt. Second, we have enlisted the assistance of the Minnesota Department of Transportation (Steven Lund), who directs the maintenance and operation unit of the Metro District. 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.

C. Timeline 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.

2018 Detailed Project Budget

Project Title: *Comprehensive Investigation of Road Salt Alternatives*

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

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**
Personnel: Professor John S. Gulliver; Supervisory and Analysis; 8% full-time; 75% Salary & 25% benefits; 3 years.	$ 69,793
Personnel: Professor Bruce Wilson; Supervisory and Analysis; 4% full-time; 75% Salary & 25% benefits; 3 years.	$ 23,177
Personnel: Research Fellow Andy Erickson; Laboratory experiments, field measurements, and analysis; 50% full-time; 75% Salary & 25% benefits; 3 years.	$ 148,830
Personnel: Junior Engineer Trainee; Laboratory experiments, field measurements, and analysis; 62% full-time; 100% Salary & 0% benefits; 3 years.	$ 50,499
Personnel: Junior Scientist; Laboratory experiments, field measurements, and analysis; 16% full-time; 79% Salary & 21% benefits; 3 years.	$ 39,000
Professional/Technical/Service Contracts: Visiting Professor Peter T. Weiss; laboratory experiments, field measurements, and analysis; on-site for 12 weeks per year at 50% time; 11.5% full-time.	$ 76,905
Professional/Technical/Service Contracts: Fortin Consulting; provide expertise and data for costs analysis;	$ 32,135
Travel: Mileage to field sites to measure friction in response to road salt alternatives. 1000 miles at $0.54/mile.	$ 540
Additional Budget Items: Equipment: $55,000 for a T5 pull-behind road friction measurement trailer for field measurements.	$ 55,000
Additional Budget Items: Equipment: $11,000 for a walk-freezer for laboratory experiments.	$ 11,000
Additional Budget Items: Field Supplies $10,000 for liquid applicator, pumps, hoses, traffic control apparatus.	$ 10,000
Additional Budget Items: Laboratory Supplies: $5,000 for chemicals, reagents, gloves, sample containers, parts and setup for pavement coring.	$ 5,000
Additional Budget Items: Printing and Duplication: $120 for printing interim and final report.	$ 120
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 521,999

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: *52% MTDC*	$ 220,409	*Secured*
MPCA involvement of Ms. Asleson: 15% FTE for one year	$ 12,000	*Secured*
Past and Current ENRTF Appropriation: 2016 appropriation for "Impacts of Adding Salt to Our Lakes, Rivers and Groundwater" by John S. Gulliver and Sara Heger.	$ 497,000	*Legally Obligated*
Other Funding History: "Permeable Pavement for Road Salt Reduction" by John S. Gulliver and Andy Erickson. Funding from the Local Road Research Board for 2016 - 2019 for research on permeable pavements as an alternative to road salt on conventional pavement.	$ 197,835	*Legally Obligated*

PROJECT TITLE: Investigation of Road Salt Alternatives and Pavement Innovations

https://www.pca.state.mn.us/water/road-salt-and-water-quality

Activity 1: Synthesize past and current investigations and apply the results to water quality impacts in Minnesota.

- Analyze water quality impacts in Minnesota for some alternatives

Road Salt Alternatives:

- Magnesium Chloride
- Calcium Chloride
- Calcium Magnesium Acetate
- Potassium Acetate
- Formates
- Glycerol/Glycol
- Beet Juice
- Tomato Juice
- Pickle Brine
- Potato Juice
- Barley Residue
- Cheese Brine
- Volcanic Minerals (traction)

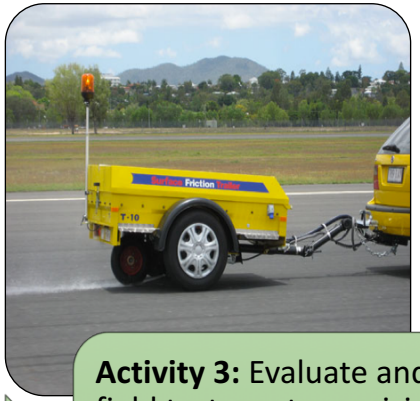
https://uwaterloo.ca/centre-pavement-transportation-technology/about-centre-pavement-and-transportation-technology/lab

Activity 2: Conduct friction tests on pavement cores to select promising techniques

- Laboratory road friction tests completed in various conditions for road salt alternatives
- Develop ranking metrics from cost and predicted road friction results for all alternatives

Pavement Types:

- Conventional Asphalt
- Conventional Concrete
- Permeable Asphalt
- Permeable Pavement
- Permeable Block Pavers
- Surface Textured Pavements
- Epoxy Aggregate Surface Coating
- Hydrophobic Coating
- Conductive Pavement



http://www.roadtraffic-technology.com/contractors/test/asft/asft4.html

Activity 3: Evaluate and field test most promising techniques in natural winter conditions

- Field test road surface friction for different road salt alternatives/pavement innovations
- Write report on laboratory and field test results

Outcomes:

- Guidance to reduce chloride load from road runoff using road salt alternatives or pavement innovations
- Better understanding of road friction for road salt alternatives and pavement innovations
- Improved decision-making process for public and private entities

07/29/2017

ENRTF ID: 037-B

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.