Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2019 ENRTF Work Plan (Main Document)

Today's Date: February 8, 2019
Date of Next Status Update Report: March 1, 2020
Date of Work Plan Approval:
Project Completion Date: June 30, 2021
Does this update include an amendment request?

PROJECT TITLE: Evaluating Locally-Sourced Sanding Materials for Road Salt Reduction

Project Manager: Chan Lan Chun
Organization: University of Minnesota Duluth
College/Department/Division: Civil Engineering and Natural Resources Research Institute
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Location: Statewide

Total Project Budget: $162,000
Amount Spent: $0
Balance: $162,000

Legal Citation: M.L. 2019, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

I. PROJECT STATEMENT:

Minnesota uses hundreds of thousands of tons of salt annually for winter road maintenance. Unfortunately, road salt is also a major contributor to elevated chloride levels in Minnesota water bodies because the chloride in road salt is not naturally broken down, transformed, or removed from the environment. Elevated chloride levels have detrimental impacts on ecological and water quality, including toxicity to aquatic life in freshwater and contamination of drinking water supplies. Along with road salt, sand is the most common abrasive used at all temperatures, particularly during very cold temperatures when salts are ineffective. But the use of conventional sands has been declining to straight road salt application due to a recognition of their limited effectiveness in sand/salt mixtures. So how might chloride loadings be reduced? By using locally sourced alternative sanding (abrasive) materials. There are natural materials such as woodchips, corncob, and iron-bearing minerals which may be better alternatives to sand. Their effectiveness and environmental benefits/impacts, however, have not been examined in Minnesota.

The proposed project will evaluate the effectiveness and feasibility of locally available natural materials including agricultural and iron industry byproducts as alternative effective abrasive materials to sand. The materials include corncob, various types of woodchips, and iron industry byproducts such as taconite tailings, crushed iron ores, and processing byproducts. Potentially, these materials may not only offer traction and skid resistance required on the icy and frozen roads during winter, but also hold effectiveness of salt for a longer duration and capture other contaminants on roads. We hypothesize that more effective sanding materials on roadways will eventually lower

salt use for the protection of water resources. In addition, agricultural byproducts are biodegradable, and iron industry byproducts have high solar absorbance to enhance deicing efficiency. This project will characterize their physical and chemical properties, develop the formulation and application practice to use them as sanding materials with the combination of chloride and non-chloride deicers, and assess their deicing efficacy and potential environmental impacts and benefits. The results of this project will lead environmental benefits: reducing impacts of chloride on watersheds through the reduction of road salt use, and beneficially utilizing waste and byproduct materials as green and more-effective sanding alternatives. The project outcome will provide essential information for the development of implementation research.

II. OVERALL PROJECT STATUS UPDATES

First Update March 1, 2020

Second Update September 1, 2021

Third Update March 1, 2021

Final Report between project end (June 30) and August 15, 2021

III. PROJECT ACTIVITIES AND OUTCOMES*:*

ACTIVITY 1 Title: ***Physical and chemical properties of bio-based materials and iron-bearing minerals as alternatives to sand***

Description: We will explore and review locally available natural resources as alternative sanding materials for winter road maintenance. Locally sourced materials include bio-based materials such as corncob-derived abrasive and wood or bark mulches, and iron industry byproducts including taconite tailings and processing byproducts. As for corncob materials, we will test both a commercial abrasive derived from corncob (e.g., Abrasives INC) and raw corncob materials for processing. The raw corncob materials will be obtained through communication with the Minnesota Corn Growers Association and University of Minnesota Extension. Woodchips and bark mulches will be collected from forestry product industries (e.g., pulp and paper mills and biofuel industry) across Minnesota. Locally sourced iron-bearing materials will be explored from the iron industry across the Mesabi Range in northeastern Minnesota. Taconite tailings that are currently utilized as road aggregates by the Minnesota Department of Transportation (MnDOT) will be included. The candidate locally-sourced materials will be paired with commercial products of alternative ecological abrasives for winter road maintenance if available. For examples, the candidate wood chips and bark mulches collected from forestry product industries (e.g., pulp and paper mills, sawmill and wood product plants) across Minnesota will be evaluated with commercial woodchip-based abrasive such as Stop Gliss Bio® and Eco Ice Grip. These materials will be screened based on MnDOT's current specification and recommendations of materials for winter road abrasive applications, which are larger than 297 micron (ASTM Sieve No. 50) and smaller than 3/8 inch. Moreover, the sand materials currently used by MnDOT for winter road maintenance will be tested as reference materials. When the materials are collected, the characterization data that are available from literature and previous studies will be collected and compared for the selection of candidate materials (approximately 20) to be tested.

Physical and chemical properties of the candidate materials will be characterized. The characterizations include particle size distribution, physical properties, and chemical compositions. Particle size distribution will be measured by sieving method according to American Society of Testing and Materials C33 (ASTM, 2016). The mechanical properties including hardness, angularity, density, and silt content will be examined to determine if the candidate materials meet required qualities of sanding/abrasive material for winter maintenance. Chemical compositions of the materials will be determined by wet-chemistry extraction methods including water extraction, week acid extraction, and aqua regia digestion. As for iron-bearing mineral materials, mineralogical composition will be examined using x-ray diffraction. Morphological features and surface chemical composition will be observed using scanning Electron Microscopy equipped with an energy dispersive x-ray spectroscopy (element mapping).

ACTIVITY 1 ENRTF BUDGET: $ 71,200

Outcome	Completion Date
1. Database of locally available natural byproducts for the selection of abrasive materials	October 31,2019
2. Selected abrasive materials characterized: Chemical and mineralogical composition and physical properties	June 30, 2020

First Update March 1, 2020

Second Update September 1, 2021

Third Update March 1, 2021

Final Report between project end (June 30) and August 15, 2021

ACTIVITY 2 Title: ***Evaluation of traction and deicing efficacy and potential environmental impacts***
Description: Based on chemical and physical characteristics of the candidate materials in Activity 1, we will select the materials to meet properties of sanding/abrasive materials for winter road maintenance. The materials will be evaluated for traction and deicing efficiency and potential environmental impacts. For traction efficiency, skid resistance will be quantified on normal surface, ice and/or snow-covered surface for different types of road (e.g., asphalt, concrete, and gravel). The skid resistance will be tested through a portable friction test using British Pendulum test and texture measurement like sand patch method. The measurement will be conducted at various conditions to determine application rate, and frequency and weather condition will be recorded. Additionally, the durability of materials will be assessed by material loss upon different loading. We will perform laboratory tests to examine if the selective materials also enhance or inhibit deicing efficacies with the combination with chloride and non-chloride deicing chemicals. The deicing behavior will be evaluated by measuring a eutectic temperature and effective temperature for freezing/melting point and ice melting capacity based on Strategic Highway Research Program ice melting test methods. Additionally, solar absorbance of the materials will be tested using American Society of Testing Material Method E903 since greater solar absorbance can increase pavement surface temperature which results in the prevention of ice formation and enhancement of ice melting.

We will evaluate potential environmental benefits and impact of natural byproduct-based abrasives on soil/roadside vegetation, nearby water bodies, and air. Chemical analysis of leachate from the materials will be conducted. The chemical analysis includes trace metals, major anions, nutrient compounds (phosphorus-, nitrogen-, and sulfur compounds), and biochemical oxygen demand. Additionally, sorption experiments of common roadside contaminants (i.e., heavy metals, petroleum hydrocarbon, and chloride) with the selective candidate materials will be conducted to determine their sequestration capacity of the contaminants. As for organic materials, the breakdown materials collected from the durability test will be further evaluated for biodegradation rate and biochemical oxygen demand (BOD) loading. As for the impact of the materials on the air quality, silt generation will be examined using material loss measurement.

Collectively, preliminary recommendations will be developed for the application of natural byproducts as sanding/abrasive material in northeastern Minnesota based on the laboratory results and statistical analyses from Activity 2. The recommendations will be generated in consultation with St. Louis County and MnDOT District 1 based on current practice and equipment. The recommendations will include road types, storage and preparation (e.g. mixing and loading) of materials, application methods (e.g., pre-wetting and loading), and methods for the interception and recovery of sanding materials from reaching the watershed (e.g., stormwater grit chamber and holding ponds).

ACTIVITY 2 ENRTF BUDGET: $ 91,000

Outcome	Completion Date
1. Deicing efficacy and traction efficiency of natural byproduct-based abrasives determined	January 31, 2021
2. Potential environmental benefits and impacts evaluated	March 31, 2021
3. Preliminary recommendations made for the application of natural byproducts as abrasive material in Minnesota, in the form of a final report	June 30, 2021

First Update March 1, 2020

Second Update September 1, 2021

Third Update March 1, 2021

Final Report between project end (June 30) and August 15, 2021

IV. DISSEMINATION:

Description: Findings will be disseminated and archived via reports to LCCMR, peer-reviewed publications, and presentations at conferences. A fact sheet that summarizes our findings will also be shared with state agencies, particularly MnDOT and MPCA. Several manuscripts will be written and submitted for publication in peer-reviewed journals. All publications resulting from this project will be made available through Open Access journal websites. In addition, we will develop educational materials and opportunities for community discussion about water quality and winter road maintenance. These activities will provide opportunities to engage school and community groups in small-scale projects and build community support for water resource protection. Moreover, these partners and researchers will take the results of our study into consideration as they make management decisions and will work with us to ensure that our data products and research papers reach a broad audience within their agencies.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

First Update March 1, 2020

Second Update September 1, 2021

Third Update March 1, 2021

Final Report between project end (June 30) and August 15, 2021

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures: See attached budget spreadsheet.

Explanation of Capital Expenditures Greater Than $5,000: N/A

Explanation of Use of Classified Staff: N/A

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation*:*

FTE per this project/appropriation

Enter Total Estimated Personnel Hours for entire duration of project: 2,912	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: 1.4

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: N/A

VI. PROJECT PARTNERS:

A. Partners outside of project manager's organization receiving ENRTF funding

B. Partners outside of project manager's organization NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Duane Hill	District Engineer	MnDOT District 1	Providing consultation for winter road maintenance and strategies
Christopher Cheney	Maintenance Superintendent	MnDOT District 1	

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

This project aligns well with the state's collaborative efforts to reduce the amount of chloride entering the environment while still providing safe winter driving road conditions for Minnesota. A key project outcome will be the generation of essential information for developing best-use implementation strategies and guidelines. In the long term, this project will help to facilitate adoption of chloride management and mitigation practices and enhance sustainability of our economy and natural water resources in Minnesota.

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted March 1 and September 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2021

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

Submit any additional work plan components or mark as N/A.

A. Budget Spreadsheet
B. Visual Component or Map
C. Parcel List Spreadsheet N/A
D. Acquisition, Easements, and Restoration Requirements N/A
E. Research Addendum N/A

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2019 Budget Spreadsheet
Legal Citation:
Project Manager: Chan Lan Chun
Project Title: Evaluating Locally-Sourced Sanding Materials for Road Salt Reduction
Organization: University of Minnesota
Project Budget: $162,000
Project Length and Completion Date: 2 years and June 30, 2021
Today's Date: Febuary 8, 2019

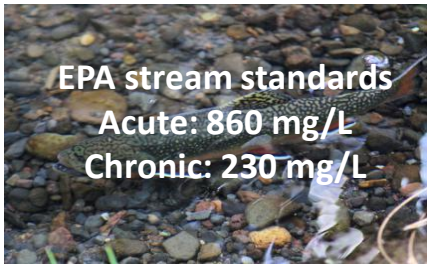
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 130,524	$ -	$ 130,524
Chan Lan Chun, Principal Investigator: $23,568 (66.5% salary, 33.5% benefits); 7.4% FTE each year for 2 years			
Manik Barman, Co-investigator: $ 12,384 (66.5% salary, 33.5% benefits); 3.8% FTE each year for 2 year			
Larry Zanko, Co-investigator: $10,128 (66.5% salary, 33.5% benefits); 3.8% FTE each year for 2 year			
Graduate Student Research Assistant: $ 81,854 (15% benefits and tuition reimbursment in academic year); 50 % FTE in academic year and 50% FTE summer each year for 2 years			
Undergraduate Student Research Assistant: $ 2,590 (100% salary); 5% FTE each year for 2 year			
Equipment/Tools/Supplies			
Laborabory supplies ($15,000): Chemical, thermal control and expendable lab supplies (e.g. plasticware, bottles, columns, disposable labware) and field test supplies ($8,000): Friction tester (British Pendulum tester) and expendable supplies	$ 23,000	$ -	$ 23,000
Printing			
Printing and copy for factsheet and communication	$ 276	$ -	$ 276
Travel expenses in Minnesota			
Sample collection, meeting with state agency, and field testing : ~2000 miles x$0.55/mi =$1,100 + vehicle rental use $10/day x 10days=$100	$ 1,200	$ -	$ 1,200
Other			
Chemical, mineralogical, and microscopic analyses: University of Minnesota Research Analytical Lab: SEM-EDX($34/hr, 70 hrs), XRD($15/hr, 50 hrs), ICP($26/sample, ~100 samples), and nutrient analysis ($64/sample, ~20 samples)	$ 7,000	$ -	$ 7,000
COLUMN TOTAL	$ 162,000	$ -	$ 162,000

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
In kind: Unrecovered indirect: 54% modified total direct cost ($131,566 base; excludes graduate student tuition)	Secured	$ 71,046	$ -	$ 71,046

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
Current appropriation:		$ -	$ -	$ -
Past appropriations:		$ -	$ -	$ -

Chloride Contamination in Minnesota Water Resources by Road Salts

Toxic to aquatic life in freshwater



Drinking water supply contamination

Evaluating Locally-Sourced Sanding Materials for Road Salt Reduction

Potential Benefits

Greater solar absorption

Physical qualities of abrasive material

Affinity to capture other contaminants on road

Interactable from reaching watershed

Biodegradable

Retaining salt longer