Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2016 Work Plan

Date of Report: May 29, 2016

Date of Next Status Update Report: January 1, 2017

Date of Work Plan Approval: June 7, 2016

Project Completion Date: June 30, 2019

Does this submission include an amendment request? No

PROJECT TITLE: Understanding Impacts of Salt Usage on Minnesota Lakes, Rivers, and Groundwater

Project Manager: John S. Gulliver

Organization: University of Minnesota

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Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$497,000**
	Amount Spent:	**$0**
	Balance:	**$497,000**

Legal Citation: M.L. 2016, Chp. 186, Sec. 2, Subd. 04n

Appropriation Language:

$497,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to quantify the current water-softening salt loads in Minnesota lakes, rivers, and groundwater, assess alternative water-softening materials and methods, and quantify the transport of de-icing and water-softening salt through the soil. This appropriation is available until June 30, 2019, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Understanding Impacts of Salt Usage on Minnesota Lakes, Rivers, and Groundwater

II. PROJECT STATEMENT:

Minnesota uses an increasing amount of salt (sodium chloride) to de-ice our roads, parking lots, and sidewalks (increased by 230% between 1991 and 2006) and soften our water. Deicing salt infiltrates into roadside soils during snowmelt events or directly runs off into surface waters. Water-softening salt is often discharged from wastewater treatment plants to surface waters and also from private septic systems directly into adjacent soils. 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 de-icing salt is the dominant source of chloride in the Twin Cities metro area, and is accumulating to toxic levels in many lakes, wetlands and rivers. We know relatively little about proportion of salt sources in rural Minnesota, and how chloride accumulates in soil-water 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 surface waters and groundwater are no longer toxic to fisheries?

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 protecting aquatic life. Greater Minnesota may have similar problems, given the prevalence of private septic systems near lakes and streams. While the contribution of chloride from softening is less than from road salt, this may be the "low hanging fruit" in the reduction of salt use because it is not related to public safety. By better understanding softening salt use, we will determine potential methods required to make significant progress in the reduction of this salt use.

Minimizing the impacts of increased use of salt to surface waters and groundwater in Minnesota is necessary because it is impractical and very expensive to remove chloride after it is dissolved in water. 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 surface waters and groundwater across Minnesota.

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 de-icing salt, municipal wastewater treatment system operators, and thousands of rural communities and property owners with subsurface sewage treatment systems in Minnesota.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of January 1, 2017:

Project Status as of July 1, 2017:

Project Status as of January 1,2018:

Project Status as of July 1, 2018:

Project Status as of January 1, 2019:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Estimate statewide sodium chloride use

Description: This activity will determine a chloride budget for Minnesota focusing on the amount of chloride that is being used statewide to remove hardness from water. The estimate will include amount of water softening salt used by municipalities, industrial sources and in private homes (discharges to wastewater treatment plants or septic systems). The estimate of the amount of water softening salt will be compared to purchase records to further refine the estimate. From this estimate, the percent contribution of chloride from water softening in Minnesota surface and groundwater will be estimated. This activity will also include evaluating the number, percentage of water softened, efficiency and calibration of in-home units compared to water softening at municipal water treatment facilities. A varying range of densities and watershed scales will be considered. We will identify locations where chloride loads are likely to impact aquatic life by identifying point discharges from wastewater treatment plants and non-point discharges through homes with septic systems.

Summary Budget Information for Activity 1:	**ENRTF Budget:**	**$ 89,500**
	Amount Spent:	**$ 0**
	Balance:	**$ 89,500**

Outcome	Completion Date
1. Estimate overall sodium chloride use for water softening	*6/30/2017*

Activity Status as of January 1, 2017:

Activity Status as of July 1, 2017:

Activity Status as of January 1,2018:

Activity Status as of July 1, 2018:

Activity Status as of January 1, 2019:

Final Report Summary:

ACTIVITY 2: Develop best management practices to reduce salt due to water softening

Description: This activity will compare private and municipal water softening. An evaluation of municipal softening options will be conducted. Next this activity will evaluate the efficiency of various types of private softening units and the effectiveness of units that do not use chloride for removal of hardness. From this evaluation of municipal water softening, private chloride-based water softening, and private non-chloride-based water softening, a matrix of options will be developed.

The matrix will form the framework for private landowners, municipalities and watersheds to make smart decisions about reducing chloride loading to protect Minnesota surface and groundwater. This will include an economic assessment considering the effectiveness and cost of the system and the operation. This activity will evaluate the use of an online tool to help parties evaluate and choose the best water softening options in any particular situation. Recommendations on the proper use of in-home units to

reduce the amount of sodium chloride will be developed. Best management practices (BMPs) will also be developed for municipalities. Information will be developed about the negative impacts of softening on water quality so homeowners, municipalities, and watersheds are able to make informed decisions about water softening.

Summary Budget Information for Activity 2:

ENRTF Budget: $ 173,500
Amount Spent: $ 0
Balance: $ 173,500

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 Status as of January 1, 2017:

Activity Status as of July 1, 2017:

Activity Status as of January 1,2018:

Activity Status as of July 1, 2018:

Activity Status as of January 1, 2019:

Final Report Summary:

ACTIVITY 3: Chloride transport through, and retention in, Minnesota soils

Description: A number of field sites across Minnesota will be chosen for collecting soil samples to measure the retention of chloride in soil moisture. Soil samples will be transported to St. Anthony Falls Laboratory, and sub-samples will be analyzed for soil properties such as soil classification, particle size distributions, hydraulic conductivity, moisture characteristics, organic matter and clay content, soil texture, initial chloride concentration, metal concentrations as Cd, Cu, Fe, Pb, Cd, and Zn and cation exchange capacity.

Soil samples will then be installed into column test equipment and experiments will be performed to simulate continuous (septic) or seasonal chloride loading (snowmelt water), and rinsing (by infiltrating rainwater or irrigation); conditions typically observed in Minnesota climates. Sequences and rates of chloride-laden water and freshwater applications will be varied in the laboratory tests. Important criteria such as flow rate, chloride concentration, saturation time, and temperature will either be measured or controlled during the experiments. After the column tests are complete, the soil properties and characteristics will be analyzed again to identify any changes due to chloride storage and transport.

The results of the column experiments will be analyzed to determine the residence time of salt and relate these to soil properties. An existing chloride transport model will be enhanced and further developed to incorporate chloride residence time from given soil properties based the results of the experiments. The transport model will then be able to predict the response of chloride transport into surface water and groundwater after reductions in salt application. The residence time is specifically of interest to

management personnel and to understand the long-term impact of de-icing and softening salt reductions on chloride transport to receiving water bodies.

Summary Budget Information for Activity 3:

ENRTF Budget: $ 234,000
Amount Spent: $ 0
Balance: $ 234,000

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. Enhance and further develop a predictive simulation model that can predict the transport and time lag in movement of chloride through the soil.	*6/30/2019*

Activity Status as of January 1, 2017:

Activity Status as of July 1, 2017:

Activity Status as of January 1,2018:

Activity Status as of July 1, 2018:

Activity Status as of January 1, 2019:

Final Report Summary:

V. DISSEMINATION:

Description: Dissemination and transfer of new knowledge and technology will be directed towards homeowners, practitioners, regulatory units of government, and other interested stakeholders. The project team has a long history of providing training and dissemination of science through the Water Resource Center, the Erosion and Stormwater Certification Program and the MN Road Salt Applicator training. Information learned in this study will be incorporated into this and other certification curriculum. The team is well equipped to communicate and disseminate results. Outreach will occur through a variety of established formats. The results will be incorporated into MPCA chloride reduction programing and policy.

Knowledge transfer will also be completed through its written and electronic communications streams including St. Anthony Falls Laboratory's UPDATES, a quarterly stormwater research newsletter distributed to over 2,400 subscribers and the University of Minnesota Extension Water Resources News published 4-6 times per year. The team will also seek to include information in the Minnegram newsletter published by the Water Resources Center and in the Seiche printed by Minnesota Sea Grant. In addition one or more journal articles will be submitted for publication from the results of this project.

The team is also well equipped to engage in dialogue and collaboration with public entities including watershed districts, municipalities, counties, universities, the Minnesota Cities Stormwater Coalition, and statewide entities working on stormwater management. Finally, the team is able to collaborate and communicate with researchers and educators across multiple campuses spread throughout the state.

Status as of January 1, 2017:
Status as of July 1, 2017:

Status as of July 1, 2018:
Status as of January 1, 2019:
Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 395,189	Project manager at 4% FTE each year for 3 years ($24,270); Research Associate at 30% FTE for 3 years ($83,372); Research Associate at 6% FTE for 3 years ($17,133); Research Fellow at 50% FTE for 3 years ($131,320); 1 graduate research assistant at 50% FTE each year for 3 years ($109,700); Junior Scientist at 4% for three years ($6,557); Junior Engineer Trainee at 25% for 3 years ($19,287); Editor at 2.5% time for 3 years ($3,826).
Professional/Technical/Service Contracts:	$95,411	Contract with Fortin Consulting Inc. to provide expertise and experience with data collection and analysis related to road salt and water ($66,300); Visiting Professor (Peter Weiss) will be on-site 12 weeks each summer and work 1/4-time on the project ($29,111).
Equipment/Tools/Supplies:	$5,000	Analytical laboratory charge for soils analysis and Misc. Supplies for experimental setup and analysis.
Capital Expenditures over $5,000:	$	
Fee Title Acquisition:	$	
Easement Acquisition:	$	
Professional Services for Acquisition:	$	
Printing:	$	
Travel Expenses in MN:	$1,400	Travel to sites to collect samples. 2500 miles @ $0.56/mi.
Other:	$	
TOTAL ENRTF BUDGET:	**$497,000**	

Explanation of Use of Classified Staff: N/A

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

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 5.13

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 0.177 FTE's over 3 years.

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
	$	$	
State			
University of Minnesota (in-Kind Support)	$233,103		Unrecovered F&A at 52% MTDC
John S. Gulliver (In-Kind Support)	$68,611		In-kind time for supervision of project, 12% of appointment
Andrew Ronchak (In-Kind Support)	$22,500	$	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.
TOTAL OTHER FUNDS:	**$324,214**	**$**	

VII. PROJECT STRATEGY:

A. Project Partners:

Project Partners Not Receiving Funds:

Andrew Ronchak, Brooke Asleson (Minnesota Pollution Control Agency)

Project Partners Receiving Funds:

Connie Fortin (Fortin Consulting) $66,300

Peter T. Weiss (Visiting Professor from Valparaiso University) $29,111

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 expectations of the length of time required to recover the water quality of our lakes, streams and groundwater resources. For example, is the current strategy sufficient to protect our lakes, or will the reduction of chloride concentration stop short of the goal? How long until our groundwater tastes salty to the citizens of the state of Minnesota? Do we need better long-term solutions? The impact of the research will help prioritize and focus salt reduction strategies for long-term solutions.

C. Funding History: N/A

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List: N/A

B. Acquisition/Restoration Information: N/A

IX. VISUAL COMPONENT or MAP(S):

See attached graphic.

X. RESEARCH ADDENDUM:

See attached Research Addendum

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted not later than January 1, 2017; July 1, 2017; January 1, 2018; July 1, 2018, and January 1, 2019. A final report and associated products will be submitted between June 30 and August 15, 2019.

Environment and Natural Resources Trust Fund

M.L. 2016 Project Budget

Project Title: Understanding Impacts of Salt Usage on Minnesota Lakes, Rivers, and Groundwater

Legal Citation: ML 2016, Chap. 186, Sec. 2, Subd. 4n

Project Manager: John S. Gulliver

Organization: University of Minnesota

M.L. 2016 ENRTF Appropriation: $497,000

Project Length and Completion Date: 3 Years, June 30, 2019

Date of Report: May 29, 2016

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Estimate statewide sodium chloride use***			***Develop best management practices to reduce salt due to water softening***			***Chloride transport through, and retention in, Minnesota soils***				
Personnel Overall (Wages and Benefits)	$66,93		$66,93	$129,76		$129,76	$198,48		$198,48	$395,18	$395,18
Personnel: Professor (J. Gulliver), Supervisory and Analysis, 4 FTE (75% salary, 25% benefits) each year for 3 years.Estimated total $24,270											
Personnel: Research Associate (S. Heger), Supervisory, data gathering and analysis related to water softeners, 30% FTE (75% salary, 25% benefits) each year for 3 years. Estimated total $83,174											
Personnel: Research Associate (W. Herb), Analysis, 6% FTE (75% salary, 25% benefits) each year for 3 years.Estimated total $17,133											
Personnel: Editor (C. Hansen), Proof and edit documents, 2.5% FTE (78% salary, 22% benefits) each year for 3 years.Estimated total $3,826											
Personnel: Research Fellow (A. Erickson), Field sample collection, laboratory experiments and Analysis, 50% FTE (75% salary, 25% benefits) each year for 3 years. Estimated total $131,242											
Personnel: Graduate Student, Data gathering and analysis rel to water softeners, 50% FTE (53% salary, 47% benefits) each year for 3 years. Estimated total $109,700											
Personnel: Junior Scientist (A. Ketchmark), Field sample collection and experimental apparatus, 4% FTE (78% salary, 2 benefits) each year for 3 years. Estimated total $6.557											
Personnel: Junior Engineer Trainee, Field sample collection and laboratory experiments, 25% FTE (100% salary) each year for 3 years. Estimated total $19,287											
Professional/Technical/Service Contracts											
Professional/Technical/Service Contracts: Contract with Fortin Consulting Inc. to provide expertise and experience with data collection and analysis related to road salt and water softening. 11.7% FTE (100% Salary) each year for 3 years.	$22,562		$22,562	$43,738		$43,738				$66,300	$66,300
Professional/Technical/Service Contracts: Contract with Peter Weiss (Visiting Professor) to provide oversight and expertise with column experiments. 6% FTE (100% salary) each year 3 years.							$29,111		$29,111	$29,111	$29,111
Equipment/Tools/Supplies											
Equipment/Tools/Supplies: Analytical laboratory charge for soils analysis.							$3,000		$3,000	$3,000	$3,000
Equipment/Tools/Supplies: Misc. Supplies for experimental set and analysis.							$2,000		$2,000	$2,000	$2,000
Travel expenses in Minnesota											
Travel: To sites to collect samples. 2500 miles @ $0.56/mi							$1,400		$1,400	$1,400	$1,400
COLUMN TOTAL	**$89,499**	**$0**	**$89,499**	**$173,501**	**$0**	**$173,501**	**$234,000**	**$0**	**$234,000**	**$101,811**	**$497,000**

Salt Impacts the Environment

Road Salt

(www.overtimepaylaws.org)

&

Softening Salt

(www.watergem.us)

=

Dead Fish

(www.poleshift[illegible].com)