

**Environment and Natural Resources Trust Fund  
2020 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 076-B**

Reducing Chloride in Minnesota's Water from Water Softening

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**Category:** B. Water Resources

**Sub-Category:**

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**Total Project Budget: \$** 362,699

**Proposed Project Time Period for the Funding Requested:** June 30, 2023 (3 yrs)

**Summary:**

This project will promote salt reduction through testing non-salt water softening alternatives; developing a residential web-based water softener tool; and working with two communities to implement softener salt-reduction strategies.

**Name:** Sara Heger

**Sponsoring Organization:** U of MN

**Job Title:** Dr.

**Department:** Water Resource Center

**Address:** 1985 Buford Ave, 173 McNeal Hall  
St. Paul MN 55406

**Telephone Number:** (612) 625-7243

**Email** sheger@umn.edu

**Web Address:** https://www.wrc.umn.edu/watersoftening

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**Location:**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

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**Alternate Text for Visual:**

This image shows that salt from water softeners is harmful to aquatic species, but by reducing or eliminating salt through tested and documented methods, water quality will be improved.

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



**Environment and Natural Resources Trust Fund (ENRTF)**

**2020 Main Proposal Template**

**PROJECT TITLE: Reducing Chloride in Minnesota’s Waters from Water Softening**

**I. PROJECT STATEMENT**

This project will test non-salt softening alternatives; develop a web-based tool for property owners to optimize their existing softener or purchase a new one; and work directly with communities facing wastewater treatment plant (WWTP) wastewater chloride limits related to water softeners. The primary outcome will be improved water quality in Minnesota by reducing the amount of chloride used in water softeners and discharged to Minnesota surface and groundwaters.

**WHY** – High chloride levels in surface waters and groundwater are an emerging concern in Minnesota, as they can negatively affect aquatic and plant life, lake mixing cycles, and drinking water quality. Minnesota has 50 lakes, rivers, and streams with chloride water quality impairments, 120 more at high risk for becoming impaired, and chloride levels in groundwater are increasing. When water is “softened” to remove hardness in the form of calcium and magnesium ions, sodium chloride (salt) is used to regenerate the softener. As a result, chloride is released to septic systems and WWTPs. Monitoring in Minnesota has shown over 100 WWTPs with chloride discharge concentrations greater than allowable limits for aquatic life and a recent UMN study showed household and commercial water softening are estimated to make up 65% of WWTP chloride discharge. There are no practical or affordable means to remove chloride from water resources, so methods need to be developed to reduce or eliminate salt use for water softening at the source. Additionally, research is needed to evaluate the effects of salt reduction methods on chloride levels across different communities.

**GOAL & OUTCOME** – This project’s goal is to test alternatives and develop tools and resources for citizens and communities in Minnesota to reduce their water softening chloride load into Minnesota’s surface and groundwaters. The **outcome** of this project is to develop strategies that improve water quality by providing and documenting methods to reduce the chloride load from water softening. The methods and tools developed and tested during this project will assist municipal WWTP operators, communities and property owners with hard water.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1: Test non-salt hardness reduction and non-scaling techniques**

**BUDGET: \$178,400**

**Description:** The **objective** of this activity is to assess which, if any, available non-salt based hardness reduction techniques are best for Minnesota tap water in order to reduce chloride discharge. Although salt-consuming ion exchange softeners are by far most common, treatment devices using other methods of reducing hardness and/or hard water “scale” are on the market. Examples are template assisted crystallization, magnetization, and electrically induced precipitation. Some of these techniques have shown varied results in testing by Arizona State University and others, but none has been scientifically tested in Minnesota. In this activity, a trailer-based mobile test rig with 4-5 parallel, identical testing stations will be constructed to determine how effectively each technique reduces hardness and/or scale. Over two seasons, the mobile unit will be towed to 10 small communities across Minnesota to test source water onsite. An automated routine will run water through the treatment alternatives in a pattern that mimics home water use and water heating. Test categories include 1) chemical analysis (hardness, pH, etc.), 2) measuring scale build up on heating coils, since scale forms fastest in hot water, 3) clogging of fixtures (i.e. showerhead), and 4) soap lathering (cleaning) ability of the treated water.

<b>Outcome</b>	<b>Completion Date</b>
<i>1. Testing protocol for 4-5 alternatives completed with stakeholder input</i>	<i>12/31/20</i>
<i>2. Alternatives tested, analyzed and ranked in up to 10 communities</i>	<i>12/31/22</i>
<i>3. Results disseminated through a report, website and tool developed in Activity 2</i>	<i>6/30/23</i>

**Activity 2: Develop online tool for homeowners to reduce water softening salt**

**BUDGET: \$79,370**

**Description:** Most of Minnesota has moderately hard to very hard water, and many residents use ion exchange water softeners to reduce this hardness. Chloride can be reduced through ensuring that water softeners are set correctly for water use and water hardness levels. The **objective** is to develop a user-friendly online tool for residential application to help property owners either reduce the salt used in their current softener or select a



**Environment and Natural Resources Trust Fund (ENRTF)**

**2020 Main Proposal Template**

**PROJECT TITLE: Reducing Chloride in Minnesota’s Waters from Water Softening**

new treatment device. In this activity, a group of stakeholders will provide input to assure the tool fairly evaluates all potential factors affecting treatment, including: the source and hardness of their water; efficiency and sizing of their softener; iron and chlorine content of source water; only softening a portion of the water, water conservation; and maintenance. Based on the user input, the tool will offer suggestions to reduce their softening salt use. A tool development expert will be hired. The tool will be piloted and refined based on user input and as new information is learned in Activity 1, non-salt alternatives will be added.

<b>Outcome</b>	<b>Completion Date</b>
1. Wireframe of online tool completed with stakeholder input	12/31/20
2. Online tool developed, tested and completed	12/31/21
3. Tool is refined as needed based on feedback and results from Activity 1 & disseminated	6/30/23

**Activity 3: Community level chloride reduction strategies**

**BUDGET: \$104,929**

**Description:** The **objective** of this activity is to assist two communities and document water quality improvements from water softening salt reductions in partnership with the MPCA. Minnesota communities can reduce their chloride discharge by optimizing softeners with demand-based regeneration, using alternative technology, or installing a centralized water softening facility. However, the chloride reductions achieved depend on water hardness and the degree of commercial and industrial activity. In partnership with the new MPCA water softener grant program, two communities will be selected and support provided to implement reduction strategies and document chloride reduction. Chloride data from the two communities will be evaluated and salt reduction will be collected and summarized in case studies. This data will be used to estimate a range of salt savings at the household scale and chloride reductions at the community scale.

<b>Outcome</b>	<b>Completion Date</b>
1. Identify community or communities	12/31/20
2. Community implemented chloride reduction strategy with updated water softeners	12/31/22
3. Case studies completed and tools developed	6/30/23

**III. PROJECT PARTNERS AND COLLABORATORS:**

- Dr. Sara Heger, Project PI. Researcher and Instructor, Water Resources Center, UMN – TC
- Mr. Jeffrey Marr, Oversight of non-salt alternative testing, Associate Director of Engineering and Facilities, St. Anthony Falls Laboratory, UMN– TC
- Fortin Consulting, development and testing of the online tool, technology assessment/protocol
- A laboratory technician and student will assist with the testing of non-salt alternatives.
- A research assistant will assist in the WRC with tool development, alternative testing and community implementation and data collection and analysis.

- Tool developer: Consultant will be hired with expertise in online tool development.

**In-Kind Partners and Collaborators:**

- Brooke Asleson, Development of tool and community salt reduction strategies. Water Pollution Prevention Coordinator, MPCA.
- Kathy Lake, Stakeholder input, Pollution Prevention Manager for Madison Metropolitan Sewerage District
- Minnesota Water Quality Association will provide stakeholder input and assist with community reduction strategies.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

The objectives of this study will help citizens of Minnesota reduce their outputs of chloride by either using non-salt alternatives or optimizing typical ion-exchange softeners. All results from this study will be posted to the UMN Water Resources Center and MPCA websites. The community case studies will provide the MPCA and water resource managers’ concrete examples of effective chloride reduction strategies that can be used in other communities across Minnesota with chloride impairments and those faced with chloride limits.

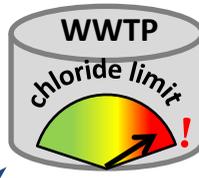
Attachment A: Project Budget Spreadsheet  
 Environment and Natural Resources Trust Fund  
 M.L. 2020 Budget Spreadsheet



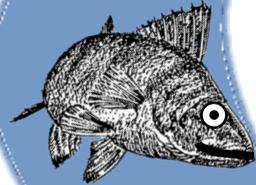
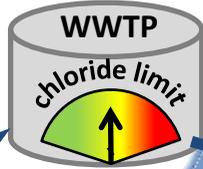
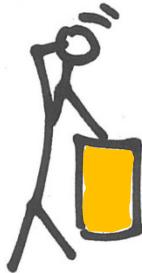
Legal Citation:  
 Project Manager: Dr. Sara Heger  
 Project Title: Reducing Chloride in Minnesota's Water from Water Softening  
 Organization: University of Minnesota  
 Project Budget: \$362,699  
 Project Length and Completion Date: 3 years, 6/30/23  
 Today's Date: 4/8/19

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget	Amount Spent	Balance
<b>BUDGET ITEM</b>				
<b>Personnel (Wages and Benefits)</b>				
Dr. Sara Heger/Project PI, \$33,595 (64% salary, 36% benefits), 9.3% FTE each year for 3 of years		\$ 184,965	\$ -	
Jeff Marr/Engineer, \$9,373 (64% salary, 36% benefits), 1.9% FTE each year for 3 of years				
4 - Research Scientists, \$132,519 (70.5% salary, 29.5% benefits), 3 years - WRC Reseacher \$50,649, 29% FTE for 3 years, SAFL Researcher \$32,878, 13% FTE for 3 years, SAFL Researcher \$34,713 18% FTE for 3 years, SAFL Researcher \$14,279, 5% FTE for 3 years				
Student Worker, \$7,803 (100% salary), 10.7% per year for 3 years				
Editor, \$1,674, (70.5% salary, 29.5% benefits), 1% FTE for 3 years ( \$1,292.66 salary + \$381.33 benefits)				
<b>Professional/Technical/Service Contracts</b>				
Fortin Consulting will provide expertise related to tool development and softening alternatives through a sole source contract following UMN policies (futher documentation could be provided if needed).		\$ 18,000	\$ -	
Tool development expert with be hired through a completeive bid process following UMN Policies.		\$ 45,000	\$ -	
Contract lab to analyze water quality samples hired through UMN contracting.		\$ 8,600		
<b>Equipment/Tools/Supplies</b>				
Salt-free alternative water conditioning systems		\$ 7,500	\$ -	
Mobile test unit plumbing, water heating and electrical		\$ 9,000		
Mobile test unit furnishing, signage, safety equip.		\$ 3,700		
Mobile test unit maintenance, repairs, modifications		\$ 3,900		
Mobile test unit control and data system, remote communication		\$ 4,980		
Chemicals, water test kits, supplies		\$ 5,975		
Software, domain fees		\$ 400		
Water softener replacement/rebate program removal in one of the two communities (50 homes at \$1,000/ home)		\$ 50,000		
<b>Capital Expenditures Over \$5,000</b>				
Enclosed trailer (approx. 7'x16') to build mobile test unit for salt-free softener alternatives		\$ 8,000	\$ -	
<b>Travel expenses in Minnesota per UMN policy</b>				
Activity 1 - 3,520 miles at \$0.58/mile for 10 outstate sites (\$2,042), 7,040 miles at \$1/mile tow vehicle for mobile test trailer (\$7,040), 16 hotel nights @ \$80/night (\$1,280), and 32 first/last day per diem @\$41.25 (\$1,320)		\$ 12,679		
Activity 3 - 1,000 miles to visit 2 communities at \$0.58/mile (\$580)				
<b>Other</b>		\$ -	\$ -	\$ -
<b>COLUMN TOTAL</b>		\$ 362,699	\$ -	
<b>SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT</b>				
	<b>Status (secured or pending)</b>	<b>Budget</b>	<b>Spent</b>	<b>Balance</b>
<b>Non-State: Unrecovered UM Indirect at 54% minus capital equipment</b>	pending	\$ 191,537	\$ -	\$ -
<b>State:</b>		\$ -	\$ -	\$ -
<b>In kind:</b>				
Minnesota Pollution Control Agency, Brooke Asleson, Water Pollution Prevention Coordinator will provide expertise in development of tool and assist with community salt reduction strategies with 0.10 FTE over 3 years	Secured	\$ 45,000		
Madison Metropolitan Sewerage District, Kathy Lake, Pollution Prevention Manager will provide expertise related to the water softener chloride reduction programs in place in Madison, WI.	Secured	\$ 4,500		
Minnesota Water Quality Association, Scott Schiesser, President, Expertise in alternative testing protocol and online tool development	Secured	\$ 6,250		
<b>Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS</b>	<b>Amount legally obligated but not yet spent</b>	<b>Budget</b>	<b>Spent</b>	<b>Balance</b>
		\$ -	\$ -	\$ -

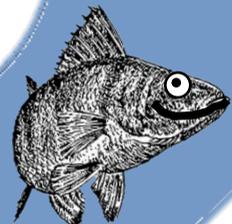
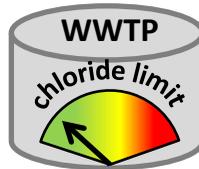
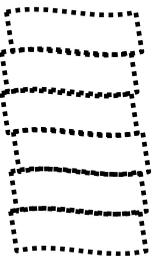
# Softener salt:



# reduce it...



# or eliminate it...



... for happy fish and waters. Page 5 of 11 | FFD: 076-B

## Reducing Chloride in Minnesota's Water from Water Softening

### Project Manager Qualifications & Organization Description

#### Dr. Sara Heger

*University of Minnesota, Water Resources Center*  
*Onsite Sewage Treatment Program, [septic.umn.edu](mailto:septic.umn.edu)*  
[sheger@umn.edu](mailto:sheger@umn.edu), O: 612-625-7243 C: 612-239-8198

**Project PI: Dr. Sara Heger** is an engineer, researcher and instructor in the Onsite Sewage Treatment Program in the Water Resources Center and is an Adjunct Assistant Professor in the Bioproducts and Biosystems Engineering Department. Since 1998, she has been providing education and technical assistance to homeowners, small communities, onsite professionals and local units of government regarding onsite wastewater treatment. Sara coordinates the research program at the UMN and is currently serving as the principle investigator on grants to evaluate chloride impacts from water softeners on water quality ([https://www.wrc.umn.edu/watersoftening - LCCMR 2016-2019](https://www.wrc.umn.edu/watersoftening-LCCMR-2016-2019)) and MnDOT rest stops served by septic systems and evaluate chemicals of emerging concern from septic systems. Sara serves on the NSF International Committee on Wastewater Treatment Systems. She is also the chair of the Minnesota State Advisory Committee on Decentralized Systems. She has BS in Biosystems & Agricultural Engineering and a MS and a PhD in Water Resources Science. Heger will oversee the entire project and provide expertise in water quality sampling, data analysis and impacts of water softening.

**Jeff Marr** is the associate director for engineering and facilities at the St. Anthony Falls Laboratory (SAFL) at the University of Minnesota. In this role, Jeff oversees the applied research team at SAFL, which has ongoing work in the areas of urban stormwater and water quality, hydraulic modeling, wind and water power, river engineer/restoration, and technology development for field monitoring. His personal research interests include water hydraulics, river engineer and river restoration, sediment transport dynamics, and wind engineering. Marr received his BS and MS in civil engineering from the University of Minnesota in 1996 and 1999, respectively. Currently, he is serving as the associate director of the Eolos Wind Energy Research Consortium, a wind research center at the University of Minnesota. Marr is also a licensed professional engineer in the state of Minnesota. SAFL has the needed facilities and technical expertise to construct the mobile test unit for the project and to test the protocol during development.

**The University of Minnesota Onsite Sewage Treatment Program (OSTP)** has been providing education and performing research on septic systems since the mid-1970s. OSTP is a multi-disciplinary program with four distinct yet interrelated activities and programs: 1) Professional Training, 2) Research and Demonstration, 3) Small Community Wastewater Education, and 4) Homeowner Operation and Maintenance. The integration of the four programs has continued to be a priority for the overall program, both within the University and state of Minnesota and on a broader scale to partnering Universities' research, education, and outreach functions across the nation.

**UMN WRC Capacity**, The University of Minnesota is a large, comprehensive, public land grant research university serving a state where both water resources and agriculture are hallmarks of the economy. UMN Sponsored Projects Administration (SPA) will be the entity authorized by the Board of Regents to manage the project agreements with LCCMR program. The WRC is the primary coordination unit for University of Minnesota research, outreach and graduate education related to water resources. It manages over 30 active grants, from federal, state, and private funders, totaling over \$2 million at any one time, works across disciplines and across institutions. The WRC maintains sufficient permanent staff to complete all grant reporting and data submittal requirements in the timeframe required.