

**Environment and Natural Resources Trust Fund
2011-2012 Request for Proposals (RFP)**

LCCMR ID: 036-B

Project Title: Minnesota Drinking Water: Reducing Arsenic in Private Wells

Category: B. Water Resources

Total Project Budget: \$ \$527,132

Proposed Project Time Period for the Funding Requested: 3 yrs, July 2011 - June 2014

Other Non-State Funds: \$ 0

Summary:

Private wells with arsenic exceeding drinking water standards are found statewide, but sources are poorly understood. Our goal is to develop and test prototype sub-surface maps for groundwater arsenic risk.

Name: Brandy Toner

Sponsoring Organization: U of MN

Address: 439 Borlaug Hall, 1991 Upper Buford Cir
Saint Paul MN 55108

Telephone Number: 612-298-0499

Email: toner@umn.edu

Web Address: http://www.tc.umn.edu/~toner/

Location

Region: Statewide

Ecological Section: Statewide

County Name: t, Todd, Traverse, Wadena, Waseca, Wilkin, Wright, Yellow Medicine

City / Township:

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

PROJECT TITLE: Minnesota Drinking Water: Reducing Arsenic in Private Wells

I. PROJECT STATEMENT

- arsenic in drinking water affects the health of hundreds of thousands of Minnesotans
- sources of arsenic to groundwater used by private drinking water wells remain elusive
- our research builds on previous State investments (e.g. County Atlas Program) and applies novel approaches to a public-health issue for which there is no current solution
- our goal is help Minnesotans place wells where the probability of safe water is highest

In Minnesota (MN), 150,000 to 250,000 people statewide are estimated to use drinking water from private (primarily domestic) wells with arsenic concentrations exceeding 10 micrograms of arsenic per liter of water (Fig.1). The 10 micrograms of arsenic per liter maximum contaminant level (MCL) is the more protective *public* drinking water system standard set by the U.S. Environmental Protection Agency (EPA) in 2001; the arsenic MCL was previously 50 micrograms per liter. Consumption of drinking water with arsenic concentrations at 50 micrograms per liter carries an increased risk of skin, lung, and bladder cancer.

In response to EPA's new standard for public drinking water systems and knowledge of the widespread area of elevated arsenic, the MN Department of Health (MDH) changed the well code to require that each new potable water supply well – estimated at 8,000-12,000 wells annually – be tested for arsenic. Most of these new water supply wells are private household wells. The arsenic tests provide families with important information about the quality of their drinking water; unfortunately, the information comes only after the well has been drilled. Our lack of knowledge regarding the sources of arsenic to drinking water limits the efficacy of public policies directed at wise placement and construction of new wells, which has negative consequences for the health of hundreds of thousands of Minnesotans.

Over the past 12 years, MN state agencies have conducted studies in arsenic-affected areas. A 1998-2000 study of arsenic occurrence and exposure in western MN found that over 50% of the sampled private wells had arsenic concentrations over 10 micrograms per liter (earlier statewide studies showed that 14% of sampled wells exceeded 10 micrograms per liter arsenic). In 2005, University of MN (UMN)-led research identified well placement (location and depth) and construction as factors contributing to higher risk of arsenic in well water. However, the processes that drive arsenic from geological materials into well water remain elusive.

The goal of the proposed research is to help Minnesotans place their wells where the probability of safe groundwater is highest. We intend to identify the chemical form of the arsenic, its location, and the conditions leading to its release to groundwater. We will begin the study in west-central (Traverse, Grant, Stevens, Douglas, Pope, Big Stone, and Swift) and south-central (Sibley, Nicollet, Blue Earth) MN counties. We will collect novel data, and integrate it with existing databases generated by past State initiatives, including the Regional Hydrologic Assessments (MN-DNR) and the County Atlas Program (MN Geological Survey and MN-DNR). The **outcome of this research** will be an assessment of three-dimensional sub-surface maps for arsenic risk in MN groundwater – will they work at a useable scale and in a cost-effective manner – and practical guidelines for well-drillers on how to produce healthier well-waters.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1 (Budget \$244,876): **Identify and quantify sources of arsenic to private wells.** PI Toner and UMN students will measure the chemical form of arsenic (speciation) in sediments in 865 samples from 20 west-central and south-central MN drill cores.

| Outcome | Date |
|---|-----------|
| 1. Measure total arsenic (plus associated elements for 865 samples) | 12/1/2011 |

| | |
|--|----------|
| 2. Identify form of arsenic (865 samples; two different methods) | 7/1/2013 |
|--|----------|

Activity 2 (Budget \$228,872): **Evaluate factors that correlate with high arsenic in drinking water.** Using methods developed by co-PI Erickson, we will use MN Dept of Health, MN Geological Survey, MN DNR, and County Atlas databases to improve our understanding of the sources of arsenic to private well water.

| Outcome | Date |
|--|-----------|
| 1. Integration of geospatial databases from previous State investments | 7/1/2012 |
| 2. Determine whether the chemical form of arsenic can predict unsafe water | 12/1/2013 |

Activity 3 (Budget \$50,384): **Develop and test prototype 3D subsurface arsenic maps for west-central and south-central MN.** Activity 3 is a series of feasibility tests where the 3D sub-surface mapping techniques developed by co-PI Berg (for groundwater sensitivity to surface water contamination) are evaluated for arsenic in drinking water. We will focus on quantifying the appropriate spatial scale and data density required for successful assessment of risk for arsenic contaminated well water. If the methods developed for seven Traverse-Grant counties are successful, they will be applied to three south-central counties. Based on the results of Activity 3, we will evaluate the potential for similar sub-surface arsenic maps for additional MN counties.

| Outcome | Date |
|---|-----------|
| 1. Map arsenic in sub-surface for west-central and south-central counties | 7/1/2013 |
| 2. Test arsenic map against in-coming new well code data | 12/1/2013 |
| 3. Evaluate feasibility of arsenic mapping for additional MN counties | 3/1/2014 |

Activity 4 (Budget \$3000): **We will disseminate information and solicit feedback from project partners and collaborators** by hosting a yearly symposium for our colleagues in the MN DNR, MN Dept. Health, MN Geological Survey, U.S. Geological Survey, and the UMN in three ½ day symposia (hosted by PI-Toner).

| Outcome | Date |
|---|-----------|
| 1. Symposium1: Experimental outcomes and existing resources | 10/1/2012 |
| 2. Symposium2: Factors correlating with high arsenic in private wells | 10/1/2013 |
| 3. Symposium3: Recommendations for 3D sub-surface mapping | 6/1/2014 |

III. PROJECT STRATEGY

A. Project Team/Partners. The project team partners that will receive NRTF funds are: PI Toner (Assistant Professor, UMN) and co-PI Melinda Erickson (Groundwater Specialist; U.S. Geological Survey). The project team partner that will not receive NRTF funds is co-PI James Berg (MN DNR). As part of past funding, we have built collaborations with MN Geological Survey and MN Dept. of Health scientists (they will not receive NRTF funds).

B. Timeline Requirements. The proposed project will be completed in 3 years.

C. Long-Term Strategy and Future Funding Needs. Our longer term efforts will be defined by the outcomes of Activity 3. If we discover that the data currently available for MN statewide is sufficient, then additional arsenic speciation mapping will be warranted. In this case, with the prototype methodology demonstrated, we may seek funding through federal grants. If we find that additional drilling is required to ground-truth the arsenic speciation maps, then follow up funding requests may be made of LCCMR to complete the prototype project. In either case, the proposed 3 year project is a good investment for the people of MN because we will identify the location and form of arsenic in the geologic materials hosting groundwater.

2011-2012 Detailed Project Budget

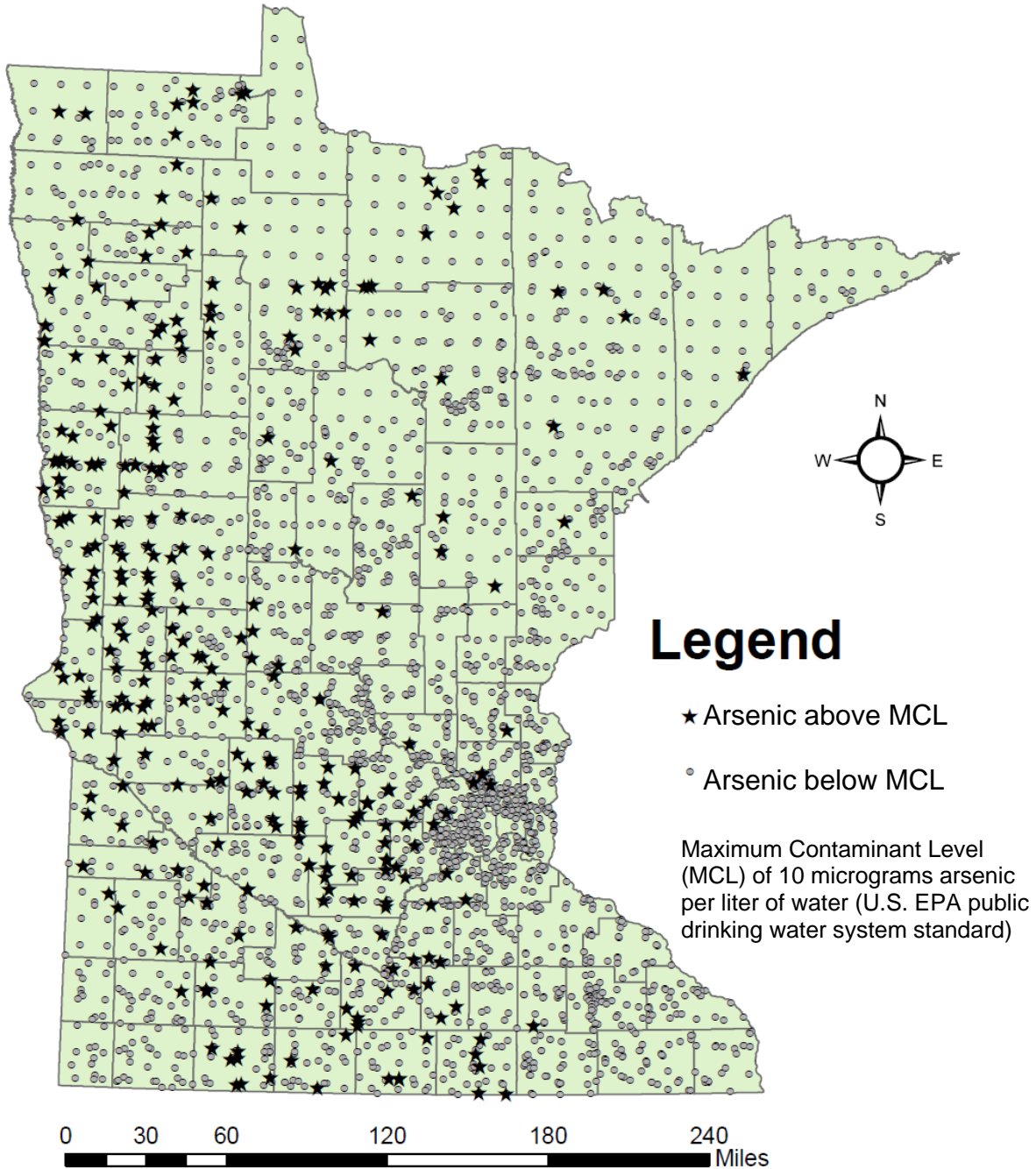
IV. TOTAL TRUST FUND REQUEST BUDGET 3 years

| BUDGET ITEM | AMOUNT |
|--|-------------------|
| Personnel: Brandy Toner (PI), project manager, 1 month summer salary, salary (\$27,542), benefits (\$7254) for each of the three years | \$ 34,796 |
| Personnel: Joel Nelson, GIS Specialist, 30 % appointment, salary (\$54,835), benefits (\$21,988) for each of three years | \$ 76,823 |
| Personnel: Sarah Nicholas, Ph.D. student, full time, salary (\$79,062), tuition-fees-benefits (\$62,460) for each of three years | \$ 141,522 |
| Personnel: Sara Baldvins, undergraduate student, salary (\$32,426), benefits (\$2389) for each of three years | \$ 34,815 |
| Contracts: Professional services, geochemical analysis of 865 rotary sonic drill core samples; U.S. Geological Survey; \$65 per sample for 45 elements. | \$ 56,269 |
| Contracts: Sub-contract, USGS Groundwater Specialist, GS-13, 17% FTE per budget year, 30% fringe (co-PI Melinda Erickson) for each of three years | \$ 108,105 |
| Equipment/Tools/Supplies: Chemical reagents (\$9738); supplies for arsenic quantification (\$34,500); supplies for Coy anaerobic chamber (\$11,490) for 865 samples; all extractions/measurements done by students in Toner lab for \$64 per sample. | \$ 55,728 |
| Travel: Synchrotron radiation X-ray absorption spectroscopy for direct measurement of arsenic speciation in sediments will be conducted at the Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley, CA. The only way to make the proposed measurements is at this Department of Energy facility. The <i>instrument time is free of charge</i> , but one must travel to use the instrument. PI Toner and Ph.D. student Nicholas will travel to conduct analyses two times yearly. 14 days of instrument time anticipated. Travel and lodging costs about \$1340 per person per trip. Total: \$5358 per budget year. | \$ 16,074 |
| Additional Budget Items: Disseminate research findings and solicit feedback from project partners and collaborators by hosting one symposium per year for ~ 30 people over the three year budget (host: PI Toner). Estimate \$33 per person for food, beverages (coffee/tea), printed materials. | \$ 3,000 |
| TOTAL ENVIRONMENT & NATURAL RESOURCES TRUST FUND \$ REQUEST | \$ 527,132 |

V. OTHER FUNDS

| SOURCE OF FUNDS | AMOUNT | Status |
|---|-----------|--------------------------|
| Other Non-State \$ Being Applied to Project During Project Period: Other Non-State \$ USGS 40/60 matching funds | \$ 72,070 | <i>Pending</i> |
| Other State \$ Being Applied to Project During Project Period: | none | <i>na</i> |
| In-kind Services During Project Period: ~ 110 of MN Geological Survey staff hours over 3 year project | unknown | <i>Written agreement</i> |
| Remaining \$ from Current ENRTF Appropriation (if applicable): | none | <i>na</i> |
| Funding History: Center for Urban and Regional Affairs (\$42,903; PI Toner; collaborator Erickson) funded early work related to this LCCMR proposal (primarily supported Ph.D. student Nicholas); New faculty start-up funds from UMN (\$100,000; PI Toner) have been used to support development of arsenic speciation methods (including staff salaries), purchase of equipment required for proposed research, and conduct field sampling efforts | \$142,903 | <i>ends May 31, 2010</i> |

Arsenic in Minnesota Groundwater



Private wells with arsenic exceeding drinking water standards are found statewide, but the sources of arsenic are poorly understood. Our goal is to develop and test prototype sub-surface maps for groundwater arsenic risk.

IV. PROJECT MANAGER QUALIFICATIONS & ORGANIZATIONAL DESCRIPTION

A. Project Manager Qualifications - *Principal Investigator and Project Manager.*

Dr. Toner is an Assistant Professor of Environmental Geochemistry at the University of Minnesota in the Department of Soil, Water, and Climate. Toner was trained in Environmental Studies at Bemidji State University, Bemidji, MN with specializations in Hydrogeology and Mathematics. As an undergraduate, Toner participated in research activities with the U.S. Geological Survey at an Interdisciplinary Research Initiative Site, Akeley, MN (stream hydrology) and a hydrocarbon spill site near Bemidji, MN (contaminant hydrogeology). Toner received a M.S. degree from the University of California at Berkeley in Civil and Environmental Engineering with emphasis on water chemistry and hydrogeology. Toner's Ph.D. research on metal speciation in freshwater systems was conducted in the Ecosystem Sciences Division at the University of California at Berkeley. Toner was awarded a National Research Council Associateship in 2005 and a NASA Postdoctoral Fellowship in 2006.

Dr. Toner's current research activities at the University of Minnesota focus on biogeochemical processes that move metals through natural systems. Toner is an expert in using synchrotron radiation X-ray absorption spectroscopy (XAS) to measure the specific chemical form, or speciation, of metals. Toner brings a history of working productively in multi-disciplinary collaborations, and has experience in mentoring undergraduate and graduate students and colleagues in XAS research.

The proposed project on arsenic in Minnesota groundwater has been the central research effort of the Toner laboratory since 2008. Early collaboration with project co-PI Erickson led to a 1 year grant from the Center for Urban and Regional Affairs (CURA), University of Minnesota. On October 1, 2009 Toner's UMN research group hosted a day-long symposium on *Arsenic in Minnesota Groundwater*. The purpose of the symposium was to bring together professionals in multiple state agencies with expertise in arsenic contamination, groundwater hydrology, public health and policy, and glacial geology to discuss of the current state-of-knowledge, and identify obstacles to and opportunities for progress. One outcome of the symposium was a new collaboration with co-PI Berg.

Dr. Toner has a 9 month appointment through the University of Minnesota and has requested 1 month summer salary support. As lead PI and Project Manager, Toner will be responsible for overseeing all aspects of the proposed research. Dr. Toner will meet regularly with co-PIs Berg (MN DNR) and Erickson (USGS) to ensure satisfactory progress on research objectives. Dr. Toner will supervise GIS Specialist Joel Nelson, Ph.D. student Sarah Nicholas, and undergraduate student Sara Baldvins.

B. Organizational Descriptions

- The University of Minnesota's mission is threefold: (1) Research and Discovery; (2) Teaching and Learning; and (3) Outreach and Public Service.
- The mission of the Minnesota Department of Natural Resources – Division of Waters is: Helping people ensure the future of our water resources.
- The mission of the Water Resources Discipline of USGS is to provide reliable, impartial, timely information that is needed to understand the Nation's water resources.