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

Project Title: **ENRTF ID: 047-B**

Natural Denitrification: Helping and Hiding Drinking Water Problems

Category: B. Water Resources

Total Project Budget: $ 664,000

Proposed Project Time Period for the Funding Requested: 4 years, July 2018 to June 2022

Summary:

Natural denitrification is beneficial for protecting drinking water from nitrate contamination, but it may hide aquifer vulnerability to other contaminants (pesticides or chloride). Project will measure and map natural denitrification.

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Sponsoring Organization: U. S. Geological Survey

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Map of MN showing nitrate concentrations in well water around the state and denitrification processes that can hide drinking water quality problems.

_____ Funding Priorities _____ Multiple Benefits _____ Outcomes _____ Knowledge Base

_____ Extent of Impact _____ Innovation _____ Scientific/Tech Basis _____ Urgency

_____ Capacity Readiness _____ Leverage _______ TOTAL ______%

PROJECT TITLE: Natural Denitrification: helping and hiding drinking water problems

I. PROJECT STATEMENT

Minnesota water managers are keenly aware of *where* nitrate occurs in groundwater, but less aware of *why* or *why not*. Many state and local agencies routinely monitor for nitrate. New drinking water wells have been sampled for nitrate for decades, and nitrate analyses are inexpensive. Over half of the land in the State receives abundant nitrogen inputs from activities such as agricultural production and urban landscaping. In some parts of the state, high rates of nitrogen addition cause substantial groundwater contamination, but in other parts of the state with high rates of nitrogen addition, groundwater resources appear to be relatively unaffected by nitrogen.

If high nitrates are present in a well, a conclusion is easily reached: well water is not "clean." That is, the water is noticeably affected by human activities that occur near land surface, and must be purified. For example, in Hastings and Park Rapids, drinking-water supply aquifers are contaminated with nitrate, so these cities have invested in expensive treatment facilities. In these settings, nitrate can serve as an indicator of other groundwater contaminants that require much more expensive analyses, such as pesticides.

In contrast, the conclusion is not as clear if a well has low or no nitrates in a landscape with high rates of nitrogen addition; other water quality problems may be hidden. Reasons for unexpected low nitrates are: (1) the time required for nitrate to get from the surface to aquifers is very long (so well water nitrate concentrations reflect nitrogen inputs from many decades ago), or (2) the nitrate disappears by natural denitrification before it reaches the well. Natural denitrification is the breakdown of nitrate contaminants dissolved in groundwater to harmless nitrogen gas in low-oxygen conditions, but other types of contaminants are not broken down in the same way. Natural denitrification processes mediated by organic materials or iron sulfides (such as pyrite) have been studied in eastern North Dakota and are providing significant protection from nitrates to some North Dakota aquifers. Because parts of Minnesota have similar geologic settings to eastern North Dakota, it is reasonable that similar natural denitrification processes are at work in some Minnesota aquifers.

The primary objective of this project is to collect new data and compile existing data to inform these questions: **My well has low nitrates despite being in an area where abundant nitrogen is applied, does that mean my water is safe from surface contaminants? For how long will my water be safe to drink?**

For the protection of drinking-water resource aquifers, water resource managers, well owners, and well contractors need to know where and how natural denitrification is occurring or likely to occur, and how long it is expected to occur. Natural denitrification requires specific geochemical conditions to occur, and the denitrification 'capacity' of an aquifer can be depleted over time as organic materials or iron sulfides are broken down. An understanding of the expected geographical and temporal extent of natural denitrification will assist in development of appropriate drinking-water source protection measures and drinking water testing recommendations.

Activity 1: *Identify target regions and aquifers likely to have active denitrification* **Budget: $176,800**

Using existing water chemistry and geology data, select target sites for core collection, monitoring well installation, and water sampling.

Outcome	Completion Date
1. Confer with relevant water management and water protection agency scientists	March 2020
2. Compile and analyze existing geologic and water chemistry data	March 2020
3. Select target sites and obtain landowner permission for core sampling, monitoring well installation, and groundwater sampling	March 2020

Activity 2: *Field activities and laboratory analyses* **Budget: $530,400**

Collect cores of unconsolidated sediments (e.g., soil, clay, and sand) for up to 100 analyses for major element chemistry and mineralogy; install up to 8 monitoring wells; sample well water over time for selected constituents, including tritium as an indicator of water age and dissolved gasses indicative of denitrification.

Outcome	Completion Date
1. Collect core samples, approximately 100 samples for laboratory analyses	December 2020
2. Install and develop monitoring wells, seal wells at the end of the study	December 2021
3. Sample monitoring wells for selected constituents (for example, major elemental chemistry, nitrate, dissolved gasses, approximately 40 samples for full laboratory analyses; up to one analysis per well of other parameters, such as tritium and pesticides	September 2021
4. Quality assurance/quality control review of laboratory data	December 2021

Activity 2: *Data analysis, interpretation and reporting* **Budget: $181,800**

Using appropriate methods and tools, analyze data and develop publications, maps, and presentations to communicate results to a wide audience.

Outcome	Completion Date
1. Statistical, redox/geochemical, and/or groundwater flow path modeling	June 2022
2. Prepare and publish results	June 2022
3. Present results at local, regional, and national meetings	June 2022

III. PROJECT STRATEGY

A. Project Team/Partners

Project team members requesting funds:

- PI Jared Trost (Hydrologist, USGS), and other USGS scientists and technicians.
- Paul Putzier (Hydrologist, DNR), and other DNR hydrologists and technicians

Project partners NOT requesting funds:

- Steve Robertson (Supervisory hydrologist, MDH), and other MDH scientists
- Dr. Jeppe Kjaersgaard (hydrologist, MDA), and other MDA scientists.

All project team members and project partners will actively participate in site selection, interpretation, and reporting of results. USGS will lead the field activities, conduct the laboratory analyses, and lead the data analysis, interpretation, and reporting. DNR team members will provide some supervisory and technical support and complete drilling activities under a separate work plan. USGS, DNR, and MDH would each contribute a portion of the total project cost from non-ENRTF funds. All participating agencies will also contribute some 'in-kind' staff time in support of the project.

B. Project Impact and Long-Term Strategy

The proposed work would demonstrate the methods and effectiveness of a strategy to better understand and map natural denitrification potential for environmental and public health benefits. The project outcome can be directly used to communicate natural denitrification to decision-makers and the public regarding drinking water quality risks, drinking water protection strategies, and drinking water testing. The methods developed during the project could be applied in other regions of the state.

C. Timeline Requirements

The project is proposed as a 4-year project, July 2018 – June 2022. Based on past project experience requiring identifying appropriate project sites and obtaining land-owner permissions, field work would begin in spring of 2020. Field activities would be completed during calendar 2020 and 2021, with publications completed in 2022.

2018 Detailed Project Budget

Project Title: ***Natural Denitrification: helping and hiding drinking water problems***

IV. TOTAL USGS ENRTF REQUEST BUDGET 4 **years**

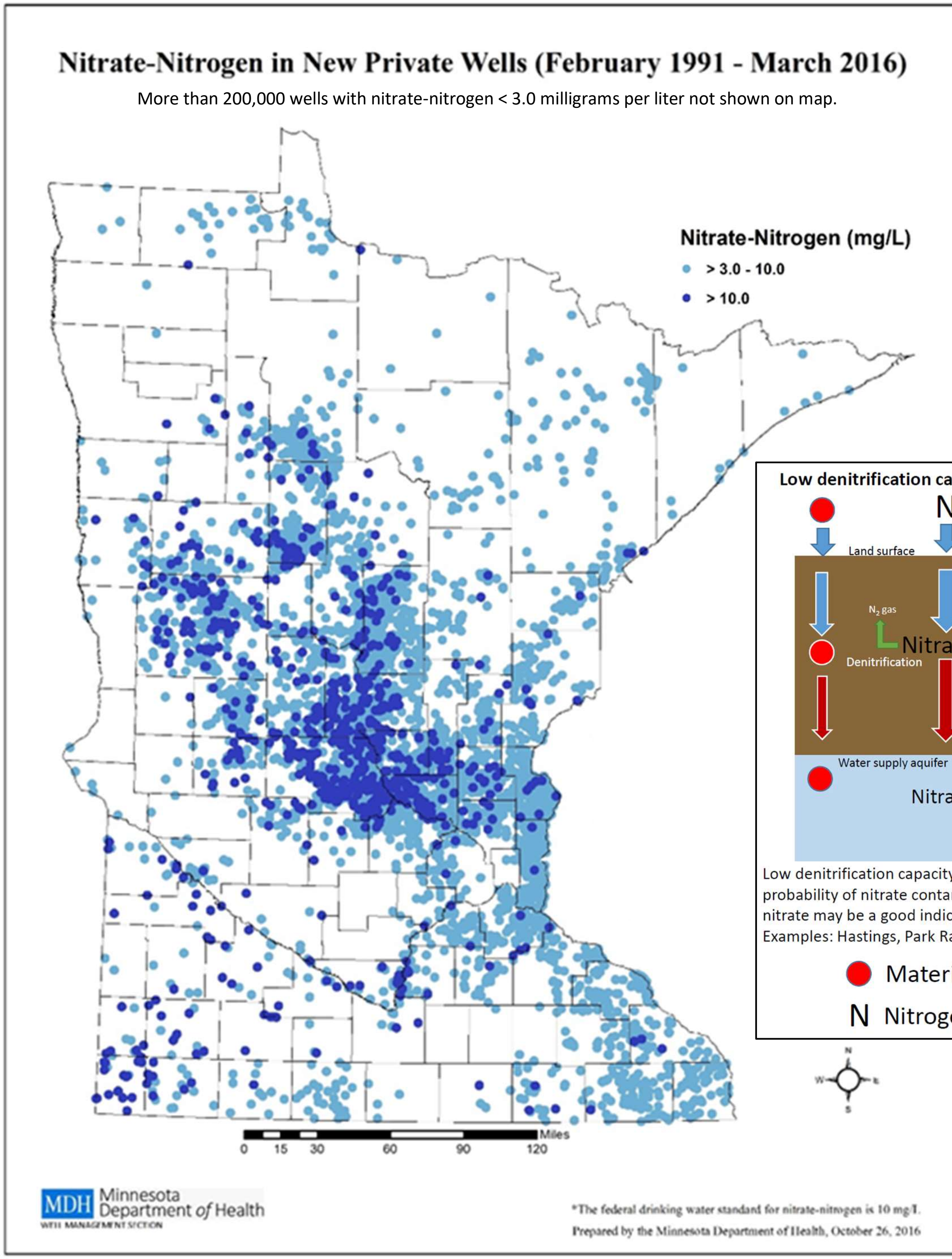
BUDGET ITEM	AMOUNT
USGS Personnel: Hydrologist/project manager (Jared Trost) (73% salary, 27% benefits) 30% FTE for 4 years. Leads project, conducts QA, analyzes data, leads publication writing, presents results at meetings.	$ 160,000
USGS Personnel: Hydrologist (Alyssa Witt) (71% salary, 29% benefits) 30% FTE for 4 years. Coordinates data collection and compilation, data analysis, publication writing.	$ 100,000
USGS Personnel: Hydrologic Technician (TBD) (74% salary, 26% benefits) 30% FTE for one year. Sample collection, ships samples, and ensure field data are entered into USGS public databases.	$ 35,000
USGS Personnel: Student or recent graduate employee (TBD): (81% salary, 19% benefits) 20% FTE for 4 years. Assists in GIS, data collection and field activities.	$ 20,000
USGS Personnel: Program Management and Quality Control (72% salary, 28% benefits) 11% FTE for 4 years. Project supervision, staff and other resource scheduling, quality control and technical support.	$ 42,500
USGS Personnel: Administrative and IT support (69% salary, 31% benefits) Two people at 5% FTE for 4 years. Provide support for funding agreements, cost accounting, billing, and information technology.	$ 38,500
Professional/Technical/Service Contracts: Soil core, water, and dissolved gas laboratory analyses at USGS laboratories or USGS contract laboratories.	$ 125,000
Professional/Technical/Service Contracts: Contract with DNR for project management, technical support, and drilling, equipment, supplies, and travel in support of the project. Funding would be a direct allocation to the DNR.	$ 111,000
Professional/Technical/Service Contracts: USGS contract fee for report preparation, editing, and production (Science Publishing Network) or scientific journal open-access fee. This includes electronic publishing and distribution of published products. Conference registration fees.	$ 10,000
Equipment/Tools/Supplies:USGS field supplies for collecting soil core samples, water samples, and dissolved gas samples, including shipping costs.	$ 10,000
Travel: USGS personnel 16 person-weeks of travel (vehicle usage, hotel, per diem) to locations in Minnesota to inspect potential sites; install monitoring wells; collect soil, water, and dissolved gas samples; and seal monitoring wells. One week of travel to project and scientific meetings within Minnesota, which may include overnight travel.	$ 12,000
TOTAL USGS + MN DNR ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 664,000

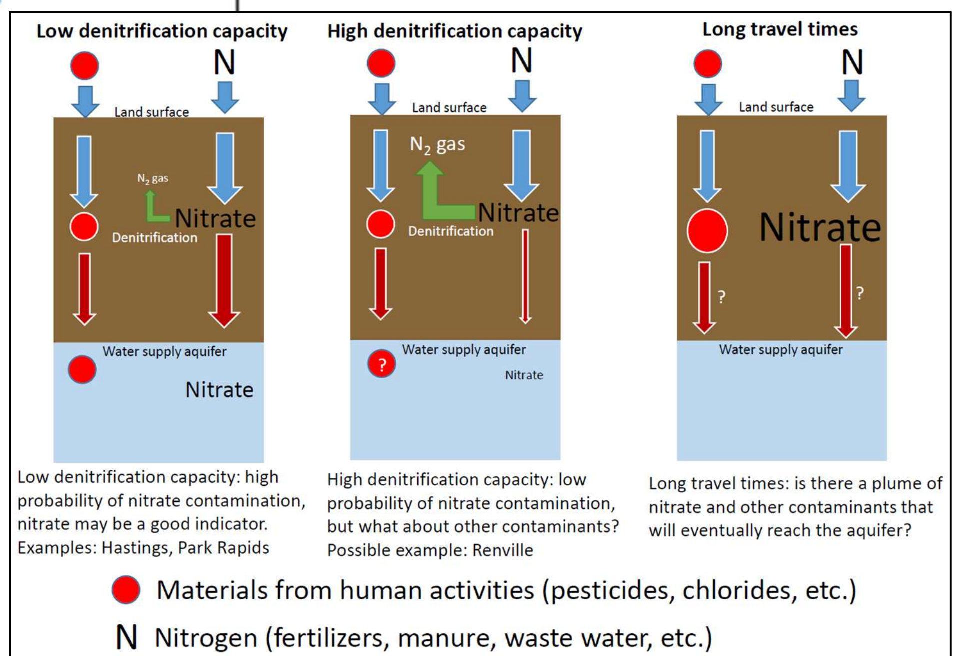
V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: USGS cooperative matching fundsin support of a portion of USGS facility and other indirect costs not covered by ENRTF request and travel to out-of-state professional meetings.	$ 75,000	*Pending*
Other State $ To Be Applied To Project During Project Period: DNR and MDH funding for USGS Joint Funding Agreement, in support of a portion of USGS facility and other indirect costs not covered by ENRTF request.	$ 150,000	*Pending*
In-kind Services To Be Applied To Project During Project Period: DNR, MDH, MDA staff time in support of project activities. DNR waiver of agency overhead for ENRTF requested funded.	$ 100,000	*Pending*
Past and Current ENRTF Appropriation: None	NA	
Other Funding History: None	NA	

Natural Denitrification: helping and hiding drinking water problems

My well has low nitrates. Does that mean my water is safe from surface contaminants? For how long will my water be safe to drink?





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Biography

Jared Trost has over 15 years of experience managing, leading, and publishing scientific research projects. He worked as a research project manager under Dr. Peter Reich at Cedar Creek Ecosystem Science Reserve from 2000-2008 and has worked at the U.S. Geological Survey since 2006, where he began as a part-time student, and transitioned to a full-time hydrologist in 2010. In his time at Cedar Creek, he managed all field operations for a large field experiment that included soil, soil-water, and groundwater sampling and co-authored five publications that examined topics including nitrogen effects on plant productivity, leaching losses of nitrogen and other contaminants, and soil-water dynamics under different crop types. In his current capacity as the site coordinator for the national USGS Toxic Substances Hydrology Program's Bemidji crude oil spill site, he has led many field investigations on contaminant fate and transport where redox conditions play a central role. He has experience in facilitating and communicating research to technical and lay audiences, having given many presentations at local and national meetings, including the American Geophysical Union and the Geologic Society of America. He is currently serving a second term as the elected chair of the Unsaturated Zone Interest Group (UZIG), an organization with over 420 members whose mission it is to advance unsaturated-zone science by fostering information exchange and collaborative studies among kindred groups across multiple organizations.

Education

2000, B.A. Biology and Chemistry, Augsburg College, Minneapolis, Minnesota
2010, M.S. Water Resource Science (Soil Hydrology emphasis), University of Minnesota.

Selected Publications

Jones, P.M., **Trost, J.J.**, Diekoff, A.L., Rosenberry, D.O., White, E.A., Erickson, M.L., Morel, D.L., and Heck, J.M., 2016, Statistical analysis of lake levels and field study of groundwater and surface-water exchanges in the northeast Twin Cities Metropolitan Area, Minnesota, 2002 through 2015: U.S. Geological Survey Scientific Investigations Report 2016–5139–A, 86 p., http://dx.doi.org/10.3133/sir20165139A

Sihota, N.J., **Trost, J.J.**, Bekins, B.A., Berg, A., Delin, G.N., Mason, B., Warren, E., and Mayer, K.U., 2016, Seasonal variability in vadose zone biodegradation at a crude oil pipeline rupture site: Vadose Zone Journal, v. 15, no. 5, 14 p.

Trost, Jared J.; Kiesling, Richard L.; Erickson, Melinda L.; Rose, Peter J.; Elliott, Sarah M. Land-cover effects on the fate and transport of surface-applied antibiotics and 17-beta-estradiol on a sandy outwash plain, Anoka County, Minnesota, 2008–09; 2013; SIR; 2013-5202

Organization

The U.S. Geological Survey's mission is to provide unbiased science about the natural hazards that threaten lives and livelihoods, the water, energy, minerals, and other natural resources we rely on, the health of our ecosystems and environment, and the impacts of climate and land-use change. USGS scientists develop new methods and tools to enable timely, relevant, and useful information about the Earth and its processes. With respect to water resources, USGS scientists work with local partners to monitor, assess, and conduct targeted research on the wide range of water resources and conditions, including streamflow, groundwater, water quality, and water use and availability.