

**Environment and Natural Resources Trust Fund  
2019 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 033-AH**

Influences of Glacial Sediment Chemistry on Water Quality

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**Category:** H. Proposals seeking \$200,000 or less in funding

**Sub-Category:** A. Foundational Natural Resource Data and Information

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**Total Project Budget: \$** 199,244

**Proposed Project Time Period for the Funding Requested:** June 30, 2022 (3 yrs)

**Summary:**

Glacial sediments cover much of Minnesota, but little is known about their chemistry. Our project will assess their role as sources of natural contaminants such as arsenic, sulfate, and phosphorous.

**Name:** Chad Wittkop

**Sponsoring Organization:** Minnesota State University - Mankato

**Title:** \_\_\_\_\_

**Department:** Department of Chemistry and Geology

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Mankato MN 56001

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**Web Address**

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**Location**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

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**Alternate Text for Visual:**

Map showing thickness of glacial sediments in Minnesota. Examples of how sediment chemistry may influence the environment.

<input type="checkbox"/>	Funding Priorities	<input type="checkbox"/>	Multiple Benefits	<input type="checkbox"/>	Outcomes	<input type="checkbox"/>	Knowledge Base
<input type="checkbox"/>	Extent of Impact	<input type="checkbox"/>	Innovation	<input type="checkbox"/>	Scientific/Tech Basis	<input type="checkbox"/>	Urgency
<input type="checkbox"/>	Capacity Readiness	<input type="checkbox"/>	Leverage	<input type="checkbox"/>		TOTAL	<input type="checkbox"/> %
<input type="checkbox"/> If under \$200,000, waive presentation?							



**PROJECT TITLE: Influences of glacial sediment chemistry on water quality**

**I. PROJECT STATEMENT**

The majority of Minnesota is underlain by thick (typically 100 feet or more) glacial deposits, which form the foundation for our prized lakes and landscapes. **These sediments also represent natural sources of contaminants of concern such as arsenic, sulfate, and phosphorus, but the data needed to fully evaluate the influence of these sediments on the environment are lacking.**

Known and suspected cases in which glacial sediment chemistry influenced water quality can be found throughout the state. In western and southwestern Minnesota, glacial sediments are the primary source for arsenic in drinking water. In the Minnesota River basin, erosion of river bluffs composed of glacial sediments is a primary contributor to surface water impairment, and may also represent a source of phosphorus to surface waters. Sulfate is a contaminant of ongoing and emerging concern in many parts of the state, and interactions between glacial sediments and groundwater may represent a major natural source of sulfates to surface waters and groundwater. And new research suggests sediments may represent significant sources of nitrogen in some systems.

In recent decades, Minnesota’s geologic mapping and drilling efforts have placed our state at the scientific forefront in understanding the distribution, texture, and rock composition of glacial materials. However, much less is known about the chemistry of these sediments. We therefore propose to add a comprehensive chemical dimension to glacial sediment analysis in Minnesota. Our project has three primary goals:

1. Characterize a wide range of environmentally relevant chemical parameters from a representative set of samples from glacial deposits around the state.
2. Evaluate cost effectiveness and scientific outcomes of several analytical methods and identify best practices for ongoing work.
3. Conduct statistical analysis of newly generated data within the context of existing environmental quality data, and disseminate these findings to stakeholders.

Within the context these goals, we aim to provide technical data that is relevant to regulators and consultants, as well as plain language summaries for non-technical audiences. Our project will involve undergraduate students at three institutions in all dimensions of the fieldwork, data collection, and analysis. This work model adds further benefit to the state by cross-training future environmental professionals in two fields (glacial geology and geochemistry) that rarely intersect in the undergraduate curriculum.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:** *Comprehensive chemical analysis of representative glacial materials across Minnesota*

**ENRTF BUDGET: \$152,100**

**Description:** **The majority of our time and effort will focus on comprehensive sediment analysis to assess the potential for glacial materials to influence soil and water quality.** Completion of this activity will provide the first 3-dimensional framework for evaluating glacial sediment chemistry in the state. We will partner with the Minnesota Geological Survey to collect representative samples of glacial sediment and samples of sediment near the mouths of the three major rivers in the state to re-evaluate the influence of glacial sediments on their chemistry. The inorganic chemical (elemental) composition of the samples will be analyzed in parallel at Gustavus Adolphus College and Minnesota State University Mankato using both high precision (e.g. ICP-MS) and low precision (e.g. XRF) techniques. The organic carbon and carbonate content of sediments will also be determined. A subset of samples will be processed using more specialized techniques, including nutrient extraction and sediment fingerprinting analysis using radiogenic isotope and zircon U-Pb dating.

Outcome	Completion Date
1. <i>Collect glacial sediment samples from surface sites, archived cores, and major rivers representative of materials from across the state</i>	12/31/2020



**Environment and Natural Resources Trust Fund (ENRTF)  
2019 Main Proposal Template**

2. Chemically analyze the sediments using parallel techniques at both high and low levels of precision, and assess organic and inorganic carbon components	5/31/2021
3. Identify a subset of samples for detailed analysis including nutrient extraction and high precision sediment fingerprinting and complete this work	8/31/2021

**Activity 2: Technique evaluation and statistical analysis ENRTF BUDGET: \$36,400**

**Description:** We will comprehensively analyze the data generated in activity 1 to answer two primary questions: 1. Does a deeper understanding of glacial sediment chemistry shed light on recognized environmental problems? And 2. What techniques work best in the context of our materials? Statistical analysis will be guided through interaction with Carleton College students and faculty. A major objective of this activity will be to identify scenarios where low-cost techniques provide information relevant to environmental problems. This analysis will also allow us to leverage the data collected in Activity 1 into a framework of existing environmental data archived at various state agencies, including the Minnesota Geological Survey, Minnesota Department of Natural Resources, and Minnesota Department of Health.

Outcome	Completion Date
1. Evaluate results and identify scenarios where low cost techniques are informative relative to high cost approaches	8/31/2021
2. Compile key soil and water chemistry datasets and perform statistical analysis to evaluate influence of glacial sediment chemistry on the environment	6/30/2022

**Activity 3: Publish findings and disseminate results to stakeholders ENRTF BUDGET: \$9,600**

**Description:** Develop open-access publications, perform outreach, and make presentations to stakeholders.

Outcome	Completion Date
1. Develop publications and make presentations at in-state environmental conferences	Ongoing
2. Meetings with stakeholders (e.g. MPCA, DNR, local governments)	Ongoing

**III. PROJECT PARTNERS:**

**A. Partners receiving ENRTF funding**

Name	Title	Affiliation	Role
Julie Bartley	Professor	Gustavus Adolphus College	Project Co-Director

**B. Partners NOT receiving ENRTF funding**

Katherine St. Clair	Associate Professor	Carleton College	Statistical Consultant
Anthony Runkel	Chief Geologist	Minnesota Geological Survey	Sample selection coordinator

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

Data generated by this project will have decades of useful life, informing natural resource management in the state for years to come. Examples of possible implementations include informing sulfate management practices, and predicting aquifer quality based on sediment composition. This project will leverage investments in the County Geologic Atlas program, and we will work to distribute our findings in a manner that is informative to both professional scientists and the everyday citizen. Our project may stimulate additional work of this nature, but the resources required for completing the outcomes described above are requested in the current proposal.

**V. TIME LINE REQUIREMENTS:** Three years are required to facilitate the time-consuming activities of student training, sample collection, sample processing, chemical analysis, and data reduction and dissemination. The third year of the project will focus largely on statistical analysis and dissemination.

## 2019 Proposal Budget Spreadsheet

Project Title: Influences of glacial sediment chemistry on water quality

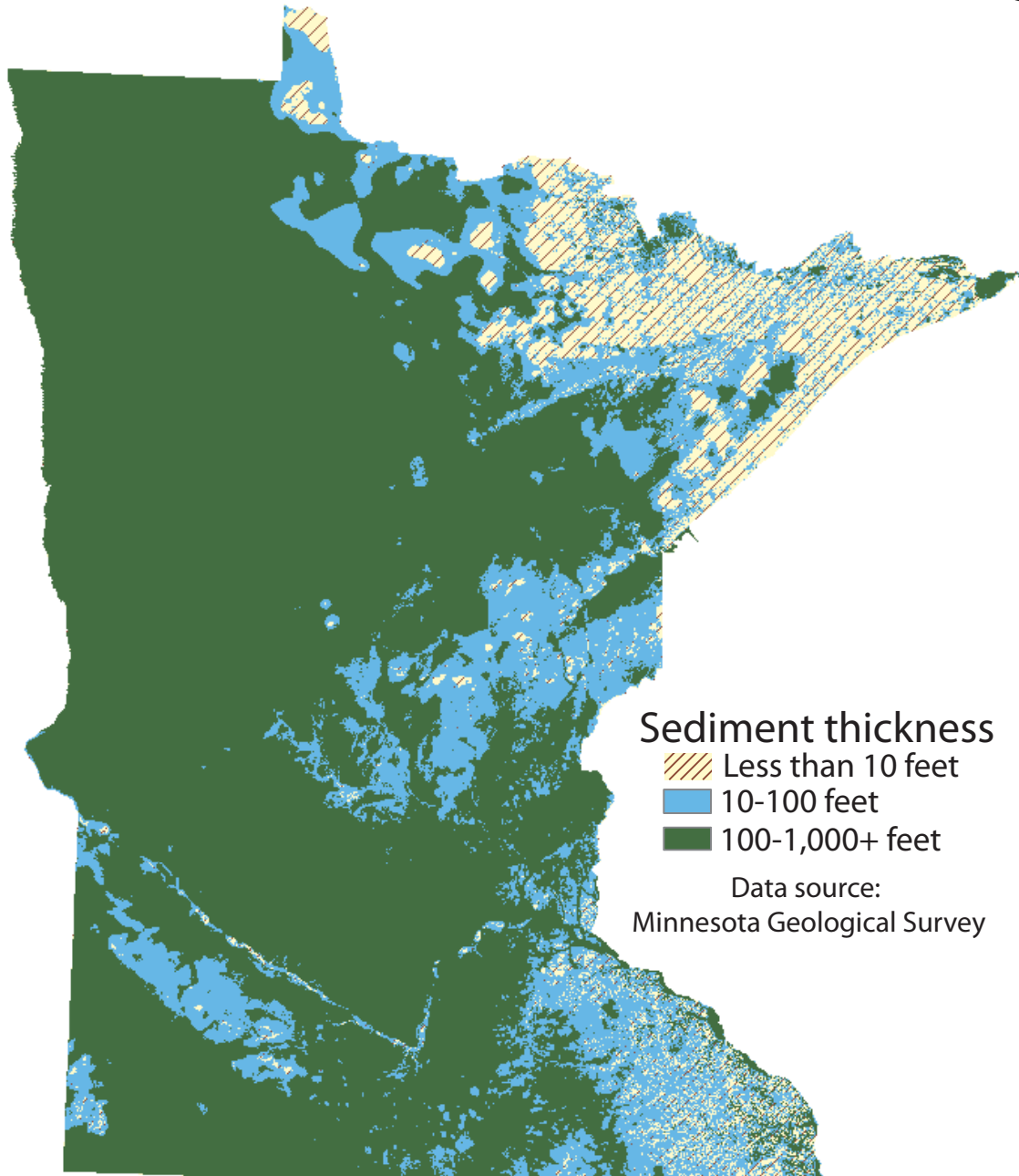
### IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM (See "Guidance on Allowable Expenses")	AMOUNT
Personnel: Chad Wittkop, Project Director (81% salary, 19% benefits); 11% FTE, Project coordination, supervision of undergraduate students, method development, project reporting,	\$ 33,986
Personnel: Undergraduate student researchers (92% salary, 8% benefits); 25% FTE durng academic year, 100% FTE during summers, 1 student per year for three years	\$ 24,912
Professional/Technical/Service Contracts: Contract to Gustavus Adolphus College for ICP-MS analysis and reporting. Personnel: Julie Bartley, Project Co-Director (\$30,754 total, 84% salary, 16% benefits); 11% FTE, Project coordination, supervision of undergraduate students, method development. Undergraduate student researchers (\$24,912 total, 92% salary, 8% benefits); 25% FTE durng academic year, 100% FTE during summers, 1 student per year for three years. Supplies and equipment (\$5,900 total): Argon gas, Li-borate flux, acids/consumables. In state travel (\$3,900 total) to collect core samples and present results, rates per comissioner plan.	\$ 65,446
Professional/Technical/Service Contracts: Sediment fingerprinting: zircon U-Pb analysis at University of Arizona Laserchron Center (no source in Minnesota)	\$ 26,000
Professional/Technical/Service Contracts: Sediment fingerprinting: radiogenic isotope analysis (contract with Trent University, ON or lab with similar capability - no source in Minnesota)	\$ 26,000
<b>Equipment/Tools/Supplies:</b>	\$ 13,300
Sample processing supplies (ball mill, sieves, cleaning solvents) \$1,600	
Sample cups for XRF analysis \$2,000	
He gas for XRF \$2,000	
P10 gas for XRF \$1,000	
Sample vials, acids, supplies for carbonate analysis \$800	
Consumables for nutrient extractions \$500	
Hach 2800 Spectrophotometer for nutrient analysis \$3,000	
Quantek CO2 sensor for carbonate analysis \$2,400	
Travel:In state to collect samples at Minnesota Geological Survey, Hibbing Core Repository, and various field sites. In-state travel to conferences and stakeholder meetings. Rates per commissioner plan.	\$ 4,000
<b>Additional Budget Items:</b> Publication costs, open access fees for Elsvier journals. 1 article each in Applied Geochemistry (\$2,600) and Geochimica Cosmochimica Acta (\$3,000).	\$ 5,600
<b>TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =</b>	<b>\$ 199,244</b>

### V. OTHER FUNDS (This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period:	N/A	
Other State \$ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: Minnesota State University Mankato overhead for state projects (12% of project total, \$23,909), Gustavus Adolphus College overhead (48% of salaries and wages, \$24,151).	\$ 48,060	Secured
Past and Current ENRTF Appropriation:	N/A	
Other Funding History:	N/A	

# A thick layer of glacial sediment covers bedrock across much of Minnesota



Little is known about the chemistry of these sediments, especially at depth. Glacial sediment chemistry may influence:

## Well water quality



Potential source of arsenic, manganese, and calcium (hard water)

## Surface water quality



Natural source for sulfate and phosphorous

## Soil health



## **Project manager qualifications**

**Chad Wittkop** is an Associate Professor of Geology at Minnesota State University Mankato (MSU). He will supervise students, oversee sample selection, manage chemical analysis at MSU, and lead in project reporting. He has professional experience in both agency and academic settings, and mapped glacial sediments for the New Hampshire Geological Survey in his early career. With MSU funding, he has spent the past two years working with Julie Bartley and the Minnesota Geological Survey to develop preliminary data and refine methods relating to the chemistry of glacial sediments in our region. He has managed external research projects funded by public and private foundations including the National Science Foundation (NSF) and the Huron Mountain Wildlife Foundation. He earned degrees in Geology from Winona State University (B.S., 1998), and the University of Minnesota (Ph.D., 2004).

**Julie Bartley** is an Associate Professor of Geology and Associate Provost at Gustavus Adolphus College. She will supervise students, manage high precision chemical analysis at Gustavus, and contribute to data analysis and project reporting. Since moving to Minnesota in 2009 she has worked as a collaborating scientist on water resource and geologic hazard assessment projects in the state. Over the past two years she has worked collaboratively with members of this project to develop preliminary data and methods relating to glacial sediment chemistry in the state. Her research has been funded by public and private foundations including the Petroleum Research Fund, the National Geographic Society, NASA, and NSF. She earned degrees in Chemistry from Bryn Mawr College (A.B., 1988) and UCLA (M.S., 1990), and a Ph.D. in Geology from UCLA in 1994. She was awarded a Postdoctoral Fellowship to Harvard University from 1995-1997.

**Katherine St. Clair** teaches in the Statistics Program at Carleton College. Through her own work and through guided student-based consulting projects she has served clients in academia, state and local government, and industry. She earned a B.S. in Statistics from University of Minnesota Duluth in 1999 and a Ph.D. in Statistics from the University of Minnesota in 2004.

**Anthony Runkel** is the Chief Geologist at the Minnesota Geological Survey, and will coordinate with project members to select and procure samples, and provide supporting geologic data.

Minnesota State University Mankato is a regional comprehensive university serving more than 15,000 students. The MSU Geology program maintains three research and instrumentation labs which support a range of externally funded projects serving local, regional, and national collaborators.

Gustavus Adolphus College is a church-related, residential liberal arts college firmly rooted in its Swedish and Lutheran heritage. Laboratories collaboratively supported by the departments of Chemistry and Geology serve numerous externally funded projects.