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

Project Title: **ENRTF ID: 087-B**

Sediment Impairments in Northern Minnesota Non-Agricultural Streams

Category: B. Water Resources

Total Project Budget: $ 335,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

In-stream particle/sediment formation is common in wetland streams. This project quantifies terrestrial and in-stream source contributions to sediment-impaired streams, emphasizing seasonal and hydrologic influences on in-stream sediment formation processes.

Name: Diana Karwan

Sponsoring Organization: U of MN

Address: 1530 Cleveland Ave. North

Saint Paul MN 55108

Telephone Number: (612) 624-2774

Email dlkarwan@umn.edu

Web Address https://www.forestry.umn.edu/people/diana-l-karwan

Location

Region: Northeast

County Name: Cook, Itasca, Koochiching, Lake, St. Louis

City / Township:

Alternate Text for Visual:

Map showing agriculture land cover in south of state and forest/wetland land cover in northeast. Impaired streams statewide are shown.

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

PROJECT TITLE: Sediment Impairments in Northern Minnesota Non-Agricultural Streams

I. PROJECT STATEMENT

Stream impairments due to excess turbidity and total suspended solids (TSS), a.k.a. "sediment," are common throughout Minnesota. While these impairments are linked to agricultural practices across much of the state, turbidity and sediment impairments in northeastern Minnesota are controlled by a different set of environmental factors. The characteristic wetland/peatland landscape and iron-rich geology of northeastern Minnesota strongly influence water quality here, and these factors may also directly prevent or promote suspended sediment formation in streams. While previous research in wetland/peatland streams has demonstrated that organic matter-rich waters can actively block the formation suspended sediments under some conditions, important questions remain regarding the sources of turbidity and TSS in these streams and the conditions related to these water quality impairments. These questions include:

- How much do landscape erosion and in-stream chemical processes each contribute to stream turbidity and TSS levels in northeastern Minnesota?
- What are the hydrological conditions that promote or suppress the formation of suspended sediments within these streams?
- How do seasonal conditions affect the amount of suspended sediment generated within these streams?

Resource management efforts to improve the quality of sediment-impaired streams will directly benefit from this research. By understanding the hydrological, seasonal, and chemical conditions related to suspended sediment formation, resource managers can target their mitigation and restoration efforts to the specific conditions responsible for turbidity and TSS impairments. The unique conditions leading to sediment formation in organic matter-rich waters are also highly relevant to other toxicity-related impairments throughout northern Minnesota, including those involving arsenic and mercury. Because particles formed via in-stream chemical processes are particularly chemically reactive, they readily adsorb other metals such as arsenic and mercury. Therefore, identifying the conditions that promote in-stream suspended sediment formation has direct application to the mitigation of other toxicity-related impairments.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Identification of sediment impaired streams and instrument installation **Budget: $135,357**

One sediment impaired stream and one non-impaired stream with similar stream and watershed characteristics will be selected. Stream measurements will include discharge and water depth; turbidity; stream temperature; pH; and concentrations of dissolved oxygen, dissolved and particulate organic matter, dissolved and particulate ions (e.g., iron, arsenic, etc.), and suspended sediment.

Outcome	Completion Date
1. Identify potential paired stream sites	*October 1, 2018*
2. Final site selection	*October 1, 2018*
3. Stream instrumentation for continuous discharge, stage, and water quality measurement and automated sampling of water and suspended solids during hydrological events	*May 31, 2019*

Activity 2: Stream monitoring, chemical analysis, and sediment source identification **Budget: $199,643**

Stream monitoring will continue for two years. Chemical analysis of suspended sediments and particulate materials from potential landscape erosional source areas will be conducted to establish the "chemical fingerprints" of these materials. Comparison of sediment chemical fingerprints to seasonal and

hydrological stream conditions (e.g., dissolved oxygen, iron, and organic matter concentrations; pH; temperature; discharge) will be used to assess in-stream vs. erosional contributions to turbidity and TSS loads.

Outcome	Completion Date
1. *Collection of particulate materials from potential erosional source areas for chemical and physical characterization ("chemical fingerprints")*	*August 1, 2019*
2. *Continuous monitoring of stream discharge, depth, pH, dissolved oxygen, temperature, and turbidity*	*May 31, 2021*
3. *Seasonal collection of baseflow stream water and suspended particulate samples, and high frequency sample collection during hydrological events (e.g., snowmelt, rain storms)*	*May 31, 2021*
4. *Chemical and physical analysis of stream water, suspended particulates, and erosional source materials*	*June 30, 2021*
5. *Comparison of in-stream particulates and erosional source materials to quantify erosional source contribution to streams*	*June 30, 2021*
6. *Comparison of particulate sources (landscape or stream derived) in impaired and non-impaired streams*	*June 30, 2021*

III. PROJECT STRATEGY

A. Project Team/Partners

Project Manager: Dr. Diana Karwan; Assistant Professor, University of Minnesota Department of Forest Resources

- Manages project design, site selection, landowner communications
- Receives funds from this request

Project Co-Manager: Dr. Lucy Rose; Postdoctoral Researcher, University of Minnesota Department of Forest Resources

- Assists with project design, site selection, landowner communications
- Manages instrument installation, sample collection, sample analysis, data analysis
- Receives funds from this request

B. Project Impact and Long-Term Strategy

This project will improve our understanding of water quality impairments in northern Minnesota by identifying the factors that contribute to elevated turbidity and TSS in organic matter-rich, non-agricultural streams. Specific impacts of this project include:

- A quantitative assessment of in-stream and landscape contributions to stream TSS loads
- The identification of seasonal, hydrologic, and chemical influences on elevated turbidity and TSS
- Characterization of the suppression/promotion of suspended particle formation by organic matter

The results of this work will provide actionable, relevant information for resource managers focused on maintaining and improving water quality in streams throughout northern Minnesota.

C. Timeline Requirements

As currently described, the project duration is 3 years. Following initial site selection and instrumentation, a data collection period of at least two years would be required for adequate evaluation of seasonal patterns of in-stream particulate formation.

2018 Detailed Project Budget

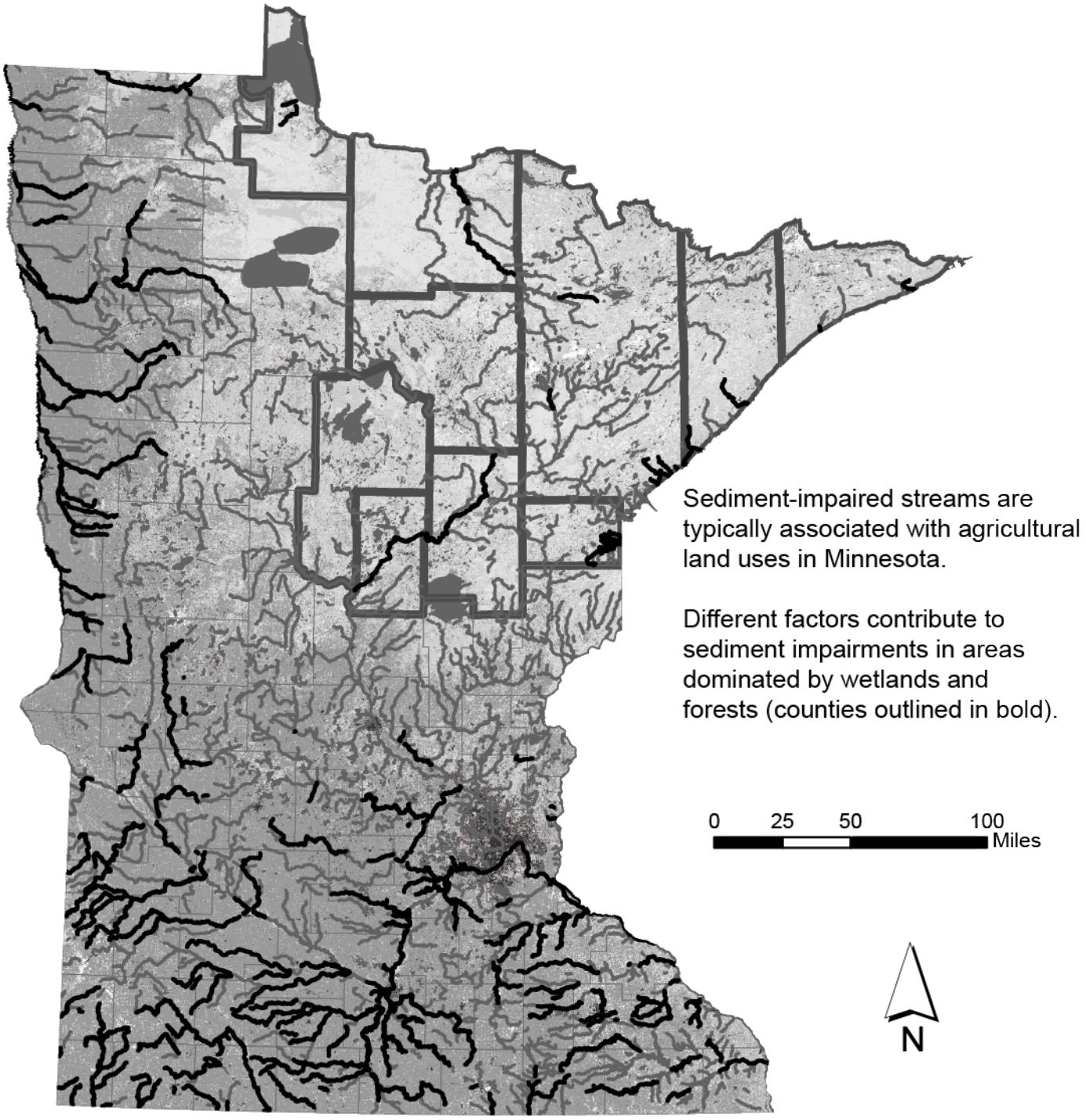
Project Title: Sediment Impairments in Northern Minnesota Non-Agricultural Streams

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel:	$ -
Diana Karwan, Project Manager; 4% FTE for years 1-3 (two weeks summer salary).	$ 20,101
Lucy Rose, Project co-Manager; 100% FTE for years 1-3.	$ 210,381
Undergraduate research assistant (TBD) (*During semester for years 1-3* : 93 % salary, 7% benefits at $14/hr for 10 hrs/week for 32 weeks; *During summer for years 1-3* : 100 % salary at $14/hr for 40 hrs/week for 10 weeks); 1 person in this position.	$ 31,534
Professional/Technical/Service Contracts:	$ -
Sediment physical analysis-- Dr. Kyungsoo Yoo's Laboratory (University of Minnesota); services provided: sediment particle surface area analysis; 90 samples	$ 3,000
Sediment chemical analysis-- University of Minnesota Research and Analytical Lab; services provided: sediment organic matter and trace metal analyses; 90 samples	$ 5,000
Water chemical analysis-- University of Minnesota Research and Analytical Lab; services provided: water organic matter and trace metal analyses; 270 samples	$ 10,000
Equipment/Tools/Supplies:	$ -
Continuous discharge sensor and datalogger (2 units)-- for stream depth and discharge rate measurement. Remains at University of Minnesota upon project conclusion to be used for future research.	$ 16,700
Automated water sampler (2 units)-- for stream water and suspended sediment collection	$ 8,400
Multi-probe sensor and datalogger (2 units)-- for in-stream measurement of dissolved oxygen, temperture, pH, conductivity. Remains at University of Minnesota upon project conclusion to be used for future research.	$ 12,000
Optical turbidity sensor and datalogger (2 units)-- for in-stream measurement of stream turbidity	$ 4,384
Field and laboratory supplies (gloves, filters, bottles, datalogger memory cards)	$ 3,500
Travel: Vehicle rental and lodging expenses to be reimbursed per University of Minnesota plan.	$ 10,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 335,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	N/A
Other State $ To Be Applied To Project During Project Period:	N/A	N/A
In-kind Services To Be Applied To Project During Project Period:	N/A	N/A
Past and Current ENRTF Appropriation:	N/A	N/A
Other Funding History:	N/A	N/A


Sediment-impaired streams are typically associated with agricultural land uses in Minnesota.
Different factors contribute to sediment impairments in areas dominated by wetlands and forests (counties outlined in bold).
0
25
50
100
Miles
N
Land Use / Land Cover
Agricultural
Wetland / Forest
Urban / Developed
Open Water
Sediment-impaired streams
Streams not impaired by sediment

PROJECT TITLE: Sediment Impairments in Northern Minnesota Non-Agricultural Streams

Project Manager Qualifications

Dr. Diana Karwan has over 10 years experience conducting and managing hydrologic research focusing on the effects of land cover change on water quantity, quality, and in-stream processes. She has authored several peer-reviewed journal articles on hydrology and sediment and given presentations at scientific conferences and for community groups on these studies (listed at https://www.forestry.umn.edu/people/diana-l-karwan) as well as led large teams collecting water quantity and quality data in forest, agricultural, and suburban landscapes in response to recent hurricanes in the mid-Atlantic USA. Most appropriate to this request, her work includes multiple projects on sediment chemistry, fingerprinting, and response to hydrologic conditions (see Karwan and others, *Forest Science*, 2007). Karwan is currently an Assistant Professor in the Department of Forest Resources at the University of Minnesota.

Dr. Lucy Rose has over 15 years of management and research experience focusing on forest ecology, hydrology, and biogeochemistry. In addition to conducting academic research at the University of Minnesota, University of Pittsburgh, and University of Illinois, she has also worked with researchers and land managers at the U.S. Forest Service and The Nature Conservancy. Dr. Rose has designed and implemented ecological research studies across spatial scales ranging from individual trees to entire watersheds and temporal scales ranging from a single hour to multiple years. She has authored or co-authored peer-reviewed publications on topics including fire ecology and management, nitrogen pollution in forest ecosystems, and pollutant emissions associated with natural gas extraction. In her current position at the University of Minnesota, she works with Dr. Karwan on field research examining changes in stream discharge, turbidity, and suspended sediment loads and sources following timber harvesting practices.

Organization Description

The University of Minnesota is a land-grant institution and research university with a strong tradition of education and service to the state. The Department of Forest Resources is the leading research and educational institution on forest related issues in Minnesota. For over 100 years the department has played a key role in discovering and fostering sustainable forest resource management activities in Minnesota.