Environment and Natural Resources Trust Fund

2025 Request for Proposal

General Information

Proposal ID: 2025-107

Proposal Title: Soil Health Management for Water Storage

Project Manager Information

Name: Marcelle Lewandowski

Organization: U of MN - Water Resources Center

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Project Basic Information

Project Summary: We will create guidance for watershed managers using in-field and near-riparian soil health practices to reduce streamflow. We will complete essential research and modeling connecting soil management to watershed impacts.

ENRTF Funds Requested: $500,000

Proposed Project Completion: June 30, 2028

LCCMR Funding Category: Water Resources (B)

Project Location

What is the best scale for describing where your work will take place?

Region(s): Central, SE, SW,

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Two of the state's most challenging water quality issues – excess sediment and nitrogen loads – are largely driven by the increasing rates of streamflow and increasing amounts and intensity of precipitation. While driven by climate, streamflow rates and volume can be mitigated by increasing water storage across the watershed to reduce or delay the precipitation that reaches the stream channel. One approach to increasing water storage is to replace surface storage that was removed from the land when wetlands and closed depressions were drained to allow for agriculture. A complementary approach is to increase the amount of water stored in the soil by improving soil structure and increasing soil organic matter. While soil water storage is theoretically important, we do not know the magnitude of possible changes in soil water retention, and we do not know where in a watershed to site soil water storage improvements to maximize impacts. This research will connect state investments in water storage to in-field practices.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

We will conduct the on-farm and model-based research needed to understand practical issues of soil water storage. Then we will create guidance to help watershed planners and land managers effectively use soil health management to help mitigating streamflow.

On-farm studies will measure soil health, soil aggregation, and soil water storage potential to determine the potential for realistic soil management practices to alter soil hydrology. While many studies have measured changes in soil carbon and biology in response to soil management, few have examined the changes in soil structure and hydrology. In addition, we will measure the potential for sub-soil water storage near riparian areas.

The field results will be used to adjust parameters in an existing model such as SWAT to ensure that the model accounts for changes to in-field soil hydrology. Then, the model will be run to quantify the potential impacts of land management on streamflow.

Practical guidance will be written based on the field and modeling work. The guide will be targeted at watershed planners and land managers to help them effectively prioritize land use change incentives and to improve the probability that land management practices will achieve desired outcomes

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

By quantifying the potential to change water storage capacity in agricultural lands, planners will be able to evaluate the impact on watershed goals of in-field practices in combination with structural storage practices. They will be able to effectively prioritize specific soil health practices and programs to achieve their water storage and water quality goals. Soil health approaches enhance agricultural production, so they keep land in production while protecting water.

Activities and Milestones

Activity 1: Model selection and sensitivity analysis

Activity Budget: $105,000

Activity Description:
We will examine several hydrologic models (e.g. SWAT, GSSHA, HSPF), and determine which is best suited for accounting for field-scale changes in soil health on the water balance for a representative watershed. In order to make this determination, we will review and consider the model's theoretical framework and availability of already-calibrated projects for agricultural watersheds in the Minnesota River basin. Once the appropriate model has been chosen, additional calibration will be conducted as needed to obtain accurate model predictions of watershed hydrology given current management and land-use. A sensitivity analysis will then be conducted on the calibrated model in order to quantify how the model's predictions of soil-water storage and streamflow change consider changes in input parameters related to soil health. The sensitivity analysis will employ a First Order approximation or Monte Carlo approach. A review of literature will be used to help identify input parameters to include in the sensitivity analysis.

Activity Milestones:

Description	Approximate Completion Date
Select a model that will best represent impacts of soil management changes	October 31, 2025
Complete sensitivity analysis to identify key soil parameters	December 31, 2025

Activity 2: On-farm measurements of soil hydrology

Activity Budget: $188,000

Activity Description:
Selecting fields that span a gradient of diversity, disturbance, and perenniality on two landscape positions, we will assess soil physical properties that drive model outcomes. Specifically, we will compare 1) conventional annual crop fields with full-width tillage, low diversity; 2) soil health management systems (SHMS's) of annual cropping systems; and 3) perennial systems including pasture, hay, or undisturbed grassland. By assessing bulk density, hydraulic conductivity, and soil water retention in these three types of systems, we will be able to deliver localized, realistic estimates of soil-water processes under different land use to inform modeling efforts.
The first fall will be devoted to identifying cooperating landowners and doing field visits to confirm soil type matches. In the second year, we will take samples shortly after planting, and midsummer, to capture some seasonal variability in soil processes (avoiding spring and fall to accommodate field work in annual cropping systems). Saturo dual-head infiltrometers will be used to assess saturated hydraulic conductivity. We will build a soil water retention curve and estimate curve number and available water capacity at 0-10 cm. Bulk density will be assessed using a 1" core, in 10 cm segments to 30 cm.

Activity Milestones:

Description	Approximate Completion Date
Select research sites	December 31, 2025
Measure infiltration and take soil cores	August 31, 2026
Analyze field data	May 31, 2027

Activity 3: Examine rapid infiltration and near-surface groundwater storage

Activity Budget: $85,000

Activity Description:
While Activity 2 is focused on water storage in farm fields, Activity 3 explores the potential to store or detain water below the surface near riparian areas. Runoff and drainage from farmed areas can be directed through coarse subsurface materials where water can be slowed and perhaps denitrified before reaching aquifers or stream channels.

Use the Quaternary soils data to locate optimal soil conditions where rapid infiltration of runoff could occur within a small watershed and investigate impacts of groundwater storage and the associated water quality. This activity is focused on subsurface hydrology below the root zone to explore the fate and transport of redirecting runoff into a shallow aquifer. The project's overarching goal is to measure and model practices to alter surface and near surface hydrologic pathways that can drain into ditches and streams and redirect water into the ground for longer term storage. This activity will quantify water storage, residence time and the concordant water quality in shallow aquifer systems and the viability of scaling up this practice in concert with soil health management systems (SHMSs) across southern Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Select study locations	November 30, 2025
Install pipe and data loggers	February 28, 2026
Collect data through 2026 and 2027 and provide the data to support Activity 4	January 31, 2028

Activity 4: Model watershed hydrology to scale up from field studies to watershed impacts. Write guidance.

Activity Budget: $122,000

Activity Description:
Use the field-measured soil properties and hydrology determined in Activity 2 to run the hydrologic model (from Activity 1) and investigate impacts of soil health management on watershed hydrology. These modeling activities will examine: how much change over how many acres is required to produce a significant change in streamflow out of the watershed; the proportion of the watershed that needs to have SHMSs to achieve streamflow goals; how the location of SHMSs in the watershed impacts streamflow; how impacts differ very near vs. far from the SHMSs; and how land management "upstream" from water storage structures impacts the function of the structure.
Write guidance for conservationists aiming to use SHMSs to meet watershed flow goals. The guidance will include results from the scenarios above, plus a comparison of the impacts of various soil health management practices (or combination of practices). Begin outreach activities to share the guidance with users.

Activity Milestones:

Description	Approximate Completion Date
Re-run model and simulations using field-validated parameters	October 31, 2027
Write guidance on using soil health management to meet streamflow goals	February 28, 2028

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Grace Wilson	U of M Dept of Bioproducts and Biosystems Engineering	Design and implement Activities 1&4	Yes
Dr. Anna Cates	U of M Dept of Soil Water and Climate	Design and implement Activity 2	Yes
Dr. Joe Magner	U of M Dept of Bioproducts and Biosystems Engineering	Design and implement Activities 3	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

The MN Office for Soil Health (MOSH) is equipped to share results from this project through its outreach activities and its network of local conservation and agricultural professionals. MOSH will also ensure the information is updated and linked to future research projects. Field data will be added to the G.E.M.S Soil Health Database – a privacy-protected system maintained by MOSH for sharing soil health measurements with other researchers for future analyses.
The soil health guidance will be shared with BWSR and PCA managers who support Comprehensive Watershed Management Plan development and implementation.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Quantifying New Urban Precipitation and Water Reality	M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 04e	$500,000

Project Manager and Organization Qualifications

Project Manager Name: Marcelle Lewandowski

Job Title: Senior Research and Extension Coordinator, Water Resources Center

Provide description of the project manager's qualifications to manage the proposed project.

In the past ten years, Marcelle has been the Principle Investigator or Project Manager for 15 grants, totaling $3.8 million received from federal and state agencies and private funders. For these projects, she has ensured completion of all project deliverables and reporting requirements, and coordinated teams that cross academic disciplines, government agencies at all levels, and the private sector. She has 25 years' experience in research and outreach related to soil and water quality management in agricultural landscapes, including work in soil health, watershed management and linking soil management to watershed outcomes. Marcelle coordinates the Minnesota Office for Soil Health.

Organization: U of MN - Water Resources Center

Organization Description:

The WRC is the primary coordination unit for U of M research, outreach, and graduate education related to water resources. In collaboration with U of M Extension, as well as state and federal agency partners, WRC develops and delivers outreach and professional education programs on agriculture and rural watersheds, urban stormwater management, on-site sewage treatment, and other topics. It manages 20-25 active grants, from federal, state, and private funders, totaling over $2 million at any one time, and working across disciplines and institutions. The WRC maintains sufficient permanent staff to complete all grant reporting and data submittal requirements in the timeframe required.

The Minnesota Office for Soil Health (MOSH) is a program housed in the WRC with base funding from the MN BWSR. MOSH helps local government and private sector agricultural professionals to develop practical soil management skills. MOSH facilitates networking among the public, private, and research sectors to advance applied soil health learning and outreach. Since its inception in 2018, MOSH-managed projects include five awards greater than $400,000 from state and federal agencies, plus several smaller awards.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Principle investigator		Project coordination and reporting. Lead writing of final guidance document.			27%	0.21		$29,799
Co-PI		supervise modeling work (Activities 1 & 4), contribute to sensitivity analysis, writing of reports			27%	0.45		$60,386
Co-PI		Design and implement Activity 2			27%	0.06		$9,958
Co-PI		Design and implement Activity 3			27%	0.45		$60,386
Graduate student researcher		Conduct modeling, analyze field data, write grant report and papers			53%	1.25		$176,622
Field and lab manager		Assist graduate student and faculty with field data collection and data management.			25%	0.45		$33,405
field staff (multiple undergraduates)		Assist graduate student and faculty with field data collection and data management.			0%	1.29		$44,138
Extension support		Assist in field work, data analysis, and outreach for Activity 2 and 4			25%	0.3		$24,964
							Sub Total	**$439,658**
Contracts and Services								
UC Davis	Professional or Technical Service Contract	Deuterium and O18 tests to determine residence time				-		$2,160
Farmer cooperators	Professional or Technical Service Contract	Access to farmland for soil sampling, and management data.				0		$9,000
							Sub Total	**$11,160**
Equipment, Tools, and Supplies								
	Tools and Supplies	Pressure transducers: Five @$600.	Measure near-surface water movement for Activity 3					$3,000

	Tools and Supplies	Field supplies including water containers, water sample containers, soil bags	Field data collection for Activity 2					$3,000
	Equipment	One new Saturo device ($6500) and maintenance expenses for the existing Saturo devices ($2,000).	to measure soil infiltration					$8,500
							Sub Total	**$14,500**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	3 destinations (with 3 sites each) X 350 miles/trip X 2 trips/yr = $4221 mileage and $1104 lodging (1 night/trip) per year for 3 years	Site visits for Activity 2 field data collection					$15,975
	Miles/ Meals/ Lodging	1 destination area (with 3 sites) X 250 mi/trip X 14 trips/yr = $3283 and $5152 for lodging (2nights/trip) for 2 years	Field data collection for Activity 3					$16,870
							Sub Total	**$32,845**
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	flight, conference registration, and hotel for one person	Professional conference to present project results	X				$1,837
							Sub Total	**$1,837**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$500,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	flight, conference registration, and hotel for one person	Conference attendance to present results from the project

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $500,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: f1d2100d-491.pdf

Alternate Text for Visual Component

The graphic illustrates the causal link from land management, to changes in soil properties, to changes in the amount and quality of water reaching the field edge, to changes in streamflow and water quality....

Supplemental Attachments

Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other

Title	File
UofM SPA Letter of Support-Lewandowski	3811bacd-c19.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, sale of products and assets, or revenue generation?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Jodi Rahn, U of M Water Resources Center, Finance Professional