Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-388

Proposal Title: Tools to Improve Downstream Hydrology and Water Quality

Project Manager Information

Name: John Nieber

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Basic Information

Project Summary: Project will enhance understanding of how increasing upstream storage moderates downstream flow and create tools that will improve siting and design of storage to improve downstream hydrology and water quality

ENRTF Funds Requested: $504,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Water (B)

Project Location

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

Region(s): SW, Central,

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

Region(s): SW, Central,

When will the work impact occur?

In the Future

Narrative

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

We see a dire need to provide better ways to improve storage design that will effectively offset current downstream impacts in the Minnesota River Basins (MRB).

The MRB with its tributaries is one of the most contaminated river systems in Minnesota. The MRB experiences high flows and flooding with associated water quality impacts from excessive sediment, nitrogen and phosphorus. Flow and its impacts are highly correlated so controlling flow can have multiple co-benefits.
The Basin has seen significant changes in land use and increases in precipitation since the 1930s, both increasing flow volumes and peak flows. Many past water resources studies and current practitioners have stated that increased storage is the most straightforward and effective way to mitigate increased flows, thus reducing flooding, stream erosion and improving water quality. But where do we locate the storage projects? Should they be upstream or downstream? How much area or flow volume must be treated to be effective? If we lower peak flows, do we make baseflows higher and more erosive?

We currently lack consistent methods to locate and design storage systems to estimate both the potential improvements and the net cost of improvements (cost–benefits) to downstream water resources from upstream 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 propose developing a cumulative basin tool that will assist storage design by providing integrated estimates of physical improvements in flow and water quality plus an economic evaluation of the improvements.

First, we propose investigating the best model for capturing the local hydrologic response to changes in land use and precipitation in the MRB. One likely option could be to leverage MPCA's extensive water quality work using the HSPF model for large subwatersheds in the MRB.

We propose creating cumulative watershed model that predicts downstream flow and benefits. The subwatershed models will be combined to provide a cumulative MRB model for estimating flow downstream. The HSPF model might be a good model with some extra definition of the mainstem longitudinal profile and cross-sections. We understand data are available from FEMA but might have some missing data that could be estimated from LiDAR. Finally, we will use a unit-cost approach to estimate the economic benefits, thus providing a cumulative cost-benefit number for the proposed storage

We will use this new MRB model to simulate a wide range of storage location and sizing scenarios that will help us understand how storage can be optimized to improve downstream hydrology in a large subwatershed.

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?

This work will provide clarity on the effects of storage on flow and impacts in the MRB that could help guide the best choices of practices for effectiveness and sustainability. It will also provide, for the first time, a simple storage decision support tool that will be useful to many water practitioners, to water resources projects like the One Watershed, One Plan, and local watershed management plans. In addition, any resulting improvements in storage design could provide relief from the observed higher flows and pollutants in the MRB.

Activities and Milestones

Activity 1: Development of Models Suitable for Local Hydrology

Activity Budget: $177,000

Activity Description:
This activity will collate available monitoring data for fields and subwatersheds and test existing hydrologic models using the selected data.
First, we will assemble available monitoring data for fields and subwatersheds to compile and curate a useful dataset. We will review national literature and datasets (USDA National Agricultural Library Ag Data Commons), local state research (MN, IA), Minnesota experimental stations (Waseca, Lamberton), and Minnesota agencies (MPCA, MN-DNR, MDA). Preliminary searching via our collaborators had yielded many (>15) sites with data that might be useful. The outcome of this task will be high-quality data suitable for small-scale model testing.
Second, we will compile and test hydrological models that can simulate field and subwatershed scale hydrological processes accurately. We will evaluate the characteristics that make these models suitable within the context of the MRB. We will include models that have been previously used in the MRB (e.g. HSPF, GSSHA). The top models will be tested for model performance at the field and subwatershed and compared to existing measured data. The outcome of this task will be a preferred small-scale hydrological model.

Activity Milestones:

Description	Approximate Completion Date
Define data needed for field tasks	September 30, 2027
Assemble available field-scale system monitoring data	December 31, 2027
Compile and test field-scale hydrological models	March 31, 2028

Activity 2: Develop a Routing Model Suitable for the Entire MRB

Activity Budget: $142,000

Activity Description:
This activity will involve development of a routing model to be utilized in conveying flows from subwatersheds flows to the outlet of the MRB. We propose to utilize the HSPF model for this purpose since it has been used previously by the Minnesota Pollution Contral Agency (MPCA) for simulating flows along the Main Branch of the Minnesota River. For this we will need to acquire additional channel cross-sectional data from available high-resolution LiDAR data and other some additional channel characteristics to be able to simulate routed flows accurately. We will use gauging station data from sites located along the river channel to verify the accuracy of the model. The tested model will then be suitable for routing flows downstream from the upstream sub-basins.

Activity Milestones:

Description	Approximate Completion Date
Develop the modeling tool for routing flows downstream from subwatersheds	June 30, 2028
Test the flow routing tool against observed river flows	September 30, 2028

Activity 3: Development of Economic Metrics

Activity Budget: $50,000

Activity Description:
In this task, we will develop unit economic metrics for changes in flow and pollutants to account for their externalized economic cost. For example, external costs can be achieved in public expenditures to deal with flood damage and sedimentation, or the installation of treatment systems at public water treatment plants to remove nutrients and pollution. Economists have already estimated the social costs of different types of water pollution. One recent study monetized the effects of excess nitrogen and another study looked at annual sediment impacts. However, none of these studies looked specifically at the negative impacts from excessive flow and how the positive effect of storage systems might be maximized through better choice of location and design.
The economic analysis in this task will develop unit economic costs for changes in flooding, sediment, and pollutants that are associated with flow. These unit values could be used in conjunction with estimates of MRB flow reductions from storage to create consistent cost-benefit metrics that include the benefit of downstream flow improvements.

Activity Milestones:

Description	Approximate Completion Date
Compile literature data on economic impacts of flow on flooding, sediment and pollutants	April 30, 2028
Summarize studies and create per-unit economic metrics	June 30, 2028

Activity 4: Tool for Minimizing Downstream Flows and Economic Costs

Activity Budget: $90,000

Activity Description:
This activity will develop tools for estimating and optimizing downstream flow reductions and economic benefits. First, we will couple the model flow outputs with the economic unit-process costs into a simple decision support framework. The resulting tool could then be used to evaluate storage design decisions at downstream locations within the MRB. The outcome of this task will be a simple tool that could improve storage design and increase benefits. Second, we will include a more complex optimization framework to help rank target projects by cost per unit flow reduction to help prioritize future regional planning work. This optimization approach will be useful to future revisions of One Watershed, One Plan assisting communities toward making rational and cost-effective choices.

Activity Milestones:

Description	Approximate Completion Date
Develop coupled flow and economic cost model	January 31, 2029
Develop optimization addon to flow-cost tool	April 30, 2029

Activity 5: Coordination, Reporting and Outreach

Activity Budget: $45,000

Activity Description:
The team will establish a Technical Advisory Committee (TAC) with experts from Minnesota Department of Agriculture (MDA), Minnesota Pollution Control Agency (MPCA), and Minnesota Department of Natural Resources. The TAC will meet every three to six months while the full project team will meet biweekly or monthly. Leveraging our existing relationships, we will establish a stakeholder group from cities, counties, watershed districts/organizations, and non-profits.

A draft and final report will provide documentation of the project and to clearly explain the proposed decision support framework/tool. Following the completion of the final report, our Team will develop draft and final training slides, then

conduct a one-hour workshop (recorded) on the proposed tool. The storage tool, workshop and user documentation will be stored on a public website. The project results and tool will be presented to our TAC and local conferences (see Dissemination).

Our team will provide periodic updates to the LCCMR as contracted. The updates will include status of the tasks, discussion of unexpected issues and resolutions, and up to date results.

Activity Milestones:

Description	Approximate Completion Date
Finalize proposed TAC members	September 30, 2027
Present a one-hour training webinar	May 31, 2029
Draft and final report	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Nigel Pickering & Geosyntec Team	Geosyntec, Inc.	Contractor will provide technical assistance for all aspects of the project including developing the conceptual framework, data collection, modeling, tool development, report preparation, and webinar preparation/presentation. Senior Engineer, Programmer, Economist, Data Analyst, GIS Analyst, and Administrator.	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
The results of this project will be disseminated by interacting closely with practitioners in our TAC and presenting the results at local conferences like the Minnesota Water Resources Conference, Minnesota Watersheds Conference, and the Regional International Drainage Symposium. All data collected will be available on the Data Repository for the University of Minnesota (DRUM) open data site. All reports, presentations, and other products from this project will acknowledge ENRTF funding using LCCMR's suggested guidelines.

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 primary outcome of this project will be an improved understanding of how upstream storage changes downstream hydrology. A secondary outcome will be a simple decision support tool for improved storage design that estimated flow reduction and economic benefits. These outcomes could be implemented in future One Watershed, One Plan efforts and could guide alternatives for proposed storage mitigation efforts. The proposed tool could be used in future storage design and permitting, be applied to other best management practices, and be extended to other regions in Minnesota.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Mapping Aquifer Recharge Potential	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 04h	$391,000
Protecting Minnesota's Headwaters of the Mississippi/Pineland Sands	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 04m	$1,693,000
Quantifying Environmental Benefits of Peatland Restoration in Minnesota	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 08l	$754,000
Flood and Drought Modeling for Minnesota	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 04j	$499,000
Road Salt Pollution of Surface Waters from Groundwater	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 08n	$622,000
Pilot Water Budget Framework for Managing Water Withdrawals	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 04s	$198,000

Project Manager and Organization Qualifications

Project Manager Name: John Nieber

Job Title: Professor

Provide description of the project manager's qualifications to manage the proposed project.
John Nieber has 45 years conducting research and teaching at major research universities (6 years at Texas A&M University and 41 years at the University of Minnesota). He has conducted research in hydrology and water quality problems during that time. He has published over 100 refereed journal manuscripts and is a license professional engineering and certified professional hydrologist.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Organization Description:
In the College of Food, Agricultural and Natural Resources Sciences (CFANS) at the University of Minnesota, we look at the bigger picture. When we envision a better tomorrow, it includes disease-resistant crops, products that protect our health, lakes free from invasive species, and so much more. We use science to find answers to Minnesota's and the world's grand challenges and solve tomorrow's problems. Almost 93 percent of students who earn CFANS undergraduate degrees find jobs in their career field or enter graduate school within six months of graduation.

The Department of Bioproducts and Biosystems Engineering, in CFANS, discovers and teaches solutions for the sustainable use of renewable resources and the enhancement of the environment. We discover innovative solutions to address challenges in the sustainable production and consumption of food, feed, fiber, materials, and chemicals by integrating engineering, science, technology, and management into all degree programs.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Principal Investigator		Oversee all project activities and manage the project to meet proposed deadlines.			36.6%	0.3		$34,833
Post-doc		The post-doc, with expertise in hydrology, will work with the project collaborators in to process available data and perform storage modeling. This person will also conduct economic analysis under the guidance of the collaborating economist.			26.1%	2		$192,624
Economics professional		Will provide advice to the project on the economic impact of changes in the upper basin			36.6%	0.1		$27,543
							Sub Total	**$255,000**
Contracts and Services								
Nigel Pickering and Geosyntec Team	Service Contract	Contractor will provide technical assistance for all aspects of the project including developing the conceptual framework, data collection, modeling, tool development, report preparation, and webinar preparation/presentation. Senior Engineer, Programmer, Data Analyst, GIS Analyst, and Administrator.				2		$245,000
							Sub Total	**$245,000**
Equipment, Tools, and Supplies								
							Sub Total	**-**
Capital Equipment								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**

Travel In Minnesota								
	Miles/ Meals/ Lodging		To visit field sites within the upper basin of the Minnesota River, and also visit locations along the main stem of the river					$2,000
	Conference Registration Miles/ Meals/ Lodging	registration at the Minnesota Water Resources Conference; 2 persons, 2 years	Present results of the project at the Minnesota Water Resources Conference in years 1 and 2					$2,000
							Sub Total	**$4,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$504,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

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

Total Project Cost: $504,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 6ac9d2e7-cec.pdf

Alternate Text for Visual Component

On the left is a graphical plot of sediment load related to discharge on the Minnesota River near Mankato. On the right is an image showing the mouth of the sediment laden Minnesota River (as it meets the Mississippi River) at Pike Island....

Supplemental Attachments

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

Title	File
letters of support	e2fb0da4-271.pdf
PROPOSAL SUBMISSION AUTHORIZATION	c3e1bb70-23a.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I understand the UMN Policy on travel applies.

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?

No

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:

Nigel Pickering, Geosyntec

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

Yes, I understand