Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)

Project Title: **ENRTF ID: 103-B**

Timing is everything: When is Groundwater in MN Recharged?

Category: B. Water Resources

Sub-Category:

Total Project Budget: $ 520,164

Proposed Project Time Period for the Funding Requested: June 30, 2024 (4 yrs)

Summary:

The goal of this project is to collect robust field data that allow us to determine when groundwater in Minnesota is recharged and quantify the amount of recharge.

Name: Salli Dymond

Sponsoring Organization: U of MN - Duluth

Job Title: Dr.

Department: Earth and Environmental Sciences

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Location:

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Groundwater recharge is assumed to happen after snowmelt, yet frozen soils can impede this. Alternatively, recharge may occur in the autumn, when soils are not frozen.

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

PROJECT TITLE: Timing is everything: When is groundwater in MN recharged?

I. PROJECT STATEMENT

Shallow groundwater is essential to the state of Minnesota, where, in addition to maintaining streamflow during dry periods, it is used for municipal and agricultural purposes. Despite its importance, we do not understand *when and how much precipitation* makes it into groundwater in our state, particularly in the northern regions. It is generally thought that most groundwater recharge in Minnesota occurs during spring snowmelt, after the ground thaws but before the growing season. One implication of this assumption is that warm winters might lead to reduced snowpack volume and thus reduced groundwater recharge. However, we suspect that a second 'window of opportunity' for recharge in the **autumn**, after leaf-off but before the ground freezes, is comparable in importance. This autumn recharge may be critical in maintaining groundwater reservoirs during warm or dry winters where spring recharge is reduced. Understanding the timing and amount of groundwater recharge is vitally important for managing these precious stores, especially during periods of extreme drought and flooding.

Our specific objectives are to:

1) Develop a network of research sites to measure precipitation, soil, and groundwater across the state.
2) Observe the timing and magnitude of groundwater recharge (spring, summer, or fall) at the different sites and identify the weather and soil conditions that influence the timing of recharge.
3) Develop and improve upon models for estimating groundwater recharge, with a focus on capturing the interplay between soil characteristics (i.e., moisture and temperature) and groundwater infiltration.

Almost three-quarters of Minnesotans rely on groundwater for drinking water, resulting in over 700 million gallons of water withdrawn per day.

- **The Challenge:** Groundwater overuse is of particular concern in the NE, SE, and Metro portions of the state. The sensitivity of groundwater recharge to seasonal soil conditions is not well understood.
- **The Issue:** We need the most scientifically sound models of groundwater recharge to predict aquifer response to climate conditions and thus ensure acceptable withdrawal rates.
- **The Opportunity:** Current groundwater models—including those embedded within climate models—are lacking in verifiable field-data about the timing and magnitude of recharge in the cold climate of Minnesota. Our monitoring network would provide missing field data that will be synthesized to improve these models, ensuring that they accurately represent physical processes controlling recharge.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Establish a network of research sites distributed across the state*

We will establish a network of five research sites across different climatic regions in the state. Where possible, we will overlap our sites with established field-based research sites, thereby leveraging existing facilities and avoiding costly duplication of efforts. We will add to their monitoring with any missing components. At each site we will aim to monitor weather conditions, soil moisture/temperature at various depths, groundwater, and streamflow. These data will be collected using continuously deployed sensors over a period of three full field seasons (May 2021 - November 2023). Additionally, we will characterize the overlying vegetation, topography, and predominant soils at each study site. Lastly, we will collect water samples periodically from precipitation, soil, groundwater, and streams to better understand water movement and fluxes throughout the system.

Outcome	Completion Date
1. Identification of five research sites across the state	*December 2020*
2. Installation of monitoring equipment and site-level assessment	*June 2021*
3. Characterization of site topography, soils, and vegetation	*September 2021*
4. Periodic collection of water samples for stable isotope analysis	*November 2024*
5. Continuous monitoring of weather and hydrology at each site	*November 2024*

ENRTF BUDGET: $456,639

Activity 2: *Synthesis of data and model assessment and development*
Current approaches to estimating groundwater recharge in MN rely heavily on the interpretation of stream hydrographs. While these methods are time efficient and require minimal environmental data, they are underpinned by simplifying assumptions that may not hold in our cold climates. Our proposed monitoring network will pair direct field observations of water movement and storage, allowing us to assess the validity of current recharge estimates. We will use our data to refine existing models of recharge that will allow for interfacing with climate-models.

Outcome	Completion Date
1. Compilation of data that will be publically available	*June 2024*
2. Quantify the amount of groundwater recharge across the sites	*June 2024*
3. Determine the timing of groundwater recharge at each site	*June 2024*
4. Refine existing groundwater models	*June 2024*
5. Disseminate results via publications and presentations	*October 2024*

ENRTF BUDGET: $63,525

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Dr. Salli Dymond	**Assistant Professor**	**UMN-Duluth**	**Lead PI**
Dr. John B. Swenson	**Associate Professor**	**UMN-Duluth**	**Co-PI**

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role

IV. LONG-TERM- IMPLEMENTATION AND FUNDING: This project will provide data to determine the timing and amount of groundwater recharge across different portions of the state. We will use the field-data to update existing groundwater recharge models to help the DNR better manage the state's groundwater resources. We will keep our sensors deployed at the existing sites, which have the potential to collect long-term data. This project directly addresses two LCCMR priorities for the 2020 funding cycle: A. Foundational Natural Resource Data and Information, and B. Water Resources.

V. TIME LINE REQUIREMENTS: We request funding for three full field seasons plus an additional 9 months to complete analyses and writing (July 1, 2020 - June 30, 2024). Three field seasons will increase the likelihood of capturing a wider range of thermal and hydrologic conditions and thus allow us to gain more physical insight into the feedbacks and history dependence that control the timing of groundwater recharge.

Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet
Legal Citation:
Project Manager: Dr. Salli F Dymond
Project Title: Timing is everything: When is groundwater in MN recharged?
Organization: University of Minnesota Duluth
Project Budget: $520,164
Project Length and Completion Date: 4 years (July 1, 2020 - June 30, 2024)
Today's Date: April 5, 2019

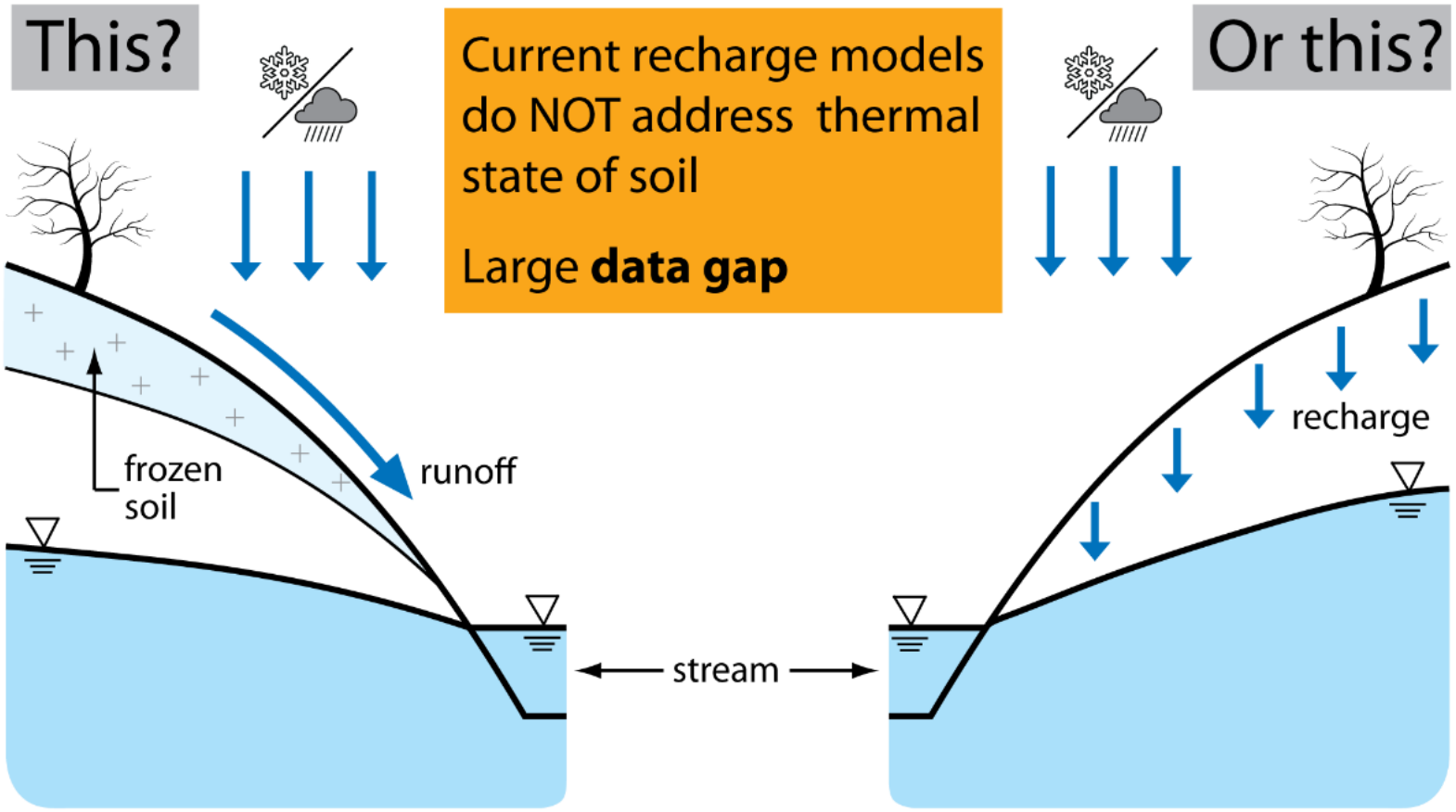
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 395,714	$ -	
University of Minnesota Duluth Assistant Professor summer salary (76% salary, 24% benefits); 16.5% FTE for years 1 and 2, 8% FTE for years 3 and 4 (total fringe + salary = $72,515)	$ -		
University of Minnesota Duluth Associate Professor summer salary (76% salary, 24% benefits); 16.5% FTE for years 3 and 4 (total fringe + salary = $63,525)	$ -		
UMD Graduate research assistant to collect, analyze, and evaluate field data. Salary (60% salary, 40% benefits); 63% FTE in years 1-3; 25% FTE in year 4; (total fringe + salary = $160,155)			
One part-time research technician to assist with school-year field sampling, engineering, and laboratory analyses (77% salary, 23% benefits); 25% FTE years 1-3; 16% FTE in year 4 (total fringe + salary = $53,371)			
2 undergraduate students to collect, analyze, and assist with data collection for 4 summers of the project (100% salary); 2 students at 25% FTE each years 1-3; 1 student at 25% FTE in year 4; (total salary = $46,148)			
Professional/Technical/Service Contracts			
	$ -	$ -	$ -
Equipment/Tools/Supplies			
Soil moisture and temperature sensors (3 per site x 5 sites x $1700 each)	$ 25,500		
Data loggers for recording data + solar panels and batteries for powering stations ($2200 each x 3 per site x 5 sites)	$ 33,000		
Field Materials (PVC pipe, screens, pea gravel - $300 each) and pressure transducers ($550 each) for shallow and deep groundwater monitoring (3 per site x 5 sites)	$ 12,750		
Soil augers (1 sand and 1 clay bucket) for installing equipment ($500 each x 2)	$ 1,000		
Field and lab computers for recording data (2 x $750 each)	$ 1,500		
Field consumables (flagging, notebooks, extra sensor parts and batteries) - $250/year x 4 project years	$ 1,000		
General lab consumables (glass vials, parafilm, label tape, standards) at $1000/year for 4 project years	$ 4,000		
Sample costs for O and H isotopes. $7/sample x 600 samples (150/year x 4 years).	$ 4,200		
	$ -	$ -	$ -
Capital Expenditures Over $5,000	$ 25,000		
Weather station for monitoring weather conditions and snowfall ($5000 each x 5 sites)			
	$ -	$ -	$ -
Fee Title Acquisition			
	$ -	$ -	$ -
Easement Acquisition			
	$ -	$ -	$ -
Professional Services for Acquisition			
	$ -	$ -	$ -
Printing			
	$ -	$ -	$ -
Travel expenses in Minnesota			
Travel for mileage (75%) and lodging (25%) within Minnesota for researchers, students, and technicians to monitor the 3 projects sites (located in Northern, Central, and Southern MN) throughout the year. A large amount of travel will be required due to the spread of research sites across the state and the need to visit them multiple times per year. Approximately 10 site visits per year planned. Where possible, loding will occur at provided bunkhouses or in campgrounds. Travel reimbursement will follow University of Minnesota protocols.	$ 16,500		
	$ -	$ -	$ -
Other			
	$ -	$ -	$ -
COLUMN TOTAL	$ 520,164	$ -	$ -

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:	N/A	$ -	$ -	$ -
State:	N/A	$ -	$ -	$ -
In kind: University Overhead (54% MTDC); MTDC base = $447,194	Secured	$ 241,485	$ -	$ 241,485

Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	Amount legally obligated but not yet spent	Budget	Spent	Balance
		$ -	$ -	$ -

Timing is everything: When is groundwater in MN recharged?

A field and modeling study to better understand and manage Minnesota's groundwater resources



1. Data will tell us **WHEN** and **HOW MUCH** water makes it to groundwater and streams in cold climates

2. Better management of groundwater resources during warm and dry years

05/12/2019

ENRTF ID: 103-B

F. Project Manager Qualifications and Organization Description

Project Manager and PI Dr. Dymond received her Ph.D. in Natural Resources Science and Management (with an emphasis on Watershed Hydrology) from the University of Minnesota in 2014. She worked as a research hydrologist for the USDA Forest Service Pacific Southwest Research Station from 2015-2016 before joining the Department of Earth and Environmental Sciences at the University of Minnesota Duluth as an assistant professor in 2017. Dr. Dymond's research interests focus on soil hydrology and the interaction between soils and plant water use. Relevant to this proposed project, Dr. Dymond has extensive expertise in designing, implementing, and monitoring large field-based campaigns. She has worked with a variety of hydrological data, including precipitation, snowpack, soil moisture, groundwater, evapotranspiration, and streamflow. She also is an expert in stable water isotope analysis. She teaches courses in watershed hydrology, ecosystems ecology, isotope hydrology, and soil science. Additionally, Dr. Dymond serves as an associate fellow of the University of Minnesota's Institute on the Environment, as a member of the American Geophysical Union's Ecohydrology Technical Committee, and maintains an active membership with the Society of American Foresters.

Co-PI Swenson received a Ph.D. from the University of Minnesota's Department of Geology and Geophysics in 2001. From 2000 onward, he has been a faculty member in the Department of Earth and Environmental Sciences at the University of Minnesota Duluth. Swenson's research interests focus on sedimentology and stratigraphy, hydrogeology, and heat transfer. Relevant to this proposed project, Swenson has expertise in the modeling of 1) heat and mass (groundwater) transfer in porous media and 2) moving-boundary problems, e.g. tracking a melting front. He teaches courses in Physical Hydrogeology and Well Hydraulics. In addition, Swenson serves as an industry consultant in the energy and minerals sectors, where he works on a wide range of problems in hydrogeology, heat flow, and sediment transport.

Organization Description

The PI's WaTER (Watershed and Tree Ecohydrology Research) Lab has storage space for field equipment, workspace for graduate students and undergraduate assistants, a workspace for building/programming sensors and dataloggers, and clean lab with microscopes and computers.

PI Dymond also has access to equipment at the Large Lakes Observatory (LLO), which is an institute within UMD. LLO currently houses five ~1000 square foot laboratories for organic, inorganic, and stable isotopic biogeochemistry, algal ecology, sedimentology, and a sediment core processing. A technician at the LLO, Julia Halbur, is supported part time by LLO department funds and part time by research grants and PI Dymond's startup funds.

The Earth and Environmental Sciences department has an accounts supervisor who help with administration of grants and personnel. There is also additional support from the UMD Sponsored Projects Administration, who assist with grant management.