Environment and Natural Resources Trust Fund
2010 Request for Proposals (RFP)

LCCMR ID: 005-A1

Project Title:

Quantifying Flows -The Missing Link in Managing Water

LCCMR 2010 Funding Priority:

A. Water Resources

Total Project Budget: $ $646,000

Proposed Project Time Period for the Funding Requested: 2 years, 2010 - 2012

Other Non-State Funds: $ $80,000

Summary:

Atlases quantifying the statewide temporal and geographical distribution of hydrologic flows will be developed and a network for monitoring the dynamic nature of hydrologic flows will be designed.

Name: John Nieber

Sponsoring Organization: U of MN

Address: 1390 Eckles Ave
St. Paul MN 55108

Telephone Number: (612) 625-6724

Email: nieber@umn.edu

Fax: (612) 624-3005

Web Address: www.bbe.umn.edu/nieber

Location:

Region: Statewide

County Name: Statewide

City / Township:

_____ Knowledge Base _____ Broad App. _____ Innovation

_____ Leverage _____ Outcomes

_____ Partnerships _____ Urgency _____ TOTAL

MAIN PROPOSAL

PROJECT TITLE: Quantifying Flows -- The Missing Link in Managing Water

I. PROJECT STATEMENT

Why this project is important: When humans extract more groundwater than what is available from the natural flow of the hydrologic system, it adversely affects the ecological services upon which humans depend for health and economy, and threatens the long-term viability of water availability (quantity and quality) for future generations. It is clear that we are living in a time of increasing demand for water coincident with the threat of imminent climate change, and as such the Minnesota Statewide Conservation and Preservation Plan has called for increased efforts to manage Minnesota water resources sustainably. Understanding water sustainability is analogous to understanding the state's budget. The flow of money through the state treasury determines the sustainability of state programs. Similarly, water flow through groundwater systems, not the water stored, represents the water available for use. This flow determines whether the use of water from a given area can be sustained. The County Geologic Atlas Program managed by the MGS together with the MnDNR groundwater monitoring program provide an excellent framework for understanding the extent of aquifers, and the amount and quality of water in them. A complete assessment of water resource sustainability requires knowledge of flows through groundwater and surface water systems, ***but is presently a critical missing piece***. Our proposed project will assess hydrologic budgets and flows through groundwater systems to develop tools needed for sustainable water resource management.

Goal of the project: Develop user-friendly tools for application in sustainable water management. These tools will include atlases of water flows at various scales within the state, computer-based algorithms for predicting temporal and geographical variations in hydrologic flows, and designed hydrologic monitoring networks.

How to achieve the goal: In our 2007 LCCMR project we have used a system analysis approach to define hydrologic unit areas that form the basis for analyzing hydrologic budgets and quantifying flows. That work is yielding estimates for average annual flow conditions, while for comprehensive sustainable water management it is necessary to look at changes in flow from year-to-year and even within years. In the proposed project we will use the system analysis approach with hydrologic data along with the established hydrologic unit areas to develop relationships necessary for predicting how hydrologic flows change with time and geographical location. The system analysis approach will be used with hydrologic data and established hydrologic units to design the water resources sustainability monitoring networks.

II. DESCRIPTION OF PROJECT RESULTS

Result 1. Develop atlases of shallow and deep groundwater recharge. **Budget: $60,000.**
In our 2007 LCCMR project we are developing atlases of deep groundwater recharge for three spatial scales, while in 2004-2007 the USGS developed regional recharge maps for shallow groundwater. In the proposed project we will combine the results from the two studies to provide atlases of total groundwater recharge at multiple spatial scales.

Deliverable	Completion Date
1. Report on procedures for unification of recharge estimates	06/30/11
2. Report of multiscale atlases of sustainable water supply	12/31/11

Result 2. Development of equations for the landscape water balance model. **Budget: $466,000.**
Available recorded data (streamflow, groundwater levels, air temperature, precipitation, etc) will be used to develop regional sustainability water flow relations for the established hydrologic units. These relations will make it possible to predict spatial and time variability of hydrologic flows in response to climate

variability, and variability in soils, landscapes, geology and land use. Along with the USGS we will also use recent USGS results for low-flow characteristics to build a tool for prediction of regional low-flows in streams, and associate these with risks of not meeting ecological streamflow requirements. The prediction tool will use the regional structure expressed by established hydrologic unit areas, and will be linked with the STREAMSTATS tool now being developed by the USGS (for MN/DOT) for Minnesota.

Deliverable	**Completion Date**
1. Report of the tools predicting low-flows and predicting the risk of sustained low-flows.	03/31/12
2. Atlases of variability of sustainable water supply as affected by climate change	05/31/12

Result 3. Design of networks for monitoring water flows. **Budget: $120,000.**
Regimes and patterns of stream flow, climate variables, and groundwater levels quantified and developed in Result 2 will be used in the design of monitoring systems for the integration of the essential components of the hydrologic cycle water balance. Recommendations and maps will be provided regarding the designed networks.

Deliverable	**Completion Date**
1. Report on method for network design	03/31/12
2. Map of network of monitoring sites	05/31/12

III. PROJECT STRATEGY

A. Project Team/Partners

The tasks will be conducted by the UofM in the lead role, partnering with South Dakota State University and the USGS (Mounds View). Team members: **UofM -** John Nieber, PI, collaborators Drs. David Mulla, Bruce Wilson, and Roman Kanivetsky, Three Graduate Research Assistants; **SDSU -** Boris Shmagin, 1.5 Graduate Research Assistants; **USGS –** Tim Cowdery, Mindy Erickson, Don Hansen, Dave Lorenz, Jim Stark; **Advisory assistance from EQB** – John Wells, Princesa van Buren

B. Timeline Requirements

Two year project duration. The proposed project requires two years to compile, link and analyze existing statewide hydrologic, landscape and climatic data. The identification of linkages between hydrologic data (streamflow, water levels in wells, water levels in lakes, etc.) and landscape features and climatic characteristics requires substantial analysis involving statistical and hydrologic modeling, and data mining techniques.

C. Long-Term Strategy

The proposed project builds on products generated in our 2007 LCCMR project, which is developing atlases of hydrologic unit areas and associated mean annual groundwater recharge rates for different spatial scales ranging from the state, to the region, to the county scale. The proposed project will use those established hydrologic units for developing multiscale atlases of trends and risks in water resource sustainability and for developing sustainability monitoring systems. Additional work will be needed in future to extend the methodologies and tools to other regions of the state. There is also a long-term goal to be able to develop a Quantitative Information System (QIS) for sustainable management of water resources including tools for assessing any shortfall of ecosystem streamflow needs. Our long-term goal is to see the development of a market mechanism of water sustainability. Such a system will make possible the design of a rational policy for human economic activities based on sustainable management of water resources.

Project Budget

IV. TOTAL PROJECT REQUEST BUDGET (2 years)

BUDGET ITEM	AMOUNT
Personnel:	
Roman Kanivetsky; 40% time - 83% salary, 17% fringe benefits	$79,000
Three Graduate Research Assistants; 50% - 61% salary, 39% fringe benefits	$227,000
One Undergraduate assistant; 25% - 90% salary, 10% fringe benefits	$11,000
Contracts: .	
South Dakota State University; Main effort for the hydrologic statistical analysis and development of prediction tools	$166,000
USGS - Mounds View; Development of risk analysis for low-flow conditions and linkage with impact on ecological services for aquatic systems	$160,000
Travel:	
Travel - Instate travel and travel specifically to Brookings, SD to foster collaboration. 880 miles per year at $0.55/mile; Hotel; 4 nights per year and 2 rooms (4 people total) per night at $70/room; 4 days of meals per year at 4 persons @$30 per person.	$3,000
Additional Budget Items: N/A	$0
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$646,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
The USGS will be able to match up to 50% of the USGS dollars requested. Because the Federal budget is not yet approved the final match is not known at present.	up to $80,000	Secured
	N/A	*N/A*
In-kind Services During Project Period: 5% of John Nieber's salary plus fringe for two years.	$15,215	Secured
Remaining $ from Current Trust Fund Appropriation (if applicable): Water Resource Sustainability (ML 2007, [Chap._30___], Sec.[__2__], Subd._5(i)____); as of May 1	$16,780	Secured
Funding History:	N/A	N/A

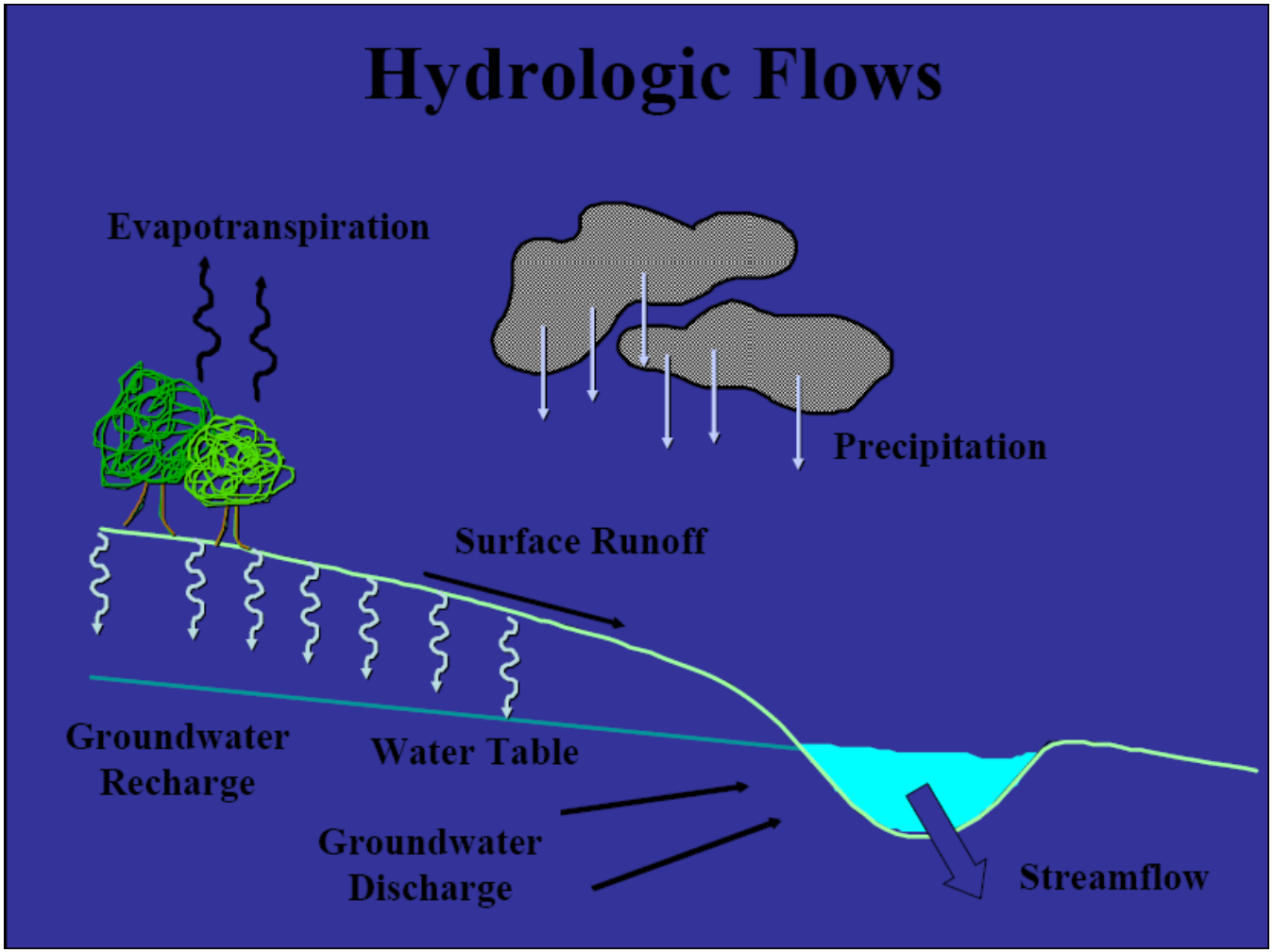

Illustration of hydrologic flows in the landscape. These flows need to be quantified in order to be able to manage water resources sustainably.

Project Manager Qualifications.

Dr. John Nieber is a professor in the Department of Bioproducts and Biosystems Engineering at the University of Minnesota. He has been a faculty member at the University of Minnesota since 1985, and prior to that he was a faculty member at Texas A&M University for six years. He teaches courses in hydrology and water quality, and specializes in research in the topics of flow and transport in the vadose zone and ground water, and water management engineering. In addition to this general area of research he is currently conducting research on highway drainage, development of environmentally friendly and cost-effective drainage ditch design, stream classification for TMDL assessments, assessment of stormwater BMP effectiveness, and modeling of the hydrology and biogeochemistry of wetlands for TMDL assessment of wetland systems. He is the Principal Investigator for the University of Minnesota contract with the MPCA's Impaired Waters and Stormwater Program (Master Contractor), and is Principal Investigator on a recently funded LCCMR project, "Water Resource Sustainability". He currently works with several graduate students and research associates in conducting his research. John Nieber works closely with other faculty in the department, including Drs. Bruce Wilson, Gary Sands, Roman Kanivetsky, and Sangwon Suh. The environmental and ecological engineering group also collaborates closely with other faculty in CFANS, the Institute of Technology, and the College of Biological Sciences. His responsibilities for the project on "**Quantifying Flows -- The Missing Link in Managing Water"** include:

- Manage all project personnel activities to keep the project on schedule with the stated objectives and outcomes/deliverables
- Work with selected physically-based models of flow in the vadose zone and ground water flow systems to assist with the interpretation of results derived from statistical analysis of hydrologic, climatic, and landscape data.

Organizational Description.

The research will be performed within the research guidelines of the University of Minnesota, and specifically it will be conducted within the Departments of Bioproducts and Biosystems Engineering (BBE) and Soil, Water and Climate (SWC). BBE is one of the new departments in the College of Food, Agriculture and Environmental Sciences (CFANS). An important part of the BBE department is the emphasis area of environment and ecological engineering. Working with John Nieber in BBE is Bruce Wilson, Roman Kanivetsky, and in SWC is David Mulla. The research will be conducted in collaboration with Boris Shmagin who is affiliated with the Department of Agricultural and Biosystems Engineering at South Dakota State University, and with Tim Cowdery, Mindy Erickson, Don Hansen, David Lorenz, and Jim Stark who are all affiliated with the USGS at Mounds View. Boris Shmagin brings expertise in regional analysis, time series analysis, and multidimensional statistical analysis. The USGS partners bring expertise in ground water and surface water hydrology, regional analysis, hydrologic frequency analysis, low-flow hydrologic analysis, and analysis of water quality data.

The university faculty (at both UofM and SDSU) work with an excellent group of undergraduate students, graduate students, and research associates. Both undergraduate students and graduate students will be significant participants in the proposed project, and these students will also help with the collaborations with the USGS and in fostering the collaboration between the UofM and SDSU. Dr. Mindy Erickson at the USGS is an Adjunct Assistant Professor in the Department of Bioproducts and Biosystems Engineering, and with that position is able to participate in advising graduate students at the UofM. The undergraduate and graduate students provide the opportunity for the project managers to try out new ideas that will help to enhance the outcomes from the project. The value of the synergistic outcomes from the undergraduate and graduate student contributions cannot be measured by the project cost allocated to those students.