Environment and Natural Resources Trust Fund (ENRTF)
2010 Work Program

Date of Report: November 23, 2009
Date of Next Progress Report: December 31, 2010
Date of Work Program Approval:
Project Completion Date: June 30, 2012

I. PROJECT TITLE: Strategic Planning for Minnesota's Natural and Artificial Watersheds.

Project Manager: David Mulla
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Location: Statewide

Total ENRTF Project Budget:	**ENRTF Appropriation**	**$ 327,000**
	Minus Amount Spent:	**$**
	Equal Balance:	**$ 327,000**

Legal Citation: ML 2010, Chap.[____], Sec.[____], Subd._____.

Appropriation Language:

II. PROJECT SUMMARY AND RESULTS:

Minnesota's natural and artificial watersheds are intimately linked. Artificial watersheds have significant areas that are drained using ditches and/or buried perforated pipes, leading to hydrologic characteristics that differ from natural watersheds. Water and pollutants from artificial watersheds often disturb the hydrologic regime and impair water quality in natural watersheds.

This project aims to protect Minnesota's natural watersheds by disconnecting them from the artificial watersheds. This can be done by using GIS techniques to identify locations that are suitable for installation of wetlands, riparian buffer strips, and perennial vegetation that will help manage the excess flows and contaminants from artificial watersheds. GIS data layers collected will include high resolution elevation and aerial photos where available, hydrology, land use, and soils. Efficient computer algorithms for analysis of high resolution elevation data and aerial photos will be developed to identify locations in the artificial watersheds where they are hydrologically connected to the natural watersheds. GIS techniques will be used to process the collected data layers and identify the optimum locations for wetlands, riparian buffer strips and perennial vegetation.

Project deliverables will include data maps, improved software for terrain analysis and image analysis, GIS based maps and reports documenting artificial watersheds and GIS based maps, and reports identifying optimal locations for the placement of wetlands and vegetated buffers to disconnect the artificial and natural watersheds. This project will lead to information that can be used to restore and maintain the integrity, purity and health of Minnesota's natural watersheds. Decoupling the artificial and natural watersheds is needed to reduce flooding and water quality impairments, expand wildlife habitat, increase supply of renewable energy, and reduce greenhouse gas emissions.

III. PROGRESS SUMMARY AS OF *November, 23, 2009*:

IV. OUTLINE OF PROJECT RESULTS*:*

RESULT 1: Geographic Spatial Databases

Description:

During this first period of the project, spatial data for the project will be gathered and organized into a geographic database. These data will include elevation, soils, land cover, and slope combined with locations of tiles, ditches, streams, rivers and other surface water bodies. The topographic data will consist of standard statewide elevation based on USGS digital elevation models (DEMs) as well as Light Imaging Detection and Ranging (LiDAR) data. Slope data will help characterize terrain and will be estimated from the DEM data. Soils data will be pulled from statewide SSURGO coverages. Artificial soil drainage will be partially derived from locations specified as hydrologic classes C and D in the SSURGO database. Land cover will be based on the USDA-NRCS 2008 Crop Land Database. DNR hydrologic data will be used to identify locations of ditches, streams, rivers and lakes.

These databases will be gathered, reviewed for content and accuracy, converted as necessary for cross-layer spatial compatibility (so they accurately overlay with each other) and then maintained as the knowledge base for analysis using GIS and topographic software.

Maps will be produced showing locations of the naturally- versus the artifically-delineated watersheds across Minnesota. These maps and reports will provide information relating to:

- The current state of these watersheds;
- Where these watersheds are relative to political boundaries (municipal, township, county, metropolitan);
- How these watersheds interact and affect the natural and public environment;
- Why these two types of watersheds need to be disconnected;
- How various land cover elements (ex: tiles or ditches) affect hydrological processes; and
- How wetlands and vegetation buffers will help to disconnect these two types of watersheds and improve public and natural environmental health.

A picture is worth a thousand words. These maps will be the visual representation of the background, study site and goals of this project. This type of representation will help users of all backgrounds to better understand the scope, need and application of the work that we will do in this project.

Electronic versions of all maps and and reports will be made freely available for public download via a website. Hardcopy maps and reports will be printed and made available for distribution during public presentations by University of Minnesota staff and to governmental or

public entities as requested. Some maps will have to be printed on large-format graphic printers which increase printing costs. Note that presentations and meetings about this study will extend well into the study period or potentially even after the study period, so these maps and reports will be used during the entire project period.

Summary Budget Information for Result 1:	**ENRTF Budget:**	**$59,000**
	Amount Spent:	**$**
	Balance:	**$ 59,000**

Deliverable	Completion Date	Budget
1. Assembled spatial databases	Dec. 2010	$49,000
2.Data maps and reports	Dec. 2010	$10,000

Result Completion Date: Dec. 2010

Result Status as of December 22, 2010

Final Report Summary:

RESULT 2: Computer Topographic Analysis Software

Description: Custom software will be developed to extract critical landscape features from the geographic spatial database and represent connections between the natural and artificial watersheds. This software will be custom-tailored and calibrated for accuracy with data from several well-studied small watersheds. The computer code in this software will be custom-tailored so it can efficiently analyze large datasets typical of LiDAR DEMs.

Calibration results will be discussed with experts for accuracy and usefulness towards project goals. Software refinement will be on-going until calibration results are acceptable to experts who are knowledgable about agriculture and watershed management. Software development and calibration routines will also be documented and posted on the project website. Project background and methods will be presented at public meetings and conferences as needed or requested.

Summary Budget Information for Result 2:	**ENRTF Budget:**	**$84,000**
	Amount Spent:	**$**
	Balance:	**$ 84,000**

Deliverable	Completion Date	Budget
1. Procedures and documentation of methods	Dec. 2011	$42,000
2.Geographic software and documentation	Dec. 2011	$42,000

Result Completion Date: Dec. 2011

Result Status as of June 30, 2011

Result Status as of December 21, 2011

Final Report Summary:

RESULT 3: Analyses of Artificial Watershed Improvements

Description:

Methods for defining critical areas for mitigation, and methods for decoupling the natural and artificial watersheds (ex: wetland restoration) will be refined and applied to the assembled databases. Critical landscape features will be identified and documented in maps and reports. Critical landscape features are regions that have a high potential for runoff and are in close proximity with surface water features. Wetland restoration is most feasible for critical landscape features that also have a high potential for collecting runoff and are located on soils with slow permeability (Hydrologic Classes C and D).

Final analyses will be conducted with the GIS and custom computer algorithms. The results will be validated with field observations, public input, and expert opinion. Critical locations in the watersheds will be identified to determine where buffers and wetlands can be placed naturally and where landscape modifications would be desirable and feasible. These locations will be based on criteria such as proximity to surface water, soil hydrologic class and terrain analysis attributes involving Stream Power Index (SPI) and Compound Topographic Index (CTI).

Final maps and reports will document these results. They will be made available electronically and in hard-copy form for agency and public use. The Board on Soil and Water Resources (BWSR), the Soil and Water Conservation Districts (SWCD) and the Minnesota Agriculture Department are the public agencies which will most likely be interested in these maps and reports. In addition, there will likely be significant interest in the software and map products from the DNR and MPCA. Given the growing regulatory environment concerning water quality, municipalities and county governments will be interested as well.

Maps and reports will be made available through the LCCMR website, as well as websites at BWSR and the University of Minnesota.

Summary Budget Information for Result 3:	**ENRTF Budget:**	**$184,000**
	Amount Spent:	**$**
	Balance:	**$ 184,000**

Deliverable	**Completion Date**	**Budget**
1. GIS-based maps and reports analyzing and documenting the artificial watershed of the state. These maps and reports will be made freely available for public use.	June 2012	$92,000
2. GIS-based maps and reports identifying the locations within artificial watersheds which are optimal for treating tile drain effluents based on considerations of topography, soils, and environmental benefits.	June 2012	$92,000

Result Completion Date: June 30, 2012

Result Status as of December 21, 2011

Result Status as of June 30, 2012

Final Report Summary:

V. TOTAL ENRTF PROJECT BUDGET:

Personnel: $ 308,000

Clarence Lehman	(30% FTE) $68,000
Mary A. Williams	(100% FTE) $120,000
Joel Nelson	(7% FTE) $10,000
Jake Galzki	(100% FTE) $100,000
Kevin Betts	(5% FTE) $10,000

Equipment/Tools/Supplies: $10,000

Equipment/Tools include 2 laptops with enough hard-drive and RAM to store and process GIS and LiDAR spatial data. These spatial data are very large datasets of detailed terrain data and require high-speed processors and large-capacity storage units – both for the computer's harddrive, and for external back-up and storage. Current university laptops that meet these requirements are used full-time for other projects.

Additional supplies and tools include the purchasing of published data (maps) supplementing agricultural spatial data and large-capacity external back-up data drives. Additionally, rewriteable CDs/DVDs and other supplies will be purchased to mail or distribute software programs, maps and documents.

Travel: $ 4,000

Travel expenses include travel for field surveys done for data verification, calibration and validation. This also includes travel to or the hosting of workshops or meetings for presentation or discussion of project goals, methodologies or results.

Additional Budget Items: $ 5,000

Additional items include license fees for specialized ESRI ArcGIS and other software necessary for the laptop computer processing of large spatial data layers.

TOTAL ENRTF PROJECT BUDGET: $327,000

Explanation of Capital Expenditures Greater Than $3,500: None

VI. PROJECT STRATEGY:

A. Project Partners: ***David Mulla*** (UMN Soil, Water, and Climate) is the project manager. He will supervise a GIS specialist (**Joel Nelson**), and a Research Fellow (**Jake Galzki**) who are both familiar with GIS and terrain analysis techniques. In addition, ***Clarence Lehman*** (UMN, Ecology) will provide his long-time software expertise to design algorithms, carry out the computer computations, data processing, and geographic mapping. ***Donald Wyse and Kevin Betts*** (UMN, Agronomy) will contribute their expertise on agricultural systems, including parameters related to their drainage and sustainability. They will provide essential connections with government and industry, including those who must supply information and those who can use the results. ***Mary A. Williams*** (UMN, Ecology) will provide her work experience with

software development, geographic information systems and spatial database development, integrating this with her training and knowledge in hydrogeology and watershed modeling. Project team partners will coordinate their efforts with several other ongoing related research efforts including the LCCMR Ecological Ranking of CRP project led by Julie Klocker at BWSR, the MDA Targeting BMP project led by David Mulla, and the LCCMR water/biofuel project led by Clarence Lehman.

B. Project Impact and Long-term Strategy: High-resolution LiDAR data are presently available for a fraction of the state, and the entire state will be covered by 2012. The methods developed in this project will be immediately available to utilize it as LiDAR data emerges. The state-wide results will be available as drainage systems are gradually rebuilt and improved as they age. The beneficial consequences of this project will therefore ripple through the century.

C. Other Funds Proposed to be Spent during the Project Period: None.

D. Spending History: None.

VII. DISSEMINATION: Results of this project will be disseminated through reports submitted to LCCMR and other interested entities. Presentations about project results will be organized with various agency and NGO entities.

VIII. REPORTING REQUIREMENTS: Periodic work program progress reports will be submitted not later than December and June of each year. A final work program report and associated products will be submitted between June 30 and August 1, 2012 as requested by the LCCMR.

IX. RESEARCH PROJECTS:

Attachment A: Budget Detail for 2010 Projects - Summary and a Budget page for each partner (if applicable)

Project Title: *Strategic Planning for Minnesota's Natural and Artificial Watersheds.*

Project Manager Name: *David Mulla*

Trust Fund Appropriation: $ *327,000*

1) See list of non-eligible expenses, do not include any of these items in your budget sheet

2) Remove any budget item lines not applicable

	July 2010 to Dec 2010			Jan 2011 to Dec 2011			Jan 2011 to June 2013				
2010 Trust Fund Budget	**Result 1 Budget:**	Amount Spent *(date)*	Balance *(date)*	**Result 2 Budget:**	Amount Spent *(date)*	Balance *(date)*	**Result 3 Budget:**	Amount Spent *(date)*	Balance *(date)*	**TOTAL BUDGET**	**TOTAL BALANCE**
BUDGET ITEM	*Geographic Spatial Database*			*Computer Topographic Software*			*Analyses of Artificial Watershed Improvements*				
PERSONNEL: total wages plus benefits											
Clarence Lehman (30% FTE)	15,000			38,000			15,000			68,000	
Mary A. Williams (100% FTE)	30,000			36,000			54,000			120,000	
Kevin Betts (5% FTE)							10,000			10,000	
Joel Nelson (7% FTE)				5,000			5,000			10,000	
Jake Galzki (100% FTE)	6,500						93,500			100,000	
[1]**Computers - NOT ALLOWED** unless unique to the project	1,500						1,500			3,000	
Printing	500			2,000			0			2,500	
[2]**Supplies** *(maps, computer supplies)*	2,000			1,000			1,500			4,500	
[3]**Travel expenses in Minnesota**	1,000			2,000			1,000			4,000	
[4]**Other** *(GIS software and other licenses)*	2,500						2,500			5,000	
COLUMN TOTAL	**$59,000**	$0	$59,000	**$84,000**	$0	$84,000	**$184,000**	$0	$184,000	**$327,000**	**$0**

[1] Two computers with enough harddrive and RAM to store and process GIS and LiDAR spatial data

[2] Supplies include acquisition of published data (maps) describing/supplementing agricultural spatial data, large-capacity external back-up data drives and CD/DVDs and other supplies to mail or distribute software programs, maps and documents.

[3] Travel expenses include travel for field surveys done for data verification, calibration and validation. Travel also includes travel to workshops or meetings for presentation or discussion of project goals, methodologies or results.

[4] Other includes license fees for specialized ESRI ArcGIS and other software necessary for the laptop computer processing.