Environment and Natural Resources Trust Fund
2009 Phase 1 Request for Proposals (RFP)

LCCMR ID: C20

Project Title: Cedar Creek Groundwater Project using Prairie Biofuel Buffers

Total Project Budget: $ $799,000

Proposed Project Time Period for the Funding Requested: July 2009 - June 2012 (3 yrs)

Other Non-State Funds: $ 338,000 from USGS

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Region:	County Name:	City / Township:
Central	Anoka, Isanti	East Bethel & Athens Townships within Cedar Creek Ecosystem Science Reserve

Summary: Develop quantitative data on annually cropped prairie buffers to remove emerging contaminants from water before they reach our streams, lakes, and aquifers—simultaneously producing perpetually renewable bioenergy and ecosystem services.

Main Proposal: 0808-1-061-proposal-0808-1-061-Main Proposal - Clarence Lehman.doc

Project Budget: 0808-1-061-budget-0808-1-061-Budget - Clarence Lehman.xls

Qualifications: 0808-1-061-qualifications-0808-1-061-Qualifications - Clarence Lehman.doc

MAIN PROPOSAL

PROJECT TITLE: Cedar Creek Groundwater Project using Prairie Biofuel Buffers

I. PROJECT STATEMENT

Develop quantitative data on annually cropped prairie buffers to remove emerging contaminants from water before they reach our streams, lakes, and aquifers—simultaneously producing perpetually renewable bioenergy and ecosystem services.

II. DESCRIPTION OF PROJECT RESULTS

Water quality, renewable energy, and habitat conservation—these three crucial issues are the subject of this renewal proposal for the prairie-biofuel/groundwater project funded in 2007. In its first year, that LCCMR project has already made a potentially major environmental discovery: prairie plants grown and burned for bioenergy remove antibiotic residues from the environment.* Antibiotic contaminants are recognized problems for the environment and for human health, with federal legislation and agency action aiming to reduce residual antibiotics. This proposal is to capitalize on our recent discovery by focusing on fine-scale and large-scale processes that determine the fate of these and other chemicals. The goal is to aid in the development of best management practices for implementation across the landscape. We are proposing to:

- **Fine-scale insights.** Use the instrumentation and infrastructure already installed for the current project to understand how contaminants are processed and consumed—within plant tissues and within the microbial soil community—and to understand how that can be used to benefit the environment.
- **Large-scale tests.** Test these ideas at the production level by applying selected methods from the existing project to working fields, with associated waters and buffers under varying slopes and soils.

Combining biofuel and water quality from the microscopic to the field scale makes this unlike anything that has been has been done before. It will prepare our state for large-scale watershed planning, including future drain-tile and buffer-strip structures, ultimately providing cleaner waters and local bioenergy throughout the state. Properly designed, perennial buffer systems will yield renewable energy to reduce our carbon emissions and our dependence on foreign oil while improving water quality and creating fish and wildlife habitat corridors spanning the state.

Result 1: Fine-scale insights. Budget: $541,000.

The aboveground plants that provide biofuels interact belowground with the unseen microbes of the soil to process and consume water-borne contaminants. Now that we have discovered that antibiotic contaminants are taken up by prairie plants, the next crucial step is to understand how to exploit that for environmental ends, and to extend it to other contaminants. We will apply major new technologies to (a) analyze how much of the contaminants are metabolized by microbes, how much by biofuel plants, and how much are absorbed intact; (b) examine interactions between the prairie, hay, and corn with their microbial communities; (c) document any development of antibiotic resistance in soil microbes; and (d) determine the best practices to combine bioenergy and water purification in agro-ecosystems.

This we will accomplish by analysis of water, soil, microbe, and plant tissue samples collected throughout the project, by water balance analyses, hydrological analyses of flow to recharge groundwater, and accumulation of contaminants in soil and roots.

Deliverable	Completion Date
1. Extended water purification measurements	10/30/2009
2. Base-line mechanistic measurements	1/30/2010
3. Final microbial assays and datasets	6/30/2011
4. Analysis and reporting	6/30/2012

** As indicated by enzyme-linked immuno-sorbant assay on below- and above-ground plant tissues, August 2008.*

Result 2: Large-scale tests. Budget: $258,000.
Full-sized fields will provide biofuel and water-quality data to complement intensive plot-level results and prepare for biofuel/water-quality production sites that can span the state. Applying what is learned in the finely instrumented plots of the existing project to the varying topography and soils of working agricultural fields will test contaminant removal under actual biofuel production conditions. Hydrological sampling points and instruments will be used to verify parameters including water balance and water use. A prime candidate for field-scale work is the Elm Creek site already established with past LCCMR funds.

Deliverable	Completion Date
1. Establishment of field-scale infrastructure	1/15/2010
2. Measurements at the field scale	1/15/2011
3. Analysis and reporting	6/30/2012

The two results described above are interrelated and synergistic, but separate enough that either of them could be pursued independently.

III. PROJECT STRATEGY AND TIMELINE

A. Project Partners. This project is a continuing partnership between the University of Minnesota (UMN) and the United States Geological Survey (USGS). Team members from the USGS include James Stark, Richard Kiesling, Perry Jones, Goeff Delin, and Jared Trost. Team members from the UMN include David Tilman, John Nieber, Linda Kinkel, and Donald Wyse. Bioenergy, microbial, and soil processes are aspects managed by the UMN; contaminant analysis, surface and groundwater hydrology and chemical processes are aspects managed by the USGS. The UMN will receive $386,000 and the USGS will receive $413,000 in this proposal.

B. Project Impact. This project will have broad impact by demonstrating how working lands can provide both products and services. This strategy will stem the loss of conservation lands and ultimately promises (1) profitable buffers to reduce contamination of groundwaters, (2) reduced water consumption in biofuel production, (3) increased habitat for wildlife and longer habitat corridors, (4) enhanced biodiversity, and (5) reduced greenhouse gas emissions.

In addition, the project will extend scientific knowledge to practical issues and will be visible through scientific publications, public reports, and public tours of the study sites. The project will also extend partnerships between the University and the USGS and will immediately leverage LCCMR funds to include substantial federal contributions.

Related to this project, land application of biosolids is likely to become more prevalent, but biosolids applied to food crops generate serious health concerns. In contrast, biosolids applied to biofuel lands, where contaminants can be absorbed by the plants and subsequently eliminated when the biofuel is burned for heat and power, could become a workable solution. This project will provide information to guide that possible solution.

The ideas can be applied to broad areas of the state, providing important ecological and economic benefits to the region and setting examples for neighboring states to follow.

C. Time. This is a three-year continuation proposal. Its first year will establish field-scale and microbial-scale infrastructure and initial measurements. Its second year will encompass detailed measurements provided for in the first year. Its third year will be for evaluation, analysis, and reports. Funds are be allocated more heavily to measurements in the first two years.

D. Long-Term Strategy. This project is part of a long-term strategy, funded through various sources, to use perennial buffers and basins to accomplish energy production, water purification, and other services to society. Perennial landscapes can purify tile drainage, sub-surface flow, and surface runoff from agricultural and urban areas before the waters reach our streams, lakes, and aquifers. That will not only help our waters but will also irrigate and partially fertilize biofuel areas, increasing yields for farmers and in the process improving the state's carbon footprint.

Project Budget

IV. TOTAL PROJECT REQUEST BUDGET

BUDGET ITEM	AMOUNT	% FTE
Personnel: Academic salary and benefits (Lehman/Nieber)	$ 73,000	21%
Personnel: Civil Service salary and benefits (field research assistant)	$ 121,000	100%
Personnel: Civil Service salary and benefits (research interns)	$ 34,000	29%
Personnel: U of MN undergraduate salary and benefits	$ 32,000	29%
Personnel: Graduate Student salary and benefits	$ 83,000	100%
USGS Subcontract: Personnel, equipment, and analytical cost for sampling water quality	$ 413,000	
Equipment/Tools: sampling equipment, sample storage equipment, batteries, and related items.	$ 21,000	
Acquisition (Including Easements):	N/A	
Restoration:	N/A	
Other: Cost for analysis of field samples (non-USGS samples)	$ 13,000	
Other: Shipping, repair of equipment, and mileage reimbursement	$ 8,000	
Other: Travel	$ 1,000	
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$ 799,000	

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Remaining $ From Previous Trust Fund Appropriation (if applicable): ML2007 (5n) appropriation to "Cedar Creek Groundwater Project using Prairie Biofuel Buffers." Includes only funds available after 7/1/09.	$ 161,000	*Unspent*
Other Non-State $ Being Leveraged During Project Period: United States Geological Survey (USGS) matching funds. $167K matched to existing appropriation, $338K matched to renewal appropriation.	$ 505,000	*Secured*
Other State $ Being Spent During Project Period:	N/A	
In-kind Services During Project Period:	N/A	
Past Spending: $249K trust fund + $77K match already spent, another $249K trust fund + $166K match allocated for spending prior to 7/1/09	$ 741,000	

Project Manager Qualifications

Clarence Lehman is an adjunct faculty member in the Department of Ecology, Evolution, and Behavior, College of Biological Sciences, at the University of Minnesota. For six years he served as Associate Director of Cedar Creek Natural History Area, the University's ecological research site, where this project is proposed to be situated. (Now named Cedar Creek Ecosystem Science Reserve.)

His academic degrees are all from the University of Minnesota, with Masters and PhD received studying under Prof. David Tilman, one of the participants in this proposed project. Clarence Lehman's research covers theoretical, experimental, and computational ecology, renewable biofuel energy and the planet's future temperature trajectory, biodiversity and its ecosystem properties, connections between ecology and economics, and restoration of natural habitats. He has restored several areas of native prairies, savannas, and wetlands in northwestern Minnesota and maintains them through specialized experiments for adaptive management (www.cedarcreek.umn.edu/lehman/2001-01-26/).

Clarence Lehman has experience designing a number of experiments related to the present proposed project, including the computerized aspects of the design and layout of Cedar Creek's two long-term biodiversity experiments and its long-term carbon dioxide enrichment experiment. He also has designed and managed three practical prairie experiments located in northwestern Minnesota to determine best establishment practices, seeding times, and burning frequencies for restored native prairies. He is the project manager on two LCCMR grants, one on bioenergy and water purification, another on bioenergy and wildlife conservation. He also designed and established a new prairie biofuel experiment located on the St. Paul Campus of the University of Minnesota, in partnership with David Tilman.

Scientific papers authored and coauthored cover topics such as biodiversity and the functioning of ecosystems, habitat destruction and extinction, competition among species, environmental change, long-term carbon cycling, and ecological economics. (www.cedarcreek.umn.edu/biblio/citation/iaLehman.html). He was a principle author of the prescribed burning plan for maintaining prairie areas at Cedar Creek and a co-author on the Science paper on carbon-negative biofuel (Tilman et al., Science 314:1598-1600, Dec. 8, 2006). He also has long-term experience in computer science and practical experience in the business world. Software development related to this project includes a computer system to select native prairie plants suited to a specified geographic location in Minnesota under specified soil, moisture, and sunlight conditions.

Organization Description

Cedar Creek Ecosystem Science Reserve is a research station, managed and funded through the College of Biological Sciences at the University of Minnesota. Cedar Creek's mission is to understand our planet's ecosystems and how they are changing under human pressures.