Environment and Natural Resources Trust Fund
2012-2013 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **145-I**

Modern Microbiological Analysis of Public Drinking Water Supplies

Topic Area: I. Water Resources

Total Project Budget: $ 145,355

Proposed Project Time Period for the Funding Requested: 2 yrs, July 2013 - June 2015

Other Non-State Funds: $ 0

Summary:

This project will determine the microbiological safety of a public water supply (that is not disinfected) from a small community in central Minnesota.

Name: Timothy LaPara

Sponsoring Organization: U of MN

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Location

Region: Central

County Name: Crow Wing

City / Township:

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

PROJECT TITLE: Modern Microbiological Analysis of Public Drinking Water Supplies

I. PROJECT STATEMENT

Within the century, unrestricted access to safe drinking water has become an implicit expectation of modern society. Indeed, the National Academy of Engineering lists "Water Supply and Distribution" as the fourth-greatest achievement of the 20th Century, just behind electrification, the automobile, and the airplane and just ahead of electronics, radio, and television (www.greatachievements.org). Prior to the last century, however, drinking water was often unsafe, possibly carrying deadly diseases, such as cholera, dysentery, and typhoid – diseases that are essentially unknown to modern-day Minnesotans.

The principal technology that protects Minnesotans from these horrible diseases is drinking water disinfection; virtually all public drinking water supplies, therefore, are treated with either chlorine or chloramine to prevent the spread of dangerous microbial diseases. Since the 1970s, however, the scientific community has recognized a consequence of drinking water chlorination, in which the chlorine unexpectedly reacts with naturally-existing organic matter in the water to generate unwanted, cancer-causing compounds. This had led to a "drinking water paradox" in that the chlorine that protects us from horrible, deadly diseases (like cholera and dysentery) can actually cause a horrible, deadly disease like cancer (albeit *much* later in life). Although the disinfection of drinking water has continued (and will continue), substantial (and successful) efforts have been made to reduce the presence of these cancer-causing agents in Minnesota's drinking water, the chlorination of drinking water will always lead to the generation of these compounds in our drinking water.

Although most public drinking water supplies are disinfected, there are numerous examples in Minnesota in which public drinking water supplies are not chlorinated. These are almost all small, rural communities that use groundwater as a source-water (i.e., a surface water is *never* used as a source-water without disinfection). In these cases, public health is protected by the generally high quality of groundwater (wells are rarely contaminated by disease-causing microorganisms) and by microbiological monitoring for fecal coliforms (to detect the rare cases in which wells are contaminated). Fecal coliforms are bacteria that are easily detectable in water and suggest the presence of fecal material – thus they *indicate* the possible presence fecal organisms that might cause disease. In the unlikely occurrence that these small communities have fecal coliforms in their drinking water, they are then forced to disinfect their water to ensure that the water consumers are protected from microbiological diseases.

It is clearly the *ideal* scenario for these small communities to provide microbiologically safe water without disinfection, as it avoids the potential hazards posed by disinfection by-products while reducing their cost to generate drinking water. Unfortunately, the approach behind detecting "fecal coliforms" is inherently flawed – it merely detects the possible presence of fecal material, which then reflects an increased likelihood of disease. A much better approach would be to directly detect specific disease-causing organisms to ensure that public health is protected. Unfortunately, these microbiological techniques have been developed only within the last 5-10 years (in the past, the fecal coliform test was the best available assay), such that there is a substantial gap in our knowledge and ability to protect public health with drinking water that are not disinfected.

The goal of this project, therefore, is to provide a detailed microbiological analysis of a small, central Minnesota community water supply – both at the well and at the tap (note: the community has requested to remain anonymous). Because we will be directly detecting known pathogens, rather than merely an indicator of fecal material, we will be able to definitively assess the microbiological safety of this drinking water supply. This project, therefore, should lead to one of two outcomes: (1) the microbiological safety of this water will be confirmed, suggesting that chlorination is unnecessary, and (2) disease-causing organisms will be detected, demonstrating that the microbiological safety of this water is questionable and that this drinking water should be chlorinated to protect public health. The outcome of this research will have broad implications for the numerous small communities throughout Minnesota that provide drinking water to their citizens without chlorine or chloramine disinfection.

II. DESCRIPTION OF PROJECT ACTIVITIES

In this project, therefore, water samples will be collected monthly for a period of at least one year from two specific tap water locations (from one residence and from City Hall) from a small community in central Minnesota as well as directly from the City's well. It is necessary to collect samples from these locations because the raw well-water might be microbiologically safe but then become contaminated as it is distributed throughout the City. Similar samples will also be collected from the City of St. Paul (a surface water source) and the City of Blaine (a groundwater source) to provide a basis of comparison for municipal water supplies that have been disinfected. Total genomic DNA will be extracted and purified from these samples and then used as template to quantify the following organisms by quantitative real-time PCR: adenovirus, hepatitis A virus, rotavirus, *Escherichia coli*, *Enterrococcus* spp., *Bacteroides* spp., and various genes that encode resistance to antibiotics. This research will allow us to confirm that the microbiological quality of this drinking water is safe for human consumption, which would be enormously beneficial for small communities using very quality groundwater as their source-water without the expense and concerns associated with chlorination.

Activity 1: *Sample collection and quantification of specific microbes* **Budget:** $145,355

Include detailed description of the activity you are proposing to do here.

Outcome	Completion Date
1. Sample Collection	July 2014
2. Genomic DNA extraction and purification	August 2014
3. Quantification of specific microorganisms by quantitative real-time PCR	December 2014

III. PROJECT STRATEGY

A. Project Team/Partners

Dr. Timothy M. LaPara (Department of Civil Engineering, University of Minnesota) will be responsible for coordinating the entire project and co-mentoring of a graduate student (yet to be hired). Dr. LaPara has considerable expertise in municipal wastewater treatment, having published more than 40 manuscripts that have been published in the peer-reviewed literature. An anonymous City in central Minnesota will also participate and serve as a partner on this project.

B. Timeline Requirements

The first year of this project will be devoted to collecting (and preserving) water samples and training the graduate student on the techniques required to quantify the specified organisms. The second year will be devoted to quantifying the organisms of concern (this should take 3-6 months), collating the data and interpreting its meaning (this should take < 3 months), and sharing the results with interested end-user. We anticipate that, in addition to the unnamed participating community, the Minnesota Department of Health, numerous small communities that do not currently disinfect their public water supplies, and the Minnesota Rural Water Association.

C. Long-Term Strategy and Future Funding Needs

The proposed project will be completed within the two-year project period. Additional work could be carried out (at additional communities) in the future, with the cost borne by the individual communities (or other sources).

2012-2013 Detailed Project Budget

IV. TOTAL ENRTF REQUEST BUDGET: 2 years

BUDGET ITEM	AMOUNT
Personnel: Timothy M. LaPara, Project Manager. 6 weeks of salary per year plus associated fringe benefits. Duties: Project management, graduate student supervision, results dissemination	$ 47,010
Personnel: Graduate Student, University of Minnesota. Funding for a graduate student for two years plus associated fringe benefits (including tuition). Duties: sample collection, quantification of genes, assistance with report preparation	$ 83,344
Equipment/Tools/Supplies: Supplies to collect samples (vaccuum pump, glassware, filters, etc), extract genomic DNA & RNA (commercially available kits), and perform quantitative polymerase chain reaction (reagents)	$ 12,500
Travel: *Travel to Central Minnesota to collect water samples*	$ 2,500
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 145,355

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	$ -	
Other State $ Being Applied to Project During Project Period:	$ -	
In-kind Services During Project Period:	$ -	
Remaining $ from Current ENRTF	$ -	
Funding History:	$ -	

Project Manager Qualifications

***Timothy M. LaPara,* Associate Professor, Department of Civil Engineering, University of Minnesota**

Education
B. S. C. E., 1995, Civil Engineering, University of Notre Dame
Ph.D., 1999, Environmental Engineering, Purdue University

Research and Teaching
Dr. LaPara's research is focused on the role of drinking water treatment, municipal wastewater treatment, and industrial wastewater treatment in preserving environmental quality and in protecting public health. Dr. LaPara teaches courses in the design of municipal water and wastewater treatment facilities and in environmental microbiology.

Organization Description
The University of Minnesota-Twin Cities is the state of Minnesota's largest institution of higher education