Environment and Natural Resources Trust Fund
2015 Request for Proposals (RFP)

Project Title: **ENRTF ID:** **044-B**

Solving Problems From Pesticides and Spills in Minnesota

Category: B. Water Resources

Total Project Budget: $ 440,000

Proposed Project Time Period for the Funding Requested: 2 years, July 2015 - June 2017

Summary:

This proposal will scale up and make practical the use of helpful bacteria in specially-prepared mats to adsorb and eat pesticides and spilled chemicals thereby protecting Minnesota resources.

Name: Lawrence Wackett

Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Visual shows the adsorbing, chemical-consuming mat material at normal and microscopic scale

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

PROJECT TITLE: Solving Problems From Pesticides and Spills in Minnesota

I. PROJECT STATEMENT

We propose to use helpful bacteria in specially-prepared mats to adsorb and consume chemicals that do not belong in the environment and to thereby protect our natural habitats and the plants and animals that occupy them. Helpful bacteria operate in natural ecosystems to recycle organic matter in the environment, but today's natural systems are often overloaded by heavy use of pesticides or by chemical spills, and our material is a novel and versatile solution to these problems. Chemicals, for example pesticides, are often tolerated as part of the cost of modern life or, if spilled, are handled by adsorbing the chemical and transferring everything to a hazardous waste landfill---neither of which solves the problem.

Instead we can address these problems with natural bacteria that actually eat the chemicals of concern and turn them into harmless natural substances such as ammonia. The natural bacteria are permanently entrapped within nano-fibers of a novel mat material we make into silicone dioxide---the same material as sand. The mat is inexpensive and can be left in place after the job is done. Our research of the natural bacteria and their placement in the cleansing mats at a laboratory scale has been successful and is now complete. We are ready to scale-up to make this "real-world" effective---useful to the environment and to local businesses---by making it available in fields and at spill sites. The main focus of the proposed project is to develop optimal methods to produce the helpful bacteria and the adsorbing materials on a large scale.

We aim to treat specific Minnesota problems using this technology. First, we will test the material for both adsorption capacity and the ability to neutralize pesticides in the spaces between and around crop rows in agricultural fields. This could prevent both runoff of pesticides and their migration into groundwater. Second, we will test conditions related to spills from leaking train cars carrying crude oil from North Dakota through the state of Minnesota. Third, we will cooperate with two other independent projects being proposed to the LCCMR this year, if they are funded, one to test our mats on the output of drain tiles before chemicals reach waterways (Valentas), and another to incorporate mats into reduced-pesticide perennial crop systems (Sheaffer).

We have spoken about specific Minnesota problems that can be addressed with Ms. Virginia Yingling of the State Department of Health, Dr. Mark Ferrey of the Minnesota Pollution Control Agency, and Dr. Joseph Zachmann of the Minnesota Department of Agriculture. We believe that a demonstration of the efficacy of the technology on scale will promote the adoption of the technology to be used by Minnesota industry.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Scale up production of mat material containing helpful bacteria **Budget: $ 200,000**

We will work in the laboratory and use University facilities to explore methods to easily and cheaply manufacture the mat material on scale. The materials are very cheap and so, once a manufacturing method is developed, this could be done on an industrial scale for 1/1000 the cost of the research price. We are confident of solutions because of many examples of "electrospinning" and other manufacturing methods that can be developed and many experts at the University who can contribute experience and advice.

Outcome	Completion Date
1. Production of 5 pounds of material for mechanical testing and efficacy in a laboratory	November 1, 2015
2. Production of 25 pounds of material for efficacy with environmental sample in the lab	February 28, 2016
3. Production of 250 pounds of material for use in Activity 2 (see below)	June 30, 2016

Activity 2: Demonstration of effectiveness of mat material in field and spill tests **Budget: $ 240,000**

We will work with our contacts in the Departments of Health and Agriculture, and MPCA, to identify possible sites for testing, making contacts with involved parties and obtain any necessary approvals. Note that we have

conducted soil cleanup approved by state agency and the U.S. EPA using a different technology, so we understand the issues involved in moving from laboratory to field applications.

Outcome	Completion Date
1. Identify field site for testing based on access, pesticides present, and ability to measure	July 31, 2016
2. Travel to site, establish method of deployment	August 15, 2016
3. Measure pesticide levels before and during treatment and analyze data	December 31, 2016
4. Identify appropriate spill site activities	August 31, 2016
5. Test mat material with key substances (eg. petroleum liquids)	January 31, 2017
6. Set up simulated spill situation at safe site working with state agency partners	February 28, 2017
7. Carry out simulated spill test using 100 pounds of mat material	May 31, 2017
8. Analyze data and prepare reports	June 30, 2017

III. PROJECT STRATEGY

A. Project Team/Partners. The project team will consist of Professors Lawrence Wackett (Biotechnology, Project Manager), Al Aksan (Mechanical Engineering, co-PI), Ms. Lisa Kasinkas (project field engineer) and Ms. Sujin Yeom (project lab coordinator) working with Ms. Virginia Yingling of the Minnesota Department of Health, Dr. Mark Ferrey of the Minnesota Pollution Control Agency and Dr. Joseph Zachmann of the Minnesota Department of Agriculture. We also partner with a Minnesota Company Minnepura Technologies, Inc. that specializes in commercialization of innovative methods for treating environments to remove unwanted chemicals. All funds will go to the University of Minnesota faculty who will carry out research and conduct field tests to determine the efficacy of the mat material that both adsorbs and eats problem chemicals. Professor Wackett will oversee growth and efficacy of the bacteria, analytical testing, and serve as overall project manager. Professor Aksan will oversee development and scale up of the mat material.

B. Project Impact and Long-Term Strategy. The citizens of Minnesota care deeply about their environment, particularly their water. In addition, Minnesota companies enjoyed more than $729 million in foreign sales in 2012 (http://mn.gov/deed/events/index/index.jsp), illustrating that outlooks for a good environment can also make for good business. The work to be conducted here provides the key component of what we expect will be a commercial activity to address pesticides and hazardous spills that otherwise dramatically affect our environments. Quick treatment will prevent problems from becoming chronic and expensive.

We expect that the work initiated here will continue with funding from other sources and develop "a life of its own." First, the basic science underlying the mat technology described here was developed at the University of Minnesota with funding from the National Science Foundation. The PI and co-PI on this proposal have a strong history of federal funding and have been successful in bringing in more than $10 million into the state of Minnesota for related projects. In light of that, we expect that we will be highly competitive to receive additional Federal funding as needed to advance fundamental research issues. Additionally, we have worked closely with industry on the environmental cleanup of chemicals. Minnesota companies are particularly interested in innovative treatment technologies. One company we have worked with is Minnepura Technologies, that has licensed previous patents developed from our work. For any patentable technology produced in this project, the University would manage the patents through their Office of Technology Commercialization and Minnepura and other Minnesota companies would have the option to license and further develop the technology. We would consider this to be an excellent added benefit of this work.

C. Timeline Requirements. We are confident that the proposed research will proceed as described and be completed to a stage where commercial activities are likely after the two-year time frame.

2015 Detailed Project Budget

Project Title: Solving Problems With Pesticides and Spills in Minnesota

IV. TOTAL ENRTF REQUEST BUDGET: 2 years

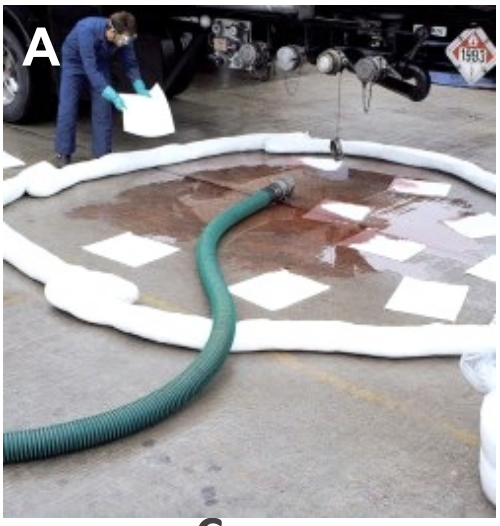
BUDGET ITEM	AMOUNT
Personnel:	
Lisa Kasinkas, Project Manager, (73% salary, 27% benefits); 100% FTE for 2 years Funds are requested for two years of support for a scientist to direct the project, Ms. Lisa Kasinkas, who holds a B.S. degree in Mechanical Engineering from the University of Minnesota. Ms. Kasinkas is a crucial component of the project.	$ 150,000
Sujin Yeom, (61% salary, 39% benefits); 50% FTE for2 years Funds are also requested for a graduate student who will conduct the biological component of the research, Ms. Sujin Yeom, a graduate student in Biochemistry, Molecular Biology, and Biophysics.	$ 90,000
To be determined, Undergraduate research assistant Funds are also requested for an undergraduate assistant to the project who will work part time during the Fall and Spring semesters and full-time in the summer.	$ 20,000
Contracts:	
Services conducted at the BioTechnology BioResource Center Funds are requested for service provided by the BioTechnology Institute Pilot Plant to prepare the biological material used in this proposed research.	$ 70,000
Equipment/Tools/Supplies:	
Funds are for construction of an instrument to produce encapsulated cell materials for field testing. In addition to routine lab supplies (chemicals, flasks, pipetters) we also need equipment and	$ 100,000
Acquisition (Fee Title or Permanent Easements): *In this column, indicate proposed number of acres and and name of organization or entity who will hold title.*	N/A
Travel:	
Funds are requested to travel to state sites for acquiring soils samples, and testing our materials in actual field environments.	$ 10,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$440,000

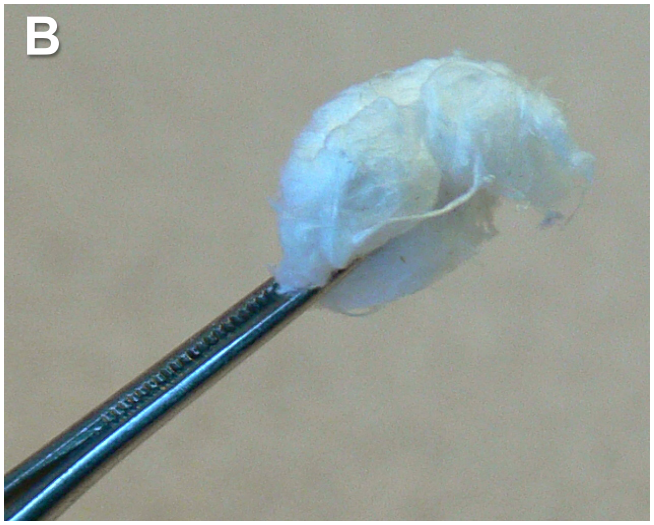
V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period: *Indicate any additional non-state cash dollars secured or applied for to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	N/A	*N/A*
Other State $ To Be Applied To Project During Project Period: *Indicate any additional state cash dollars (e.g., bonding, other grants) secured or applied for to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.*	N/A	*N/A*
In Kind services: F&A matching $440,000 - $35,100 (grad student fringe) * 52% = $211,000. Faculty salary time paid by the University of Minnesota = $20,000 Biotechnology Institute access fee waiver = $20,000	$ 251,000	*Secured*
Funding History:	N/A	N/A
Remaining $ From Current ENRTF Appropriation:	N/A	*N/A*

Solving Problems From Pesticides and Spills in Minnesota

Lawrence P. Wackett and Alptekin Aksan
University of Minnesota, Twin Cities





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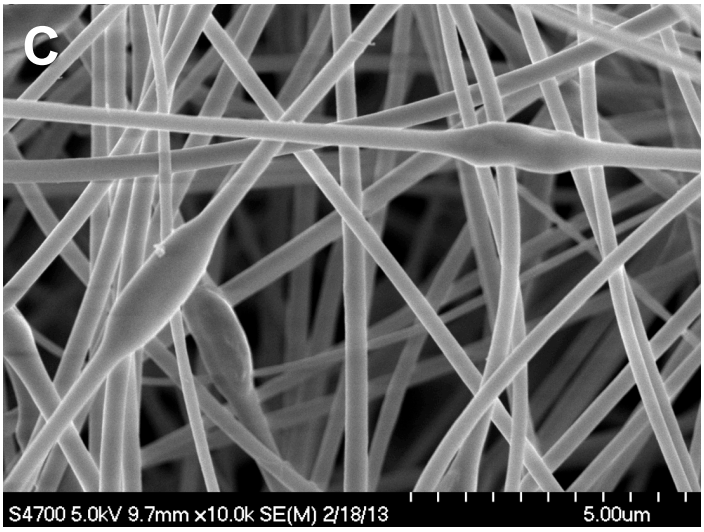

Figure explanation. Helpful bacteria in specially-prepared mats can consume chemicals that don't belong in the environment, for example from spills or from agricultural runoff, and thereby protect our natural environments and the plants and animals that occupy them. (A) This shows a typical procedure for removing environmental chemicals by adsorbing them onto a material and transferring the material to a hazardous waste landfill. (B) Mat material generated in our laboratory on a small scale has been shown to adsorb and degrade a very wide range of chemicals using adsorptive material and carefully-selected, natural bacteria that eat the chemicals. (C) This electron microscope image shows the tiny fibers of the mat with trapped helpful bacteria that are visible as expanded regions of the fiber. These have only been prepared on a small scale and it remains to scale up this technology and test it in real world situations.

PROJECT MANAGER - Lawrence P. Wackett
Distinguished McKnight University Professor

Position: Professor, Dept. of Biochemistry, Molecular Biology and Biophysics & BioTechnology Institute, University of Minnesota, St. Paul, MN 55108

Previous:

1992-1996	Associate Professor, University of Minnesota
1987-1992	Assistant Professor, University of Minnesota
1984-1987	NIH Postdoctoral Fellow, Chemistry, MIT

Qualifications pertaining specifically to project:

- Carried out EPA-approved soil cleanup of 1000-pound herbicide spill
- Technology for pesticide-treatment licensed to Renovo, Inc.
- Technology led to development of commercial Melamine test kit
- Over 200 papers published on technology related to proposed research
- Aided startup and funded on research by LS9, Inc., major venture startup
- Co-developer, University of Minnesota Biocatalysis/Biodegradation Database
- Wrote book, "Biocatalysis and Biodegradation," published in English & Chinese
- Invited speaker at over 200 Universities, Industry seminars, & Conferences
- Consultant for major International companies: GE, Celgene, Dow, Genencor

Project management:

Professor Wackett will be overall manager for the proposed research project. He has extensive experience in pesticide and petroleum hydrocarbon mitigation, both with respect to fundamental research and practical cleanup of the environment. Professor Aksan (Mechanical Engineering) is a critical component of the management team, with specific expertise in engineering and scale up. Ms. Lisa Kasinkas is a scientist/engineer with a B.S. degree in mechanical engineering who will oversee the field testing component of the project. Ms. Sujin Yeom is a predoctoral fellow in the Department of Biochemistry, Molecular Biology and Biophysics and will oversee the laboratory operations needed to produce the mat material for chemical adsorption and consumption. Professor Wackett will coordinate the personnel on this project, working with others from the Minnesota agencies of Agriculture, Health, and Pollution Control as described in the Project Desription.

Organization:

The University of Minnesota supports this research project with laboratory space, other infrasructure, and administrative support. Both PIs are members of the BioTechnology Institute and thus have access to the BioProcessing Plant for large scale cell growth that will be crucial for this proposed research. Professor Aksan (co-PI) is a member of the College of Science and Engineering and thus has access to advanced characterization and fabrication facilities available within that College.