Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)

Project Title: **ENRTF ID: 048-B**

Neonicotinoid Insecticides: Occurrence And Influence on Algal Blooms

Category: B. Water Resources

Sub-Category:

Total Project Budget: $ 356,000

Proposed Project Time Period for the Funding Requested: June 30, 2022 (3 yrs)

Summary:

The potential of neonicotinoid insecticides to initiate algal blooms will be tested by measuring the occurrence of neonicotinoids and their breakdown products in Minnesota's surface and ground waters.

Name: William Arnold

Sponsoring Organization: U of MN

Title: Professor

Department: Civil, Environmental, and Geo- Engineering

Address: 500 Pillsbury Dr. SE

Minneapolis MN 55455

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Neonicotinoid insecticides enter water from urban, suburban, and agricultural uses and may cause algal blooms

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Neonicotinoid Insecticides: Occurrence And Influence on Algal Blooms

I. PROJECT STATEMENT

New studies that document the baseline occurrence of neonicotinoid insecticides *in natural and engineered waters (such as drinking water, wastewater, and storm water) are urgently needed to determine any potential effects in Minnesota waters and to develop guidelines for safe use of neonicotinoids*. Neonicotinoid insecticides, are synthetic chemicals that are widely used in urban and agricultural areas. They are highly toxic to many aquatic and terrestrial organisms. They were introduced in the 1990s and now represent a large portion of insecticides not only used in row-crop agriculture, but also in nurseries, in lawns and gardens, and for flea treatment of pets. In the few studies that have been conducted, neonicotinoid compounds have been detected in urban and agricultural streams, groundwater, and even wastewater treatment plant effluent. They have also been detected in soil and rain. Our previous ENTRF research has shown that neonicotinoid insecticides are relatively persistent and likely highly mobile in the environment. These characteristics would suggest they could move away from their point of application and into the broader aquatic environment. The neonicotinoid insecticides have been shown to produce a number of breakdown products, but little is known about the environmental behavior or environmental occurrence of these chemicals. This study would provide a baseline survey of where and at what level these chemicals occur in Minnesota and provide insight into the pathways by which they reach surface and ground waters.

The goals of the project are to:

- Quantify the occurrence of neonicotinoids and their breakdown products in Minnesota's natural and engineered waters,
- Assess any relationship between neonicotinoid levels and formation of algal blooms, and
- Disseminate the findings to stakeholders, regulators, and the public.

Data on neonicotinoid use and environmental detections in Minnesota's waters are limited. Six neonicotinoid insecticides are registered for use in Minnesota for non-agricultural (i.e., urban) and agricultural uses. The Minnesota Department of Agriculture has found four of the six in streams and three of the six in groundwater samples. *The results of this work will have direct impacts on management of neonicotinoid use and the environmental health of Minnesota's urban and out-state surface waters and ground waters.* This work will provide information to the public on the occurrence of these high profile chemicals and aid in management and regulatory decisions related to these compounds.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Frequencies and concentrations of neonicotinoids and breakdown product occurrence in natural and engineered waters* **ENRTF Budget: $128,000**

Streams (50 samples), storm water (20 samples), drinking water (10 samples), and treated wastewater effluents (20 samples) in urban and agricultural areas throughout Minnesota will be sampled to provide a baseline survey of the frequency of occurrence and concentrations of the neonicotinoid insecticides and reaction products. Locations of the sampling sites will informed and complement the work of the MN Departments of Agriculture and Public Health as well as water and wastewater treatment facilities. Water samples will be analyzed for six neonicotinoid insecticides, fipronil (a related veterinarian insecticide), and selected breakdown products.

Outcome	Completion Date
1. *Analytical method developed for low-level analysis neonicotinoids and degradates*	06/30/20
2. *Water samples collected and analyzed for low-level neonicotinoid and degradates*	11/01/21
3. *Dissemination of Activity 1 findings via open access journal publication(s)*	06/01/22

Activity 2: *Quantify the occurrence of neonicotinoids and breakdown products in shallow groundwater* **ENRTF Budget: $122,000**

Neonicotinoid insecticides are persistent and mobile in the environment. They have a high potential for moving into and through shallow groundwater. Groundwater is an important source of drinking water to a large portion of the State's population, and groundwater discharge (base flow) is also an important source of water to most lakes and streams. Thus, when groundwater becomes contaminated with the neonicotinoid insecticides, the groundwater can be a vector for delivering these chemicals to both humans and aquatic biota. This portion of the study collaborates with the MN DNR County Geologic Atlas Program to investigate the occurrence of the neonicotinoid insecticides and breakdown products in 72 wells in 12 counties across the state in a mixture of urban, agricultural, and natural lands.

Outcome	Completion Date
1. *Groundwater samples collected and analyzed for neonicotinoid and degradates*	11/01/21
2. Statistical summary and interpretation of the data	02/01/22
3. Dissemination of Activity 2 findings via open access journal publication(s)	06/01/22

Activity 3: *Assess any relationship between neonicotinoid levels and formation of algal blooms* **ENRTF Budget: $106,000**

Neonicotinoid insecticides present in surface waters are toxic to many aquatic fauna including zooplankton such as *Daphnia* (water fleas). *Daphnia*, which eat algae, are important in controlling the algal populations in surface waters. If the neonicotinoid insecticides are present at concentrations that affect the *Daphnia*, then their control on the algal population may be comprised, and the insecticides may indirectly facilitate in the development of an algal bloom. This Activity examines this possible relationship by quantifying neonicotinoid insecticides concentrations and relative abundance of *Daphnia* populations during periods with and without algal blooms in selected lakes (~10 lakes, samples before, during, and after blooms).

Outcome	Completion Date
1. *Sampling and analysis of neonicotinoids and Daphnia during and without algal blooms*	09/01/21
2. Data analyzed and statistical relationships established	02/01/22
3. Dissemination of Activity 3 findings via open access journal publication(s)	06/01/22

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Paul Capel	Adjunct Assoc. Prof.	U of MN	Co-investigator

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
John Barry	Hydrogeologist	MN DNR	Collect groundwater samples
Shawn Schottler	Environmental scientist	Science Museum of Minnesota	Algal bloom sampling

IV. LONG-TERM- IMPLEMENTATION AND FUNDING: This project will provide a baseline assessment of the occurrence of the neonicotinoid and selected reaction products in various waters impacted by humans and if they play any role in algal blooms. This work will provide methods to the Minnesota State Agencies for continued studies of these chemicals if needed. Results of the proposed work will provide a strong basis for evaluating the persistence and toxicity of neonicotinoids thus allowing for informed use, management, and, if needed, regulatory actions. The results will be disseminated via open-access scientific literature and reports.

V. TIME LINE REQUIREMENTS: The project will be completed in a three year period. The sample collection and method development for the trace-level identification and quantification of the insecticides to assess their occurrence, as well as the field and laboratory investigations for the relative abundance of *Daphnia* during algal blooms all require attention to detail and replication.

2019 Proposal Budget Spreadsheet

Project Title: Neonicotinoid Insecticides: Occurrence And Influence on Algal Blooms

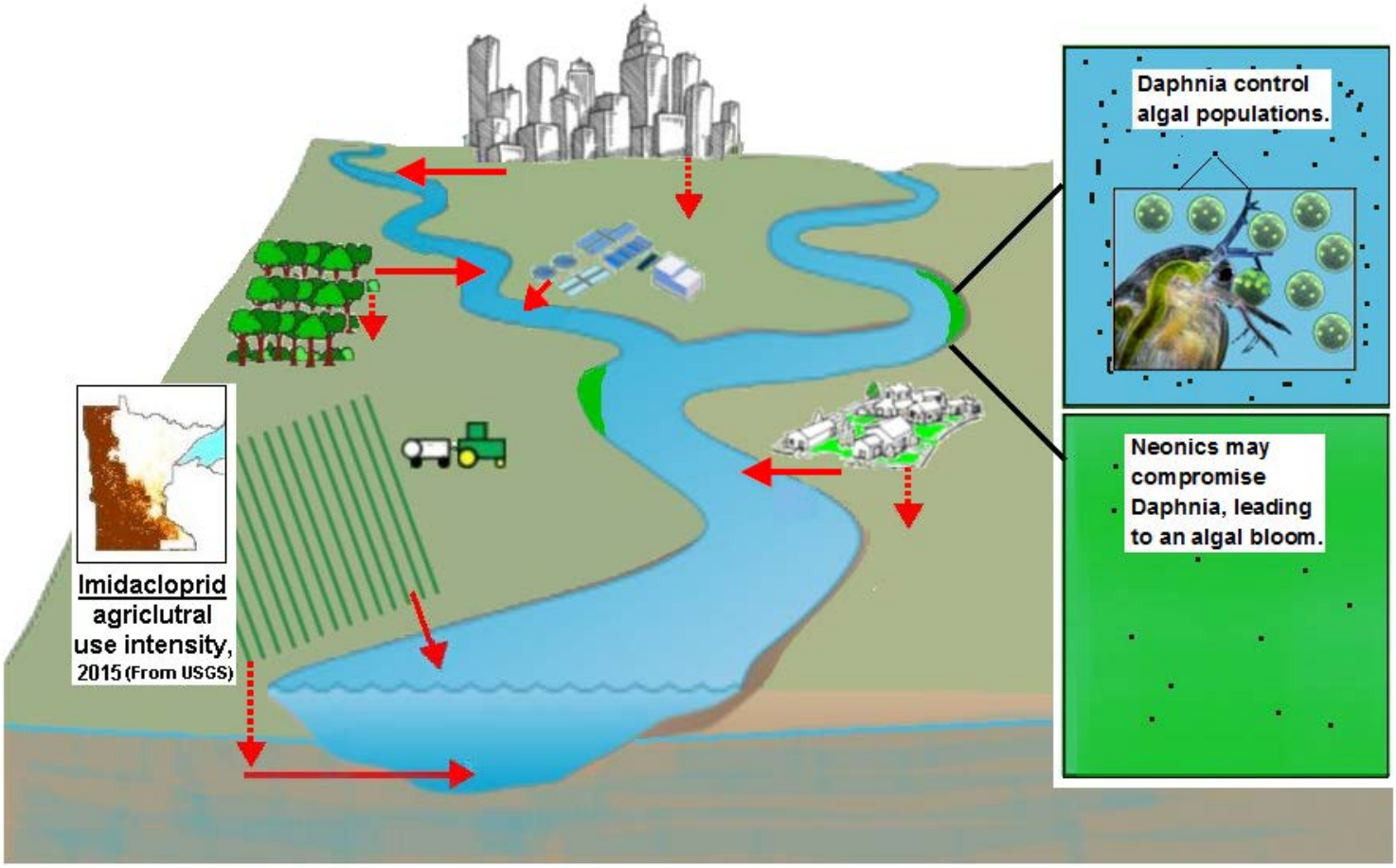
IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM (See "Guidance on Allowable Expenses")	**AMOUNT**
Personnel: William Arnold, Project Manager (75% salary, 25% fringe benefits). 6% FTE for years 1-3. Project coordination, development of analytical protocols. supervision of graduate and undergraduate researchers.. $51,000 Paul Capel, co-Project Manager (75% salary, 25% fringe benefits). 6% FTE for years 1-3. Field sampling study design, supervision of graduate and undergraduate researchers. $51,000 Graduate student Research assistant, sample collection, processing, measurement of concentrations (57% salary, 43% fringe benefits) 50% FTE for years 1-3. $149,000 Undergraduate researchers. Assist with field sampling, processing of samples, data analysis. Two undergraduates 10 hrs per week during academic year, 40 hours per week in summer. (100% salary) $52,500	$ 303,500
Equipment/Tools/Supplies: Supplies (chemical and isotopically labelled standards, chemical reagents, necessary glassware, solvents, consumable supplies, laboratory notebooks, software licenses; $16,000 total). Analytical time for compound quantification (210 samples including surface waters, groundwaters, and samples during algal blooms, $100 per sample)is a major portion of supply costs ($7,000 per year). Operating costs for laboratory instruments required for analyses and experiments; costs portioned based on usage by project ($3,000 total)	$ 40,000
Travel:charges and university vehicle rental charges for trips to water samples. Hotel/meal charges if overnight stay required. Attendence for students at local conferences to disseminate project findings to agriculture and environmental interests. Reimbursement will be according to University of Minnesota guidlines.	$ 7,500
Additional Budget Items: Publication charges to make published journal articles (2-3) immediately available via open access to maximize data availability and dissemination	$ 5,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 356,000

V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period: N/A	$ -	
Other State $ To Be Applied To Project During Project Period: N/A	$ -	
In-kind Services To Be Applied To Project During Project Period: Because the project is overhead free, laboratory space, electricty, and other facilities/adminstrative costs (54% of direct costs excluding permanent equipment and graduate student tuition benefits) are provided in-kind. Additionally, in kind sample collection will be performed by MN DNR and St. Croix Watershed Research Station.	$ 164,000	*secured.*
Past and Current ENRTF: M.L.2016,Chp186,Sec.2,Subd.04e,Assessing Neonicotinoid Insecticide Effects on Aquatic and Soil Communities $400,000	$ 185,000	Unspent; will be spent by 6/30/2019
Other Funding History: N/A	$ -	

Neonicotinoids have a variety of sources and may lead to algal blooms



Key Outcomes:

1. Assess urban, suburban, and agricultural sources of neonicotinoids to surface waters
2. Quantify neonicotinoids in groundwater
3. Identify reaction products
4. Assess role of neonicotinoids on formation of algal blooms

Project Manager Qualifications and Organization Description

William A. Arnold
Distinguished McKnight University and Joseph T. and Rose S. Ling Professor and Associate Head
Department of Civil, Environmental, and Geo- Engineering, University of Minnesota

B.S., Chemical Engineering, 1994, Massachusetts Institute of Technology, Cambridge, MA.
M.S., Chemical Engineering, 1995, Yale University, New Haven, CT.
Ph.D., Environmental Engineering, 1999, The Johns Hopkins University, Baltimore, MD.

Dr. William Arnold will be responsible for overall project coordination and supervision of the study and development of analytical methods and protocols. He has been studying the fate of pharmaceutical and pesticide compounds in aquatic environments for sixteen years. As part of these studies, he has determined the transformation rates and identified reaction products of numerous compounds. Recent work has focused on the hydrolysis and photolysis of neonicotinoid insecticides. He has published over twenty peer-reviewed papers on pesticide and pharmaceutical fate since 2003, and he is the co-author of a textbook on water chemistry published in 2011. Dr. Arnold is a Resident Fellow of the University of Minnesota Institute on the Environment, an Associate Fellow of the Minnesota Supercomputing Institute, and a member of the graduate faculty in Water Resources Science. He won the *Arcadis/Association of Environmental Engineering and Science Professors Frontier in Research Award* in 2012 and the University of Minnesota College of Science and Engineering *George W. Taylor Award for Distinguished Research* in 2011.

Paul D. Capel
Adjunct Associate Professor
Department of Civil, Environmental, and Geo- Engineering, University of Minnesota

B.A., Chemistry, 1979, Evangel College, Springfield, MO.
M.S.C.E, Civil Engineering, 1983, University of Minnesota, Minneapolis, MN.
Ph.D., Civil Engineering, 1988, University of Minnesota, Minneapolis, MN.

Dr. Paul Capel will be responsible for design and supervision of the field studies. His work focuses on the environmental behavior and transport of chemicals in the environment, and the importance of hydrologic flowpaths on chemical transport. He worked for the US Geological Survey for more than 30 years designing, conducting, and directing large-scale, water-quality field and modeling studies on pesticides and nutrients in agricultural and urban watersheds. Dr. Capel is a member of the graduate faculty in Water Resources Science. He has co-authored over 100 articles in peer reviewed journals, reports, and books. He has served on advisory and review panels for the US Department of Agriculture, US Environmental Protection Agency, and US Department of the Interior. He has trained 20 MS and 4 PhD students, as well as numerous undergraduates.

Organization Description
The University of Minnesota is one of the largest, most comprehensive, and most prestigious public universities in the United States (http://twin-cities.umn.edu/about-us). The laboratories and offices of the PI contain the necessary fixed and moveable equipment and facilities needed for the proposed studies.