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

Project Title: **ENRTF ID: 063-B**

Removing Phosphorous from Draintile Water Discharge- Phase II

Category: B. Water Resources

Sub-Category:

Total Project Budget: $ 398,000

Proposed Project Time Period for the Funding Requested: June 30, 2021 (2 yrs)

Summary:

In our previous LCCMR project, a metal modified char effectively removed phosphorous from water at laboratory scale. Phase II scale-up, in collaboration with NRRI, will culminate with a field trial.

Name: Kenneth Valentas

Sponsoring Organization: U of MN

Title:

Department: Coulee of Biological Sciences

Address: 140n Gortner Lab, 1479 Gortner Ave.

St. Paul MN 55108

Telephone Number: (763) 595-0365

Email valentas@umn.edu

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Removing Phosphorus from Draintile Water Dicharge

_____ 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: Removing Phosphorus from Draintile Water Discharge- Phase II

I. PROJECT STATEMENT: Phosphorus is often the limiting nutrient in aquatic ecosystems and the main culprit in eutrophication. Once phosphorus enters our waters it is virtually impossible to remove. The simple solution is to reduce the amount of phosphorus getting into the waterways in the first place, but to date little progress has been made in that regard. In our previous LCCMR project we have found a way to construct modified chars, utilizing readily available agricultural residues and certain metals, that will remove phosphorous from agricultural draintile waters containing typical concentrations of phosphorus. We have filed patents covering the critical aspects of this technology, developed with trust funds from our previous LCCMR project. Future revenues will be shared as required. These promising results were obtained at the laboratory scale, demonstrating proof of principle. The present proposal is the next logical step to advance the technology to a field trial---a fast-paced project establishing efficacy and measuring phosphorus removal under field conditions. This requires equipment on a larger scale to make sufficient quantities of modified chars, and to this end we are partnering with the NRRI (Natural Resources Research Institute), who possess the needed equipment.

Overall Goal: We propose to take a significant step in mitigating phosphorus pollution in Minnesota water resources by scaling up our technology, based on metal-char composite materials developed at the University of Minnesota, culminating in a field trial to remove a meaningful portion of phosphorus from draintile discharge water in Minnesota.

This will be accomplished by:

- Fabricating phosphorus removing, metal-char pellets made from agricultural residues
- Coating pellets with polymers to enhance retention of phosphorus, as needed.
- Constructing and testing a prototype drain tile filter for phosphorus removal at pilot scale and in field trials.
- Evaluate metal and phosphorus recovery from phosphorous saturated pellets.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Fabricate and evaluate metal-char composite pellets, made from agricultural residues, that will remove phosphorus from water containing 2-4 ppm phosphorus and will have a phosphorus equilibrium removal capacity of 20-50 mg/g of pellet. Performance will be measured via Hach spectrophotometer in both batch and continuous flow configurations. Possible leaching of the metal hydroxide or phosphate will be evaluated with the Hach or by ICP analysis.

ENRTF BUDGET: $ 155,000

Outcome	Completion Date
1. Fabricate corn stover biochars and thermally treated hydrochars from manure. (NRRI)	Nov.30, 2019
2. Modify chars with metals and conduct pelletizing experiments (NRRI, BTI)	March 1, 2020
3. Test pelletized metal-chars for phosphorus removal and leaching in batch and continuous small- scale configurations (BTI, Biotechnology Institute)	June 30, 2020

Activity 2: To enhance physical integrity of the modified pellets and to prevent any potential leaching of metal- phosphate they will be coated or encapsulated with an appropriate polymeric material that will permit the flow of water and dissolved phosphates but not solids such as insoluble metal phosphates. This work will be conducted in close collaboration with the "coatings group" in the chemical engineering department.

ENRTF BUDGET $ 93,000

Outcome	Completion Date
1. Test various polymeric materials as coatings for modified pellets at small scale(CEMS)	June 30, 2020
2. Evaluate best candidates in prototype filter configuration (CEMS, BTI)	Nov. 30, 2020

Activity 3: Construct a prototype drain-tile filter and determine efficacy for phosphorous removal for both coated and uncoated metal modified pellets, culminating with field trials. Evaluate effluent from batch and continuous leaching tests for presence of metal phosphate. **Investigate feasibility of metal-phosphate recovery** from the phosphorous saturated, spent char composite from drain-tile filters. Recovery schemes that take advantage of the effect of pH on metal- phosphate solubility will be evaluated.

ENRTF BUDGET $ 150,000

Outcome	Completion Date
1. Design, construct test a phosphorus filter for drain tile application. (ALL)	Sept. 30, 2020
2. Test filter in continuous and batch flow modes with coated and uncoated pellets and conclude with field trials. (BTI,CEMS)	June 30, 2021
3. Conduct proof of principle experiments for metal and phosphorus recovery from spent pellets. (BTI,NRRI)	June 30, 2021

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role
Dr. Satish Kumar	Professor	Dept. Chemical Eng.	Develop coating system
Dr. Kenneth Valentas	Adjunct professor	Biotechnology Institute	Project Manager
Dr. Donald Fosnacht	Associte Director	- NRRI	Process chars, pelletizing

IV. LONG-TERM- IMPLEMENTATION AND FUNDING: Success on this project would provide the data needed to license the technology for commercialization, ultimately leading to a significant reduction of phosphorous being discharged into our water resources.

V. TIME LINE REQUIREMENTS: This is a two-year collaborative project that integrates efforts from the Biotechnology Institute, the department of Chemical Engineering & Material Science and the NRRI.

2019 Proposal Budget Spreadsheet

Removing Phosphorous from Draintile Water Discharge- Phase II

IV. TOTAL ENRTF REQUEST BUDGET 2 years

BUDGET ITEM (See "Guidance on Allowable Expenses")	**AMOUNT**
Personnel: Research technician (to be named) to conduct experiments on twin cities campus for char modification, column testing and assistance in coating experiments. 100% FTE for 18 months, $103,000, 27.2% fringe, 72.8% salary.	$103,000.00
Post doctoral student in CEMS to conduct coating experiments and design columns for breakthrough and other testing. 100% FTE for 12 months , $61,000, 21.4% fringe, 78.6% salary.	$61,000.00
NRRI technician in Duluth to conduct experiments and produce chars, heat treated chars, and pelletized modified chars. 100% FTE for 12 months $45,000 salary plus fringe	$45,000.00
Ken Valentas, Adjunct Professor, Biotechnology Institute, P.I. and project manager, 45% FTE for 2 years, $120,000, 33.5% fringe, 66.5%salary. Valentas has a 50% unpaid appointment and is on soft money.	$120,000.00
Technician support for field trials for 4 months $23,000; 27.2% fringe, 72.8% salary	$23,000.00
Undergraduate Student Workers. Assist in experiments and analysis for 18 months, $13,000, 100% salary	$13,000.00
Equipment/Tools/Supplies:	$31,500.00
Materials to construct breakthrough and leaching columns. Rigid tubing, stands, connectors, peristaltic pump, flow splitters. $4375	
Specialty chemical activating agents, filter papers, centrifuge tubes, glassware, gloves 18months @ $250/month $4500	
Quartz inserts and end fittings for Tube Oven used for post treating chars 6 @ $550 each set $3300.	
Hach spectrphotometer chemicals, tips and syringes for 1000 tests @ $4/test $4000.	
Chemicals and supplies for coating experiments on modified chars $3500.	
Elemental analysis for lanthanum 60 samples @$45/sample. $2700.	
Surface analysis of modified nchars and coatde chars, SEM, FTIR 20 tests @ $100/test $2000	
Ultimate and proximate analysis to support material balances. 15 tests @ $115/test $1725.	
Materials to construct filter for field trials. $5400.	$ -
Travel: In state travel to conduct experiments at NRRI facility in Duluth and field trials reimbursed at University rates. Estimate 5 visits @$300./visit	$1,500.00
Additional Budget Items:	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 398,000

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:	$ -	
Other State $ To Be Applied To Project During Project Period:	$ -	
In-kind Services To Be Applied To Project During Project Period: In kind services will be provided by the University of Minnesota to cover indirect costs associated with managing the research project and providing administrative support to researchers as indirect costs are not allowed on state awards. (54% of total costs).	$ 214,920	
Past and Current ENRTF Appropriation: **"Past and Current ENRTF Appropriation:. Preventing Phosphorous and Pesticides from Entering Water Resources Through Draintiles, 2015 appropriation. Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 04d , "M.L. 2016, Chapter 186, Section 2, Subdivision 18" "Carryforward: (b) The availability of the appropriations for the following projects are extended to June 30, 2018: (2) Laws 2015, chapter 76, section 2, subdivision 4, paragraph (d), Preventing Phosphorous, Nitrogen and Pesticides from Entering Water Resources through Drain Tiles.** **"**	$505,000	0 remaining. Project completed 6/30/18
Other Funding History:	N/A	

AGRICULTURAL RESIDUES

CORN STOVER

OR

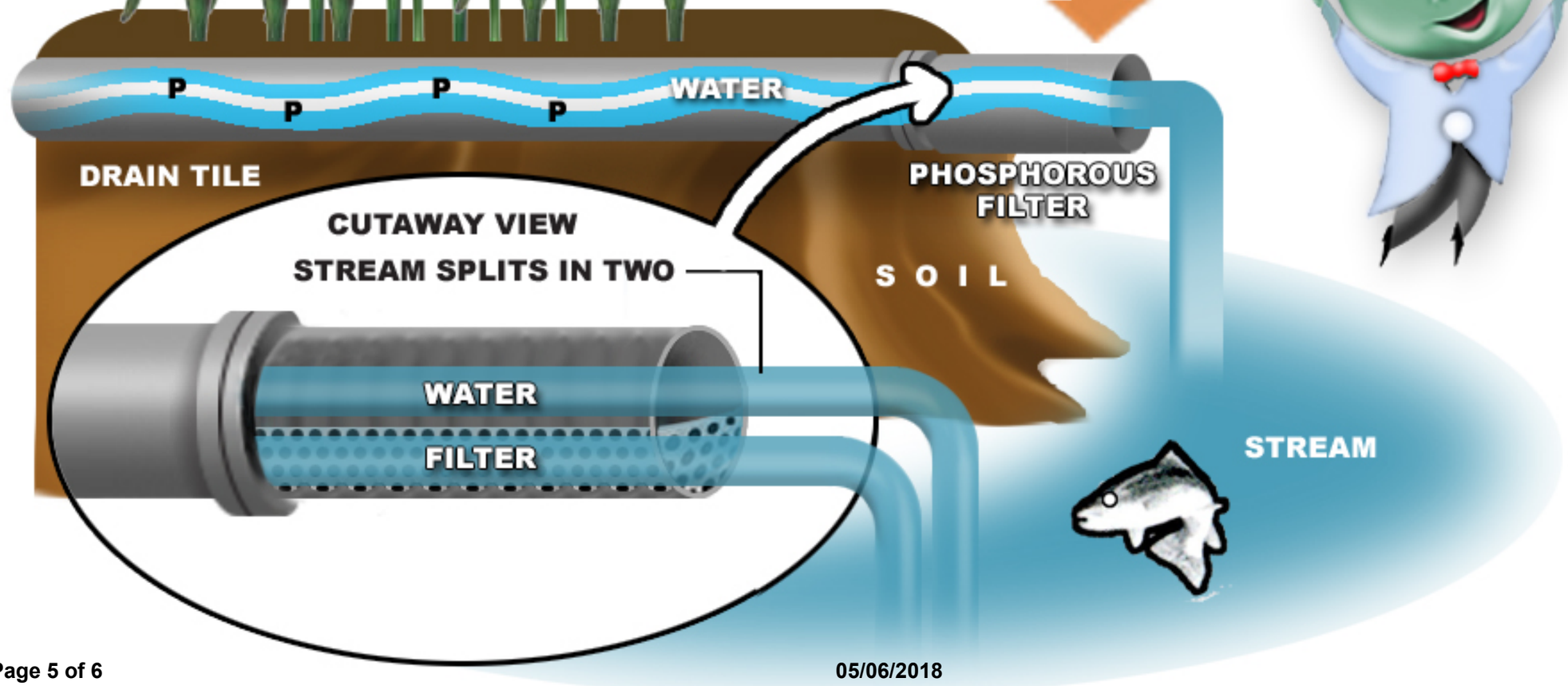
MANURES

HYDROTHERMAL CARBONIZATION

ACTIVATING HEAT TREAT

METAL ADDITION

REMOVING PHOSPHOROUS FROM DRAIN TILE WATER DISCHARGE



Project Manager Qualifications

Kenneth Valentas is Adjunct Professor in the Biotechnology Institute (BTI) at the University of Minnesota. Previously he was Director of the BTI for 16 years and Associate Director for two years. Prior to joining BTI, Valentas was Sr. Vice President of Engineering at Pillsbury/Grand Met, and in total spent 24 years in industry at Sinclair Oil, General Mills and Pillsbury/Grand Met. He holds nine patents related to process engineering.

His PhD in Chemical Engineering is from the University of Minnesota under Regents Professor and former head Neal Amundson. Valentas is a recognized expert in process engineering and the author of two books on the subject. His research while at the BTI has focused on renewable energy with particular emphasis on thermochemical processing and hydrothermal carbonization (HTC) of biomass.

As Director of the BTI and Sr. Vice President of Engineering at Pillsbury, Valentas has gained particular expertise in managing teams of inter-disciplinary researchers and engineers in complex projects. The most recent pertinent experience relevant to this proposed project was his role as principal investigator and project manager for two state funded Biofuel Feasibility Studies (1, 2). A few pertinent peer reviewed publications are listed below (3), (4), (5), (6)

Valentas will serve as *P.I.* and project manager to provide overall direction and coordinate cross-functional activities, write reports and make presentations as required.

(1) Valentas et al (2009) “White Earth Biofuels Feasibility Study”, 94pp., Funded by MNDA under Minnesota statute 48A.10.
(2) Valentas et al (2009), “Chisago, Isanti and Pine Counties Biofuels Feasibility Study”,90pp., Funded by MNDA under Minnesota Session Laws 2007 Chapter 45.
Copies of (1) and (2) are posted at www.bti.umn.edu
(3) Biomass & Bioenergy 2010, 34, 875-882; “Hydrothermal carbonization of microalgae”
(4) Applied Energy 2011, 88(10), 3286-3290; “Hydrothermal carbonization of microalgae. II. Fatty acid, char and algal nutrient products”
(5) Biomass & Bioenergy 2011, 35, 2526-2533; “Hydrothermal carbonization of distiller’s grains”
(6) Heilmann, S., J.S. Molde, J.G.Timler, B.M.Wood, A.J.Mikula, G.V.Vozhdayev, E.C.Colosky, K.A. Spokas and Kenneth Valentas, “Phosphorous Reclamation through Hydrothermal Carbonization, of Animal Manures”, Environmental Science and Technology, 2014

Organization Description

The University of Minnesota is the state’s main research and graduate teaching institution. Our university has been repeatedly ranked number-one in the nation for Ecology/Environment and Chemical Engineering, based on the citational influence of its scientific publications.