

**Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 242-F

Biological Sulfate-Reduction System

Category: F. Methods to Protect, Restore, and Enhance Land, Water, and Habitat

Sub-Category:

Total Project Budget: \$ 1,268,266

Proposed Project Time Period for the Funding Requested: June 30, 2023 (3 yrs)

Summary:

Field demonstrate a low-cost sulfate-reducing system to remove sulfate from contaminated water that facilitates meeting state and federal sulfate standards while protecting wild rice and improving water quality.

Name: Jeffrey Hanson

Sponsoring Organization: Clearwater BioLogic LLC

Job Title:

Department:

Address: 8457 Spring Ridge Road

Babbitt MN 55706

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Web Address: www.ClearwaterBioLogic.com

Location:

Region: Northeast

County Name: Itasca, Koochiching, Lake, Stearns

City / Township: Iron Range Cities

Alternate Text for Visual:

Map of Aurora and mining lands north to Mesabi Nugget. Shows a sketch of floating bioreactor raft.

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



Environment and Natural Resources Trust Fund (ENRTF)
2020 Main Proposal Template

PROJECT TITLE: Biological Sulfate-Reduction System

I. PROJECT STATEMENT:

Our floating bioreactor process can remove sulfate from industrially-impacted Minnesota waters so that downstream lakes and rivers will meet the state sulfate standard as well as the federal secondary drinking water standard. These treated waters will allow the rivers and lakes they enter to, once again, support wild rice growth. They will also be more suitable for human consumption.

The Clearwater BioLogic process costs about 10% of alternative sulfate-removal methods. It could allow mining operations (e.g. Mesabi Nugget), power plants (e.g. MN power), and cities (e.g. Aurora) to meet the 10 mg/L state wild rice standard without going broke.

Our process relies on biomimicry and naturally-occurring bacteria to convert the sulfate from taconite mine pit lakes and basins to sulfide. Modular tanks will be floated in those lakes for the biologic portion of the process. In a second step, the system will use a USP Technologies' method to chemically convert the sulfide to elemental sulfur. A third step will mechanically remove that sulfur so that sulfate cannot be regenerated in the water downstream. Water treated by Clearwater BioLogic's process can be safely released into the rivers and swamps surrounding the lakes without threat of further contamination.

We have selected a demonstration site location to show all interested parties how the process works. It will also demonstrate the benefit to municipalities when sulfate from industrially-impacted water is removed upstream before it reaches those cities.

To ensure independent monitoring and reporting of results, we will work with the Fond du Lac Tribe and will ask for participation from students and professors at regional academic and research institutions.

II. PROJECT ACTIVITIES AND OUTCOMES:

Activity 1: Installation of the Clearwater BioLogic sulfate-reduction system

We will install this system in a mine pit lake that is upstream but isolated from the St. James Pit Lake from which Aurora draws its city water supply. The attached map shows three possible site locations. The system consists of four bioreactor modules, the USP Technologies sulfide control system, and the clarifiers for collection and removal of the sulfur. It includes appropriate monitoring and control systems.

Activity 2: Demonstrate the Clearwater BioLogic sulfate-reduction system for three years

The system will maintain a water flow of up to 24 gpm. We will add all amendments for ideal performance. The first year will be devoted to construction and deployment of the system and development of an active sulfate-reducing bacterial colony. During the next two years, we will demonstrate consistency through the seasonal cycles. Our objective is to reduce 90% of the sulfate from the water treated, which means we will remove approximately 300,000 pounds of sulfate from over 30,000,000 gallons of mine pit lake water during this three-year demonstration. Minnesota state officials, city representatives, mining company personnel, and others will be able to visit the site to understand the process.

Activity 3: Monitor water characteristics and report on operations and conclusions

We will monitor relevant water parameters to manage performance. We will ask regional schools, colleges, and Native American Tribes to independently monitor the results. We will provide on-going and final reports of results so others can draw conclusions with us about long-term feasibility of our methods.

ENRTF BUDGET: \$ 1,268,266



Environment and Natural Resources Trust Fund (ENRTF)
2020 Main Proposal Template

Outcome	Completion Date
1. Install the Clearwater BioLogic system with 4 bioreactors and chemical treatment	Fall of 2020
2. Operate this system to remove 300K pounds of sulfate from >30M gallons of water	Fall of 2023
3. Monitor and report on water quality and long-term feasibility of this system	Fall of 2023

III. PROJECT PARTNERS AND COLLABORATORS:

Clearwater BioLogic LLC will provide the overall project management, supervision, project control, construction, water testing, and monitoring.

Clearwater Layline LLC has developed the biological sulfate-reduction and will provide input on these systems. It has had past collaboration with IRRRB, NRRI, ERJPB, UMD and UMN. This technology and related patents have been assigned to Clearwater BioLogic LLC.

RNAS Remediation Products Inc has developed proprietary electron donor and nutrient formulations for this system. They will supply the electron donor and nutrient amendments as needed.

USP Technologies Inc has developed the patented PRISC system for converting sulfide to sulfur. They will collaborate in the installation and operation of this part of the system as well as supply the chemical amendments as needed.

A University or College from the NE Minnesota region will monitor and report on results.

IV. LONG-TERM IMPLEMENTATION AND FUNDING:

The purpose of this field installation and operation is to demonstrate to industry, municipalities, and the state that the Clearwater BioLogic sulfate-reduction system can achieve the necessary sulfate-reduction to meet state water quality standards. Clearwater BioLogic LLC is prepared to deploy full scale sulfate-reduction systems on a fee-for-service basis; any clients will be charged a value related to the amount of sulfate to be removed. A minimal installation fee will be charged proportional to the rate of flow necessary for the system.

V. SEE ADDITIONAL PROPOSAL COMPONENTS:

A. Proposal Budget Spreadsheet (see attachment A)

B. Visual Component or Map (see attachment B)

C. Letter or Resolution (see attachment C)

D. Project Manager Qualifications and Organization Description (see attachment D)

E. Financial Capacity (see attachment E)

F. Acquisition, Easements, and Restoration Requirements

The system needs minimal on-shore space as it will float in the mine pit lake. Three lakes have been identified as potential sites. One is under the authority of Aurora, and two are on the Erie/LTV Area 1 mine property. We will negotiate access to one of these locations. Upon completion of the demonstration, the system will be removed from the site.

Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet

Legal Citation:

Project Manager: Jeffrey Hanson

Project Title: Biological Sulfate-Reduction System

Organization: Clearwater BioLogic LLC

Project Budget: \$1,268,266

Project Length and Completion Date: 3 years, July 2020 to July 2023

Today's Date: April 13, 2019



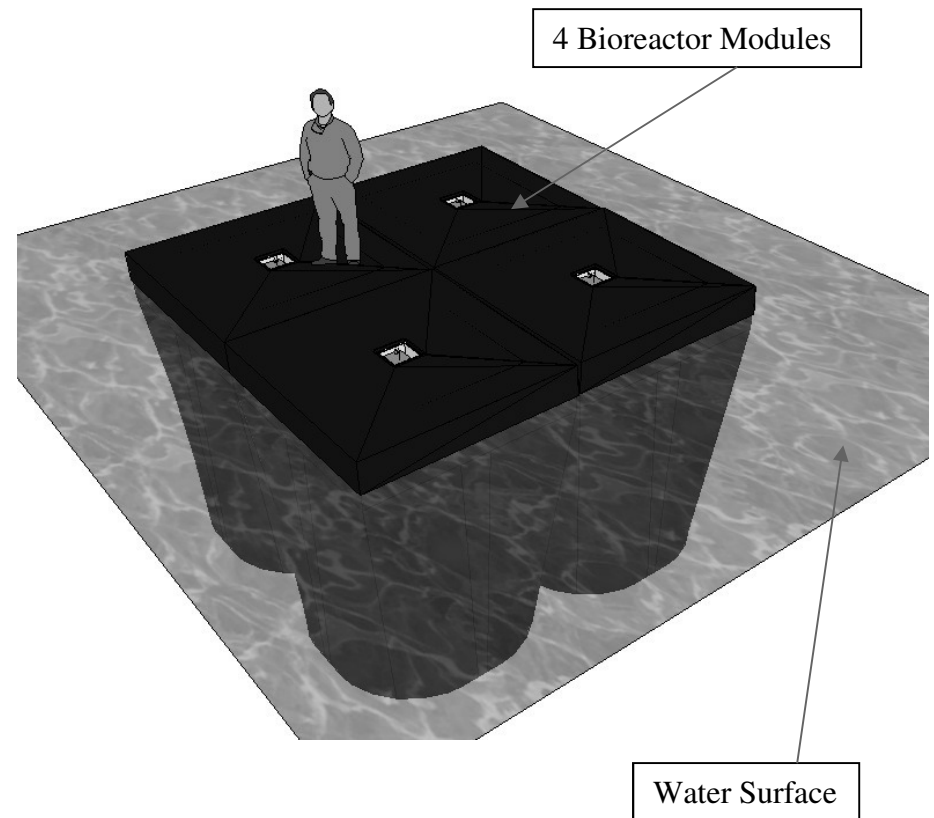
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget 3 Years	Amount Spent	Balance
BUDGET ITEM				
Personnel (Wages and Benefits)		\$ 707,616	\$ -	\$ 707,616
On-Site construction, monitoring, and testing, 2 people, 2 FTE, Carl Hanson and Stephanie Hanson based in Babbitt, MN \$58,240 annually each	\$349,440			
Management, technical support and project control, 1 person, 0.5 FTE, Jeffrey Hanson based in Babbitt, MN \$58,240 annually	\$174,720			
Benefits for on-site personnel at 40% of salary	\$183,456			
Professional/Technical/Service Contracts		\$ 64,280	\$ -	\$ 64,280
Acedemic monitoring and reporting of results, students and professores chosen from area colloges by invitation and evaluation of qualifications	\$41,000			
Equipment rental (extended reach forklight, generator) required or launching and removal of the system, competitive local bid	\$15,000			
Storeage container rental for equipment & supplies, competitive local bid	\$4,860			
On-site portable toilet, competitive local bid	\$3,420			
Equipment/Tools/Supplies		\$ 292,000	\$ -	\$ 292,000
Electron donor and nutrient blend supply for sulfate-reducing bacteria, proprietary from RNAS Remediation Products, Inc., Brooklyn Center, MN	\$90,000			
Hydrogen sulfide treatment chemical amendmets, hydrogen peroxide and ferrous chloride, with dosing tecnical support from USP Technologies, Atlanta, GA	\$192,000			
Water testing equipment, safety materials and lab testing supplies, aquired through competitive bid	\$10,000			
Capital Expenditures Over \$5,000		\$ 66,700	\$ -	\$ 66,700
4 Bioreactor modules with related flow control equipment, supplied by Clearwater Layline, Babbitt, MN	\$26,200			
Solar panels and power supply system, bid to Minnesota supplier, preferred supplier is Heliene, Mountain Iron, MN.	\$15,500			
Monitoring, amendment dosing equipment for hydrogen sulfide, USP Technologies, Atlanta, GA	\$17,750			
Clarifier and settle tank configured and supplied by Clearwater Layline, Babbitt, MN	\$7,250			
Fee Title Acquisition		\$ -	\$ -	\$ -
Easement Acquisition		\$ -	\$ -	\$ -
Professional Services for Acquisition		\$ 100,000	\$ -	\$ 100,000
Certified water sampling and testing for water permit reporting to the MPCA. Supplied by contracted service suppliers for existing permit compliance.	\$100,000			
Printing		\$ -	\$ -	\$ -
Travel expenses in Minnesota		\$ 37,670	\$ -	\$ 37,670
Vehicle expenses on-site personel, 60 miles/d, 5 days/wk at \$0.545/mile	\$23,544			
Vehicle exp management, technical support 60 mi/d, 3 days/wk, at \$0.545/m	\$14,126			
Other		\$ -	\$ -	\$ -
COLUMN TOTAL		\$ 1,268,266	\$ -	\$ 1,268,266
SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT				
	Status (secured or pending)	Budget	Spent	Balance
Non-State: Mining companies or Tribes for water monitoring and access	pending	\$ 100,000	\$ -	\$ 100,000
State: IRRR or Laurentian Partnership grants	pending	\$ 100,000	\$ -	\$ 100,000
In kind: Clearwater BioLogic and Clearwater Layline overhead and expenses	secured	\$ 80,000	\$ -	\$ 80,000
In kind: RNAS and USP Technologies technical support, amendment discount	pending	\$ 45,000	\$ -	\$ 45,000
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS				
	Amount legally obligated but not yet spent	Budget	Spent	Balance
		\$ -	\$ -	\$ -

Attachment B: Map of potential demonstration sites



Aurora draws their water from the St. James Pit Lake immediately north of the town site. The area north and upstream of the St. James Pit Lake are the Area 1 mine pit lakes of the Eire/LTV mine that closed in 2001. The, now closed, Mesabi Nugget plant is on the north side of Pit 1. Mesabi Nugget was unable to discharge water from these mine pit lakes due to high sulfate concentrations. All these mine pit lakes have high sulfate concentrations and contribute to the sulfate found in the St. James Pit Lake and Aurora town water. The choice of optional sites depends on an evaluation of site access.

Sketch of Floating Sulfate Reducing Bioreactors



The Clearwater BioLogic sulfate reducing system uses floating bioreactor modules with the active biological process operating underwater to avoid freezing and contact with oxygen. The modular design allows for building systems to treat any volume of water flow. The demonstration system would have four modules for the biological first stage as the one shown above that would be floating in one of the mine pit lake options shown on the left.

Attachment D:

March 12, 2019

Project Manager and Organization Qualifications

Jeffrey Hanson, a mechanical engineer from the University of Minnesota, is the Project Manager. As the owner of Clearwater Layline LLC of Babbitt, MN, he has successfully managed and administered the grants that were used for the development of the biological sulfate-reducing technology by Clearwater Layline. These grants and funding sources included:

- Innovation Grants of \$125,000 and \$75,000 from the Laurentian Vision Partnership of the Iron Range Resources and Rehabilitation Board (IRRRB) via the East Range Joint Powers Board (ERJPB), Natural Resources Research Institute (NRRI) development matching Permanent University Trust Fund (PUTF) grants of \$125,000 and \$75,000,
- Participation in an NRRI grant from MnDRIVE for \$500,000,
- In-kind contributions from two mining companies, and support from Clearwater Layline for the development work.

Jeffrey Hanson invented the patent-pending “floating sulfate-reducing bioreactor” biological sulfate treatment system. This concept was successfully lab- and field-tested from 2010 to 2017. The MnDRIVE phase of this development was documented by an NRRI report published July 14, 2017, under the title “The MnDRIVE Transdisciplinary Project Implementation of Smart Bioremediation Technology to Reduce Sulfate Concentrations in NE Minnesota Watersheds.”

In 2018 Jeffrey Hanson joined forces with Bill Newman of RNAS Remediation Products to form Clearwater BioLogic LLC. With this union, the company has the expertise of Jeffrey for the bioreactors and of Bill for electron donor and nutrient blends as food for the bacteria. Clearwater BioLogic then adopted the USP Technologies patented PRISC® system for hydrogen sulfide conversion to elemental sulfur. USP Technologies provides the technical support for implementation of their system in the field.

This combined expertise, under the banner of Clearwater BioLogic and the management of Jeffrey Hanson, is prepared to demonstrate the complete sulfate-reducing system as proposed.