**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 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**

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| **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.