Feasibility Evaluation of Engineered Ecosystems to Remove Phosphorus in the St. Albans Bay Watershed

STONE ENVIRONMENTAL

Services / Expertise
Vermont Water Quality
Lake Champlain TMDL
Phosphorus Removal System
Agricultural Conservation

Markets
Watershed Organizations
Municipal Government and RPCs

Project Location
St. Albans Bay, Vermont

Date Completed
Phase 1: 2016-2018
Phase 2: 2018-present

Project Owner
Lake Champlain Basin Program

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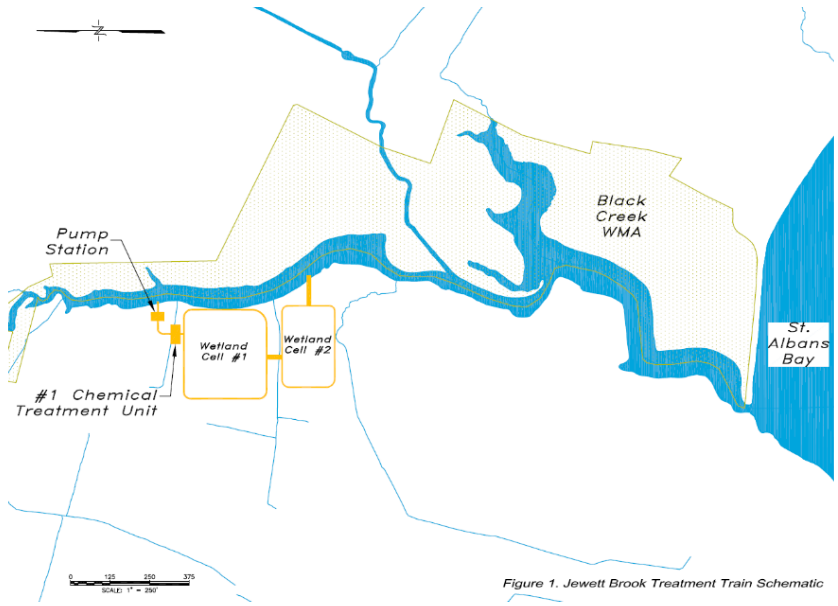

Conceptual Schematic of a Treatment Train System at Jewett Brook

FOR many years, a top priority of lake managers and the agricultural sector in Vermont has been reducing phosphorus (P) runoff from farmland through the implementation of agricultural conservation practices. These practices, however, may not be sufficient to address the problem in Lake Champlain's eutrophic St. Albans Bay. The Lake Champlain TMDL Phase 1 Implementation Plan states that higher nutrient loading from agricultural runoff in a handful of subwatersheds, including St. Albans Bay, will require implementation of creative solutions and innovative restoration techniques – measures that extend and enhance ongoing agency programs – to achieve the goals of the Lake Champlain TMDL

Phosphorus inputs to St. Albans Bay are dominated by tributary loading. The tributary with the highest median phosphorus concentration – nearly 400 μg/L in the 2009-2015 period – is Jewett Brook. Internal flux of phosphorus, from the Bay's sediments to the water column, represents a second substantial input. Chemical treatment options to sequester P in the bay's sediments have been considered, but not pursued, largely because high tributary P loadings are predicted to negate the effectiveness of in-lake treatments over a relatively short period of time. Therefore, reducing watershed P loads is a necessary precursor to any in-lake treatments.

Many of the phosphorus interventions contemplated explicitly in the TMDL Phase 1 Implementation Plan rely on the completion of substantial but dispersed, watershed-based nutrient reduction actions. The cumulative effects of these practices will take time – certainly years and possibly decades – to produce significant measured improvements in Lake Champlain's water quality. It is clear there are segments of the lake, including St. Albans Bay, in need of more immediate relief, and thus requiring more aggressive intervention.

One innovative P reduction approach that is starting to gain attention in Vermont is the development of treatment systems to remove P from streamflow before it reaches Lake Champlain. In theory, treating streamflow in certain priority watersheds would complement existing conservation programs and achieve more certain, near-term P reductions. Though technologies capable of removing significant quantities of P from surface waters are in their infancy, there have been successful applications of these systems on tributaries of Grand Lake St. Marys (GLSM) in Ohio. The largest of three treatment train systems at GLSM draws up to 2.5 million gallons per day from Coldwater Creek and removes approximately 80% of total P and 50-60% of soluble reactive P during the spring and summer seasons when it operates most efficiently.

Operation of a facility that would remove phosphorus from streamflow prior to discharge to Lake Champlain holds certain advantages not present at the scale of individual farms or developments. Treatment technologies could be applied that are not be feasible at smaller scales. Such a facility would have electric power to run pumps, chemical feeds, and mixers. It would have reliable, year-round access, which can be a challenge with on-farm practices. It would be staffed by a trained operator, who would follow standard operating procedures, maintain equipment, and monitor system performance. Treatment performance could be optimized throughout the year by adjustment of pumping rates and chemical dosing, considering the flow rate, temperature, and nutrient and sediment concentrations of the streamflow. With the possible exception of winter operation, the facility would remove phosphorus continuously, because, in contrast to farm-scale practices, flow is perennial.

Given the potential for a stream treatment facility to remove significant quantities of P, it is incumbent on resource managers to consider this option where required non-point source P load reductions may be difficult to achieve through BMP implementation alone. The Lake Champlain P TMDL requires a 24.5% reduction in the non-point source P load to St. Albans Bay and a 34.5% reduction in the agricultural non-point source P load. Implementing a treatment train system could extend and enhance ongoing agency programs focused on BMPs and nutrient management and bring the St. Albans Bay P targets within reach.

Development of such a treatment facility in the St. Albans Bay watershed will be a multiyear effort. In 2017, Stone initiated a project for Lake Champlain Basin Program to evaluate the regulatory feasibility of developing a treatment train facility to remove phosphorous from Jewett Brook prior to discharge into St. Albans Bay. During Phase 1 project, Stone coordinated and conducted meetings with pertinent regulatory bodies to evaluate the project with respect to applicable rules and regulations. Stone summarized these findings in a final report for this portion of the feasibility process. This stage in the process was completed in March 2018 with the presentation of a final report. While challenges exist, particularly concerns regarding potential thermal impacts to certain fish populations, we expect potential resource impacts could be minimized through accommodations in facility design and operations, which will be considered further in Phase 2 (technical feasibility evaluation) of the project.

This Phase 2 Technical Feasibility Evaluation will provide managers and engineers in the LCB with a carefully researched and considered facility design that may be applied in other watersheds of the Lake Champlain Basin. The scope of this technical feasibility evaluation and cost analysis includes evaluating potential siting locations; conducting an analysis of available flow and water quality data for Jewett Brook; considering design and sizing of treatment components; developing a treatment train facility conceptual design; preparing estimates of P reductions achievable by the system; developing cost estimates for final design, permitting, land acquisition, construction, and operations; and providing a cost-benefit analysis comparing the treatment train facility with conservation practice alternatives. A successful demonstration of this technology in Vermont would encourage and inform the development of additional treatment train systems on other small agricultural watersheds in the Lake Champlain Basin, such as Saxe Brook, Hospital Creek, and Whitney Creek.