Design, Installation and Monitoring of Subsurface Treatment System to Reduce Phosphorus Loading from Tile Drains

STONE ENVIRONMENTAL

Services / Expertise
TMDL Implementation Support
Subsurface Treatment System Design
Phosphorous Filtration Technology
Removal of P from Tile Drainage Water

Markets
Watershed Organizations
State Government
Local Government

Date Completed
2015-Present

Project Partner
Friends of Northern Lake Champlain

Project Owner
Lake Champlain Basin Program

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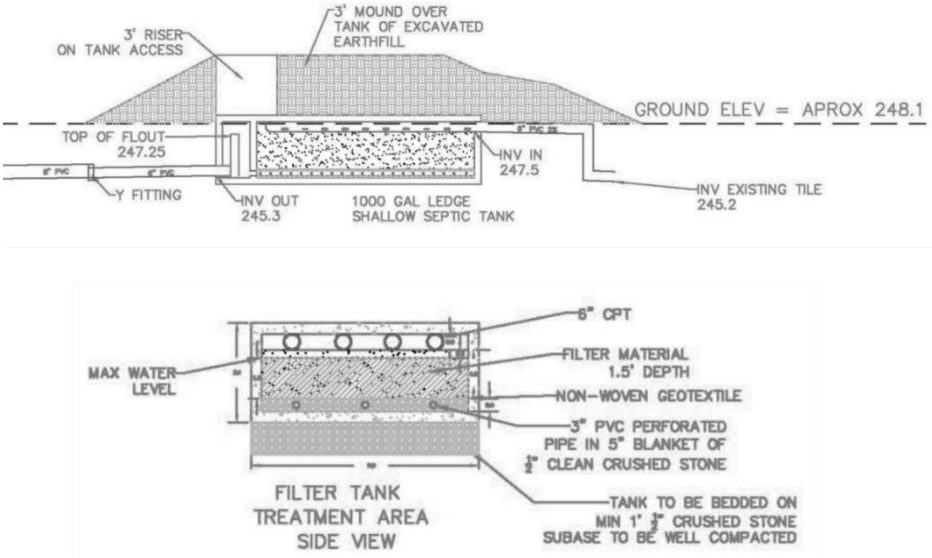

Details extracted from construction drawings of the subsurface tile drain treatment system designed, installed, and operated by Stone on a Franklin County farm.

ONCE dismissed as negligible, phosphorus levels in subsurface tile drain flow are now recognized as significant. Phosphorus removal systems installed at the outlets of tile drains that direct flow through filtering media have the potential to significantly reduce P loads to drainage ditches and receiving waters. Stone and the Friends of Northern Lake Champlain (FNLC) implemented Vermont's interim practice standard (Phosphorus Removal System, Code 782) for the first time. Stone designed and constructed a phosphorus removal system on a farm in Franklin, Vermont designed to capture phosphorus via sorptive media immediately before it discharged to surface waters as a pollutant and return it to cropland in a soil amendment for beneficial reuse. This practice has been successfully employed to treat water in drainage ditches, as well as runoff from agricultural and residential land uses. Stone evaluated a variety of media and selected a limestone bedding sand from a Swanton quarry and drinking water treatment residuals from Champlain Water District.

Both filters removed substantial percentages of total and dissolved P and total suspended solids over the 11-month monitoring period (Braun 2017). The inflow P concentrations were highly variable, 93 – 2,520 μg/L, with a median event mean concentration of 345 μg/L. The filter containing drinking water treatment residuals (DWTR) performed consistently better than the filter containing crushed limestone. The filter containing DWTR removed 69% of total P and 72% of total dissolved P, while the filter containing crushed limestone removed 54% of total P and 51% of total dissolved P. The P removal efficiency of both filters improved with increasing inflow P concentration. Neither filter effectively removed nitrogen.

The greatest challenge encountered in the Franklin study was premature clogging of both filters with sediment. The filtration rates of both filters decreased by more than 90% over the monitoring period, which resulted in a high proportion of water

bypassing the filters. Due primarily to lower than anticipated filtration rates, the inflow P load and the mass of P retained in the filters were lower than expected.

Stone is currently applying the findings from our Franklin study in a new study funded by the Lake Champlain Basin Program to construct and evaluate two reactive media filters to treat tile drainage water on a commercial dairy farm in the St. Albans Bay watershed, Vermont. The proposed study site is a tile drained cornfield that Stone is currently monitoring in the Jewett Brook tile drainage assessment project that has been shown to discharge significant amounts of P. The two filters will be designed to remove P from tile drainage water using sorptive media. The types of media used will be subject to further consideration by Stone in consultation with project advisors; at this time there are four candidate medias we are most interested in evaluating. A peak flow bypass will be incorporated in the design to avoid damage to the filter or surcharging of the tile line under high flow conditions and special attention will be given in the design to minimize sediment accumulation within the media beds. Monitoring stations will be constructed at the tile drain inflow and at the outflow from each filter to enable evaluation of the treatment performance of each filter.

The proposed filter design differs from the filters installed in Franklin in several important respects:

- Installation of a sedimentation chamber upstream of the filters to reduce the potential for clogging of the media
- Construction of the filters in lined excavations, permitting greater media volumes to be used and lower cost relative to the concrete tanks used in Franklin
- Use of media with substantially greater hydraulic conductivity than either media used in Franklin, to reduce the potential for clogging of the filters and loss of hydraulic head through the media beds
- The ability to backflush the filters into the sedimentation chamber to maintain acceptable filtration rates

The outputs of this project will primarily consist of data and information provided in written reports and oral presentations. The plans, specifications, and guidance developed in designing the P removal systems are additional important outputs that will be of interest to LCBP, Vermont NRCS, and Vermont State agencies. Other outputs include the constructed treatment system, the monitoring structures and instrumentation, and appurtenant structures. The filter design and associated procedures and guidance will provide managers and technicians in the LCB with a tested and documented approach for reducing P contributions from tile drains. Widespread adoption of tile drain treatment systems has the potential to reduce P loading to Lake Champlain and improve its water quality.

This project was funded by an agreement awarded by the Environmental Protection Agency to the New England Interstate Water Pollution Control Commission in partnership with the Lake Champlain Basin Program. NEIWPCC manages LCBP's personnel, contract, grant, and budget tasks and provides input on the program's activities through a partnership with the LCBP Steering Committee. Although the information in this document has been funded wholly or in part by the United States Environmental Protection agency under agreement LC00A00377 to NEIWPCC, it has not undergone the Agency's publications review process and therefore, may not necessarily reflect the views of the Agency and no official endorsement should be inferred. The viewpoints expressed here do not necessarily represent those of NEIWPCC, the LCBP Steering Committee, or EPA, nor does mention of trade names, commercial products, or causes constitute endorsement or recommendation for use.

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