Denitrification Bioreactor in Northwest Iowa

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Denitrification bioreactors for removal of nitrate in tile drainage are a new water quality technology that has rapidly gained interest in Iowa. A bioreactor is composed of an excavated trench filled with woodchips that are colonized by denitrifying bacteria. As drainage waters containing nitrate flow by these "good" bacteria, they convert the nitrate in the water to nitrogen gas. A critical component in evaluating the performance of these treatment systems is the documentation of nitrate-N reduction over a range of weather and flow conditions.

Materials and Methods

A denitrification bioreactor was installed at the Northwest Research and Demonstration Farm in August 2019. The bioreactor's dimensions were 80 ft. long, 3 ft. deep, and 20 ft. wide (Figure 1).

Hardwood chips were used as fill material. Water samples were taken from the control structures by farm staff approximately weekly during flow conditions from late-2019 through mid-2021. The samples were analyzed for nitrate-nitrogen at Iowa State University.

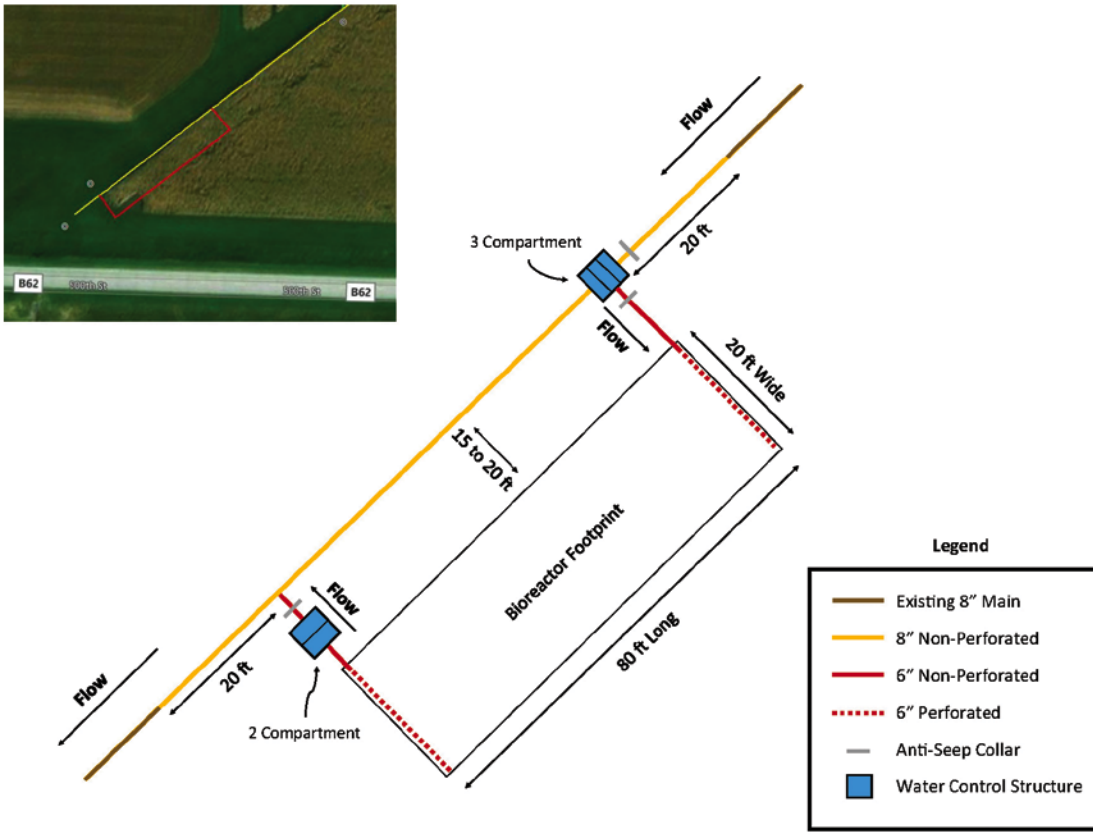

Figure 1. Bioreactor dimensions.

Results and Discussion

The bioreactor consistently reduces nitrate concentration of effluent water (Figure 2). While flow is not shown, the periods where influent and effluent concentrations are similar are during high flow conditions where there would be low retention time in the bioreactor. Conversely, periods when concentrations of the effluent water are near zero are during very low flow conditions.

Box plots of influent and effluent nitrate-N concentrations are shown in Figure 3. From this information, the mean influent concentration was 11.6 mg per L while the mean effluent concentration was 8.3 mg per L. The median concentration was 11.8 and 9.1 mg per L for the influent and effluent, respectively. Overall, there was a 28% reduction in mean nitrate-N concentration and 23% reduction in median nitrate-N concentration of the water that went through the bioreactor. Work continues on summarizing drainage flow information to calculate an overall load reduction due to the bioreactor.

Acknowledgements

The work of the Northwest Iowa Research Farm for the continued collection of these bioreactor water samples is gratefully acknowledged. Support of Heinsohn Digging and Tiling in installing the bioreactor is gratefully acknowledged. Support from Prinsco, Inc. in ensuring the bioreactor is monitored is greatly appreciated.

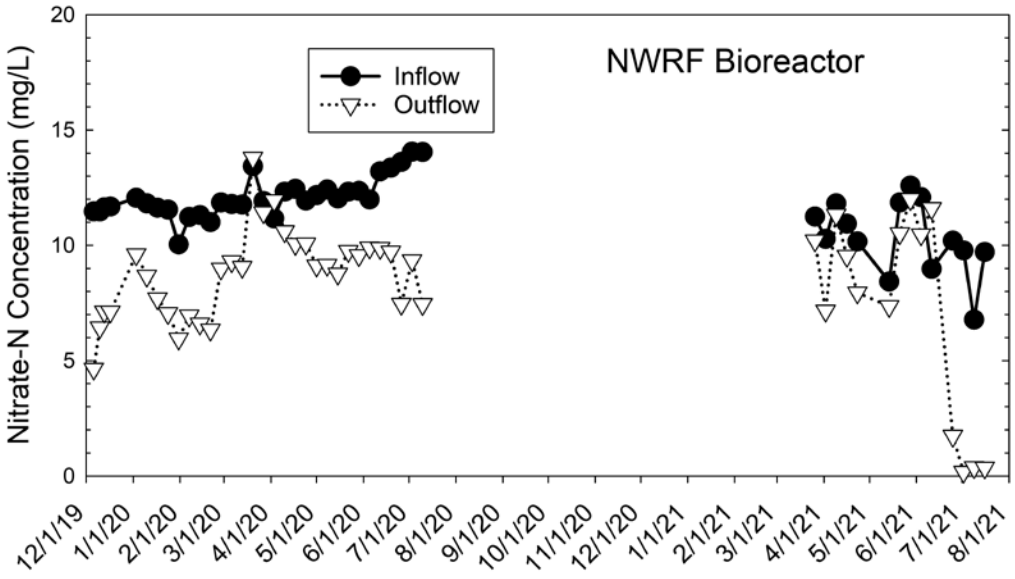

Figure 2. Time-series of nitrate-N concentrations in the influent and effluent from the bioreactor for 2019-2021.

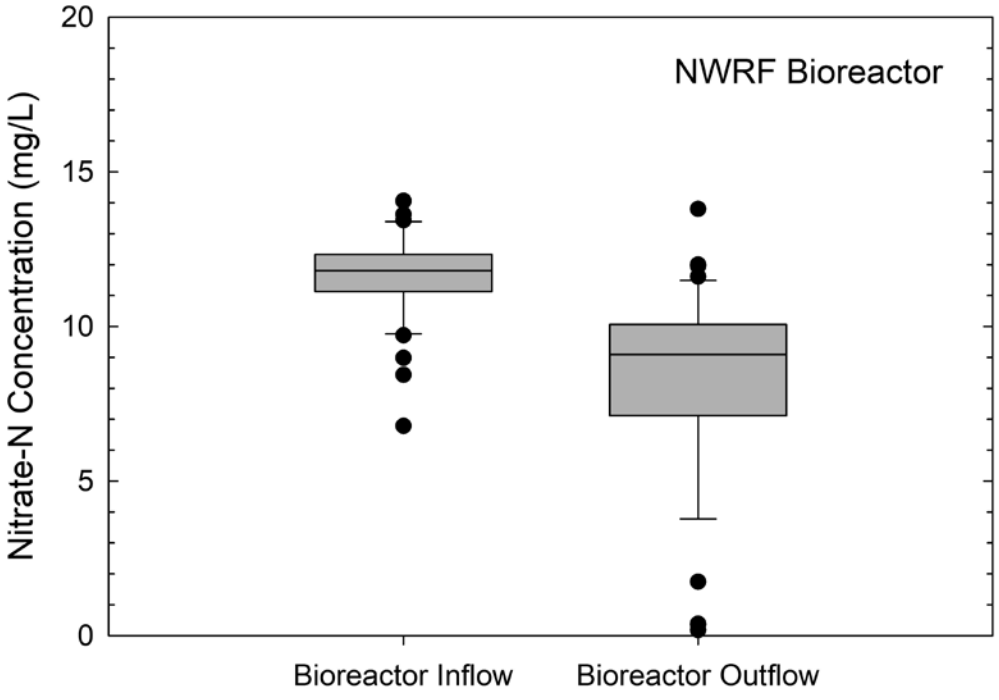

Figure 3. Box plot of nitrate-N concentrations in the influent and effluent from the bioreactor for 2019-2021.