



Denitrification Bioreactor in Northeast Iowa

Matt Helmers—professor, Department of Agricultural and Biosystems Engineering

Carl Pederson—agricultural specialist, Department of Agricultural and Biosystems Engineering

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, these 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 in weather and flow conditions.

Materials and Methods

A denitrification bioreactor was installed at the Northeast Research and Demonstration Farm in April 2009. A unique feature of this bioreactor was that it was constructed with a trapezoidal cross-section, the first in the state. The bioreactor’s dimensions were 120 feet long × three feet deep × 15 feet (top width) to eight feet (bottom width).

Hardwood chips from a local supplier were used as fill material. Water samples were taken from the control structures by farm staff approximately twice weekly during flow conditions from 2012 through 2021. The samples were analyzed for nitrate-nitrogen at the Agricultural and Biosystems Engineering Water Quality Laboratory.

Results and Discussion

The bioreactor consistently reduces nitrate concentration of effluent water (Figure 1). 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. This was very noticeable in 2020 and 2021 when relatively dry conditions resulted in low flow through the bioreactor. Work is ongoing to examine the flow through the bioreactor to estimate overall pounds of nitrate removed by the bioreactor.

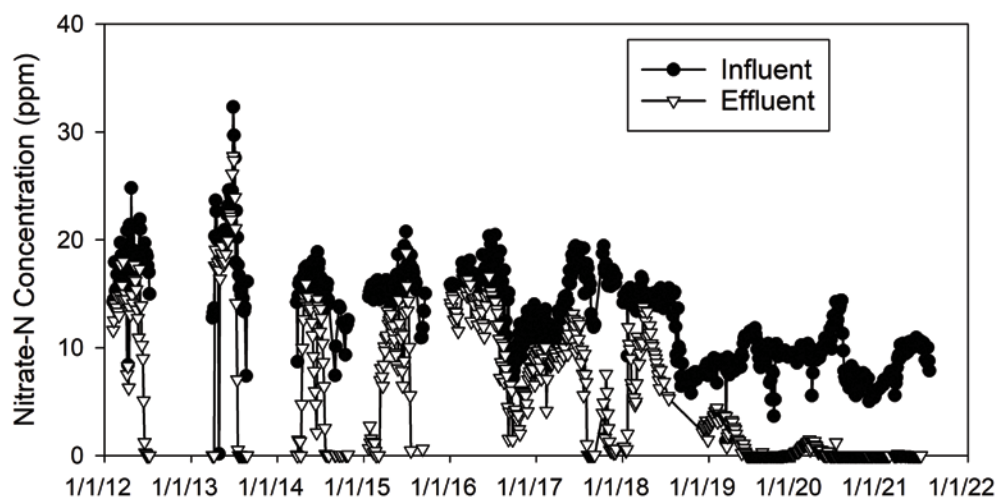


Figure 1. Nitrate-N concentrations in the bioreactor influent and effluent from 2012-2021.

Acknowledgements

The work of the Northeast Research and Demonstration Farm for the continued collection of these bioreactor water samples is gratefully acknowledged.