

**McHENRY COUNTY
CONSERVATION DISTRICT**

Woodchip Bioreactor

Nitrogen is an element that is essential for life on this planet but excess amounts of nitrogen in water cause concern for human and environmental health. When excess amounts of nitrogen are found in water, such as tile drainage, a woodchip bioreactor is one option to clean the water before the nitrogen causes a problem downstream.

A woodchip bioreactor is a trench full of woodchips that cleans nitrogen from water by maximizing the process of denitrification. Denitrification is a natural part of the nitrogen cycle where native bacteria convert nitrate (a form of nitrogen) in the water to harmless nitrogen gas. It's these bacteria that lend the "bio" to the name bioreactor. The woodchips serve as the bacteria's food source, and as nitrate in the water flows by the bacteria, they convert the nitrate to nitrogen gas, thus cleaning the water.

WOODCHIP BIOREACTOR DESIGN

With the assistance of an Illinois Farm Bureau (IFB) Nutrient Stewardship Grant and in partnership with McHenry County Farm Bureau (CFB), a 40 ft wide x 40 ft long bioreactor on a McHenry County Conservation District (MCCD) property was built in 2020 to clean nitrate in water from a 45-acre tile drained field. The drainage system outlet pipe was 12" in diameter, which was relatively large compared to the 6" or 8" outlet pipe size for which most conventional bioreactors are designed. Most of these conventional bioreactors are long and narrow trenches, for example, 10 ft wide x 50 ft long. However, because this outlet tile pipe was a larger diameter and would thus carry more water than most bioreactor situations, this bioreactor was purposely designed to be wider. Water that is not captured by the bioreactor bypasses to the stream and is untreated.

NITROGEN TREATMENT RESULTS IN YEAR 1

In summary, from April 2021 to April 2022, the bioreactor captured 78% of the flow and removed 170 pounds of nitrate-nitrogen. This means the bioreactor removed 11% of the nitrogen that would have otherwise gone downstream.

**Bioreactor quick stats for
April 2021 to April 2022:**

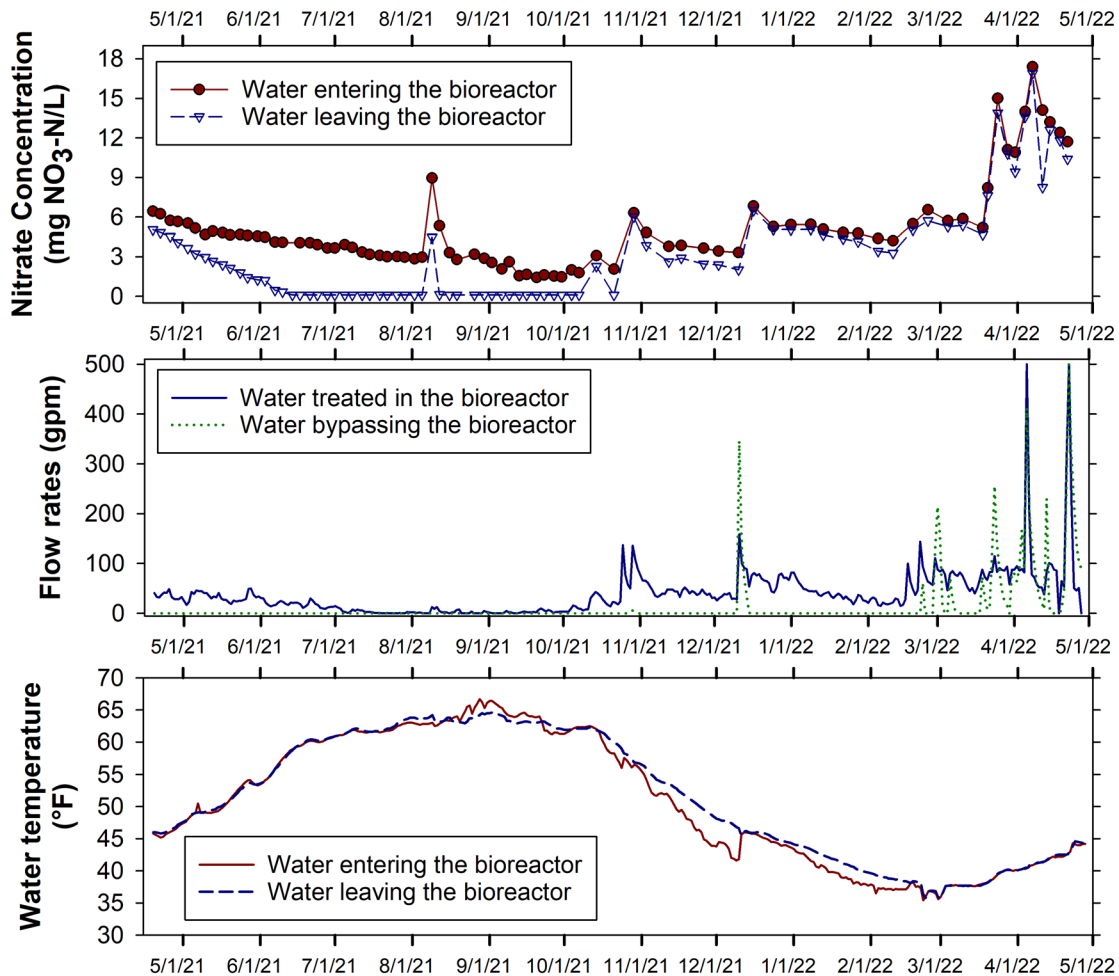
Pounds of nitrate-nitrogen leaving the field without bioreactor treatment	1520 lb N
Pounds of nitrate-nitrogen removed with bioreactor treatment	170 lb N
lb N/acre kept from going downstream	3.7 lb N/ac
Percentage of the drainage flow from the field routed into the bioreactor	78%
Overall nitrate-nitrogen removal efficiency considering untreated bypass flow	11%

Devoted volunteers have collected samples of water entering and exiting the bioreactor at least weekly since April 2021. Every sample event shows that nitrate is being removed across the bioreactor. In other words, the nitrate concentrations in the water leaving the bioreactor (blue triangles in the figure) are all lower than the nitrate concentrations in the water entering the bioreactor (red circles) for samples collected on the same date.



The nitrate concentration reduction provided by the bioreactor (the difference between the circles and triangles) is impacted by how fast the water moves through the woodchips. When the bioreactor's flow rate was less than 15 gallons per minute, like in late summer 2021, the bioreactor generally removed all the nitrate that entered. However, when drainage flows increased starting in October 2021, the difference between the nitrate concentrations for water entering and exiting the bioreactor was reduced. This is because the water was moving faster through the bioreactor, which gives less time for the natural bacteria to do their biological process of denitrification.

An additional compounding factor is that winter and spring drainage water flows are cooler than summer flow. Water temperature impacts all biological processes, including denitrification, with cooler temperatures slowing these processes.



Contact Dr. Laura Christianson (LEChris@illinois.edu) at the University of Illinois for more information about this study, www.ilfb.org/FieldDays for more information about the McHenry County woodchip bioreactor, or your local USDA NRCS office to ask about bioreactors.

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