



Woodchip Bioreactor Partnership 2020

Henry County Farm Bureau

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Speakers for the Virtual Field Day included:

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Background

As part of the Woodchip Bioreactor Partnership (Partnership), the Illinois Farm Bureau (IFB), Illinois Land Improvement Contractors Association (ILICA), Illinois Natural Resources Conservation Service (NRCS), and the University of Illinois College of Agricultural, Consumer and Environmental Sciences (ACES) joined together for the first time in 2017 to install a woodchip bioreactor to improve water quality and implement the Illinois Nutrient Loss Reduction Strategy (NLRs).

The goal of the Partnership is to study the effectiveness of woodchip bioreactors designed pursuant to NRCS standards on farms in the tile-drained areas of Illinois, as well as provide education, outreach and demonstration of the practice to government agency staff, contractors, farmers, landowners, and the general public. The Partnership intends to install at least five woodchip bioreactors during the life of the Partnership. Following installation, researchers from ACES will monitor

the woodchip bioreactors to collect data and study the improvements made to water quality. The intention is for the research, education, outreach and demonstration activities to continue for a minimum of five years following installation of each woodchip bioreactor. The farm sites are also expected to serve as settings for tours of elected officials, regulators and media.

Henry County Farm Bureau

Henry CFB is a not for profit agricultural membership organization based in Cambridge, Illinois. Henry CFB represents over 1,400 farm families on local, state, and national issues. An additional 2,400 associate members utilize services from Henry CFB and support the organization in a variety of ways. Henry CFB provides members with legislative representations on trade, transportation,

education, renewable fuels, land use, taxes, and government regulation. They also provide members the opportunity to participate in educational events, conferences, and seminars. The Farm Bureau Foundation is responsible for the Agriculture in the Classroom program in Henry County, reaching over 12,000 students each school year.

Illinois Natural Resources Conservation Service

The role of NRCS in the Partnership is to provide technical assistance and, in the case of this particular bioreactor, financial assistance through federal conservation programming. NRCS uses research information to develop conservation practice standards and guidance for design and implementation of conservation practices, all over the state. NRCS has local field office staff in nearly every county in the state, as well as Area and State level specialists that are experts in planning and designing conservation practices,

like woodchip bioreactors. Their offices are generally co-located with the local Soil and Water Conservation District in each county. NRCS works closely with landowners to plan site specific practices or a suite of practices that address the resource concerns they have on their individual operations. They also promote, plan, design, implement, and monitor conservation practices such as denitrifying bioreactors in an effort to address issues outlined in the Illinois NLRs.



Bioreactor installation in McHenry County, August 2020

Illinois Land Improvement Contractors Association

ILICA is a non-profit trade association dedicated to the professional conservation of soil, water, and natural resources. Comprised of over 200 contractor members, ILICA encourages high standards of workmanship in resource management and land improvement practices through membership education and training. ILICA's mission

is "To promote, perpetuate, and improve the proper use of our natural resources for the benefit of all."

For the fourth consecutive year of the Partnership, ILICA brings decades of conservation and construction expertise into the field to improve water quality. Through its active contractor and associate members,

ILICA handles construction of the woodchip bioreactors in partnership with IFB, NRCS, and ACES. From the initial site inspections to the logistics of obtaining all the necessary labor and materials to meet the designed practice requirements, ILICA provides in-kind support to the Partnership to help build water quality education and practice implementation.

Illinois Farm Bureau Nutrient Stewardship

Since 2015, IFB has contributed to the NLRS. Through leadership and participation from our farmer members across the state, IFB has been able to make meaningful contributions toward water quality improvements in Illinois. From 2016 to present, IFB has committed approximately \$1.5 million of its own funding to build and maintain its sustainability programs.

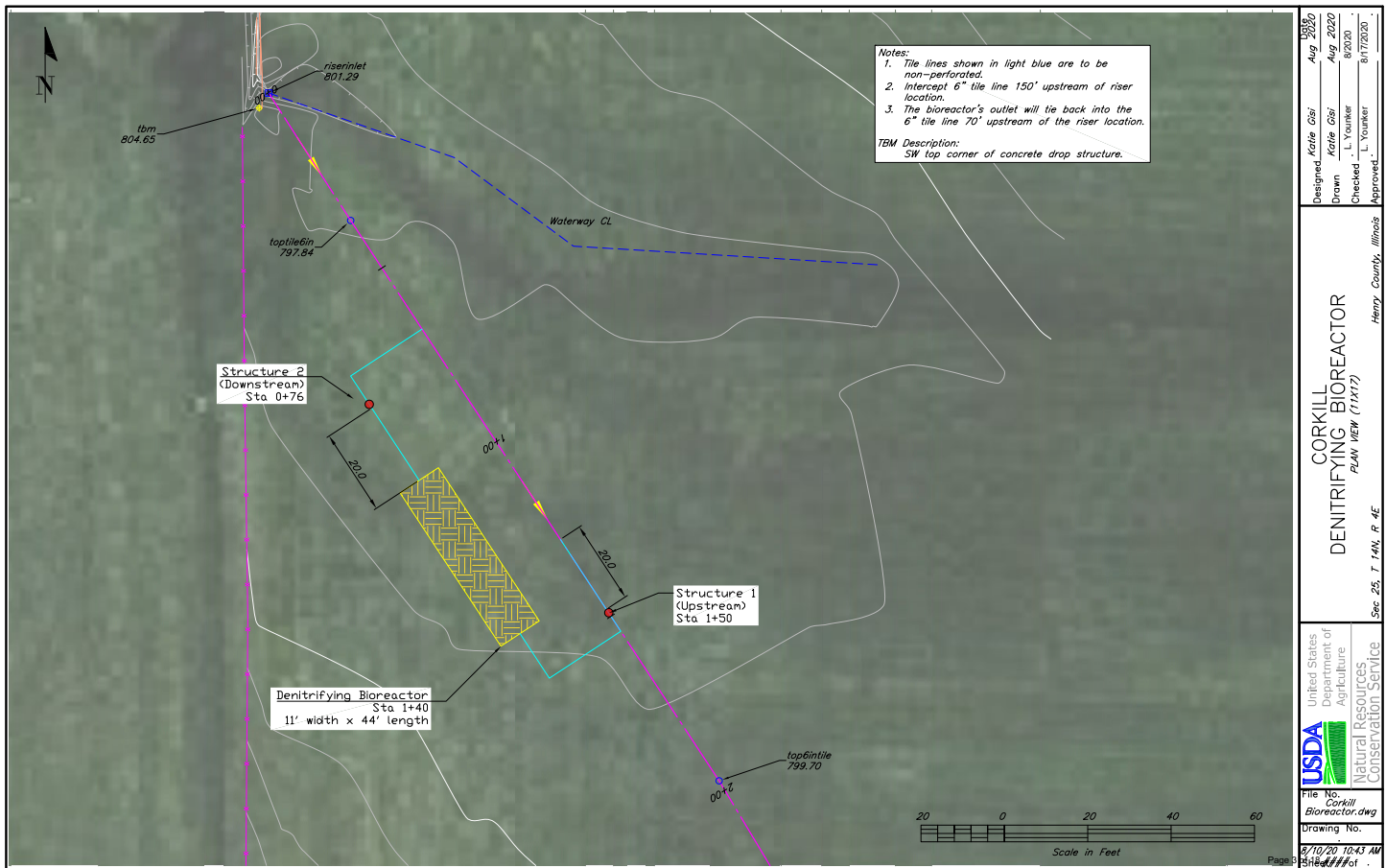
The NLRS is a science-based framework for using research, technology and industry experience to assess and reduce nutrient loss to Illinois waters and to the Gulf of Mexico. The NLRS sets forth a plan to leverage existing programs to optimize nutrient loss reduction while promoting collaboration, research, and innovation among the private sector, academia, non-profits, wastewater treatment agencies, the agricultural sector, and state and local government. The primary goals include reducing nitrate-nitrogen losses by 15% and reducing total phosphorus losses by 25% by the year 2025 from established baseline conditions. The NLRS was released in July of 2015 after multiple years of stakeholder discussions in which IFB actively participated. Since 2015, IFB has continued its participation in NLRS meetings and work groups in order to strategically guide the effort. In addition, IFB created new programs in 2015 to support farmer implementation of best management practices (BMPs) to help Illinois meet the goals of the NLRS.

For the past several years, IFB has made it an organizational priority to lead on environmental issues, most notably, the NLRS. IFB's NLRS efforts focus in four priority areas: 1) education and outreach to farmers, landowners and the general public; 2) supporting research of best management practices to reduce nutrient loss from agricultural fields; 3) supporting farmer implementation efforts across the state; and 4) demonstrating progress toward the long-term goals of the NLRS. The IFB Board of Directors committed significant financial resources and support from staff to accomplish some ambitious goals, allowing IFB to tackle environmental challenges head-on. IFB will continue to prove that voluntary, incentive-based conservation, based on science, will move the needle on water quality improvements in our state.

Participating in the Partnership is one example of the many ways IFB is creating lasting impacts in implementing the NLRS across Illinois. In this Partnership, IFB plays the role of vetting active IFB farmer members who are interested in installing a woodchip bioreactor and can be depended upon to host on-farm research sites and outreach/education/demonstration events throughout the life of the Partnership. IFB also provides financial support for the construction of the woodchip bioreactor, water quality monitoring and research, and promotional support for field days, meetings and other general Partnership information. For more information on IFB's environmental efforts, see:

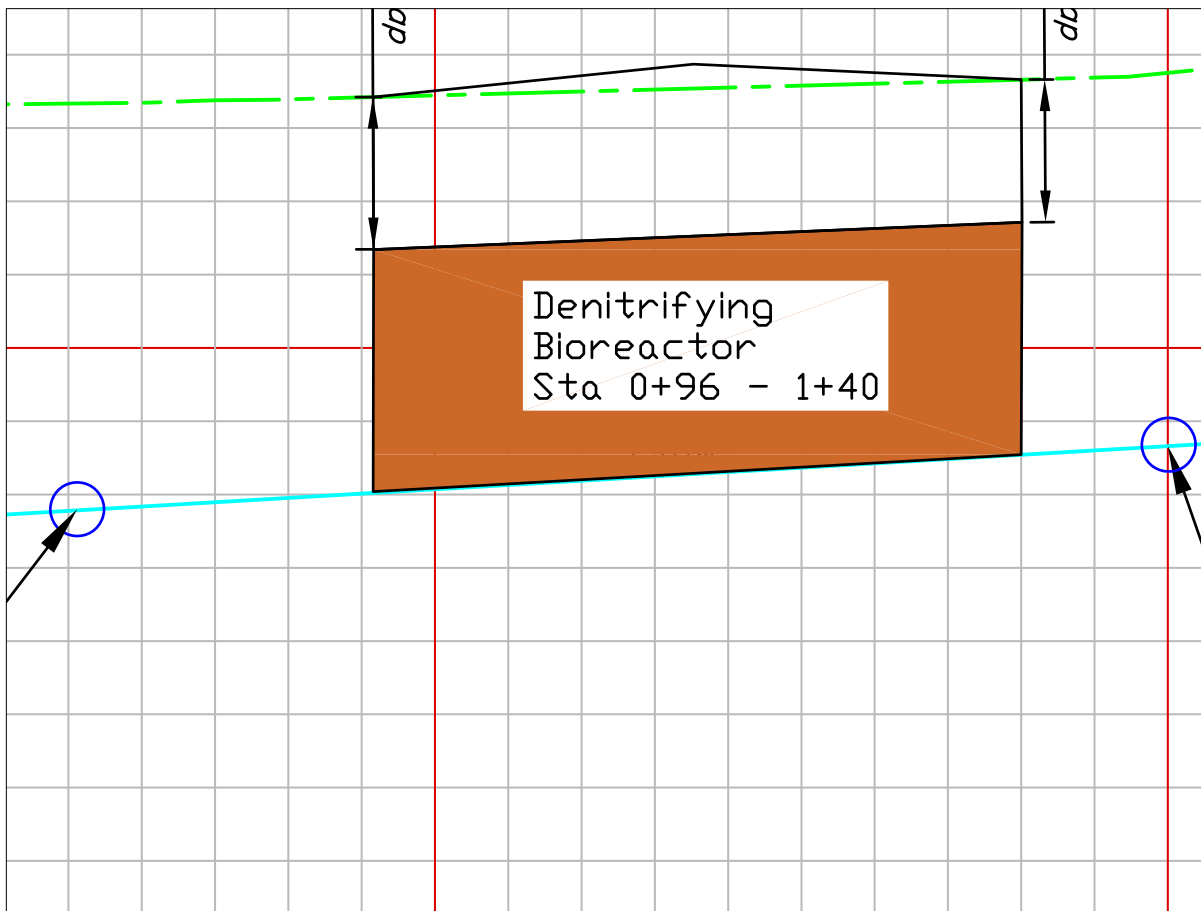
<https://www.ilfb.org/take-action/current-priorities/protecting-our-environment/>

Design Schematics - Overhead Plan View



- The denitrifying bioreactor was planned to treat a 6" tile line draining roughly 20 acres of land (purple stationing line).
- The bioreactor (yellow hatched rectangle) is located along the tile line near the edge of the field.
- To properly design the bioreactor, the tile had to be exposed in 2 locations upstream and downstream of the planned bioreactor location. This allowed the designer to calculate the slope of the tile going into the bioreactor and how much tile flow it would need to be able to handle.

Design Schematics - Profile View Image



- The bioreactor was designed to be 11' wide, 44' long, and filled with 3.4' of woodchip material, with a 2' cap of soil on top.
- Two water control structures (one upstream, one downstream) will be used to manage the inflow and outflow of the bioreactor.
- The bottom of the bioreactor is gradually sloped so that water will flow through it, rather than sit and stagnate.



Picture of previous woodchip bioreactor installation.

Woodchip Bioreactor Research

Agricultural productivity in the US Midwest is underlain by a foundation of more than 48 million acres of tile drainage networks, with approximately 10 million tile-drained acres in Illinois alone. After more than 150 years of improving land drainage in this way, this practice is fully integrated into the economy and culture of our crop production. However, in changing how water leaves our fields by installing tile pipes, we have also changed how nutrients can leave our fields. Nitrate is a particularly tricky nutrient because it does not “stick” to soil and is thus highly susceptible to leaching. Edge-of-field practices like woodchip bioreactors allow us to keep our tile drainage systems functioning for good crop production while also cleaning nitrate out of drainage water before it moves downstream.

A woodchip bioreactor is a woodchip-filled trench that cleans nitrate from tile drainage water. Bioreactors clean nitrate from water using the process of denitrification, which is a natural part of the nitrogen cycle where nitrate in the soil or in water is converted into benign nitrogen gas. This process of denitrification has been happening

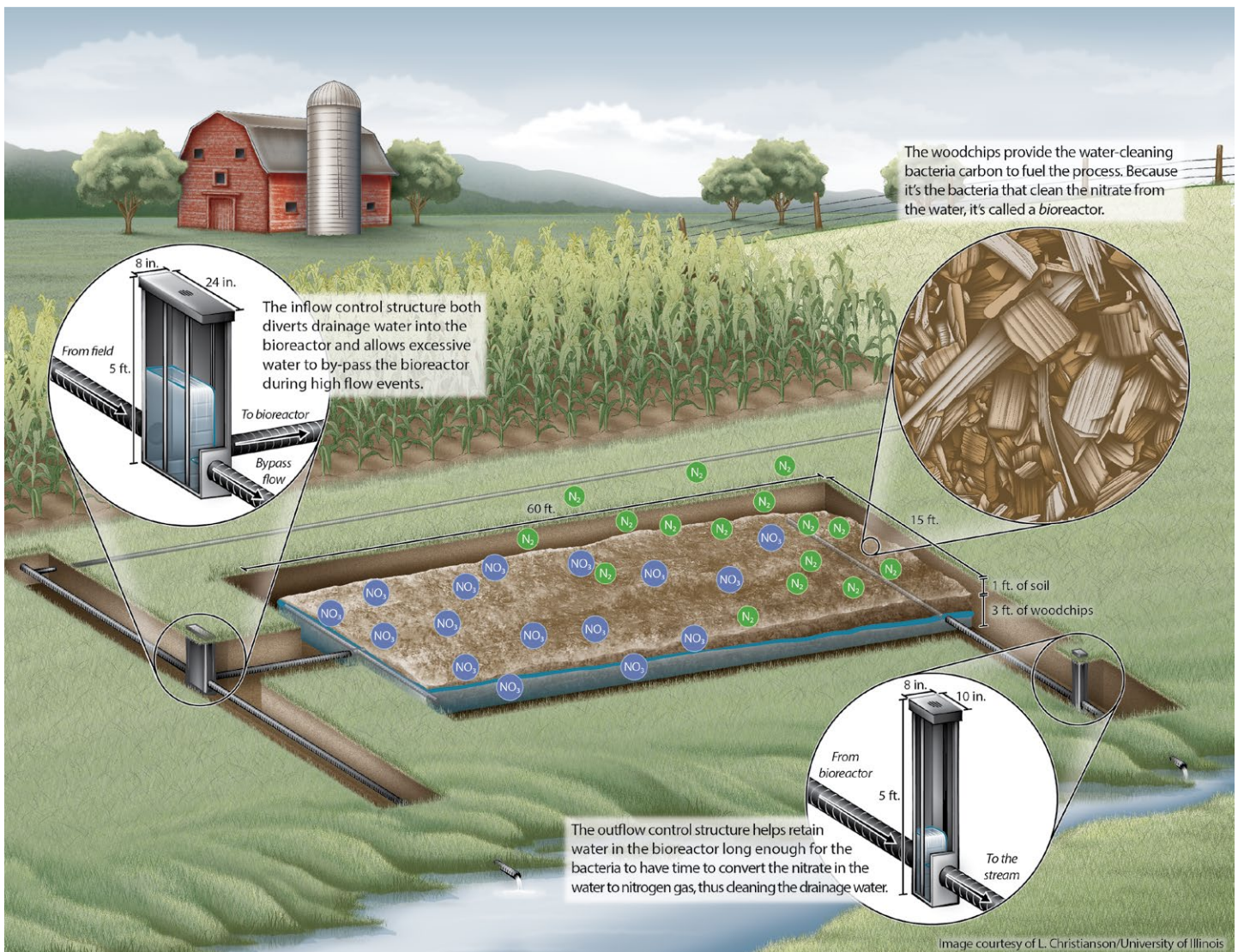
for millions of years on its own, and in a bioreactor, ideal conditions are created to enhance this nitrate conversion. One of the important aspects of denitrification is that the process is performed by bacteria. These denitrifying bacteria are the work horses of converting the nitrate in the water to harmless nitrogen gas. In other words, inside a bioreactor, the nitrate doesn't stick to the woodchips or get physically filtered out of the water. It is biologically converted into nitrogen gas by these bacteria. It is this biological conversion of nitrate that lends the name “bio”-reactor.

From a research perspective, there are two main pieces of information needed to estimate how much nitrate a woodchip bioreactor has removed. Firstly, researchers collect water samples at the inflow control structure and at the outflow control structure. The water samples are brought to a laboratory and are analyzed to determine their nitrate concentrations. There should be a lower nitrate concentration in the water, leaving the bioreactor compared to the water flowing in. That means the bioreactor is

working. Oftentimes automated samplers are used to do the water sampling, so research staff doesn't have to be physically at the bioreactor to collect the samples over long periods of time.

However, simply collecting water samples does not provide the full picture of how well a bioreactor is working. The amount of water being treated in the bioreactor also needs to be quantified. The second component of bioreactor research is monitoring the water flow. Small hot-dog shaped pressure transducers are placed in the control structures to continuously record how much water is pushing down on them as the water flows through the structure. That water depth is logged and later related to a flow rate using an equation in the laboratory. A lot of water pushing down on the pressure transducer is related to a high flow rate, whereas relatively shallower depths of water pushing down on the pressure transducer are related to relatively slower water flow rates.

One of the most commonly asked questions about bioreactors is: "How long do the woodchips last?" Practical observation and research across the US Midwest have shown woodchips in a bioreactor last approximately 7-12 years before the woodchips need to be replaced (or, "recharged"). Another common question involves if the type of woodchip matters. The short answer is the tree species used to make the woodchips generally does not matter. All woods contain roughly the same amount of carbon, which is the fuel for the process of denitrification inside a bioreactor. Rather than the type of tree, it's the physical size and shape of the woodchips that are more important. Locally-available woodchips will be most cost-effective, but they must be clean from leaves or dirt. Ideally, the woodchips should have a square/ rectangular "chip shape" and be around 1" or more in size. There is a restriction on the use of oak woodchips due to concerns about leaching of tannins, although this is an area of active research.



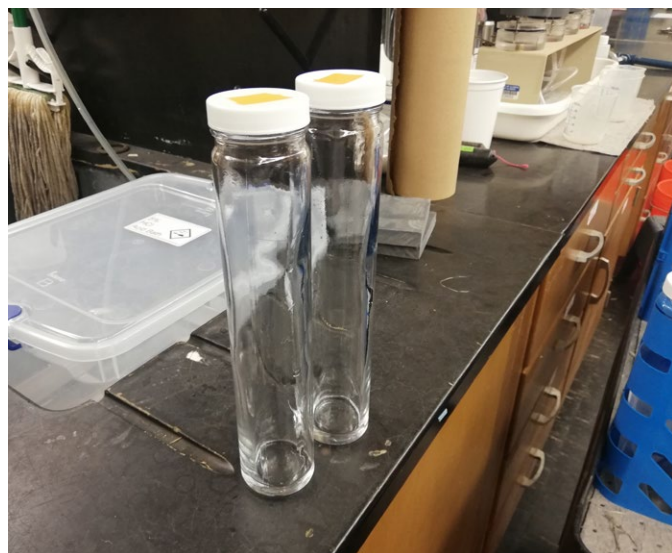
5. Frozen samples are thawed and then analyzed in our Lachat Quikchem machine to determine nitrogen concentration. Results are later uploaded to a spreadsheet by our lab manager.



6. Samples are put into milk crates once they have been analyzed and acidified so they can be stored.



7. Some sites with autosamplers deployed collect water in glass bottles which have acid in them, so these samples do not need to be frozen, but always filtered before analyzed. After filtering, samples go into the plastic shampoo bottles like every other sample. These samples have to be neutralized before analyzed too.





Contact Information

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To learn more about all other IFB Virtual Field Days, visit:

www.ilfb.org/FieldDays

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