Quantifying the Effectiveness of Installing Saturated Buffers on Conservation Reserve Program to Reduce Nutrient Loading from Tile Drainage Waters

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PROJECT COLLABORATORS:

Agricultural Drainage Management Coalition Member Companies

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NUMBER OF SITES: 9

"Quantifying the Effectiveness of Installing Saturated Buffers on Conservation Reserve Program to Reduce Nutrient Loading from Tile Drainage Waters"

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Number of Sites: 8 (Additional site, MN4 added to this report)

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List of deliverables/products of project activities:

Deliverables:

This project will:

1) Measure and estimate nitrogen concentrations and flow data from the agricultural tile drains before being distributed along the buffer, monitor the flow data for water through tile drains and distributed to the buffers, and the nitrogen concentration in ground water as it moves through the buffers,
2) Incorporate this data with other monitoring data to conduct an analysis of the cost effectiveness of saturated buffers in reducing nitrogen loadings from tile drainage water,
3) Evaluate the use of saturated buffers within a farm operation, and
4) Develop outreach materials to increase awareness of the suitability and effectiveness of the saturated buffer practice.

Executive Summary

Nutrient loss through subsurface drainage systems is a major concern throughout the Midwest. This project sought to further demonstrate and evaluate the effectiveness of a new conservation practice commonly referred to as a Saturated Buffer (SB). By hydrologically reconnecting a subsurface drainage outlet with an edge-of-field buffer this practice takes advantage of both the denitrification and plant nutrient uptake opportunities that are known to exist in buffers with perennial vegetation to remove nutrients from the drainage water. The USDA-NRCS developed practice standard (604) for Saturated Buffers and released it in May 2016.

The objectives, or deliverables, of this project were 1) measure and estimate nitrogen concentrations and flow data from agricultural tile drains before being distributed along the buffer, monitor the flow data for water through tile drains and distributed to the buffers, and the nitrogen concentration in ground water as it moves through the buffers, 2) incorporate this data with other monitoring data to conduct an analysis of the cost effectiveness of saturated buffers in reducing nitrogen loadings from tile drainage water, 3) evaluate the use of saturated buffers within a farm operation, and 4) develop outreach materials to increase awareness of the suitability and effectiveness of the saturated buffer practice.

Deliverable 1: Measure and estimate nitrogen concentrations and flow data from the agricultural tile drains before being distributed along the buffer, monitor the flow data for water through tile drains and distributed to the buffers, and the nitrogen concentration in ground water as it moves through the buffers.

This project monitored 9 SB’s in Iowa, Illinois, and Minnesota. These sites intentionally included a variety of soil types, buffer vegetation, surface topographies, and ditch/stream channel depths. This variety was included to evaluate the effectiveness of this practice if it were to be adopted on a regional scale. The monitoring timeline included a period from September 2016 through February 2017, yielding 6 months of flow and nutrient samples. Collected data included: flow and nitrogen samples within the structure, the before flow distribution to the buffer lines; nitrogen concentrations within the stream; monitored flow before and after SB tile distribution by comparing pre and post structure flow; and nitrogen concentrations of groundwater within the buffer via a series of monitoring wells.

There was flow diverted from the main tile system to the buffer in 7 out of the 9 sites (Fig. 2). The sites ranged from a low of 22% to a high of 95% with an average of 65% of the flow diverted.

All 9 sites were consistent in showing nitrate concentration reductions from the main line of the drainage system to the stream side test well. This reinforces data from the previous study where 27 out of 28 field years indicated the same reductions.

Of the 9 SB sites seven (IA-1, IA-3, MN-3, MN-4, IL-2, IL-4, and IL-5) showed substantial nitrate removal. IA-1 removed 17.7 lbs, IA-3 removed 342.3 lbs, MN-3 removed 82.1 lbs, MN-4 removed 148 lbs, IL-2 removed 13.5 lbs, IL-4 removed 11.4 lbs, and IL-5 removed 60.0 lbs of nitrate-N. The average nitrate load reductions of all sites for this period was 61% (Fig. 16).

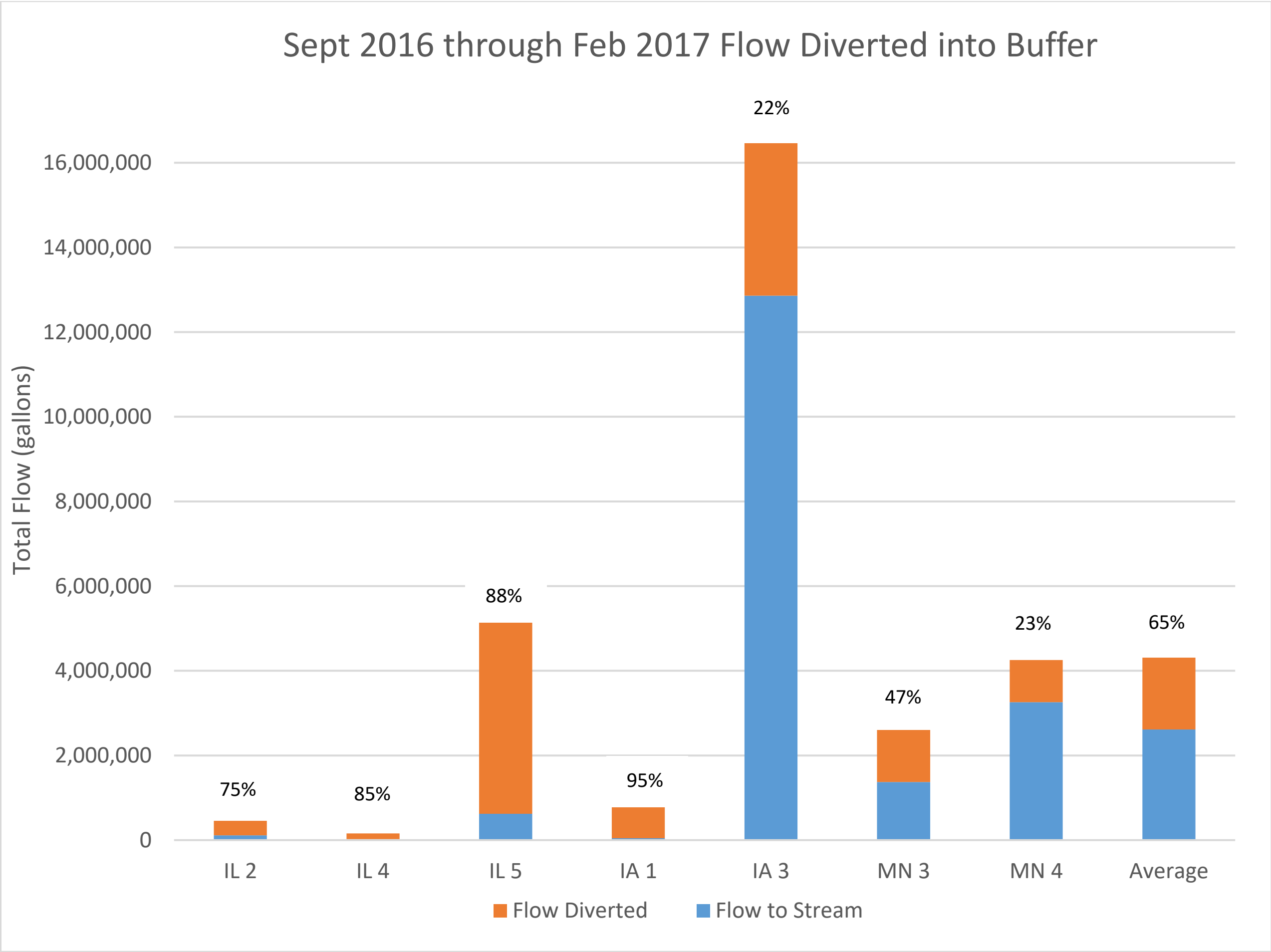

Figure 2: *Flow Reduction Summary*

Deliverable 2: Incorporate these data with other monitoring data to conduct an analysis of the cost effectiveness of the saturated buffers in reducing nitrogen loadings from tile drainage water.

Since loads were only monitored over a 6-month period, the total was doubled to receive the full year's data set with which we calculated the cost of reduction. Two (2) sites were eliminated in the computation due to flow monitoring problems encountered. The average installation cost was $3,700 per saturated buffer. Assuming a 50-year lifespan and 4% inflation rate, the cost of nitrate removal averaged $2.44/lb-N. This makes them competitive with other field-edge practices for nitrate load reduction. Comparing these numbers to the initial 2013-2015 report, the reduction cost per pound of N showed a slight increase from $2.13/lb-N removed. The increase in cost is likely due to the former project calculating flows over spring months, compared to this project, which only used data in the late fall and winter.

Deliverable 3: Evaluate the use of saturated buffers within a farm operation

This project has shown the importance of managing SB's efficiently within a farm operation. In an ideal scenario, the SB would be at a substantially lower elevation than the adjacent field. This would require no management of the water table underneath the buffer. The same board settings can be used throughout all times of the year and not impact the field condition. Often, the SB is at a similar elevation to the adjacent field. In this case, it is important to educate the producers on managing their SB according to season. Board settings will need to be lowered slightly during the growing season to ensure ideal field conditions and to not harm their crop. After harvest has taken place, boards need to be added back to the structure to ensure more water can be treated when adequate drainage in the field is not needed. Addressing the management schedule with producers will be a vital part to widespread implementation. The producers reported no yield losses due to the saturated buffer in this evaluation.

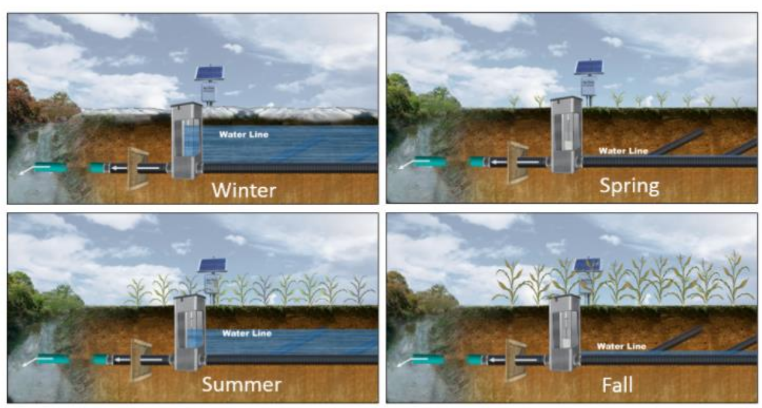

Figure 1: *Desirable water table control for water quality and yield*

Deliverable 4: Develop outreach materials to increase awareness of the suitability and effectiveness of the saturated buffer practice.

Outreach of the results of this demonstration will take on several forms. The first will be the distribution of the entire report in hard copy to the Farm Service Agency. There will be multiple copies available for distribution throughout the agency. It is critical that all necessary FSA personnel have access to the report given their jurisdictional responsibilities with CRP. Post card announcements will be created and mailed to over two hundred stakeholders. These stakeholders include NRCS officials from seven states, university academia from fifteen universities in the Midwest, State FSA officials from eight Midwestern states, major agricultural associations from all Midwestern states and EPA regional offices. This announcement will describe briefly the findings and a driver to the Saturated Buffer website (www.saturatedbufferstrips.com). The website will be updated with a copy of the report for review or download. There will also be a press release announcing the report and showing briefly the results. This press release will be distributed to all major agricultural media outlets. It is anticipated that this media release will generate commentary and interview requests for Dr. Dan Jaynes, Charlie Schafer, ADMC president, and Stephen Baker, ADMC project director. All of these individuals will be available for this. These individuals will also do presentations to stakeholders over an indefinite time period about the SB practice.

Conclusion

Data from this demonstration confirms that proper siting and design considerations have to be met for the SB to achieve Nitrogen transport reductions from subsurface drainage systems. This work confirms the details of those design considerations. The data also leads to the conclusion that SB are not just going to work in year one (1). Many of these sites have three-year data sets all with similar results. The significant geographical spread in locations of the sites gives a view of the sites with different weather patterns, soil types and agronomy practices. The SB continue to perform in a wide area of geography across the Midwest.

All of these SB were retrofits from existing CRP buffers. The SB in all cases have healed nicely and show no detriment to the original purpose of the buffer. Vegetation returned quickly and there seems to be no long-term harm to wildlife (Fig. 26 & 27).

Streambank stability was studied in detail in the pilot study of SB. This study confirms the conclusion that was reached in that work. Streambanks with stable banks will not have increased sloughing due to the SB condition. There was no streambank instability observed in any of these sites in our current work.