## Saturated Buffer Performance, Challenges and a Path Forward

## Season 1, Episode 5

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**John McMaine:** Thanks for joining us on Streamlines, your source for water knowledge. I’m your host, John McMaine, with South Dakota State University (SDSU) Extension. This is Episode 5.

**John McMaine:** Well, hello everyone again, John McMaine here.

**Anthony Bly:** And Anthony Bly.

**John McMaine:** And today we are continuing our discussion about saturated buffers. And if you missed it or need a refresher, I would like to introduce our good friend Dr. Jeppe Kjaersgaard, and he will tell us what a saturated buffer is.

**Jeppe Kjaersgaard:** So, a saturated buffer is constructed by installing a drainage control structure on the main line of a drainage outlet, but within a buffer that may be located along a stream or a drainage ditch. And then the distribution lines are connected to the control structure and then installed or plowed in roughly parallel to the stream at the same depth activity as the tide line, or the main line is. And then when the saturated buffer is operating, water is routed from the main line through the control structure into the distribution line. And then the water moves from the distribution line into the soil in the buffer and makes it way downgradient to the stream. And then as the water moves through the buffer, the nitrate is removed either through plant uptake of any vegetation that may be on that buffer or through a process called denitrification which is a soil microbial process where nitrate is converted to homogenous nitrogen gas. And then there is typically a bypass installed with a control structure, so that if there is more water coming through the tile than what the capacity of the buffer is, well then, that access water is routed into the regular outlet and then moved directly into the stream. So, a saturated buffer is not holding water back in the field. But it has the drain system will still has its full capacity.

**John McMaine:** Alright. Saturated buffers, like I said last time, one of my favorite conservation drainage practices. But we ended last episode on some of the challenges or situations where saturated buffers would not be ideal.

**Anthony Bly:** Yes. Landscape.

**John McMaine:** Landscape, topography.

**Anthony Bly:** Slope.

**John McMaine:** Slope, organic matter, or having enough organic matter.

**Anthony Bly:** Got to have a stream to run it along or a bank.

**John McMaine:** You need a buffer there, don’t you?

**Anthony Bly:** Yeah, you do.

**John McMaine:** To have a saturated buffer. So, it is not perfect for every situation. But, just like bioreactors, there are some situations where it performs better than others. If you remember in the last episode, Jeppe said the performance of their saturated buffer was very high.

**Anthony Bly:** Yeah.

**John McMaine:** Was it-

**Anthony Bly:** 90% through the buffer and 75% overall.

**John McMaine:** Yes, that’s right. Yeah 90% through the buffer and 75% load reduction overall, for nitrate. Which is amazing.

**Anthony Bly:** Oh yeah, that’s… those are awesome numbers.

**John McMaine:** Those are awesome numbers. And so, we don’t see that all the time? Right?

**Anthony Bly:** No.

**John McMaine:** I asked Jeppe, ‘what are some of the factors that influence performance of nitrate reduction in a saturated buffer?’

**Jeppe Kjaersgaard:** So, some of the things that effects the performance of a saturated buffer is, well, one thing is the soil temperature as water is moving through it. At lower temperatures, the microbial process that converts nitrate to nitrogen gas is slower. Another factor that impacts it is the characteristics of the flow of water moving through it. Meaning that if the water is moving through it sort of on a, over a long period of time, the buffer may be able to handle most of that water. Whereas, if the water is more in a pulsing fashion that there is flow for a few days and then there is no flow and then we have flow again. Then that might impact the performance as well since it might not be able to handle all the water coming through a pulse as compared to if it is more of a steady flow that is moving through it. Also, the design of the saturated buffer in terms of for example, the width of the buffer. Again, typically 30 feet is the minimum, 50 feet if possible is good. Just to make sure there is enough length of buffer, or width if you will, to remove the nitrate from the water. And then also, the soil itself needs to be relatively uniform as in there shouldn’t be any say, sand lenses or gravel lenses located below the ground surface, within the buffer. Because if there are sand lenses like that, they may act as a preferential flow path for the water so that the water is moving through those sand lenses directly to the stream and it is a fairly quick process. As opposed to slowly moving through the buffer as a whole. So, it is typically, maybe necessary, to do a few soil borings prior to installing a saturated buffer just to make sure that there aren’t any sand lenses. Or even just look at the stream bank if the ditch of the steam is ever cleaned out, and there you can see if the soil looks uniform and there are no pockets of gravel or sand.

**John McMaine:** So that’s kind of the homework you need to do before.

**Anthony Bly:** Oh yeah, there’s a lot of planning.

**John McMaine:** There’s a lot of planning that goes into it and those are not always apparent if you are just looking at a, you know, a stream bank.

**Anthony Bly:** Vegetation can cover a lot.

**John McMaine:** Vegetation can cover a lot. So, I mean, a farmer knows his field well. Would they have a suspicion if there is a sand lenses or anything like that running through?

**Anthony Bly:** I, I kind of doubt it.

**John McMaine:** Yeah.

**Anthony Bly:** I don’t, you know. Maybe, you know. You kind of see those things stick out during the drought year.

**John McMaine:** Sure, yeah.

**Anthony Bly:** You know.

**John McMaine:** Yeah.

**Anthony Bly:** Cause there would hardly be any vegetation over those areas.

**John McMaine:** Sure, cause everything’s, yeah. There’s no water holding capacity there and so it’s all-

**Anthony Bly:** Right.

**John McMaine:** Flowed out, yeah. But if you’re not in a drought year, then yeah. It’s like-

**Anthony Bly:** It’s going to look all the same.

**John McMaine:** It’s going to look all the same, sure. So that’s some homework you need to do on the front end. You need to make sure that you design it properly and understand the limitations of certain situations, I guess.

**Anthony Bly:** That’s with everything we do.

**John McMaine:** Right. The nice thing about saturated buffers is once you have done that homework, once you got it installed, they’re pretty low maintenance.

**Anthony Bly:** Just keep the trees out of there.

**John McMaine:** Keep the trees out of there. And I asked Jeppe to kind of compare saturated buffers with other conservation drainage practices like bioreactors in terms of maintenance, and this is what he had to say.

**Jeppe Kjaersgaard:** Saturated buffers, in most cases, there is very little maintenance that is involved with having a saturated buffer. It may be to go out and just to check to make sure that it is functioning, that the control structure is not being clogged by a root ball or something else that might have come down through the tide line. But normally, once it is installed and set and in place, you really don’t have to go out and do any further adjustments. It’s just sitting there and doing its thing without any further adjustment. That is as opposed to other practices such as controlled drainage which is a practice where you use a control structure to adjust the outlet elevation and thereby hold water back within the field during times of the year when you don’t need rain and that requires a little more maintenance. Because in most situations, that a person will have to go out and manually adjust the height of those boards a number of times a year. So, a separated buffer really is very low maintenance. Also, you can contrast it to a bioreactor where it’s a trench filled with woodchips that the water is routed through which is a very effective system. But there is a certain life span on those woodchips and that’s typically that 10-15 year range. Maybe a little longer. And after which time, those woodchips will need to be replaced, so scooped out and fresh ones put in. And then you are good for another, say, 12-15 year period. For a separated buffer, you do not have that need to replace anything like that. It is sitting there on its own and it is utilizing what is in the soil already: bacteria and organic matter. And it is utilizing a process that has been around for millions of years. The denitrification process is nothing that we have come up with, it has been around for a very, very long time.

**Anthony Bly:** A natural process.

**John McMaine:** Nature. I mean, I would say that that’s the best process, right?

**Anthony Bly:** Yeah, that’s right. Use it.

**John McMaine:** There’s no inputs. There’s no energy inputs. There’s no cost inputs after it’s in there, it’s doing its thing, which is great to see. I think the future is bright for saturated buffers. I think they are very functional, low maintenance, low cost, and honestly, the sky is the limit. I mean, I think we can put in as many saturated buffers as we have appropriate sites for.

**Anthony Bly:** Absolutely. Got to plan for those.

**John McMaine:** Right. And so that was kind of the last question that I left with Jeppe. Is what does he see as the future for saturated buffers, what’s the excitement around saturated buffers, what’s the interest, that type of thing. His answer was really cool because it wasn’t just the farmer. But it was all the way up to federal policy makers that were interested in the research and demonstrations sides that they had and saw the value in those. But I’ll let him fill out the details.

**Jeppe Kjaersgaard:** With any practice, it is a continuous effect to keep talking about these practices and keep bringing it in front of farmers, contractors, and all the conservation professionals. So, we have field days every year. We present information at workshops, regional meetings, national conferences and such. And so, in the last 4 years, we have reached upwards of 2,000 individuals working or just talking about these drainage conservation practices. That includes 3 U.S Representatives and then one of the Senators from Minnesota looking at it as well. We also more recently partnered with two multi-state research projects to expand the reach and impact of the research and demonstration we are doing at this particular site. Our one is in collaboration with North Dakota, and Minnesota, and then the Canadian Province of Manitoba to share information and look at nutrient management that is added on top of these conservation drainage practices control drainage and saturated buffer. And the other one is a multi-state collaboration between Minnesota, Iowa, and Illinois. Looking at data sharing on sites with bioreactors and saturated buffers and testing new monitoring techniques. And through those research projects, we have expanded the reach. We have a website, a dedicated website for the project at Minnesota Department of Agriculture. If you are interested, please go ahead and check it out. If nothing else, google ‘Red River Valley Drainage Water Management Project’ and then it will be the first hit. And then finally, I do want to mention multi-state products that came out two years ago. It is an Extension publication called “Questions and Answers About Saturated Buffers for the Midwest.” That has more information about saturated buffers, considerations for where to install them, and designs, and such. It is available at TransformingDrainage.org. Or you can simply google ‘Questions and Answers About Saturated Buffers for the Midwest.’

**John McMaine:** So, as you can see, Jeppe’s excited there’s a lot of multi-state work, which is really interesting because a lot of times these practices may perform differently in different temperatures, different soil types, things like that.

**Anthony Bly:** Correct.

**John McMaine:** And so, getting a kind of multi-regional, multi-state regional look at these practices, I feel like is very important. But I would like to see more in South Dakota.

**Anthony Bly:** Yeah, I would too.

**John McMaine:** We have two research saturated buffers that went in, in kind of the early 2010s, so we have been looking at those the last 6-8 years. I mean, pretty good results, that’s not a quantitative term, right? ‘Pretty good.’

**Anthony Bly:** Pretty good, yeah.

**John McMaine:** That’s not statistically significant. But yeah, we have seen results. Not up to the 75 and 90 percent reduction that Jeppe saw on the Minnesota site, but upwards of 50% reduction for nitrate.

**Anthony Bly:** That’s still pretty good.

**John McMaine:** That’s still pretty good. And so, I would like to see these systems expand in South Dakota. Again, they are one of my favorite conservation drainage practices because of the cost, because of the low maintenance. Like you can easily do it as part of a system install when you are out there with your tile plow and laterals, you just need to get another control structure out there. So, Anthony, you have a farm?

**Anthony Bly:** Yes.

**John McMaine:** You have some tile?

**Anthony Bly:** Yes.

**John McMaine:** Are you going to put in a saturated buffer?

**Anthony Bly:** Well, I have been thinking about that through the whole discussion and I just don’t think that I have the right place suited for one, cause it’s really about the site and just don’t have the stream, you know, with the buffer along it.

**John McMaine:** And so, I think that is one of the biggest considerations we have to make. We talked about some challenges, maybe areas that are not ideally suited. And you bring up a big one, that really you need a stream and buffer that has enough space, that you can put in one, and be effective.

**Anthony Bly:** Sure. You take advantage of that natural process.

**John McMaine:** Exactly. And then, another big one, is thinking about that elevation drop from the field to the stream. If you want this to be a controlled drainage system, that’s one thing. But a lot of times, you know, you’re not looking for that to be controlled drainage, you’re looking for it to be a saturated buffer, so you need some elevation drop from the field, down to the stream.

**Anthony Bly:** Correct.

**John McMaine:** So, you’re not backing water up into the field.

**Anthony Bly:** Right.

**John McMaine:** And then the other thing with siding, is thinking about the soils and how homogeneous the soils are, how much they vary, and there’s two pieces with that. One is if you have any sand lenses or gravel lenses those could be preferential flow paths. You get a preferential flow path; you lose the retention time through that buffer. And when you lose retention time, you lose treatment. The other piece is the amount of organic matter you have in that buffer. And a lot of times we don’t have to worry too much about this.

**Anthony Bly:** Well, we’re pretty high in South Dakota.

**John McMaine:** But, again, if you have an area with a lot of sand, then you might run into-

**Anthony Bly:** Going to be restricted, yeah.

**John McMaine:** So then, you got a double whammy of lower retention time because the water is able to preferentially flow through that sand and there’s not much organic matter to get denitrification to happen.

**Anthony Bly:** Correct.

**John McMaine:** So, those are the challenges. Let’s finish on a high note. Benefits of saturated buffers. What’s your favorite thing about a saturated buffer?

**Anthony Bly:** Well, I think when you got the right site, it’s pretty much somewhat of a guarantee it’s going to be effective.

**John McMaine:** That’s a really good point.

**Anthony Bly:** For the money that you put into it, which isn’t a lot.

**John McMaine:** You know that’s a really good point because a lot of times people are concerned about, they may be interested in putting in a conservation practice, but there’s no guarantee it’s going to work.

**Anthony Bly:** Right.

**John McMaine:** Saturated buffer, that’s a pretty good guarantee that it’s going to do what you want it to do. You’re going to get nitrate reduction, day in day out. Natural process of bacteria just cranking away, doing your job.

**Anthony Bly:** Takes care of itself.

**John McMaine:** I really liked the low-cost aspect. I really liked the fact that you can put it in kind of in conjunction with another tiling project.

**Anthony Bly:** Absolutely, same time.

**John McMaine:** Same time. Same equipment. Same materials. You’re good to go. And I think the cost is another big benefit.

**Anthony Bly:** Absolutely.

**John McMaine:** 2,000 bucks, 75% nitrate load reduction. That’s a good deal.

**Anthony Bly:** Cost ratio conversion there is pretty easy to see.

**John McMaine:** Yup. So, saturated buffers: the good, the bad, the ugly. You heard it here on Streamlines.

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**John McMaine:** Thanks for joining us today on Streamlines! We sure had a lot of fun today, hope you did too. If you want to learn more about anything you heard today, head on over to the SDSU Extension website. But for now, I’m John McMaine.

**Anthony Bly:** I’m Anthony Bly.

**John McMaine:** And we’ll catch you next time.