CONSERVATION QUARTERLY

Fall 2021

Onondaga County Soil & Water Conservation District

RESEARCH EDITION

Overview

The Skaneateles Lake Watershed Agricultural Program (SLWAP) and farmers in the watershed have been interested in the quality of the water exiting their fields through drain tiles. In 2021, a research project on tile drainage was conducted in the Skaneateles watershed to research the quality of this water.

History of Drain Tiles

Egyptians, Babylonians and Romans used extensive ditching and "under drainage" techniques to remove excess water from saturated soils. In 1583, an unknown Englishman wrote extensively about drainage. Oliver de Serre's Theatre of Agriculture (1600) recommended that four-foot-deep trenches be filled with half stone and half soil to make a covered drainage system that cut off sources of springs. The goal was to create small gaps that allowed for the entry of shallow ground water and an exit to flow the water away from the roots of the crops. Additional benefits of drainage systems include:

-Less saturation allows for greater oxygen diffusion into the root zone of the crops as well as reduction in root diseases associated with excessive early season moisture. This enables the soil temperature to be warmer which helps promote the germination and growth of seeds.

-Greater mineralization of soil makes nutrients more available for uptake and utilization by the crops, promoting less nutrient runoff.

-Lower risk of soil compaction.

-Less overland flow of surface runoff, resulting in less soil erosion and release of nutrients into the environment.

Around 1810, the first cylindrical clay tiles were reportedly made in England. In 1836, clay tiles were made in Waterloo, NY. Eventually, there were five factories and over 180,000 tiles were made per year and shipped around the United States.

Tile Drainage Research

Extensive research has been done at the Miner Institute in Plattsburgh, NY on tile drainage and its impact on nutrient losses since 2010. Overall, they have found that there is greater potential for overland flow of stormwater across undrained agricultural fields than tiled fields. On undrained fields, fertilizer and/or manure nutrients can be washed into conveyances that lead into streams and lakes. Additionally, soil particles eroding from the field can have phosphorus (P) attached to them, leading to additional nutrient losses from the field.

In a tile drained field, storm water can better infiltrate into the soil compared to undrained fields with similar natural drainage. Most nutrients are retained within the soils and there is much less erosion of soil particles, reducing the potential for P to be lost from the agronomic system.

Materials & Methods

Research was conducted on a crop farm in the Town of Skaneateles year round in 2021. Water samples were taken from a tile under a 32-acre corn field and compared to upslope stream water flowing from a 13-acre wood lot. Samples were taken twice a month from May-October and once a month from November– April.

Samples were collected in two different 250 ml bottles. Each bottle was pre-rinsed with the water from each sampling location. Samples were then brought on ice to Upstate Freshwater Institute in Syracuse. Samples were analyzed for: Total Phosphorous (TP), Total Dissolved Phosphorous (TDP), and Nitrogen Oxides (NOx) (Nitrate and Nitrite).

Precipitation data was collected, measured and recorded by the farmer when there was rain in the gauge. The gauge was located at his house, which is just east of the sampling locations. Data was graphed along with the results of nutrient content from the two sites (Figures, 1, 2 and 3).

Samples will continue to be taken throughout 2022.

Soil Types

Honeoye silt loam (well-drained) and Ovid silt loam (somewhat poorly drained) are the main soil types of the woods through which the stream flows. The field that the tile outlet drains from consists primarily of Lima silt loam (moderately well-drained) with a lesser amount of Ovid silt loam and Honeoye silt loam. Without proper tile drainage on this field, there would be lower crop productivity because Lima is a more saturated soil.

Field Management/History

In 2021, the field was no-till planted to corn for grain. In 2020, the field was planted to wheat and in 2019, the field was planted to soybeans.

The corn was planted on April 28, 2021. Three hundred pounds of 10-20-20 fertilizer was applied at time of planting through the planter.

No side-dress nitrogen was applied to the crop during the growing season. Corn was harvested for grain on October 19, 2021. The farmer does not over fertilize because they use recommendations for application based off the soil test they receive every three years with assistance from the Skaneateles Lake Watershed Agricultural Program.

Results

Total Phosphorus (TP)

Visual trends of the total phosphorus (TP) graph can be observed in Figure 1 below. From May to October 2021, total phosphorus concentrations were higher overall in the water coming out of the woods compared to the water coming from the tile line. There were only three occurrences where this was not the case. Two of these occurrences were on dates where the stream flowing through the woods was completely dry (June 7 and June 21). The other sample in which TP was higher in the tile outlet water was on October 18, 2021. This was shortly after a major rain event on October 16, 2021. Overall concentrations of TP were higher in the woods in the fall months. High microorganism activity and nutrient cycling from leaf litter during that period of the year can be contributing factors to this result. As the sample size of the data continues to increase over the years, we will be able to identify more trends to help us further interpret the data.

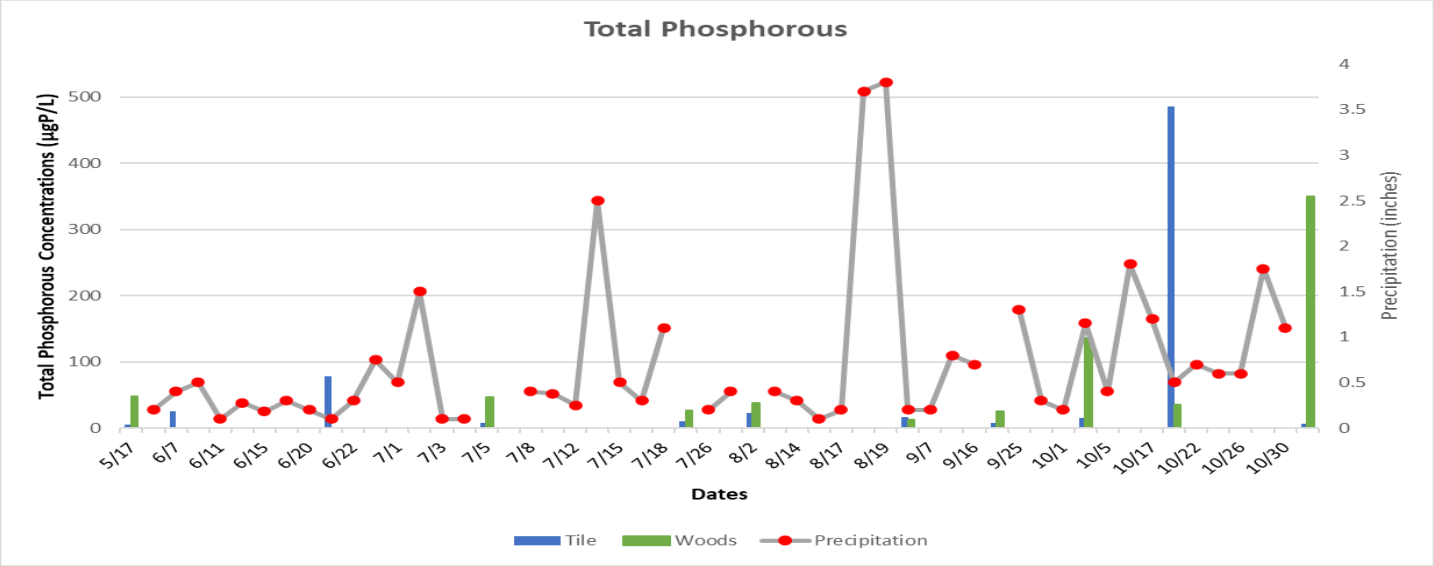

Figure 1. Graph representing total phosphorus concentrations of tile drainage water versus stream water flowing through woods in the Skaneateles watershed

DISTRICT NEWS

Total Dissolved Phosphorus (TDP)

Overall, TDP concentrations were higher in the water coming out of the woods compared to the tile drain outlet (Figure 2). There were only three times that tile outlet water had higher concentrations of TDP than stream water sampled coming out of the woods. For two of those instances, there was no water available for sampling coming out of the woods (June 7 and June 21). On September 20, TDP was higher in the tile drain water than that measured in stream water.

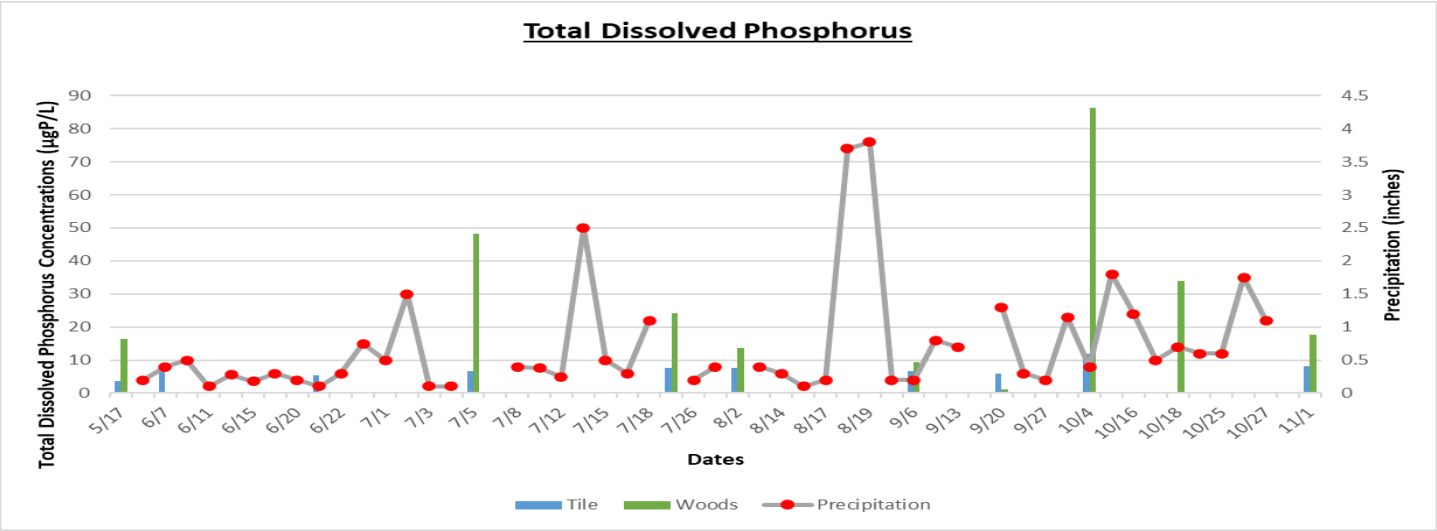

Figure 2. Graph representing Total Dissolved Phosphorus concentrations of tile drainage water versus stream water flowing through woods in the Skaneateles watershed

Nitrogen Oxides (NOx)

The results for NOx followed the same trends as TP and TDP (Figure 3). In all but three instances, NOx were higher in samples exiting the woods compared to the tile outlet water. Again, on June 7 and 21, there was no water flowing from the woods, although the tile was running. On October 18, after corn harvest and the second most significant rain event of the growing season, NOx concentrations were higher in the tile outlet water than the stream water.

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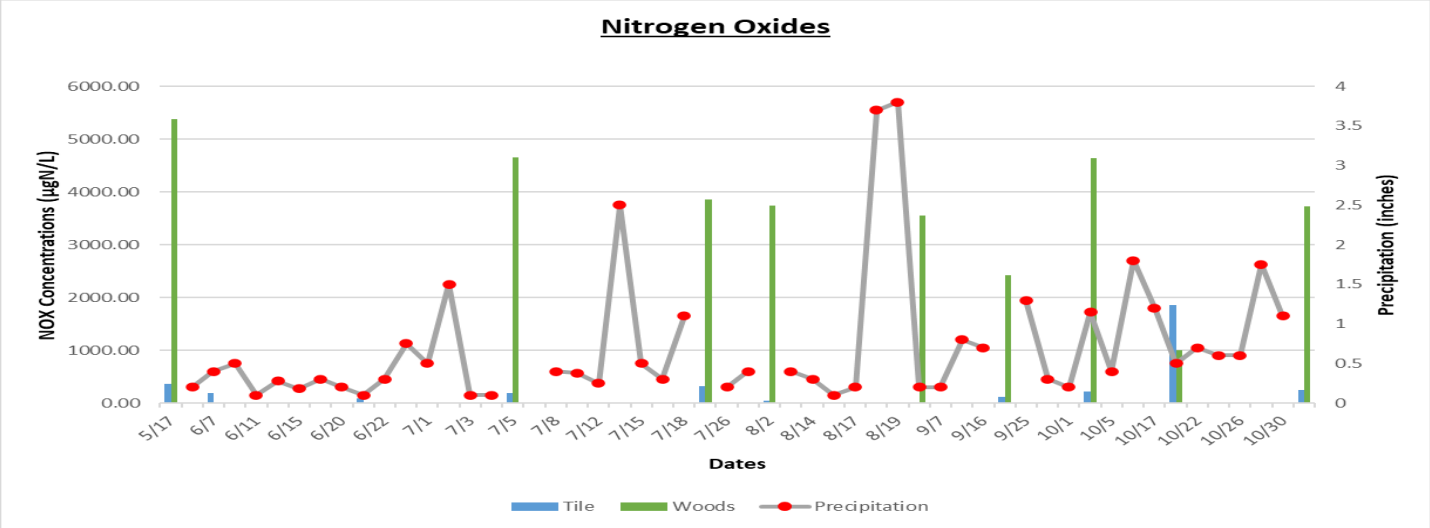


Figure 3. Graph representing Nitrogen Oxides concentrations of tile drainage water versus stream water flowing through woods in the Skaneateles watershed

Discussion

The results of this study confirm the benefits of tile drainage, such as a decrease in nutrient loading and improved water quality. TP, TDP and NOx were likely higher coming out of the woods because of the mineralization of organic matter by micro-organisms in the soil. The organic matter provides carbon (food) for the micro-organisms to live on. The soil type of the woods also plays a role in the amount of nutrients running off into the ditch. The soil type in the woods is made up of 18-28% clay. Clay is made up of smaller particles which increase the surface area for bonding cations like NH4+. Cations bonded to the negatively charged soil particles can become a source of increased nutrients when sediment is present in any runoff water.

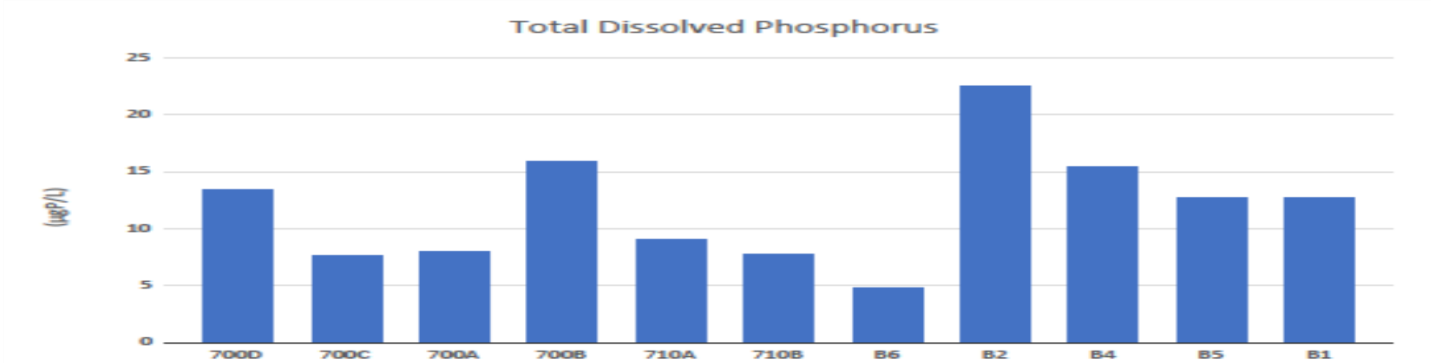
Researchers at Miner Institute have documented up to 85% reductions in surface runoff on tiled agricultural fields. When looking at P losses between untiled and tiled fields, there is an average 50% reduction in P loss. Based on these smaller plot scale studies, P loss averaged 0.12 pounds per acre whereas tiled plots averaged 0.06 pounds per acre. The reason for this is due to a greater amount of surface runoff and associated P transported across untiled fields.

It is interesting to note that the results found on the crop farm in Skaneateles were similar to the findings observed by the Owasco Watershed Lake Association (OWLA) between 2018 and 2019. OWLA sampled water coming onto a dairy farm that has land within both the Skaneateles Lake and Owasco Lake watersheds. The sampling locations can be seen on the aerial image in Figure 4. The sample water coming onto the farm was compared to water exiting the cropland area. OWLA essen-

tially searched for "hotspots" because excessive loss of P and Nitrogen in lake water can contribute to Harmful Algal Blooms (HAB) that generate toxins that pose a risk to the municipal drinking water supply.

Figure 4. Aerial image representing water sampling locations on a dairy farm in the Owasco Lake Watershed *(Image provided courtesy of Twin Birch Dairy and OWLA)*

The study found that generally the levels of TDP and NOx measured in the water exiting the farm were equal to, or at times even less than, the levels measured in the water entering the farm (Figures 5 and 6). The results of this study support that the establishment of Best Management Practices (BMPs), along with nutrient management planning on the farm, reduce nutrient loading to adjacent waterways.



Sampling Locations

Figure 5. Graph representing the Total Dissolved Phosphorus concentrations of water on a dairy farm in the Owasco Lake Watershed *(Graph provided courtesy of Twin Birch Dairy and OWLA)*

The Skaneateles Lake Watershed Agricultural Program is a cooperative effort between the Soil & Water Conservation Districts and Cornell Cooperative Extension Associations of Onondaga, Cortland and Cayuga Counties, the USDA Natural Resources Conservation Service, the City of Syracuse, and Skaneateles Lake watershed farmers. Principal funding provided by the City of Syracuse.

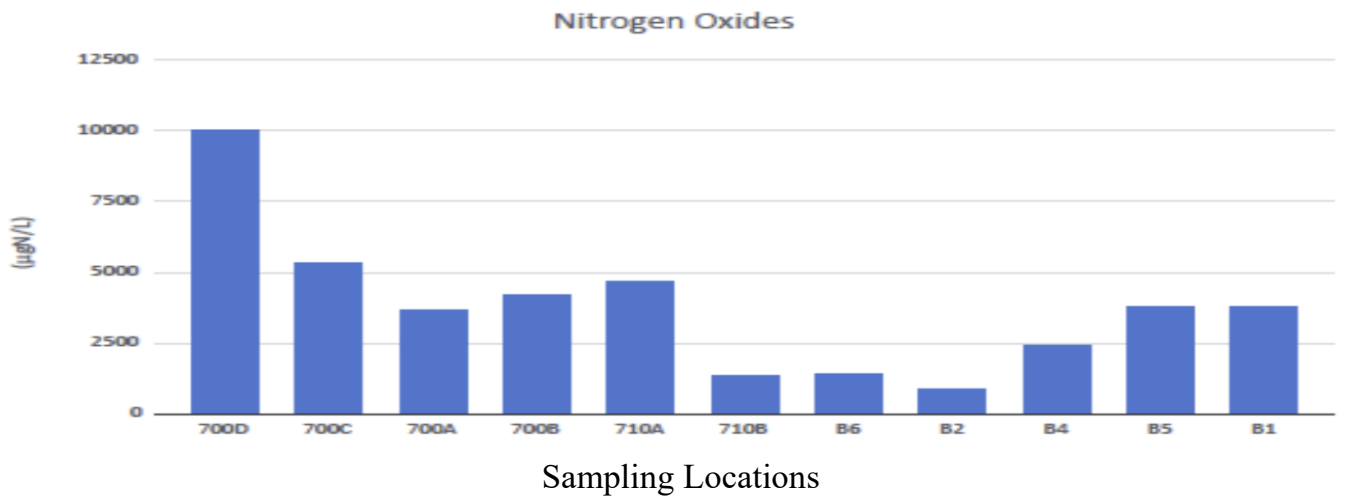


Figure 6. Graph representing the Nitrogen Oxide concentrations of water on a dairy farm in the Owasco Lake Watershed *(Graph provided courtesy of Twin Birch Dairy and OWLA)*

Conclusion and Recommendations

The water quality entering and exiting agricultural land has the potential to remain in natural condition if the farmer focuses on building and preserving soil health. This means establishing and maintaining vegetative buffers on the downslope side between fields, streams and ditches. Planting cover crops annually also enhances soil health.

Hire a qualified agricultural nutrient management planner to develop a plan. Strictly adhere to the Nutrient Management Plan (NMP) as this plan will determine the nutrients your fields need for the intended crop growth. It is important to only apply the amount of nutrients needed.

If you are an animal farmer, work with your nutrient management planner and/or your local Soil and Water Conservation District to sample your manure to determine the amount of nutrients in that manure. Then, have a planner develop an NMP so that you can maximize the nutrient benefits of your manure. One local farmer in the Skaneateles Lake watershed estimates "$180 per acre saved on fertilizer due to efficient manure management. "For my 1,400 acres that receive manure nutrient applications, that's over $250,000 in savings to my farm's bottom line every year."

Research has shown that tile drained fields generally provide the farmer with more flexibility in terms of crop management and harvesting, as well as in the timing of manure spreading. As a result, cover crops can then be planted earlier in the fall.

Our vision - The Skaneateles Lake watershed will be an environmentally sound region, where a viable agricultural industry and others benefiting from the lake work together harmoniously to improve and maintain a high standard of water quality.

Our mission - To carry out a cost-effective, innovative program for the farming community that upholds the high drinking water quality standards of Skaneateles Lake.

Other BMPs in the agricultural toolbox to help protect water quality and build soil health include, but are not limited to:

- Buffers
- Protected/enhanced wetlands -
- Cover Crops
- No-till planting -
- Filter Strips
- Grassed Waterways
- Water & Sediment Control Basins (WASCOBs)
- Terrace
- Strip Cropping
- Crop Rotation
- Diversions
- Bio Reactors
- Residue & tillage management
- USDA NRCS CREP

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For More Information:

Griffith, Keegan E., et al. "Winter Rye Cover Crop Impacts on Runoff Water Quality in a Northern New York (USA) Tile-Drained Maize Agroecosystem." *Water, Air, & Soil Pollution*, vol. 231, no. 2, 2020.

Klaiber, Laura B., et al. "Impacts of Tile Drainage on Phosphorus Losses from Edge-of-Field Plots in the Lake Champlain Basin of New York." *Water*, vol. 12, no. 2, 2020.

Owasco Watershed Lake Association, "Achieving Sustainability on a Large Dairy Farm," unpublished data, 2019.

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SKANEATELES LAKE WATERSHED AGRICULTURAL PROGRAM

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