Controlling Nutrient Loss in Tile Systems

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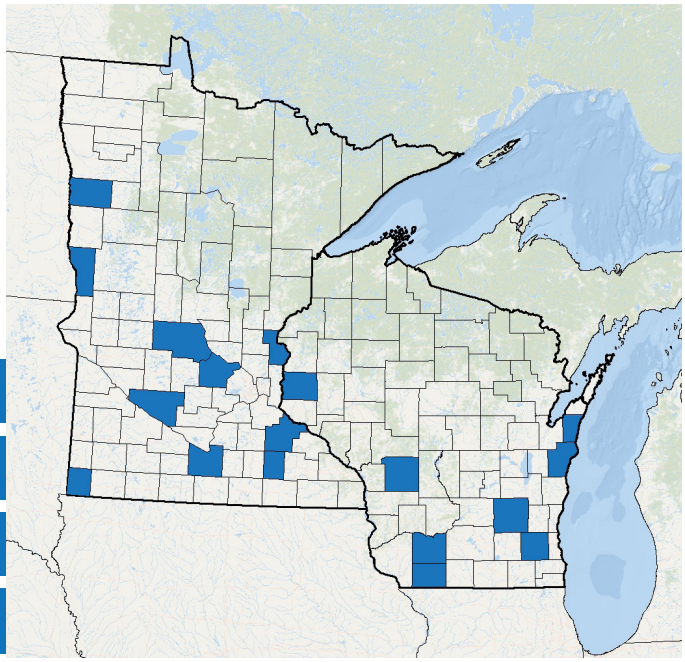
Discovery Farms programs in Minnesota and Wisconsin have collected edge-of-field water quality information from 45 fields on 24 working farms starting in 2002. A total of 112 site years of surface runoff data and 47 site years of tile flow have been collected at the various locations. This large dataset allows for review and analysis of important water quality topics, including an examination of the differences between surface runoff and tile flow and the factors that impact losses in tile systems.



- 24 Farms
- 45 Fields
- 112 Surface Site Years
- 47 Tile Site Years

Quantity and timing of tile flow is different from surface runoff.

There is typically more water that comes through tile lines (known as tile flow) than runs off the surface on an annual basis. There are also differences between the timing and intensity of surface runoff and tile flow.

Tile flow is relatively consistent throughout the year, whereas surface runoff is often inconsistent. Tile drainage has many more days of flow and generally occurs at a different time of year than surface runoff.

Category	Tile Flow	Surface Runoff
Annual range (inches)	1.8 to 6.5	1.3 to 4.2
Average annual days of flow	195	10
Average intensity of flow (inches per day of flow)	0.03	0.38
Typical timing of flow	Early spring through summer	Snowmelt and from planting to crop canopy

Soil and phosphorus are generally lost from the soil surface, not tile lines.

Soil and phosphorus losses are typically five times higher from the surface compared to tile. Most often, soil and phosphorus loss is controlled by adopting management strategies that reduce erosion. However, there are certain cases when soil and phosphorus losses are higher from tile sites than from surface sites. These scenarios suggest that updating and maintaining tile systems and managing soil test phosphorus levels can help prevent such high losses.

Nitrogen is transported in tile lines.

Nitrogen losses are typically five times higher from tile lines compared to the surface. Nitrogen loss is controlled by adopting management strategies that reduce leaching into tile systems. On average, for every inch of tile flow, 5 lb/ac of nitrogen is lost. Nitrogen losses can be reduced by decreasing the amount of tile flow or the concentration of nitrogen.

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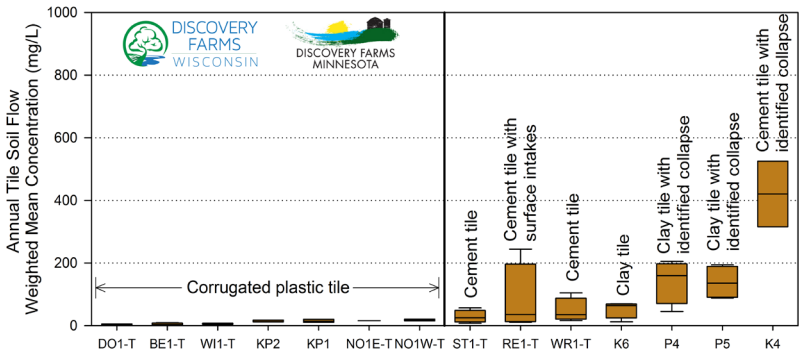
USGS science for a changing world

Maintain tile systems to prevent soil and particulate phosphorus loss.

Tile monitoring sites with higher concentrations of soil were older cement or clay tile systems with surface intakes or tile collapses. Sites with corrugated plastic had almost no soil loss (left side of graph) compared to sites with cement or clay (right side of graph). Also, particulate phosphorus concentrations increased as soil concentrations increased.



Modernize old cement or clay tile systems with corrugated plastic pipe.

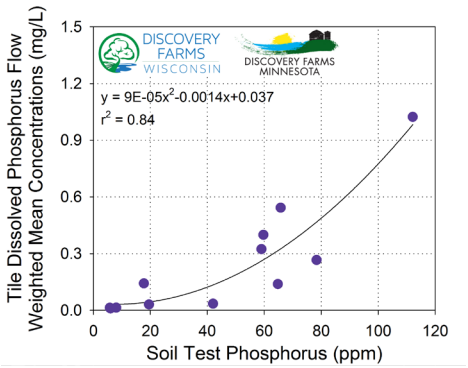
Gaps at the connections of cement and clay pipes are larger than the perforations in modern corrugated plastic tile and allow more soil particles to pass through.

Remove the need for surface intakes.

Surface intakes allow more soil to enter the system because they are directly connected to the surface.

Prevent collapse.

Collapses can create direct conduits to the soil surface. Check for degradation over time, inadequate venting, outlet blockages, and animal burrows. Adequately size mains and use proper joints to prevent collapse.



Check soil test phosphorus levels to reduce dissolved phosphorus loss.

Dissolved phosphorus concentrations increased as soil test phosphorus levels increased. Routine soil testing and following University recommendations for phosphorus fertilizer applications will effectively manage soil test phosphorus levels and reduce dissolved phosphorus losses.

Consider timing and rate of nutrient application to reduce nitrogen loss.

The graph displays tile nitrate concentrations from 2011-2013 at a Discovery Farms location in Central Minnesota. In 2011 and 2012, spring manure applications were made and resulted in little change in tile nitrate concentrations. In 2013, manure was applied in the fall and resulted in higher nitrate concentrations in the tile flow the following spring. An additional fertilizer application was made in the spring and further increased the nitrate concentrations.

Determine nitrogen rates based on crop need, previous crop, soil texture, and organic matter content.

Applying the proper rate of nitrogen is essential to reduce nitrogen losses through tile systems. Many studies show that nitrate concentrations in tile flow decrease as nitrogen fertilizer rates decrease.

Time application as close to crop need as possible.

Timing of application has a large impact on water quality. Switching nitrogen applications from fall to spring has the most potential to limit losses because the time between application and crop uptake is decreased. If still applying in the fall, wait until soil temperatures are below 50 F or use a nitrification inhibitor to reduce the potential for losses.