Reducing Watershed Scale Phosphorus Export through Integrated Management Practices

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Objectives:

Demonstrate and quantify the watershed scale benefits of:
1. *Using end–of–tile cartridge system to filter drainage waters*
2. *Implementing filter socks and application setbacks from surface inlet structures,*
3. *Using the two practices in tandem.*

Phosphorus continues to be a water quality focus in freshwater systems worldwide. Phosphorus losses from managed turf are comparable to those reported for other land uses such as urban/suburban and crop production agriculture.

The experimental site is located on Northland Country Club (NCC) golf course located in Duluth, MN. Specifically, the study area is a 21.8 ha subarea of the golf course that contained 7 greens (0.3 ha), 8 tees (0.5 ha), 10.5 fairways (3.95 ha), grass roughs (8.1 ha), and 8.95 ha of unmanaged mixed northern hardwoods. The course is characterized by several micro–depressions or ´potholes.´ In order to facilitate drainage, these potholes are often drained by tapping into the existing subsurface drainage network. A surface inlet is placed at the bottom of the pothole to rapidly remove water that collects in the depression.

Figure 1. The filter cartridges located on the east drain of North–land Country Club are being evaluated for filtering phosphous from leaving a golf course property.

Discharge and water quality samples are collected by a combination of grab samples and automated sample collection. In the spring of 2004, two tile lines responsible for draining the majority of the study area were instrumented to determine flow rate. In 2009, a commercialized end–of–tile filter was installed on the outlet of the east drain. All sites are equipped with Isco 6712 automated samplers and programmed to collect discrete flow proportional samples.

Objective 1: In 2009, we installed an end–of–tile filter cartridge system on the outlet of the east drain. Each cartridge was filled with a mixture of activated carbon, activated alumina, and zeolite. Data were collected at the inflow and outflow of the cartridge system from 2009 through 2012. Two different analyses were used to assess the effectiveness of the filter, a

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Figure 2. Filter socks were installed around each inlet within the eastern drainage area. The filter socks were filled with 75% steel slag, 2.5% cement kiln dust (CKD), and 22.5% silica sand by volume.

before–after analysis of concentrations and a before–after, control–impact (BACI) design to assess the effectiveness of the cartridge filter on phosphorus loading. In the BACI approach, a relationship was developed between the east and west drain during the before or control period (2004–2008). Following implementation (after period) a similar relationship was developed and compared to the relationship developed for the before period to determine the impact of the cartridge system.

With respect to concentrations, there was a 33% reduction in median DRP concentration and a 20% reduction in median TP concentration from the inflow to the outflow using the cartridge system. Reductions in concentrations were statistically significant. Additionally, peak concentrations entering the cartridge system were reduced by an order of magnitude. There was a decrease in monthly DRP loading of 0.01 kg and a decrease in monthly TP loading of 0.018 kg following filter implementation. However, these decreases were not statistically significant.

Objective 2: We used a similar BACI design to investigate the impacts of filter socks placed around all surface inlets. The filter socks were filled with 75% steel slag, 2.5% cement kiln dust (CKD), and 22.5% silica sand by volume and placed around all 19 surface inlets within the east drainage basin. In this study there was only one year of treatment, 2011. Data collected in 2011 indicate that the implementation of the filter socks had no impact on monthly DRP or TP loadings in the east drain. However, the slope of the lines during the treatment period for both DRP and TP had shifted downward indicating a potential positive effect over time and if more data were collected.

Objective 3: The final objective was to assess the effects of combining the two practices (cartridge system and filter socks around inlets). A similar BACI design using the relationship between the east and west drainage basins was used for this assessment. The control period was the period from 2004–2010, while the treatment period was for the single year 2011. Using the combination of practices yielded a significant reduction in both monthly DRP and TP loading, indicating that this combination and approach might be considered a best management practice for reducing phosphorus from tile drainage discharge on golf courses.

Data collected in 2013 will help to confirm these findings and should provide much needed information on practices that can be implemented to address offsite nutrient transport.

Figure 3. Compoind weirs in the outlet of the west (control) and east (treatment) drainage lines at Northland Country Club.

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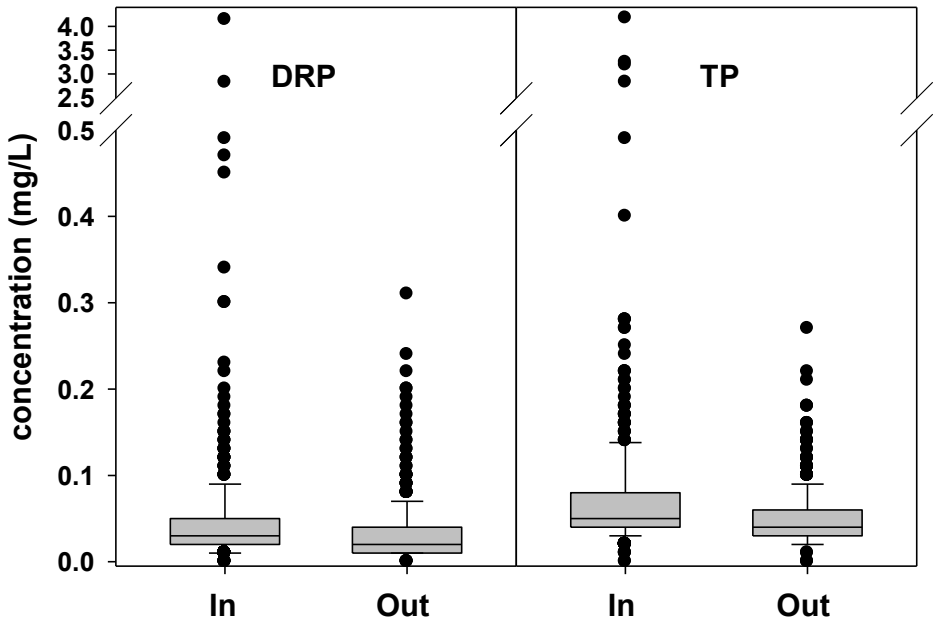
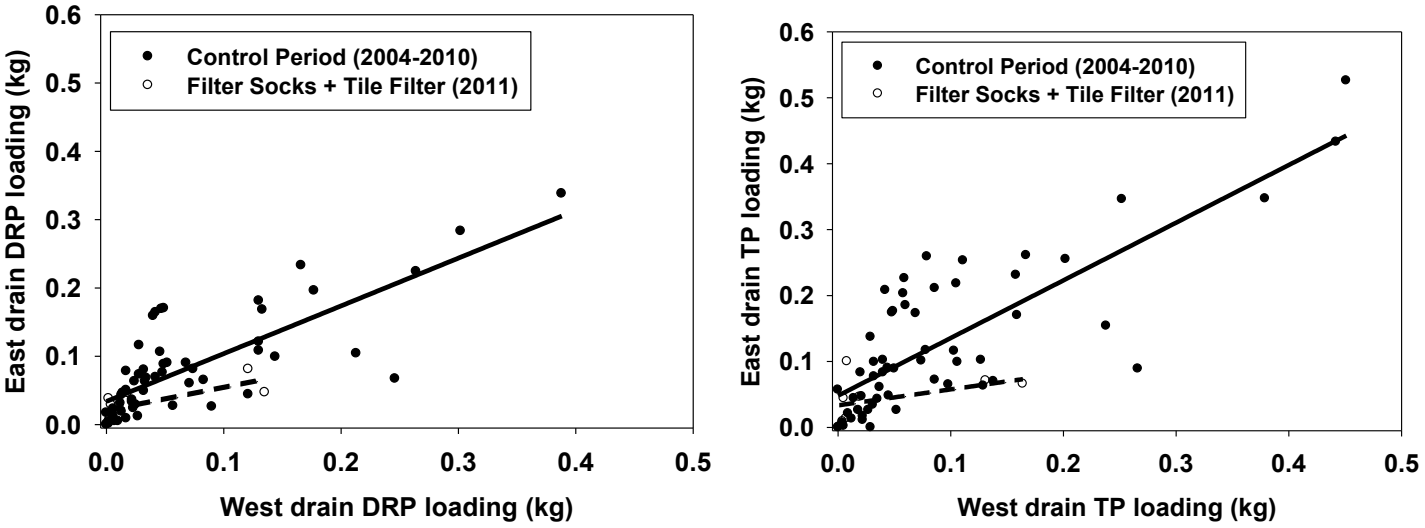
Figure 4. Inflow (before filter cartridge system) and outflow (after filter cartridge system) concentrations of DRP and TP.



Summary Points

- A paired approach was designed and implemented at NCC to assess the impacts of an end–of–tile cartridge system and physical practices to reduce phosphorus transport
- Implementation of an end–of–tile cartridge system significantly reduced median DRP and TP concentrations as well as peak concentrations.
- No statistical difference in monthly loadings was measured with the use of the cartridge filter system, but a downward trend was noted
- No statistical difference in monthly DRP or TP loading was measured following implementation of the filter socks around surface inlets.
- Statistical differences in monthly DRP and TP loading were measured when the cartridge filter system and filter socks around inlets were used in combination .

Figure 5. Relationship between west drain (control) and east drain (treatment) during the control period (2004–2010) and the treatment period (2011) showing the positive effects of using the filter socks and filter cartridges system in tandem.



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