An Approach to Rehabilitating a Constructed Stormwater Wetland
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There are numerous environmental issues associated with the interactions between stormwater and non-point source pollutants (Kadlec and Knight 1996; Schueler and Holland 2000). Overland stormwater runoff flows becomes concentrated with high levels of nutrients (i.e. phosphorous and nitrogen) and other contaminants and may deteriorate water quality in the receiving waterbody. Water quality impairment and increased storm flows often arise due the impact urban and suburban development has on the surrounding environment (Walsh et al. 2005) and agricultural practices. Between 1982 and 2003, the United States’ land use designated as “developed” increased 48%, while croplands, pasture land and rangeland all decreased (NRCS 2003). Increased impervious surfaces cause increased stormwater delivery into receiving waterbodies. In turn, there are changes in the aquatic habitat, such as increased variation in flow, increased erosion and sedimentation, greater temperature fluctuation, elevated levels of nutrients and pollutants and unstable stream channel morphology (Paul and Meyer 2001). Accompanying the habitat changes are shifts in population dynamics from species intolerant of these changes to tolerant species (Fraker et al. 2002; Helms et al. 2005; Morgan and Cushman 2005). Urbanization of watersheds results in simplification of aquatic ecosystems and loss of diversity.

Best management practices (BMPs) are implemented within watersheds to intercept and naturally treat polluted runoff prior to entering the receiving water body, mitigating the effect of nonpoint source pollution. As BMPs are introduced into the stormwater management landscape, it is necessary to ensure that these facilities perform optimally (Roesner et al. 2001). Constructed stormwater wetlands (CSWs) are an effective BMP that provides benefits downstream, including pollutant removal, flood mitigation, temperature moderation, and decreased streambank erosion, however further research is needed to validate the CSW’s ability to reduce nutrient loads, and to relate the hydraulic and water quality components.

While CSWs improve water quality and respond to changes within a watershed, this change is not always positive. For example, native plant species which are intolerant to elevated chloride levels that arise in developed areas disappear and are replaced by organisms which are tolerant, such as the invasive Phragmites australis. A CSW can still properly function with invasive species in terms of stormwater management, however biological diversity is reduced, which will ultimately impact ecosystem health and lower the ecological value of the CSW.

The Villanova University CSW, a converted detention basin, lies at the headwaters of Mill Creek, which drains into the Schuylkill River. The present design is typical of a CSW; the Villanova University CSW incorporates a sediment forebay, a central weir and a meandering channel. Previous baseflow data shows total nitrogen and total phosphorous through the CSW have approximately 70% and 50% removal efficiency, respectively. For limited storm events, the removal efficiency of total phosphorous was approximately 50%, but the results for total nitrogen were mixed. The
facility became the subject of a study again in summer 2007 to evaluate water quality and quantity of a mature CSW under base flow and storm conditions.

The Villanova University CSW was originally planted with approximately 20 native species. Over time, the CSW has become overgrown with *P. australis* (>90% coverage). In fall 2006, a control plan was implemented. The plan included an application of glyphosate at the end of the fall 2006 growing season, harvest in March 2007 and several glyphosate applications through the spring and summer of 2007. Under the current plan, it is expected that it will take three years to have reduced *P. australis* to manageable levels with several rounds of herbicide treatment. Once an “acceptable level” of *P. australis* population is established, it will be necessary to continue a management regime; otherwise *P. australis* is likely to re-establish dominance if a more diversified plant community is not established (Ailstock et al. 2001). Repeated applications of herbicide treatment over several seasons raise concerns about the potential negative impacts on non-targeted plants and wildlife. Thus, future research and control plans look to control *P. australis* with natural competition and design elements within the wetland bathymetry.

In addition to rehabilitating the Villanova University CSW plant community, the water quality treatment efficiency, in terms of volume, is under investigation. Most CSWs are constructed according to simple “rules of thumb” for arranging and sizing design elements, and these guidelines have not advanced alongside new science and knowledge. Although the rule-based design process produces effective CSWs, these works may be operating at less than optimal efficiency when compared with other possible configurations within the same footprint. As hydrodynamics drive the primary mechanisms of water quality improvement, peak flow reduction and groundwater exchange in a CSW, a deeper understanding the flow through a CSW may lead to an optimized design. A model of the CSW is being developed to draw links between water quality and water quantity; the model will ultimately be used as a design tool. The present work links discrete storm and baseflow samples and hydraulic modeling of the site to integrate the hydraulic and environmental areas to fully validate the nutrient reduction benefits of a stormwater wetland BMP.

**Reference:**


