Article 90

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Adequate Treatment Volume Critical in Virginia Stormwater Wetland

The performance of a small stormwater wetland (0.3 acre) was assessed over a two year period in suburban Northern Virginia. The wetland was created within an existing stormwater detention basin that served a 40 acre residential and commercial watershed (30% impervious). The total treatment volume was not great, approximately 0.1 watershed-inch of storage.

The shallow wetland was planted with container-grown common three square, rice cutgrass, and arrowhead at a density of one plant per four square feet. Waterlily and spatterdock were planted in the deeper zones of the marsh as well. The performance of the wetland was characterized by continuous flow composite sampling of 23 storm events, as well as routine baseflow monitoring. In addition, the investigators examined the seasonal nutrient dynamics in the wetland's biomass.

The large input of stormwater from all storms appeared to overwhelm the capacity of the wetland to remove nutrients (Table 1). Removal was low or negative for most forms of phosphorus and nitrogen. The wetland also was a net exporter of zinc and aluminum. Removal of suspended solids was only moderate (62%).

The wetland performed much better during smaller storms (defined as storms generating runoff volumes smaller than the 0.1 watershed-inches of storage provided by the wetland). In fact, nutrient and sediment removal rates frequently exceeded 60 to 70%. This finding strongly suggests that stormwater wetlands can be effective in removing pollutants from urban stormwater, but need to be sized appropriately to accommodate greater runoff volumes.

Table 1: Pollutant Removal Performance of the Stormwater Wetland (Pollutant mass Reduced During Both Storms and Baseflow) N=27 (OWML and GMU, 1990)

Pollutant	Small Storms	All Storms
Ortho-phosphorus	59%	-5.5%
Total Soluble Phosphorus	66%	-8.2%
Total Phosphorus	76%	8.3%
Ammonia-Nitrogen	68%	-3.4%
Total Suspended Solids	93%	62.0%
Total Kjeldahl N	81%	15.0%
Nitrate+Nitrite N	68%	1.2%
Total Nitrogen	76%	-2.1%

The seasonal baseflow monitoring provided several interesting insights about the nutrient dynamics of the wetland. First, no dramatic increase in soluble nutrients was experienced at the end of the growing season when the plants die back. A number of researchers have predicted that large nutrient pulses could be expected from stormwater wetlands at the end of the growing season. In fact, the highest soluble phosphorus concentrations leaving the wetland in baseflow were witnessed in the summer.

During much of the year, the wetland tended to be a slight exporter of particulate phosphorus and nitrogen. Apparently, the wetland "packaged" soluble nutrient forms into particulate ones through algal or plant uptake which were subsequently exported from the wetland. Part of the reason for the lack of a pronounced nutrient pulse at the end of the growing season may be that most of the plant nutrients were located below the sediment surface of the wetland.

The researchers also made an attempt to determine the fate of above-ground plant biomass using "litterbags" (mesh bags containing wetland plant matter that are measured over time to determine the rate of decomposition). They concluded that 40 to 65% of the above-ground plant biomass (and nutrients) could be retained in the wetland, and that the wetland was accumulating organic matter and nutrients over time.

The development of the wetland plant community in the first three years after its creation was recorded. Wetland plants quickly took over all the shallow depth zones and grew rapidly in biomass (200-600 gms ash free dry weight /m^2). The wetland plant species coverage after two years is reported by depth zone in Table 2. Eighteen volunteer species had become well established in the wetland after two years. Cattails, spike rush, and duckweed were the most dominant invading species (the first two species were thought to be present in the seedbank of the site prior to construction).

Of the planted species, rice cutgrass had greatly expanded its coverage in the shallowest depth zones (zero to six inches) after two growing seasons. Both spatterdock and water lily expanded their coverage into the deeper areas. Interestingly, the investigators believed that the spatterdock was displacing cattails by the end of the growing season. While common three-square (*Scirpus americanis*) was still present in the plant community, it did not greatly expand its coverage in the first two years.

Although this undersized stormwater wetland did not perform well, the study did provide several insights into better stormwater design. Clearly, additional treatment volume beyond 0.1 watershed-inches was needed to assure good removal during larger storm events. Second, performance was compromised by both sediment deposition (loss of capacity) and resuspension. Perhaps a sediment forebay near the inlet might have improved overall performance.

On the positive side, the study showed that a reasonably diverse wetland plant communities could become rapidly established if a wide range of depth zones were provided. Lastly, the study of the internal plant nutrient dynamics indicated that most of the nutrients taken up by the wetland plants are stored in below-ground biomass or as organic detritus, and the much-feared end of season nutrient pulse may not be of critical importance.

—TRS

Reference

Occoquan Watershed Monitoring Lab and George Mason University. 1990. *Final Project Report: The Evaluation of a Created Wetland as an Urban Best Management Practice.* Northern Virginia Soil and Water Conservation District. 170 pp.

Table 2: Dominant Plants Recorded in the Stormwater Wetland by Depth Zone After Two Growing Seasons (OWML and GMU, 1990)

Depth Zone in Created Wetland	Dominant Species — % Cover*
0-6 inches above normal pool	*Juncus effusus* (soft rush) — 70%
0-6 inches below normal pool	*Leersia orzoides* (rice cutgrass) — 61% *Eleocharis obtusa* (spikerush) — 29%
6-12 inches below normal pool	*Typha latifolia/augustifolia* (cattail) — 45% *Eleocharis* — 41% *Leersia* — 30%
12-18 inches below normal pool	*Typha* — 68% *Ludwigia plustrus* (water purslane) — 16% *Eleocharis* — 13% *Lemna spp.* (duckweed) — 13%
18-30 inches below normal pool	*Lemna spp.* — 100% *Typha* — 90% *Eleocharis* — 50% *Nuphar* — 50% *Nymphea odorata* (water lily) — 70%

** percent of random 1 meter square quadrats where the indicated species was present.*