Article 113

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Runoff and Groundwater Dynamics of Two Swales in Florida

One of the most detailed assessments of the performance of grassed swales was conducted by Harvey Harper (1988) in Central Florida. The monitoring study looked at the changes in the quality of surface water, groundwater and sediments as runoff passed through two 200-foot-long swales draining an interstate highway.

While equal in length, the two swale system were remarkably different in character (Table 1). For example, the "wet swale" was constructed at about the same elevation as the water table, and consequently the surface of the swale system was ponded with at least a few inches of water throughout the year. As a result, wetland plants, such as pickerelweed, water pennywort, and panic grass, grew well across its entire length. The infiltration rate of the wet swale was effectively zero. Therefore, the major pollutant removal processes operating in the wet swale were settling and vegetative filtering. In many respects, it was more comparable to a pocket wetland than a grassed swale.

Table 1: A Tale of Two Swales—Comparative Attributes of Two Swales Monitored by Harper (1988) in Central Florida

Characteristic	Wet Swale	Dry Swale
Swale length	70 meters	70 meters
Underlying soils	sandy soils, < 5% silt clay	sandy soils < 5% silt/clay
Infiltration rate	effectively zero	13.4 inches/hour
Groundwater depth	0 to 2 ft above	2 ft below surface
Vegetation	wetland plants	sparse grass/weeds
Sideslopes	3 to 1 (h:v)	6 to 1 (h:v)
Longitudinal slope	1.8%	0.7%
Age of swale	23 years	16 years
Drainage area	1.17 acres	0.83 acres
Imperviousness	100%	70%
Time of concentration	9 minutes	45 minutes
Storms monitored	11 events	16 events
Groundwater interactions	groundwater moves into swale; creates shallow ponding	80% of runoff infiltrates through swale

The water table was at least two feet below the surface of the "dry swale." This swale had very sandy soils with an extremely high infiltration rate of 13.6 inches/hour. Only a rather sparse cover of annual weeds and grasses became established in the dry swale, even though it had been constructed some 16 years ago. Even so, it was estimated that at least 80% of the incoming runoff to the swale infiltrated into the swale before it reached the outlet. The dry swale also had a gentle slope, and a residence time approximately five times longer than the wet swale. The key pollutant removal process operating within the swale was infiltration of runoff into groundwater, and some sedimentation.

The comparative pollutant mass removal of each swale is depicted in Table 2. Both the wet swale and the dry swale were very effective in removing particulate pollutants contained in highway runoff. However, the nutrient removal capability of the wet swale was rather modest (total nitrogen 40%, total phosphorus 19%). Negative pollutant removal (or export) was noted for dissolved orthophosphate and ammonia. The wet swale also removed most trace metals at rates ranging from 30 to 90%. It should be noted, however, that the dissolved or soluble fractions of the metals were not removed as readily as the particulate fraction (see Table 3). More than 50% of the metals were found in soluble form at the outflow from the swale. It is speculated that the sandy, low organic matter soils did not provide many binding sites to capture soluble metals as they passed through the swale.

The dry swale was the best performer in removing pollutants, with mass reduction rates of 70% or greater for all parameters sampled. Much of the load reduction could be attributed to the infiltration of runoff into the soil of the dry swale. The effect of the swale in reducing pollutant concentrations of runoff that actually reached the outflow sampling point, however, was much less pronounced (Table 3). In fact, the wet swale consistently outperformed the dry swale in reducing the concentration of pollutants that traveled the entire length of the swale. The sparse vegetative cover in the dry swale apparently was not as effective in filtering runoff.

Groundwater and sediment sampling were conducted at both sites to determine the fate of pollutants that had been trapped in the swale. The monitoring