Grassed Swale Pollutant Efficiency Study

Problem
As part of a commitment to environmental protection, the Maryland State Highway Administration is exploring the use of novel technologies to reduce highway runoff volume and improve the quality of this runoff. Grass swales are one such technology that has been incorporated into highway right-of-ways as an aesthetically pleasing method for conveying highway runoff. However, good performance data and mechanistic understanding of swale design parameters are not available.

Objective
This project evaluates the performance of grass swales as a stormwater management practice using field-scale monitoring. The two major objectives of this study were to characterize the overall performance of grass swales and to evaluate the effect of the shallow sloped grass pre-treatment area adjacent to the swale in most designs.

Description
The system is designed as an input/output comparison study to determine the removal of several water quality parameters (total suspended solids, total phosphorus, nitrate, nitrite, total Kjeldahl nitrogen, cadmium, lead, copper, and zinc). Two grass swales were constructed in the median of Maryland Route 32 near Savage, Maryland to allow the determination of discharge water flow and quality parameters. One swale receives runoff directly from the highway (SHA swale), while the other has the shallow sloped filter strip pretreatment area between it and the highway (MDE swale). Because any direct monitoring of input parameters would be intrusive and affect output, an indirect method was used. A concrete channel, with similar dimensions and a roadway drainage area identical to those used for the grass swales, was constructed immediately adjacent to the roadway. The water flow and quality in this channel are assumed to be identical to the input for the swales.
Flow data and water samples for all three channels were taken over 6-8 hour sampling periods at regular intervals, resulting in 12 samples for each system that were analyzed for the water quality parameters indicated above. Pollutant concentrations are presented as a function of time for both the influent and effluent leaving the swales. Combining the flow and concentration data, a total pollutant mass and an event mean concentration (EMC) are calculated. Comparing inputs and outputs yields mass removals and EMC removals for each swale.

Results

Three separate storm events were sampled over the fall and winter of 2004/05. These results confirm the positive EMC removal (35-84%) of most pollutants of interest, including total suspended solids, nitrate, nitrite, total Kjeldahl nitrogen, copper, lead and zinc. The swales demonstrated some export of phosphorus and chloride. Export of phosphorus in a natural system like a grass swale is understandable because this element is present in all organic material. Chloride export likely results from accumulation of road salt. Pollutant concentrations show the presence of a first flush, in which runoff pollutant concentrations are very high in the beginning of rainfall event, and then quickly decrease. The grassed swales effectively controlled this first flush for most pollutants and thereby achieved the removals listed above.

These data indicate that grass swales are an effective technology for water quality improvement. However, the small sample population, caused by snow, technical problems, and destruction of one of the sampler boxes by an errant vehicle, does not allow any statistical comparisons. These findings suggest further use of grassed swales in highway projects as a method to reduce runoff pollutant loading.

Report Information

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