Appendix D: Modelling Filtration Media System Performance

Introduction

Media filtration systems are modelled in MUSIC as a surface detention system (e.g., pond, swale etc.) in which the low flow orifice or riser outlet has been replaced by the discharge characteristics associated with the filtration media which detained water infiltrates into. The filtered flow is assumed to be collected by an underdrain and returned to the watercourse; it is not lost from the system to groundwater, except where there is an exfiltration specified. There are two locations for water quality improvement - in the storage over the filter, and in the filter itself.

Treatment in Storage

Water quality improvement in the storage over the filtration media is modelled in the same way as for a pond, although the user can alter the $k$ and $C^*$ parameters to reflect swale or wetland operating behaviour if desired. Hence the storage design philosophy and the parameter entry dialogue boxes are also very similar to those for a pond, although the available options have been simplified. A separate inlet pond cannot be specified, the hydraulic conductivity of the filtration media replaces the orifice outlet, and the permanent pool volume is always set to zero as the filter is assumed to be at the lowest point in the storage. If relatively low flow rates through the filter lead to long detention times in the storage, the water quality improvement in storage may form a substantial part of the total improvement.

Treatment in the Filtration media

Water quality improvement in the filtration media is calculated using observed relationships derived from data reported in the technical literature. Output concentration decreases as detention time becomes longer, and also decreases as the filter particle size becomes smaller (i.e., as the total area of filter particles increases). The detention time is computed from the hydraulic conductivity and depth of the filter medium. The revised equations are:

\[
\begin{align*}
\log \text{SS Output}\% &= 0.52 - 0.39 \log \left( \frac{\text{Detention Time}}{\text{Particle Size}} \right) \\
\log \text{TP Output}\% &= 1.28 - 0.19 \log \left( \frac{\text{Detention Time}}{\text{Particle Size}} \right) \\
\log \text{TN Output}\% &= 1.62 - 0.10 \log \left( \frac{\text{Detention Time}}{\text{Particle Size}} \right)
\end{align*}
\]

for detention time in days, and median particle diameter in millimetres. The relationships are shown in the following graphs:
The relationships for total suspended solids and total nitrogen are both satisfactory, although there is some scatter present. For total phosphorus the scatter of observed data is particularly wide, and as a result the slope of the regression line is poorly defined. The regression line for total phosphorus has been rotated slightly to give the trend line shown, so that the point of no effective treatment (Output%=100%, or LogOutput%=2) matches that for TSS and TN.

The original performance data was derived from the papers of Bouwer et al (1974), Harmeson et al (1968), Veenhuis et al (1988), and Wanielista et al (1981), and from the Airpark, Megginnis, Seton, and State Highway 45 sites included in the National Stormwater Best Management Practices Database (ASCE & USEPA 1999) without standard Author/date references. The additional data has been derived from Davis et al (2001), Davis et al (2003), and studies currently underway at Griffith University (Henderson, Greenway et al, pers. comm.) and Monash University (Hatt et al, pers. comm.). The study of Harmeson et al (1968) produced an extensive data set, of which only a small fraction was summarised in the published paper. To partly capture this information, four points from their fitted curves (largest and smallest filter media diameter used paired with highest and lowest hydraulic loading tested) have been used in the present study.

References


