Sediment Filters and Sediment Chambers

Description

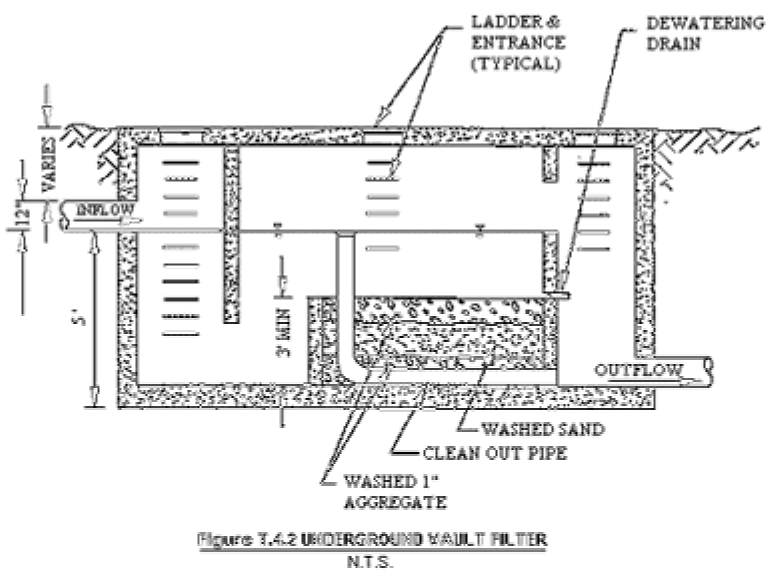
Sediment filters are sediment-trapping devices typically used to remove pollutants (mainly particulates) from stormwater runoff. Sediment filters have four components: (1) inflow regulation, (2) pretreatment, (3) filter bed, and (4) outflow mechanism. Sediment chambers are one component of a sediment filter system.

Inflow regulation is diverting stormwater runoff into the sediment-trapping device. After runoff enters the filter system, it enters a pretreatment sedimentation chamber. This chamber is used as a preliminary settling area for large debris and sediments. It is usually no more than a wet detention basin. As water reaches a predetermined level, it flows over a weir into a bed of some filter medium. The medium is typically sand, but it can consist of sand, soil, gravel, peat, compost, or a combination. The filter bed removes small sediments and other pollutants from the stormwater as it percolates through the filter medium. Finally, treated flow exits the sediment filter system via an outflow mechanism. It returns to the stormwater conveyance system.

Sediment filter systems can be confined or unconfined, on-line or off-line, and aboveground or belowground. Confined sediment filters are constructed with the filter medium contained in a structure, often a concrete vault. Unconfined sediment filters are made without a confining structure. For example, sand might be placed on the banks of a permanent wet pond detention system to create an unconfined filter. On-line systems retain stormwater in its original stream channel or storm drain system. Off-line systems divert stormwater.

Applicability

Sediment filters might be a good alternative for small construction sites where a wet pond is being considered as a sediment-trapping device. They are widely applicable, and they can be used in urban areas with large amounts of highly impervious area. Confined sand filters are man-made systems, so they can be applied to most development sites and have few constraining factors (MWCOG, 1992). However, for all sediment filter systems, the drainage area to be serviced should be no more than 10 acres.



Schematic representation of a sediment filter

The type of filter system chosen depends on the amount of land available and the desired location. The Austin sand filter and the Delaware sand filter are examples of sediment filter systems. The Austin sand filter is a surface filter system that can be used in areas with space restrictions. If space is at a premium, an underground filter might be the best choice. For effective stormwater sediment control at the perimeter of a site, consider the Delaware sand filter. It consists of two parallel, trench-like chambers installed at a site's perimeter. The first trench (sediment chamber) provides pretreatment sediment settling before the runoff spills into the second trench (filter medium).

Siting and Design Considerations

The available space is likely to be the most important siting and design consideration. Another important consideration when deciding to install sediment-filtering systems is the amount of available head. Head is the vertical distance available between the inflow of the system and the outflow point. Because most filtering systems depend on gravity to move water through the system, if enough head is not available, the system will not be effective. It might cause more harm than good. For surface and underground sand filters, a minimum head of 5 feet is suggested (Claytor and Schueler, 1996). Perimeter sand filters like the two-chambered Delaware sand filter should have a minimum available head of 2 to 3 feet (Claytor and Schueler, 1996).

The depth of filter media will vary depending on media type. For sand filters it is recommended that the sand (0.04-inch diameter or smaller) be at least 18 inches deep, with at least 4 to 6 inches of gravel for the bed of the filter. Throughout the life of a sediment filter system, there will be a need for frequent access to assess effectiveness and perform routine maintenance and emergency repairs. Because most maintenance requires manual rather than mechanical removal of sediments and debris, locate filter systems to allow easy access.

Limitations

Sediment filters are usually limited to removing pollutants from stormwater runoff. To provide flood protection, they have to be used with other stormwater management practices. Do not use sediment filters on fill sites or near steep slopes (Livingston, 1997). In addition, sediment filters are likely to lose effectiveness in cold regions because of freezing conditions.

Maintenance Considerations

Maintenance of stormwater sediment filters can be relatively high compared to other sediment-trapping devices. Routine maintenance includes raking the filter medium and removing surface sediment and trash. These chores will likely need to be done by hand rather than by mechanical means. Depending on the medium used in the structure, the filter material might have to be changed or replaced up to several times a year. How often depends on, among other things, rainfall intensity and the expected sediment load.

Inspect sediment filters of all media types monthly and after each significant rainfall event to make sure they are filtering properly. Remove trash and debris during inspections. Remove sediment from the filter inlets and sediment chambers when 75 percent of the storage volume has been filled. Because filter media have the potential for high loadings of metals and petroleum hydrocarbons, have the filter medium analyzed periodically to prevent it from reaching levels that would classify it as a hazardous waste. This is especially true on sites where solvents or other potentially hazardous chemicals are used. Implement spill prevention measures as necessary. Replace the top 3 to 4 inches of the filter medium once a year, or more frequently if the water level does not go down within 36 hours of a storm event.

Effectiveness

Treatment effectiveness depends on factors like treatment volume; whether the filter is on-line or off-line, confined or unconfined; and the type of land use in the contributing drainage area. MWCOG (1992) states that sand filter removal rates are "high" for sediment and trace metals and "moderate" for nutrients, biochemical oxygen demand, and fecal coliform bacteria. Removal rates can be increased slightly by using a peat/sand mixture as the medium because peat has adsorptive properties (pollutants attach to it) (MWCOG, 1992). The estimated pollutant removal capabilities for various filter systems are shown in Table 1.

Table 1. Pollutant removal efficiencies for sand filters

Source	Filter system	TSS[a] (%)	TP[a] (%)	TN[a] (%)	Other pollutants
Claytor and Schueler, 1996	Surface sand filter	85	55	35	Bacteria: 40%-80% Metals: 35%-90%
	Perimeter sand filter	80	65	45	Hydrocarbons: 80%
Livingston, 1997	Sand filter (general)	60-85	30-75	30-60	Metals: 30%-80%

[a]TSS=total suspended solids; TP=total phosphorus; TN=total nitrogen.

Cost Considerations

MWCOG (1992) estimates the cost of construction for sand filters at $3.00 to $10.00 per cubic foot of runoff treated. Annual costs are estimated at about 5 percent of construction costs.

References

Claytor, R., and T. Schueler. 1996. *Design of Stormwater Filtering Systems*. Center for Watershed Protection, Silver Spring, MD.

Livingston. 1997. *Operation, Maintenance, and Management of Stormwater Management Systems*. Watershed Management Institute, Ingleside, MD.

MWCOG (Metropolitan Washington Council of Governments). 1992. *A Current Assessment of Urban Best Management Practices: Techniques for Reducing Non-Point Source Pollution in the Coastal Zone*. Metropolitan Washington Council of Governments, Department of Environmental Programs, Washington, DC.