SECTION 11: SAND FILTER

Sand Filtration Facilities

11.1 General Characteristics and Purpose

Sand filtration systems used for stormwater treatment work similar to those that are used in the drinking water purification process. These systems remove pollutants through sedimentation, filtration, and microbial activity within the sand. Stormwater filtration systems consist mainly of a pretreatment or sedimentation basin, and the filter area. Runoff first enters the sedimentation basin where the runoff velocity is reduced allowing larger pollutant particles to drop out. When the stormwater exits the sedimentation area it is spread evenly over the filter bed where it then flows downward through the filter. As the stormwater flows through the filter, the filtration media trap and absorb pollutants present in the stormwater. Sand filtration systems are beneficial when land space is scarce or expensive, because they can be designed to be placed underground or to border the perimeter of a parking lot or other impervious surface.

Sand filtration facilities are best used for smaller sites (5 acres or less) where the percent imperviousness and the land value is high. Also, the facilities should be used on sites where the drainage area to the facility will remain well stabilized after the construction phase to prevent excess sediment and debris from prematurely clogging the filter. It is recommended that individual sand filtration facilities be sized to treat relatively small drainage areas (1 to 2 acres or less). Implementing multiple facilities on a site will prevent the entire site from being untreated if one filter facility happens to get clogged.

The cost of the construction of concrete underground sand filtration facilities is high in relation to other BMPs and the maintenance burden for the owner can be quite substantial. However, because the BMP can be placed underground, the construction and maintenance costs may be offset by the saving in land area.

To prevent loose debris such as grass clippings, landscape debris, etc from entering the facility, it is highly recommended that sand filtration facilities treat only runoff from impervious surfaces. It is a good idea to implement pollution prevention BMPs, such as paved area sweeping and covering, to minimize the sediment and other pollutants that enter the BMP.

Sand filtration BMPs differ from bioretention, in the fact that the hydraulic head above the filtration bed can be significantly higher than the 6 inches allowed for bioretention. Thus a smaller filter bed surface area will be required.

There are three basic sand filtration BMP types: (1) underground sand filter, (2) perimeter sand filter, and (3) surface sand filter. The underground BMP is ideal to treat stormwater in the ultra-urban environment where land costs are high. The perimeter sand filter and surface sand filter are good to treat parking lot runoff.

Description of Various Sand Filter Types

Underground Sand Filter

There are several different configurations for a sand filtration facility placed in an underground basin. The most widely known type is the District of Columbia (DC) sand filter developed by Mr. Hung V. Truong of the D.C, Environmental Regulation Administration. This type BMP is designed for use in the ultra-urban setting where the drainage area is small (less than one acre). The DC facility consists of three chambers: a wet sedimentation chamber, sand filtration chamber, and outlet chamber (see Figure 3.10).

The wet sedimentation chamber serves to dissipate the incoming velocity and settle out grit. The sedimentation chamber also has a submerged orifice that serves to trap floating debris and prevent it from entering the sand filtration chamber. Mr. Truong points out that the sedimentation chamber can be replaced by a commercial hydrodynamic BMP (see section 3.4.13, Proprietary Stormwater Treatment Facilities). The sand filtration chamber consists of the 24 inch sand bed layer underlain by a gravel bed with perforated PVC drain pipes. An optional layer of geotextile (plastic filter cloth) liner can be placed on top of the sand bed to prevent debris from getting into the sand layer. The outlet chamber collects the effluent from the underdrain pipes, and flow from the by-pass pipe when the volume of the basin is exceeded.

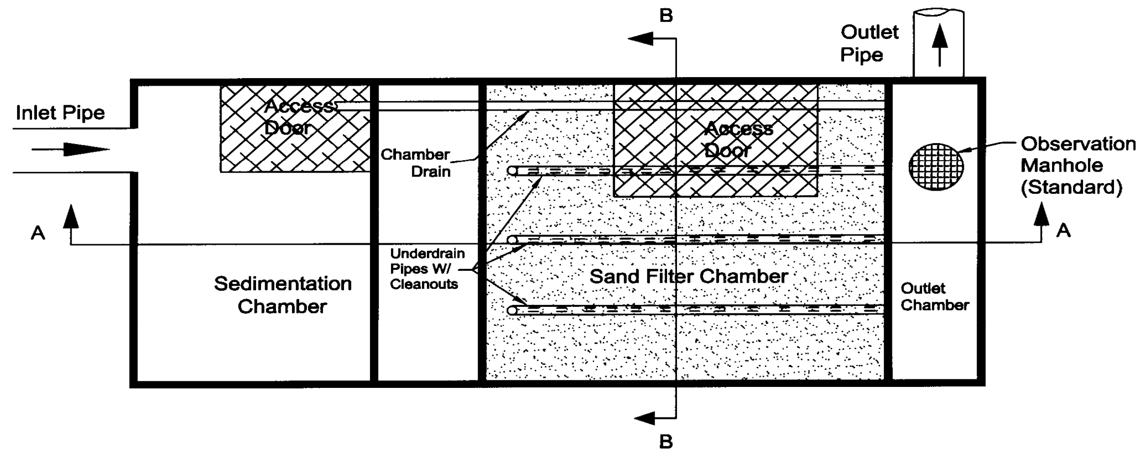
Perimeter Sand Filter (Delaware Sand Filter)

The perimeter sand filter was originally developed by Mr. Earl Shaver of the Delaware Department of Natural Resources and Environmental Control. This type of facility was primarily intended to border the perimeter of parking lots and treat the runoff from it. The facility consists of two parallel concrete chambers; a wet sedimentation chamber and a sand filtration chamber (see Figure below and Figures 12-a and 12-b of the State's Stormwater BMP manual) Runoff in the form of sheet flow enters into the wet sedimentation chamber where the energy is dissipated, flow is dispersed, and coarse sediments drop out. The flow then overflows into the sand filtration chamber where it percolates through the sand medium and is collected by an underdrain system. An overflow weir should be implemented to safely bypass storms larger than the water quality volume.

Surface Sand Filter (SSF)

The City of Austin, Texas first developed and used surface sand filtration systems for treating stormwater runoff (see Figure below and Figure 11-1 of State's Stormwater BMP Manual). The sand filter can be placed in a concrete or earth basin. A sedimentation basin is needed to pretreat the incoming runoff and to bypass larger storm events. The City of Austin found that it was important to size the sedimentation chamber to remove suspended solids to prevent excessive sediment loading on the sand filtration chamber. Since the SSF is an open basin, it will generally cost less than the other enclosed sand filter types and is usually practical to treat a larger drainage area.

Figure: Example of Underground Sand Filter (DC Filter)



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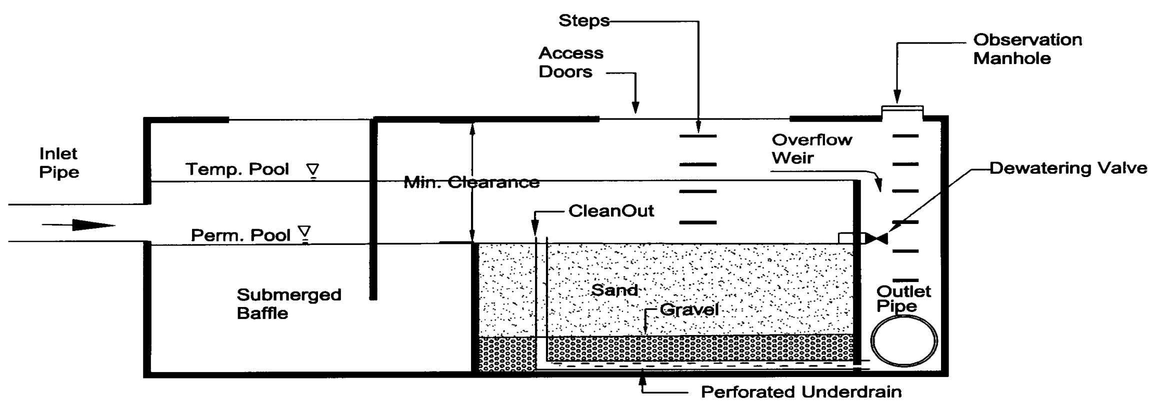

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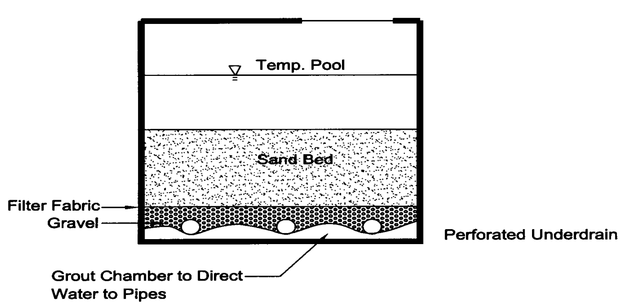
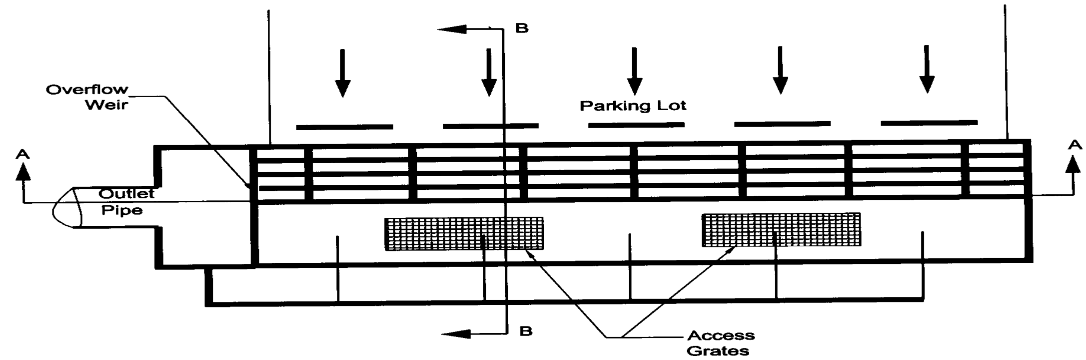


SECTION B-B

Figure: Example of Perimeter Sand Filter (Delaware Sand Filter)



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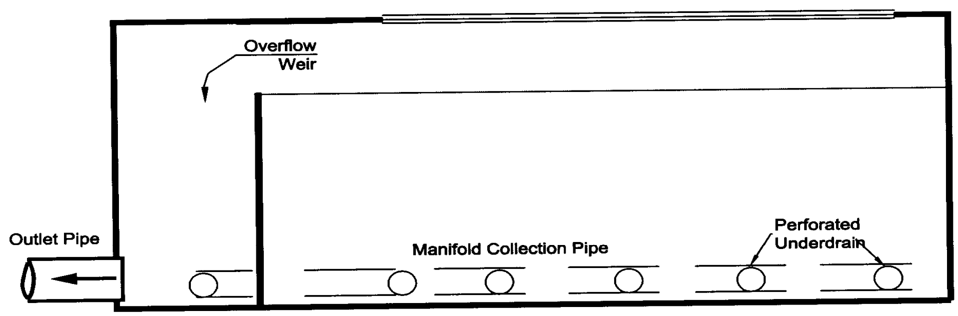

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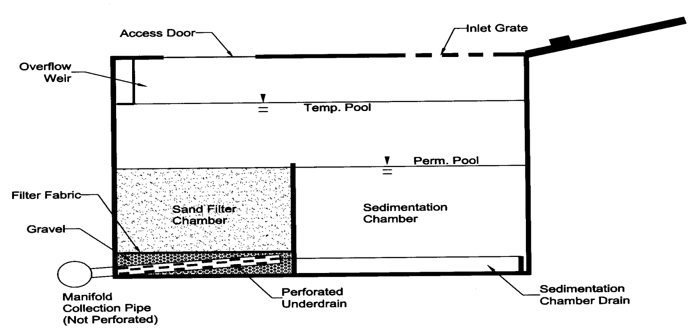
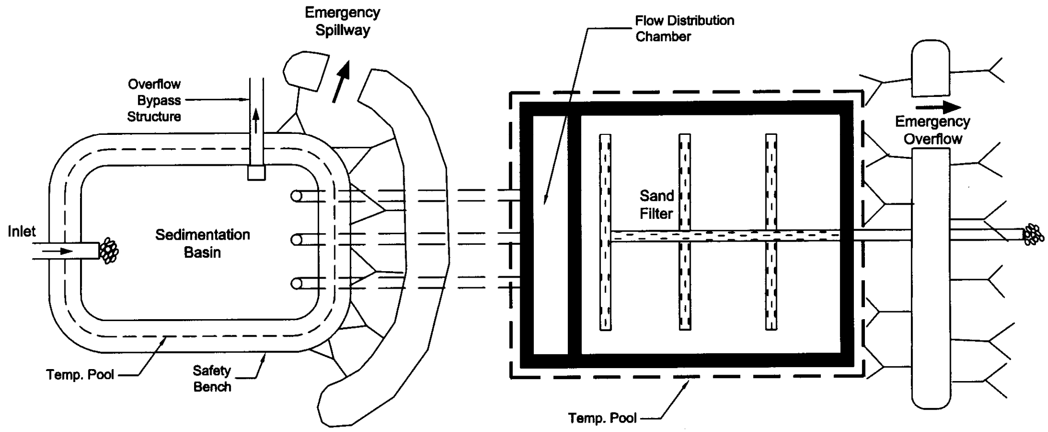


SECTION B-B

Figure: Example of Surface Sand Filter



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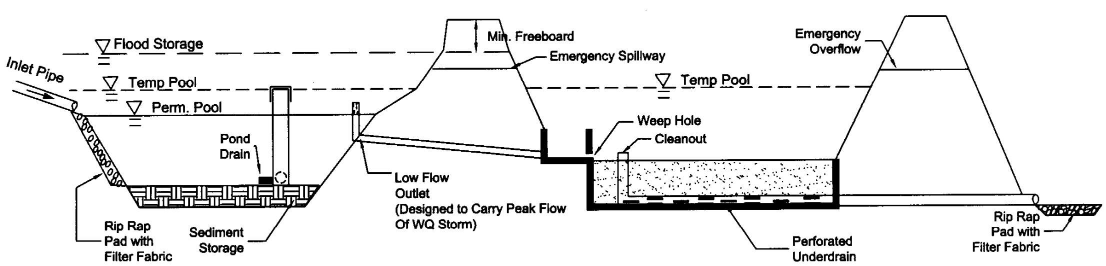

PROFILE

Figures 11-1 and 11-2a show a perforated pipe extending the length of the sand filter chamber and not merely just a solid pipe stubbing into it.

Since an underdrain is required to be incorporated into the device in Greensboro, the device does not require a one hundred feet (100') separation from water supply wells unless it is a community well. A community well has fifteen (15) or more connections and/or serves twenty five (25) or more people.

11.4 Maintenance

11.4.1 Common Maintenance Issues

A 20' wide access easement shall be provided from the public street right-of-way to the sand filtration and pretreatment areas. A drainage maintenance and utility easement (DMUE) shall be paced over the entire facility and extend 15' beyond its perimeter. The access easement should be kept to ensure the BMP is easily accessible for inspection and maintenance.

For sand filtration facilities that are underground, adequate access shall be provided into the facility for inspection and maintenance. It is preferred that large aluminum or steel doors be placed to access the sand filtration chamber. Steps will need to be provided for the underground facility. Also observation manholes or doors should be provided for underground overflow chamber and the sedimentation chamber. Maintenance to the underground sand filtration facility will involve entering a confined space and the appropriate provisions should be made to comply with OSHA confined space requirements.

For ease of maintenance and safety, the distance between manholes and/or access points shall be 100 linear feet maximum. There must be one manhole access point each at the inlet and exit ends of the detention structure. There must be a minimum of two manholes per pipe run. Manholes and access structures must meet or exceed the City of Greensboro's standards. All facility access manholes must be 36 inches in diameter where required. Access ladders must be used rather than manhole steps. Manhole covers must be bolted. Concrete manholes must be used for access to HDPE pipes. Manhole access is required at the terminal end of all pipe runs. Access must be provided over the inlet pipe and outflow structure.

Access to the sand or filter media for inspection and maintenance should be considered during design and ensured during construction. Sediment, debris, and other floatable trash commonly interfere with the proper function or effectiveness of sand filters. Proper grounds keeping and house keeping measures should be utilized throughout the drainage area to prevent these pollutants from entering the BMP in the first place.

11.4.3 Reduction of Pollutants Entering BMPs

Stormwater BMPs are not 100% efficient in removing pollutants; therefore, when the amount of pollutants into the BMP is higher, the amount of pollutants discharged from the BMP will be higher. Also, increased amounts of pollutants entering the BMP will increase the maintenance required to keep the BMP functioning properly.

To assist the stormwater BMP in removing pollutants, every effort should be made to reduce the initial pollutant load entering the BMP. Pollution prevention activities described elsewhere in this manual should be implemented along with the following efforts:

- ⇨ Outside trash dumpsters should be kept covered, and the area around the dumpster should be kept neat and clean.
- ⇨ Chemicals, petroleum products and other pollution sources (such as machinery) should be stored in a covered area away from possible stormwater contact. Spent chemicals are to be properly disposed or recycled.
- ⇨ Fertilizers and pesticides should be used conservatively on the property grounds. Excessive amounts of these chemicals can be washed away with stormwater runoff increasing the nutrient load to the BMP.
- ⇨ Trash and vegetative floatables (grass clippings, leaves, limbs, etc.) should be cleaned from the BMP surface and surroundings periodically to promote a healthy, aesthetically pleasing environment, and to prevent blockage of the outlets. Studies have shown that people are less likely to litter areas that are aesthetically pleasing.

11.4.4 Stabilization of BMP drainage area

The area draining to the BMP should remain stabilized to prevent excessive sediment from entering the BMP facility. When the bare soil is directly exposed to precipitation the sediment concentration in runoff is much higher than for soil that is stabilized. A stabilized area is covered by impervious surfaces (pavement, buildings), grass cover, landscaped cover (mulch, pine straw), etc.

For filtration practices such as sand filtration facilities and bioretention, maintaining a stabilized drainage area is especially important. Eroded sediment can quickly "seal" the filtration bed, drastically decreasing its filtration capacity.

Erosion Concerns
The inlet and outlet areas, side slopes (swales), and the rest of the conveyance area should be inspected for erosion problems.

Where water discharges from a pipe and where the stormwater runs off impervious area onto pervious area, there may be erosion problems. The BMP should have riprap protection at the end of pipes and a gravel trench at the edge of impervious areas to help prevent erosion. These devices should be inspected to ensure they are functioning properly. If erosion is noticed within the rip rap pad or along the edges of the pad, more rock may be needed or it may have been improperly placed (no geotextile liner or improper placement of liner, rip rap not well graded, etc.) If the rock or gravel is displaced downstream, a larger size rock or gravel should be used.

Rill erosion (small channels or gulleys in the ground) is a common problem found in these control devices where the water runoff is naturally trying to channelize. Rill erosion can be repaired by filling in the rills with suitable (clayey) soils and reseeding. It may be necessary to use a temporary erosion resistant matting or to use sod to repair these areas.