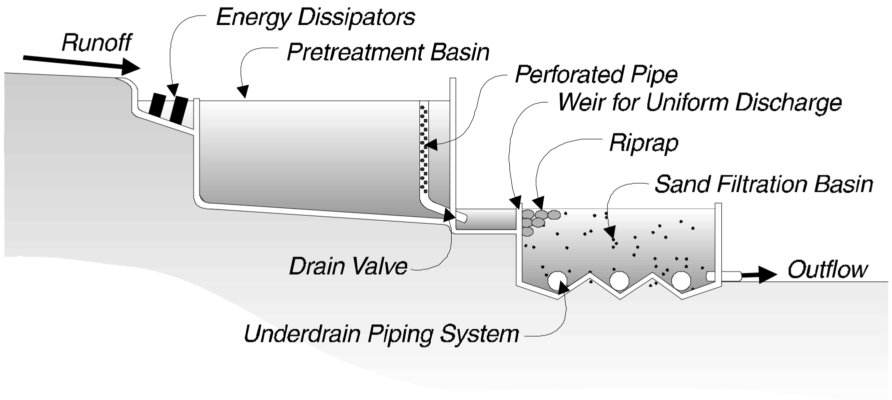
BMP MF: Media Filter



Adapted from City of Austin
"City of Austin" Sand Filter

Definition and Purpose

A media filter is a two-stage constructed treatment system, including a pretreatment settling basin and a filter bed containing sand or other filter media. It is recommended for tributary areas up to 100 acres and is designed to remove sediment (particulate pollutants) only. The pretreatment sedimentation basin is included to avoid rapid clogging of the filter. Possible configurations include:

- Surface sand filter
- Underground sand filter
- Linear basin

Applications

Media filters remove particulate and floatable materials and are appropriate for drainage areas of up to 100 acres. The sand filter has a removal efficiency of 70 to 90 percent, which is similar to the removal efficiency for wet and dry detention basins. The sand filter is ideal for Southern California because it does not require vegetation and requires less space than other BMPs with similar removal efficiencies when a partial treatment sedimentation basin is used. The effectiveness of the sand filter was proven in the City of Austin, where they are widely used today.

Selection of a unit configuration for a media filter depends on the size of the drainage area and the facility location. Land uses for which media filters are appropriate include residential, commercial, and institutional uses, and industrial uses, except for extractive, chemical/petroleum, food and printing. A media filter is not appropriate for agricultural sites or other areas with expanses of erosive soil upstream of the unit.

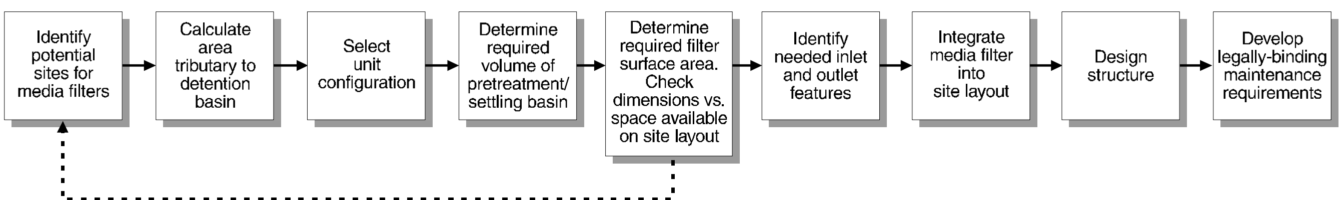
For large watersheds, i.e., 50 to 100 acres, a "City of Austin" sand filter is recommended (see figure above). For very small catchments, a linear basin (see Figure MF-5) is recommended because these smaller media filters provide for lower flows and fit in compact, underground places. Underground linear sand filters are especially suitable for industrial sites because they can be situated to accept sheet flow from adjacent pavement.

Limitations

Heavy maintenance requirements.
Not effective at removing liquid and dissolved pollutants.
Significant headloss may limit use on flat sites.
Severe clogging potential if erodible soil surfaces exist upstream.

Design Guidance, General

The objective of using a media filter is the removal of particulate pollutants, as with extended detention basins (BMP DD and BMP WD) and constructed wetlands (BMP CW). The filter medium used in this BMP is typically sand and sometimes a peat/sand mixture. Advantages of using media filters are that they require less space than other treatment practices and can be located underground. Media filters may be used when there is a lack of water and it is infeasible to use a wet detention basin, wetlands or biofilter. The following flow chart shows suggested steps for using media filters during planning for site development.



The following sections provide specific guidance for sizing the pretreatment/settling basin and the filter basin.

Pretreatment/Settling Basin Design

Size the pretreatment/settling basin to hold the entire water quality volume equivalent to 80% annual capture volume (Appendix B) and to release the volume to the filter over a 40-hour drawdown period.

> Review the unit's drainage area and determine the percentage of impervious area. Impervious area includes paved areas, roofs, and other developed, non-vegetated areas. Non-vegetated, compacted soil areas shall be considered an impervious area. Porous pavements installed and maintained as a stormwater quality control BMP may be considered a pervious area. The percentage of impervious area will be used to determine the runoff coefficient ("C").

> Using Table B-1 (Appendix B), determine the runoff coefficient ("C") for the unit's drainage area based on the percentage of impervious area. The runoff coefficient ("C") will be used to determine the appropriate curve in Figure B-1.

- Enter Figure B-1 (Appendix B) on the vertical axis at 80% Annual Capture. Move horizontally to the right across Figure B-1 until the curve corresponding to the drainage area's runoff coefficient ("C") is intercepted. Move vertically down Figure B-1 from this point until the horizontal axis is intercepted. Read the Unit Basin Storage Volume along the horizontal axis. Interpolation between curves may be necessary.

- Calculate the required basin volume by multiplying the Unit Basin Storage Volume by the unit's drainage area. Convert the required storage volume to cubic feet.

- For a partial pretreatment sedimentation basin (recommended where site constraints exist), use no less than 20 percent of the volume calculated for the full sedimentation design. When a partial pretreatment sedimentation basin is used, filter maintenance requirements increase substantially and must be reflected in the maintenance manual.

- Lay out the basin such that the length to width ratio is 4:1 (preferably, 2:1 is acceptable) and maintain 1 foot of freeboard.

- Locate energy dissipator upstream of the entrance (see figure on page MF-1).

- Design an outlet for the pretreatment basin. Include provisions to drain the basin, such as using a perforated pipe or a drain. Outlet configurations vary. The "City of Austin" sand filter design incorporates a perforated riser pipe (see BMP DD). The sediment trap design (Figure MF-1) includes an additional horizontal perforated outlet that conveys flow to the outlet structure. For linear basins, the water crests over a wall to enter the filter basin (Figure MF-5).

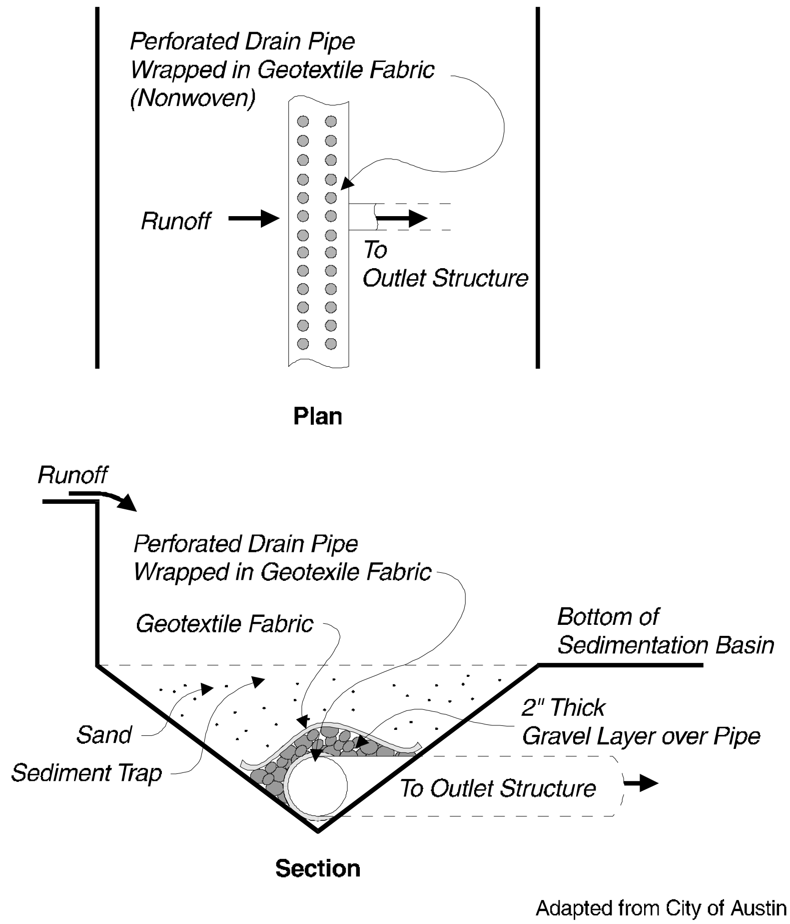


Figure MF-1

Filter Basin Design

The filter basin surface area can be determined with the following equation for a maximum (full pretreatment basin) filtration time of 24 hours and an average hydraulic head on the filter of 3 feet:

Let Filter Area = A_F,

$$A_F = \frac{A_T\ S}{K\ T_D}$$

Where A_F = filter area (sq ft)

A_T = area draining to facility (sq ft)

S = unit basin storage volume from Appendix B (ac-ft/ac)

K = coefficient of permeability = 3.5 ft/d for full sedimentation and 2 ft/d for partial sedimentation (ft/d)

T_D = drawdown time of the maximized volume = 40 hours (1.67 days) for full pretreatment and 8 hours (0.33 days) for partial pretreatment (days)

This equation provides an appropriate surface area for filter media of diameter of 0.02- to 0.04-inch, as recommended by the City of Austin. The filter area must be larger if smaller media is used. The sand bed can be designed as shown in Figure MF-2. Geotextile fabric between the sand and the gravel and the gravel and the pipe can help prevent maintenance difficulties. The clean sand size of 0.02- to 0.04-inch diameter is recommended. Install underdrains (Figure MF-2): use 4-inch diameter PVC pipe with 3/8-inch perforations around pipe with 6 inches of space between each perforation group, a maximum of 10 feet between laterals, and a minimum slope of 1/8 inch per foot. A flow spreader shall be included between the pretreatment and filtration basins.

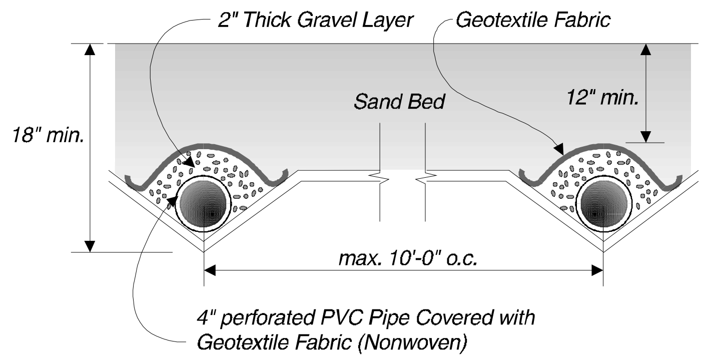


Figure MF - 2

Sand Bed Underdrains

Include a bypass around the filter for flows larger than a 2-year event (see Appendix A) and minimize the potential for erosion upstream of the filter. A final factor that shall be considered in filter design is the trade-off between media maintenance requirements and pollutant removal efficiency. Smaller-grained media provides better performance than coarser-grained media, but has higher maintenance requirements.

Geotextile fabrics must meet the minimum specifications listed in Table MF-1.

Table MF-1
Geotextile Properties (Nonwoven)

Property	***Test Reference***	***Minimum Specification***
Grab Strength	ASTM D4632	90 lbs
Elongation at peak load	ASTM D4632	50 %
Puncture Strength	ASTM D3787	45 lbs
Permitivity	ASTM D4491	0.7 sec^{-1}
Burst Strength	ASTM D3786	180 psi
Toughness	% Elongation x Grab Strength	5,500 lbs
Ultraviolet Resistance (Percent strength retained at 500 Weatherometer hours)	ASTM D4355	70%

Adapted from SSPWC, 1997.

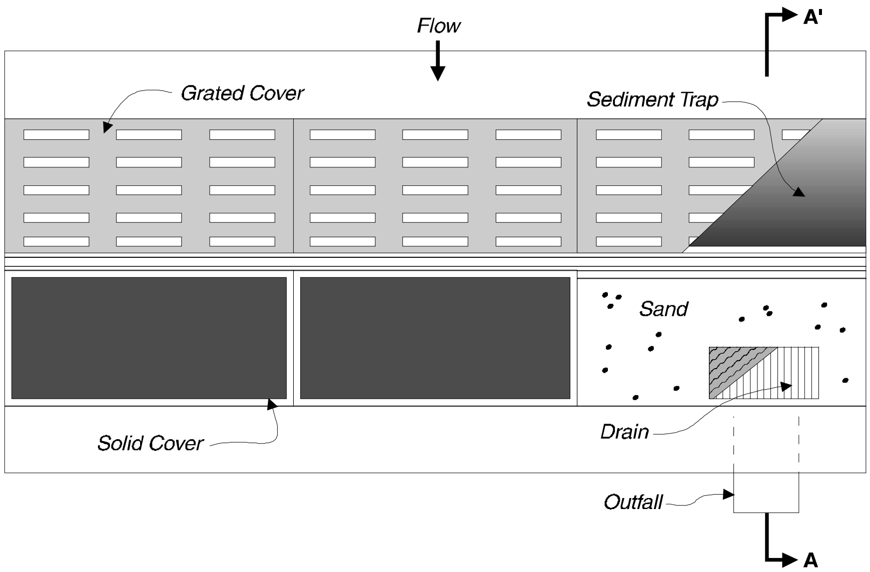
Additional Criteria for Specific Configurations

A linear basin configuration is recommended for smaller drainage areas, i.e., a few acres or less, because it provides adequate treatment for low flows and fits in compact spaces.

Linear Basin

The linear basin's settling basin and filter should be sized according to the general media filter design criteria. Example structures are shown in Figures MF-3 and MF-4. The structure must be able to withstand traffic loads if located in areas subject to traffic.

Minimum sand depth shall be 18 inches and maximum outlet pipe diameter shall be 6 inches (use multiple pipes if needed). The flow should enter the sedimentation chamber in an even distribution. Sedimentation chamber should be positioned carefully relative to the pavement to ensure sheet flow.



Source: Shaver, 1991

Figure MF - 3

Linear Basin (Plan)

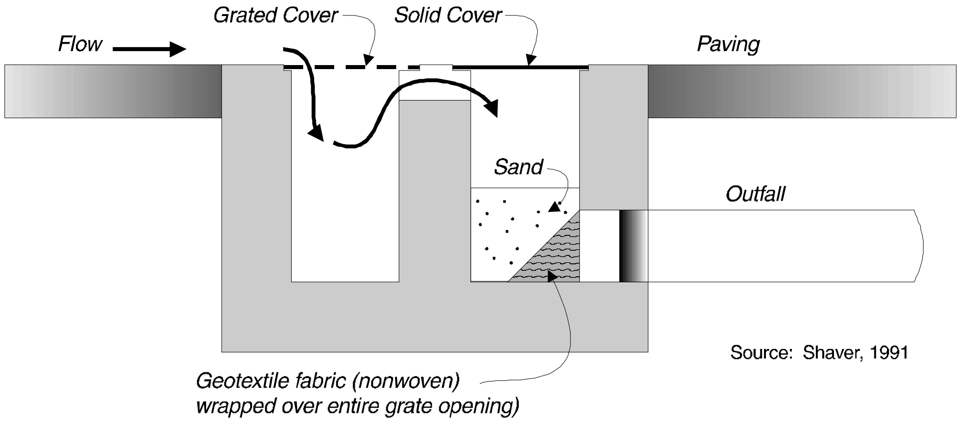


Figure MF - 4

Linear Basin (Section A'A)

Maintenance and Inspection Requirements

Media filters require periodic maintenance and inspection including the following practices:

- Inspect filter sand a minimum of twice a year, before and after the rainy season, after large storms, or more frequently if needed. Media filters with partial pretreatment require quarterly filter cleaning, or more often if the drainage area is erosive.

- Clean filter surface and filter semiannually, or more often if the drainage area is erosive. Media filters with partial pretreatment require quarterly filter cleaning, or more often if the drainage area is erosive.

- Remove sediment when it accumulates to fill 25 percent of the original capacity of the pretreatment basin, or more frequently if needed.

- Remove floatables when they cover more than 25 percent of the surface area of the pretreatment basin, or more frequently if needed.

- Replace media, if necessary (if loss of permeability is noted), after construction activity has ceased and soils have stabilized.

- Clean pretreatment area to avoid plugging of the filter media a minimum of twice a year, before and after the rainy season, after large storms, or more frequently if needed.

- Control mosquitoes, as necessary.

- Prepare a maintenance manual and submit it to the appropriate agency prior to facility installation.

- Report on maintenance to the appropriate agency.