B.9 MEDIA FILTRATION

DESCRIPTION OF SAND FILTERS

Media filters are two-stage constructed treatment systems, including a pretreatment settling basin and a filter bed containing sand or other filter media. Various types of sand filter designs have been developed and implemented successfully in space-limited areas. The filters are not designed to treat the entire storm volume but rather the water quality volume (WQV), that tends to contain higher pollutant levels. The WQV represents the site runoff volume generated from 0.75-inches of rainfall. Sand filters can be designed so that they receive flow directly from the surface (via inlets or even as sheet flow directly onto the filter bed) or via storm drain pipes. They can be exposed to the surface or completely contained in underground pipe systems or vaults.

While there are various designs, most intermittent sand filters contain four basic components, as shown schematically in Figure 1 and discussed below:

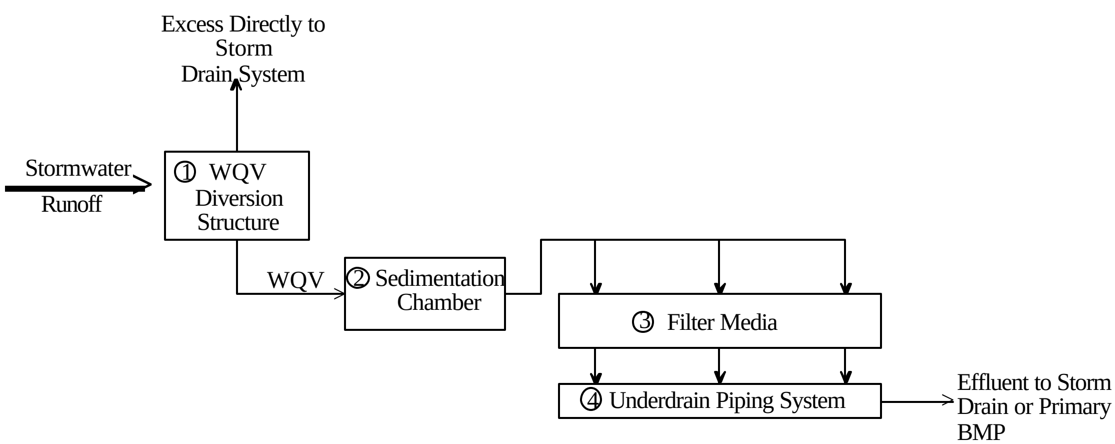

Figure 1. Schematic of a typical sand filter.

1. *Diversion Structure.* Either incorporated into the filter itself or as a stand alone device,

the diversion structure isolates the WQV and routes it to the filter. Larger volumes are bypassed directly to the storm drain system.

2. *Sedimentation Chamber.* Important to the long-term successful operation of any filtration system is the removal of large grained sediments prior to exposure to the filter media. The sedimentation chamber is typically integrated directly into the sand filter BMP but can also be a stand alone unit if space permits.
3. *Filter Media.* Typically consists of a 1-inch gravel layer over an 18 to 24 inch layer of washed sand. A layer of geotextile fabric can be placed between the gravel and sand layers.
4. *Underdrain System.* Below the filter media is a gravel bed, separated from the sand by a layer of geotextile fabric, in which is placed a series of perforated pipes. The treated runoff is routed out of the BMP to the storm sewer system or another BMP.

ADVANTAGES

1. May require less space than other treatment control BMPs and can be located underground.
2. Does not require continuous base flow.
3. Suitable for individual developments and small tributary areas up to 100 acres.
4. Does not require vegetation.
5. Useful in watersheds where concerns over groundwater quality or site conditions prevent use of infiltration.
6. High pollutant removal capability.
7. Can be used in highly urbanized settings.
8. Can be designed for a variety of soils.
9. Ideal for aquifer regions.

LIMITATIONS

1. Given that the amount of available space can be a limitation that warrants the consideration of a sand filter BMP, designing one for a large drainage area where there is room for more conventional structures may not be practical.
2. Available head to meet design criteria.
3. Requires frequent maintenance to prevent clogging.
4. Not effective at removing liquid and dissolved pollutants.
5. Severe clogging potential if exposed soil surfaces exist upstream.
6. Sand filters may need to be placed offline to protect it during extreme storm events.

DESIGN CRITERIA

1. *Volume.* Calculate the flow rate of stormwater to be mitigated by the media filtration system using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.
2. *Surface area of the filter.* The following equation is for a maximum filtration time of 24 hours:

A. Surface Systems or Vaults

Filter area (ft^2) = $3630S_uAH/K(D+H)$

Where:	S_u	=	unit storage (inches-acre)
	A	=	area in acres draining to facility
	H	=	depth (ft) of the sand filter
	D	=	average water depth (ft) over the filter taken to be one-half the difference between the top of the filter and the maximum water surface elevation
	K	=	filter coefficient recommended as 3.5

This equation is appropriate for filter media sized at a diameter of 0.02 to 0.04 inches. The filter area must be increased if a smaller media is used.

B. Underground Sandfilter Systems

a. Compute the required size of the sand filter bed surface area, A_F. The following equation is based on Darcy's law and is used to size the sand filter bed area:

A_F (ft^2) = $24(WQV)(d_f)/ [k (h_f + d_f) t_f]$

Where:	A_f	=	sand filter bed surface area (ft^2)
	WQV	=	Water quality treatment volume (ft^3)
	d_f	=	sand filter bed depth (ft)
	k	=	filter coefficient recommended as 3.5 (ft/day)
	h_f	=	average height of water above the sand bed (ft)
		=	$h_{max}/2$
	h_{max}	=	elevation difference between the invert of the inlet pipe and the top of the sand filter bed (ft)
	t_f	=	time required for the runoff to filter through the

sand bed (hr). (Typically 24 hr).
Note: 24 in the equation is the 24hr/day constant.

b. Choose a pipe size (diameter). The selection of pipe size should be based on site parameters such as: elevation of the runoff coming into the sand filter system, elevation of downstream connection to which the sand filter system outlet must tie into, and the minimum cover requirements for live loads. A minimum of 5' clearance should be provided between the top of the inner pipe wall and the top of the filter media for maintenance purpose. Use:

$D = d + 5$

Where:
- D = pipe diameter (ft)
- d = depth of sand filter and underdrain pipe media depth (ft)
  = $d_g + d_f$
- d_g = underdrain pipe media depth = 0.67’
- d_f = sand filter bed deph (ft): 1.5 to 2.0 feet

c. Compute the sand filter width(based on the pipe geometry):

$W_f = 2\,[R^2 - (R - d)^2\,]^{0.5}$

Where:
- W_f = filter width (ft)
- R = pipe radius (ft)
  = $D/2$

d. Compute the filter length:

$L_f = A_f / W_f$

Where: L_f = filter length (ft)

3. *Configuration*

A. Surface sand filter

Criteria for the settling basin.

a. For the outlet use a perforated riser pipe.
b. Size the outlet orifice for a 24 hour drawdown

c. Energy dissipator at the inlet to the settling basin.
d. Trash rack at outlets to the filter.
e. Vegetate slopes to the extent possible.
f. Access ramp (4:1 or less) for maintenance vehicles.
g. One foot of freeboard.
h. Length to width ratio of at least 3:1 and preferably 5:1.
i. Sediment trap at inlet to reduce resuspension.

Criteria for the filter.
a. Use a flow spreader.
b. Use clean sand 0.02 to 0.04 inch diameter.
c. Some have placed geofabric on sand surface to facilitate maintenance.
d. Underdrains with:
  - Schedule 40 PVC.
  - 4 inch diameter.
  - 3/8 inch perforations placed around the pipe, with 6 inch space between each perforation cluster.
  - maximum 10 foot spacing between laterals.
  - minimum grade of 1/8 inch per foot.

B. Underground sand filter

Criteria for the settling tank (if required).
a. Use orifice and/or weir structure for the outlet.
b. Size the outlet orifice or weir for a 24 hour drawdown time
c. Provide access manhole for maintenance.

Criteria for the filter.
a. Use a flow spreader.
b. Use clean sand 0.02 to 0.04 inch diameter.
c. Some have placed geofabric on sand surface to facilitate maintenance.
d. Underdrains with:
  - Schedule 40 PVC.
  - 4 inch diameter
  - 3/8 inch perforations placed around the pipe, with 6 inch space between each perforation cluster.
e. Provide access manhole for maintenance.

REFERENCES

1. Camp, Dresser and McKee, Inc., Larry Walker Associates, 1993. *California Best Management Practices - Municipal*, California State Water Resources Council Board. Alameda, CA.

2. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

3. B. R. Urbonas, January/February 1999. *Design of a Sand Filter for Stormwater Quality Enhancement*, Water Environment Research, Volume 71, Number 1. Denver, CO.

4. Ventura Countywide Stormwater Quality Management Program, *Draft BMP MF: Media Filters*, June 1999. Ventura, CA.

5. Northern Virginia BMP Handbook, City of Alexandria Virginia, February 1992. Alexandria, VI.

6. US EPA, Developments in Sand Filter Technology to Improve Runoff Quality, www.epa.gov/owowwtr1/NPS/wpt/wpt02/wpt02fa2.html.

The following is a list of known locations where a Media Filtration was installed. The design of the installed filter in each location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the locations herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	Brand/Manufacturer	Owner/Client
Eastern Regional Maintenance Station	N/A	Caltrans
Foothill Maintenance Sta.	N/A	Caltrans
Termination Park & Ride	N/A	Caltrans
Paxton Park & Ride	N/A	Caltrans