4.4-h MEDIA FILTER

Alternate Names: Bed Filter, Sand Filter (Underground or Surface), Cartridge Filter, Proprietary Media Filter

BMP DESIGN APPROACH
☐ Pollutant Source Control
☐ Hydrologic Source Control
■ **Stormwater Treatment**
SCALE OF APPLICATION
☐ All SFR and MFR < 1 acre
■ **MFR 1-5 Acre and CICU < 5 acres**
■ **MFR and CICU > 5 acres and all WQIPs**
TYPE OF APPLICATION
☐ Temporary
■ **Permanent**

DESCRIPTION

Media filters typically consist of a pretreatment settling chamber followed by a chamber/fixed bed that contains filter media or filter cartridges. Stormwater entering the device is first passed through the pretreatment chamber to remove coarse particles and debris by settling or screening. A weir is typically used to pass stormwater from the pretreatment chamber to the media chamber. An assortment of filter medias are available including sand, leaf compost, activated carbon, perlite, amended sand, zeolite, or a combination of these medias. After passing through a filter media, stormwater is collected using an underdrain system and piped to the outlet of the device.

APPLICABILITY

- Typically used for commercial, industrial, or roadway applications where space constraints limit the use of other stormwater treatment BMPs.
- Depending upon inflowing pollutant loads, frequent maintenance may be necessary to avoid filter clogging and maintain effectiveness.
- Most designs require a site that can provide a minimum of 4 feet of hydraulic head for the media filter to operate properly.

Advantages

- Specific pollutants can be targeted by customizing the media installed in the filter.
- Can provide removal of pollutants of concern for lake clarity (i.e. fine sediment particles and particulate species of phosphorus and nitrogen).

Disadvantages

- Media replacement and other maintenance activities may require confined space entry.
- Units with standing water potentially promote mosquito breeding.
- Installation and maintenance costs are typically higher relative to most other stormwater treatment BMPs referenced in this Handbook. However, for space constrained sites, costs may be significantly lower relative to land acquisition costs for siting alternative stormwater treatment BMPs.

A media filter installed on a commercial parking lot directly adjacent to Lake Tahoe to meet regulatory discharge standards where infiltration is limited due to high groundwater.

DESIGN CONSIDERATIONS

The following guidelines are water quality design considerations. Refer to applicable drainage design manuals within the responsible jurisdiction for requirements associated with structural integrity, drainage design, public safety, and other factors. Below is a list of design considerations organized by the different types of media filters discussed in this Handbook.

General Considerations

- Include a pretreatment chamber to reduce inlet velocities and to remove debris and coarse sediment. A settling basin or a forebay is commonly used for this purpose.
- Ensure sufficient hydraulic head from the inlet to the outlet is available. Most media filters need at least 4 feet of hydraulic head to operate properly.
- The minimum filtering rate of the media, or media cartridges, shall equate to the water quality treatment rate for the design storm.
- Underground media filters may function better in cold climates because of fewer problems from freezing. However, underground filters are typically more burdensome to maintain relative to above ground filters.
- Shallow groundwater may damage underground structures or affect the performance of underdrain systems.
- To facilitate timely maintenance of a media filter, consider designing an inlet bypass system.

Cartridge Filter

- Cartridge filters can be individual units placed in a vault, or a single unit placed in a storm drain inlet.
- For proprietary systems like cartridge filters, refer to the manufacturer's instructions for design guidance.

Cartridge based filter installed at a commercial site.

Sand Filter

- A surface sand filter uses an exposed media bed. Relative to underground sand filters, surface sand filters can typically treat larger drainage areas and are the easier to maintain.
- An underground sand filter is installed below grade in a vault. This type of design is preferred where space limitations or topography (inadequate hydraulic head) preclude the use of a surface sand filter.
- For maintenance of surface sand filters, include access ramps at the inlet and the outlet of the system.
- Design flow spreaders to minimize turbulence and spread runoff uniformly across the media bed. Design stone riprap, geotextile fabric, or other energy-dissipation devices to prevent gouging of the media.
- Types of underdrain systems include: a central collector pipe with lateral feeder pipes; a geotextile drain strip in a drain rock bed; or a collector pipe in a drain rock bed.
    - The internal diameter of underdrain pipes should be a minimum of 6 inches, with two rows of 0.5 inch diameter holes spaced a maximum of 6 inches apart longitudinally. Space rows 120 degrees apart with the holes laid downward. The maximum distance between two lateral feeder pipes should be 15 feet. All piping should be Schedule 40 PVC, or pipe with greater wall thickness.
    - Slope the central collector pipe a minimum of 0.5 percent. If the pipe will be subject to freezing, slope the collector pipe a minimum of 1 percent.
    - If drain rock is used, place a geotextile fabric between the sand layer and the drain rock. Drain rock shall be clean, thoroughly washed and ¾ to 1 ½ inches in size.
    - Provide maintenance access to the underdrain piping.
- Compose the filter bed of at least 18 inches of clean washed sand (or other media selected for use) and placed level. Avoid over compaction to ensure adequate filtration capacity. After the sand layer is placed, water settling is

recommended. Flood the sand with 10-15 gallons of water per cubic foot of sand.

- The table below provides a suggested sand gradation.

U.S. Sieve Number	Percent Passing
4	95-100
8	70-100
16	40-90
30	25-75
50	2-25
100	<4
200	<2

INSTALLATION CONSIDERATIONS

Below is a list of installation considerations organized by the different types of media filters discussed in this Handbook.

Cartridge Filter:

- A pre-cast or cast-in-place vault is typically installed over an underdrain manifold pipe system. This is followed by installation of the cartridge filters.
- For proprietary systems such as cartridge filters, refer to the manufacturer's instructions for installation guidance.

Surface Sand Filter:

- Provide erosion protection along the first foot of the sand bed adjacent to the inlet flow spreader. Geotextile fabric secured on the surface of the sand bed, gravel, or equivalent method may be used.

Underground Sand Filter:

- Provide a minimum of 24 square feet of ventilation grate for each 250 square feet of sand bed surface area. Grates may be located in one area if the sand filter is small, but placement at each end is preferred.
- Provide removable panels over the media bed for maintenance access.

Linear/Perimeter Sand Filter:

A sand filter is typically a long, shallow, two-celled, rectangular vault. The first cell is designed for settling coarse particles, and the second cell contains the filter bed. This type of media filter is most applicable for long, narrow spaces, such as within a road right-of-way.

- Divide the two cells with a divider wall that is level and extends a minimum of 12 inches above the sand bed.
- The width of the sand bed should be between 5 and 15 feet.
- Vent the system as for underground sand filters.
- Provide removable panels over the media bed for maintenance access.

INSPECTION AND MAINTENANCE

All Media Filters:

- Inspect several times during the first year to establish loading and cleaning frequencies. Inspect routinely every six months and after major storm events.
- Frequently maintain pretreatment systems to reduce debris and sediment loading to the filter media.

Cartridge Filters:

- Refer to manufacturer's specifications for inspection and maintenance guidelines.
- Depending on pollutant loading to the filter, cartridge filters typically need to be replaced every 2 to 4 years.

Sand Filters:

- Remove accumulated silt and debris from the top of the sand when deposition exceeds 0.5 inch or when significant caking of material is evident. Once deposition is removed, restore the filtration media by striating the surface layer of the media.
- Media replacement frequency will depend on pollutant loading to the filter.
- Inspect the filter during significant runoff events.

    - Frequent overflow or slow drawdown rates are indicators of plugging problems and the need for maintenance.
    - Rapid drawdown in the sand bed (greater than 12 inches per hour) may indicate short-circuiting of the filter. Inspect cleanouts on the underdrain pipes and along the base of the embankment for leakage.

- Formation of rills and gullies on the surface of the filter media may be an indication of an improperly functioning inlet flow spreader. Inspect the function of the filter during significant storm events and maintain as necessary.

EFFECTIVENESS CONSIDERATIONS

Media filters are considered to be effective for removal of pollutants of concern for lake clarity (fine particles) when the media filter is properly designed and maintained. Media filters rely on filtration as the primary treatment process, which is considered a viable pollutant removal mechanism for pollutants of concern. However, effectiveness for dissolved nutrients may be limited.

Three performance monitoring studies conducted on a single Lake Tahoe Region media filter are cited below.

- *StormFilter Performance Analysis*[14]and *Lake Tahoe BMP Monitoring Evaluation Process*[15] noted the following performance for the media filter treating stormwater runoff from the Ski Run Marina in South Lake Tahoe, California:
  - The media filter demonstrated variable (typically poor) ability to remove dissolved nutrients from stormwater, including nitrate, nitrite, orthophosphate, and dissolved phosphorus.
  - The media filter consistently reduced particulate pollutants in urban stormwater.
    - Event mean concentrations of total nitrogen were reduced on average by 13 percent.
    - Event mean concentrations of total phosphorus were reduced on average by 45 percent.
    - Event mean concentrations of total suspended sediment were reduced on average by 80 percent.
- *Focused Stormwater Monitoring to Validate Water Quality Source Control and Treatment Assumptions*[16] noted the following performance for the media filter treating stormwater runoff from the Ski Run Marina in South Lake Tahoe, California. While the data are very limited, this study provides some of the first performance monitoring data for fine sediment particles:
  - Roughly a 65 percent reduction in the fine sediment particle loading was observed.

[14] 2NDNATURE, 2005, *Storm Filter Performance Analysis* prepared for the City of South Lake Tahoe. ftp://2ndnaturellc.com/2ndnature/2NDNATURE_Reports/Lake%20Tahoe/CSLTStormFilterPerformanceAnalysis_FinalReport.pdf

[15] 2NDNATURE, 2006, *Tahoe Basin BMP Monitoring Evaluation Process: Synthesis of Existing Research* prepared for USFS Tahoe Basin Management Unit.

[16] 2NDNATURE and Northwest Hydraulic Consultants, 2010, *Focused Stormwater Monitoring to Validate Water Quality Source Control and Treatment Assumptions* prepared for US Army Corps of Engineers, Sacramento District. ftp://2ndnaturellc.com/2ndnature/2NDNATURE_Reports/Lake%20Tahoe/PLRM%20Refinement_FinalPhaseI_TechnicalReport.pdf