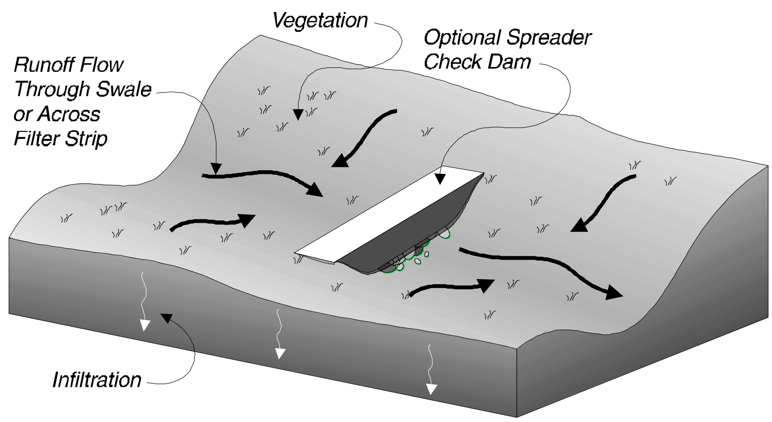
Definition and Purpose



A biofilter passes stormwater slowly over a vegetated surface in the form of a *swale* or *filter strip* to filter pollutants and infiltrate the runoff.

Applications

Biofilters are appropriate for retarding/reducing runoff and removing sediment. Biofilters also achieve some removal of nutrients, heavy metals, toxic materials, floatable materials, oxygen demanding substances, and oil and grease.

Biofilters are most effective when designed to receive sheet flow from paved areas and maximize water contact with the biofilter vegetation and the soil surface. They are often placed within vegetated setbacks, landscaped common areas and other required open areas in residential, commercial, industrial and institutional land uses. Biofilters can have tributary areas of up to 5 acres, which makes them appropriate for lawn and parking areas.

Limitations

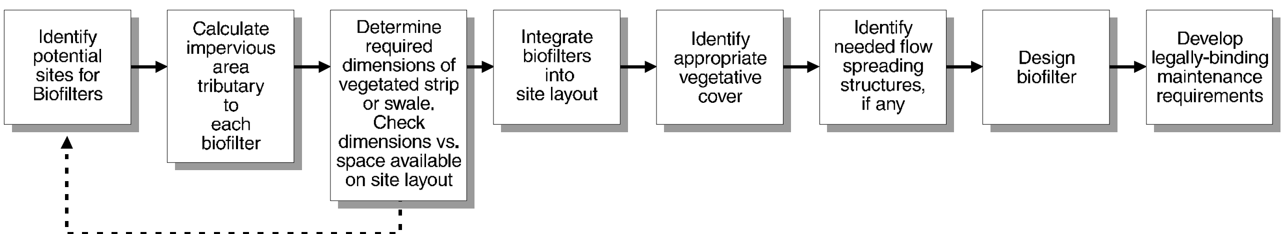
- Irrigation may be necessary to maintain vegetative cover.
- Sheet flow (for strip configuration) may be difficult to maintain.
- Channelization in swales may be difficult to avoid.
- Not appropriate for steep unstable slopes.
- Large area requirements may make this BMP infeasible for some sites.
- Slow infiltration rates in areas with soils in Hydrologic Soil Group C or D (See Appendix C) may cause runoff to pond.
- Not appropriate for pollutants toxic to vegetation.
- Tributary areas for this BMP are limited to 5 acres or less.

Design Guidance, General

Biofilters are an effective means for removing stormwater pollutants, infiltrating runoff, stabilizing soil and controlling erosion. Biofilters accomplish this in several ways. Vegetative covers shield soil surfaces from the impact of falling rain. Vegetation, such as turf grass or other ground cover, disperses flow and provides a rough surface to reduce flow velocity, which promotes infiltration and sediment deposition. Plants also remove nutrients in stormwater and transpire moisture from the soil. Healthy vegetation further helps to maintain a porous soil structure, aiding infiltration. These means for increasing runoff quality are achieved by conveying shallow (less than 3 inches) flow across the vegetative cover. Pollutant removal effectiveness for biofilters is a function of area, flow depth, travel time and the quality of the vegetative cover.

Biofilters are relatively easy to design, install and maintain. Vegetated areas that would normally be included in the site layout, if designed for appropriate flow patterns, may be used as biofilters. Landscape architects can easily alter planting schemes to include appropriate turf or ground cover species for biofiltering purposes. Finally, maintaining a biofilter often requires little more than normal landscape maintenance activities such as irrigation and mowing. Compared with some other means for improving stormwater runoff quality, biofilters provide a relatively unobtrusive, attractive, long-term and inexpensive stormwater quality management technique.

There is some flexibility associated with biofilter configuration. Either filter strips or vegetated swales may be used, depending on the site layout, size of the impervious area, and the designer's vision of the landscape architecture. Filter strips, which are appropriate to place along and receive sheet flow from paved surfaces, are especially simple to incorporate. Vegetated swales, which can be designed to effectively treat concentrated flows from areas up to 5 acres, provide temporary runoff storage as well as filtering, require more area and are appropriate for larger sites. The flow chart below shows the general steps to follow when designing biofilter BMPs.



Location

The appropriate location for a biofilter on the site is determined by the locations of other site facilities, and the flow characteristics of the site. Biofilters are effective and simple when sited directly down gradient and adjacent to the impervious area from which they receive flow. Filter strips, for example, are easily sited adjacent to a driveway or other paved area. A swale may be used both as a traffic calming device/ parking area separator and as a means for adding landscape interest, in addition to using it as a stormwater quality management unit. Figures BF-1 and BF-2 show examples of biofilter placement. If a biofilter is located such that it receives flow from both pervious and impervious areas, the entire flow will need to be intercepted. Where space is limited biofilters shall be sited such that they receive follow only from impervious areas to limit the size of the unit.

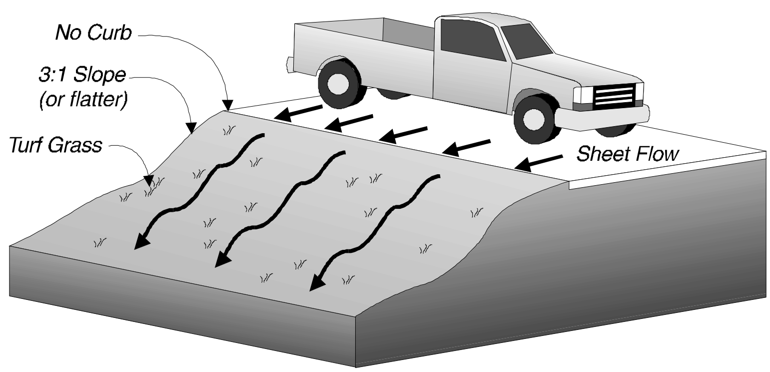


Figure BF – 1

Biofilter Strip Adjacent to Parking Area

Size

Biofilters are sized according to the impervious area from which they receive flow. Figure BF-3 presents sizing criteria for large impervious areas for various areas of Ventura County. While a unit's drainage area may include both on- and off-site areas, accepting flow from off-site areas shall be avoided, if possible to minimize the size of unit. Several biofilters may be used on a single site, each sized according to the impervious area from which it receives flow. Flow shall be distributed across the biofilter as uniformly as possible, to avoid concentrating the flow. Strip configurations shall be sized appropriately for the dimensions of the contributing impervious area, and swales shall be sized based on a design storm flow, as described below under the guidelines for specific configurations.

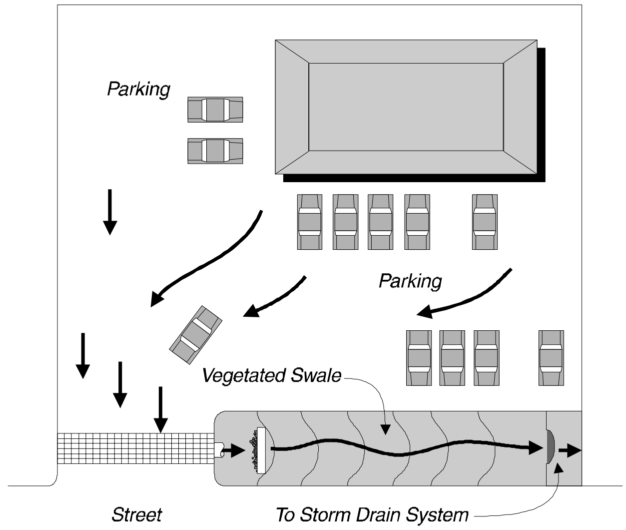


Figure BF – 2

Biofilter Placement

Dimensions

Both strip and swale configurations require a slow, shallow flow pattern and low-flow velocity. Recommended practice is to keep the flow depth below the height of the vegetation (up to about 3 inches deep) and the flow velocity under 1 ft/sec. Maximum flow depth, therefore, will vary slightly depending on the species of vegetative cover chosen, and upon desired maintenance practices.

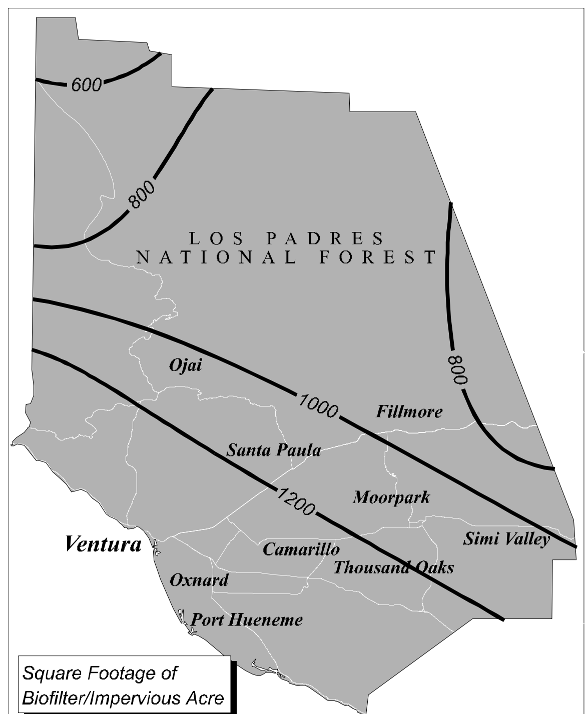


Figure BF – 3

Biofilter Sizing Criteria

Slope and Flow Path

Slopes of filter strips and side slopes of swales shall be 3:1 or flatter.

Slope of swales in the direction of flow shall be 0.5 to 2 percent. Slopes greater than 2 percent can be reduced with check dams. Slopes less than 1 percent require under drains.

Peak velocity of flow through/across the unit shall be less than 1 ft/sec.

Vegetation

Vegetation serves primarily to maintain soil porosity and prevent erosion. The effectiveness and aesthetic appeal of biofilters is enhanced by selection of appropriate vegetative cover. Turf grass is preferred, and some other ground covers also may be appropriate.

An important maintenance consideration in the selection of appropriate vegetation is whether irrigation is planned for the site.

Table BF-1 at the end of this section provides a sample list of appropriate vegetative covers. Figure BF-4 is a map showing approximate zones of suitability for the listed species. These zones represent areas of climatological suitability according to the *Sunset Western Garden Book* and are referenced for each species in Table BF-1. Additional suggested vegetative species are listed in Table BF-2 at the end of this section. The map and tables are intended as guides in selecting vegetative covers. For specific species suitability and care information, refer to the sources listed for these tables. Contact the Natural Resources Conservation Service or the Ventura County Resource Conservation District for additional information.

Figure BF – 4

Vegetation Suitability Zones

Additional Criteria for Specific Configurations

Swale Design

Swales shall be designed to convey the Stormwater Quality Design Flow at a shallow flow depth (as appropriate for selected vegetation), typically with freeboard as required by the appropriate agency.

- Calculate the design runoff rate ($Q_{P, SQDF}$) using the method described in Appendix A.
- Use the Manning formula to obtain the required swale dimensions.

>Set Manning's "n" to 0.20 for frequently mowed swales, or set "n" to 0.24 for infrequently mowed swales.

>Use a 3:1 or flatter side slope and a longitudinal slope of 2 percent or less.

>Design for a maximum v = 1 ft/s.

>Make length of swale at least 100 feet. Minimum swale area shall be determined using Figure BF-3.

> Incorporate a bypass or overflow for flows exceeding the design capacity of the BMP.

If a wide channel is required or desired, it may be necessary to include a flow-spreading device in the design to assure that the design flow depth and velocity are maintained. Flow spreading devices include dedicated structures such as multiple inlets, but also may be as simple as a rock bed and/or a low check dam, such as the one shown conceptually on Page BF-1. Use check dams, as necessary, to achieve a slope in the direction of flow of 2 percent or less. Other optional design considerations for swales are:

Include a pretreatment area to catch sediment.

Provide good access for mowing equipment.

Use modular porous pavement (see BMP IN) to strengthen the bottom of the swale and prevent damage during mowing.

Strips

Four important design considerations govern the effectiveness of filter strips: only allow sheet flow to enter the strip; establish a dense vegetative cover; grade to a uniform, even and low slope; and install or maintain an appropriate area of filter. Below are additional notes regarding these considerations:

Use Figure BF-3 to establish the minimum size of the biofilter for the impervious area.

Establish strip configuration. For sidewalks, driveways and similar areas, filter strips shall be at least as wide (in the direction of flow) as the contributing impervious area. For other, larger impervious areas, use Figure BF-3 to calculate the total area of biofilter required and configure the strip such that flow takes 5 to 10 minutes to flow through the filter strip to achieve maximum filtering effectiveness. The slope and width shall be adjusted, as necessary, to achieve this while ensuring that flow velocities do not exceed 1 ft/sec.

Achieve sheet flow. This may be fairly straightforward for small filter strips. For larger strips, or for strips where options for shaping the filter are limited, achieving sheet flow may be very difficult, and the use of a level spreader may help. Figure BF-5 shows a cross section of a filter strip that includes a level spreader. Construction of a level spreader may be coordinated with installation of the impervious surface, and is most practical for relatively flat areas such as parking lots. Use of a level spreader may be impractical for roads or driveways with steep slopes.

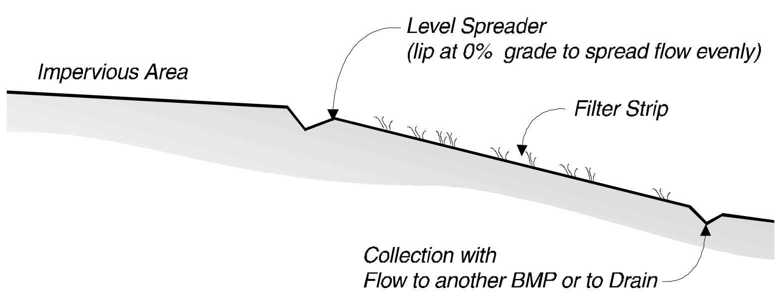


Figure BF – 5

Filter Strip with Level Spreader: Cross Section

(Level spreader usually requires concrete in order to precisely establish grade.)

Establish and maintain a dense

vegetative cover using irrigation and regular maintenance.

- # Limit the slope for a filter strip to be no steeper than 3:1. If a steeper slope is necessary because of site constraints, the biofilter may not provide adequate stormwater quality improvement, and/or the slope may require additional stabilization methods.

Maintenance and Inspection Requirements

Biofilters require periodic maintenance, including the practices listed below.

- # Check for erosion, a minimum of twice a year, before and after the rainy season, after large storms, and more frequently if needed. Repair eroded areas and revegetate as needed.
- # Inspect unit for evidence of channelization and adjust to spread flow.
- # Inspect for siltation a minimum of twice a year, before and after the rainy season and after large storms. Remove deposits, as necessary.
- # Maintain vegetation at or below the level of the pavement edge or level spreader to avoid flow concentration.
- # Monitor health of vegetation and replace, as necessary.
- # Mow, as appropriate, for vegetative cover species.
- # Apply fertilizer during spring growth. Avoid fertilizer application during the rainy season.
- # Repair vegetation in advance of the rainy season, allowing sufficient time for plant establishment.
- # Control mosquitoes, as necessary.
- # Prepare and submit a maintenance manual to the appropriate agency prior to facility installation.
- # Report on maintenance to the appropriate agency.

Table BF-1 ***Sample List of Appropriate Vegetative Covers***			
Plant Name Common (Latin)	***Appropriate Species***	***Map Zones****	***Maintenance and Usage Notes*****
Bermuda Grass (Cynodon)	ASanta Ana≅ hybrid	A	Moderate maintenance. Dormant (brown) in winter. Heat tolerant. Erosion control, swales.
Fescue (Festuca)	Red fescue (F. rubra)	A, B	Low to moderate maintenance. Tolerates some shade and poor soil. Lawns, swales, erosion control.
	AKentucky 31" Tall Fescue (F. elatior)	A, B	Low maintenance. Tolerate shade and compacted soils. Rapid germination. Lawns, swales, erosion control. Useful as overseed for Bermuda grass during dormant (winter) season.
Ryegrass (Lolium)	Perennial (L. perenne)	A, B	Moderate maintenance. Heat intolerant. Fast sprouting. Useful as overseed for Bermuda grass during dormant (winter) season. Swales.
	Annual (L. multiflorum)	A, B	Annual (may live several seasons in mild climate). Moderate maintenance. Heat intolerant. Fast growing. Useful as overseed for winter-dormant species. Swales.

*See Figure BF-4

**Generally, these species will require supplemental irrigation.

Sources: ASCE, MWCG, Sunset

Table BF-2 ***Additional Suggested Vegetative Covers***		
Plant Name Common (Latin)	***Appropriate Species***	***Usage Notes***
Orchard grass (Dactylis)	AAkaroa" or "Berber" (D. glomerata)	Irrigated Sites
Wheatgrass (Agropyron)	"Luna" or "Topar" pubescent (A. intermedium trichophorum)	Irrigated and Nonirrigated Sites
Zorro Fescue (Vulpia)	(V. myuros)	Nonirrigated Sites
Creeping wild Rye (Leymus)	(L. triticoides)	Nonirrigated Sites
Brome (Bromus)	Blando (B. mollis)	Nonirrigated Sites
	California or "Cucamonga" (B. carinatus)	Nonirrigated Sites

Source: NRCS-FOTG