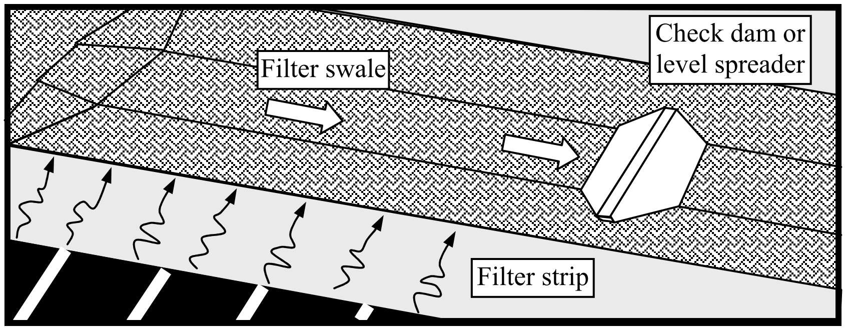
ACTIVITY: Filter and Buffer Strips

F – 03



Targeted Constituents				
● Significant Benefit	◗ Partial Benefit	○ Low or Unknown Benefit		
◗ Sediment	◗ Heavy Metals	○ Floatable Materials	◗ Oxygen Demanding Substances	
◗ Nutrients	◗ Toxic Materials	◗ Oil & Grease	○ Bacteria & Viruses	○ Construction Wastes
Implementation Requirements				
● High	◗ Medium	○ Low		
◗ Capital Costs	◗ O & M Costs	◗ Maintenance	○ Training	

Description

Filter and buffer strips are able to remove some sediments and pollutants from stormwater runoff if correctly designed and constructed. Low velocities, combined with healthy stands of grass vegetation, allow particles and debris to settle and filter out from stormwater runoff. These strips can be composed of grass or forest buffer zones, provided that efforts are made to ensure sheet flow to the buffer zone. Generally, a maintained grass filter strip is used to treat very shallow, or sheet flow. Filter strips are often used as pretreatment for other BMPs. This practice will provide a partial reduction in most types of pollutants, and will provide some groundwater recharge.

Selection Criteria

- Filter and buffer strips are often used in conjunction with other stormwater management practices to treat runoff from paved streets and parking lots.
- Filter and buffer strips can also be used to reduce the amount of directly connected impervious area (DCIA) that drains into the storm drainage system, thus reducing peak flows. In addition to pavement areas, this typically can be used for rooftops.

Design and Sizing Considerations

A filter strip is a relatively flat area (recommended 5 percent maximum grade) of healthy grass vegetation adjacent to or downstream from an impervious surface that may contain pollutants. A wildgrass or forest buffer zone may function as a filter strip. A filter strip is usually intended for sheet flow from small parking lots or streets and low-density residential and agricultural areas. A level spreader may be required to convert concentrated (channel) flow into sheet flow. Filter and buffer strips are not recommended to treat catchments larger than 5 acres.

Filter and buffer strips perform well for small light-intensity rainfalls, but typically have no effect on the large design rainfalls used for stormwater detention. Since most precipitation occurs during light-intensity rainfalls, filter and buffer strips are a major component in improving water quality from sheetflow runoff. Detention basins and constructed wetlands are relied upon to provide water quality treatment both during and between storms for the large design rainfalls. Filter and buffer strips should generally be used in combination with other stormwater treatment BMPs whenever possible.

Poor maintenance techniques, "short -circuiting", poor vegetative cover, and unsuitable location are several causes of filter strip failure. Filter strips have relatively high failure rates.

Figure F-03-2 shows examples of how filter strips can be used in parking lots and residential properties. Since thick and healthy grass vegetation is a part of most landscaped properties, filter and buffer strips are easy to incorporate into most BMP strategies. Filter and buffer strips have removed as much as 80% of total suspended sediments and 50% of soluble zinc in the metropolitan Washington D.C. area if properly constructed, but have not shown any removal for dissolved phosphorous or copper (Metropolitan Washington Council of Governments, 1992). Other studies have also shown little or no removal for heavy metals, and also generally poor performance due to incorrect construction. California guidelines include a typical size for filter strips equal to 1000 square feet per impervious acre, with a minimum width of 10 feet (Camp Dresser & McKee, et al, 1993).

The upper layout (Figure 2A - parking lot) shows sheet flow entering a wide swale rather than a gutter or curb inlet. Design considerations include width of swale, the anticipated overhang of vehicles, whether to use wheel stops, and spacing of grate inlets. In general, the grate inlets should flow to a detention basin or other stormwater treatment BMP prior to being discharged to a storm drainage system or natural stream.

The lower layout (Figure 2B – residential property) shows impervious area from rooftops and driveways. Rooftop drainage typically reaches ground level via gutters and downspouts, and it is understood that this stormwater should be conveyed at least 5 to 10 feet from the building to avoid wet basements or saturated foundations. However, downspouts should be turned into sheet flow through filter strips whenever possible.

To force ponding in a vegetated filter strip, a pervious berm constructed of a moderately permeable soil may be installed. An armored overflow should be provided in order to aid in the bypass of larger storms.

Filter and buffer strips and swales may also be used as a temporary erosion control strategy, in conjunction with other erosion control measures. Filter strips are applicable on construction sites to reduce sediment damage to adjacent properties and to disconnect upstream developments from receiving waterbodies. Filter and buffer strips and swales are used downstream from erosion control measures that remove most coarse sediment and silts from the stormwater. Also, sod (if properly pegged and stabilized) may be used as part of temporary inlet protection in conjunction with silt fence or straw bale barriers. Downstream bank erosion can be prevented by filter strips.

Habitats for wildlife, some water quality improvements, aesthetics, and occasional recreation are all benefits of a properly designed and maintained filter strip.

Pollutant Removal Efficiency

Pollutant Removal Capability: Filter strips are capable of removing suspended solids, nutrients, and organics as long as the flow is low to moderate (Schueler et al, 1987). Infiltration and biological uptake also occur as runoff flows through the filter strip. Removal capabilities are a function of the geometry of the filter strip and the contributing watershed area.

Total suspended solid removal efficiency for grass filter strips and grass buffers can be estimated using Figure F-03-1. Compute travel time using typical SCS methods such as the kinematic equation for time of concentration. Then enter the graph with an assumed depth of 0.02 feet (or about 0.25 inches). The effectiveness of a grass filter strip depends heavily upon sheet flow being maintained across the grass surface. This is accomplished by level spreaders and by careful maintenance of the grass surface.

Other design criteria are as follows:

- Forested filter strips have a high capability for pollutant removal due to biological uptake and longer retention in the forested areas; however, without the vegetative cover of grassed covered strips, forested strips should be at least two times as long as grassed filter strips.
- Wide filter strips help to maintain sheetlflow.
- The lowest elevation in the filter strip should be at least two feet above the water table.
- Keep flow paths to the strip less than 150 feet to prevent shallow concentrated flows.
- Organic matter surfaces and clay soils improve the nutrient removal capability of filter strips (Schueler et al, 1992). An infiltration rate of 0.52 inches per hour is recommended, such as a sandy loam (VDCR, 1999). Soils should be capable of sustaining vegetation with minimal fertilization.
- The water table should at least two feet below the surface to help increase the removal of soluble pollutants through infiltration (VDCR, 1999).
- Filter strips do not function properly during high flows. High velocities can cause the runoff to channelize and prevent pollutant removal. The maximum flow velocity allowed is 0.5 feet per second (KCDNR, 1998).
- The depth of flow on the filter strip should not exceed the height of the grass. A good rule of thumb is a maximum of 1.0 inch (KCDNR, 1998).
- Ultra-urban areas tend to have large amounts of impervious areas and subsequently, high runoff velocities. Because of the inability of filter strips to function properly under high flows, they are not recommended in such areas.
- Filter strips are not capable of attenuating peak flows, but instead can help to decrease runoff velocities and time of concentration. They are mostly used for water quality purposes and are most effective when used in conjunction with other BMPs.

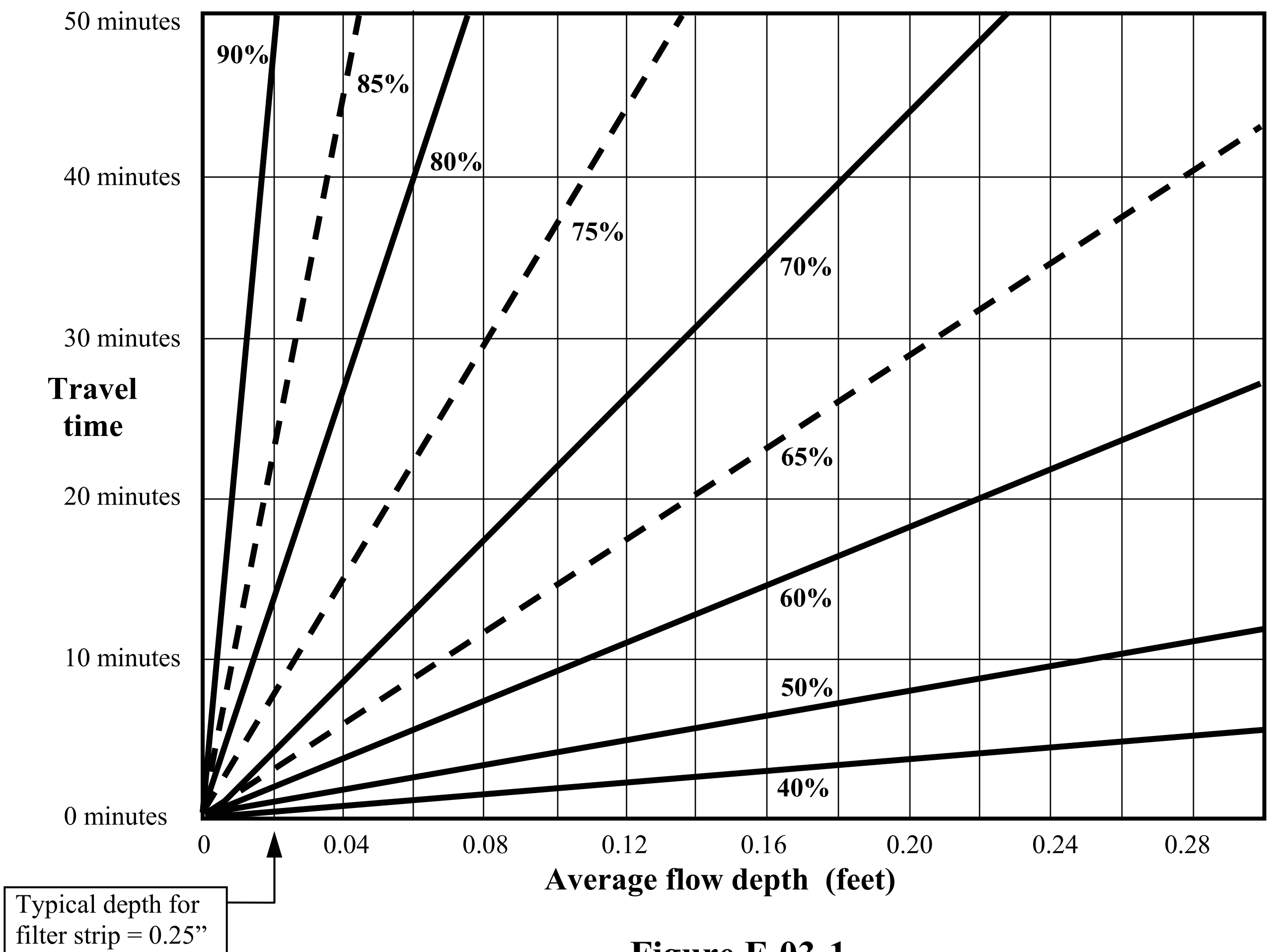


Figure F-03-1
TSS Removal Efficiency for Grass Swales and Filters

Construction/ Inspection Considerations

A minimum width of 10 feet is recommended for vegetated filter strips at a slope of 1%. Widths of 20 to 30 feet are highly recommended, particularly if the slope is more than 1%. The length of a filter strip is typically the entire length of the adjacent parking lot, street, or building. The use of sod is very beneficial in establishing a filter strip, particularly for small widths such as 10 feet. Limit the width of pavement that drains to a filter strip; typical values should be 50 to 100 feet whenever possible. Since curbs and curb cuts will concentrate flows, curbs and gutters are not desirable for paved areas with filter strips. Avoid concentrating stormwater runoff on pavements by ensuring that the pavement slopes and vegetated surface slopes are level or change very gradually. In busy parking lots, vehicle wheels or parking curb stops may channelize flow in some instances. Channelization will reduce the effective treatment area of the filter strip and may erode grass because of excessive velocities. A level spreader, check dam or energy dissipater may assist in returning channelized flow back into sheet flow, if designed and constructed properly.

Protect grass filter strips from vehicle traffic; this is typically done with wheel stops made of precast concrete, iron or landscaping timbers. Even heavy foot traffic can compact the topsoil and trample the grass, affecting performance of a filter strip. Design and analyze probable areas of foot traffic, and provide paths and sidewalks that are compatible with the grass filter strips. If irregular or uneven areas appear while the vegetation is being established, repair and restore to a smooth and even appearance to prevent concentrating stormwater sheet flows.

Sod Placement

Sodded grass is preferable to seeded grass vegetation, but either method may be used to establish grass filter strips. Sod has the advantages of immediate erosion control and stormwater treatment, healthier stands of vegetation, aesthetics, less maintenance and less inspection, and increased property values. Refer to Figure F-03-3 for a relative comparison of various types of turfgrass; information is also available from the UT Agricultural Extension website.

Sod guidelines are explained more fully in the *Tennessee Erosion and Sediment Control Handbook*. Protect sod with tarps or other covers during delivery so that it does not dry out between harvesting and placement. Prepare subgrade by removing all weeds and debris, then add fertilizer, lime and water as needed. Place sod in staggered fashion so that there are no long seams. After placing sod, lightly roll to eliminate air pockets and ensure close contact with the soil. After rolling, the sodded areas shall be watered so that the soil is moistened to a minimum depth of 4 inches. Sod should not be planted during very hot or wet weather. Do not place sod on slopes that are greater than 3:1 (H:V) if they are to be mowed.

Maintenance

- Filter and buffer strips should be inspected regularly during the establishment of vegetation. Repair or replace any damage to the sod, vegetation, or evenness of grade as needed. Look for signs of erosion, distressed vegetation or channelization of sheet flow.
- In general, grass vegetation should not be mowed shorter than 3 inches. Maximum recommended length of grass is 6 to 8 inches. Allowing the grass to grow taller may cause it to thin and become less effective. The clippings should be bagged and removed. Mowing grass regularly promotes growth and pollutant uptake.
- Keep all level spreaders or check dams even and free of debris. Remove all debris and sediment by hand and with a flat-bottomed shovel during dry periods, leaving as much of the vegetation in place as possible. Reseed or plug any damaged turf or vegetation.
- Rake or remove trapped trash such as cigarette butts and other debris to ensure a healthy filtering quality.

- Areas disturbed during construction should be immediately reseeded for proper vegetative cover.
- If the filter strip was used as a sediment control measure during construction, it should be reseeded and regraded immediately afterwards so that flow patterns within the strip are not altered.
- Proper maintenance of the filter strip, including spot repairs, fertilization, and maintaining the top edge of the filter to prevent channelization are very important, as are periodic inspections.

Sediment Removal

- The sediment accumulation rate is dependent on a number of factors such as land use, watershed size, types of industry, nearby construction, etc. The sediment composition should be identified before being removed and disposed.
- Periodic sediment removal will help maintain the infiltration and uptake capacity of the filter strip and help keep the original terrain of the area by preventing soil build-up.
- Some sediment may contain contaminants for which the Tennessee Department of Environment and Conservation (TDEC) requires special disposal procedures. Consult TDEC - Division of Water Pollution Control if there is any uncertainty about what the sediment contains or if it is known to contain contaminants. Generally, special attention or sampling should be given to sediments accumulated in facilities serving industrial, manufacturing or heavy commercial sites, fueling centers or automotive maintenance areas, large parking areas, or other areas where pollutants are suspected to accumulate.
- Clean sediment can be used as fill material, hole filling, or land spreading. It is important that this material not be placed in a way that will promote or allow resuspension in storm runoff.

Cost Considerations

The cost of constructing a filter strip is very low, especially reduced if constructed before development of the surrounding area. According to an EPA website (1993), an average filter strip will cost approximately $85.41 per acre, in 1990 dollars.

Limitations

- Grass filter strips can only treat sheet flow. Curb cuts have the effect of channelizing sheet flow and are not useful in establishing grass filter strips as a stormwater treatment BMP.
- Grass filter and buffer strips are effective only on gentle slopes, typically less than 1 or 2 percent. Filter and buffer strips located on steeper slopes generally will not receive credit as being a stormwater treatment BMP. Site topography may not allow the use of grass filter and buffer strips
- Grass filter and buffer strips are useful primarily for small areas only, typically 1 acre or less. Larger project sites or properties can also make effective use of filter and buffer strips for smaller subbasins.
- Proper maintenance is required to maintain the health and density of grass vegetation, such as irrigation during summer droughts and adding small amounts

of fertilizer or lime as needed.

- Filter strips are not recommended in areas with high runoff velocities and therefore should not be constructed in highly urbanized, impervious areas.
- Filter strips pose little threat to the environment, other than a slight risk to groundwater contamination.

Additional Information

Examples of filtering systems and grass characteristics are provided below.

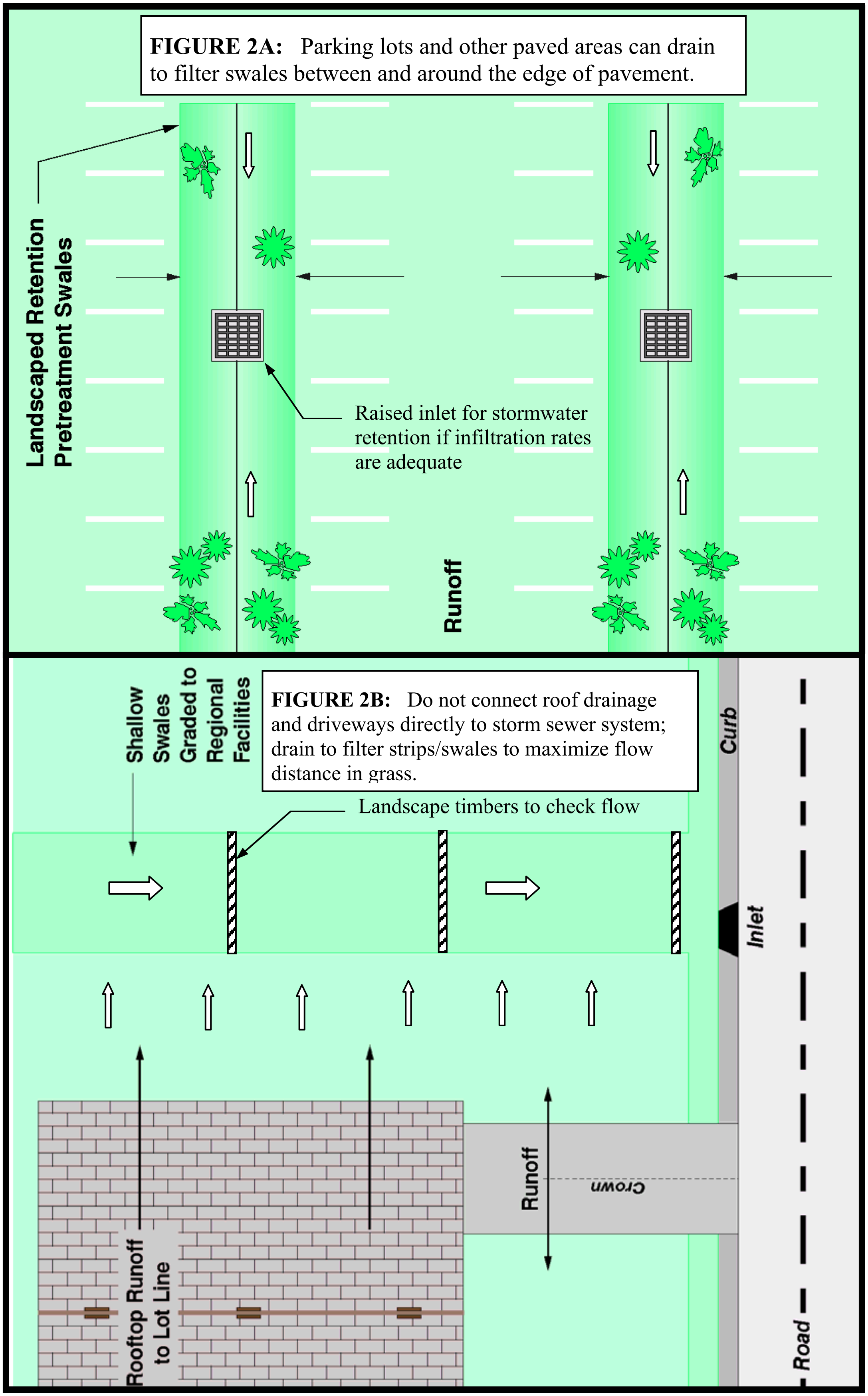


Figure F-03-2
Examples of Filter Strips and Swales

COLD TOLERANCE (winter color persistance)

High
- Creeping bentgrass
- Kentucky bluegrass
- Red fescue
- Colonial bentgrass
- Highland bentgrass
- Perennial ryegrass
- Tall fescue
- Weeping alkaligrass
- Dichondra
- Zoysiagrass
- Common bermudagrass
- Hybrid bermudagrass
- Kikuyugrass
- Seashore paspalum
- St. Augustinegrass

Low

HEAT TOLERANCE

High
- Zoysiagrass
- Hybrid bermudagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Dichondra
- Creeping bentgrass
- Kentucky bluegrass
- Highland bentgrass
- Perennial ryegrass
- Colonial bentgrass
- Weeping alkaligrass
- Red fescue

Low

MOWING HEIGHT ADAPTATION

High cut
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Weeping alkaligrass
- St. Augustinegrass
- Common bermudagrass
- Dichondra
- Kikuyugrass
- Colonial bentgrass
- Highland bentgrass
- Zoysiagrass
- Seashore paspalum
- Hybrid bermudagrass
- Creeping bentgrass

Low Cut

DROUGHT TOLERANCE

High
- Hybrid bermudagrass
- Zoysiagrass
- Common bermudagrass
- Seashore paspalum
- St. Augustinegrass
- Kikuyugrass
- Tall fescue
- Red fescue
- Kentucky bluegrass
- Perennial ryegrass
- Highland bentgrass
- Creeping bentgrass
- Colonial bentgrass
- Weeping alkaligrass
- Dichondra

Low

MAINTENANCE COST AND EFFORT

High
- Creeping bentgrass
- Dichondra
- Hybrid bermudagrass
- Kentucky bluegrass
- Colonial bentgrass
- Seashore paspalum
- Perennial ryegrass
- St. Augustinegrass
- Highland bentgrass
- Zoysiagrass
- Tall fescue
- Common bermudagrass
- Kikuyugrass

Low

Taken from California Cooperative Agricultural Extension (1984)

Figure F-03-3
Characteristics of Various Types of Grass

References

American Society of Civil Engineers and Water Environment Federation. "Urban Runoff Quality Management." WEF Manual of Practice No. 23. ASCE Manual and Report on Engineering Practice No. 87. WEF, Virginia and ASCE, VA, 1998.

California Cooperative Agricultural Extension (CCAE), *Effluent Water for Turfgrass Irrigation*, Bulletin 21500, 1991.

California Cooperative Agricultural Extension (CCAE), *Selecting the Best Turf Grass*, Leaflet 2589, 1984.

California Cooperative Agricultural Extension (CCAE), *Turfgrass Water Conservation*, Bulletin 21405, 1985.

Camp Dresser & McKee, *Sevenmile Creek Basin Pilot Stormwater Quality Master Plan*, Report to Metropolitan Nashville and Davidson County, Tennessee, February 2000.

Camp Dresser & McKee, Larry Walker Associates, Uribe & Associates, Resources Planning Associates, *Industrial/Commercial Handbook, California Storm Water Best Management Practice Handbooks,* for the California Storm Water Quality Task Force (SWQTF), March 1993.

Camp Dresser & McKee, Larry Walker Associates, Uribe & Associates, Resources Planning Associates, *Municipal Handbook, California Storm Water Best Management Practice Handbooks,* for the California Storm Water Quality Task Force (SWQTF), March 1993.

Camp Dresser & McKee, Woodward-Clyde, Aguilar Engineering, Psomas & Associates, MK Centennial, *Construction Contractors Guide and Specifications, Caltrans Storm Water Quality Handbooks*, prepared for the California Department of Transportation, 1997.

Debo, Thomas N. and Andrew J. Reese. *Municipal Storm Water Management*. Lewis Publishers, Boca Raton, FL, 1995.

Dillaha, T. A., J. H. Sherrard, and D. Lee. "Long-Term Effectiveness of Vegetative Filter Strips". *Water Environment and Technology*. November 1989.

Federal Highway Administration (FHWA), *Retention, Detention, and Overland Flow for Pollutant Removal of Highway Stormwater Runoff*, Draft Report FHWA/RD-89/203, 1989.

Groffman, P. M. et al. *Final Report: Narragansett Bay Project. An Investigation into Multiple Uses of Vegetated Buffer Strips*. University of Rhode Island.

Horner, R.R., *Biofiltration Systems for Storm Runoff Water Quality Control*, Washington State Department of Ecology, 1988.

IEP Inc., *Vegetated Buffer Strip Designation Method Guidance Manual*, *Narragansett Bay Project*, prepared for USEPA and Rhode Island Department of Environmental Management, 1991.

Kamber Engineering. "Draft, Construction Site Stormwater Discharge Control: An Inventory of Current Practices". Prepared for US Environmental Protection Agency, Washington, D.C. EPA Contract No. 68-C8-0052, 1991.

King County Department of Natural Resources (KCDNR). *Surface Water Design Manual*, 1998.

Lager, J.A., W.G. Smith, and G. Tchobanoglous, *Catchbasin Technology Overview and Assessment*, USEPA 600/2-77-051, May 1977.

Maryland Department of the Environment. *Standards and Specifications for Infiltration Practices*. Baltimore, MD, 1984.

Metropolitan Washington Council of Governments (MWCOG), *A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone*, Publication #92705, March 1992.

Phillips, N., *Decisionmaker's Stormwater Handbook*. Terrene Institute, Washington, D.C., 1992.

Roesner, L.A., J. Aldrich, J. Hartigan, et.al., *Urban Runoff Quality Management – WEF Manual of Practice No. 23 / ASCE Manual and Report on Engineering Practice No. 87*, 1998.

Sacramento County Cooperative Agricultural Extension*, Water Efficient Landscape Plants*, written by Pamela S. Bone, Environmental Horticultural Notes.

Schueler, Thomas R. et al. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*. Metropolitan Washington Council of Governments, 1987.

Schueler, Thomas R. et al. *A Current Assessment of Urban Best Management Practices Techniques for Reducing Non-Point Source Pollution in the Coastal Zone*. Metropolitan Washington Council of Governments, Washington, D.C., 1992.

Seattle (municipality), *Pollutant Removal Effectiveness of a Designed Grassy Swale in Mountlake Terrace, Washington,* (draft) 1992.

Southeastern Wisconsin Regional Planning Commission. *Technical Report Number 31: Costs of Urban Nonpoint Water Pollution Control Measures*. Waukesha, WI, 1991.

Tennessee Exotic Pest Plant Council, *Landscaping with Native Plants – Middle Tennessee Central Basin and Highland Rim*, May 1998.

Tennessee Department of Environment and Conservation (TDEC), *Tennessee Erosion & Sediment Control Handbook – A Guide for Protection of State Waters through the use of Best Management Practices during Land Disturbing Activities*, March 2002.

Tollner, E.W., B.J. Barfield, C.T. Hann, and T.Y. Kao, *Suspended Sediment Filtration Capacity of Simulated Vegetation*, Transactions of American Society of Agricultural Engineers, 19(4), pages 678-682, 1976.

United States Department of Agriculture, Natural Resources Conservation Service, Champaign, IL. *Illinois Urban Manual: A Technical Manual Designed for Urban Ecosystem Protection and Enhancement*, 1995.

Virginia Department of Conservation and Recreation (VDCR). *Virginia Stormwater Handbook*. First Edition, Volume 1. Division of Soil and Water Conservation, Richmond, VA, 1999.

Washington Department of Ecology, *Stormwater Management Manual for the Puget Sound Basin*, *Urban Land Use BMPs,* Technical Manual Volume IV, Publication #91-75, February 1992.

Woodward-Clyde Federal Services. *Draft Summary of Urban BMP Cost and Effectiveness Data for 6217(g) Guidance*. Post Construction Stormwater Runoff Treatment. Prepared for the US Environmental Protection Agency, Office of Water, 1991.

Youngner, V.B., J.H. Madison, M.H. Kimball, and W.B. Davis, *Climatic Zones for Turfgrass in California*, California Agriculture, Volume 16, Number 7, page 2, 1962.