

**VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 9****BIORETENTION****VERSION 1.9
March 1, 2011****SECTION 1: DESCRIPTION**

Individual bioretention areas can serve highly impervious drainage areas less than two (2) acres in size. Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary component of a bioretention practice is the filter bed, which has a mixture of sand, soil, and organic material as the filtering media with a surface mulch layer. During storms, runoff temporarily ponds 6 to 12 inches above the mulch layer and then rapidly filters through the bed. Normally, the filtered runoff is collected in an underdrain and returned to the storm drain system. The underdrain consists of a perforated pipe in a gravel layer installed along the bottom of the filter bed. A bioretention facility with an underdrain system is commonly referred to as a *Bioretention Filter*.

Bioretention can also be designed to infiltrate runoff into native soils. This can be done at sites with permeable soils, a low groundwater table, and a low risk of groundwater contamination. This design features the use of a “partial exfiltration” system that promotes greater groundwater recharge. Underdrains are only installed beneath a portion of the filter bed, above a stone “sump” layer, or eliminated altogether, thereby increasing stormwater infiltration. A bioretention facility without an underdrain system, or with a storage sump in the bottom is commonly referred to as a *Bioretention Basin*.

usually in commercial or institutional areas. Inflow can be either sheetflow or concentrated flow. Bioretention basins may also be distributed throughout a residential subdivision, but ideally they should be located in common area or within drainage easements, to treat a combination of roadway and lot runoff.

Urban Bioretention. These are structures such as expanded tree pits, curb extensions, and foundation planters located in ultra-urban developed areas such as city streetscapes. Please refer to **Appendix 9-A** of this specification for design criteria for Urban Bioretention.



Figure 9.1. A typical Bioretention Filter treating a commercial rooftop

The major design goal for bioretention is to maximize runoff volume reduction and nutrient removal. To this end, designers may choose to go with the baseline design (Level 1) or choose an enhanced design (Level 2) that maximizes nutrient and runoff reduction. If soil conditions require an underdrain, bioretention areas can still qualify for the Level 2 design if they contain a stone storage layer beneath the invert of the underdrain.

Both stormwater quality and quantity credits are accounted for in the Runoff Reduction Method (RRM) spreadsheet. The water quality credit represents an annual load reduction as a combination of the annual reduction of runoff volume (40% and 80% from Level 1 and Level 2 designs, respectively) and the reduction in the pollutant event mean concentration (EMC) (25% and 50% from Level 1 & 2 designs, respectively).

To compute the water quantity reduction for larger storm events, the designer can similarly use the RRM spreadsheet or, as an option, the designer may choose to compute the adjusted curve number associated with the retention storage using the TR-55 Runoff Equations, as noted in **Table 9.1**. The adjusted curve number is then used to compute the peak discharge for the required design storms.

Tables 9.2 and 9.3 outline the Level 1 and 2 design guidelines for the two scales of bioretention design.

VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 8**INFILTRATION PRACTICES**VERSION 1.9
March 1, 2011**SECTION 1: DESCRIPTION**

Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to exfiltrate into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants. Infiltration practices have the greatest runoff reduction capability of any stormwater practice and are suitable for use in residential and other urban areas where *measured* soil permeability rates exceed 1/2 inch per hour. To prevent possible groundwater contamination, infiltration should not be utilized at sites designated as stormwater hotspots.

SECTION 2: PERFORMANCE

When used appropriately, infiltration has a very high runoff volume reduction capability, as shown in **Table 8.1**.

**VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 3****GRASS CHANNELS****VERSION 1.9
March 1, 2011****SECTION 1: DESCRIPTION**

Grass channels can provide a modest amount of runoff filtering and volume attenuation within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets and pipes. The performance of grass channels will vary depending on the underlying soil permeability (Table 1). Grass channels, however, are not capable of providing the same stormwater functions as dry swales as they lack the storage volume associated with the engineered soil media (see Specification No. 10). Their runoff reduction performance can be boosted when compost amendments are added to the bottom of the swale (See Stormwater Design Specification No. 4). Grass channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography and soils permit. Grass channels can also be used to treat runoff from the managed turf areas of turf-intensive land uses, such as sports fields and golf courses, and drainage areas with combined impervious and turf cover (e.g., roads and yards).

**VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 10****DRY SWALES****VERSION 1.9
March 1, 2011****SECTION 1: DESCRIPTION**

Dry swales are essentially bioretention cells that are shallower, configured as linear channels, and covered with turf or other surface material (other than mulch and ornamental plants).

The dry swale is a soil filter system that temporarily stores and then filters the desired Treatment Volume (T_v). Dry swales rely on a pre-mixed soil media filter below the channel that is similar to that used for bioretention. If soils are extremely permeable, runoff infiltrates into underlying soils. In most cases, however, the runoff treated by the soil media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. Dry swales may appear as simple grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with turf grass, tall meadow grasses, decorative herbaceous cover, or trees.

VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 7

PERMEABLE PAVEMENT

VERSION 1.8
March 1, 2011

SECTION 1: DESCRIPTION

Permeable pavements are alternative paving surfaces that allow stormwater runoff to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated. A variety of permeable pavement surfaces are available, including **pervious concrete**, **porous asphalt** and permeable **interlocking concrete pavers**. While the specific design may vary, all permeable pavements have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom (See **Figure 7.1** below).

The thickness of the reservoir layer is determined by both a structural and hydrologic design analysis. The reservoir layer serves to retain stormwater and also supports the design traffic loads for the pavement. In low-infiltration soils, some or all of the filtered runoff is collected in an underdrain and returned to the storm drain system. If infiltration rates in the native soils permit, permeable pavement can be designed without an underdrain, to enable full infiltration of runoff. A combination of these methods can be used to infiltrate a portion of the filtered runoff.

VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 1

ROOFTOP (IMPERVIOUS SURFACE) DISCONNECTION

VERSION 1.9
March 1, 2011



SECTION 1: DESCRIPTION

This strategy involves managing runoff close to its source by intercepting, infiltrating, filtering, treating or reusing it as it moves from the impervious surface to the drainage system. Two kinds of disconnection are allowed: (1) simple disconnection, whereby rooftops and/or on-lot residential impervious surfaces are directed to pervious areas, and (2) disconnection leading to an alternative runoff reduction practice(s) adjacent to the roof (**Figure 1.1**). Alternative practices can use less space than simple disconnection and can enhance runoff reduction rates. Applicable practices include:

- Soil compost amended filter path [Stormwater (SW) Design Spec 4]
- Infiltration by micro-infiltration practice (dry wells or french drains, SW Design Spec 8)
- Filtration by rain gardens or micro-bioretenion (SW Design Spec 9)
- Storage and reuse with a cistern or other vessel (rainwater harvesting) (SW Design Spec 6)
- Storage and release in a stormwater planter. (SW Design Spec 9, Appendix A)

VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 2

SHEET FLOW TO A VEGETATED FILTER STRIP OR CONSERVED OPEN SPACE

VERSION 1.9
March 1, 2011



SECTION 1. DESCRIPTION

Filter strips are vegetated areas that treat sheet flow delivered from adjacent impervious and managed turf areas by slowing runoff velocities and allowing sediment and attached pollutants to settle and/or be filtered by the vegetation. The two design variants of filter strips are (1) *Conserved Open Space* and (2) designed *Vegetated Filter Strips*. The design, installation, and management of these design variants are quite different, as outlined in this specification.

In both instances, stormwater must enter the filter strip or conserved open space as sheet flow. If the inflow is from a pipe or channel, an engineered level spreader must be designed in accordance with the criteria contained herein to convert the concentrated flow to sheet flow.

SECTION 2. PERFORMANCE

With proper design and maintenance, these practices can provide relatively high runoff reduction as shown in **Table 2.1**.

VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 4

SOIL COMPOST AMENDMENT

VERSION 1.8
March 1, 2011



SECTION 1: DESCRIPTION

Soil restoration is an Environmental Site Design (ESD) practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance of downspout disconnections, grass channels, and filter strips (**Table 4.1**).

**VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 5****VEGETATED ROOF**

**Version 2.3
March 1, 2011**

**SECTION 1: DESCRIPTION**

Vegetated roofs (also known as *green roofs*, *living roofs* or *ecoroofs*) are alternative roof surfaces that typically consist of waterproofing and drainage materials and an engineered growing media that is designed to support plant growth. Vegetated roofs capture and temporarily store stormwater runoff in the growing media before it is conveyed into the storm drain system. A portion of the captured stormwater evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites.

There are two different types of vegetated roof systems: *intensive* vegetated roofs and *extensive* vegetated roofs. Intensive systems have a deeper growing media layer that ranges from 6 inches to 4 feet thick, which is planted with a wider variety of plants, including trees. By contrast, extensive systems typically have much shallower growing media (2 to 6 inches), which is planted with carefully selected drought tolerant vegetation. Extensive vegetated roofs are much lighter and less expensive than intensive vegetated roofs and are recommended for use on most development and redevelopment sites.

**VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 11****WET SWALE****VERSION 1.9
March 1, 2011****SECTION 1: DESCRIPTION**

Wet swales can provide runoff filtering and treatment within the conveyance system and are a cross between a wetland and a swale. These linear wetland cells often intercept shallow groundwater to maintain a wetland plant community. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions (typically less than 6 inches deep).

**VIRGINIA DEQ STORMWATER
DESIGN SPECIFICATION No. 6****RAINWATER HARVESTING****VERSION 1.9.5
March 1, 2011****SECTION 1: DESCRIPTION**

Rainwater harvesting systems intercept, divert, store and release rainfall for future use. The term rainwater harvesting is used in this specification, but it is also known as a cistern or rainwater harvesting system. Rainwater that falls on a rooftop is collected and conveyed into an above- or below-ground storage tank where it can be used for non-potable water uses and on-site stormwater disposal/infiltration. Non-potable uses may include flushing of toilets and urinals inside buildings, landscape irrigation, exterior washing (e.g. car washes, building facades, sidewalks, street sweepers, fire trucks, etc.), fire suppression (sprinkler) systems, supply for chilled water cooling towers, replenishing and operation of water features and water fountains, and laundry, if approved by the local authority. Replenishing of pools may be acceptable if special measures are taken, as approved by the appropriate regulatory authority.

In many instances, rainwater harvesting can be combined with a secondary (down-gradient) runoff reduction practice to enhance runoff volume reduction rates and/or provide treatment of overflow from the rainwater harvesting system. Some candidate secondary practices include: