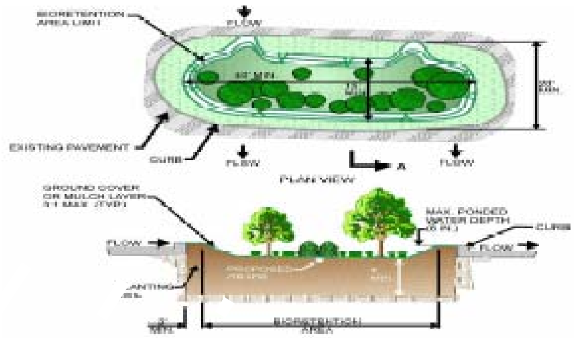
ACTIVITY: Bioretention Basin (Rain Gardens) | F – 05



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

The bioretention basin, or "rain garden", was developed by the Prince George's County, Maryland Department of Environmental Protection. It consists of seven components: The grass buffer strip; the ponding area; the surface mulch and planting soil; the sand bed; the organic layer; the plant material; and the infiltration chambers. Bioretention basins are planting areas installed in shallow basins, where stormwater runoff is filtered through the various layers mentioned above. Biological and chemical reactions occur around the roots of the plants, and water infiltrates into the soil below. Bioretention basins enhance stormwater quality through adsorption, filtration, volitization, ion exchange, microbial soil processes, evapotranspiration, nutrient uptake in plants, and decomposition prior to exfiltration into the surrounding soil mass. Such basins also enhance infiltration and groundwater recharge, thus reducing the volume of stormwater runoff.

Selection Criteria

The primary use of this BMP is for water quality control, although they provide some protection against flooding and streambank erosion, depending on the size of the basin. Bioretention basins are suitable for use at any site where the subsoil provides reasonable infiltration, and the water table is sufficiently lower than the design depth of the basin. These basins are usually designed for drainage areas of less than one acre.

Areas that have mature trees that would need to be removed, have slopes greater than 20%, and are above or close to an unstable soil strata are not appropriate areas for rain gardens. In addition, this BMP will not function properly in sites subjected to continuous or frequent flows, as the sand filter will not have time to dry and aerate.

Design and Sizing Considerations

Rain gardens are often located in the following areas:

- Landscaping islands
- Small drainage areas
- Highly impervious areas, such as parking lots

Properly designed rain gardens replicate a dense forest floor, through the use of certain plants, mulches, and nutrient-rich soils. Since rain gardens often have aesthetic value, it is recommended that the designer has working knowledge and design skills of indigenous horticultural practices, such as a landscape architect.

The size of the facility is based on the amount of impervious surface in the drainage area. For example, for facilities treating the first 0.5 inches of runoff from the impervious areas in the catchment, the surface area of the rain garden is typically small, but should be a minimum of 2.5% of the impervious area. For facilities treating the first 1 inch, the surface area should be a minimum of 5% of the impervious area.

Bioretention areas will typically need to be used in conjunction with another structural control to provide channel protection as well as overbank flood protection. It is important to ensure that a bioretention area safely bypasses higher flows.

Other design elements are as follows:

- The minimum width and length of the rain garden is 10 feet by 15 feet.
- Maximum contributing drainage area is 5 acres. 0.5 to 2 acres are preferred. Multiple rain gardens can be used for larger drainage areas.
- The site slope should be no more than 6%.
- 2 feet distance is recommended between the bioretention facility and the seasonally high water table.
- Rain gardens typically require 5 feet of head.
- The rain garden should be designed to completely drain within 48 hours. They should not be used on sites with a continuous flow from groundwater, sump pumps, or other sources.
- Bioretention area locations should be integrated into the site planning process, and aesthetic considerations should be taken into account in their siting and design. Elevations must be carefully worked out to ensure that the desired runoff flow enters the facility with no more than the maximum design depth.
- The maximum recommended ponding depth of the bioretention areas is 6 inches.

Grass Buffer Strip

The grass buffer strip pretreats the runoff. It filters particles from the stormwater runoff by reducing the velocity. Often, the buffer strip is enhanced with a pea gravel ribbon, to spread the runoff and increase infiltration through the strip. The minimum filter strip length should be 10 feet.

Sand Bed

The sand bed further slows the runoff, and spreads the runoff over the entire basin. As the water infiltrates into the sand, the water is filtered. Drainage must be designed to flow away from the sand bed, in order to guard against anaerobic conditions in the planting area, and provide exfiltration from the basin. The sand bed should be 12 to 18 inches thick. Sand should be clean and have less than 15% silt or clay content.

Ponding Area

The ponding area detains runoff waiting to be treated. It also allows for pre-settling of particulates in the stormwater runoff. The ponding area should be constructed in accordance with Section P-01, Detention Basin. The pond should be equipped with an overflow structure, with its invert elevation 0.5 feet above the organic layer.

Organic Layer

The organic, or mulch, layer filters the pollutants in the runoff, protects the soil from eroding, and provides an environment for microbes to degrade pollutants, such as petroleum-based solvents. The mulch layer may consist of either fine shredded hardwood mulch or shredded hardwood chips, and should be applied uniformly at a depth of 2-3 inches. Grass clippings are not suitable, since they contain excessive quantities of nitrogen that would limit the capability of the rain garden to filter nitrogen in stormwater runoff.

Planting Soil Layer

This layer stores water and nutrients for the plants. Clay particles in the layer adsorb heavy metals, hydrocarbons, and other pollutants. The planting soil bed must be at least 4 feet in depth. Planting soils should be sandy loam, loamy sand, or loam texture.

Plant Material

The plant species should be selected with great care, depending on their ability to treat pollutants through their interaction with other plants, soil, and the organic layer. Other factors to consider when choosing vegetation include climate of the site, shape, growth rates, maintenance requirements, size, hardiness, and type of root system. A variety of plants should be selected, in order to combat insects and disease, and increase envirotranspiration and aesthetic beauty.

Infiltration Chambers

Vented infiltration chambers provide exfiltration through open-bottomed cavities, decrease ponding time above the basin, and aerate the filter media between storms through the cavities and vents to the surface. By providing a valve equipped drawdown drain to daylight, the basin can be converted into a soil media filter should exfiltration surface failures occur.

Underdrain Collection System

The underdrain collection system is equipped with a 6-inch perforated PVC pipe (AASHTO M 252) in an 8-inch gravel layer. The pipe should have 3/8-inch perforations, spaced at 6-inch centers, with a minimum of 4 holes per row. The pipe is spaced at a maximum of 10 feet on center and a minimum grade of 0.5% must be maintained. A permeable filter fabric is placed between the gravel layer and the planting soil bed.

Construction/ Inspection Considerations

Sediment must be controlled during and after construction of the rain garden. Since infiltration is a key component of the rain garden, rain gardens are not recommended as the site of sediment detention basins during construction, as sediments tend to clog underlying soil strata. The bioretention basin will function more efficiently if the entire system is fully stabilized with vegetative and structural practices.

Use relatively light, tracked equipment during construction, to avoid compaction of the basin floor.

Maintenance

The structure and vegetation of the rain garden should be inspected and maintained frequently to assure proper function.

- Pests and weeds should be extracted from the facility.
- The facility should be frequently removed of debris and sediment.
- This BMP requires extensive landscaping.
- Rain gardens are not recommended for areas with steep slopes.

Cost Considerations

This BMP costs more than other filtering systems.

Limitations

A great deal of knowledge of engineering and horticultural knowledge is required for the successful implementation of this BMP. Maintenance and frequent inspections are also necessary.

Additional Information

Examples and applications of several different types of bioretention basins are illustrated on the following pages. The reader is referred to the Tennessee Erosion & Sediment Control Handbook for further discussion on vegetative practices (TDEC, 2002).

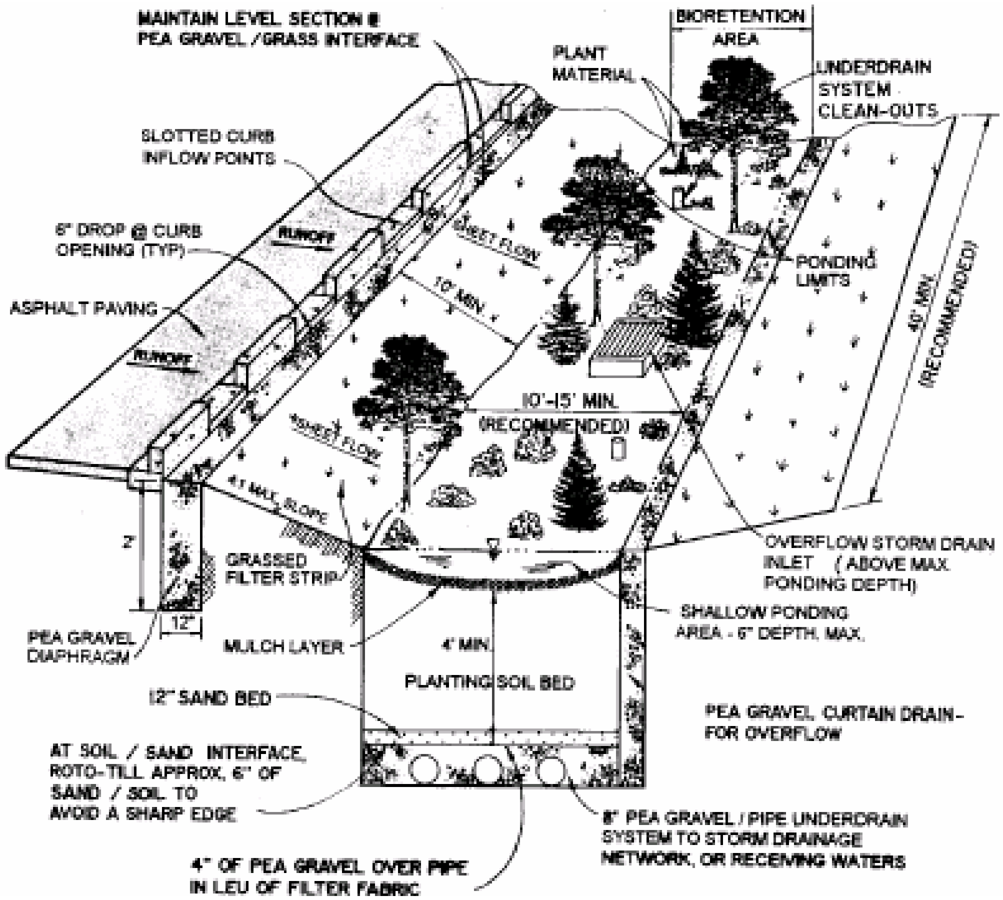


Figure F-05-1 – Bioretention Basin (Prince George's County, MD, 1993)

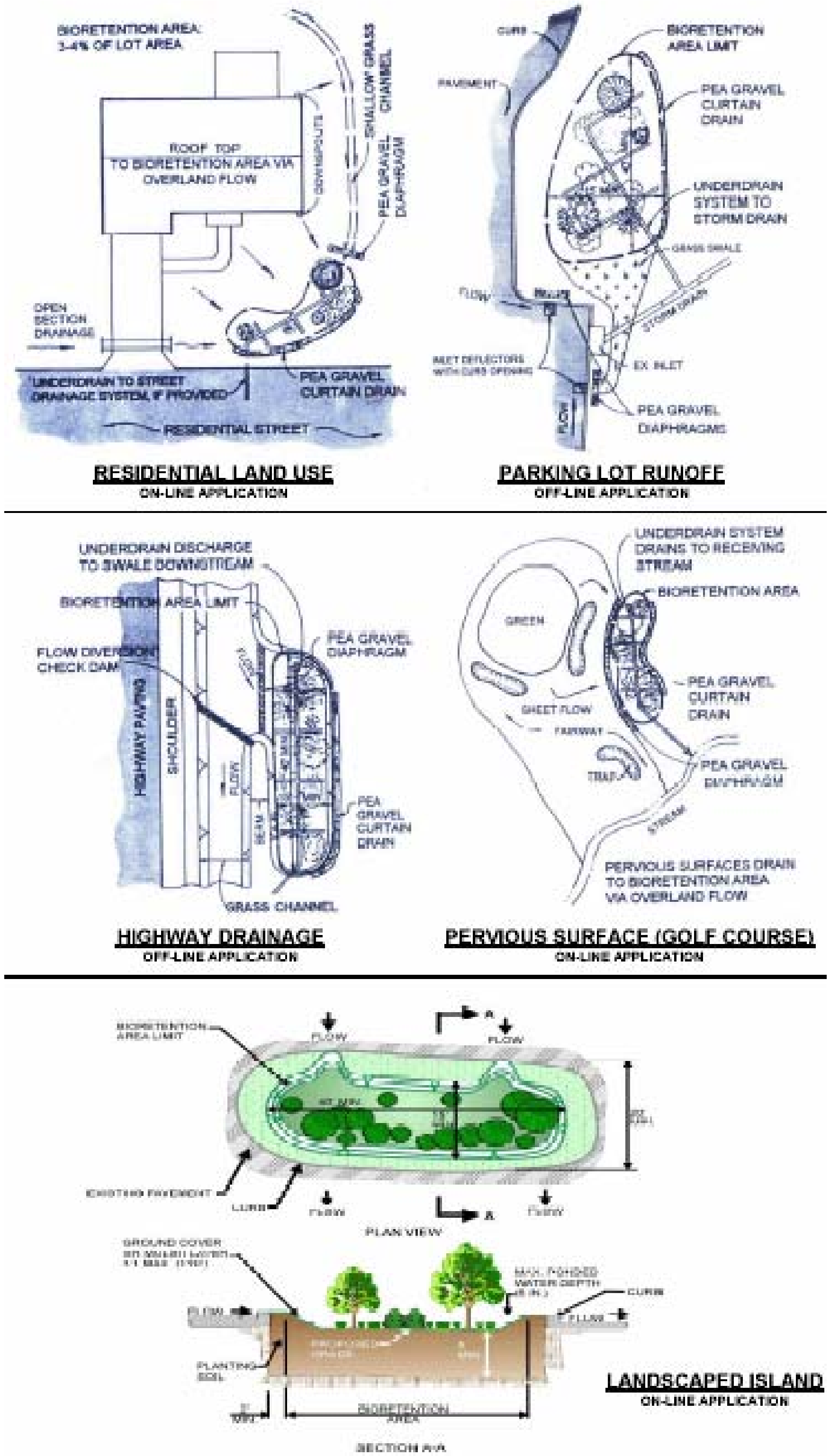


Figure F-05-2 – Bioretention Area Applications (ARC, 2001)

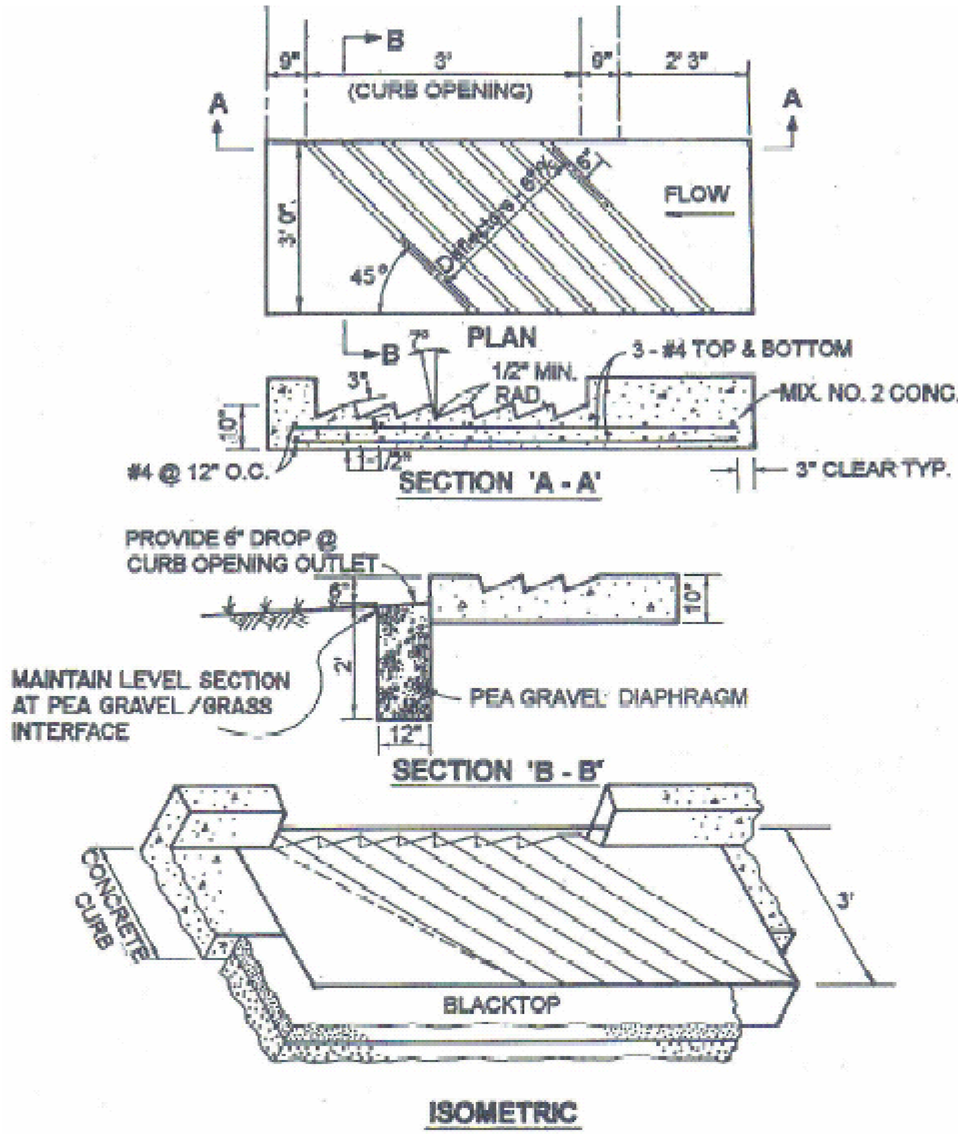


Figure F-05-3 – Typical Inlet Deflector (Prince George's County, MD, 1993)

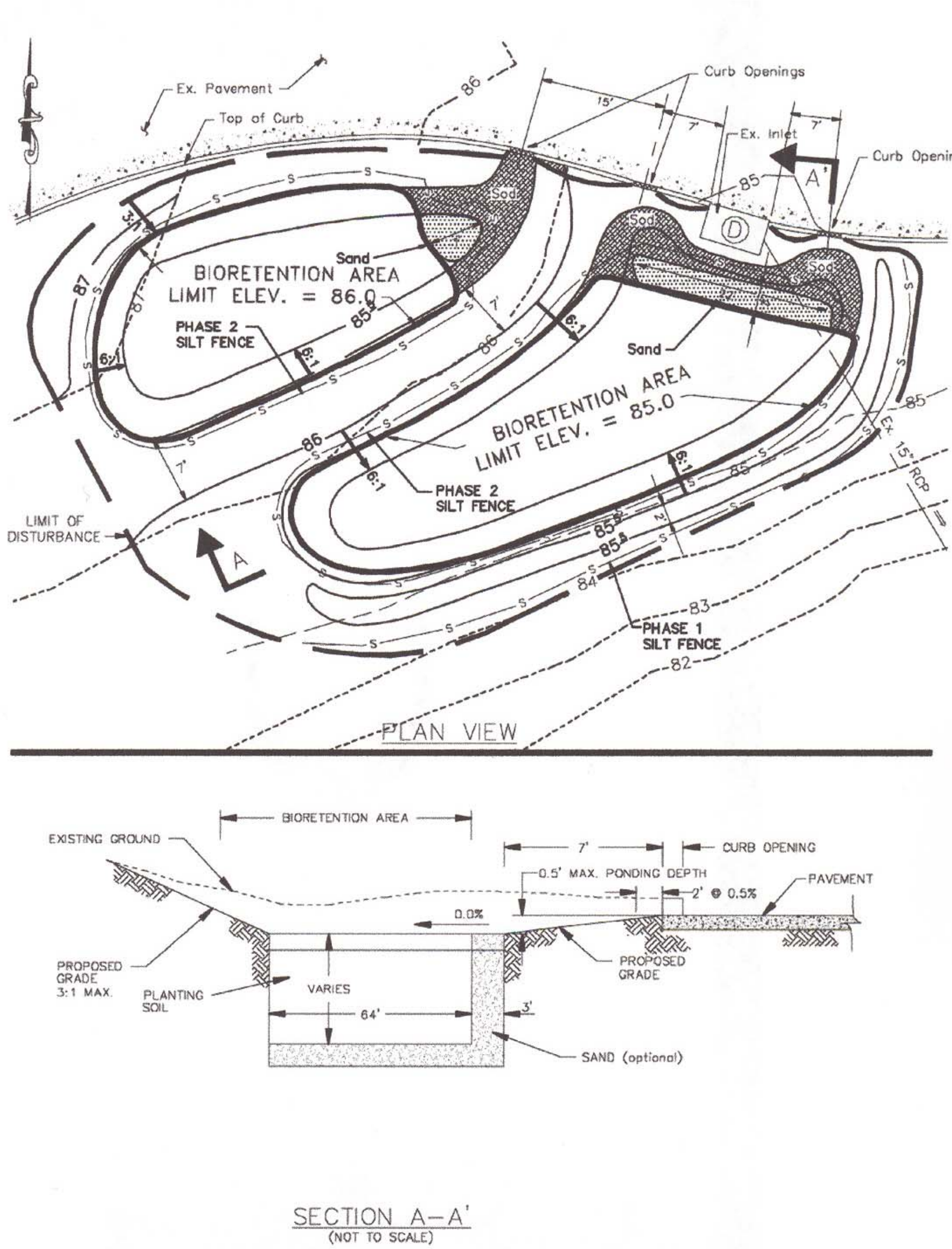
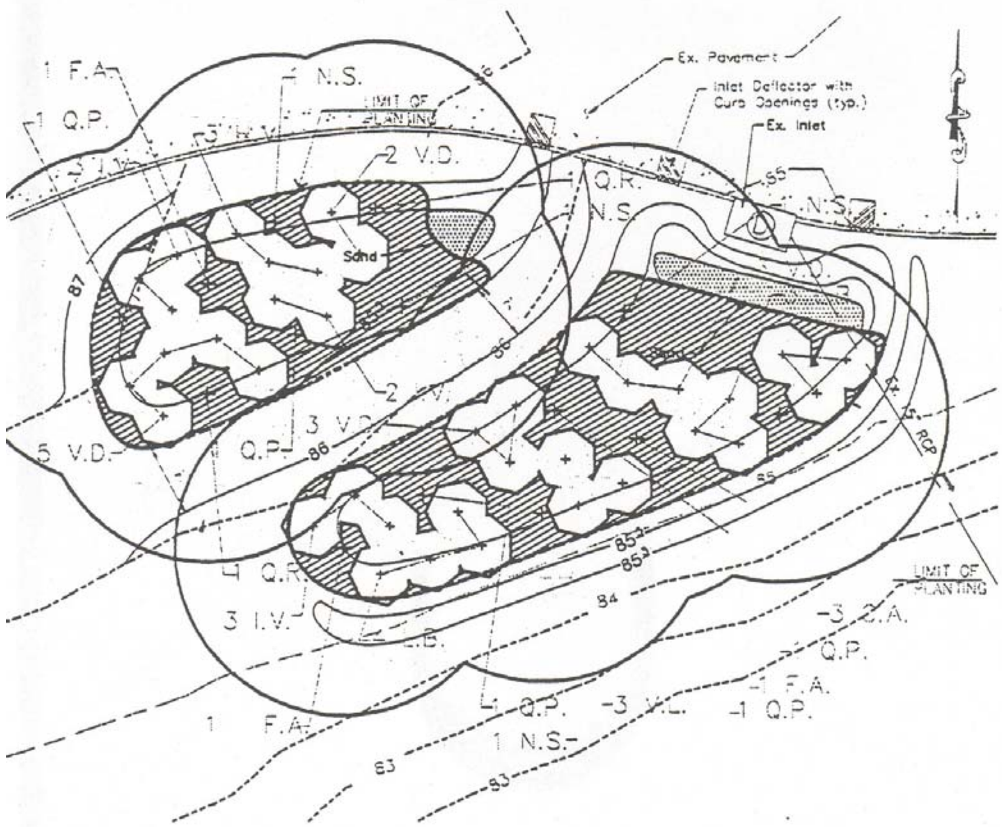


Figure F-05-4 – Grading Plan for Bioretention Basin (Virginia, 1999)



PLANTING PLAN LEGEND

HERBACEOUS COVER — SAND BED

TREE — SHRUB

TREE

SYMBOL	SCIENTIFIC NAME	COMMON NAME
F.A.	Fraxinus americana	white ash
N.S.	Nyssa sylvatica	black gum
Q.P.	Quercus palustris	pin oak
Q.R.	Quercus rubra	red oak

SHRUB

SYMBOL	SCIENTIFIC NAME	COMMON NAME
C.A.	Clethra alnifolia	sweet pepperbush
H.V.	Hamamelis virginica	witch hazel
I.V.	Ilex verticillata	winterberry
L.B.	Lindera benzoin	spicebush
V.D.	Viburnum dentatum	arrowwood
V.L.	Viburnum lentago	nannyberry

Figure F-05-5 – Sample Planting Plan for Bioretention Basin (Virginia, 1999)

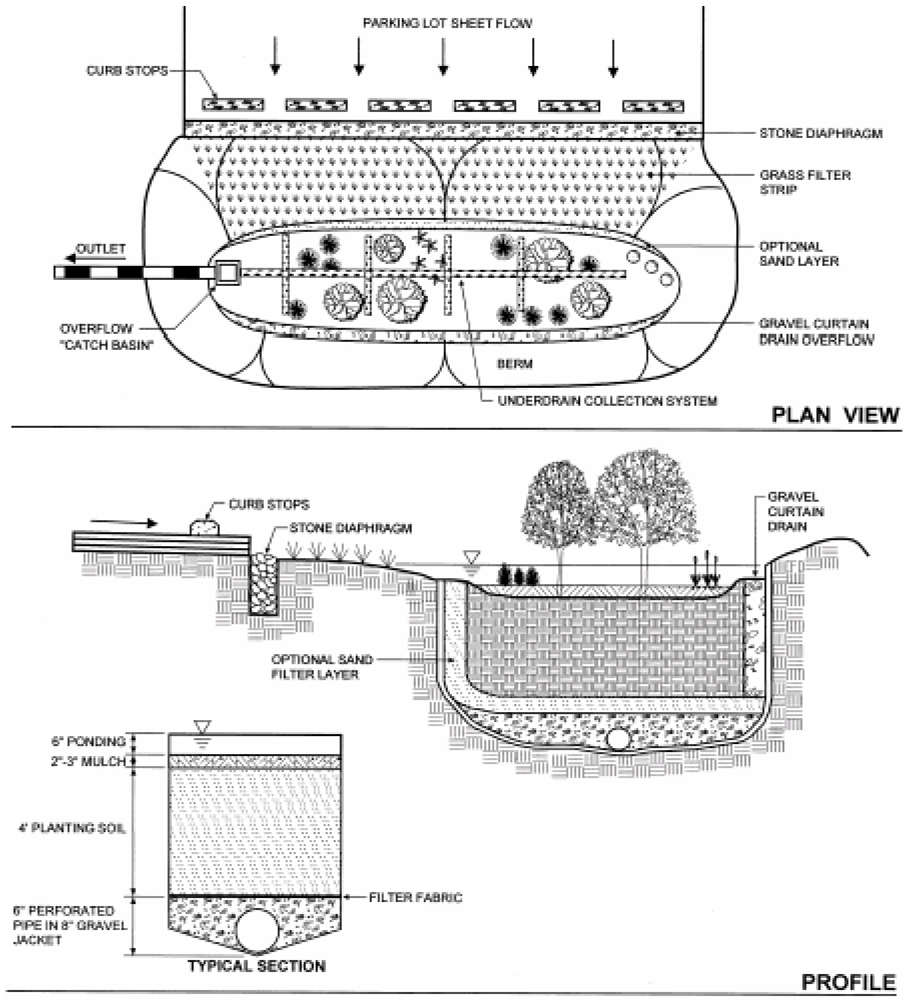


Figure F-05-6 – Typical On-line Bioretention Area (ARC, 2001)

References

Atlanta Regional Commission. *Georgia Stormwater Management Manual.* First edition, 2001.

Prince Georges County, Maryland. *Design Manual of Use of Bioretention in Stormwater Management*, Prince Georges County, 1993.

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.

Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation. *Virginia Stormwater Management Handbook*, First Edition, 1999.