5.6 BIORETENTION

5.6.1. INTRODUCTION

Rain garden and bioretention best management practices function as a soil and plant-based filtration device that remove pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a filtration bed, ponding area, organic or mulch layer, and plants. Exfiltration of the stored water in the bioretention area planting soil into the underlying soils occurs over a period of days when installed as an unlined system.

Figure 5-11 illustrates the basic components of the system and a picture of a bioretention system located in a parking lot island is presented in Figure 5-12. TSS removal efficiency = 89 percent.

Rain gardens and bioretention systems are very similar in their design and function. Both systems can be used in any land use type or for any site. For the purposes of this guidance manual, the main difference between the two systems is that a bioretention system uses engineered soils while rain gardens do not. However, rain gardens can incorporate slightly modified soils. Both systems can be designed with or without underdrains.

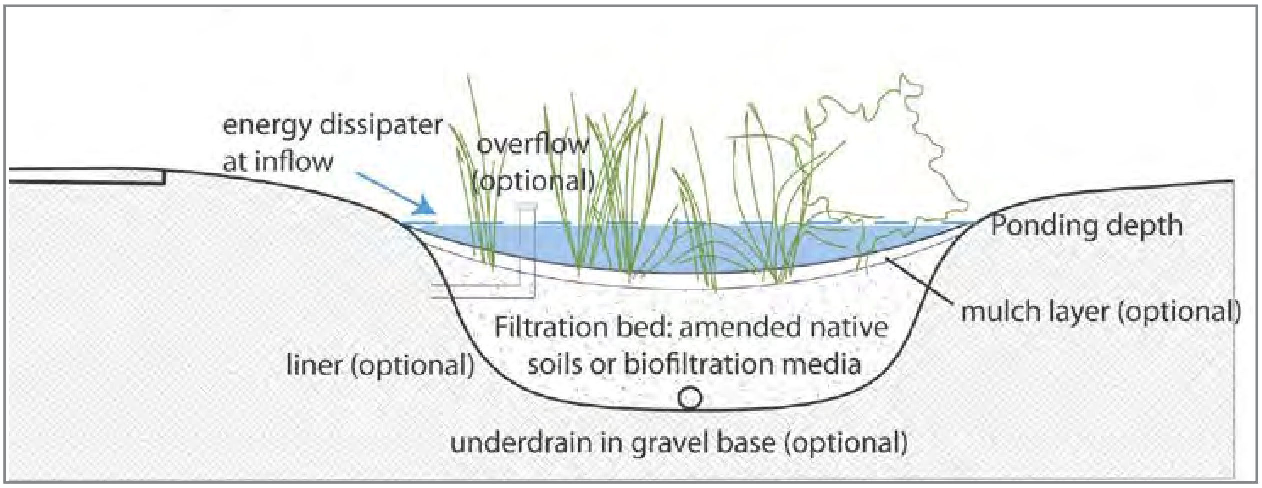


Figure 5-11: A diagram of the basic rain garden / bioretention system components including optional components.

Figure 5-12: Picture of a bioretention facility. (Photo courtesy of David Dods)

SELECTION CRITERIA

- Onsite systems serving a relatively small drainage areas are ideal since they can be incorporated into the site landscaping.
- Bioretention provides stormwater treatment that enhances the quality of downstream water bodies by temporarily storing runoff and releasing it over a period of days to the receiving water.
- Vegetation provides shade and wind breaks, absorbs noise, and improves an area's landscape.

LIMITATIONS

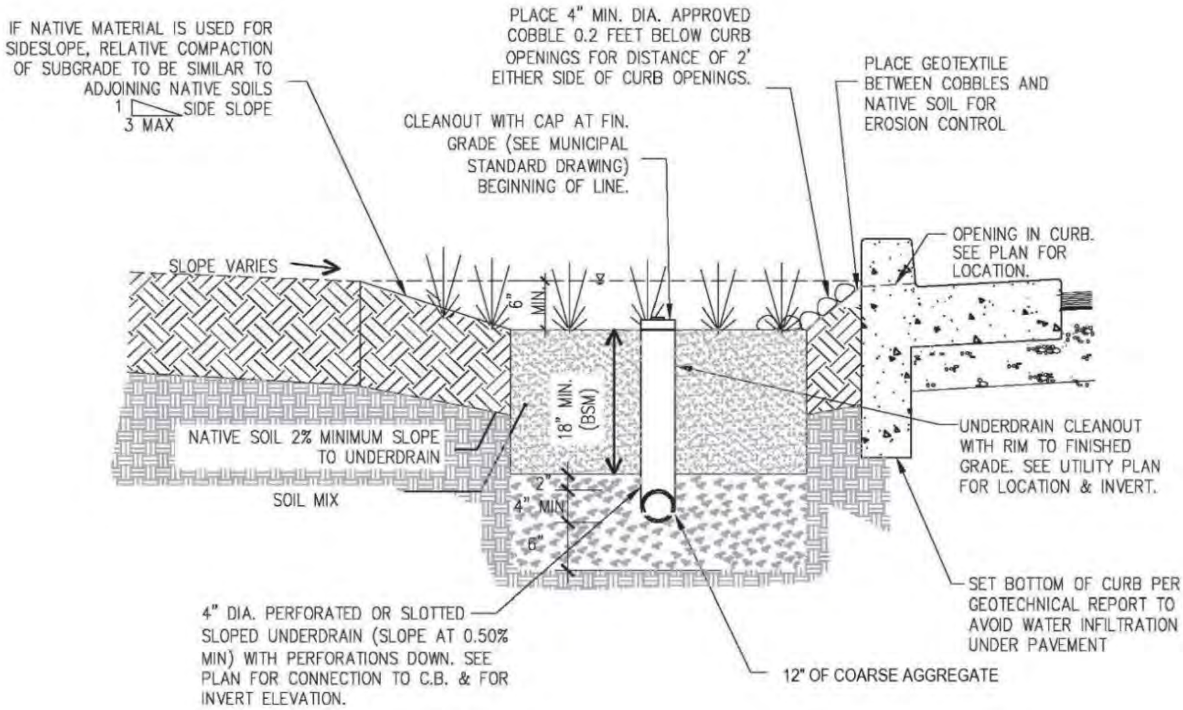
- Bioretention is not recommended for areas with slopes greater than 20% or where mature tree removal would be required since clogging may result, particularly if the facility receives runoff with high sediment loads.
- Unlined bioretention systems are not suitable at locations where the water table is within 4 feet of the ground surface and where the surrounding soil stratum is unstable.
- Inclusion of substantial amounts of compost in the filter media can substantially increase nutrients in the discharge.

5.6.2. BIORETENTION DESIGN GUIDANCE

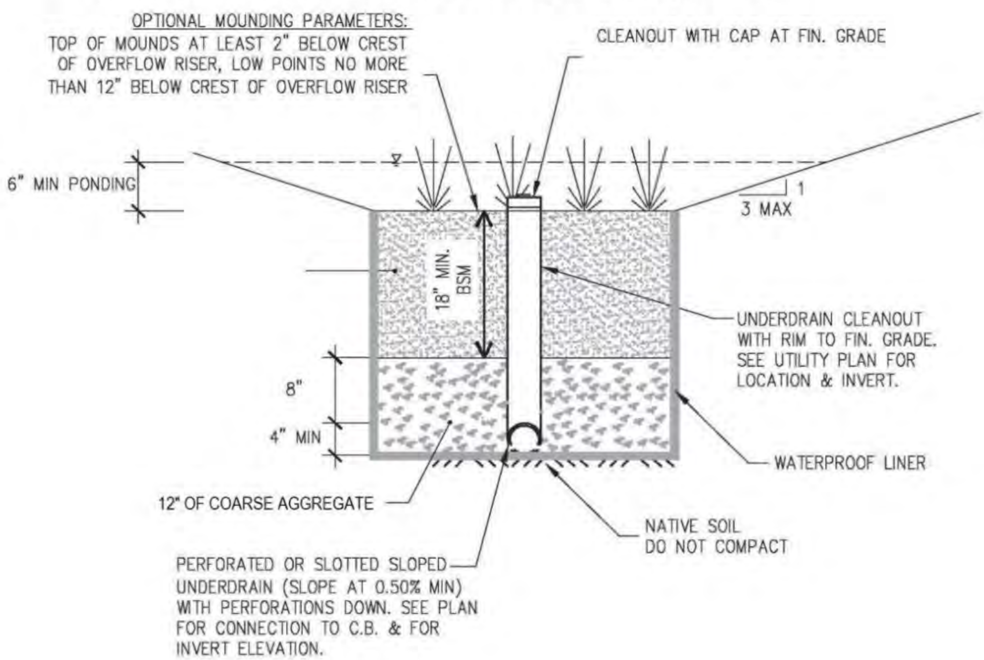
Bioretention facilities include inorganic and soil material in the filtration media to support vegetation. This allows these facilities to be integrated into site landscaping where they can provide unobtrusive treatment of stormwater runoff. The following design guidelines are appropriate for conventional systems in the public domain. The reader should be aware that there are proprietary versions of bioretention systems commonly called "tree box filters", which will provide the same level of pollutant removal. Design of these systems should follow manufacturer's recommendations.

A schematic of a bioretention system is provided in Figure 5 13, which illustrates recommended design components. The figure includes a grass filter strip for pretreatment of runoff to reduce sediment loading to the bioretention cell. While this is a useful component, it is not required and may not always be feasible depending on space constraints at the site. The "gravel curtain drain" and "optional sand filter layer" are not common or required.

Underdrains are required if the system is installed in soils with infiltration rates of less than 0.5 in/hr. A bridging layer of pea gravel should be placed between the planting media and gravel layer to prevent the planting media from migrating into the gravel layer below.



Cross-section of bioretention area showing inlet from pavement.



Cross section of lined bioretention area (Not to Scale)

Figure 5-13: Schematic diagram of a bioretention system.

1. ***Bioretention Sizing:*** The storage volume above the surface of the planting media should be sufficient to retain the volume of runoff from a 1.5-inch rainfall. Water depth over the media for the design storm should not exceed 18 inches.

2. ***Inlet Design:*** When siting bioretention facilities to intercept drainage, the designer should attempt to use a preferred "off-line" facility design. Off-line facilities are defined by the flow path through the facility. Any facility that utilizes the same entrance and exit flow path upon reaching pooling capacity is considered an off-line facility.

3. ***Media Properties:*** The filtration media should have a minimum thickness of 18 inches and should have a maximum clay content of less than 5%. Soil mixtures should be 75-90% sand; 0-4% organic matter; and 10-25% screened bulk topsoil. Soil should be a uniform mix, free of stones, stumps, roots, or other similar objects larger than two inches. No other materials or substances should be mixed or dumped within the bioretention facility that may be harmful to plant growth or prove a hindrance to planting or maintenance operations. Provide clean sand, free of deleterious materials. Sand may be composed of either ASTM C-33 (concrete sand) or ASTM C-144 (masonry sand). A good source of media is the material commonly used to construct golf course greens.

   The organic matter listed above should be carefully selected. Traditional options for organic matter include peat moss or shredded bark mulch.

   A high-flow geotextile fabric or bridging stone is required to separate the soil media from the washed river gravel under-drain. A layer of pea gravel, a minimum of three inches thick will typically provide this bridge. This is an alternative to high-flow geotextile fabric.

   Installation of filter media must be done in a manner that will ensure adequate filtration. After scarifying the invert area of the proposed facility, place soil. Avoid over compaction by allowing time for natural compaction and settlement. No additional manual compaction of soil is necessary. Rake soil material as needed to level out. For facilities designed with a liner, no scarification of the invert area is required.

4. ***Underdrains:*** Underdrains should be incorporated in all designs unless installed where infiltration rates exceed 0.5 in/hr. Underdrain piping should consist of a main collector pipe and two or more lateral branch pipes, each with a minimum diameter of 4 inches. Underdrains should be perforated with ¼ - ½ inch openings, 6 inches center to center. The pipes should have a minimum slope of 1% (1/8 inch per foot) and the laterals should be spaced at intervals of no more than 10 feet. Each individual underdrain pipe should have a cleanout access location. Ideally the cleanout access will be located in the facility embankment to reduce the possibility of bypass if the cleanout is damaged (see Figure 5-14 for example). All piping is to be Schedule 40 PVC.

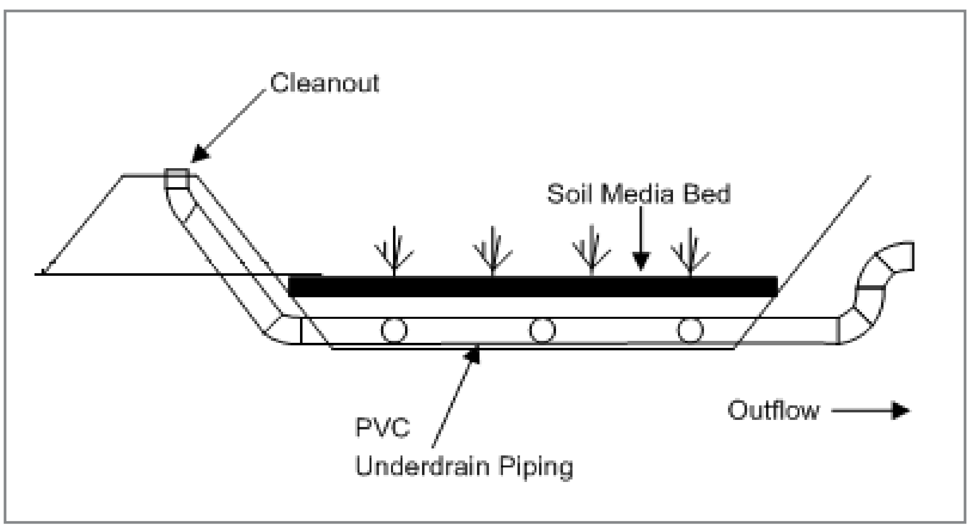


Figure 5-14: Detail of cleanout location.

5. ***Outlet:*** A raised outlet as illustrated in Figure 5-15 is optional. It has the potential advantage of reducing head-loss across the facility and providing a permanent pool that will supply additional water for plants during long dry periods.

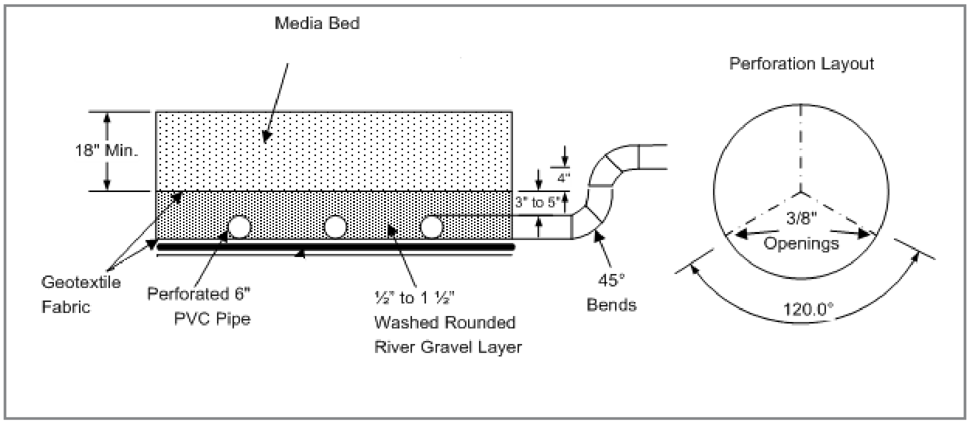


Figure 5-15: Illustration of optional outlet design.

6. ***Setbacks:*** When siting bioretention facilities, a 50-foot setback from septic fields should be provided. Setback from a foundation or slab should be 5 feet or greater.

7. ***Vegetation:*** Vegetation selected for the bioretention system should be climate-adapted and tolerant of frequent inundation during extended periods of wet weather. If a low maintenance landscape is desired, Bermuda grass throughout the basin will function as an appropriate vegetative cover. No additional plants are necessary.

8. ***Curb Cut Inlet:*** There are several design options for curb cuts, where curbs are used or modified, to allow runoff to enter the bioretention or rain garden system. Several of these (non-exclusive) options are diagrammed below. The last option in the figure below demonstrates inlet where a sediment/debris catchment area is included. These types of modifications can provide places to catch larger items such as aluminum cans or other floatables and can be designed with grates to allow water through the 'box' and into the rain garden. These curb inlets can also be designed to run level with the base of the bioretention system. In either method, they should be designed to be shovel-size for easy maintenance.

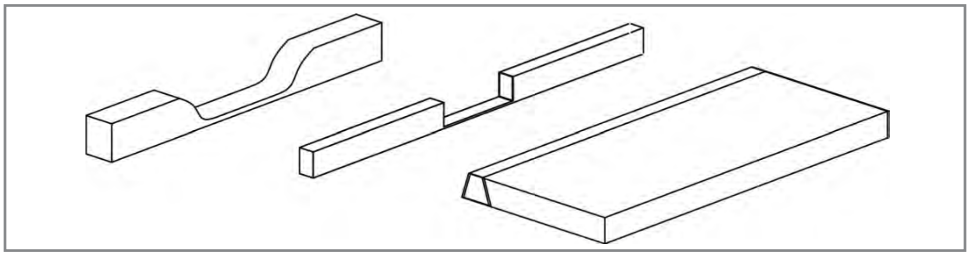


Figure 5-16: Curb cut options: smooth cut, hard cut and flush curb.

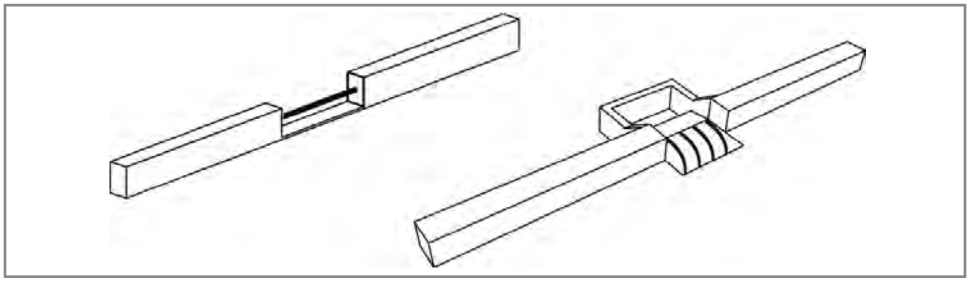


Figure 5-17: Curb cuts with optional sediment/trash screens.

9. ***Inlet Design:*** Where flows enter the treatment measure, allow change in elevation of 4 to 6 inches between the paved surface and the soil media elevation, so that vegetation growth or mulch build-up does not obstruct flow. Install cobbles, rocks or a small cement slab to dissipate flow energy where runoff enters the treatment measure.

10. ***Construction:*** During construction, minimize compaction of existing soils. Protect the area from construction traffic and site runoff. Additionally, runoff from un-stabilized areas should be diverted away from the facility.

11. ***Mulch:*** Provide a 3-inch layer of mulch to cover exposed soil between plantings.

TREE BOX FILTERS – ROADSIDE BIORETENTION

Tree box filters are bioretention systems enclosed in concrete boxes or other sub-surface structures that drain runoff from paved areas via a standard storm drain inlet structure. They consist of a precast concrete (or other) container, a mulch layer, bioretention media mix, observation and cleanout pipes, under-drain pipes, a street tree or large shrub, and a grate cover.

DESIGN REQUIREMENTS

The ponding area in Tree Box Filters shall be designed with a maximum ponding depth of 24" and the capacity to drain ponded water within 24 hours. Other criteria include:

- Plants can also be selected from those that would be used in traditional bioretention systems (See Appendix A).
- An underdrain pipe is required to drain the feature.
- A maximum of 75% of the void space volume may be counted for detention.
- Pre-manufactured systems must be installed in accordance with the manufacturer's instructions.

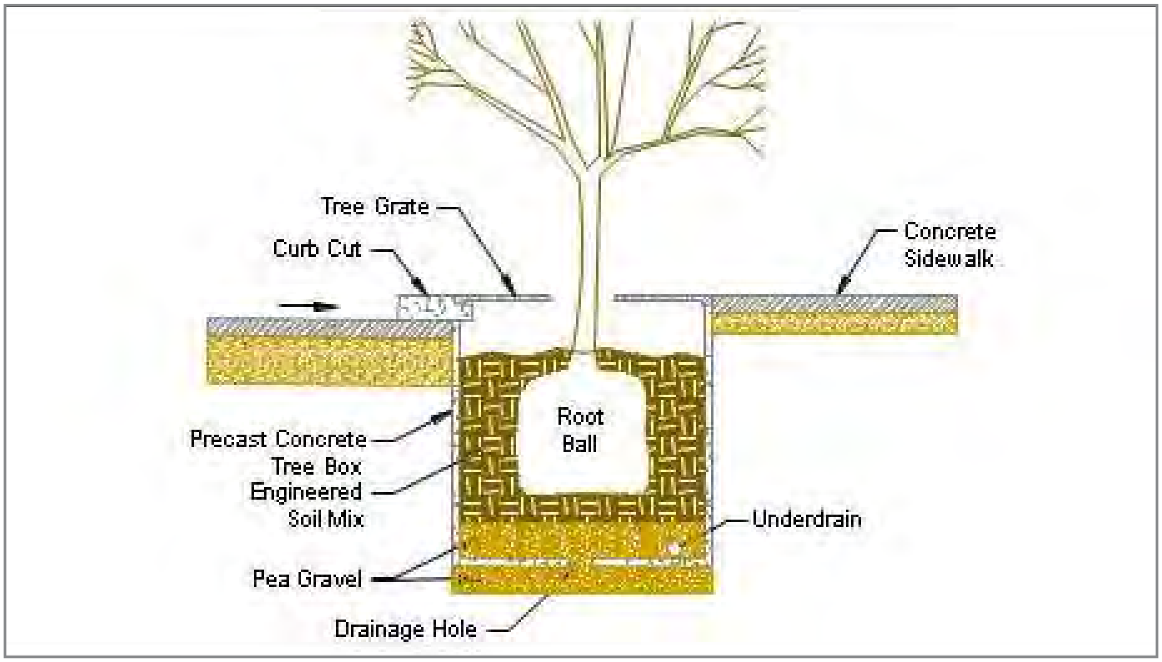


Figure 5-18: Tree Box Filters (Harris County LID Manual)

STORMWATER PLANTER BOXES – ROADSIDE AND BUILDING BIORETENTION

Storm Water Planters, also known as flow through planters, are bioretention systems enclosed in concrete structures. They can be designed to drain runoff from paved areas via curb inlet structures or pipes, or can be located under roof drain downspouts for treatment of roof runoff.

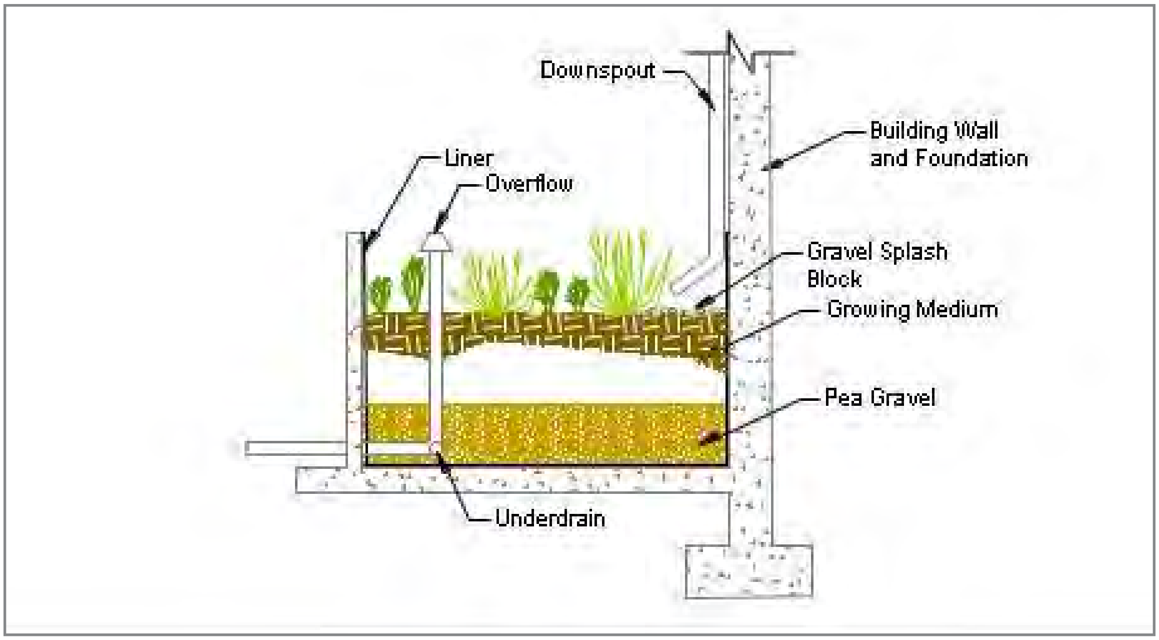


Figure 5-19: Stormwater Planter Box (Harris County LID Manual)

DESIGN REQUIREMENTS

- Waterproofing shall be incorporated into the designs of Storm Water Planters sited near buildings and other structures. An under-drain pipe is required.
- The ponding area in Storm Water Planters shall be designed with a maximum ponding depth of 24” and the capacity to drain ponded water within 24 hours.
- Plants can also be selected from those that would be used in traditional bioretention systems.
- Pre-manufactured systems must be installed in accordance with the manufacturer’s instructions.

5.6.3. RECOMMENDED MAINTENANCE

The primary maintenance requirement for bioretention areas is routine inspection and repair or replacement of the treatment area's components. Generally, this involves nothing more than periodic maintenance that is required for landscaped area. Appropriate plants for the site, climate, and watering conditions should be selected for use in the bioretention cell. Properly selected or native plants will aide in reducing fertilizer, pesticide, water, and overall maintenance requirements. Bioretention system components should blend over time through plant and root growth, organic decomposition, and the development of a natural soil horizon. These biological and physical processes over time will lengthen the facility's life span and reduce the need for extensive maintenance.

Routine maintenance should include a semi-annual health evaluation of trees and shrubs growing within the area and the subsequent removal of excessive dead or diseased vegetation. Diseased vegetation should be treated as needed using preventative and low-toxic measures to the highest extent possible. Bioretention systems have the potential to create very attractive habitats for mosquitoes because of highly organic, often heavily vegetated areas mixed with shallow water. Routine inspections for areas of standing water within the facility and corrective measures to restore proper infiltration rates are necessary to prevent mosquito breeding.

In order to maintain the treatment area's appearance, it may be necessary to prune and weed. Furthermore, mulch replacement is suggested when erosion is evident or when the site begins to look unattractive. In some cases, the entire area may require mulch replacement every year, while in others spot mulching may be sufficient.

Other potential tasks include replacement of dead vegetation, erosion repair at inflow points, unclogging the underdrain, and repairing overflow structures.

Other recommended maintenance guidelines include:

1. ***Inspections.*** Bioretention facilities should be inspected at least twice a year (once during or immediately following wet weather) to evaluate facility operation. During each inspection, erosion areas inside and downstream of the facility must be identified and repaired or revegetated immediately.

2. ***Sediment Removal.*** Remove sediment when accumulated sediment hinders the flow of water into the facility.

3. ***Drain Time.*** When the drain time exceeds 48 hours, the top few inches of filter media should be removed and replaced with material that meets the specifications of the original media.

4. ***Vegetation.*** All dead and diseased vegetation considered beyond treatment should be removed and replaced. Re-mulch any bare areas by hand whenever needed. Replace mulch annually in the spring, or more frequently if needed, in landscaped areas of the basin where grass or groundcover is not planted. Grass areas in and around bioretention facilities should be mowed at least twice annually. More frequent mowing to maintain aesthetic appeal may be necessary in landscaped areas. Use Integrated Pest Management techniques to avoid or minimize the use of synthetic pesticides and fertilizers.

5. ***Debris and Litter Removal.*** Debris and litter will accumulate in the facility and should be removed during regular mowing operations.

6. ***Filter Underdrain.*** Clean underdrain piping network to remove any sediment buildup as needed to maintain design drawdown time.