Brevard County
Natural Resources Management

Low Impact Development Retrofit Guide

for Commercial and Light Industrial Facilities

30 October 2020

This manual was funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency through an agreement/contract with the Nonpoint Source Management Section of the Florida Department of Environmental Protection.

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Disclaimer

While many developments share common elements, each is unique. The information in this guide is intended only as a starting point and guidance for the reader and should be used only with careful consideration of applicable laws, rules, codes, ordinances, and standards in effect at the time of a specific development. This guide does not change the laws applicable to planning, designing, constructing, operating, and maintaining building and development projects in Brevard County, Florida. The information is supplied on the condition that the reader will make his or her determination as to its suitability for his or her purposes. The responsibility for using a standard in this guide remains with the professional or other person responsible for planning, designing, constructing, operating, and maintaining a specific project.

The use of brand names in this publication does not indicate an endorsement by the authors, Brevard County, the State of Florida, or the United States Environmental Protection Agency.

Acknowledgements

The developers of this guidance document gratefully acknowledge the vision and work of the local governments that pioneered development of Low Impact Development Manuals and the contributions of all those who assisted with those Manuals. Significant portions of the Brevard County Low Impact Development Retrofit Guide for Commercial and Light Industrial Facilities incorporate parts of the following documents:

- City of Titusville Low Impact Development Technical Manual, Section 11.5 "Low Impact Development (LID) Best Management Practices (BMPs) Matrix, August 2020
- Escambia County Low Impact Design BMP Manual, September 30, 2016
- Sarasota County Low Impact Development Guidance Document, Updated May, 2015
- Pinellas County Stormwater Manual, February 1, 2017
- City of Ormond Beach Low Impact Development Design Manual, 1st Edition, 2013
- Low-Impact Development & Green Infrastructure: Pollution Reduction Guidance for Water Quality in Southeast Florida, Florida Department of Environmental Protection, August 22, 2019
- Maryland Stormwater Design Manual, Volume I, October 2000, Revised May 2009
- Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, First Edition, April 2009
- City of Nashville, Volume 5, Low Impact Development Stormwater Management Manual, February 2016
- San Antonio River Basin Low Impact Development Technical Design Guidance Manual, Second Edition, May 2019
- City of Toronto Low Impact Development Stormwater Management Planning and Design Guide, Version 1.0, 2010
- King County (WA) Stormwater Pollution Prevention Manual, January 2005, Chapter 5
- State of Idaho DEQ Catalog of Storm Water Best Management Practices, April 2020
- Storm Water Technology Fact Sheet - Baffle Boxes, US EPA 832-F-01-004 September 2001

We appreciate the review and comments provided by Brevard County and Florida Department of Environmental Protection (FDEP) staff on the draft guide.

This guidance document, and the public information meeting conducted on November 19, 2020 to educate users about the guide, were funded in part by a Section 319 Nonpoint Source Management Program Implementation grant from the U.S. Environmental Protection Agency through an agreement/contract with the Nonpoint Source Management Section of (FDEP).

1. Introduction

Brevard County received a Grant Type 319 from the Florida Department of Environmental Protection (FDEP, Contract Number NF003) on August 12, 2016 for a stormwater retrofit project at Pines Industrial Park near Rockledge. The Grant included an education task for development of a low impact development (LID) manual for retrofitting sites that have a land use defined as commercial and light industrial. These are areas typical of the County's project site at Pines Industrial Park and that could be used in other similar areas of the Indian River Lagoon watershed.

This guidance document presents an introduction to LID design and specifically Green Infrastructure Practices (GIPs) which are characterized by their ability to reduce stormwater runoff volume and nutrient loading through the use of infiltration, evapotranspiration, and/or rainwater harvesting. It provides technical guidance and design information on LID stormwater management practices for application to projects in Brevard County, more specifically for retrofitting existing sites that have a land use defined as commercial or light industrial.

This document is not to be used in place of – but rather as a supplement to – Brevard County and St. Johns River Water Management District (SJRWMD) stormwater and surface water management guidance documents regarding local design criteria and LID applicability. The guidance provided in the document is designed to be flexible with performance criteria provided where possible. Depending on the magnitude of specific or cumulative impacts, other methods of meeting the overall water resources objectives of Brevard County and SJRWMD should be considered. For all projects, check with local officials and other agencies to determine additional restrictions and/or surface water or watershed requirements that may apply.

LID stormwater management practices are not mandatory but rather a voluntary option in Brevard County. However, Brevard County does encourage the use of LID practices where possible to help meet its water resources objectives and is currently working on a LID Ordinance as of the printing date of this manual.

1.1. Definition of Terms

The following table contains a list of terms and their definitions to assist with technical terminology in this manual.

Baffle	Baffles are vertical walls, typically concrete, metal or fiberglass, inside structure boxes that remove sediment, suspended particles and pollutants from stormwater.
Biosorption Activated Media (BAM)	An engineered media that assists in removing pollutants, especially nutrients, from stormwater when combined with a Best Management Practice (BMP).
Detention Pond	Can be either dry or wet and detains stormwater up to the required water quality elevation and then discharges excess stormwater through a drainage structure.
Evapotranspiration	The process by which water is transferred from land to the atmosphere by evaporation from the soil and other surfaces and transpiration from plants.
Hydrologic control (non-structural)	Natural features that control stormwater runoff such as ditches and ponds.
Hydrologic control (structural)	Man-made features that control stormwater runoff such as stormwater culverts and underground retention systems.
Impervious	Does not allow water to pass through.
Infiltration	The process by which water on the ground surface enters and drains through soil.
Pervious	Allows water to pass through.
Retention Pond	Typically, dry ponds that have no outlet structures and are designed to infiltrate stormwater runoff into the groundwater.
Retrofit	To furnish an existing system with new or modified parts or components.
Sedimentation	The process of soil and other particles suspended in water settling out due to gravity.
Treatment Train	A sequence of multiple stormwater treatment systems that are designed to treat stormwater runoff.
Watershed	An area of land where stormwater drains to a common outlet such as a river, lake or lagoon.

2. What Is LID?

Low Impact Development (LID) is a stormwater management approach that uses a suite of hydrologic controls (structural and non-structural) distributed throughout the site and integrated as a treatment train (i.e., in series) to replicate the natural hydrologic functioning of the landscape. Unlike conventional stormwater treatment systems, which typically control and treat runoff using a single engineered stormwater pond located at the “bottom of the hill,” LID systems are designed to promote volume attenuation and treatment at or near the source of stormwater runoff via distributed retention, detention, infiltration, treatment, and harvesting mechanisms. The fundamental goal of applying LID concepts, design, and practice is to improve the overall effectiveness and efficiency of stormwater management relative to conventional systems, reducing total and peak runoff volumes, removing nutrients, and improving the quality of waters discharged from the site.

A site-specific suite of LID-integrated stormwater management practices can be applied to most if not all development scenarios in Brevard County. Regardless of the project context, LID requires consideration of the following core site planning and design objectives:

1. Preserve or conserve existing site features and assets that facilitate natural hydrologic function.
2. Minimize generation of runoff volume from impervious surfaces and contamination as close to the source as possible.
3. Promote the distribution of retention, detention, treatment, and infiltration of runoff.
4. Harvest stormwater and rainwater on site.
5. Minimize site disturbance and compaction of soils through low impact clearing, grading, and construction measures.

Typically, LID practices will not completely replace other more conventional “bottom-of-the-hill” stormwater management practices but can be used to complement these practices and to ensure that the entire stormwater management system meets Brevard County and SJRWMD water resources objectives.

Stormwater management that includes LID practices is most effective when sites are evaluated for LID compatibility as early as possible in the planning process and site conditions are considered carefully in the design and construction of each LID practice. LID practices can also be effective in retrofitting existing sites with or without stormwater management systems. This document supports Brevard County’s goal of applying the LID concept and design where feasible to enhance existing stormwater management measures and reduce the adverse impacts of land development projects on the County’s natural resources.

3. How Can LID Help?

Current development patterns and traditional stormwater management techniques have resulted in large amounts of impervious surfaces across the country, including Brevard County. Conventional development approaches to stormwater management often use practices to quickly and efficiently convey water away from developed areas. Though this practice may control the rate of runoff flow, this results in larger volumes of runoff flowing directly to ditches, canals, streams, rivers and storm drain systems as well as any pollutants contained in the runoff.

In contrast, LID utilizes a system of source controls and small-scale, decentralized treatment practices to help maintain the hydrologic function of the landscape by allowing water to infiltrate, evapotranspirate or be reused onsite. The conservation of open space, the reduction of impervious surfaces, and the use of small-scale stormwater controls are just a few of the LID practices that can help maintain pre-development conditions, reduce nutrients and other pollutants in stormwater discharges, and keep greater volumes of runoff from routing to the stormwater system. Green Infrastructure (GI), as used in this guidance document, is a term that refers to a subset of LID structural systems and practices that support the principles of LID and make use of volume-reducing designs and calculations.

LID techniques can offer many of the following benefits:

- Protect plants and animals. Reduce impacts to terrestrial and aquatic plants and animals.
- Reduce land clearing and grading costs
- Decrease flooding risks for small storms
- Create attractive natural and multifunctional public spaces
- Reduce infrastructure costs (streets, curbs, gutters, sidewalks)
- Reduce stormwater management costs
- Potentially reduce municipal permitting fees and increase lot yields
- Increase lot and community marketability
- Preserve integrity of ecological and biological systems
- Protect site and regional water quality by reducing sediment, nutrient, and pollutant loads to water bodies
- Preserve trees and natural vegetation
- Mitigate the heat island effect and reduce energy use

4. What Is the County Doing?

Brevard County has aggressively undertaken a series of projects to reduce pollution to the Indian River Lagoon (IRL). For information on the status and benefits of the County's various stormwater and other environmental projects to improve the health of the IRL system, please refer to the following resources:

Natural Resources Management Department
2725 Judge Fran Jamieson Way, Suite A-219
Viera, FL 32940
(321) 633-2016

Natural Resources Management Department Webpage
http://www.brevardfl.gov/NaturalResources

Save Our Lagoon Webpage
http://www.brevardfl.gov/SaveOurLagoon/Home

Save Our Indian River Lagoon Plan Project Story Map

5. LID Practices that Fit Your Property

Overall Site Considerations

In order to achieve a "best fit LID practice" for each site, a LID Guidance Menu has been provided that lists the benefits or challenges of each LID practice in this document. Refer to Figure 5-1, on the next page, for the menu; these practices are also described in more detail in Chapter 6. This tool can be used to streamline the planning approach and allow focus on only those LID practices which are practical for application at each site according to the three main considerations listed below.

LOW IMPACT DEVELOPMENT PLANNING CONSIDERATIONS

A. General Site Considerations: What is the nature of the project?
B. Environmental Site Considerations: What natural features may provide opportunities or influence LID performance?
C. Cost and Maintenance Considerations: Which LID practices are considered cost efficient or costly, and which ones are considered low or high maintenance?

Quick and Easy LID Practices

The systems below are all relatively inexpensive and simple to install systems for any site and not only help to control negative effects of stormwater but are also beneficial to the environment. More information for each of these systems is provided in Chapter 6.

Rain Barrel/Cistern – Can be purchased at most home improvement stores and nurseries for smaller scale applications. Reduces runoff volumes and promotes conservation through rainwater harvesting.

Rain Garden – Relatively easy to construct. Not only practical for reducing runoff and providing habitat for birds and butterflies but is also a beautiful addition to any site.

Disconnection of Roof Runoff – Items can be purchased at most home improvement stores for small scale applications. Can help to reduce runoff volume and to water landscaped areas.

Grassed Swale – Fairly easy and cheap to construct compared to other methods. Is feasible for most sites. Swales are also relatively easy to maintain long term.

Low impact development planning considerations	Project applicability (Y or N)	Low impact development alternatives available to meet stormwater management site needs in Brevard County														
		Retention ponds	Extended detention ponds	Second generation (nutrient removing) baffle boxes	Rainwater harvesting / cisterns	Underground storage and retention systems	Bioretention	Biofiltration	Pervious pavement systems	Grassed swales / channels	Disconnection of rooftop runoff	Dry wells	Rain gardens	Vegetated filter strips	Bio swales	Catch basin inserts
See section		6.1	6.2	6.3	6.4	6.5	6.6	6.7	6.8	6.9	6.10	6.11	6.12	6.13	6.14	6.15
A. General site considerations																
A.1 The project is constructed on undeveloped land.		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
A.2 The project is a retrofit area.		◑	◑	●	●	◑	◑	◑	●	◑	●	●	●	●	◑	●
A.3 The project is a proposed linear project (i. e., the area to be treated is linear) .		●	◑	○	○	◑	●	●	●	●	○	○	●	●	●	●
A.4 The project is comprised of a large mixed use or planned development (residential/commercial development).		●	◑	●	●	●	●	●	●	●	●	●	●	●	●	●
A.5 The site is a commercial large "big box", buildings and large parking areas.		●	●	●	◑	●	●	●	●	●	●	●	●	●	●	●
A.6 The project is a clustered, high intensity multl-family residential or "new urbanism" project.		●	◑	●	◑	●	●	●	●	●	●	●	●	●	●	●
B. Environmental site considerations																
B.1 The seasonal high groundwater table is less than 1.5 feet below land surface.		○	●	◑	●	○	○	●	○	○	●	○	●	◑	○	●
B.2 The soils on the site are poorly drained with less than 2 inches/hr infiltration (i.e., SCS Type B/D or C).		○	●	●	●	○	◑	●	◑	◑	●	◑	●	◑	◑	●
B.3 The site lies within the 100 year floodplain.		◑	●	●	●	◑	●	●	◑	◑	●	◑	●	●	◑	●
B.4 The project area either includes special habitats of concern; requires special protection measures; impacts wetlands; or there are existing impacted wetlands that may benefit from stormwater.		◑	●	●	●	◑	●	●	◑	◑	●	◑	●	●	◑	●
B.5 The project site has no positive outfall.		◑	◑	●	●	◑	◑	◑	◑	◑	●	●	●	●	●	●
C. Cost and maintenance considerations																
C.1 Capital investment.		Medium	High	Medium	Low	High	High	High	Medium	Low	Low	Low	Medium	Low	Low	Low
C.2 Maintenance concerns.		Medium	Medium	High	Low	High	Medium	High	High	Low	Low	Low	Medium	Low	Low	Low

● The lid practice is both feasible and practical and is recommended for consideration
◑ The LID practice may be feasible but may require special measures for practical implementation
○ The LID practice poses practical challenges for implementation that may limit the application

Low   Medium   High

Note: the LID evaluation and guidance tool is provided to aid stormwater professionals in planning for successful LID projects. The stormwater professional is advised to evaluate LID options for each category applicable for the proposed project as shown in Figure 5-1 and then follow design recommendations in the respective LID Chapter 6 sections. It is the sole responsibility of the stormwater professional to design the project to effectively meet both Brevard County and SJRWMD permitting requirements for stormwater management.

Figure 5-1 LID Site Planning and Evaluation Guidance Menu

6. LID Practices

6.1. Retention Ponds

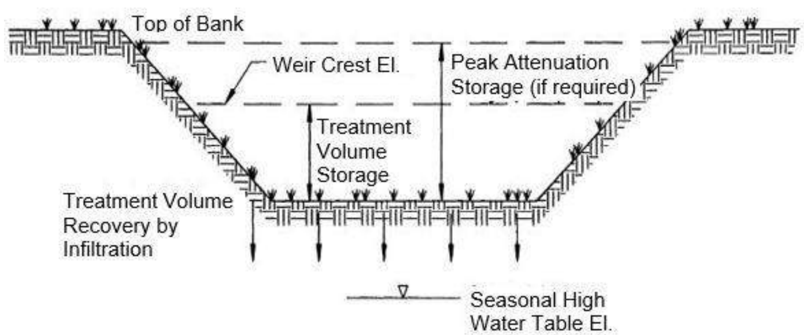
Description

A retention pond, or "dry retention pond", is a recessed area within the landscape that is designed to store and retain a defined quantity of runoff, allowing it to percolate through permeable soils into the shallow ground water aquifer.

Benefits

Retention ponds provide numerous benefits, including reducing stormwater volume, which reduces the pollutants that may be discharged from the system. Additionally, many stormwater pollutants such as suspended solids, oxygen-demanding materials, heavy metals, bacteria, some varieties of pesticides, and nutrients are removed as runoff percolates through the soil.

Limitations



Sandy soils with high permeability and a low seasonal high water table (at least 2 feet below the pond bottom) are essential for the successful use of retention ponds, so they can percolate the required treatment runoff volume within a specified time, typically 72 hours following a storm event. After recovery has been completed, the pond does not hold any water, thus the system is normally "dry." Unlike detention ponds, the treatment volume for retention systems is not discharged to surface waters.

Maintenance

Maintenance issues associated with retention ponds are related to sedimentation clogging the porous soils in the bottom, which reduces infiltration thereby slowing recovery, often resulting in standing water. Retention ponds should be inspected regularly, with removal of accumulated sediment from the pond bottom typically every 3-5 years; removal of sediment, trash and debris from inflow and outflow structures and other system components as needed to prevent clogging or impeding flow; and mowing frequently enough to prevent thatch buildup.

6.2. Extended Detention Ponds

Description

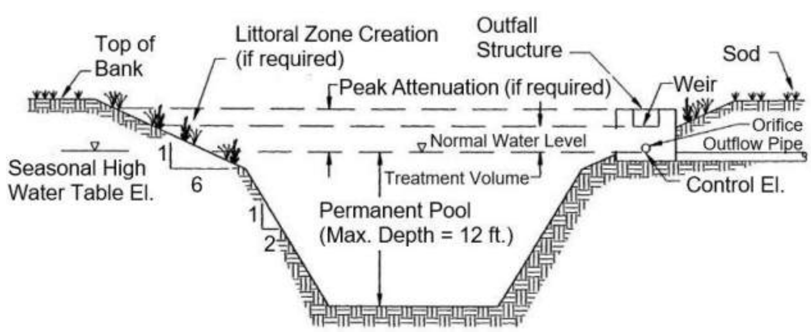
An extended detention pond discharges the design water quality treatment volume of stormwater runoff over an extended period, usually from 24 to 48 hours. These ponds function similar to flood control / detention basins but include the extended holding period to encourage settling of sediment and particulate matter, exposure to UV sunlight, and other processes that treat pollutants before discharge. Ideally, an extended detention basin is designed as part of a treatment train with other LID practices such as bioretention.

Benefits

The benefits of extended detention ponds include cost effectiveness; ease of construction, operation and maintenance; wildlife habitat; and they can serve as a multipurpose facility for recreation, open space and flood control. In addition, extended detention ponds provide the additional benefit of mitigating flooding by reducing peak discharge of stormwater runoff. In addition, controlling runoff rates helps to protect the downstream receiving waters from erosion.

Limitations

Extended detention ponds are not recommended for sites with less than 2 acres of impervious cover and drainage basins less than 5 acres. There could be a concern that undesirable appearance can detract from home values if used in residential developments.



Maintenance

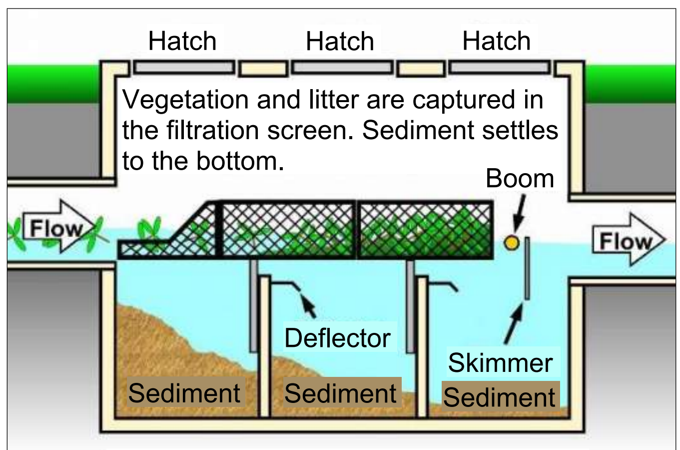
Regular maintenance of extended detention ponds includes removal of accumulated sediment from the pond bottom and inflow and outflow structures and pipes, removal of trash and debris from inflow and outflow structures and other system components to prevent clogging or impeding flow, and maintenance of side slopes and removal of invasive vegetation.

6.3. Second Generation (Nutrient Removing) Baffle Boxes

Description

Baffle boxes are typically underground flow-through concrete or fiberglass structures that are installed in-line with stormwater pipes and are designed to trap sediments and particulates and remove oils and greases from stormwater runoff. Vertical baffles separate the box into different sections. There are typically two to three sections within a box. Second generation (or nutrient separating) baffle boxes include a screen that intercepts storm flow as it enters the box and before it flows into the sedimentation sections, retaining organic debris. This prevents mobilization and export of nutrients from saturated organics within the box. More advanced versions of these boxes can also contain a replaceable media that filters the waters and assists with capture and removal of nutrients such as nitrogen and phosphorous.

Benefits



Bottom of structure is 4’ below the pipe.

Second generation baffle boxes are installed in-line with stormwater pipes. They are ideal as a water quality retrofit due to their minimal footprint and subterranean installation, allowing installation within existing rights-of-way, parking lots, or developed sites. Nutrient removal efficiencies of second generation baffle boxes are typically 20% and can be greatly increased with additional filtration using a Biosorption Activated Media (BAM).

Limitations

Second generation baffle boxes require significant maintenance to remove accumulated sediment. If the boxes are not cleaned regularly, subsequent storms may resuspend the sediment and carry it out of the box, reducing the overall pollutant removal efficiency.

Maintenance

Inspection of second generation baffle boxes should be conducted a minimum of every 6 months, with removal of accumulated sediment and debris if it equals or exceeds 50% of the minimum sediment storage volume established by the vendor. The screen should be cleaned monthly and all other components of the box cleaned as necessary but typically twice a year. Boxes can be cleaned out using a vacuum truck to remove accumulated sediment and debris.

6.4. Rainwater Harvesting / Cisterns

Description

Rainwater harvesting systems intercept and store rainfall for future use. These systems may be small or large and under or above ground, depending on the type and application. Some types of rainwater harvesting systems, include: systems that store rainwater in rain barrels for supplemental irrigation; large residential or commercial systems that store rainwater in a cistern for irrigation, vehicle washing, or other non-potable uses; and large residential or commercial systems that store rainwater in a cistern as a source of indoor graywater uses such as toilet flushing, urinal flushing, laundry wash water, and outdoor non-potable uses.

Benefits

Harvesting rainwater from the roof runoff is an easy, inexpensive way to capture water before it has contacted many potential contaminants that it picks up from flowing over parking lots or driveways. The capture and re-use of rainwater promotes conservation, as well as reduces runoff volumes and the discharge of pollutants downstream. The water can also be used to supplement irrigation, vehicle washing, and other uses.

Limitations

The roof must have gutters or drains with the appropriate screens to collect the rainwater. The site must have adequate space for a cistern and may need to be anchored to a structure. There must be a use for the harvested rainwater. The system may require a pump for distribution of harvested rainwater if the cistern or storage tank is located in a low area. Also, a flow meter and filtration system may be required depending on the determined uses of harvested rainwater.

Maintenance

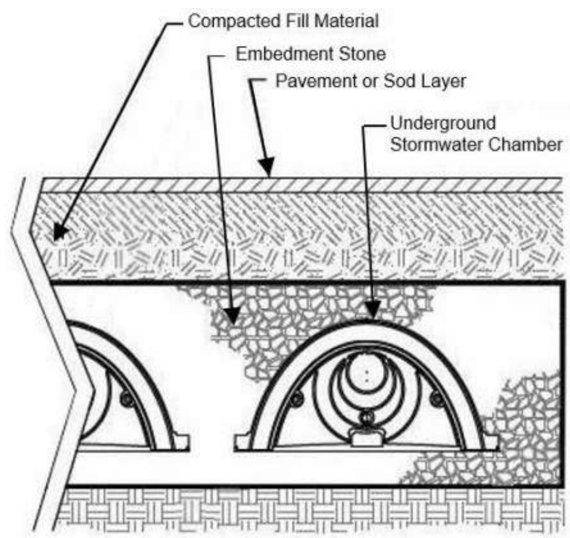
Maintenance issues associated with rainwater harvesting systems are related to the proper functioning of the filter system and of the pump and irrigation system. Regular maintenance of rainwater harvesting systems includes: inspection and cleaning of storage tank screens and pretreatment devices; removal of accumulated leaves or debris in gutters and downspouts; inspection of storage tank for algal blooms with treatment as necessary; and inspection of overflow areas for erosion, with regrading and revegetation as necessary.

6.5. Underground Storage and Retention Systems

Description

Underground storage and retention systems capture and hold stormwater below the ground surface until it can infiltrate into the underlying soil. They may be called underground tanks, vaults, or chambers, and many commercial models are available. Generally, these systems consist of lightweight, high-strength modular units with “open” bottoms, or perforated pipes, to allow for soil infiltration. They are sometimes used to minimize the potential loss of usable land that can occur with large stormwater ponds and are often used under parking lots or grassed areas.

Benefits



The benefits include: relatively large volumes of stormwater may be stored and infiltrated into the soil, providing groundwater recharge; downstream pollutant loads are reduced through volume reduction; and the land above the storage tanks is available for other uses, such as parking lots or pedestrian areas.

Limitations

Underground storage and retention systems require soils with adequate infiltration rates and a seasonal high water table at least 2 feet below the bottom to allow infiltration. It is recommended that they be operated by entities with single owners or with full-time maintenance staff. They must not be constructed within 50 feet of a public or private potable water supply well or within 15 feet of an onsite wastewater disposal and treatment system and are not appropriate on sites with potential hazardous or toxic materials.

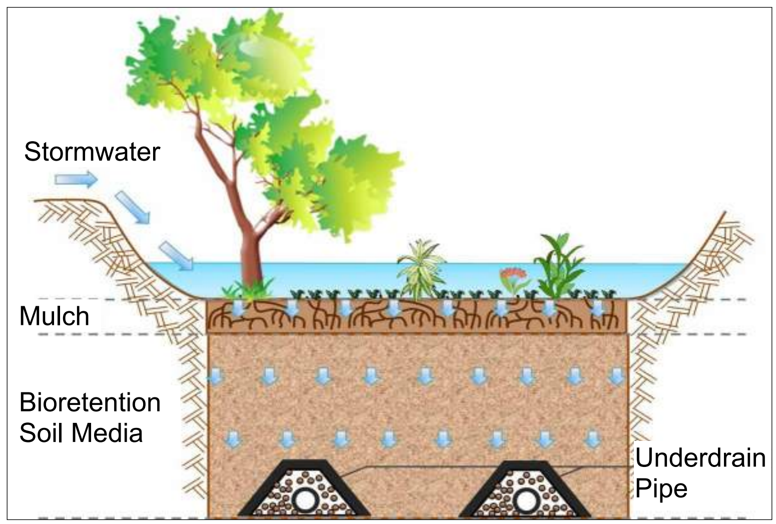
Maintenance

The maintenance intervals for an underground storage and retention system are typically more frequent than standard “dry” retention ponds. Regular, routine inspection and maintenance is important to ensure that it functions in a satisfactory manner and includes: comprehensive inspection of the system and removal of accumulated trash, debris and organic material every 6 months; periodic clean-out and rehabilitation of the system as needed to remove any accumulated trash, sediment and other inflow debris and remediate any clogged perforated pipes, aggregates and geotextile fabrics.

6.6. Bioretention

Description

Bioretention is the use of shallow depressional areas that employ conditioned soil and a carefully selected variety of plant materials that include trees, shrubs, and other herbaceous vegetation. They are designed to specifically detain stormwater runoff in the engineered soil mix and treat stormwater primarily through infiltration and plant uptake of nutrients, metals, hydrocarbons and bacterial pollutants. Bioretention areas differ from rain gardens (Section 6.12) in that they are designed to receive stormwater runoff from larger drainage areas and may be equipped with an underdrain.



Benefits

The benefits of bioretention include pollutant removal, site runoff reduction, reduced irrigation for planting beds, increased biodiversity in the landscape, benefits to wildlife, aesthetic benefits to neighborhoods, increased property values, and psychological benefits of green spaces to urban residents.

Limitations

Bioretention is not suitable if there is less than 2 feet of separation between the seasonal high water table and the bottom of the bioretention area, unless an alternative design can be shown to be appropriate for the specific site. Where infiltration rates are low, bioretention must be designed with underdrains or soil augmentation to improve function. It is recommended for the drainage area to be 2 acres or less to be consistent with the goal of treating runoff as close to the source as possible; larger basins should employ multiple bioretention facilities.

Maintenance

Regular maintenance of bioretention systems includes: inspection and repair or replacement of the treatment area components and removal of sediment, trash and debris from the system.

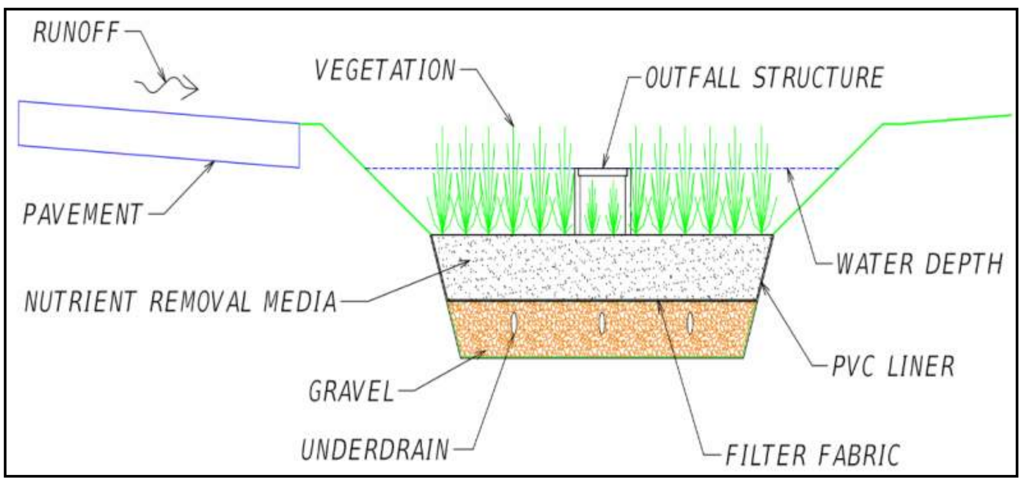
6.7. Biofiltration

Description

Biofilters or biofiltration systems are a suite of typically offline Best Management Practices (BMPs) that use engineered media, such as Biosorption Activated Media (BAM), to enhance nutrient removal when native soils cannot provide adequate pollutant removal or infiltration. They can have an underdrain for surface water discharge but can also be designed to function as retention systems; examples include rain gardens, landscape planter boxes, and tree box filters. The major components of a biofiltration system include: a pretreatment area (optional); a ponding area; ground cover layer and plants; media; and surface inlet and outlet controls.

Benefits

The benefits of biofiltration systems include pollutant removal; applicability to small drainage areas, high seasonal high water table conditions, and highly urban areas with land limitations; good retrofit capability; and can be designed as an aesthetic amenity.



Limitations

Biofiltration systems may require an underdrain system, filter media mixture, and landscaping. They can be used where seasonal high water table is high but should be hydraulically separated from the water table with an impermeable barrier (e.g., PVC liner). It is recommended for the drainage area to be 2 acres or less to be consistent with the goal of treating runoff as close to the source as possible; larger basins should employ multiple biofiltration facilities.

Maintenance

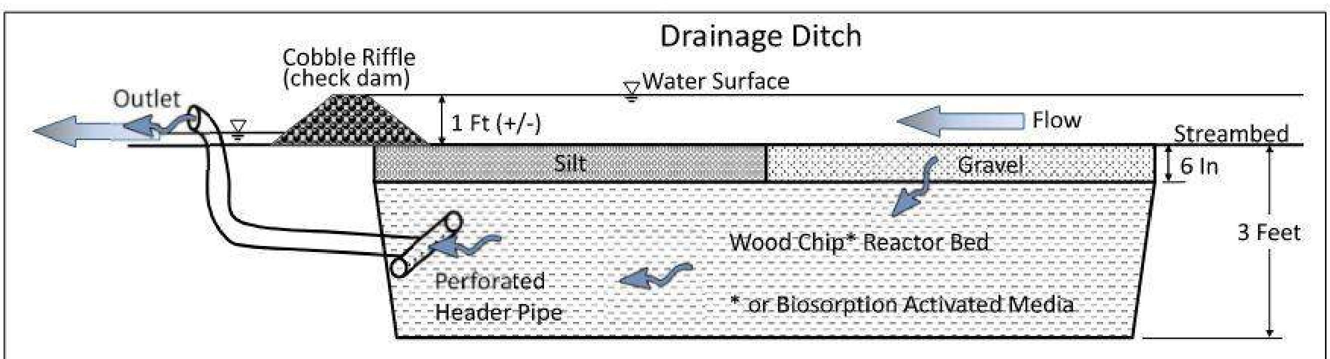
Regular maintenance of biofiltration systems includes: inspection and repair or replacement of the treatment area components; pruning and weeding regularly to keep structures clear;

mowing and removal of clippings from vegetated buffer twice during the growing season; replacement of mulch when needed; full replacement every 2-3 years; and removal of sediment, trash and debris from the system. To ensure that the biofiltration system is operating as designed, regular inspections of the system should be conducted immediately after a rainfall and, at a minimum, in the spring and during the rainy season, with any identified problems corrected as soon as possible.

In-Channel Denitrification System

Denitrification is another example of a biofiltration system which can be installed as a retrofit project in an existing drainage channel. A layer of gravel and a layer of wood chips (or biosorption activated media) are placed in the channel and a low level check dam is installed downstream. The check dam causes water to flow through the gravel to a perforated collection pipe which discharges downstream of the check dam. The check dam elevation is set so that upstream drainage systems are not affected. The environment provided by the wood chips and the gravel encourages the growth of naturally occurring bacteria which convert some nitrogen compounds into nitrogen gas (a major natural component of the air). This reduces the nitrogen in the water before it flows downstream to the receiving water body.

Below are some example photos of a recently constructed in-channel denitrification system in Brevard County, as well as a typical section showing its components and how the system works.



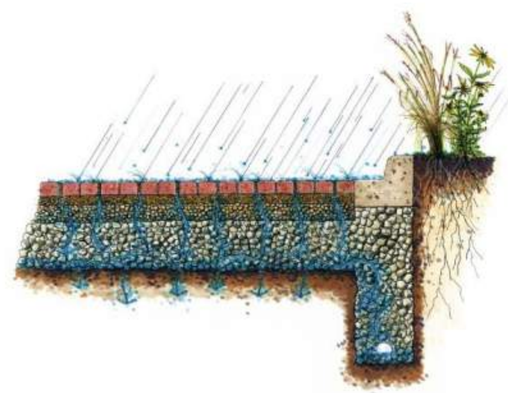
In-Channel Denitrification Bed Typical Section

6.8. Pervious Pavement Systems

Description

Pervious pavement (also commonly referred to as permeable pavement and porous pavement) systems are modified versions of standard pavements that allow water to flow through the surface. These include asphalt, concrete, modular pavers, structural turf, or various other designs, while also providing both storage and treatment of stormwater in the graded layers beneath the surface pavement. After passing through, water can infiltrate into the ground or be collected and discharged to another part of the stormwater system. Typically, pervious pavements are used for low-traffic loading with infrequent heavy vehicular traffic, and low-turning areas, such as parking spaces; residential street parking; cart, bicycle, and sidewalks; driveways; and emergency-vehicle-access lanes.

Benefits



The benefits of pervious pavement include the potential to reduce the size of or eliminate stormwater structures from impervious areas; increased usable/developable space or decreased developed footprint; white pavers can be used in place of pavement markings (as seen in the top right photo); and the possible increase in aesthetic value.

Limitations

Pervious pavement may have increased maintenance requirements and costs, and a remediation plan is required if maintenance fails to improve pavement infiltration performance. It typically has higher construction costs than conventional impervious pavements. The seasonal high water table must be at least 2 feet below the bottom of the pervious pavement system. If the surface fails, it must be reconstructed, not resurfaced.

Maintenance

For proper maintenance of most pervious pavement systems, periodic vacuum sweeping is recommended to remove fine particles and material that clog the surface. It is required at least annually or when infiltration performance declines or when nuisance ponding occurs. Vacuum sweeping also will be required for areas that are subject to wind transported soils (for example, near sand dunes) or other places where excessive soil or debris deposition is expected.

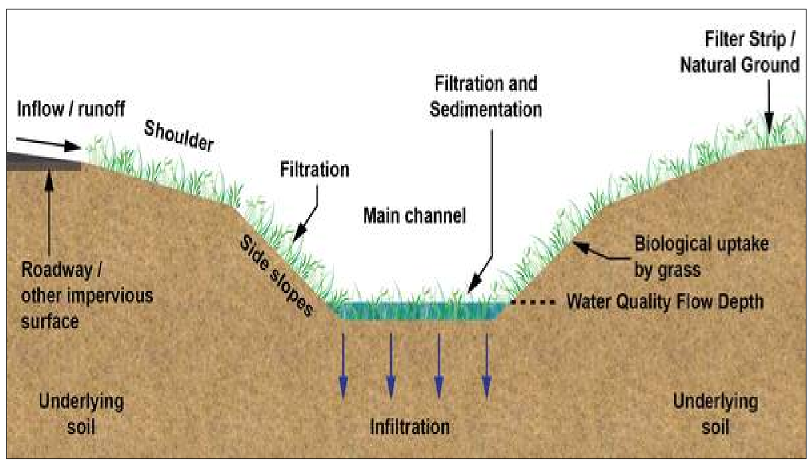
6.9. Grassed Swales / Channels

Description

A grassed swale or channel is a manmade trench with mild side slopes (greater than or equal to 3 feet horizontal to 1 foot vertical); vegetated for soil stabilization, stormwater treatment and nutrient uptake; and which has standing or flowing water only following a rainfall event. It is one of the most widely and longest used drainage devices and can be integrated into a LID plan, providing an alternative to systems that use catch basins for collection and culverts to convey runoff to a treatment system further downstream.

Benefits

The benefits of grassed swales and channels systems include: pretreatment for water quality requirements; the ability to reduce peak runoff rates and discharge volumes from a site by slowing the flow to allow for infiltration through the bottom of the swale; and require relatively low investment in the construction cost as well as minimal long term maintenance costs for the developer / property owner.



Limitations

The contributing area to each swale (or segment) should be limited. They are best suited for well-drained soils, but swales located on more poorly-drained soils can be improved through the use of soil amendments. A minimum depth from the swale bottom to the seasonal high water table of 2 feet should be maintained.

Maintenance

Regular maintenance of grassed swales and channels includes removal of accumulated sediment, trash and debris at inflow points, outlet and check dams (if any), revegetation of bare spots, and grass mowing.

6.10. Disconnection of Rooftop Runoff

Description

Rooftop disconnection involves directing flow from roof drain downspouts away from storm sewer inlets and impervious areas such as parking lots that provide direct connections to the storm drain system, and directing it instead onto a pervious area where it can soak into or filter over the ground. This reduces both runoff volume and pollutants delivered to receiving waters.

Benefits

The benefits of rooftop disconnection include cost effectiveness, with relatively low construction and maintenance costs; promotion of infiltration, reducing runoff volume and peak discharge; and the vegetated areas they flow into for infiltration provide aesthetics.

Limitations

To function well, rooftop disconnection is dependent on site conditions such as flow path length, slopes, and soils. A permeable, vegetated treatment area with an adequate flow path length down gradient from the downspout is needed. Disconnected downspouts should discharge via sheetflow on a gradual slope (5% or flatter) that conveys runoff away from the building. Downspout disconnections work best in well drained, permeable soils that allow runoff to infiltrate; clayey soils or soils that have been compacted by construction equipment greatly reduce the effectiveness of this practice and may need soil amendments. If any of these site conditions cannot be met, roof downspouts should be directed to another LID practice such as a rainwater harvesting system, grassed swale or bioretention area.

Maintenance

Maintenance of areas receiving disconnected rooftop runoff is generally no different than that required for other lawn or landscaped areas. The areas receiving runoff should be protected from future compaction (e.g., by planting trees or shrubs along the perimeter). In commercial areas, foot traffic should be discouraged as well.

6.11. Dry Wells

Description

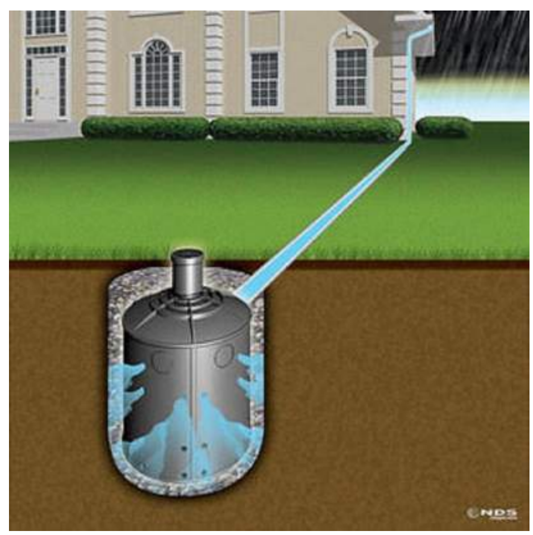
A dry well is an excavated pit or structural chamber that is either empty or filled with gravel or stone that provides temporary storage of stormwater runoff from rooftops. This system is sometimes also referred to as a French Drain and is similar to the Underground Storage Retention System shown in Section 6.5, but on a smaller scale. Rooftop runoff is directed to the dry well and infiltrates into the surrounding soils prior to the next storm event. The pollutant removal capability of dry wells is directly proportional to the amount of runoff that is stored and allowed to infiltrate.

Benefits

If properly designed, dry wells can provide significant reductions in stormwater runoff rates, volumes and pollutant loads on development sites. They are particularly well suited for use on urban development sites.

Limitations

The depth from the bottom of the dry well to the seasonal high water table should a minimum of 1 to 2 feet. A dry well should only be used on development sites with sandy soils that readily percolate.



Maintenance

Regular maintenance of dry wells includes annual inspection and cleaning of pipes, gutters, downspouts and all filters. Ponding or algal growth on the top of a dry well may indicate failure due to poor infiltration or sedimentation in the gravel media. If this occurs the system should be evaluated for repair or replacement.

6.12. Rain Gardens

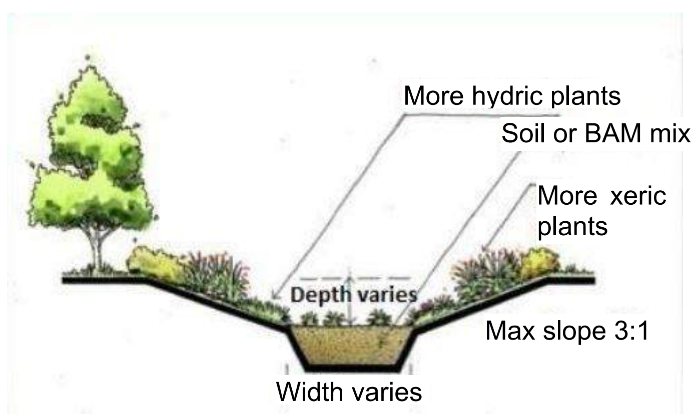
Description

A rain garden is a small, landscaped retention basin that temporarily holds captured runoff from downspouts, roof drains, pipes, swales or curb openings and allows it to naturally infiltrate into the ground or evaporate. Rain gardens typically consist of an absorbent-planted soil bed, a mulch layer, and planting materials such as shrubs, grasses, and flowers. An overflow conveyance system is included to pass larger storms.

Benefits

The benefits of rain gardens include stormwater runoff volume and pollutant loading reductions, groundwater recharge, enhanced site aesthetics, habitat for birds, butterflies, and beneficial insects, reduced irrigation for landscaping, and integration into a site's landscaping.

Limitations



The contributing drainage area for a rain garden should be relatively small. The seasonal high water table should be at least 2 feet below the bottom of the rain garden. Relatively flat slopes (< 5%) are required to accommodate runoff filtering through the system. Soils should have at least moderate infiltration rates; if the soil is not permeable enough for retention, an option is to design the rain garden as a biofiltration system (Section 6.7) to function as a filter before water is conveyed downstream via an underdrain.

Maintenance

Regular maintenance of rain gardens includes pruning, weeding, removal of accumulated trash and debris, and re-mulching as needed. Maintenance also includes annual inspection of inflow areas and removal of accumulated sediment or debris; inspection for erosion and repair and plant replacement vegetation.

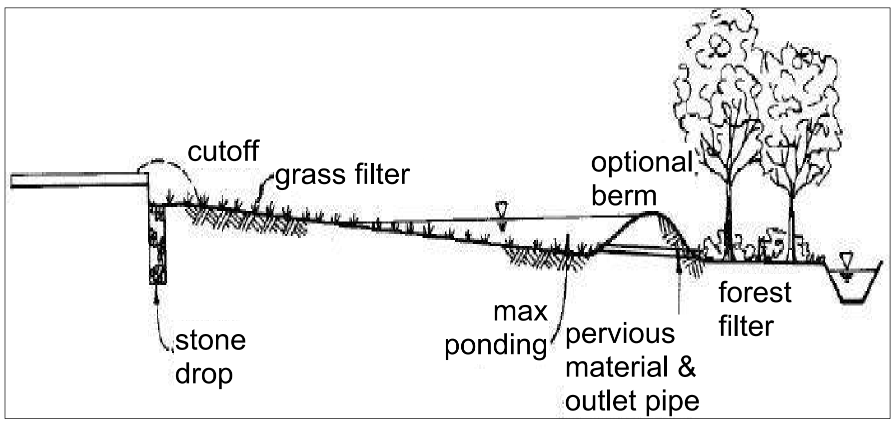
6.13. Vegetated Filter Strips

Description

A vegetated filter strip is a uniformly graded band of dense vegetation (typically turf grass), designed to slow and filter stormwater runoff generated from impervious areas. When implemented on highly permeable soils, they can also provide infiltration, reducing runoff volume. Vegetated filter strips are typically used as one component in a treatment train and may be used either as a pretreatment measure prior to flowing into another LID practice (e.g., a bioretention facility), or can also be used as a final outlet device.

Benefits

Vegetated filter strips are a good pretreatment Best Management Practice (BMP), they are simple to install (normally requiring only minimal earthwork and planting) and are aesthetically pleasing. Additionally, they have no minimum depth to water table requirements; and are cost effective, with relatively low construction and maintenance costs.



Limitations

Vegetated filter strips must be sited next to impervious surfaces and may not be suitable for large drainage areas. Vegetated filter strips are not intended to act as a standalone, primary practice for pollutant removal or volume reduction. Overland sheet flow, avoiding concentrated flows, can be difficult to maintain within a vegetated filter strip, which needs to be provided to prevent soil erosion and ensure practice performance.

Maintenance

Regular maintenance of vegetated filter strips includes mowing, pruning and trimming the vegetation, and removal of accumulated trash and debris. Maintenance also includes annual inspection, removal of accumulated sediment or debris, replacement of dead vegetation, and regrading in any eroded areas.

6.14. Bio Swales

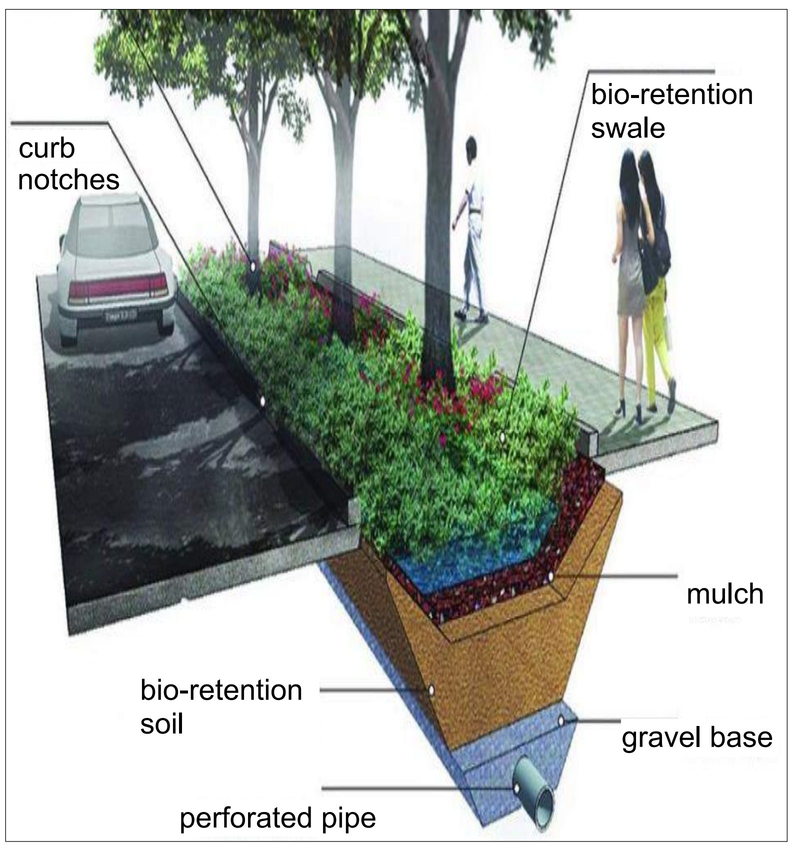
Description

Bio Swales are vegetated open channels that are filled with an engineered soil mix and are planted with trees, shrubs and other herbaceous vegetation. They are essentially linear bioretention areas (Section 6.6), in that they are designed to capture and temporarily store stormwater runoff in the engineered soil mix, where it is subjected to evaporation and plant uptake, before being conveyed back into the storm drain system through an underdrain or allowed to infiltrate into the surrounding soils.

Benefits

The benefits of Bio Swales include helping restore pre-development hydrology on development sites and reducing post-construction stormwater runoff rates, volumes and pollutant loads; and being less expensive than traditional drainage (e.g., curb and gutter, storm drain) systems.

Limitations



Bio Swales can only be used to receive runoff from relatively small drainage areas, typically 5 acres or less in size. They should be designed with slopes of between 1% and 2% to help ensure adequate infiltration and drainage. The depth from the bottom of the Bio Swale to the seasonal high water table should a minimum of 2 feet. Underdrains should be used for Bio Swales on development sites that have soils with poor infiltration rates.

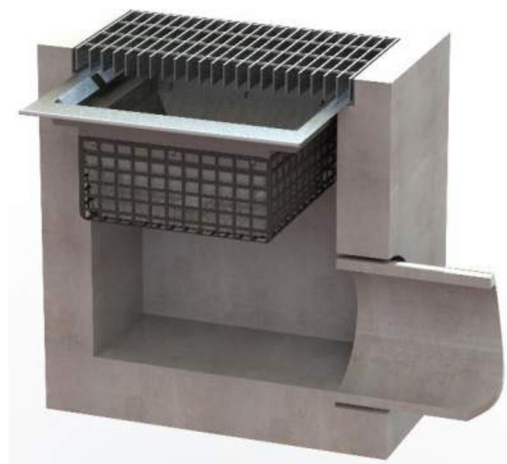
Maintenance

Regular maintenance of Bio Swales includes removal of accumulated sediment, trash and debris at inflow points, outlet and check dams (if any), revegetation of bare spots, and grass mowing.

6.15. Catch Basin Inserts

Description

Catch basin inserts are devices installed in storm drain inlets that provide water quality treatment of stormwater through filtration, settling, or adsorption before it enters a storm sewer system. Catch basin inserts are commercially available products and are typically made of filter fabric or metal screening that traps coarse particles and allows water to drain through. Absorbent material can often be incorporated into a basin insert to remove oil and grease. Due to their effectiveness for addressing oil, grease, and particulates, they are most applicable for catch basins within parking lots. Catch basin inserts are considered as one component in a treatment train and should be used only as a pretreatment measure.



Benefits

The benefits of catch basin inserts include sediment and particulate trapping; absorption of oil and grease; simple integration into existing infrastructure; no additional volume or area required for installation; and effective retrofit practice for existing storm drain systems.

Limitations

Catch basin inserts generally require more frequent, but less costly maintenance and cleaning than other treatment Best Management Practices (BMPs).

Maintenance

Metal screen systems may be cleaned with vacuuming. Catch basin inserts fitted with oil-absorbent filter media should be inspected monthly and changed when the filter media surface is covered with sediment. Inspections are especially important during the wet season. Periodic cleaning is required, at least twice a year, as they fill with sediment and debris. Thorough cleaning should occur at least monthly and/or after a one-half inch storm depending on basin size and if there is a lot of tree cover nearby. Special equipment such as a forklift or front-end loader may be necessary due to the weight of the accumulated material.

7. Where to Get More Help

As with any Best Management Practices (BMPs) for stormwater treatment, LID practices must comply with Brevard County Land Development Regulations requirements as well as the criteria adopted by the SJRWMD in Environmental Resource Permit (ERP) Applicant's Handbook, Volume II. These requirements are not identical, but stormwater treatment systems incorporating the LID practices in this guide can be designed in a manner that complies with all regulatory criteria.

As a condition of permit issuance, both ERP rules and Brevard County Land Development Regulations require a demonstration that a proposed stormwater system will not adversely affect water resources and ensure the stormwater discharge does not cause or contribute to violations of state water quality standards. Other conditions of issuance generally, applicable to the design of stormwater treatment systems incorporating LID practices, include addressing flood protection; effectiveness of system performance and function; protection of wetlands, fish and wildlife; and maintenance of minimum flows and levels established pursuant to Chapter 373.042, F.S. Users of this guide are advised to consult Chapter 62-330, F.A.C., and the SJRWMD ERP Applicant's Handbooks, Volume I and Volume II, for a complete understanding of all applicable ERP criteria.

For additional information on permitting requirements for the LID practices discussed in this guide for use on a project site, please contact:

Brevard County Planning & Development
2725 Judge Fran Jamieson Way
Viera, FL 32940
(321) 633-2187
https://www.brevardfl.gov/PlanningDev

St. Johns River Water Management District
Palm Bay Service Center
525 Community College Parkway, S.E.
Palm Bay, FL 32909
(321) 984-4940
Environmental Resource Permitting Webpage
https://www.sjrwmd.com/documents/permitting/#erp

Additionally, a professional engineering consultant can assist a user of this guide in the design and permitting process for a stormwater management system employing LID practices that meets County and State requirements.