City of Sandy Springs Green Infrastructure Manual

Single Unit Residences

Last update: January 2021

Table of Contents

Introduction

Purpose of this Manual

This manual is intended to help homeowners and residential contractors to implement green infrastructure strategies on small projects. It includes basic information on stormwater management and detailed instructions on designing, building and maintaining green infrastructure.

Please contact Community Development at the beginning of the planning phase. See the Additional Resources section below.

Urban Stormwater Basics

In a natural setting, rainfall is usually captured by the vegetation and absorbed by the ground in large quantities before reaching streams, lakes and oceans. In an urban setting, this cycle is greatly altered. Land development permanently alters how stormwater flows across a site due to the removal of vegetation, the grading and compaction of the native soils and the installation of impervious surfaces such as rooftops and roadways. The water accumulates on the ground surface and runs off to low points in large quantities, and at high speed, creating unsafe conditions.

In the City of Sandy Springs, impervious cover is defined as "any man-made paved, hardened or structural surface, regardless of material, that significantly impedes or prevents the natural infiltration of water into the soil. The term "impervious cover" includes, but is not limited to, rooftops, buildings, streets, parking lots, driveways, sidewalks, uncovered decks and patios, swimming pools, and any concrete or asphalt." (Dev. Code Div. 12.2)

Over time, cities have created systems to capture runoff and keep their communities safe. The traditional approach is called "grey infrastructure" and is composed mostly of catch basins, pipes and detention ponds. Grey infrastructure is efficient at keeping stormwater runoff from streets and properties; however, it can have negative impacts on the natural environment. Water making its way through the infrastructure carries pollutants such as phosphorus, nitrogen, bacteria, heavy metals and debris. The runoff concentrated into the pipes disturbs the receiving waterbodies like creeks and lakes by causing erosion, altering the riverbeds and decreasing the water quality, as an example of an impact. Impaired waterways are poor wildlife habitat and have limited recreational uses.

Green infrastructure (GI) is a relatively recent engineering approach to stormwater that complements grey infrastructure. The intent of GI intends to mimic the natural processes that occur in areas untouched by development. It relies on infiltration, filtration, storage and evapotranspiration to return stormwater runoff into the water cycle. The amount of runoff that ends up in the pipes can be greatly reduced.

The conservation of existing and functional soils and vegetation is the easiest way to encourage and mimic natural stormwater processes whenever possible. Limiting construction to areas that have been already developed, maintaining natural grades, conserving stands of existing vegetation stands and minimizing impervious surfaces are examples of strategies that will facilitate the natural infiltration, filtration, storage and evapotranspiration of stormwater runoff.

When this is not feasible, several GI practices that can help manage stormwater in an environmentally sound manner.

In addition to reducing the amount of runoff, green infrastructure can improve water quality by removing pollutants, create wildlife habitat, reduce the heat island effect and provide a visually pleasing landscape feature.

City of Sandy Springs Regulations

The State of Georgia has put in place several regulations to help maintain the health of our waterways, including establishing protected stream buffers and defining erosion control measures to be taken during construction. Stormwater is no exception; the State requires that the first one inch of rain to fall within a 24-hour span be infiltrated on-site for projects that disturb over 5,000 square feet of land. This is called "runoff reduction."

The City of Sandy Springs is committed to the natural environment and has enacted more stringent regulations. Our Development Code (Sec. 9.6.12) requires the reduction of the first 1.2 inches of rainfall for projects where any new development, redevelopment, addition, or replacement that involves the creation of 1,000 square feet or more of impervious cover or that involves other land development activities of 5,000 square feet or more (Dev. Code Sec. 9.6.3). Projects located within a Declared Sensitive Area, such as the Nancy Creek watershed, are subject to additional requirements (see **Appendix C**)

How to Use This Manual

This manual employs simplified design standards applicable to residential projects that involve less than one-half acre of disturbance and less than 5,000 sf of impervious surface, thus avoiding complex engineering calculations and analysis in most cases. It is meant to complement the use of the Georgia Stormwater Management Manual (GSMM), "informerly" it is still known as The Blue Book. The GSMM may be used for design purposes as appropriate in lieu of this document, but the GSMM must be used for projects that propose more than 5,000 square feet of impervious area or more than one-half acre of disturbance. This manual is not applicable for projects located within a Declared Sensitive Area. At this time, the majority of the Nancy Creek watershed is considered a Declared Sensitive Area.

The manual includes the GI strategies allowed in the City of Sandy Springs. Note that permits are required for the installation of most of them. This normally entails an application form, a site plan showing the proposed improvements, an erosion control plan, and construction details. The construction details included in this manual can be used for this purpose.

Project Planning

Types of GI Allowed in Sandy Springs

The selection of a green infrastructure practice requires the consideration of several factors. Some practices require a large area of land, others are expensive to install, and others require a higher level of maintenance. The following chapters contain information that should aid the homeowner in the selection of a practice, or a combination thereof, and the table below summarizes some of the characteristics of each type of GI.

Chapter	Practice Type	Provides Runoff Reduction	Improves Water Quality	Reduces Potable Water Use	Improves Air Quality	Supports Wildlife	Requires Higher Level of Maintenance	Landscape Feature
1	Conservation of Natural Areas	Yes	Yes	Yes	Yes	Yes	No	Maybe
2	Rainwater Harvesting (Rain Barrels and Cisterns)	Yes	No	Yes	No	No	Maybe	No
3	Dry Wells	Yes	No	No	No	No	No	No
4	Modified French / Trench Drains	Yes	Yes	No	Yes	Yes	Yes	Yes
5	Rain Gardens and Bioretention	Yes	Yes	No	Yes	Yes	Yes	Yes
6	Vegetated Filter Strips	Partial	Yes	No	Maybe	Maybe	Maybe	Maybe
7	Permeable Pavers	No	Yes	No	No	No	Yes	No

Design Tips

- Slopes are necessary to move water. They are often expressed as a percentage, calculated by dividing the change in elevation of the slope by the length of the slope. For example, a slope that drops 6" (which is equivalent to 0.5') over 15' in length is: 0.5/15 x100 = 3.33%.
- One square foot of impervious surface will generate 0.8 gallons of runoff when it rains 1.2". For example, a 50 square foot patio would generate: 0.8 x 50 = 40 gal.
- The capacity of the soil to infiltrate water is critical to the proper functioning of most practices. Testing for infiltration early in the planning process will indicate which practices are feasible.

Construction Methods

- The green infrastructure practice should be one of the first elements designed and one of the last elements to be built on the project.
- Because the infiltration capacity of soils can be highly reduced by compaction, work should be conducted from the outside of the infiltration area as much as possible. The functionality of the practice could otherwise be compromised.
- Materials like engineered soil and stone should be stockpiled away from the GI practice and covered with tarps to prevent contamination.
- For infiltration materials like stone and sand, the manufacturer's specifications should state the product is clean, free from dust and other sediments.
- Runoff should be diverted temporarily away from the practice until the site has been stabilized and is ready to receive the water. If runoff cannot be diverted from the practice during construction, the construction documents should clearly detail how the practice area will be treated and rectified to accept the practice prior to installation.
- The methods will be reviewed in more detail at the pre-construction meeting with the Land Development Division staff.

Maintenance

- The maintenance of the green infrastructure practice is another factor to be considered during the selection and design of the practice.
- Some green infrastructure practices rely on living materials to perform correctly. The homeowner must be willing to invest the time and effort necessary to maintain the plants in a healthy growing condition. As an example, and similar to any other planting bed, a vegetated GI practice will require regular weeding and pruning.
- Pervious pavers also require regular maintenance. Their surfaces may become clogged with fine particles, such as clay or very fine soils, and will need to be vacuumed or otherwise washed periodically, in accordance with the product manufacturer's specifications.

Additional Resources

City of Sandy Springs permitting information: http://www.sandyspringsga.gov/business/building-and-construction/construction-utility-permits

City of Sandy Springs Development Code: https://library.municode.com/ga/sandy_springs/codes

Georgia Stormwater Management Manual: https://atlantaregional.org/natural-resources/water/georgia-stormwater-management-manual/

City of Sandy Springs Call Center: 770-730-5600

This manual is adapted from "Green Infrastructure for Single Family Residences", City of Atlanta, November 2012

Chapter 1

Conservation of Natural Areas

The easiest approach to green infrastructure is to take advantage of existing assets. Forested areas typically offer all the environmental advantages of constructed green infrastructure, and they require minimal investment.

The less impervious surface created, the less the amount of stormwater runoff to infiltrate.

Location and Design Considerations

The natural topography may be conducive to the conservation of certain areas. Steep slopes and depressions are typically not considered desirable locations for construction, while they provide filtration of pollutants and infiltration of water.

When considering a house addition, a new accessory structure, or the expansion of an outdoor amenity, several design options and location alternatives should be considered. The smaller the footprint of the proposed structure, the better for stormwater management.

Additionally, it is preferable to conserve stands of multiple trees rather than individual trees. Several trees can withstand storms better than isolated trees, and they provide a richer habitat for other plants and animals.

Mature trees consume water through evapotranspiration at high rates, much higher than smaller and younger trees. It is one of the reasons why they are protected under the Tree Conservation section of the Development Code (Div. 9.3).

Maintenance

Naturally forested areas do not require extensive maintenance. If invasive plant species such as English ivy and non-native wisteria are a concern, control will be required over the course of the first few years. Although the plant's visible portions can be easily removed, the root system can survive above-ground damage, and new shoots will continue to pop up. Certain herbicides can effectively speed up the process; however caution should be taken when applying them. Always follow the directions on the product label, keep the application localized and avoid contamination of water sources

Chapter 2

Rainwater Harvesting: Cisterns and Rain Barrels

Cisterns and rain barrels are green infrastructure practices that store rainwater for later use, such as landscape irrigation. Rain runoff from impervious surfaces, typically a roof, is collected from a downspout system, screened to remove trash and leaves and conveyed to a storage container for subsequent use. **Figure 1** and **Figure 2**. When properly sized, they can provide significant reductions in stormwater runoff rates, volumes and pollutant loads. Rain barrels may be part of an overall stormwater management system; however, due to their relatively small size, they may not be sufficient to meet the requirements of the ordinance.

The cistern must be emptied regularly, in particular before a large storm, to allow space for incoming stormwater. Rainwater harvesting makes sense only if a proportionately dimensioned landscaping area will be irrigated.

For additional information, consult Section 4.19 Rain Water Harvesting of the GSMM Vol. 2.

Location Considerations

The preferred location for a cistern meets the following considerations:

- Gutter downspouts can be easily connected to the cistern
- Overflow can be directed to downslope areas
- The selected area is level
- The area where the stored water will be used is within reach
- There are no conflicts with utilities
- An electrical connection is available, if applicable
- Emergency ingress/egress to and from the house remain clear
- Per Development Code Section 6.1.2.B.2.b, rain barrels and cisterns less than 6 feet in height may encroach into a required setback, if it remains at least 3 feet away from any lot line. They must be screened according to the specifications for Ground Mounted Equipment of Section 8.2.9.B.4.

Figure 1 | 1500 gallon cistern (LID Urban Design Tools via City of Atlanta)

Figure 2 | Rain Barrel (City of Atlanta)

Design Criteria

- Verify with the City if a permit is required.
- Cisterns come in sizes ranging from a standard 55-gallon rain barrel to 1,500-gallon cistern tanks. See **Figure 3**. Several cisterns can be linked to increase the holding capacity. If the cistern(s) cannot hold the full 1.2 inches, one alternative is to divert overflow to another low impact development structure such as a filter strip, infiltration trench, or rain garden.
- Cistern sizing: The drainage area is calculated by multiplying the length by the width of the contributing roof section. The width is measured from the drip line of the overhang to the roof peak, ignoring the slant (see the example calculation in **Figure 5**.) This area is then multiplied that by 1.0 gallons to determine the size of the cistern needed to fully meet the 1.2 inches rainfall standard.
- The landscape area to be irrigated must be 3 times as large as the drainage area. For example, a cistern serving a roof area of 500 SF will irrigate 1,500 SF of landscaping.
- All holding tanks should be opaque to prevent algae growth, and a screen must be in place to prohibit mosquitoes and other insects from entering.
- Pretreatment of water entering the cistern will remove debris, dust, leaves, and other material. One or more options illustrated below should be chosen. A gutter screen (Option A) or a basket strainer (Option B) will prohibit debris from entering the downspouts and will require frequent gutter cleaning. The in-line leaf strainer (Option C) is located between the downspout and the cistern, within arm's reach. The first-flush clean-out (Option D) allows debris to collect at the bottom of a separate container, to be later removed. **Figure 4** and **Figure 7.**
- The cistern must have an overflow pipe so that when the tank reaches capacity, the rainwater will be directed away from adjacent buildings.
- Overflow should be directed to an area or practice that promotes sheet flow, such as a vegetated filter strip, and not a concentrated discharge. The latter could cause erosion issues.
- Drainage system components leading to the cistern should have a minimum slope of 2% for gravity drainage toward the cistern. Consider setting up the cistern on a pedestal above the ground level to improve water pressure.
- Gravity feed drip irrigation kits are available from several suppliers as well as - including instructions on how to design an irrigation system for the low pressure of a cistern system without a pump.

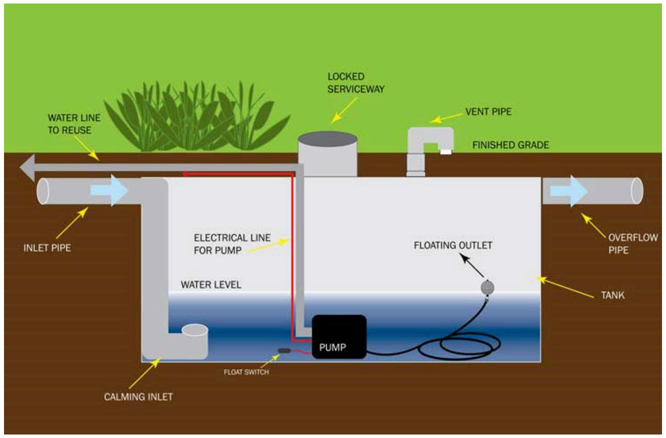


Figure 3 | Underground cistern (Contech ES)

Figure 4 | In-line screen (Rain Harvest Systems via City of Atlanta)

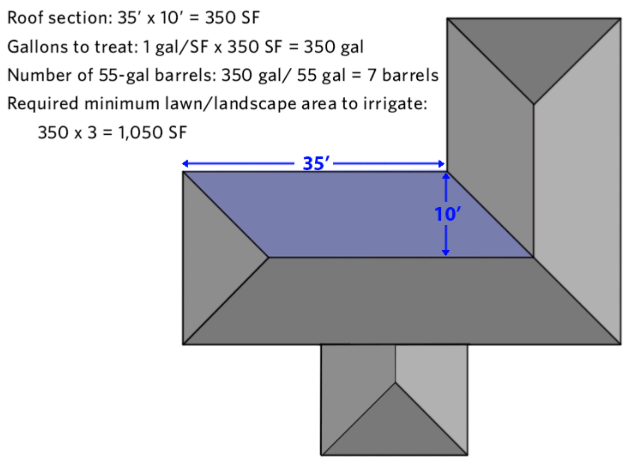


Figure 5 | Calculation example

Construction Sequence

1. Provide a level foundation of compacted earth, blocks, gravel or other hard long-lasting surface. Build the pedestal (optional).

2. Place the cistern tank and review all connections for layout and measuring.

3. Cut and route downspouts or other rainwater delivery components, leaf screen, mosquito screen and other pre-treatment option as applicable. Strap and support as needed.

4. Install water outlet connections, including pumps as applicable. Follow manufacturer's specification for all connections and fittings, including inlet, overflow, and cleanout.

5. Extend overflow to a discharge point 10 feet or more away from any common property line. The discharge point should be a surface that will not erode.

6. Test the cistern by filling with water and testing all components, including spraying water on the roof and observing flow.

Maintenance

- Follow the manufacturer's recommended maintenance and inspection schedule.

- Regularly verify for leaks, overflow and the presence of insects.

- Inspect gutters and downspouts, removing accumulated leaves and debris.

- If applicable, inspect pretreatment devices for sediment accumulation. Remove accumulated trash and debris.

- Inspect cistern for accumulated sediment, trash or debris within the storage chamber.

- Verify that the soil is not eroding at the overflow.

For more information, consult Appendix E, Operations & Maintenance Guidance Document, in the GSMM Vol. 2.

Typical components of a rainwater harvesting cistern

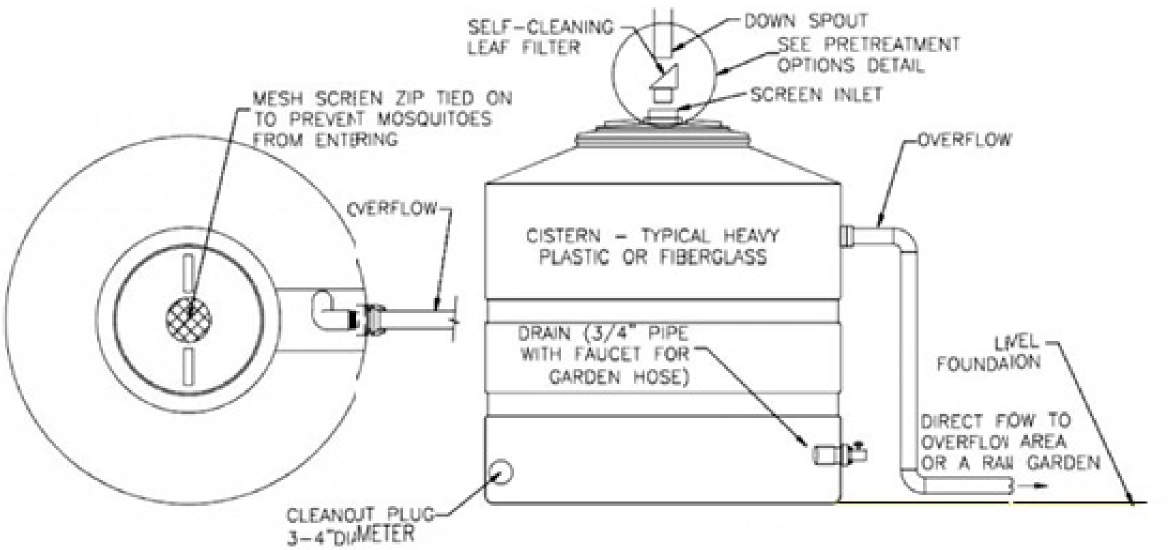


Figure 6 | City of Atlanta

Pre-Treatment Options

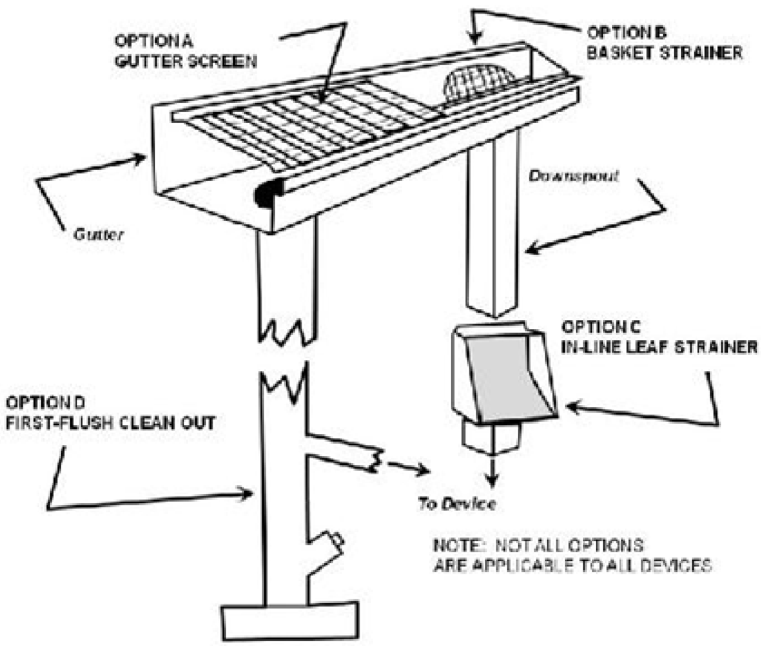


Figure 7 | City of Atlanta

Chapter 3

Dry Wells

Dry wells consist of seepage tanks set in the ground and, in metro Atlanta's clay soils, surrounded with stone designed to intercept and temporarily store stormwater runoff until it infiltrates into the soil. **Figure 8**. Alternately, a large diameter perforated standpipe filled chamber or pipe surrounded with stone can replace the tank.

Dry wells are particularly well suited to receive rooftop runoff entering the tank via an inlet grate at the ground level or directly from a gutter downspout connection. When properly sized and laid out, dry wells can provide significant reductions in stormwater runoff and pollutant loads.

For additional information, consult Section 4.7 Dry Wells of the GSMM Vol. 2.

Location Considerations

- Dry wells cannot be located:
  - Beneath an impervious (paved) surface;
  - Above an area with a water table or bedrock less than two feet below the trench bottom;
  - Over other utility lines; or
  - Above a septic field.
- Dry wells must be located at least 10 feet from building foundations, wall foundations, and property lines.
- Dry wells must be located in a lawn or other pervious (unpaved) area and should be designed so that the top of the dry well is located as close to the surface as possible.

Design Criteria

- Verify with the City if a permit is required.
- An infiltration test (see **Appendix A**) must be administered to determine that a dry well is a viable practice for the specific location. The preferred infiltration rate is 0.5 in/hr. If the rate is less than 0.5 in/hr, contact engineering staff to discuss alternate approaches and requirements. If the rate is less than 0.25 in/hr, this method cannot be used.
- The drainage area should not exceed 2,500 SF, and should have a maximum ground slope of 6% in the location where the well is installed.

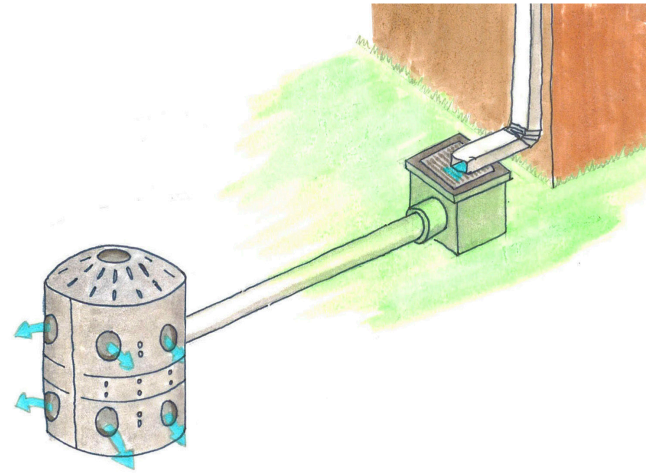


Figure 8 | Drywell system

Figure 9 | Leaf screen

- To reduce the chance of clogging, dry wells should accept runoff from impervious areas only, such as a roof or a driveway, and runoff should be pretreated to remove leaves, debris, and larger particles.
- Pretreatment options are shown on **Figure 10**. A gutter screen (Option A) or a basket strainer (Option B) will prohibit debris from entering the downspouts and will require frequent gutter cleaning. The in-line leaf strainer (Option C) is located between the downspout and the cistern, within arm's reach. The first-flush clean-out (Option D) allows debris to collect at the bottom of a separate container, to be later removed.
- Consider the drainage area size and the soil infiltration rate when determining the size of the dry well (see table below).
- An overflow, such as a vegetated filter strip or grass channel, should convey the stormwater runoff generated by larger storm events to bypass the dry well.
- Dry well covering: The landscaped area above the surface of a dry well should be covered with pea gravel if water enters through the surface rather than a pipe. This pea gravel layer provides sediment removal and additional pretreatment and can be easily removed and replaced when clogged. Alternatively, a dry well may be covered with an engineered soil mix, and planted with turf or other herbaceous vegetation.

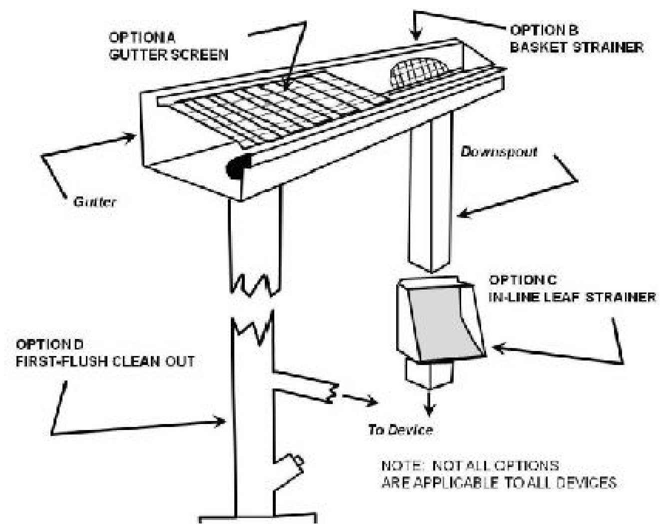


Figure 10 | Pretreatment options (City of Atlanta)

Dry Well Sizing

The Dry Well Sizing table below can be used to size a dry well system. The contributing drainage area in square feet treated determines the tank/pipe height and diameter. For example, the runoff of a 10 by 50 foot (500 square feet) roof section could be handled by one tank 60″ high, 30″ diameter. It can also be handled by two tanks 30″ high and 30″ in diameter.

Tank Height (in)	Tank Inside Diameter (in)				
	24	30	36	42	48
	Contributing Area Captured (sq ft)				
30	198	264	342	429	528
30)	223	296	381	477	584
60	371	497	644	811	999
60	396	529	683	859	1056
Hole Depth (in)	Tank Inside Diameter (in)				
	24	30	36	42	48
	Contributing Area Captured (sq ft)				
24	25	39	57	77	101
30	31	49	71	96	126
36	38	59	85	115	151
42	44	69	99	135	176
48	50	79	113	154	201
60	63	98	141	192	251

Construction Sequence – with Tank

1. Always call 811 to locate utility lines before digging.
2. Excavate the well hole and trim all large roots that would hamper the installation. Note that certain trees are protected under City regulations, and the arborist should be consulted before cutting large roots. The dry well hole should be excavated 1 foot deeper and two feet larger in diameter than the well itself to allow for a 12 inch stone fill jacket, **FIgure 11**
3. Line the sides of the well hole with permeable filter fabric (geotextile), saving a sufficient amount to cover the top later.
4. The native soils along the bottom of the dry well should be scarified or tilled to a depth of 3 to 4 inches. The surface should be leveled to ensure an even distribution of the stormwater into the stone reservoir.
5. Fill below and around the dry well approximately 12 inches of clean, washed #57 stone.

Figure 11 | Drywall installation

6. Install and secure the filter fabric.
7. Install and test the piping.
8. Fill the final top 6 inches of the excavation with native soil. Optionally, pea gravel or #8 stone can be installed to the surface.
9. If the runoff comes from a rooftop, install a leaf screen in the gutter or downspout prior to entering the dry well to prevent leaves and other large debris from clogging the dry well. For non-rooftop runoff, precede the dry well with a leaf trap.

Construction Sequence – without Tank

1. Always call 811 to locate utility lines before digging.
2. Excavate the well hole and trim all large roots that would hamper the installation. Note that certain trees are protected under City regulations, and the arborist should be consulted before cutting large roots. The dry well hole should be excavated according to the table above
3. Line the sides of the well hole with permeable filter fabric (geotextile), saving a sufficient amount to cover the top later.
4. The native soils along the bottom of the dry well should be scarified or tilled to a depth of 3 to 4 inches. The surface should be levelled to ensure an even distribution of the stormwater into the stone reservoir.
5. Fill the hole with clean, washed #57 stone.
6. Install and secure the filter fabric.
7. Install and test the piping.
8. Fill the final top 6 inches of the excavation with native soil. Optionally, pea gravel or #8 stone can be installed to the surface.
9. If the runoff comes from a rooftop, install a leaf screen in the gutter or down spout prior to entering the dry well to prevent leaves and other large debris from clogging the dry well. For non-rooftop runoff, precede the dry well with a leaf trap.

Maintenance

- Annual maintenance is important to ensure the dry wells continue to provide measurable stormwater management benefits over time.
- Inspect gutters and downspouts, removing accumulated leaves and debris.
- Inspect dry well following rainfall events.
- If applicable, inspect pretreatment devices for sediment accumulation. Remove accumulated trash and debris.
- Inspect top layer of filter fabric for sediment accumulation. Remove and replace if clogged.
- If the surface is covered with pea gravel, verify that is it not clogged from sediment.

For more information, consult Appendix E, Operations & Maintenance Guidance Document, in the GSMM Vol. 2.

Typical components of a dry well with tank

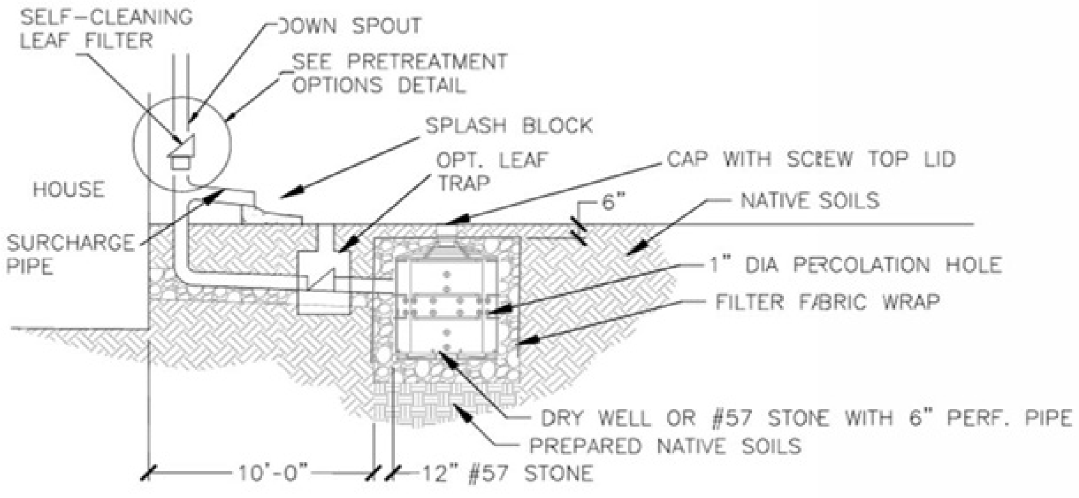


Figure 12 | City of Atlanta

Typical components of a dry well without tank

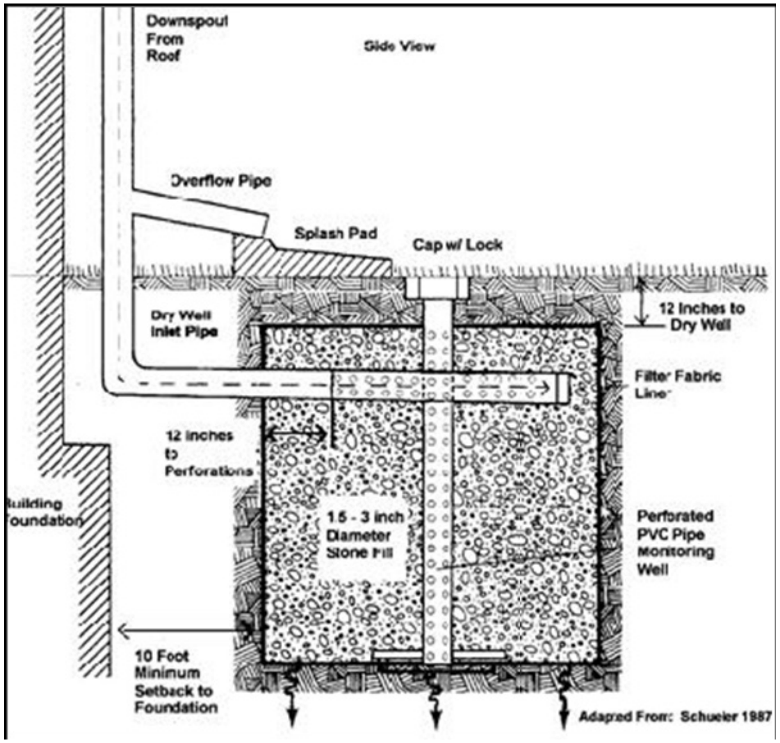


Figure 13 | City of Atlanta

Chapter 4

Modified French Drains

Modified French Drains (MFD) are shallow trench excavations filled with stone and an embedded perforated pipe. They are designed to intercept and temporarily store stormwater runoff until it infiltrates into the soil. MFDs can provide significant reductions in stormwater runoff and pollutant loads. They are particularly well suited to receive rooftop runoff and can also receive stormwater runoff from other small impervious areas.

Figure 14 and **Figure 15**

Location

- MFD trenches should be located at least 10 feet from building foundations and 10 feet from property lines. The top end of the MFD can be adjacent to the building to connect down-spouts but should be directed away from the structure.
- MFDs should slope away from the structures. The slope of the MFD pipe should be between 0.5% and 6%. It can be serpentine or multi-pronged in construction if sufficient slope is available.
- MFDs must be located in a lawn or other pervious (unpaved) area.
- MFDs cannot be located:
    - Beneath an impervious (paved) surface;
    - Above an area with a water table or bedrock less than two feet below the trench bottom;
    - Over other utility lines; or,
    - Above a septic field.
- The downstream end of the pipe must daylight for overflow at least ten feet away from the property line.

Figure 14 | Modified French drain installation (City of Atlanta)

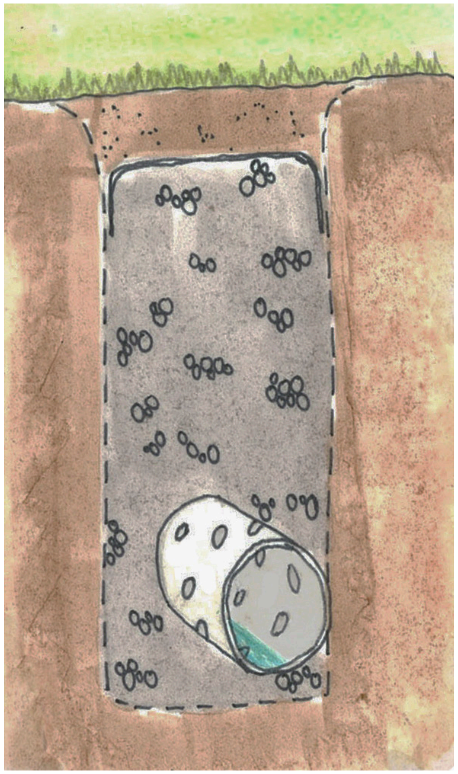


Figure 15 | Modified French drain section

Design Considerations

Impervious Area (sq ft)	Depth of Gravel from Top of Pipe (in)			
	18	24	30	36
	Required Length of MFD (linear ft)			
100	8	6	5	4
500	42	31	25	21
1000	83	63	50	42
2000	167	125	100	83
3000	250	188	150	125
4000	333	250	200	167
5000	417	313	250	208

Verify with the City if a permit is required:

- If the infiltration test shows a rate is less than 0.25 in/hr, this method cannot be used. If the rate is more than 0.50 in/hr, the length of the ditch may be decreased by 10% for every 0.50 in/hr of infiltration rate above 0.50 in/hr.
- To reduce the chance of clogging, MFDs should drain only impervious areas, and runoff should be pretreated with at least one of the leaf removal options to remove debris and larger particles.
- Pretreatment options are shown below. A gutter screen (Option A) or a basket strainer (Option B) will prohibit debris from entering the downspouts and will require frequent gutter cleaning. The in-line leaf strainer (Option C) is located between the downspout and the cistern, within arm's reach. The first-flush clean-out (Option D) allows debris to collect at the bottom of a separate container, to be later removed.
- MFD gravel depths should be at least 18 inches and no more than 36 inches. The total depth is calculated by adding the depth of stone, half the diameter of the pipe and the soil/pea gravel covering.

As a rule-of-thumb there should be about 25 cubic feet of stone for every 100 square feet of impervious surface drained. The sizing table provides MFD length requirements for different depths.

- The pipe should be 6" in diameter, have 3/8 inch perforations spaced 6 inches on center, and have a slope between 0.5% and 6%. A steeper slope would not allow sufficient standing time for the stormwater to infiltrate.
- The pipe should be covered by at least 6 inches of soil.

- The end of perforated pipe where it exits from the trench must be equipped with a pop up drainage emitter or similar, allowing for overflow of larger storms.
- An overflow, such as a vegetated filter strip or grass channel, should be designed to convey the stormwater runoff generated by larger storm events safely out of the downstream end of the MFD.

Vegetation

- A MFD is typically covered with topsoil and turf or other herbaceous vegetation.
- The downstream end of the pipe (where it daylights) must be stabilized against erosion and can be landscaped for aesthetics.

Construction Sequence

1. Always call 811 to locate utility lines before digging.
2. Excavate the ditch and trim all large roots that would hamper the installation. Note that certain trees are protected under City regulations, and the arborist should be consulted before cutting large roots. The dry well hole should be excavated 1 foot deeper and two feet larger in diameter than the well itself to allow for a 12 inch stone fill jacket.
3. The native soils along the bottom of the trench should be scarified or tilled to a depth of 3 to 4 inches.
4. Fill the MFD with clean, washed #57 stone. Embed the perforated pipe such that the stone covers the top of the pipe.
5. Install the pipe with the selected slope, between 0.5% and 6%.
6. The perforated pipe must daylight at the downstream end of the trench, in an area capable of receiving the water such as a vegetated filter strip or grass channel.
7. Place permeable landscape fabric (geotextile) over the stone and cover with at least 6 inches of topsoil or pea gravel.
8. For rooftop runoff capture, install one or more leaf screen options prior to entering the MFD to prevent leaves and other large debris from clogging the MFD. For a driveway or parking runoff, a screened inlet grate over a sump or pea gravel pit can be used to settle out material prior to entering the pipe.

Maintenance

- Inspect gutters/downspouts removing accumulated leaves and debris, cleaning leaf removal system(s).
- Inspect any pretreatment devices for sediment accumulation. Remove accumulated trash and debris.
- Inspect MFD following a large rainfall event to insure overflow is operating and flow is not causing erosion problems.
- If the surface is covered with pea gravel, verify that is it not clogged from sediment.

Typical Components of a Modified French Drain

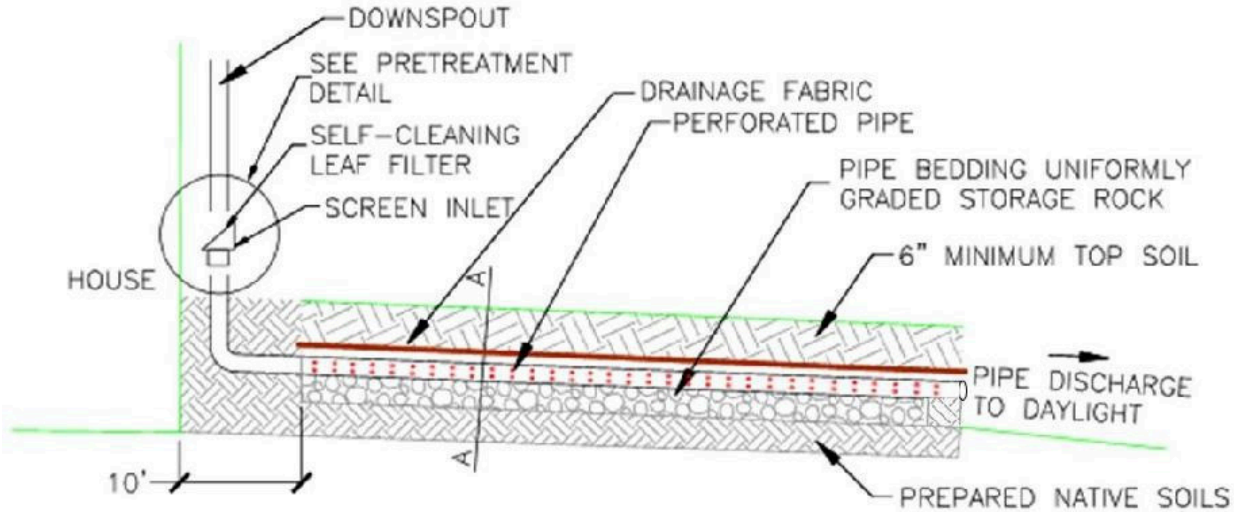


Figure 16 | City of Atlanta

Pretreatment Options

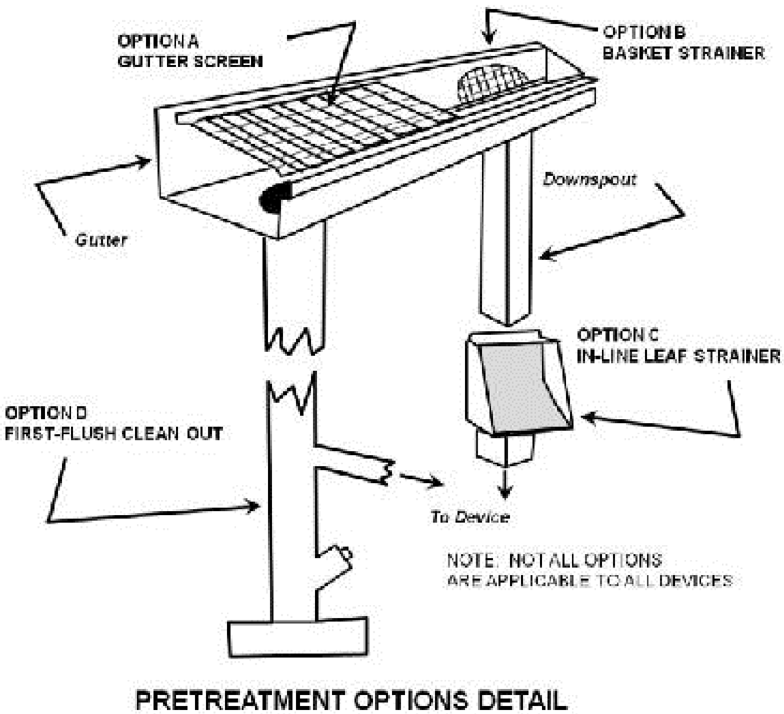


Figure 17 | City of Atlanta

Chapter 5

Rain Gardens

Rain gardens are small, landscaped depressions filled with a mix of native soil and compost and planted with trees, shrubs and other perennials. They are designed to temporarily store stormwater runoff from rooftops, driveways, patios and other impervious areas while reducing runoff rates and pollutant loads into local streams. A rain garden can be a beautiful and functional addition to the landscape. **Figure 18**

Location

- Rain gardens should be located to receive stormwater runoff from impervious surfaces.
- Swales, berms, or downspout extensions may be helpful to route runoff to the rain garden.
- Locate at least 10 feet from building foundations and retaining walls.
- Rain gardens cannot be located:
  - Within the public right-of-way;
  - Over other utility lines;
  - Above a septic field; or
  - At the edge of a steep slope.
- Rain gardens on steep slopes (>10%) may require an alternative design with terracing.

Contributing Impervious Drainage Area (sq ft)	Depth of Amended Soil (in)			
	18	24	30	36
	Required Area of Rain Garden (sq ft)			
100	9.1	7.7	6.7	5.9
250	23	19	17	15
500	45	38	33	29
1000	91	77	67	59
1500	136	115	100	88
2000	182	154	133	118
2500	227	192	167	147

Figure 18 | Rain garden (City of Atlanta)

Design Considerations

- The size of the rain garden will vary depending on the impervious surface draining to it and the depth of the amended soils. Use the table to determine the required surface area.
- A maximum ponding depth of 6 inches is allowed within rain gardens. On average, rain gardens drain within 24 hours, which does not allow for mosquito breeding.
- If the infiltration rate is less than 0.25 in/hr, additional calculations will be required. Contact City Staff. An underdrain should be used in such circumstance.
- The inflow should be slowed down by stones or dense vegetation at the entrance of the rain garden.
- If the garden is on a gentle slope, a berm at least two feet wide can be constructed on the downhill side to create the ponding area and/or the garden can be dug into the hillside.
- If the sides will be grassed and will need to be mowed, the side slopes should be a maximum of 33%.
- Soils for rain gardens should be a mix containing 2/3 of native soils and 1/3 compost.
- A mulch layer consisting of 2-3 inches of non-floatable organic mulch (fine shredded hardwood mulch) should be included on the surface of the rain garden. Pine bark and wood chips should not be used for their tendency to float and smother plants.
- The overflow from the rain garden should be non-eroding and can consist of a small berm or even an inlet grate connected to a daylighted pipe. The grate should be set at a slant or be domed to allow clogging debris to fall off.

Vegetation

- Select native species of trees, shrubs and other herbaceous vegetation with the capacity to stabilize the soil and to tolerate both wet and dry conditions. The City approved list of plant species is provided in **Appendix B**.
- As with any garden, vegetation may require irrigation in the first few seasons to properly establish. It may be appropriate to plant more densely than a normal garden to obtain the benefit of plant soil stabilization and evapotranspiration as soon as possible.

Figure 19

Figure 19 | Rain garden (City of Atlanta)

Construction Sequence

1. Excavate carefully to avoid compacting soils at the bottom of the garden. Level the bottom as much as possible to maximize the infiltration area.

2. Mix compost, topsoil, and some of the excavated subsoil together to make the 'amended soil.' The soil mix should be 1/3 compost and 2/3 native soil (topsoil and subsoil combined).

3. Fill with the amended soil, leaving the surface eight inches below the highest surrounding surface, allowing for 6 inches of ponding and 2" of mulch.

4. Build a berm at the downhill edge and sides of the rain garden with the remaining subsoil. The top of the berm needs to be level, and set at the maximum ponding elevation.

5. Install plants and mulch. Loosen up plant roots and gently compact once in the ground. The top of the roots should sit just below the top of the soil.

6. Water all plants thoroughly. As in any new garden or flower bed, regular watering will likely be needed to establish plants during the first growing seasons.

7. Install a rock lined or densely vegetated swale with a gentle slope at the inlet. Use of an impermeable liner under the rocks is recommended to keep water from soaking in at that point.

8. Create an overflow at least 10 feet from any property line and insure it is protected from erosion.

Maintenance

- Routine garden maintenance includes weeding, deadheading, replacing dead plants, and replenishing mulch when depleted. Pesticides should not be used in green infrastructure.

- Inspect after a heavy rainfall. If standing water persists beyond 36 hours, it may be necessary to install a perforated underdrain in the garden that will daylight downstream.

Typical Components of a Rain Garden

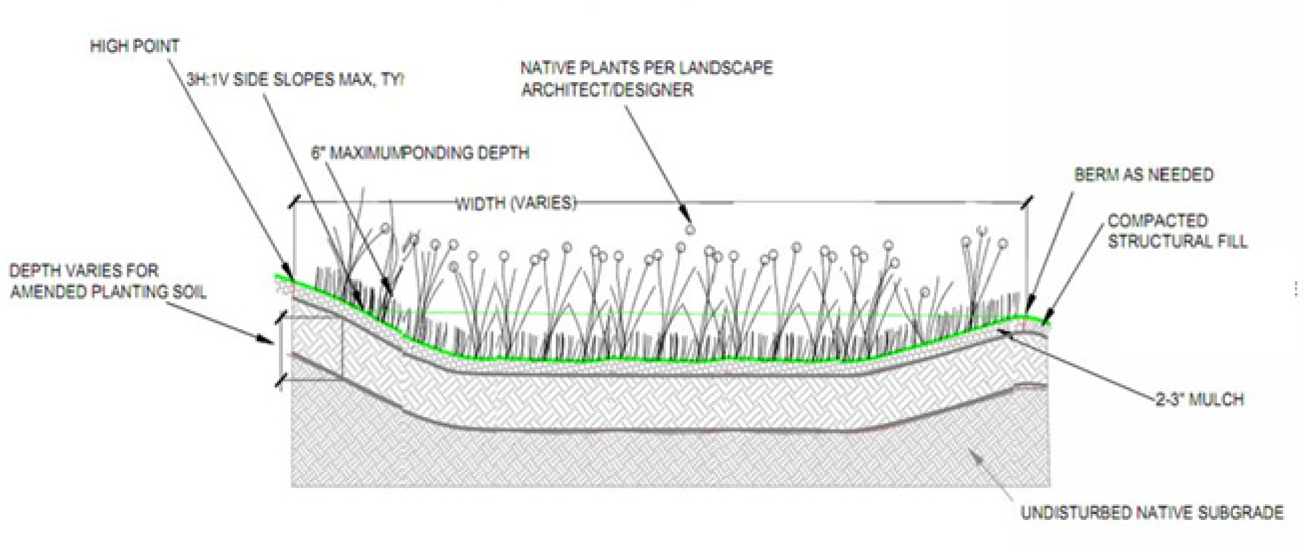


Figure 20 | City of Atlanta

Chater 6

Vegetated Filter Strips

A vegetated filter strip can be an attractive and functional addition to a home landscape. Vegetated filter strips, also known as grass filters, are evenly sloped, vegetated areas designed to receive sheet flow (as opposed to a concentrated source). This type of practice slows and filters stormwater runoff from roof gutter downspouts or parking areas. Vegetated filter strips can provide significant reductions in pollutant loads conveyed to local streams by stormwater runoff. Vegetated filter strips are only allowed to provide for a 50% reduction of the volume reduction required by Code. Vegetated filter strips are an excellent practice to use in combination with other GI practices.

Two design options are included in this section that improve the infiltration potential of the filter strip. In the first one, the existing soil is amended in a similar fashion to a rain garden. The second option uses a berm at the bottom of the strip to allow for temporary ponding. **Figure 21**

Location

- Assess the drainage paths on your property and the slope of the drainage area. Ideal locations are places where there is a gentle slope away from the structure or paved area, and where the flow can be evenly dispersed at the top.
- The slope across the level spreader should be uniform and flow perpendicular the grade of the level spreader.
- The ideal slope of a vegetated filter strip is between 1 and 5%. Greater slopes would concentrate the flow within the filter strip, while lesser slopes would encourage unplanned ponding. If the slope is greater, terracing can be used with level spreaders between each terrace.
- Placing a filter strip over utilities is acceptable. If the amended soil design option is selected, insure utility locations are noted, and the soil should be carefully amended, preferably by hand. Amended or bermed filter strips should not be placed over a septic field.
- The length of the vegetated filter strip should be at least 25 feet. If there is a permeable berm at the lower end or an amended soil design option is used, the length of the vegetated filter strip can be reduced to a minimum of 15 feet. Natural forested areas on site can be counted in the filter strip length total.
- No impervious surface area larger than 5,000 square feet should drain to a filter strip.
- Soils within proposed Vegetated Filter Strip Area must have an infiltration rate of 0.5 in/hr or greater.

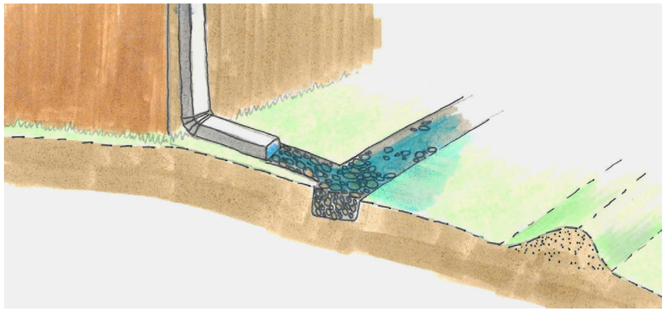


Figure 21 | Vegetated filter strip section

Design Considerations

Level Spreader

- A level spreader is a device used to evenly spread the flow across the strip, on the upper end. It can be a small trench filled with pea gravel or #8 or #89 stone installed perpendicularly to the strip.
- The level spreader should be 12′ to 18″ wide and 6″ to 12″ deep depending on the amount of expected flow. Larger diameter stone may be required to stabilize entry points for larger contributing impervious areas.
- The overflow points must be protected from erosion and not blocked by vegetation.
- If gutter downspouts are piped, a 6″ diameter perforated pipe can be inserted in the level spreader and connected to the gutter downspouts. If the roof surface draining to the strip is less than 1,000 SF, splash blocks may be sufficient to spread the flow.

Amended Soil Design Option

- The infiltration rate can be increased by amending the soil within the filter strip by tilling the existing soil 12″ deep and mixing 4″ of compost with the existing soil.

Berm Design Option

- A permeable berm at the bottom end of the filter strip can increase the ability to infiltrate. The permeable berm is used to temporarily store stormwater runoff within the filter strip.
- Permeable berms should be constructed of well-drained soils stabilized by vegetation and should be between 8″ and 12″ high. The optimum mix of materials within the permeable berm shall consist of 40% excavated soils, 40% sand and 20% pea gravel.
- The ponding area should drain within 24 hours following the end of a rainfall event. Lower the berm if it takes longer.

Figure 22 and **Figure 23** and **Figure 24** and

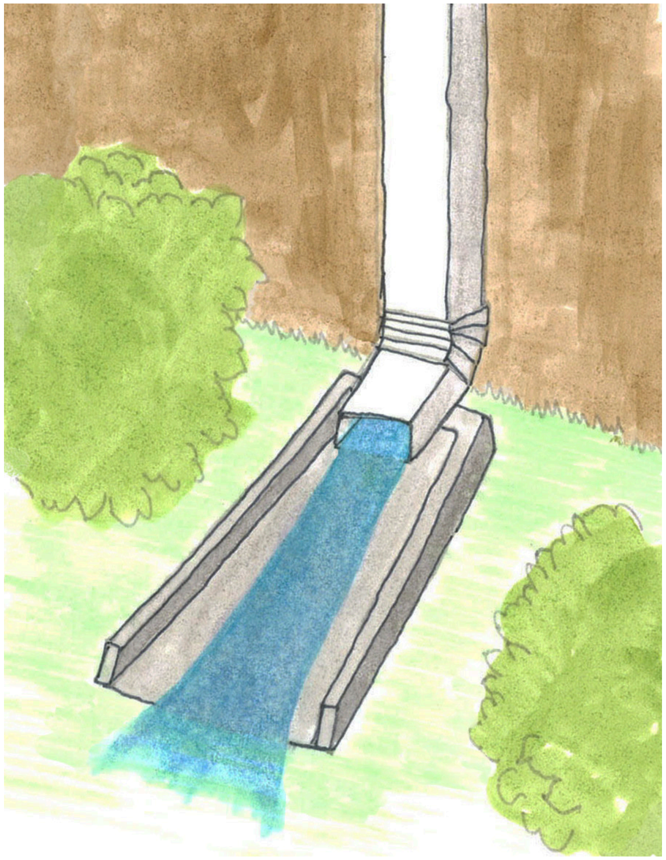


Figure 22 | Splash block

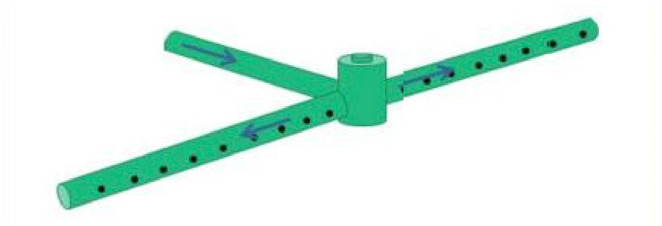


Figure 23 | Level spreader (NEORSD)

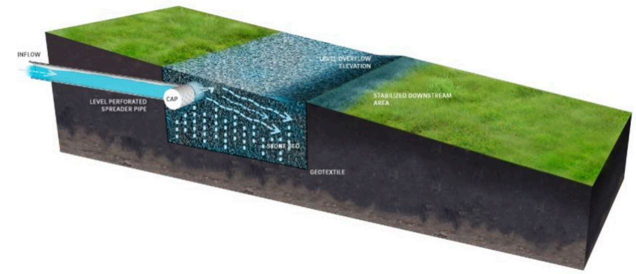


Figure 24 | Level spreader (Philadelphia Water Department)

Sizing

Contributing Impervious Drainage Area (sq ft)	Filter Strip Type		
	Conventional	Amended Soil	Berm
	Required Area of Filter Strip (sq ft)		
500	450	225	150
1000	900	250	300
2000	1800	300	600
3000	2700	450	900
4000	3600	600	1200
5000	4350	750	1500

Vegetation

- Vegetation commonly planted in filter strips includes turf, grasses, perennials and shrubs.
- Choose grasses and other vegetation that will be able to tolerate the stormwater runoff rates and volumes that will pass through the vegetated filter strip. The plants must also be able to survive short drought spells. The City-approved list of plant species is provided in **Appendix B**.

Construction Sequence

1. Always call 811 to locate utility lines before digging.
2. Lay out and mark the filter strip area, flow spreader line and inlets.
3. Construct the flow spreader, filling the trench with pea gravel or #8 or #89 stone.
4. Construct filter strip option (amended soil and/or berm) and prepare the soil accordingly.
5. Plant dense vegetation or sod/seed. Insure a temporary irrigation plan is in place.
6. Insure temporary erosion control is in place as needed until the vegetation is established and can withstand the flow.

Maintenance

Regular maintenance of the vegetated filter strip is necessary to provide measurable stormwater management benefits over time.

- Water as needed to promote plant growth and survival, especially in the first year.
- Provide normal turf or garden maintenance - mow, prune, weed and trim as needed. Pesticides should not be used in GI practices.
- Inspect the vegetated filter strip following rainfall events. Fix erosion issues immediately.
- Remove accumulated trash, sediment and debris.

Typical Components of a Vegetated Filter Strip

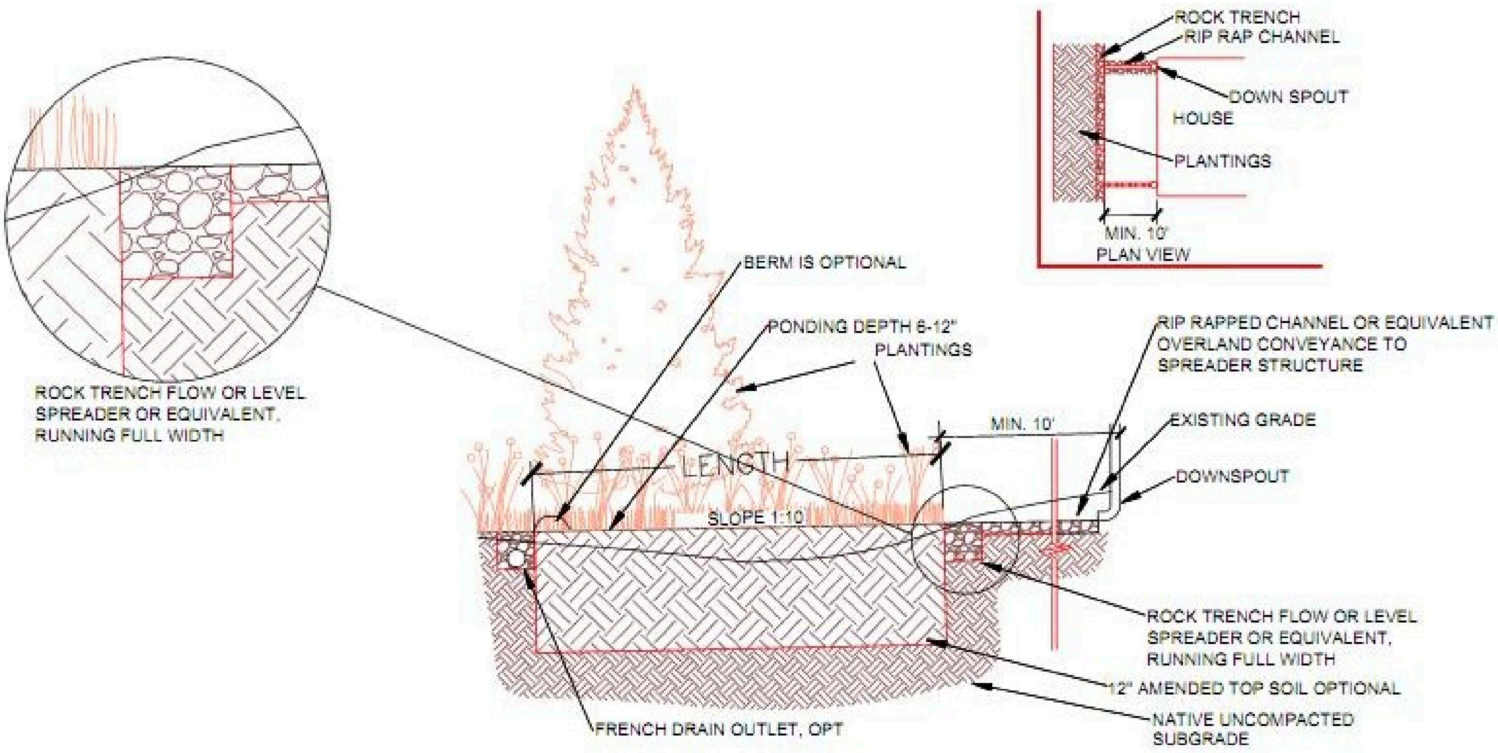


Figure 25 | City of Atlanta

Chpater 7

Permeable Pavers

Permeable pavers are an alternative to traditional paving surfaces that can decrease stormwater runoff around your home. They are well suited for constructing sidewalks, parking areas, patios, and driveways.

Permeable pavers consist of interlocking or grid concrete pavers and a drainage layer. A permeable paver system allows stormwater runoff to pass in between the pavers and into an underlying stone reservoir, where it is temporarily stored and allowed to infiltrate into the underlying soils. Permeable pavers can provide significant reductions in, and pollutant loads conveyed to streams by stormwater runoff. However, they are not considered an effective infiltration practice and cannot be used to reach the volume reduction required by Code. **Figure 26**

Location

- Permeable paver systems should be located at least 5 feet from building foundations and 10 feet from buildings with basements.
- Permeable pavers should not be located:
    - above an area with a water table or bedrock less than two feet below the gravel bottom;
    - over other utility lines; or
    - above a septic field.
- Drainage from other areas onto the pavers will eventually clog them and is not allowed.
- Permeable paver systems must be installed on slopes less than 5% to help ensure even distribution of the runoff over the infiltration surface and should slope away from structures.
- The subgrade of the permeable pavement surface must not sloped at no greater than 1%

Design Considerations

- The desirable soil infiltration rate suitable for a paver system is 0.50 inches per hour (in/hr) or greater.
- Permeable paver systems require multiple layers. Manufacturer's instructions, if they exist, should be followed in lieu of these guidelines.
- The top course consists of the pavers and a crushed aggregate material swept between

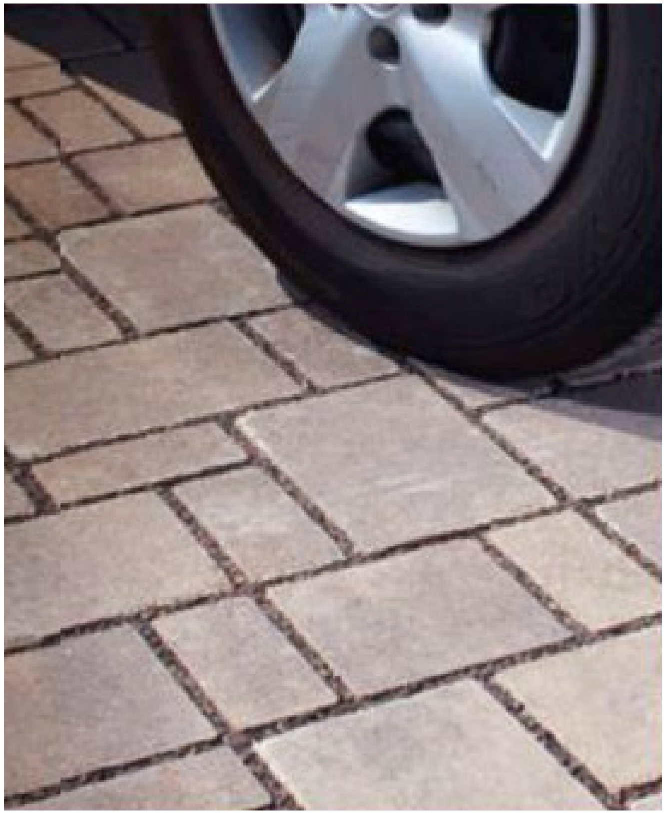


Figure 26 | Permeable pavers (City of Atlanta)

the pavers, such as #8 or #89 stone. The thickness of this layer varies depending upon the depth of the paver.

- The bedding course consists of 2 inches of #8 and #89 stone. The bedding course provides a level bed for setting the pavers evenly.
- The aggregate base course consists of #57 stone, a minimum of 6-inches in depth.
- The sub base layer consists of #2 stone, a minimum of 6-inches in depth.
- A permeable drainage fabric (geotextile) must be used to separate the sub-base course and the subgrade.
- The subgrade layer is the layer of native soils and should be prepared by scarifying or tilling to a depth of 3 to 4 inches. The slope on this layer shall be graded at less than 1% to provide for proper infiltration.
- A herringbone pattern is recommended for drivable surfaces.

Construction Sequence

1. Excavate the area and scarify the native soils to a depth of 3 to 4 inches. Verify slope to be 0%-1%
2. Place geotech fabric extending up sides throughout.
3. Place, level and compact the 6-inch minimum sub base layer of #2 stone.
4. Place, level and compact the 6-inch minimum aggregate base course of #57 stone.
5. Place, level and compact the 2-inch bedding layer of #8 or #89 stone.
6. Install the pavers and edge restraints.
7. Sweep #8 or #89 stone into the joints between the pavers.

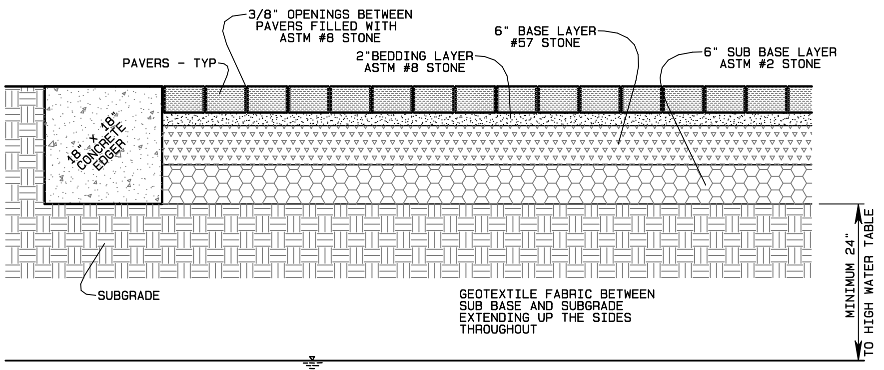
Maintenance

- Monthly, remove accumulated sediment and debris from joint spac.
- Observe the permeable paver system for excessive ponding during storm events and repair as needed.
- Vacuum, sweep, or blow permeable paver surface quarterly to keep the surface free of sediment, according to the manufacturer's specifications. New #8 or #89 stone may need to be swept into the space between stones as needed.
- Annually inspect permeable paver surface for deterioration. Repair or replace any damaged areas as needed. **Figure 27**

Figure 27 | Permeable pavers (City of Atlanta)

Typical Components of Permeable Pavers

NOTE: NO RUNOFF MAY BE DIRECTED TOWARDS PAVERS FROM OUTSIDE ITS SURFACE AREA.



PLAN

SCALE: NTS

PERMEABLE PAVER SYSTEMS

Design Criteria
- Intended for low traffic areas, or for residential or overflow parking applications, not ideal for areas with a tree canopy
- Aesthetically pleasing
- Americans with Disabilities Act (ADA) compliant
- Should be a minimum of two feet above the natural water table
- Should be a minimum of 15 feet away from buildings

Limitations
- Potential for high failure rate if not adequately maintained or used in unstabilized areas
- Geotechnical analysis of soils required; Minimum Infiltration 0.5 In/Hr
- Ineffective under tree canopy, due to clogging

Maintenance Requirements
- High maintenance requirements
- Weed and remove grass out of bricks / blocks as necessary (unless concrete grid pavers are used)
- Sweep or vacuum the pavers as necessary

Pollutant Removal
- 80% TSS Removal

Suitability
- Runoff Reduction
  - 100% of the runoff reduction credit if an underdrain is not used
  - 75% of the runoff reduction credit if an upturned underdrain is used
  - 50% of the runoff reduction credit if an underdrain is used
- Water Quality
- Channel Protection ? May provide partial benefits
- Overbank Flood Protection ? May provide partial benefits
- Extreme Flood Protection ? May provide partial benefits

PERMEABLE PAVERS MAINTENANCE

Common Problems
- Sediment Build-Up and clogging between Pavers
- Settling
- Pavers cracking or splitting

Monthly during dry weather
- Keep the pavers free of trash, debris, and sediment.
- Make sure that there is no standing water in the pavers between storms.
- Remove weeds and grass growing between pavers (unless concrete grid pavers are being used).
- Mow grass within the pavers (only for concrete grid with grass).
- Mow / trim grass or vegetation near the pavers and remove clippings from area.
- Visually inspect the pavers after large storms to ensure the overflow drainage system is working.
- Inspect the pavers for damage and repair.
- Vacuum sweep the paver surface to keep free of sediment.
- After cleaning, additional aggregate may need to be added between the pavers. Replace aggregate between the pavers as necessary.

As Needed Typical Routine Maintenance Activities
- Keep the contributing drainage area and surface of the pavers clear of debris, trash, and sediment.
- Ensure that areas surrounding the practice are stabilized and mowed, remove grass clippings.

Semi-annually in Spring and Fall
- Remove sediment, dirt, leaves, and any debris.
- Replace any joint material that has eroded or washed away.
- Observe the system during a rain event.
- Areas should be routinely inspected for settling and loss of water flow through the system. Repair settled areas.

As Needed in Winter
- Organic deicers may be used to melt ice and snow.
- Snow plows may be used when necessary under the following conditions:
  1. The edges of the plow are beveled.
  2. The blade of the snow plow is raised 1-2 inches.
  3. The snow plow is equipped with snow shoes which allow the blade to glide across uneven surfaces.

Annual Routine Maintenance Activities
- Inspect the surface for deterioration or breaking into fragments.
- Flush the underdrain system to check for clogging (if applicable).

Upon Failure Routine Maintenance Activities
- Remove the Permeable Pavers; include the top and base layers of the practice. Clean pavers and base aggregate, and replace as needed.

Record Keeping
- Records of maintenance activities are required for Non-Residential Properties.
- Records of maintenance activities are recommended and should be maintained by Homeowners or residential properties.

NOTE: REPLACEMENT WITH NON-PERMEABLE SURFACE REQUIRES APPROVAL FROM THE CITY OF SANDY SPRINGS AND INSTALLATION OF ADDITIONAL BMPs.

SHEET	OF		REVISIONS			
1	1	DATE: 4-24-2018	NO.	DESCRIPTION	DATE	
		SCALE: AS NOTED				STANDARD DETAILS
		DRAWN: G.E.Q.				PERMEABLE PAVERS
DRAWING NO.		DESIGN: G.E.Q.				
SS DETAILS - BMP-01		APPROVED: G.E.Q.				
		CITY: SANDY SPRINGS				
		COUNTY: FULTON				
		STATE: GEORGIA				

CITY OF SANDY SPRINGS

1 GALAMBOS WAY
SANDY SPRINGS, GA 30350
(770) 730-5600

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SANDY SPRINGS GEORGIA

Printed: 4/24/2018

Figure 28 | Permeable Pavers Std Detail (City of Sandy Springs)

Appendix A

Simplified Infiltration Testing Procedure

1. A minimum of 1 infiltration test shall be required for each proposed infiltration practice.
2. The location of the infiltration test(s) must correspond to the location(s) of the proposed infiltration area(s).
3. Bore or dig a hole to a depth below the bottom of the proposed infiltration area. Install a test casing of rigid 4 to 6 inch diameter pipe.
4. Remove any loose material from the sides of the test casing and any loose or smeared soil from the bottom of the casing.
5. Place a 2-inch layer of coarse sand or fine gravel at the bottom of the test casing.
6. Fill the casing with clean water and allow the underlying soils to presoak for 24 hours.
7. After pre-soaking the hole, refill the test casing. Measure the drop in water level within the test casing, in inches, after one-hour. Repeat the procedure three additional times by filling the casing with clean water and measuring the drop in water level after one hour. A total of four observations must be completed. The soils' infiltration rate can be reported as either the average of the four observations or the value of the last observation, and is reported as inches per hour.
8. After testing is completed, the casing should be removed, and test pit or soil boring should be backfilled and restored

Appendix B

Recommended Plants

Plants for rain gardens and other vegetated stormwater practices must be able to tolerate both wet and dry conditions. This list, while not exhaustive, includes many plants that will tolerate such conditions once established.

The majority of these species are native to Georgia and thus contribute to the added benefit of providing habitat for native pollinators and wildlife.

Key

Height and width: Typical size range for mature plants

Moisture: The amount of soil moisture that plants will tolerate is defined as follows:

- Frequently saturated soils.
- Moist soils that are periodically inundated.
- Areas not flooded after rains and frequently dry between rains.

Light: the amount of sunlight that plants require is defined as follows:

- Sun (Full) Direct sunlight for at least 6 hours per day
- Part (Partial shade)—Direct sunlight for 3-6 hours per day, or lightly filtered light all day
- Shade: Less than 3 hours of direct sunlight per day, or heavily filtered light all day

Botanical Name	Common Name	Evergreen	Native	Light	Heigh	Width	Moisture

Grasses and Allies

Botanical Name	Common Name	Evergreen	Native	Light	Heigh	Width	Moisture
Acorus gramineus	Sweet Flag	Semi	No	Sun to Part	6-12″	6-12″	1
Chasmanthium laftifolium	Upland River Oats	No	Yes	Part	24-36″	24-36″	2-3
Juncus effusus	Soft Rush	No	Yes	Sun	24-48″	24-48″	2
Muhlenbergia capillaris	Muhly Grass	No	Yes	Sun	24″	24″	3
Panicum virgatum	Switchgrass	No	Yes	Sun to Part	36-48″	24-36″	1-3

Perennials

Botanical Name	Common Name	Evergreen	Native	Light	Heigh	Width	Moisture
Adiantum pedatum	Maidenhair fern	No	Yes	Shade to Part	19″	24″	
Asclepias incarnata	Swamp milkweed	No	Yes	Sun to Part	36″	24″	1
Asclepias tuberosa	Butterfly weed	No	Yes	Sun	36″	24″	3
Athyrium filix-femina	Ladyfern	No	Yes	Shade to Part	24″	30″	1
Coreopsis lanceolata	Lanceleaf thickseed	Yes	Yes	Sun to Shade	24″	24″	2
Echinacea purpurea	Purple coneflower	No	Yes	Sun to Part	36″	30″	3
Iris sp.	Irises	Yes/No	No	Sun to Part	var	var	var
Iris virginica	Blue flag iris	No	Yes	Sun to Part	24-48″	18″	1
Osmunda regalis	Royal fern	No	Yes	Part to Shade	36-48″	60″	2
Polystichum acrostichoides	Christmas fern	Yes	Yes	Part to Shade	24″	36″	2
Reullia humilis	Wild petunia	No	Yes	Part	24″	24″	2-3
Zephyranthes atamasca	Atamasco rain lily	No	Yes	Part to Shade	12″	9″	2

Vines

Botanical Name	Common Name	Evergreen	Native	Light	Heigh	Width	Moisture
Bignonia capreolata	Crossvine	Yes	Yes	Sun to Part			2
Campsis radicans	Trumpet vine	No	Yes	Sun			1-2
Gelsemium sempervirens	Carolina jessmine	Yes	Yes	Sun to Part			2
Lonicera sempervirens	Coral honeysuckle	Yes	Yes	Sun to Part			1-2

Shrubs and Small Trees

Amelanchier arborea	Downy serviceberry	No	Yes	Sun to Shade	15-25′	15-25′	1-2
Amelanchier laevis	Allegheny serviceberry	No	Yes	Part to Shade	12-25′	15-25′	1-2
Aronia arbutifolia	Chokeberry	No	Yes	Sun	6-10′	3-5′	2
Calycanthus floridus	Carolina allspice, sweetshrub	No	Yes	Sun to Part	4-7;	4-6′	3
Cephalanthus occidentalis	Buttonbush	No	Yes	Sun	10-12′	10′	1-2
Cercis canadensis	Redbud	No	Yes	Sun	20-30′	25-35′	2-3
Chionanthus virginicus	Fringetree	No	Yes	Part	15-25′	15-25′	2
Hydrangea guercifolia	Oakleaf hydrangea	No	Yes	Shade	3-9′	3-9;	2
Ilex latifolia	Lusterleaf holly						
Ilex verticilata	Winterberry	No	Yes	Sun to Shade	6-10′	6-8′	1-3
Illicium floridanum	Anise tree	Yes	Yes	Part	6-10′	6-8′	2
Magnolia virginiana	Sweetbay magnolia	Yes	Yes	Part	12-20′	12-15′	2
Myrica cerifera / Morella cerifera	Wax myrtle	Yes	Yes	Sun to Shade	10-15′	10-15′	1-2
Osmanthus americanus (Cartrema americana)	Devilwood/ Wild olive	Yes	Yes	Sun to Part-Shade	20-25′	10-20′	2

Larger Trees

Betula nigra	River birch	No	Yes	Sun	50-70′	25′	2-3
Carpinus caroliniana	American hornbeam, ironwood	No	Yes	Sun to Shade	20-30′	20-30′	2
Fagus grandifolia	American beech	No	Yes	Part-Shade to Shade	50-75′	50′	3
Plantanus occidentalis	Sycamore	No	Yes	Sun	75-100′	75′	1-2
Quercus palustris	Pin Oak	No	Yes	Sun to Shade	50-75′	50′	1-3