Green Infrastructure for Single Family Residences

CITY OF ATLANTA STORMWATER GUIDELINES

Prepared for
CITY OF ATLANTA, GEORGIA
DEPARTMENT OF WATERSHED MANAGEMENT
NOVEMBER 2012

Prepared by
AMEC Environment & Infrastructure

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INTRODUCTION

Background and Purpose

Land development permanently alters the way in which stormwater flows across a site due to grading, compaction, and the installation of impervious cover. In order to mitigate these impacts, the City of Atlanta requires, in accordance with *Chapter 74, Article X. Post Development Stormwater Management*, that stormwater management measures be utilized when constructing a new home or an addition that is greater than 1,000 square feet of impervious surface.

The purpose of this document is to provide a guideline for selecting and installing the appropriate stormwater management measures when constructing a home.

This guideline employs simplified design standards more applicable to the homeowner/builder experience, thus avoiding the necessity for complex engineering calculations and analysis. This guideline is meant to complement the use of the Georgia Stormwater Management Manual (Blue Book) and the Coastal Stormwater Supplement (CSS). Those documents may be used for design purposes as appropriate in lieu of this document, but must be used for sites that propose more than 5,000 square feet of impervious area.

Submittal Information

The following section provides, in a question and answer format, the necessary information for understanding the requirements and process for submittal.

What types of Single Family Residential (SFR) projects require Stormwater Management?

The following activities are required to install stormwater management on site:

- The construction of a new or infill house; or
- Additions that involve the creation, or demolition and replacement of more than 1,000 ft^2 of impervious cover.

What portions of SFR projects require Stormwater Management?

These requirements are intended to capture the main portions of SFR impervious areas.

Impervious cover is defined as *a surface composed of any material that significantly impedes or prevents the natural percolation of water into soil, which includes, but is not limited to, rooftops, buildings, streets and roads, and any concrete or asphalt surface.* Only the major impervious areas of the property need to be treated. This includes the rooftop of the main structure and garage, parking areas and paved patio areas. It excludes minor out buildings, walkways, small miscellaneous paved areas, and the entry driveway area leading from the road to parking and turn around areas.

The area draining to any practice is called the "contributing drainage area" and normally consists of 100% impervious area, though for rain gardens and filter strips incidental small pervious areas can be included if unavoidable, and the areas are stabilized to eliminate soil erosion.

What are the principles for managing stormwater on SFR developments?

Residential developments are not required to provide the same types of stormwater management as commercial projects; however, certain requirements must be met to ensure that stormwater runoff does not overwhelm stormwater infrastructure; impact water quality in our streams; or impact adjacent property. The key principles for managing stormwater from a SFR lot are:

- Proper grading techniques and Erosion Control BMPs during construction;
- Runoff Reduction (see section below);
- Reliance on infiltration only where the water table or bedrock layer is at least two feet below the bottom of the practice in use; and,
- Proper installation and maintenance of downspouts, channels, or any other sources of concentrated flow.

What is Runoff Reduction?

The term 'Runoff Reduction' means the interception, evapotranspiration, infiltration or capture and reuse of stormwater runoff. Examples of runoff reduction techniques on a single family residential development include any appropriate combination of the following techniques termed Green Infrastructure Practices:

1. installing a rain garden or bioretention area,
2. replacing traditionally impervious surfaces (driveways, patios, etc.) with pervious paving,
3. routing downspouts to underground dry wells,
4. routing downspouts to modified French drains,
5. using cisterns for reuse or irrigation, or
6. directing sheet flow to adequately sized vegetated filter strips, or any appropriate combination of techniques.

The goal of these techniques is to reduce the volume of runoff generated by the first one-inch of rain. Other Green Infrastructure Practices that employ runoff reduction techniques may be used in lieu of these techniques with proper documentation of design criteria and details.

How are Runoff Reduction techniques sized on SFR developments?

Applicants have the choice to meet this requirement by following the practices in this technical guidance document or by utilizing the Blue Book and the CSS to design an appropriate stormwater management plan. The amount of volume to be reduced on site is directly related to the drainage area contributing runoff to the treatment technology.

What needs to be submitted?

Applicants must develop a site plan using the checklist found at http://www.atlantaga.gov/. The checklist items relevant to stormwater management include the following:

- Existing and proposed ground contours and elevations;
- Sanitary and storm sewer, structures and easements;

- Location, configuration and finished floor elevations for existing and proposed building structures;
- Location, configuration and finished elevations for existing and proposed paved areas;
- Erosion and sediment control practices in conformance with the Manual for Erosion and Sediment Control in Georgia, Chapter 6; and

Pertinent to stormwater the following guidance applies to all designs:

- Stormwater runoff from the first one inch of rainfall must be captured on site and dissipated through the use of infiltration, evapotranspiration or alternate use (e.g. irrigation). It cannot run off the site.
- Concentrated stormwater discharge from a downspout, cistern, or any collection device shall be located a distance of no less than 10 feet from any common property line.
- Details of all Green Infrastructure Practices shall be attached to the site plan using, where possible, specification sheets from this document or sets of plans of equal detail and coverage.

What is in the rest of this document?

The remainder of the document contains:

(1) A set of six information/specification sheets, one for each of the six Green Infrastructure Controls recommended for use. For each the last two pages are a tear-off set of specifications that can be filled in and stapled to construction plans.
(2) An Appendix that describes how to conduct infiltration testing.
(3) An Appendix that describes the types of vegetation recommended for use for those Controls that feature vegetation as part of the treatment approach.

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CISTERN

SINGLE FAMILY RESIDENTIAL GUIDE
CITY OF ATLANTA, GEORGIA
DEPARTMENT OF WATERSHED MANAGEMENT

Cisterns are low impact development practices that store rainwater for later use. Rain is collected from a downspout system, screened to remove trash and leaves and conveyed to a storage container for subsequent use. Unless an advanced filtration system is used, water stored in the cistern is for non-potable water use only. If properly sized, they can provide significant reductions in stormwater runoff rates, volumes and pollutant loads from residential sites. Rain barrels may be part of an overall stormwater management system; however, by themselves they may not be sufficient to meet the requirements of this ordinance.

1,500 Gallon Cistern
Source: LID Urban Design Tools

Location

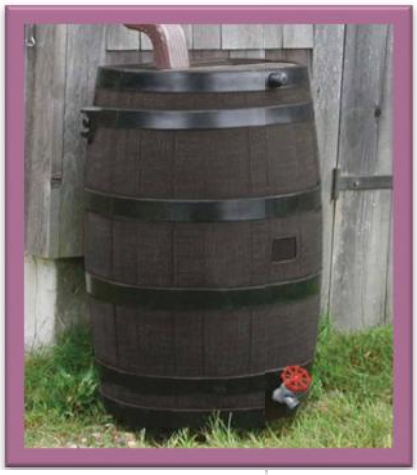
- Consider the size of the contributing drainage areas, and projected water needs, to determine how large a storage tank is needed. Cisterns should drain only impervious areas – preferably rooftops.
- Pick a location keeping in mind: (1) ease in connecting roof drains, (2) overflow to downslope areas, (3) level area, (4) location relative to intended water uses, (5) other utility conflicts, (6) electrical connections if applicable, (7) residential emergency ingress/egress, (8) leaf screen option, (9) location of hoses or other water distribution components, and (10) aesthetic considerations.

Design

- To fully meet the Atlanta standard, cistern capacity must be designed for a 1 inch storm. A good rule of thumb is that when sizing a cistern for the one inch rain standard, each square foot of rooftop will contribute 0.6 gallons of runoff. A one-hundred square foot roof surface will fill a 55 gallon barrel.
- Cisterns come in sizes from a 55 gallon rain barrel to a 1,500 gallon cistern. If the cistern cannot hold the full inch one alternative is to divert overflow to another low impact development structure such as a filter strip, or rain garden.
- Measure contributing roof area width from the drip line of the overhang to the roof peak ignoring the slant, and the length. The width times the length in feet is the drainage area. Multiply that by 0.6 gallons and that is the size of the cistern you will need to fully meet the one-inch rainfall standard.
- All holding tanks should be opaque to prevent algae growth.

- Pretreatment of water entering the cistern will remove debris, dust, leaves, and other material. Pretreatment options are illustrated on the specification sheet. One or more options should be chosen.

Example In-Line Screen - Leaf Beater by Rain Harvest Systems

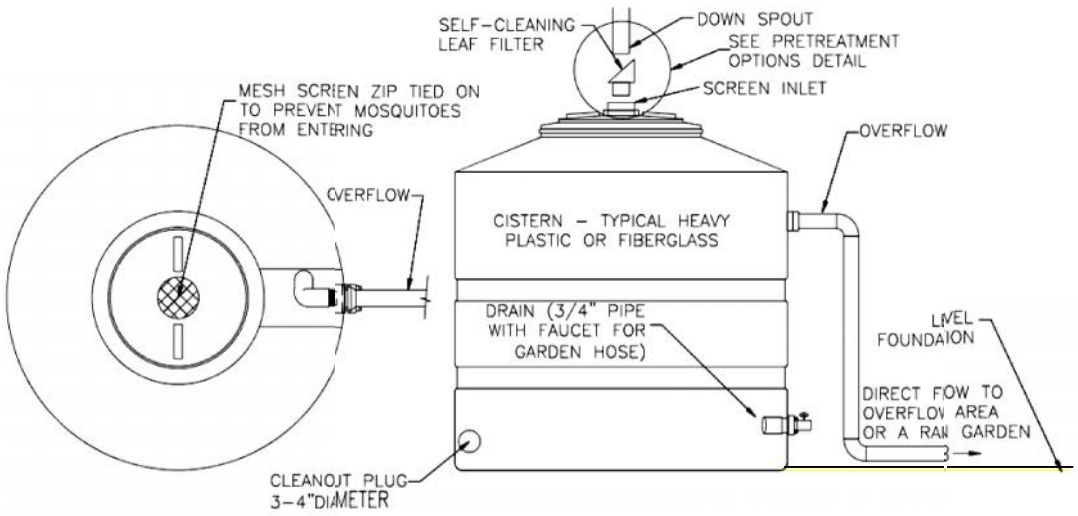

Example Rain Barrel

- The cistern should have an overflow pipe so that when the tank reaches capacity, the rainwater will be directed away from adjacent buildings. More than one cistern can be linked to increase storage capacity.
- Drainage system components leading to the cistern should have a minimum slope of 2% for gravity drainage to the cistern.
- For more complex designs a rainwater harvesting model is provided by the North Carolina State University at http://www.bae.ncsu.edu/topic/waterharvesting.
- Gravity feed drip irrigation kits are available from several suppliers as well as complete instructions on how to design an irrigation system for the low pressure of a cistern system without a pump.

Maintain

- To maintain the storage capacity of the cistern rainwater should be used regularly and a draw down plan initiated.
- Routine checks of the intake and leaf screening components should be done once in the spring and periodically during the fall if leaves fall on the contributing roof area.
- Insure mosquito screen is tight.
- Inspect and if necessary clean out tank annually by scrubbing and letting water drain through low flow plug.
- Check connections for leaks; and inspect overflow for erosion.

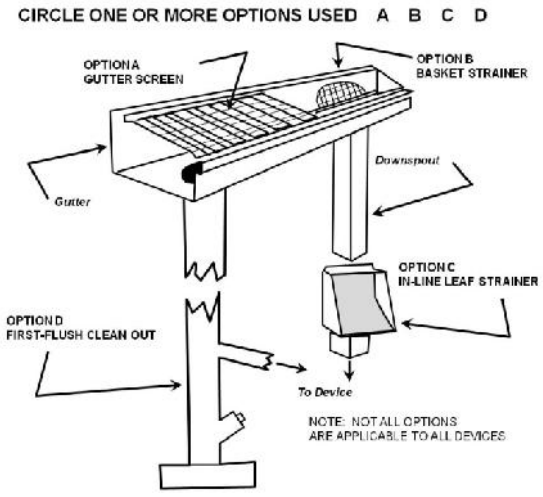

Example Linked Cisterns
Source: http://www.dic.com



TYPICAL COMPONENTS (ATTACH MANUFACTURER'S SPECIFICATIONS)

CONSTRUCTION STEPS:

1. Locate cistern for: (1) ease in connecting roof drains, (2) overflow to downslope area, (3) level area, (4) location relative to intended water uses, (5) other utility conflicts, (6) electrical connections if applicable, (7) emergency ingress/egress, (8) leaf screen option, (9) location of hoses or other water distribution components, and (10) aesthetic considerations.
2. Depending on use review and follow applicable plumbing code.
3. Provide level foundation of compacted earth, blocks, gravel or other hard long lasting surface.
4. Place cistern tank and review all connections for layout and sizing.
5. Cut and route downspouts or other rainwater delivery components, leaf screen option(s) chosen (circle selected options in Pretreatment Options Detail figure), and mosquito screen as applicable. Strap and support as needed.
6. Install water outlet connections including pumps as applicable. Follow manufacturer's specification for all connections and fittings including inlet, overflow, and clean out.
7. Extend overflow to adequate non-eroding discharge point no less than 10 feet from any common property line.
8. Test cistern by filling with water and testing all components in turn – including spraying water on the roof and observing flow.
9. Consider appearance and final landscaping and screening. Complete construction, landscaping, etc.



PRETREATMENT OPTIONS DETAIL

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	NAME/ADDRESS:	CISTERN SPECIFICATIONS PAGE 1 OF 2

SKETCH LAYOUT

PROVIDE PLAN AND ELEVATION VIEWS OF CISTERN AND HOUSE SHOWING ROOF AREA DIRECTED TO CISTERN AND KEY DIMENSIONS AND CONNECTIONS AND OVERFLOW RELATIVE TO PROPERTY LINE.

NOTES:

1. ATTACH MANUFACTURER'S SPECIFICATIONS AND OTHER DETAILS

SIZING CALCULATION:

0.6 GALLONS * SQ FT OF ROOF AREA DIRECTED TO CISTERN)

ROOF AREA DIRECTED TO CISTERN= _____ SQ FT

CISTERN SIZE= _____ GAL

TYPE OF CISTERN/MANUFACTURER:

_____

MAINTENANCE:

1. TO MAINTAIN THE STORAGE CAPACITY OF THE CISTERN RAINWATER SHOULD BE USED REGULARLY
2. ROUTINE CHECKS OF THE INTAKE AND LEAF SCREENING COMPONENTS SHOULD BE DONE ONCE IN THE SPRING AND PERIODICALLY DURING THE FALL IF LEAVES FALL ON THE CONTRIBUTING ROOF AREA.
3. INSPECT AND IF NECESSARY CLEAN OUT TANK ANNUALLY BY SCRUBBING AND LETTING WATER DRAIN THROUGH LOW FLOW PLUG. CHECK CONNECTIONS FOR LEAKS; AND INSPECT OVERFLOW FOR EROSION.

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	ATTACH THIS TWO-PAGE SPECIFICATION TO HOUSE PLAN SUBMITTAL	CISTERN SPECIFICATIONS PAGE 2 OF 2

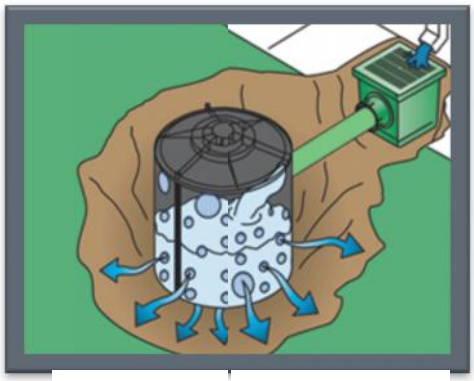
DRY WELL

SINGLE FAMILY RESIDENTIAL GUIDE

CITY OF ATLANTA, GEORGIA

DEPARTMENT OF WATERSHED MANAGEMENT

Dry wells are comprised of seepage tanks set in the ground and, in Atlanta's tight soils, surrounded with stone that are designed to intercept and temporarily store stormwater runoff until it infiltrates into the soil. Alternately the pit can be filled with stone with water entering via a perforated pipe with a perforated standpipe in place of the tank.



Source: www.earthcontactproducts.com/

Dry wells are particularly well suited to receive rooftop runoff entering the tank via an inlet grate (shown right) or direct downspout connection (below right). When properly sized and laid out dry wells can provide significant reductions in stormwater runoff and pollutant loads.

Location

- Dry wells must be located at least 10 feet from building foundations and 10 feet from property lines.
- To reduce the chance of clogging, dry wells 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.
- The height of the tank should not exceed 45 inches unless infiltration testing has been done to insure a drain time of 72 hours or less.
- Dry wells should 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.
- Dry wells should not be located: (1) beneath an impervious (paved) surface; (2) above an area with a water table or bedrock less than two feet below the trench bottom; (3) over other utility lines; or, (4) above a septic field. Always call 811 to locate utility lines before you dig.

Construction

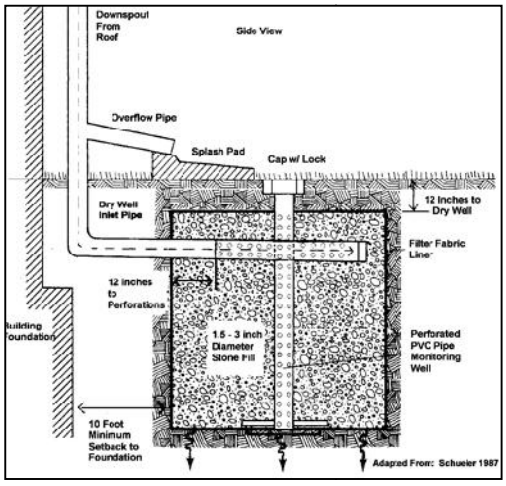
- Consider the drainage area size and the soil infiltration rate when determining the size of the dry well, (see table on next page).
- The sides of the excavation should be trimmed of all large roots that will hamper the installation of the permeable drainage fabric used to line the sides and top of the dry well.
- The dry well hole should be excavated 1 foot deeper and two feet larger in diameter than the well to allow for a 12 inch stone fill jacket.

- The native soils along the bottom of the dry well should be scarified or tilled to a depth of 3 to 4 inches.
- Fill below and around dry well approximately 12 inches of clean, washed #57 stone. #57 stone averages ½ inch to 1-1/2 inches.
- Fill the final 6 inches of the excavation with native soil. Optionally pea gravel or #8 stone can be carried to the surface.
- For rooftop runoff, 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 dry well with an in ground sump grate inlet leaf trap.
- 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 bypassing the dry well.
- The optional design involves placement of a vertical standpipe connected to the inlet pipe. See figure below.

Source: nancysteele.files.wordpress.com

The table below can be used to size a dry well system. Given the tank height and diameter the contributing drainage area in square feet treated can be read. So, for example, if a 10 by 50 foot roof is to be treated the total roof area is 20*50 = 500 square feet. This could be handled by one tank 60" high, 30" diameter. It can also be handled by two tanks 30" high and 24" in diameter.

Gravel Bed Depth (inches)	Tank Height (inches)	Tank Inside Diameter (inches)				
		24	30	36	42	48
		Contributing Area Captured (square feet)				
6	30	258	345	447	563	692
12	30	285	380	490	615	755
6	60	461	622	809	1022	1263
12	60	489	657	852	1075	1325
	Hole Depth (inches)	6" Perforated Standpipe Gravel Filled Hole Diameter (inches)				
		24	30	36	42	48
		Contributing Area Captured (square feet)				
	24	30	46	65	88	114
	30	38	58	82	110	142
	36	46	69	98	132	171
	42	53	81	114	154	199
	48	61	92	130	176	228
	60	76	115	163	219	285



If you elect to measure infiltration rate and find it is higher than 0.5 in/hr length of the dry well size can be reduced. For every 0.5 in/hr increase in measured infiltration rate above 0.5 in/hr subtract ten percent of the required dry well size as measured in square feet captured.

Vegetation

- The landscaped area above the surface of a dry well should be covered with pea gravel when water enters a dry well through surface features rather than the pipe. This pea gravel layer provides sediment removal and additional pretreatment upstream of the dry well and can be easily removed and replaced when it becomes clogged.
- Alternatively, a dry well may be covered with an engineered soil mix, and planted with managed turf or other herbaceous vegetation.

Maintenance

Annual maintenance is important for dry wells, particularly in terms of ensuring that they 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.

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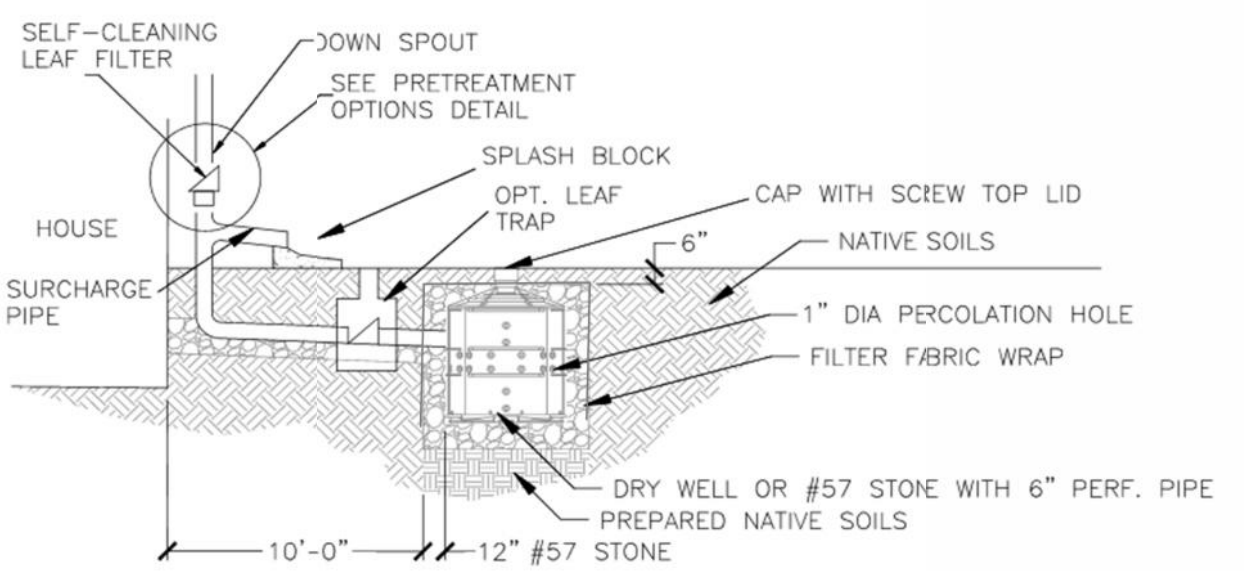
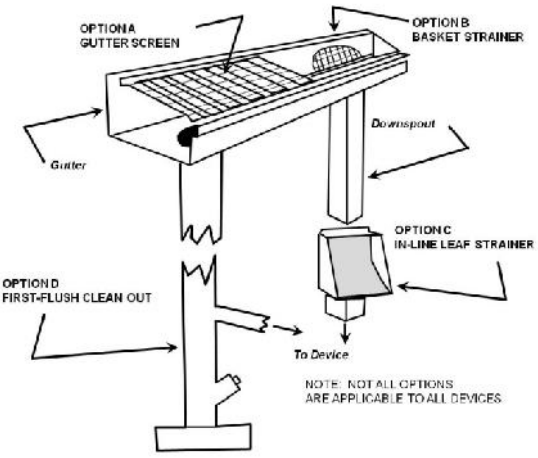


TYPICAL COMPONENTS (ATTACH MANUFACTURER'S SPECIFICATIONS)

CONSTRUCTION STEPS:

1. Review potential dry well areas and layout. Dry wells should not be located: (1) beneath an impervious (paved) surface; (2) above an area with a water table or bedrock less than two feet below the trench bottom; (3) over other utility lines; or, (4) above a septic field. Insure outlet daylights at least ten feet from property line.
2. Measure the area draining to the dry well and determine required size from the table on the next page.
3. If soil is a concern perform infiltration test according to Appendix A. If the rate is less than 0.25 in/hr this method cannot be used. If the rate is more than 0.50 in/hr the storage volume may be decreased 10% for every 0.50 in/hr infiltration rate increase above 0.50 in/hr.
4. Measure elevations and dig the hole to the required dimensions. Scarify the bottom soil surface 3".
5. Place and tamp 6" to 12" of #57 gravel in bottom. Pea gravel can be substituted for leveling purposes in the upper three inch layer below the tank.
6. Place and secure filter cloth down sides of the excavation leaving enough to fold over the top below the soil and turf.
7. Place tank and install piping. Bond top of tank in place.
8. Cut and route downspouts or other rainwater delivery components, leaf screen option(s) chosen (circle selected options in Pretreatment Options Detail figure). Strap and support as needed.
9. Create a safe overflow at least 10 feet from your property edge and insure it is protected from erosion.
10. Test connections with water flow.
11. Fill with gravel jacket around tank and place permeable fabric above between gravel and soil.
12. Backfill with soil/sod or pea gravel.
13. Consider aesthetics as appropriate and erosion control for overflow.

CIRCLE ONE OR MORE OPTIONS USED A B C D



PRETREATMENT OPTIONS DETAIL

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	NAME/ADDRESS:	DRY WELL SPECIFICATIONS PAGE 1 OF 2

SKETCH LAYOUT

PROVIDE PLAN AND ELEVATION VIEWS OF DRY WELL AND HOUSE SHOWING ROOF AREA DIRECTED TO DRY WELL AND KEY DIMENSIONS, CONNECTIONS AND OVERFLOW RELATIVE TO PROPERTY LINE.

SIZING CALCULATION:

Gravel Bed Depth (inches)	Tank Height (inches)	Tank Inside Diameter (inches)				
		24	30	36	42	48
		Contributing Area Captured (square feet)				
6	30	258	345	447	563	692
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36	46	69	98	132	171
42	53	81	114	154	199
48	61	92	130	176	228
60	76	115	163	219	285

MEASURE CONTRIBUTING DRAINAGE AREA AND READ AREA FOR GIVEN MEDIA DEPTH.

CONTRIBUTING DRAINAGE AREA= _____ SQ FT
TANK DIAMETER= _____ INCHES
TANK HEIGHT= _____ INCHES
GRAVEL BED DEPTH= _____ (6 OR 12 INCHES)
ALTERNATIVE STANDPIPE DESIGN
HOLE DIAMETER= _____ INCHES
HOLE DEPTH= _____ INCHES

MAINTENANCE:

1. INSPECT GUTTERS AND DOWNSPOUTS REMOVING ACCUMULATED LEAVES AND DEBRIS, CLEANING LEAF REMOVAL SYSTEM(S).
2. IF APPLICABLE, INSPECT PRETREATMENT DEVICES FOR SEDIMENT ACCUMULATION. REMOVE ACCUMULATED TRASH AND DEBRIS.
3. INSPECT DRY WELL FOLLOWING A LARGE RAINFALL EVENT TO INSURE OVERFLOW IS OPERATING AND FLOW IS NOT CAUSING PROBLEMS.

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	ATTACH THIS TWO-PAGE SPECIFICATION TO HOUSE PLAN SUBMITTAL	DRY WELL SPECIFICATIONS PAGE 2 OF 2

VEGETATED FILTER STRIPS

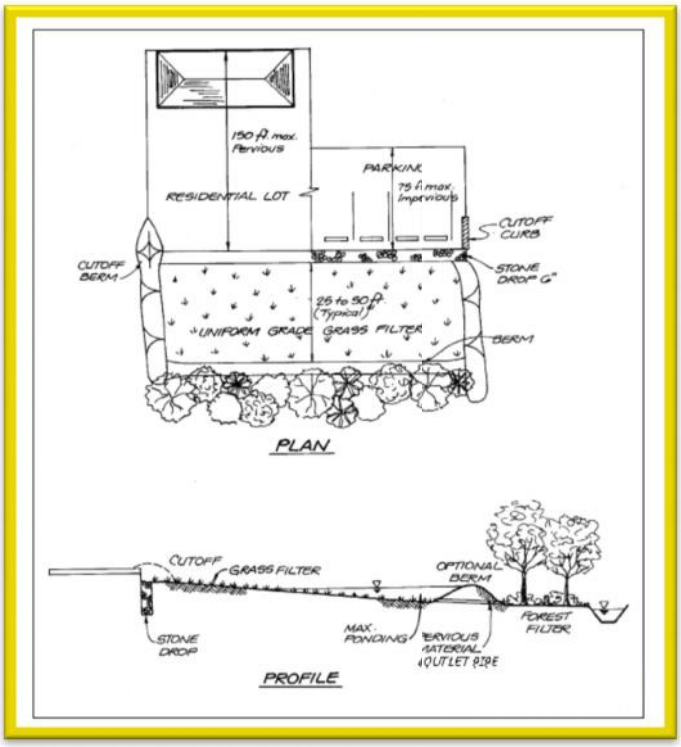
SINGLE FAMILY RESIDENTIAL GUIDE

CITY OF ATLANTA, GEORGIA
DEPARTMENT OF WATERSHED MANAGEMENT

A vegetated filter strip can be an attractive and functional addition to your home landscape. Vegetated filter strips (also known as grass filters) are uniformly graded, vegetated areas of land designed to receive rainwater as sheet flow and slow and filter stormwater runoff from roof downspouts or parking areas. Vegetated filter strips can provide significant reductions in stormwater runoff and pollutant loads in your local watershed.

Location

- Take note of the drainage patterns to determine the best location for a vegetated filter strip. Assess the drainage area flow 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, the area is relatively flat, and where the flow can be evenly disbursed along the top of the filter area.
- The ideal slope of the vegetated filter strip is between 1 and 5%. Greater slopes would encourage the formation of concentrated 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 except where the amended soil option is used. In that case insure utility locations are noted and care is taken in soil amendment actions. Amended or bermed filter strips should not be placed over a septic field.
- The length of the vegetated filter strip should be no less than 25 feet. If there is a permeable berm at the lower end, the length of the vegetated filter strip should be no less than 15 feet. Natural forested areas on site can be counted in the filter strip length total.
- The surface impervious area to any one discharge location cannot exceed 5,000 square feet.

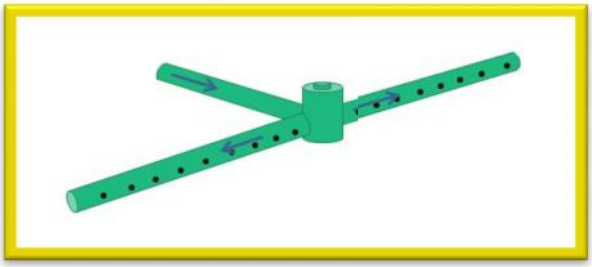


Source:
Center for Watershed Protection. 2009.
Coastal Stormwater Supplement to the
Georgia Stormwater Management Manual.

Construction

Level Spreader

- A level spreader must be used at the upstream end of the filter strip to evenly distribute stormwater runoff. A level spreader is a small trench filled with pea gravel or # 8 stone installed along a level contour.
- 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.
- To help insure more even discharge of flow into the filter strip, notches can be cut in the level spreader at intervals allowing overflowing water to enter at several locations ahead of general overflow.
- The level spreader can be connected to the downspout through a T-connection to perforated pipes embedded in the flow spreader trench (see figure).



- Insure the overflow points are protected from erosion and not blocked by vegetation.
- If the impervious drainage area to any one entry point (e.g. a downspout) is less than 1,000 square feet appropriate level spreaders may be waived if flow will flow as a sheet through the strip area. In this case simple splash blocks (see figure) can be used to introduce flow into turf (yard) areas.

Source: www.neorsd.org

Amended Soil Design Option

- Increased infiltration and a doubling of the ability to meet the one-inch standard can be achieved by amending the soil within the filter strip by tilling the existing soil 12" deep and mixing 4" of compost.

Berm Design Option

- A greater ability to meet the one-inch standard can be achieved through the use of a permeable berm at the bottom end of the filter strip. The permeable berm is used to temporarily store stormwater runoff within the filter strip, which increases the infiltration and reduces the required width of the filter strip.
- Permeable berms should be constructed of well drained soils (sand, gravels, and sandy loams) that support plant growth and should be no more than 12" high.
- Appropriately sized outlets should be provided within permeable berms to ensure that vegetated filter strips will drain within 24 hours following the end of a rainfall event.
- A stone-protected overflow area through the berm may be used to manage the stormwater runoff generated by large storm events. The overflow point must be at least ten feet from the property line if flow is onto adjoining property. Erosion protection is critical.

Design Table

Measure the rooftop and any other area that is going to be directed to the filter strip. From the site layout select the size and type of filter strip from the table to meet the one inch design standard. For example, for a 1,000 square foot rooftop conventional filter strip the filter strip surface area must be at least 2,000 square feet with a minimum flow length of 25 feet. Built with a berm it can have a surface area of 500 square feet and have a minimum flow length of 15 feet.

Contributing Drainage Area (square feet)	Filter Strip Type		
	Conventional	Amended Soil	Berm
	Filter Strip Area (sq ft)		
100	200	70	50
500	1000	350	250
1000	2000	670	500
2000	4000	1400	1000
3000	6000	2700	1500
4000	8000	5400	2000
5000	10000	6700	2500

Vegetation

- Vegetation commonly planted on vegetated filter strips includes turf, shrubs, trees, and other herbaceous vegetation.
- 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.
- Vegetation used in filter strips should be able to tolerate both wet and dry conditions.
- Refer elsewhere within this document for more guidance.

Maintenance

Maintain the vegetated filter strip so that it will continue to provide measurable stormwater management benefits over time.

- Water as needed to promote plant growth and survival especially in the first two seasons.
- Provide normal turf or garden maintenance - mow, prune, and trim as needed.
- Inspect the vegetated filter strip following rainfall events. Fix erosion issues immediately.
- Remove accumulated trash, sediment and debris.

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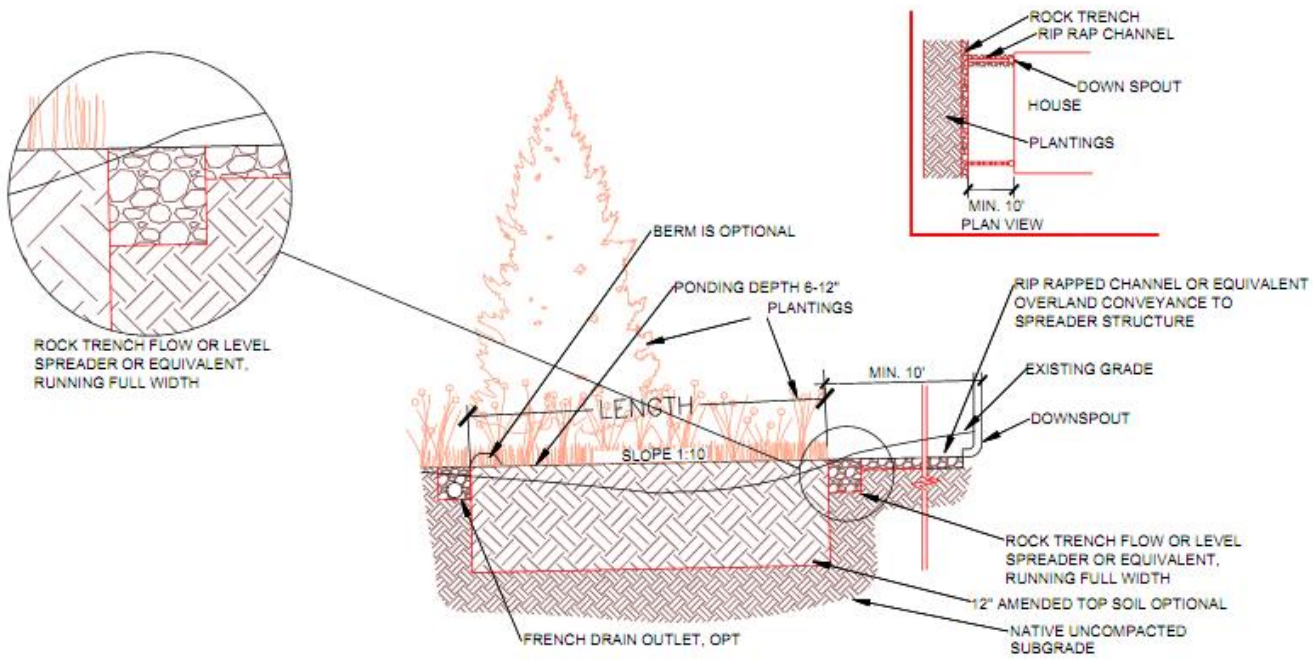
TYPICAL COMPONENTS



CONSTRUCTION STEPS:

1. Review potential filter strip areas and layout. Filter strips should slope between 1% and 5% away from the structure and should not be located above a septic field. Placing a filter strip over utilities is acceptable except where the amended soil option is used. In that case insure utility locations are noted and care is taken in soil amendment actions. If there is a concentrated overflow insure it is at least ten feet from adjacent property.
2. Measure the area draining to the filter strip and determine required surface area and minimum length from the table on the next page. Determine the desired filter strip and flow spreader options.
3. Lay out and mark filter strip area, flow spreader line and inlets.
4. Construct flow spreader filling trench with appropriate gravel and noting overflow points.
5. Construct filter strip option, prepare soil.
6. Construct erosion control at the flow entrance and exit points as applicable.
7. Plant dense vegetation according to plan, or sod/seed. Insure an irrigation plan is in place.
8. Insure temporary erosion control is in place as needed until vegetation establishment.

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	NAME/ADDRESS:	FILTER STRIP SPECIFICATIONS PAGE 1 OF 2

SKETCH LAYOUT

PROVIDE PLAN AND ELEVATION VIEWS OF FILTER STRIP AND HOUSE SHOWING ROOF AREA DIRECTED TO FILTER STRIP AND KEY DIMENSIONS, CONNECTIONS AND OVERFLOW RELATIVE TO PROPERTY LINE.

SIZING CALCULATION:

Contributing Drainage Area (square feet)	Filter Strip Type		
	Conventional	Amended Soil	Berm
	Filter Strip Area (sq ft)		
100	200	70	50
500	1000	350	250
1000	2000	670	500
2000	4000	1400	1000
3000	6000	2700	1500
4000	8000	5400	2000
5000	10000	6700	2500

MEASURE CONTRIBUTING DRAINAGE AREA AND READ AREA FOR GIVEN FILTER TYPE.

CONTRIBUTING DRAINAGE AREA= _____ SQ FT
FILTER STRIP AREA= _____ SQ FT
CONVENTIONAL – 25' MINIMUM LENGTH
BERM OPTION – 15' MINIMUM LENGTH

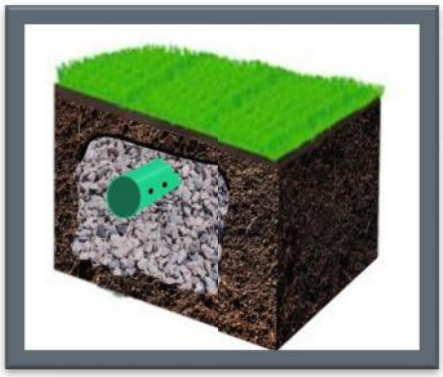
MAINTENANCE:

1. INSPECT GUTTERS AND DOWNSPOUTS REMOVING ACCUMULATED LEAVES AND DEBRIS, CLEANING LEAF REMOVAL SYSTEM(S).
2. IF APPLICABLE, INSPECT PRETREATMENT DEVICES FOR SEDIMENT ACCUMULATION. REMOVE ACCUMULATED TRASH AND DEBRIS.
3. WATER AS NEEDED TO PROMOTE PLANT GROWTH AND SURVIVAL ESPECIALLY IN THE FIRST TWO SEASONS.
4. PROVIDE NORMAL TURF OR GARDEN MAINTENANCE - MOW, PRUNE, AND TRIM AS NEEDED.
5. INSPECT THE VEGETATED FILTER STRIP FOLLOWING RAINFALL EVENTS. FIX EROSION ISSUES IMMEDIATELY.

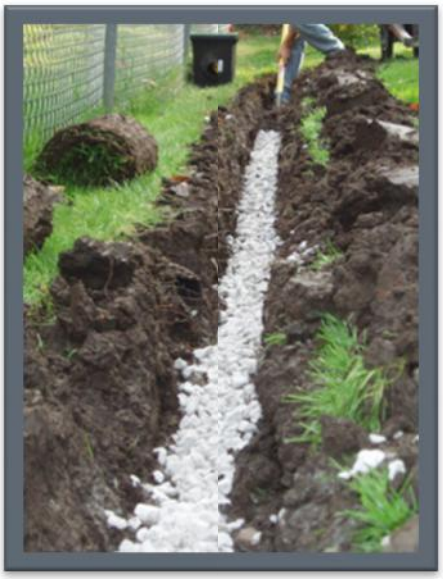
MODIFIED FRENCH DRAIN

SINGLE FAMILY RESIDENTIAL GUIDE
CITY OF ATLANTA, GEORGIA
DEPARTMENT OF WATERSHED MANAGEMENT

Modified French Drains (MFD) are shallow trench excavations filled with stone that 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, but can also be used to receive stormwater runoff from other small impervious areas. In Atlanta, due to poor draining soils, only the daylighted French Drain version is allowed in residential applications. The perforated pipe is daylighted at its end allowing for overflow of larger storms and a failsafe mechanism should infiltration not be as anticipated.



Location



- MFD trenches should be located at least 5 feet from building foundations and 10 feet from buildings with basements and property lines. The top end of the MFD can be adjacent to the building to connect downspouts 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.
- 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.
- MFD gravel depths should be at least 18 inches and no more than 36 inches.
- MFDs should be located in a lawn or other pervious (unpaved) area and should be designed so that the top of the MFD is located as close to the surface as possible to reduce digging.
- MFDs should not be located: (1) beneath an impervious (paved) surface; (2) above an area with a water table or bedrock less than two feet below the trench bottom; (3) over other utility lines; or, (4) above a septic field. Always call 811 to locate utility lines before you dig.
- The downstream end of the pipe must daylight for overflows more than ten feet from the property line.
- The desirable soil infiltration rate suitable for a MFD is 0.50 inches per hour (in/hr) or greater. If there is concern due to tight soils when digging, an infiltration test should be done as per Appendix A.

Construction

- As a rule-of-thumb there should be about 23 cubic feet of stone for every 100 square feet of rooftop. The table provides MFD length requirements for different depths.
- The assumed width in the table is 24 inches. The width can be from 18 to 32 inches. Required lengths should be adjusted proportionately if other widths are used.
- The sides of the excavation should be trimmed of all large roots that will hamper the installation of the permeable drainage fabric used part way down the sides and above the gravel layer on top of the MFD.

Rooftop Area (square feet)	Depth of Gravel From Top of Pipe (inches)			
	18	24	30	36
	Required Linear Feet of MFD			
100	6	5	4	3
500	30	25	20	15
1000	60	45	40	35
2000	120	95	75	65
3000	185	140	115	100
4000	245	190	155	130
5000	305	235	195	165

- The native soils along the bottom of the MFD should be scarified or tilled to a depth of 3 to 4 inches.
- Fill the MFD with clean, washed #57 stone embedding a six inch diameter perforated pipe in the top of the stone such that the stone covers the top of the pipe. #57 stone averages ½ inch to 1-1/2 inches.
- The pipe should have 3/8 inch perforations, spaced 6 inches on center, and have a minimum slope of 0.5% and a maximum slope of 6%.
- The perforated pipe must daylight at the downstream end of the trench.
- 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.
- Place permeable landscape fabric over gravel to keep soil or pea gravel from migrating into the gravel and filling the pore spaces, and leave four to six inches above the pipe to the ground surface.
- Cover with top soil and sod or with pea gravel.
- For rooftop runoff, install one or more leaf screen options prior to entering the MFD to prevent leaves and other large debris from clogging the MFD. For 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.

Vegetation

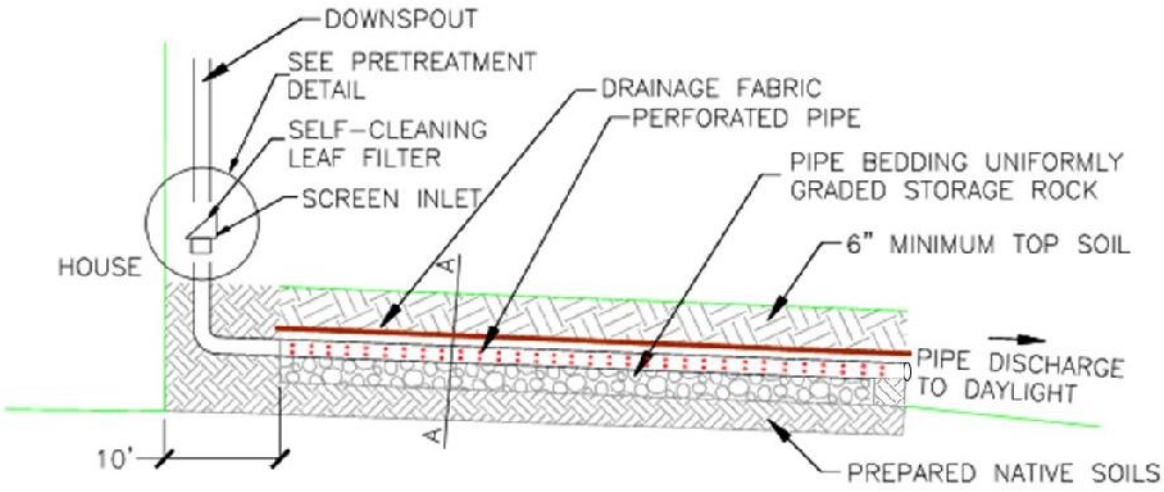
- A MFD is normally covered with topsoil and managed turf or other herbaceous vegetation.
- As an alternative, the area above the surface of a MFD may be covered with pea gravel (or larger depending on the inflow rates) to allow for incidental lateral inflow along the edge of ground level impervious surfaces.
- The downstream end of the pipe must be stabilized and can be landscaped for aesthetics.

Maintenance

Annual maintenance is important for MFDs.

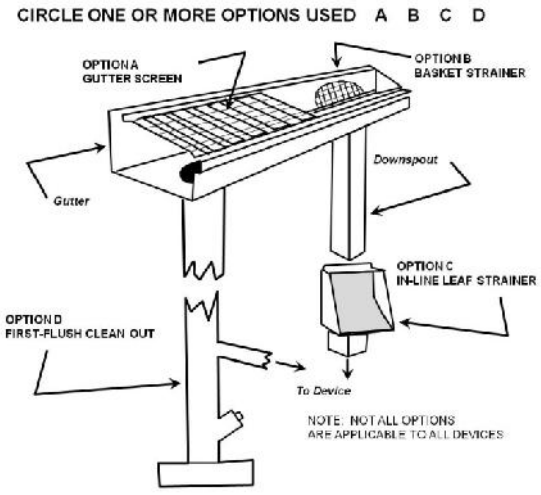
- Inspect gutters/downspouts removing accumulated leaves and debris, cleaning leaf removal system(s).
- Inspect any pretreatment devices for sediment accumulation. Remove accumulated trash and debris.
- Inspect MFD following a large rainfall event to insure overflow is operating and flow is not causing problems.

TYPICAL COMPONENTS (ATTACH MANUFACTURER'S SPECIFICATIONS)



CONSTRUCTION STEPS:

1. Review potential MFD areas and layout. MFDs should slope between 0.5% and 6% away from the structure and should not be located: (1) beneath an impervious (paved) surface; (2) above an area with a water table or bedrock less than two feet below the trench bottom; (3) over other utility lines; or, (4) above a septic field. Insure outlet daylights at least ten feet from property line.
2. Measure the area draining to the MFD and determine required length from the table on the next page using assumed width and gravel depth, and plan route and excavation depth.
3. If soil is a concern perform infiltration test according to Appendix A. If the 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 10% for every 0.50 in/hr infiltration rate increase above 0.50 in/hr.
4. Measure elevations and lay out the MFD to the required dimensions marking the route and required excavation depths. Often a level line (torpedo level) is used.
5. Remove sod using a sod cutter if appropriate. Excavate ditch to the depth of the gravel plus six inches for topsoil/pea gravel and three additional inches to accommodate half the pipe depth. Be careful not to compact soils in the bottom. Level the bottom laterally as much as possible to maximize infiltration area. Roughen bottom to a depth of at least three inches and trim roots.
6. Place and tamp gravel in ditch to planned depth placing the pipe three inches deep in the upper portion of the gravel. Then place and gently tamp gravel until it covers the pipe.
7. Place drainage fabric over top of pipe and stone.
8. Place topsoil and sod or pea gravel.
9. Cut and route downspouts or other rainwater delivery components, leaf screen option(s) chosen (circle selected options in Pretreatment Options Detail figure). Strap and support as needed.
10. Create a safe overflow at least 10 feet from your property edge and insure it is protected from erosion.



PRETREATMENT OPTIONS DETAIL

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	NAME/ADDRESS:	MFD SPECIFICATIONS PAGE 1 OF 2

SKETCH LAYOUT

PROVIDE PLAN AND ELEVATION VIEWS OF MFD AND HOUSE SHOWING ROOF AREA DIRECTED TO MFD AND KEY DIMENSIONS, CONNECTIONS AND OVERFLOW RELATIVE TO PROPERTY LINE.

SIZING CALCULATION:

Rooftop Area (square feet)	Depth of Gravel From Top of Pipe (inches)			
	18	24	30	36
	Required Linear Feet of MFD			
100	6	5	4	3
500	30	25	20	15
1000	60	45	40	35
2000	120	95	75	65
3000	185	140	115	100
4000	245	190	155	130
5000	305	235	195	165

MEASURE CONTRIBUTING DRAINAGE AREA AND READ AREA FOR GIVEN MEDIA DEPTH.

CONTRIBUTING DRAINAGE AREA= _____ SQ FT
DEPTH OF STONE MEDIA= _____ INCHES
WIDTH OF TRENCH= _____ INCHES
LENGTH OF MFD= _____ FT

MAINTENANCE:

1. INSPECT GUTTERS AND DOWNSPOUTS REMOVING ACCUMULATED LEAVES AND DEBRIS, CLEANING LEAF REMOVAL SYSTEM(S).
2. IF APPLICABLE, INSPECT PRETREATMENT DEVICES FOR SEDIMENT ACCUMULATION. REMOVE ACCUMULATED TRASH AND DEBRIS.
3. INSPECT MFD FOLLOWING A LARGE RAINFALL EVENT TO INSURE OVERFLOW IS OPERATING AND FLOW IS NOT CAUSING PROBLEMS.

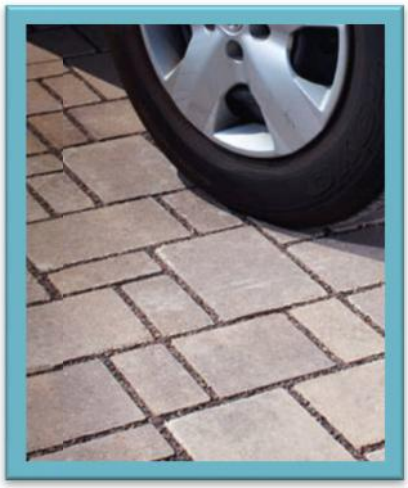
CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	ATTACH THIS TWO-PAGE SPECIFICATION TO HOUSE PLAN SUBMITTAL	MFD SPECIFICATIONS PAGE 2 OF 2

PERMEABLE PAVERS

SINGLE FAMILY RESIDENTIAL GUIDE

CITY OF ATLANTA, GEORGIA

DEPARTMENT OF WATERSHED MANAGEMENT



Permeable pavers are an alternative to traditional paving surfaces that can decrease stormwater runoff around your home. They are well suited for use when constructing sidewalks, parking areas, patios, and driveways. Permeable pavers consist of permeable interlocking or grid concrete pavers underlain by a drainage layer. A permeable paver system allows stormwater runoff to pass in between the paver surface 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 stormwater runoff and pollutant loads in your watershed.

Location

- Maximum contributing drainage area ratio to surface area is 4:1.
- 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: (1) above an area with a water table or bedrock less than two feet below the gravel bottom; (2) over other utility lines; or, (3) above a septic field. Always call 811 to locate utility lines before you dig.
- Permeable pavers should drain only impervious areas. Drainage from other areas onto the pavers will eventually clog them.
- The desirable soil infiltration rate suitable for a paver system is 0.50 inches per hour (in/hr) or greater. If there is concern due to tight soils when digging an infiltration test should be done as per the appendix. If the rate is less than 0.5 in/hr an underdrain leading to daylight should be provided. Professional assistance should be obtained in this case.
- Permeable paver systems should be installed on slopes less than 6% to help insure even distribution of runoff over the infiltration surface, and should slope away from structures.

Construction

The table at the right provides Permeable Paver area size requirements for different depths of the #57 stone layer. This stone averages in size from ½ inch to 1-1/2 inches.

Example: A roof top is 1000 square feet. For a stone depth of 8 inches the required area of permeable pavers 280 sq ft.

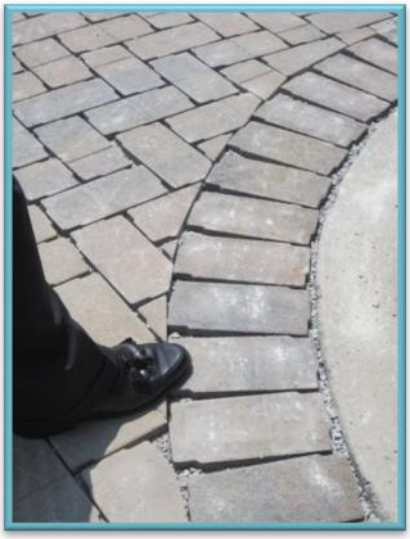
Contributing Drainage Area (square feet)	Depth of Lower Stone Storage Layer (inches)				
	3	4	5	6	8
	Area of Pavers (square feet)				
100	54	45	39	34	27
500	280	230	200	170	140
1000	550	460	390	340	280
2000	1090	910	780	680	550
3000	1630	1360	1170	1020	820
4000	2180	1810	1560	1360	1090
5000	2720	2270	1940	1700	1360

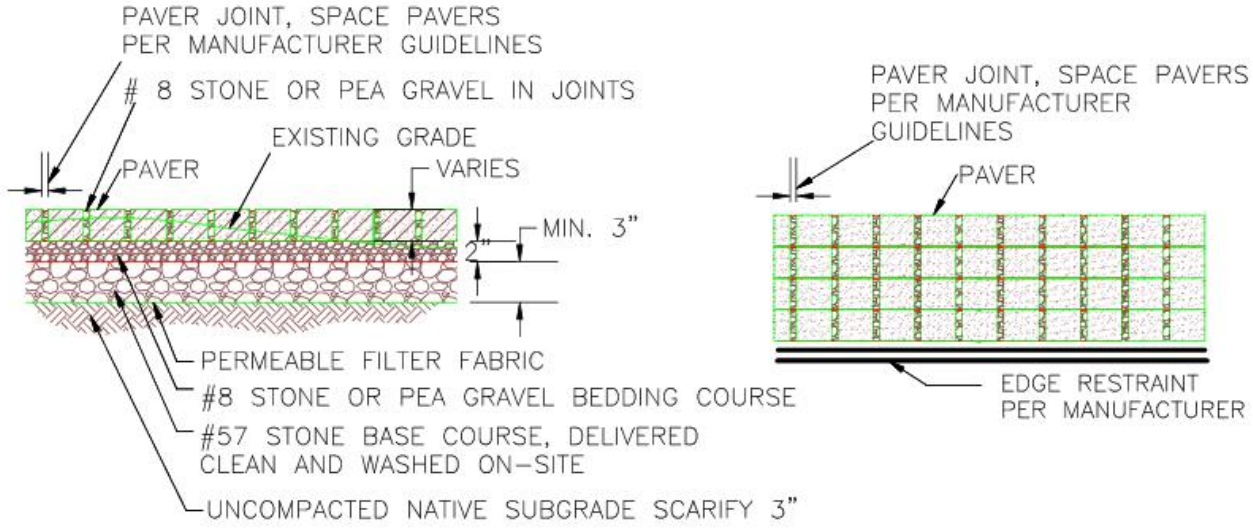
- Permeable paver systems require multiple layers. Manufacturer's instructions, if they exist, should be followed in lieu of these guidelines.
- The top course consists of the pavers and a crushed aggregate material swept between the paver joints, such as #8 stone or 1/8" to 3/8" pea gravel. The thickness of this layer varies depending upon the depth of the paver.
- The bedding course consists of 2 to 3 inches of #8 stone or 1/8" to 3/8" pea gravel. The bedding course provides a level bed for setting the pavers evenly.
- The aggregate base course consists of #57 stone, a minimum of 3 inches. The aggregate base course acts as a reservoir to provide stormwater storage capacity and must be compacted.
- As an option, a permeable drainage fabric can be used to separate the aggregate base course and the subgrade.
- The subgrade layer is the layer of native soils below the gravel and the permeable drainage fabric (if used). The subgrade soil layer should be prepared by scarifying or tilling to a depth of 3 to 4 inches.

Maintenance

Maintenance is very important for permeable pavers systems, particularly in terms of ensuring that they continue to provide measurable stormwater management benefits over time.

- Remove accumulated sediment and debris from joint space monthly.
- 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. New #8 stone may need to be swept into the space between stones as needed.
- Inspect permeable paver surface for deterioration annually. Repair or replace any damaged areas as needed.

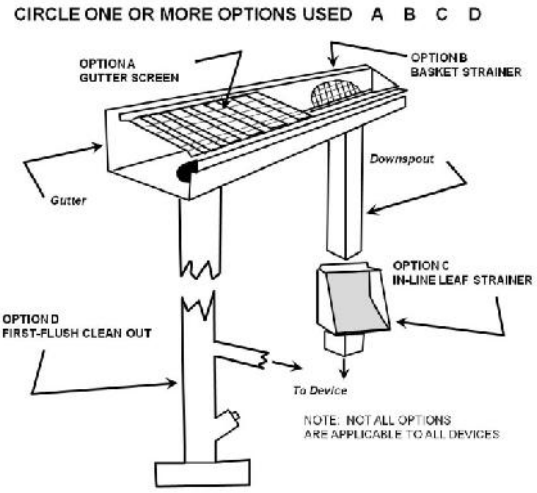




TYPICAL COMPONENTS (ATTACH MANUFACTURER'S SPECIFICATIONS)

CONSTRUCTION STEPS:

1. Review potential paver areas and layout. Pavers should slope less than 6% away from the structure and should not be located: (1) above an area with a water table or bedrock less than two feet below the trench bottom; (2) over other utility lines; or, (3) above a septic field.
2. Measure the area draining to the pavers and determine required paver area from the table on the next page based on the depth of the lower stone storage layer.
3. If soil is a concern perform infiltration test according to Appendix A. If the rate is less than 0.25 in/hr this method cannot be used. If the rate is more than 0.50 in/hr the pave area may be decreased 10% for every 0.50 in/hr infiltration rate increase above 0.50 in/hr.
4. Excavate area to appropriate depth and scarify soil to 3-4".
5. Place, level and compact gravel to planned depth in no more than 6" lifts. Three inch minimum depth.
6. Place, level and compact #8 stone or pea gravel bedding layer. Two inch minimum depth.
7. Lay paving stone one at a time or using mechanical placement as applicable. Cut stone at edges to fit.
8. Install edge restraints per manufacturer's specifications.
9. Sweep more #8 stone or pea gravel into stone joints until filled and even.
10. Cut and route downspouts or other rainwater delivery components, leaf screen option(s) chosen (circle selected options in Pretreatment Options Detail figure). Strap and support as needed.



PRETREATMENT OPTIONS DETAIL

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	NAME/ADDRESS:	PERMEABLE PAVER SPECIFICATIONS PAGE 1 OF 2

SKETCH LAYOUT

PROVIDE PLAN AND ELEVATION VIEWS OF PERVIOUS PAVER AND HOUSE SHOWING ROOF AREA DIRECTED TO PAVERS AND KEY DIMENSIONS, CONNECTIONS AND ANY APPLICABLE OVERFLOW RELATIVE TO PROPERTY LINE. ATTACH MANUFACTURER'S SPECIFICATIONS IF APPLICABLE.

SIZING CALCULATION:

Contributing Drainage Area (square feet)	Depth of Lower Stone Storage Layer (inches)				
	3	4	5	6	8
	Area of Pavers (square feet)				
100	54	45	39	34	27
500	280	230	200	170	140
1000	550	460	390	340	280
2000	1090	910	780	680	550
3000	1630	1360	1170	1020	820
4000	2180	1810	1560	1360	1090
5000	2720	2270	1940	1700	1360

MEASURE CONTRIBUTING DRAINAGE AREA AND READ AREA FOR GIVEN MEDIA DEPTH.

CONTRIBUTING DRAINAGE AREA= _____ SQ FT
DEPTH OF STONE MEDIA= _____ INCHES
PAVER AREA= _____ SQ FT

MAINTENANCE:

1. REMOVE ACCUMULATED SEDIMENT AND DEBRIS FROM JOINT SPACE MONTHLY.
2. OBSERVE THE PERMEABLE PAVER SYSTEM FOR EXCESSIVE PONDING DURING STORM EVENTS AND REPAIR AS NEEDED.
3. VACUUM, SWEEP, OR BLOW PERMEABLE PAVER SURFACE QUARTERLY TO KEEP THE SURFACE FREE OF SEDIMENT. NEW STONE MAY NEED TO BE SWEPT INTO THE JOINTS AS NEEDED.
4. INSPECT PERMEABLE PAVER SURFACE FOR DETERIORATION ANNUALLY. REPAIR OR REPLACE ANY DAMAGED AREAS AS NEEDED.

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	ATTACH THIS TWO-PAGE SPECIFICATION TO HOUSE PLAN SUBMITTAL	PERMEABLE PAVER SPECIFICATIONS PAGE 2 OF 2

RAIN GARDENS

SINGLE FAMILY RESIDENTIAL GUIDE

CITY OF ATLANTA, GEORGIA

DEPARTMENT OF WATERSHED MANAGEMENT

Rain gardens are small, landscaped depressions that are filled with a mix of native soil and compost, and are planted with trees, shrubs and other garden-like vegetation. They are designed to temporarily store stormwater runoff from rooftops, driveways, patios and other areas around your home while reducing runoff rates and pollutant loads in your local watershed. A rain garden can be a beautiful and functional addition to your landscape.

Location

- Rain gardens should be located to receive the maximum amount of stormwater runoff from impervious surfaces, and where downspouts or driveway runoff can enter garden flowing away from the home.
- Swales, berms, or downspout extensions may be helpful to route runoff to the rain garden.
- Locate at least 10 feet from foundations, not within the public right of way, away from utility lines, not over septic fields, and not near a steep bluff edge. Call 811 before you dig to locate the utility lines on your property.
- Rain gardens on steep slopes (>10%) may require an alternative design with terracing.

Design

- 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 a day which will not create a mosquito problem.
- Design rain garden entrance to immediately intercept inflow and reduce its velocity with stones, dense hardy vegetation or by other means.
- If sides are to be mowed rain gardens should be designed with side slopes of 3:1 (H:V) or flatter.

Contributing Drainage Area (square feet)	Depth of Amended Soil (inches)			
	18	24	30	36
	Area of Rain Garden (square feet)			
100	6.6	5.7	5.1	4.6
500	35	30	25	23
1000	65	60	50	45
2000	135	115	100	90
3000	200	170	150	140
4000	260	230	200	185
5000	330	290	255	230

- For best results, it is suggested to test your soil characteristics as you would for a garden, or contact your local County Extension Service for help www.caes.uga.edu/extension/fulton.
- Soils for rain gardens should be amended native soils containing: 2/3 native soils and 1/3 compost.

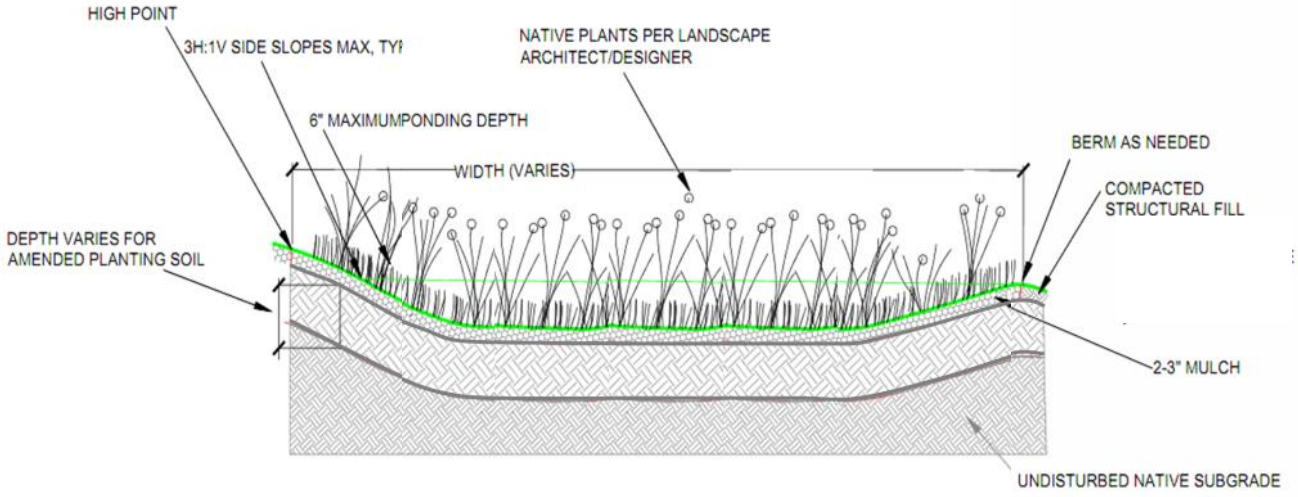
- A mulch layer consisting of 2-3 inches of non-floatable organic mulch (fine shredded hardwood mulch, pine straw, or leaf compost) should be included on the surface of the rain garden. Pine bark and wood chips should not be used.
- Often rain gardens have a better appearance and can be more easily maintained if they have defined edges similar to a normal garden.
- The overflow from the rain garden should be non-eroding and can consist of a small berm or even an inlet grate set at the proper elevation in the garden. The grate should be set at a slant or be domed to allow clogging debris to fall off.

Vegetation

- Vegetation commonly planted in rain gardens includes native trees, shrubs and other herbaceous vegetation. When developing a landscaping plan, you should choose vegetation that will be able to stabilize soils and tolerate the stormwater runoff rates and volumes that will pass through the rain garden.
- Vegetation used in rain gardens should also be able to tolerate both wet and dry conditions. See Appendix F of Volume 2 of the Georgia Stormwater Management Manual (ARC, 2001) for a list of grasses and other plants that are appropriate for use in rain gardens in the state of Georgia. Please refer elsewhere within this document for additional information on plants appropriate for rain gardens.
- As with any garden in the first season the vegetation may require irrigation to become well established. 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.

Maintain

Routine garden maintenance should include weeding, deadheading, replacing dead plants, and replenishing mulch when depleted. Catching areas of erosion is also important as is correcting standing water problems. If standing water persists it may be necessary to place a perforated underdrain in the garden daylighting downstream.



CONSTRUCTION STEPS:

1. Locate rain garden(s) where downspouts or driveway runoff can enter garden flowing away from the home. Locate at least 10 feet from foundations, not within the public right of way, away from utility lines, not over septic fields, and not near a steep bluff edge.
2. Measure the area draining to the planned garden and determine required rain garden surface area from the table on the next page and your planned excavation depth.
3. Optionally, perform infiltration test according to Appendix A. If the rate is less than 0.25 in/hr an underdrain will be necessary. If the rate is more than 0.50 in/hr the size of the garden may be decreased 10% for every 0.50 in/hr infiltration rate increase above 0.50 in/hr.
4. Measure elevations and stake out the garden to the required dimensions insuring positive flow into garden, the overflow elevation allows for six inches of ponding, and the perimeter of the garden is higher than the overflow point. If the garden is on a gentle slope a berm at least two feet wide can be constructed on the downhill side and/or the garden can be dug into the hillside taking greater care for erosion control at the garden inlet(s).
5. Remove turf or other vegetation in the area of the rain garden. Excavate garden being careful not to compact soils in the bottom of the garden. Level bottom of garden as much as possible to maximize infiltration area.
6. Mix compost, topsoil, and some of the excavated subsoil together to make the 'amended soil'. The soil mix should be 1/3 compost, 2/3 native soil (topsoil and subsoil combined).
7. Fill rain garden with the amended soil, leaving the surface eight inches below your highest surrounding surface. Eight inches allows for 6 inches ponding and 2" of mulch. The surface of the rain garden should be as close to level as possible.
8. 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.
9. Plant the rain garden using a selection of plants from elsewhere in this manual.
10. Mulch the surface of the rain garden with two to three inches of non-floating organic mulch. The best choice is finely shredded hardwood mulch. Pinestraw is also an option.
11. 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 season.
12. During construction build the inlet feature as a pipe directly connected to a downspout or use a rock lined swale with a gentle slope. Use of an impermeable liner under the rocks at the end of the swale near the house is recommended to keep water from soaking in at that point. Test the drainage of water from the source to the garden prior to finishing.
13. Create an overflow at least 10 feet from your property edge and insure it is protected from erosion.

CITY OF ATLANTA DEPARTMENT OF WATERSHED MANAGEMENT	NAME/ADDRESS:	RAIN GARDEN SPECIFICATIONS PAGE 1 OF 2

SKETCH LAYOUT

PROVIDE PLAN VIEWS OF RAIN GARDEN AND HOUSE SHOWING DRAINAGE AREA DIRECTED TO RAIN GARDEN AND KEY DIMENSIONS AND OVERFLOW AREA RELATIVE TO PROPERTY LINE.

SIZING CALCULATION:

Contributing Drainage Area (square feet)	Depth of Amended Soil (inches)			
	18	24	30	36
	Area of Rain Garden (square feet)			
100	6.6	5.7	5.1	4.6
500	35	30	25	23
1000	65	60	50	45
2000	135	115	100	90
3000	200	170	150	140
4000	260	230	200	185
5000	330	290	255	230

MEASURE CONTRIBUTING DRAINAGE AREA AND READ AREA FOR GIVEN MEDIA DEPTH.

CONTRIBUTING DRAINAGE AREA= _____ SQ FT
DEPTH OF SOIL MEDIA= _____ INCHES
AREA OF RAIN GARDEN= _____ SQ FT

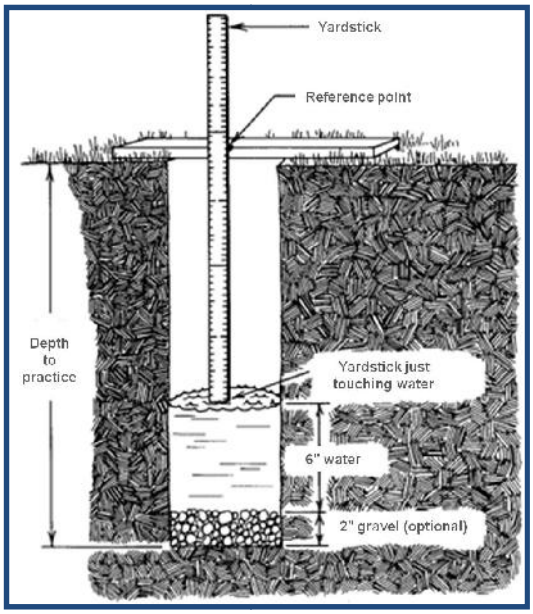
MAINTENANCE:

1. IRRIGATE VEGETATION AS NEEDED IN FIRST SEASON
2. REMOVE WEEDS
3. REPLACE UNSUCCESSFUL PLANTINGS
4. REPLENISH MULCH
5. REPAIR ERODED AREAS
6. RAKE CLOGGED SURFACE TO RESTORE INFILTRATION
7. MONITOR RAIN GARDEN FOR APPROPRIATE DRAINAGE TIMES IF GARDEN DOES NOT DRAIN AN UNDERDRAIN MAY BE NECESSARY

APPENDIX A

Testing Infiltration: the Simple Approach

It is assumed that an infiltration rate of 0.25 to 0.50 inches per hour exists on residential sites. The sizing criteria are set for this rate. However, if the soils have a higher infiltration rate the size of the features could be reduced. At the discretion of the property owner the following infiltration test can be conducted, and if it returns a higher infiltration ate than 0.50 inches per hour suitable reductions in the size of the infiltration-based facilities can be made. See each practice for the adjustment procedure.



Source: modified from www.ag.ndsu

Infiltration features (rain gardens, dry wells, permeable paver gravel layers) should reliably drain within the recommended time limit. Here is how to test if your soils can handle this type of feature.

1. Locate the approximate center of the area where you expect to build your feature.
2. Dig an access pit down to the bottom of the amended soils or gravel layer in the feature.
3. At that elevation dig a narrow test hole at least eight inches deep. You can optionally place 2" of course gravel in the bottom. The test hole can be excavated with small excavation equipment or by hand using a spade shovel or post-hole digger.
4. If you run into a hard layer that cannot be penetrated with a shovel or, you come across water in the whole, stop. Infiltration features should not be sited over impenetrable rock surfaces or over high water tables, so your site is inappropriate.
5. Place a flat board across the hole to serve as a measuring point (see figure).
6. Fill the hole with water to a depth of six inches. Measure from the flat board to the water surface. Record the exact time you stop filling the hole and the height of the water every 10 minutes for fast draining soils for a minimum of one hour or every 30 minutes for slow draining soils for a minimum of two hours.
7. Refill the hole again and repeat step 5 twice more. The third test will give you the best measure of how quickly your soil absorbs water when it is fully saturated.
8. If on the third test the water is dropping at least ½" per hour the soil will work for the infiltration features.

Source: www.learntogrow.com

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 conditions in rain gardens. The plants in this list do have different preferences for both moisture and light, as shown in the columns labeled 'Moisture' and 'Sun'. Additionally, the majority of these plants are native to Georgia and thus contribute the added benefit of providing habitat and food for native pollinators and wildlife. Those plants that are not native to Georgia are marked with an asterisk (*).

Key

Height: Typical height range for mature plants

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

W (Wet) —Frequently saturated soils
M (Moist) —Moist soils that are periodically inundated.
D (Dry) — Areas not flooded after rains and frequently dry between rains. Plants designated 'D' will tolerate drought conditions

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

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

	Botanical Name	Common Name	Height	Moisture	Sun
Small Trees	Acer floridanum	Southern Sugar Maple	20'-25'	M	F/P/S
	Amelanchier arboria	Serviceberry	15'-25'	W/M/D	F/P
	Cercis canadensis	Redbud	20'-30'	M	F/P
	Chionanthus virginicus	Fringe Tree	12'-20'	M	F/P
	Cornus florida	Flowering Dogwood	15'-30'	M/D	F/P
	Hamamelis virginiana	Witchhazel	15'-30'	W/M	P/S
	Ilex decidua	Possumhaw	15'-25'	M/D	F/P
	Ilex vomitoria	Yaupon Holly	20'-25'	M/D	F/P
	Lagerstroemia indica *	Crape Myrtle *	15'-50'	M/D	F/P
	Magnolia virgininana	Sweetbay Magnolia	10'-30'	W/M	F/P
	Magnolia x soulangeana *	Saucer Magnolia *	15'-25'	M	F/P
	Vitex agnus-castus *	Chaste Tree *	15'-20'	M/D	F/P

	Botanical Name	Common Name	Height	Moisture	Sun
Med.- Large Trees	Acer rubrum	Red Maple	60'-90'	W/M/D	F/P
	Betula nigra	River Birch	40'-70'	W/M	F/P
	Carpinus caroliniana	Musclewood	30'-50'	W/M	F/P
	Crataegus phaenopyrum	Washington Hawthorne	25'-30'	W/M/D	F/P
	Fraxinux pennsylvanica	Green Ash	50'-70'	W/M/D	F
	Ilex opaca	American Holly	30'-60'	M/D	F/P
	Magnolia grandiflora	Southern Magnolia	40'-80'	M/D	F/P
	Magnolia macrophylla	Bigleaf Magnolia	30'-40'	M	F/P
	Nyssa sylvatica	Black Gum	35'-70'	W/M/D	F/P
	Platanus occidentalis	American Sycamore	75'-100'	W/M	F
	Quecus lyrata	Overcup Oak	35'-50'	M/D	F
	Quercus bicolor	Swamp White Oak	50'-60'	W/M/D	F/P
	Quercus phellos	Willow Oak	60'-80'	W/M/D	F/P
	Salix babylonica *	Weeping Willow *	30'-50'	W/M	F
	Taxodium distichum	Bald Cypress	50'-100'	W/M/D	F/P

* denotes plants not native to Georgia

	Botanical Name	Common Name	Height	Moisture	Sun
Shrubs-Evergreen	Ilex glabra	Inkberry	6'-8'	M	F/P
	Ilex vomitoria nana	Dwarf Yaupon Holly	5'	W/M/D	F/P
	Illicium floridanum	Florida Anise Tree	10'-15'	M	P/S
	Illicium parviflorum	Small Anise Tree	7-10'	M/D	F/P
	Myrica cerifera	Southern Waxmyrtle	10-15'	W/M/D	F/P

	Botanical Name	Common Name	Height	Moisture	Sun
Shrubs- Deciduous	Callicarpa americana	Beautyberry	6'	M/D	F/P
	Cephalanthus occidentalis	Buttonbush	3-10'	W	F
	Clethra alnifolia	Summersweet	5'-10'	W/M/D	F/P
	Cornus amomum	Silky Dogwood	6'-12'	W/M	F/P/S
	Hibiscus moscheutos	Swamp Mallow	4'-8'	W/M	F/P
	Hypericum densiflorum	Bushy St Johns wort	4-6'	M/D	F/P
	Ilex verticillata	Winterberry	6'-10	W/M	F/P
	Itea virginica	Virginia Sweetspire	4'	W/M/D	F/P
	Lindera benzoin	Spicebush	6-12'	W/M/D	F/P
	Sambucus canadensis	Elderberry	6-'15'	W/M	F/P
	Viburnum acerifolium	Mapleleaf viburnum	3'-6'	M/D	M/S
	Viburnum dentatum	Arrowwood	5'-10'	W/M/D	F/P
	Viburnum nudum	Possumhaw	6'-12'	W/M/D	F/P/S

	Botanical Name	Common Name	Height	Moisture	Sun
Grasses and Allies	Acorus calamus	Sweet Flag	2'-4'	W/M	F/P/S
	Carex spp	Sedges	up to 3'	varies	varies
	Chasmanthium latifolium	River Oats	3'-5'	W/M/D	F/P/S
	Juncus effusis	Soft Rush	1'-4'	W/M	F/P/S
	Juncus tenuis	Path Rush	under 12"	W/M	F/P/S
	Liriope muscari *	Monkey Grass *	18"-24"	M/D	F/P/S
	Muhlenbergia capillaris	Pink Muhly Grass	3'-4'	M/D	F/P/S
	Ophiopogon japonicus *	Mondo Grass *	under 12"	M/D	F/P/S
	Panicum virgatum	Switchgrass	2'-9'	W/M/D	F/P/S
	Schizachyrium scoparium	Little Bluestem	2'-4'	W/M/D	F/P/S
	Sorghastrum nutans	Indiangrass	4'-8'	M/D	F/P/S

	Botanical Name	Common Name	Height	Moisture	Sun
Herbaceous Perennials	Amsonia hubrechtii	Narrow Leaf Blue Star	2'-3'	M/D	F/P
	Asclepias tuberosa	Butterflyweed	1'-3'	M/D	F/P
	Chrysogonum virginianum	Green and Gold	6"	M/D	P/S
	Coreopsis verticillata	Threadleaf Coreopsis	8"-20"	M/D	F/P
	Echinacea purpurea	Purple Cone Flower	1'-3'	M/D	F/P
	Eupatorium fistulosum	Joe Pye Weed	2'-7'	W/M/D	F/P
	Hemerocallis spp. *	Daylily *	1-3'	M/D	F/P
	Iris sibirica *	Siberian Iris *	1'-3'	W/M/D	F/P
	Iris virginica	Blue Flag Iris	12"-24"	W/M	F/P
	Lobelia cardinalis	Cardinal Flower	2'-4'	W/M	F/P
	Monarda didyma	Beebalm	2'-4'	W/M	F/P
	Osmunda cinnamomea	Cinnamon Fern	up to 4'	W/M	F/P/S
	Osmunda spectabilis	American Royal fern	2'-5'	W/M	P/S
	Phlox divaricata	Woodland Phlox	12"-18"	M	P/S
	Phlox stolonifera	Creeping Phlox	6"-12"	M/D	F/P/S
	Polystichum acrostichoides	Christmas Fern	1'-3'	M/D	P/S
	Rudbeckia fulgida	Orange Coneflower	18"-36"	M/D	F/P
	Rudbeckia hirta	Black-Eyed Susan	12"-36"	M/D	F/P
	Solidago spp.	Goldenrod	1-4'	W/M/D	F/P
	Tiarella cordifolia	Foamflower	6"-12"	M	P/S

* denotes plants not native to Georgia