Green Infrastructure for

Single Family Residences

City of Decatur Stormwater Guidelines

City Of Decatur, Georgia

July 2021

STORM WATER

MASTER PLAN | DECATUR, GEORGIA

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INTRODUCTION

Background and Purpose

The development or redevelopment of any site permanently alters the character and hydrology of the land surface. Installation of new or improved impervious covers raises flooding, drainage, and water quality concerns due to increase in urban runoff and its associated pollutants. To mitigate these impacts, all land development and redevelopment projects in the City of Decatur (City) should adopt storm water management measures in accordance with Article 9 of the City's Unified Development Ordinance (December 2020). To comply with the requirements of the ordinance, single-family residential developments are required to utilize storm water mitigation measures when constructing a new home or an addition/ replacement that is greater than 500 square feet of impervious surface.

The purpose of this document is to provide guidelines to property owners/developers of single-family residences about the post construction stormwater best management practices (BMPs). A menu of BMP options is included to support the property owners in finding solutions that are most appropriate for their sites:

- Dry Wells
- Vegetated Filter Strips
- Modified French Drains
- Permeable Pavers
- Bioretention/Rain Gardens
- Soil Amendments/Restoration
- Tree Preservation/Plantings

All of these options promote green infrastructure practices. Green Infrastructure (GI) mimics natural hydrologic processes and uses natural components such as soils and plants to reduce flooding and protect water quality resulting from the post-development stormwater runoff. The guidelines employ simplified design standards/tables for each GI, thus avoiding the necessity for complex engineering calculations and analysis. To comply with the regional standards, the minimum design standards are adopted from Georgia Stormwater Management Manual (GSMM).

Stormwater Management Principles

The key principles for managing stormwater from a single-family residential lot are:

- Maintaining the pre-development hydrologic response in their post-development state as nearly as practicable
- Retaining and causing infiltration of the first 1.0-inch of rainfall from impervious surfaces using runoff reduction methods to the maximum extent practicable
- If the entire 1.0-inch runoff reduction volume cannot be infiltrated on-site, treating the remaining runoff from the 1.2-inch rainfall with other storm water management practices
- Managing runoff impacts to adjacent properties by requiring post development runoff to be directed away from existing adjacent structures and released in a manner similar to the existing condition and by maintaining a drainage path for any existing off-site runoff that drains through the site

Submittal Information

This document is intended for small scale residential improvements (less than or equal to 4,000 square feet of impervious area) and can be implemented without significant compliance burden. The following submittals will suffice for the recommended GI options:

- Existing and proposed developments with an impervious area breakdown
- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions
- GI on plan with sizing calculations or selection chart information
- GI details based on design standard or manufacturer's details and cross-section
- Plantings plan if applicable with plant types, counts, and spacing

Alternative stormwater mitigation measures may be used when designed by a professional experienced with GI systems (LA, Arch, LS, Arb, Frstr, or other design professional). Any development or redevelopment project exceeding 4,000 square feet of impervious area must be designed by a professional engineer (PE).

DRY WELLS

Dry wells are shallow excavations, typically filled with stone, that are designed to intercept and temporarily store post-construction stormwater runoff under the ground surface until it infiltrates into the underlying and surrounding soils. They are comprised of seepage tanks set in the ground in areas where the soils are tight and permeable enough and the water table is low enough to provide for the infiltration of stormwater runoff.

Location

- Dry wells should be located in a lawn or other disturbed pervious area and should be designed so that the top of the dry well is located as close to the ground surface as possible.
- Dry wells are particularly well suited to receive rooftop runoff entering the tank via an inlet grate or direct downspout connection.
- Dry wells should drain only impervious areas to reduce the chance of clogging. Runoff should be pretreated with at least one of the leaf removal options to remove debris and larger particles.
- Runoff should be directed away from adjacent structures and released in a manner similar to natural conditions.

Dry Well System
Source: Homesace.com

Downspout Release
Source: istockphoto.com

Construction

- Dry wells should be installed and maintained in accordance with the manufacturer's recommendations.
- 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.
- Excavation should be limited to the width and depth specified in the development plans and allow for a minimum of 12-inch stone fill jacket at the bottom and sides of the dry well.
- The top layer of the filter fabric should be located 6 inches from the top of the excavation, with the remaining space filled with appropriate landscaping.
- The bottom and sides should be filled with clean, washed #57 stone. #57 stone averages ½ inch to 1-1/2 inches.
- The native soils along the bottom should be scarified and tilled to a depth of 3 to 4 inches.
- For rooftop runoff, a leaf screen in the gutter or down spout should be installed prior to entering the dry well to prevent leaves and other large debris from clogging the dry well. For non-rooftop runoff, dry well should be preceded with an inground 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.

Design Table

Table 1 can be used to size a dry well system based on the contributing drainage area to be treated.

Knowing the stormwater runoff that drains into the dry well system, the required tank size and depth can be determined. So, for example, if a 20 by 50 foot roof is to be treated the total roof area is 20*50 = 1000 square feet. This could be handled by one tank 60" high, 42" diameter. It can also be handled by two tanks 30" high and 42" in diameter. Check with manufacturer for the standard tank height and diameter that is typically available to buy and select the size that can capture the estimated stormwater runoff from the contributing drainage area.

Table 1: Design Table – Dry Well System

Tank Height (Inches)	Tank Inside Diameter (inches)				
	24	30	36	42	48
	Contributing Area Captured (square feet)				
30	285	380	490	615	755
60	489	657	852	1075	1325

Submittal Requirements

- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions.
- Sizing calculations as illustrated below or standard manufacturer's size.

Sizing Calculations:

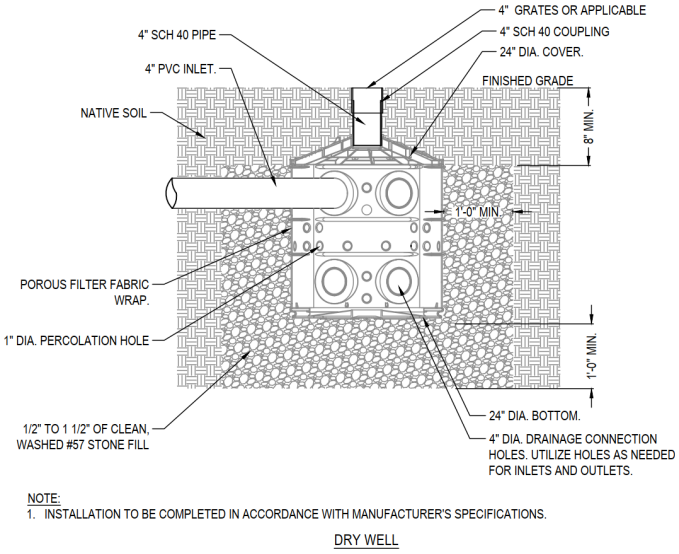
Measure contributing drainage area and read the area from Design **Table 1**.

Contributing drainage area = _____ sq ft

Tank diameter = _____ inches

Tank height = _____ inches

- Dry well system on plan with key dimensions determined from the design table or manufacturer's specifications
- Maintenance and typical components/ standard details. Attach manufacturer's specifications if applicable.



Dry Well System - Typical Cross-Section

Maintenance

Annual maintenance is important for dry wells. Listed below are some of the common maintenance practices. For specific maintenance practices, it is recommended to follow the manufacturer's requirements:

- 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.

VEGETATED FILTER STRIPS

Vegetated filter strips are uniformly graded and densely vegetated areas of land designed to treat runoff from and remove pollutants through vegetative filtering and infiltration. They are designed to receive rainwater as sheet flow and slow and filter stormwater runoff from roof downspouts or parking areas.

The vegetated filter strip is planted or seeded with a mix of turf, herbaceous vegetation and groundcovers. The vegetation slows water flow and allows contaminants like sediment, chemicals, and nutrients to collect in grass, shrubs, and trees. Trees are not required for vegetated filter strips but are encouraged where applicable. Tree species should be selected by their adaptability to moist-to-dry conditions and full size at maturity. Similarly, filter strips are most effective when used in combination with other agronomic or tree preservation practices.

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 slope would encourage unplanned ponding. If the slope is greater, terracing can be used with level spreaders between each terrace.

Vegetated Filter Strip
Source: City of Atlanta Stormwater Guidelines, November 2012

Downspout Disconnect
Source: Georgia Stormwater Management Manual, 2016

Construction

- Vegetated Filter Strips are used in conjunction with downspout disconnect. The downspout disconnect is a method to spread rooftop runoff from individual downspouts across lawns and other pervious areas, where it is slowed, filtered and allowed to infiltrate into the native soils.
- Flow should be routed into vegetated filter strips from the paved areas or the areas where the downspout has been disconnected from the storm or sanitary sewer.
- Ensure temporary erosion control is in place as needed until vegetation establishment.
- Uniform grading should be maintained across filter strip to encourage sheet flow and prevent concentrated flows.
- Both the top and toe of the slope should be as flat as possible to encourage sheet flow and prevent erosion.
- 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.
- Ensure the overflow points are protected from erosion and not blocked by vegetation.

- Plant dense vegetation according to plan, or sod/seed. Ensure an irrigation plan is in place
- The surface impervious area to any one discharge location cannot exceed 4,000 square feet.

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 strips.
- Vegetation used in filter strips should be able to tolerate both wet and dry conditions.

Design Table

Table 2 can be used to size a conventional filter strip (25 feet minimum length) based on the area draining to the filter strip. Measure the rooftop and any other area that is going to be directed to the filter strip. Determine the required surface area of the filter strip from the table. For example, for a 1,000 square foot contributing drainage area, the conventional filter strip surface area must be at least 2,000 square feet with a minimum flow length of 25 feet.

Table 2: Design Table – Filter Strips

Contributing Drainage Area (square feet)	Filter Strip (Conventional Only)
	Contributing Area Captured (square feet)
500	1000
1000	2000
2000	4000
3000	6000
4000	8000

Submittal Requirements

- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions.
- Sizing (surface area) calculation as illustrated below.

Sizing Calculations:

Measure contributing drainage area and read it from Design **Table 2**.

Contributing drainage area = _____ sq ft

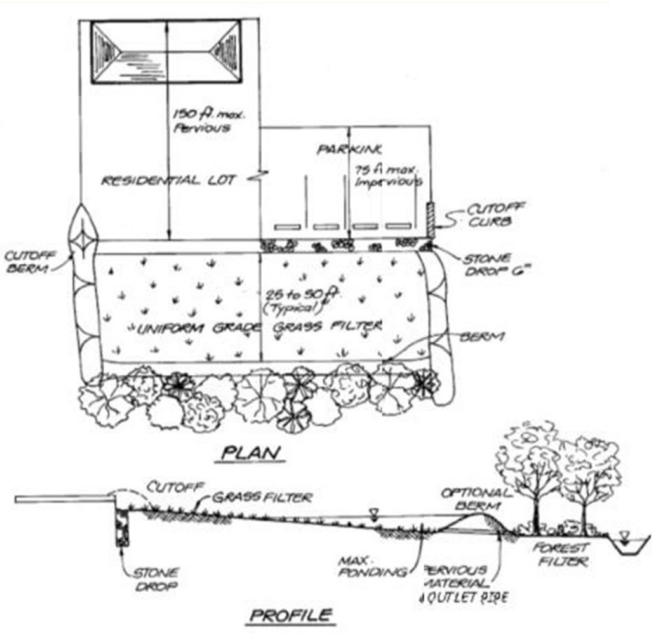
Filter strip area = _____ sq ft

Conventional – 25 feet minimum length

- Filter strip on plan with surface area determined from the design table and plantings plan.
- Maintenance and typical components/ standard details

Maintenance

- Inspect gutters and downspouts removing accumulated leaves and debris, cleaning leaf removal system(s).
- 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.



Vegetated Filter Strip - Typical Plan and Profile
Source: Coastal Stormwater Supplement to the Georgia Stormwater Manual,2009

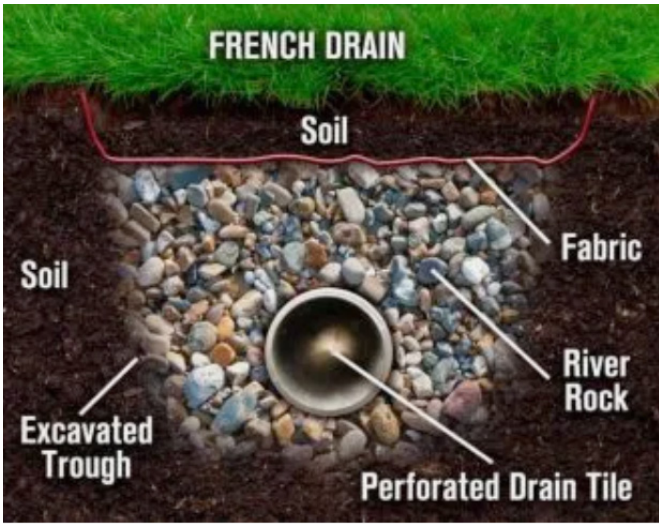
MODIFIED FRENCH DRAINS

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. In Decatur, due to poor draining soils, only the daylighted French Drain version is allowed in residential applications.

Location

- 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.
- The top end of the MFD may be placed adjacent to the building to connect downspouts but should be directed away from the structures.
- 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.
- Concentrated discharges should be avoided where possible and pre-development flow characteristics should be maintained.
- To reduce the chance of clogging from debris and larger particles, MFDs should drain only impervious areas, and runoff should be pretreated with at least one of the leaf removal options.
- The downstream end of the pipe must daylight for overflows which should be directed away from the adjacent structures and released in a manner similar to natural conditions.

Modified French Drain Installation
Source: crackedslab.com



Modified French Drain
Source: lawncarebygrasshopper.com

Construction

- As a rule-of-thumb there should be about 23 cubic feet of stone for every 100 square feet of rooftop.
- The depth of gravel from the top of pipe should be 24 inches.
- 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.
- The native soils along the bottom of the MFD should be scarified or tilled to a depth of 3 to 4 inches.
- The MFD should be filled with clean, washed #57 stone embedding a six inch diameter perforated pipe at the top of the stone. #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.
- Permeable landscape fabric should be placed over gravel to keep soil or pea gravel from migrating into the gravel and filling the pore spaces. Four to six inches space should be allowed above the pipe to the ground surface.
- The MFD should be covered with top soil and sodded or with pea gravel.
- For rooftop runoff, one or more leaf screen options should be installed 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 materials 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.

Design Table

Table 3 provides MFD length requirements for different rooftop draining areas. The assumed width of the MFD trench in the table is 24 inches.

Table 3: Design Table – Modified French Drain

Rooftop Area (square feet)	Depth of Gravel from Top of Pipe = 24 inches
	Required Linear Feet of MFD
500	25
1000	45
2000	95
3000	140
4000	190

Submittal Requirements

- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions.
- Sizing calculations as illustrated below or standard manufacturer's size.

Sizing Calculations:

Measure contributing drainage area and read it from Design **Table 3**.

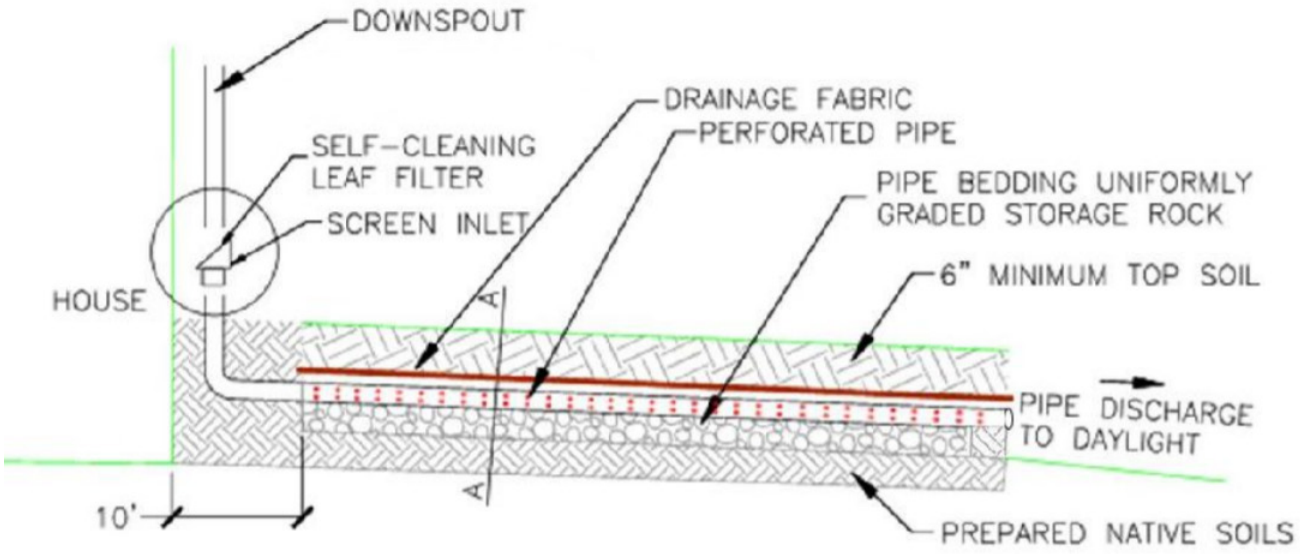
Contributing drainage area = _____ sq ft

Depth of Stone Media= 24 inches

Width of Trench= 24 inches

Length of MFD = _____ feet

- MFD on plan with key dimensions based on the sizing calculations or manufacturer's specifications.
- Maintenance and typical components/ standard details. Attach manufacturer's specifications if applicable.



Modified French Drain - Typical Cross-Section
Source: City of Atlanta Stormwater Guidelines, 2012

Maintenance

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

PERMEABLE PAVERS

Permeable pavers are an alternative to traditional paving surfaces that can provide structural support and reduce stormwater volume. 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.

Location

- Permeable pavers should drain only impervious areas. Drainage from pervious areas onto the pavers will eventually clog them due to the sediment loads.
- Permeable paver systems should be installed on slopes less than 6% to help ensure an even distribution of runoff over the infiltration surface and should slope away from adjacent structures. It is recommended that the subsoil of the permeable paver systems have a slope of 0% and the surface have a slope of 0.5% if possible.

Construction

- 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 with a minimum depth of 6 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.

Permeable Pavers
Source: tremron.com

- 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.

Design Table

Table 4 provides the paver area requirements for a range of contributing drainage areas. The #57 stone averages in size from ½ inch to 1-1/2 inches. Example: For a contributing drainage area equal to 1000 square feet and a stone depth of 6 inches, the required area of permeable pavers is 340 sq ft.

Table 4: Design Table – Permeable Pavers

Contributing Drainage Area (square feet)	Depth of Lower Stone Storage Layer (inches)		
	6	9	12
	Area of Pavers (square feet)		
500	170	122	92
1000	340	244	183
2000	680	489	367
3000	1020	733	550
4000	1360	978	733

Submittal Requirements

- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions.
- Sizing calculations as illustrated below or standard manufacturer's size.

Sizing Calculations:

Measure contributing drainage area and read it from Design **Table 4**.

Depth of stone media = _____ inches

Paver area = _____ sq ft

- Pavers on plan with key dimensions determined from the design table or manufacturer's specifications.
- Maintenance and typical components/ standard details. Attach manufacturer's specifications if applicable.

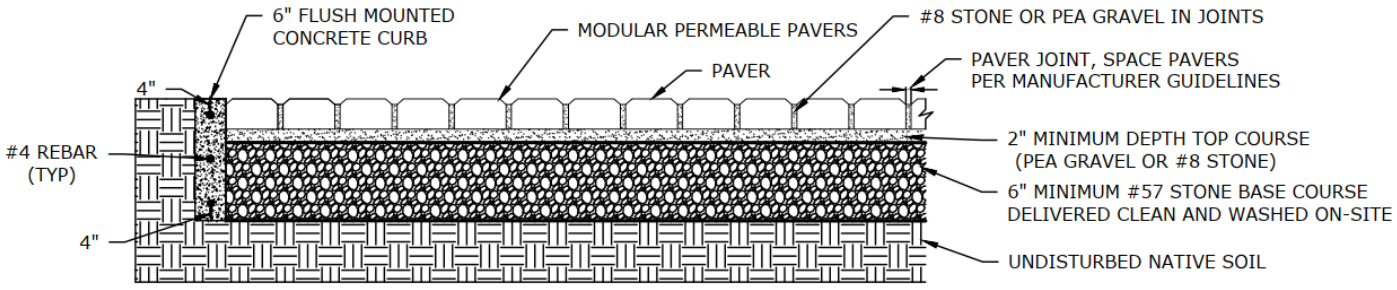
Maintenance

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 stone may need to be swept into the joints as needed.
- Inspect permeable paver surface for deterioration annually. Repair or replace any damaged areas as needed.

NOTES TO DESIGNERS

1. MINIMUM GRAVEL BASE COURSE DEPTH IS 6".
2. FOLLOW PAVER MANUFACTURER'S DESIGN RECOMMENDATIONS.



Permeable Pavers :
Typical Cross-Section

BIORETENTION/ RAIN GARDENS

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 the home. Bioretention areas slightly differ from rain gardens in that they are an engineered structure that has a larger drainage area and may include an underdrain. These may be designed in conjunction with enhanced swales. The swales are shallow channels designed to reduce the flow rate, retain a portion of the runoff, and once saturated convey the runoff to a safe outlet such as a rain garden or other infiltration areas.

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.
- Adequate distance should be provided from building foundations and adjacent structures.
- Rain gardens on steep slopes (>10%) may require an alternative design with terracing.

Construction

- A ponding area containing vegetation with an engineered planting media and native soils to infiltrate the runoff should be created. Where native soils have low infiltration rates, an engineered soil mix including coarse sand, silt, clay, and other organic matter should be provided.
- Planting media should be protected with an organic/mulch layer. The 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.
- The size of the rain garden will vary depending on the impervious surface draining to it and the depth of amended soils. The minimum recommended media depth is 18 inches.
- 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.
- Turf or other vegetation in the area of the rain garden should be removed. Rain garden should be excavated being careful not to compact soils in the bottom of the garden. Bottom of garden should be levelled as much as possible to maximize the infiltration area.
- The rain garden entrance should be designed 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.
- 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.
- During construction inlet feature should be built as a pipe directly connected to a downspout or a rock lined swale with a gentle slope should be used. 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.

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 table below for a list of grasses and other plants that are appropriate for use in rain gardens in the state of Georgia.

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

Recommended Plants

Table 5: 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

* denotes plants not native to Georgia

Table 6: Medium – Large Trees

Botanical Name	Common Name	Height	Moisture	Sun
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
Metasequoia glyptostroboides	Dawn Redwood	70'-100'	W/M/D	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

Table 7: 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

* denotes plants not native to Georgia

Table 8: Shrubs – Deciduous

Botanical Name	Common Name	Height	Moisture	Sun
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

* denotes plants not native to Georgia

Table 9: Grasses and Allies

Botanical Name	Common Name	Height	Moisture	Sun
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

* denotes plants not native to Georgia

Table 10: Herbaceous Perennials

Rain Garden
Source: thisoldhouse.com

Botanical Name	Common Name	Height	Moisture	Sun
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

- 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 (*).
- 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.

Design Table

Table 11 can be used to size a rain garden based on the contributing drainage area to be treated and the depth of amended soil. Knowing the stormwater runoff that drains into the rain garden and the depth of amended soil, the required surface area can be determined. For example, for a rain garden that receives runoff from a 1000 square feet drainage area with the depth of amended soil equal to 18 inches, the required area of the rain garden is 65 square feet.

Table 11: Design Table – Rain Gardens

500	35	30
1000	65	60
2000	135	115
3000	200	170
4000	260	230

Submittal Requirements

- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions.
- Sizing calculations as illustrated below

Sizing Calculations:

Measure contributing drainage area and read the area from Design **Table 11**.

Contributing drainage area = _____ sq ft

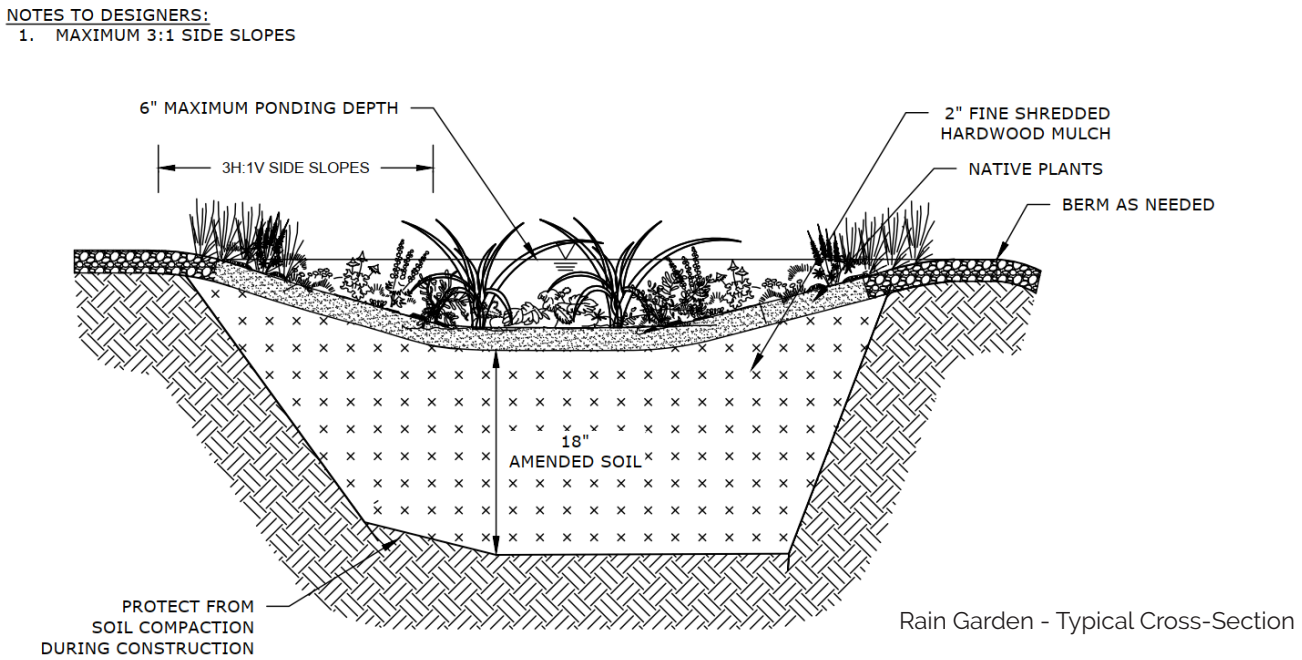
Depth of stone media = _____ inches

Area of rain garden = _____ sq ft

- Rain garden on plan with key dimensions determined from the design table and plantings plan.
- Maintenance and typical components/ standard details.

Maintenance

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.



Rain Garden - Typical Cross-Section

SOIL AMENDMENTS / RESTORATION

Soil restoration is the process of tilling and adding compost and other amendments to soils to restore them to their pre-development conditions. This improves the soil's ability to reduce post-construction stormwater runoff rates, volumes and pollutant loads.

Location

- It is ideal for use on lawns and other pervious areas that have been disturbed by clearing, grading and other land disturbing activities.
- To avoid damaging existing root systems, soil restoration should not be performed in areas that fall within the drip line of existing trees.
- Soil restoration should not be used on areas that have slopes of greater than 10%.

Construction

- To properly restore disturbed pervious areas, soil amendments should be added to existing soils to a minimum depth of 18 inches until an organic matter content of 8% to 12% is obtained.
- Depths greater than 18 inches should be amended when shrubs or trees are being installed.
- Compost should be incorporated into existing soils, using a rototiller or similar equipment, to a depth of 18 inches and at an application rate necessary to obtain a final average organic matter content of 8%-12%.

Soil Restoration
Source: Georgia Stormwater Management Manual, 2016

Organic Compost
Source: http://www.organicgardeninfo.com

- Only well-aged composts that have been composted for a period of at least one year should be used to amend existing soils. Composts should be stable and show no signs of further decomposition.
- Restored pervious areas should be protected from future land disturbing activities.
- To help prevent soil erosion, landscaping should be installed immediately after the soil restoration process is complete.
- Temporary irrigation may be needed to quickly establish vegetative cover on a restored pervious area.
- Test pits or a rod penetrometer can be used to verify that soil amendments have reached a depth of 18 inches.
- Simple erosion and sediment control measures, such as temporary seeding and erosion control mats, should be used on restored pervious areas that exceed 2,500 square feet in size.

Design Table

If native soils on the filter strip site are highly compacted, or of such low fertility that vegetation cannot become established, they should be amended to a minimum depth of 18 inches. **Table 12** can be used to size the filter strip based on the impervious area draining into it. Measure the rooftop and any other area that is going to be directed to the filter strip. Determine the required surface area of the filter strip from the table. For example, for a 1,000 square foot contributing drainage area, the required surface area of the filter strip must be at least 670 square feet with a minimum amended soil depth of 18 inches.

Table 12: Design Table – Filter Strips with Amended Soil

Contributing Drainage Area (square feet)	Filter Strip with Amended Soil (Amended Soil Depth =18 inches)
	Contributing Area Captured (square feet)
500	350
1000	670
2000	1400
3000	2700
4000	5400

Submittal Requirements

- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions.
- Sizing calculations as illustrated below

Sizing Calculations:

Measure contributing drainage area and read it from Design **Table 12**.

Contributing drainage area = _____ sq ft

Filter strip area = _____ sq ft

Amended Soil Depth = _____ feet

- Specifications of composts used to amend existing soil.
- Filter strip on plan with surface area determined from the design table, and plantings plan.
- Maintenance and typical components/ standard details

Maintenance

- In order to keep the water that exits the soil restoration area clean, fertilizers should be used sparingly during the establishment of the practice. Once the vegetation in the practice has been established, fertilizers should not be used.
- Water to promote plant growth and survival as needed (following construction).
- Inspect restored pervious area following rainfall events. Plant replacement vegetation in any eroded areas (following construction).
- Inspect restored pervious area for erosion annually (semi-annually during first year). Plant replacement vegetation in any eroded areas.
- Inspect restored pervious area for dead or dying vegetation annually (semi-annually) during first year). Plant replacement vegetation as needed.

TREE PRESERVATION / PLANTINGS

Tree canopy promotes stormwater runoff reduction by capturing and storing rainfall and releasing water into the atmosphere through evapotranspiration. Trees also help to slow down and temporarily store runoff, which further promotes infiltration. Additionally, trees reduce pollutants by taking up nutrients and other pollutants from soils and water through their roots. To effectively manage the stormwater runoff generated, tree preservation practices should be used in combination with filter strips.

Location

- Credit for trees is achieved by combining trees with a vegetative filter strip, where the tree allows a reduction in size of the vegetative filter strip, while continuing to meet the one-inch standard for mitigating runoff.
- Both existing protected and planted tree canopies can be credited.
- The placement and spacing of trees must be compatible with site spatial limitations, topography, and with considerations towards the potential height and crown size of the tree.
- Required trees shall be placed where runoff can be even distributed amoung the trees, and they are able to grow to maturity with a minimum of restriction to their roots, trunks and crowns, and where they will not create conflicts with sight, vehicle, and pedestrian clearance, infrastructure such as overhead and underground utility lines, streets, walkways, utility poles, and other infrastructure.

Construction

- Existing protected tree canopy on site can be counted in the total filter strip length which should be no less than 25 feet for a conventional filter strip.
- Tree species should be selected by their adaptability to moist-to-dry conditions and full size at maturity.
- Trees planted for tree canopy cover credit shall have a minimum amount of soil volume present at the time of planting to promote health, growth and the ability to achieve the size potential for the species.
- The minimum depth of soil shall be 36 inches
- the minimum open soil surface area, soil volume and planting area dimension for trees by mature canopy size are shown in **Table 13**.
- Unless specified otherwise, requirements established in the City Tree Protection Ordinance and Administrative Standards are applicable to trees that recieve credit for stormwater mitigation.

Table 13: Required Minimum Open Soil Areas and Soil Volumes by Mature Canopy Size

Mature Canopy Size	Minimum Open Soil Area (square feet)	Minimum Soil Volume (cubic feet)	Minimum Planting Area Width for Landscape Strips (feet)
Large	400	1,200	5
Medium	225	675	4
Small	100	300	3
Very Small	36	108	3

Also, see page 5 for additional info related to construction standards for vegetative filter strips.

Design Table

Determine the tree credit and deduct it from the standard filter strip area, which is typically double the impervious area being treated.

Table 14: Tree Credit by Mature Canopy Size

Typical Mature Canopy Size	Tree Credit (square feet)
Large	1,600
Medium	900
Small	400
Very Small	100

For example, three medium trees would provide a credit of 2,700 squarefeet. If the project was intended to treat a 3,000 squarefoot addition, the standard filter strip would be 6,000 squarefeet. Planting these three trees would reduce the filter strip to 3,300 squarefeet.

For quick selection when using only 1 tree, the minimum filter strip area required can be chosen from **Table 15**, based on the impervious area to be treated and the tree's mature canopy size.

Table 15: Design Table – Filter Strips with Tree Plantings

Contributing Drainage Area (square feet)	Mature Canopy Size Category			
	Very Small	Small	Medium	Large
	Filter Strip Area (square feet)			
500	900	600	225	
1000	1900	1600	1100	400
2000	3900	3600	3100	2400
3000	5900	5600	5100	4400
4000	7900	7600	7100	6400

Note, a filter strip area cannot be smaller than the tree's required open soil area. So, the filter strip area for a medium tree will always be at least 225 squarefeet. And, a filter strip containing three large trees will always require at least 1,200 square feet.

Trees do receive credit at the time of project completion based on the tree canopy cover potential for the species at maturity.

Submittal Requirements

- Site plans with contributing drainage area to be treated such as roofs, patios, driveways, walkways, and other impervious areas with key dimensions.
- Tree Plan with location and size of existing and proposed trees.
- Tree Establishment (Planting) Standards.
- Filter strip sizing calculations as illustrated below:

Sizing Calculations:

Measure contributing drainage area and read the area from design **Table 15**.

Contributing drainage area = _____ sq ft

Tree canopy cover credit = _____ sq ft

Reduced Filter Strip Area = _____ sq ft

Open Soil Area = _____ sq ft

Select larger of filter strip and open soil areas.

- Filter strip on plan with key dimensions determined from the design table.

Maintenance

Required maintenance for existing protected or new tree plantings shall be performed in accordance with the City Tree Protection Ordinance.

Areas around trees will be maintained in accordance with standard for vegetative filter strips on page 6.

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