

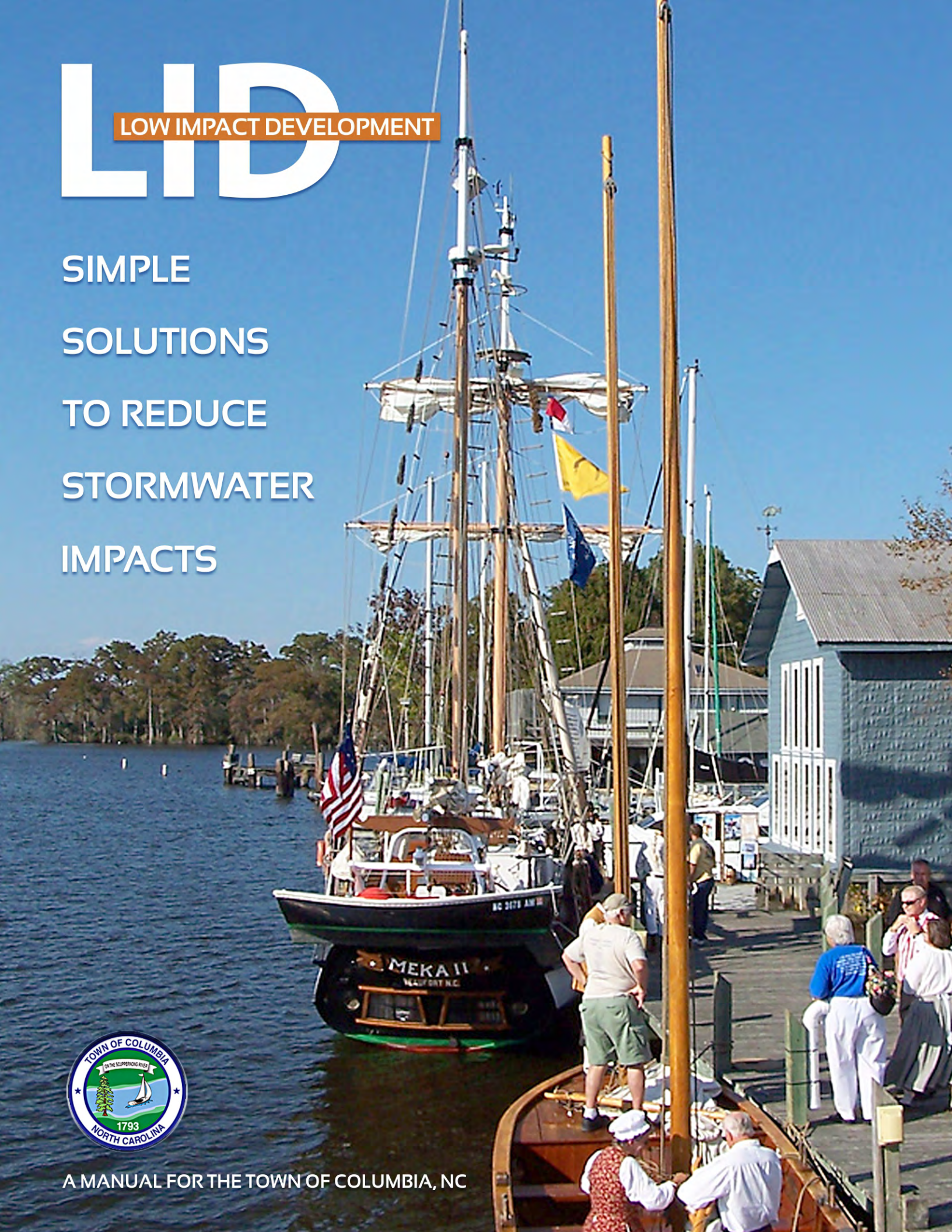
# LID

LOW IMPACT DEVELOPMENT

SIMPLE  
SOLUTIONS  
TO REDUCE  
STORMWATER  
IMPACTS



A MANUAL FOR THE TOWN OF COLUMBIA, NC



# Acknowledgments

On October 4, 2010 the Town of Columbia adopted a resolution supporting the use of Low Impact Development (LID) practices in real estate development within the Town and its Extra Territorial Jurisdiction. The resolution also supported the crafting of an LID Guidance Manual to provide information and resources about how to design, construct and maintain voluntary LID practices to meet state stormwater rules.

In 2012, the Town began work with the NC Coastal Federation to develop the manual. This project is based on the recently adopted LID manual for the coastal towns of Cedar Point and Cape Carteret. The Town of Cedar Point worked in partnership with the Town of Cape Carteret, the NC Coastal Federation, engineering consultants Withers & Ravenel, the NC Division of Water Quality and the LID Technical Review Team to complete the Cedar Point/Cape Carteret manual.

We would like to thank these two communities and their partners for sharing their work and providing a great model for us to follow.



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# Project Background and Purpose

Stormwater management is a major issue for communities and developers. The way we develop and manage land dramatically increases the flow of stormwater by creating pathways for runoff to reach the water. Stormwater runoff flushes bacteria and other pollutants directly to our coastal creeks, rivers and sounds. While bacteria sources from wildlife and pet waste have always been present, the common use of impervious surfaces (such as roofs and parking lots) plays a large role in directing polluted runoff into our coastal waters, instead of stormwater remaining on land so that it can be absorbed into the ground or evaporate.



## LID Manual and Project Impacts

- This manual provides a tool for implementing Low Impact Development (LID) in the Town of Columbia. By utilizing LID techniques for reducing stormwater runoff from new development and for mitigating the impacts of runoff from existing development, the Town will increase the potential for water quality protection in addition to creating landscapes that absorb and treat stormwater runoff.

## Manual Development

- As noted in the acknowledgments, the Town of Columbia adopted a resolution supporting the use of LID and the development of an LID guidance manual in October 2010.
- To begin implementing the LID resolution, the Town of Columbia formed a Low Impact Development Technical Review Team (TRT). This team was composed of developers, realtors, educators, and local town officials. The TRT met over the course of six months during 2012 to review the Cedar Point/Cape Carteret manual and suggest wording for the Columbia manual.

## TRT Members

- Durwood Cooper, Jr., Village Realty
- Tessi Hollis, Hollis Realty
- Tony Sawyer, Sawyer & Sons, Inc.
- Midge Ogletree, Columbia Board of Aldermen
- Ray Marner, Columbia Board of Aldermen
- James Cahoon, Columbia Planning Board
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- Pat Armstrong, Columbia Middle School
- Vickie Furlough, Columbia High School
- Marcel Van Dorpe, Columbia resident
- Dee Furlough, Tyrrell County Extension Agent
- Laverne Jeske, Extra Territorial Jurisdiction resident

## Staff Support

- Lauren Kolodij and Ladd Bayliss, NC Coastal Federation

## Application of Manual

- This document provides technical guidance on the application of LID as an acceptable approach to meet state and local stormwater management objectives.
- The information in this manual is intended as a starting point to provide guidance in the application of LID.
- For new development and redevelopment requiring permits, this manual should be used in conjunction with applicable current local, state and federal laws, rules, codes, ordinances and standards.
- This manual is intended for use not only by professional developers and builders, but also by property owners and residents. Because everyone in a community plays a vital role in protecting the health of coastal waters, everyone can use the simple solutions described. These solutions can be implemented on a lot by lot basis and usually do not require permits. The Town of Columbia staff can provide information and guidance on these matters.





LID is a stormwater management approach that uses a variety of techniques to replicate the natural hydrologic function of the landscape. These techniques include creative site planning and small, decentralized treatment and infiltration techniques that minimize stormwater runoff. Watershed hydrology refers to the flow of water over the land carrying sediment and dissolved materials by a network of tributaries that feed a main creek or series of creeks. It is water that drains off land from the highest point to the lowest point.

### Goal of LID

- The goal of LID is to mimic a site's natural hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain stormwater runoff close to its source. LID can help prevent runoff and minimize the flow of stormwater from existing development and land uses. The use of LID techniques can reduce the volume of runoff that is generated and maximize the treatment capabilities of the landscape, while controlling runoff as close to the source as possible.

### Applications of LID

- LID is versatile and can be applied to all types of existing land uses and new development including industrial, commercial, residential subdivisions, mixed use development, individual lots, public lands, roads and parking facilities, and other areas.

### LID Principles

#### 1. Focus on Prevention

- Protect streams, wetlands, floodplains and coastal habitats.
- Maintain slopes and flow paths.
- Minimize grading and tree clearing.

#### 2. Work with the Landscape

- Identify environmentally sensitive areas.

- Outline a development plan that protects those areas.
- Use hydrologic features of the site.

#### 3. Keep It Simple

- Use lower-cost approaches to decentralize.
- Micromanage stormwater close to where it falls.
- Direct runoff from impervious surfaces to landscaped areas and other small-scaled devices for infiltration.

#### 4. Practice Multi-tasking

- Create a multifunctional landscape that can provide open space, wildlife habitat and stormwater treatment. Such landscapes can provide filtration, treatment, and infiltration while also providing curb appeal. The distribution and small scaled nature of LID practices means that multiple devices are working as a team to reduce the impacts of stormwater runoff.

#### 5. Maintain and Sustain

- Maintain LID features for effectiveness and long-term success.

### Fact Sheets for LID Techniques

- See stormwater solutions fact sheets and simple solutions fact sheets for LID techniques to prevent and reduce polluted stormwater runoff.

### LID For New Development

- LID site design for new development includes identifying important natural features, strategically placing buildings, roads and parking areas, and designing a stormwater management system that works with the site to maintain or mimic the predevelopment hydrology. The attention to natural hydrology, stormwater "micromanagement," and integrated use of the landscape results in a more attractive, multifunctional landscape. Unlike conventional strategies that treat stormwater as a secondary

component of site design, LID incorporates the natural slope, soils and hydrology as an integrating framework for site design starting at the project concept level.

### Simple Solutions for Existing Development

- The volume of stormwater runoff from existing land uses can also be reduced by installing LID stormwater reduction measures. When stormwater volume is reduced, so is the amount of bacteria and pollution reaching surface waters.
- The goal of simple stormwater reduction measures is to utilize the soil, plants and stormwater collection techniques to capture the rain before it has a chance to become polluted runoff. Some techniques such as rain gardens absorb the runoff. Others such as rain barrels catch the runoff for later use.
- Stormwater retrofits are strategically placed to more closely mimic a watershed's hydrology. The result is a hydrologically functional landscape that generates less surface runoff, less pollution, less erosion, and less overall damage to coastal waters.
- Over time, as areas are redeveloped and rebuilt using LID, the negative impact from those existing developments on water quality is greatly reduced. The cumulative impact of retrofitting existing flows of stormwater runoff can have a significant impact and are a part of the town's overall strategy for managing stormwater.
- LID retrofits can be used on individual lots, throughout residential subdivisions, on commercial and institutional facilities, and incorporated into capital improvement projects, roads and parking areas.





# LID Fact Sheets: Stormwater and Simple Solutions

## Use of Manual Fact Sheets

- This manual contains fact sheets for incorporating LID into new development designs and for using LID techniques to retrofit existing development.

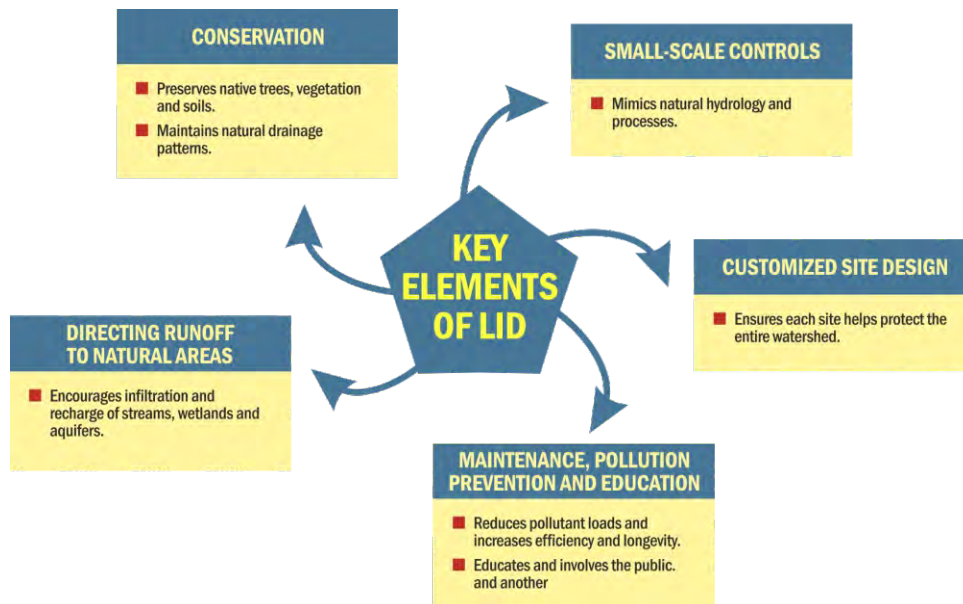
## Stormwater Solutions and Simple Solutions

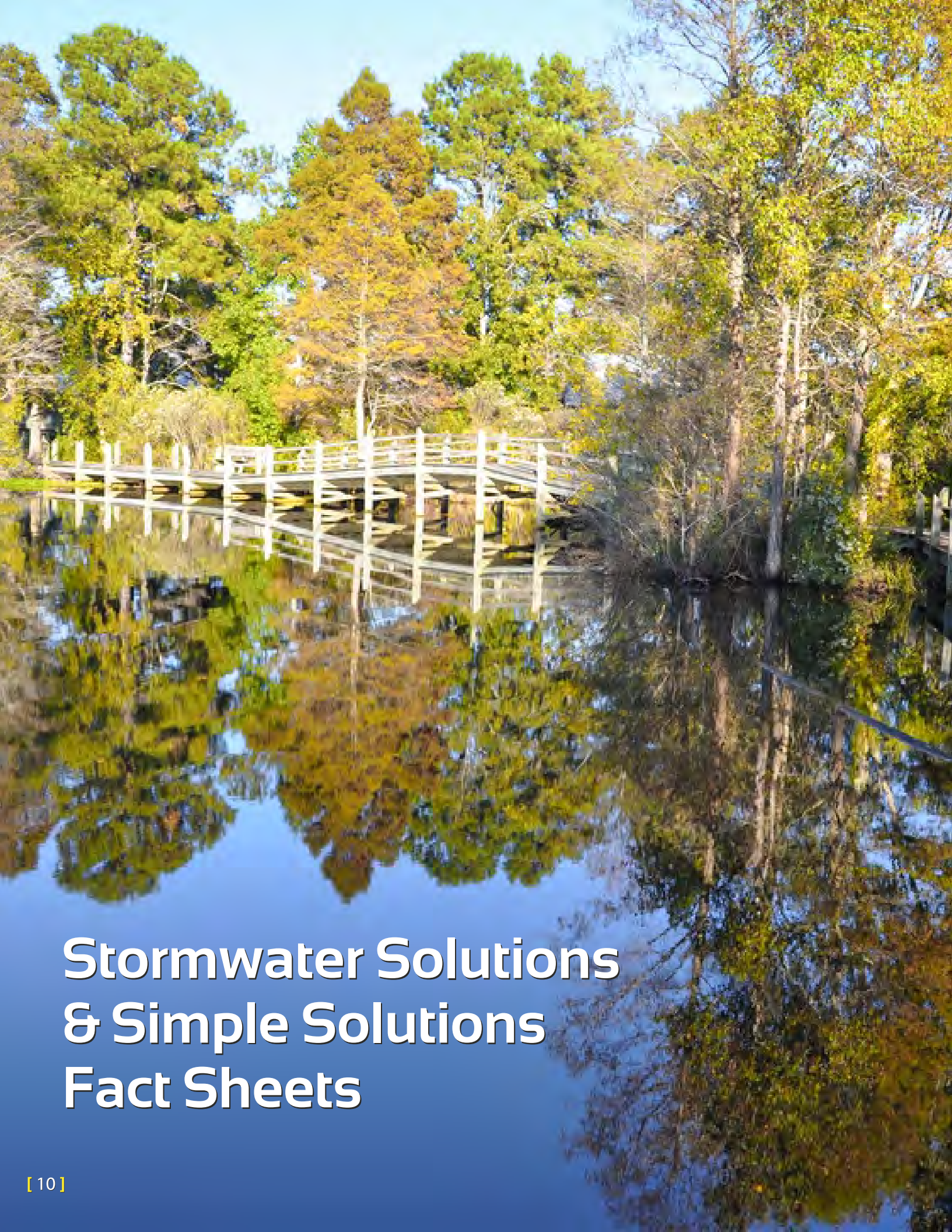
- These fact sheets are intended for use by developers, engineers, contractors, local government planners, permitting officers, state permitting agencies, and local property owners.
- The first series of fact sheets, Stormwater Solutions, are generally more suited for use when considering incorporating LID into new development projects. These techniques include Site Fingerprinting, Cisterns, Disconnect Impervious Surfaces, Planter Boxes, and Permeable Pavements.
- Simple Solutions are fact sheets focused on LID techniques that can be not only incorporated into a new development site but also applied to fix an existing stormwater problem on an individual site. These techniques are referred to as Simple Solutions and are entitled Rain Gardens, Backyard Wetlands, Re-route Downspouts, Rain Barrels, and Native Landscaping.
- All fact sheets can be used individually or together to help create a stormwater management strategy for a given project and to get local stakeholders on board with watershed management approaches that reduce the flow of stormwater runoff.

## Fact Sheet Contents

- Each fact sheet contains a brief overview of the LID technique and benefit provided. In addition, the fact sheets provide information on the siting, installation and maintenance of each technique. Fact sheets include photos of local practices illustrating the technique and includes references and resource links.

## LID APPROACH TO STORMWATER MANAGEMENT





# Stormwater Solutions & Simple Solutions Fact Sheets

# Stormwater Solutions: Site Fingerprinting

LOW IMPACT DEVELOPMENT: SIMPLE SOLUTIONS TO REDUCE STORMWATER IMPACTS



## What Is Site Fingerprinting?

Site Fingerprinting is a practice that uses the site design as a stormwater management tool by reducing land disturbance, preserving soil structure, and utilizing suitable natural areas (rather than expensive structural best management practices for runoff management). Rather than grading land to fit a desired development type, the type of development is dictated by the existing conditions of the site, resulting in developed sites which use the land to maintain and protect the natural balance of the surrounding ecosystem.

## Did You Know?

- Site Fingerprinting can be done during the planning process for no additional cost and can often lead to reduced infrastructure costs.
- By fitting the development to the land, it is often easier to preserve existing vegetation, giving a more established look to new developments.
- A little preservation goes a long way toward effective stormwater management.

## Benefits

- Reduced stormwater runoff volumes discharged into our waterways
- Maintained natural drainage patterns
- Reduced infrastructure costs
- Healthier green space

## Helpful Hints

- When trying to preserve the health of the local watershed, the best place to start is to enhance and preserve the natural stormwater treatment areas. These include marshes, wetlands, and coastal forests, which have great potential to control and treat stormwater runoff.

# Where to Start

## Natural Resource Inventory

### 1. Start by identifying the natural characteristics of a site:

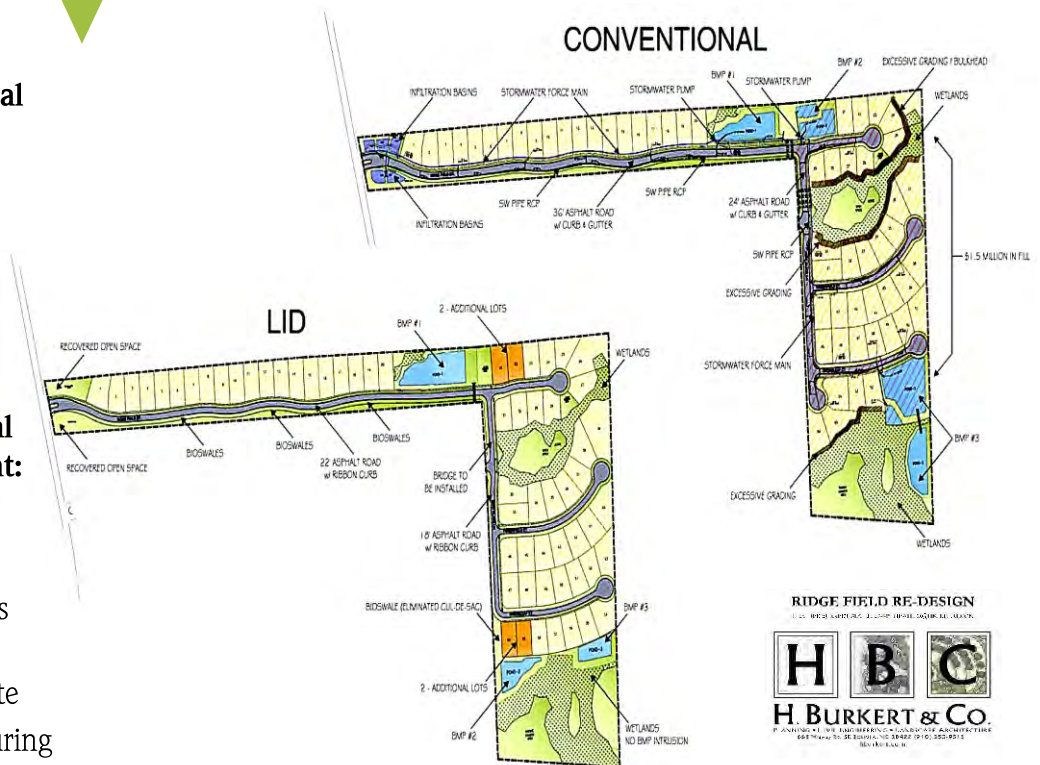
- Wetlands
- Shoreline
- Floodplain
- Forests
- Flow patterns

### 2. Determine the site's potential for LID stormwater treatment:

- Locate development on the least sensitive natural areas
- Protect the preservation areas during construction
- Use density where appropriate
- Minimize soil compaction during construction
- Use disconnected impervious areas to minimize runoff volumes
- Use the natural drainage patterns

## References and Resources

- **Low Impact Development Center**  
[www.lowimpactdevelopment.org](http://www.lowimpactdevelopment.org)
- **Green Growth Guidelines**, Chapters 1-6, "Site Fingerprinting Utilizing GIS/GPS Technology"  
[coastalgadnr.org/cm/green/guide](http://coastalgadnr.org/cm/green/guide)
- **Urban Land Institute**  
[www.uli.org](http://www.uli.org) [search LID]
- **American Institute of Certified Planners (AICP)**  
[www.planning.org](http://www.planning.org) [search stormwater]
- **American Society of Landscape Architects (ASLA)** [www.asla.org](http://www.asla.org) [search LID]
- **Ladybird Johnson Wildflower Center**  
[www.wildflower.org](http://www.wildflower.org) [search LID]



One of the many benefits of site fingerprinting is reduced infrastructure costs for developers. The Ridgefield project in Wilmington, NC was redesigned from conventional development to LID development using techniques such as site fingerprinting. Final statistics for the project confirm a reduction in development costs from \$2 million to \$889,000, added open space, and 4 additional lots with the LID design.

## Ridgefield Redesign in New Hanover County FINAL STATISTICS

- ➔ Gained 4 additional lots
- ➔ Reduced stormwater pipe by 89%
- ➔ Decreased road widths 9%
- ➔ Eliminated 9,000 ft curb and gutter \$\$\$\$
- ➔ Eliminated 5 infiltration basins \$ in construction and maintenance
- ➔ Eliminated 5 monitoring wells \$ in construction and monitoring fees
- ➔ Eliminated 10,000 linear feet of stormwater force main
- ➔ Saved \$1 million in fill and grading
- ➔ Increased localized stormwater infiltration
- ➔ Eliminated 3 Tsurumi stormwater pumps
- ➔ Increased functional and recreation open space
- ➔ Minimized wetlands intrusion and wildlife impacts
- ➔ Buyers prefer "green" real estate
- ➔ Promoted good neighbor
- ➔ Decreased construction traffic



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# Stormwater Solutions: Disconnected Impervious Surfaces

LOW IMPACT DEVELOPMENT: SIMPLE SOLUTIONS TO REDUCE STORMWATER IMPACTS



## What is a Disconnected Impervious Surface?

Roof tops, parking lots, and other impervious surfaces often drain directly to pipe systems or ditches, increasing runoff and preventing rainwater from soaking into the ground. Disconnected impervious areas are those which divert or direct stormwater to naturally vegetated areas. This reduces pollution by slowing down the runoff, increasing infiltration, and filtering flow through vegetation.

## Did You Know?

- During small storms, disconnected impervious areas can reduce runoff volume by 30% to 100%.
- Benefits include reduced need for irrigation, better aesthetics, and lower infrastructure costs.

## Benefits

- Reduces stormwater runoff volumes discharged into our waterways
- Reduces infrastructure costs
- Reduces dependence on irrigation
- Provides healthier green space

## Helpful Hints

- For the best effect, tie multiple practices together. Use disconnected impervious areas as part of a larger stormwater management strategy.

# Where to Start

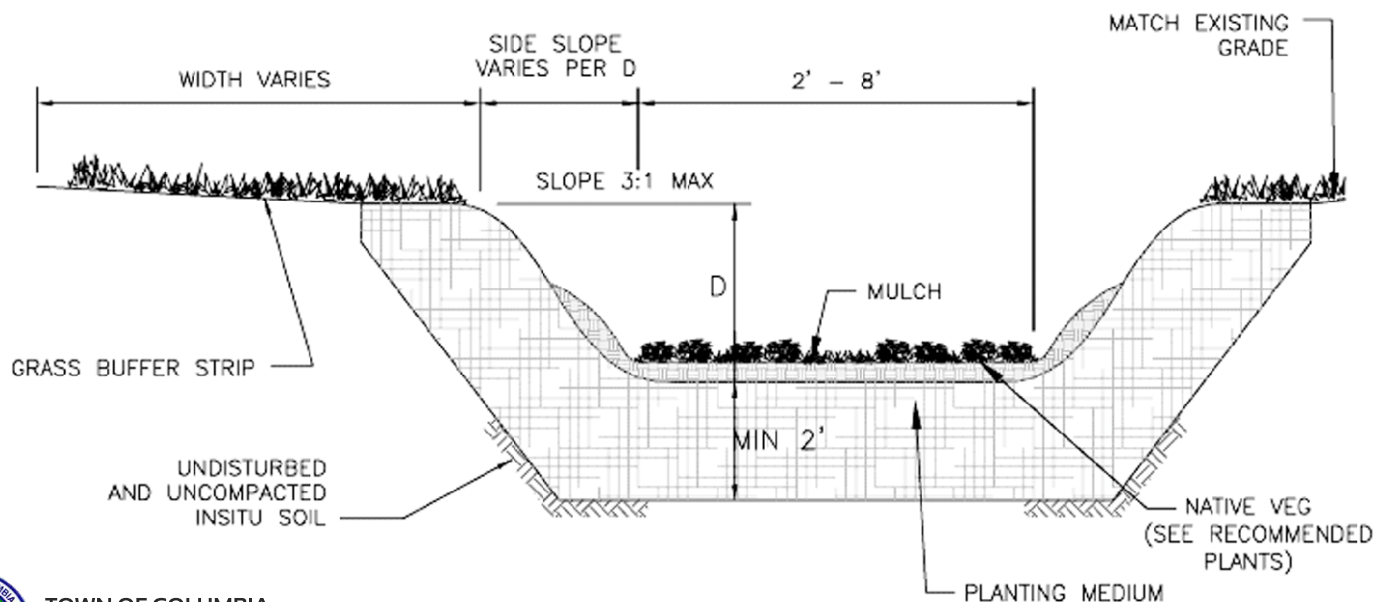
## Location

- As a retrofit, see if it's possible to add curb cuts in the edge of the parking lot to allow runoff flow into vegetated areas.
- On new or re-development sites, try to slope the parking lots, roofs, and sidewalks into landscaped areas, open spaces, or woods.
- Make sure water is directed away from buildings.
- Disconnect the building downspouts. [see [Simple Solutions fact sheet](#)]



## References and Resources

- See the **Simple Solutions: Downspout Disconnection** fact sheet for more help. Contact your local nursery or Town staff for more assistance.
- **NC Cooperative Extension**  
[www.ces.ncsu.edu/search/impact\\_solutions](http://www.ces.ncsu.edu/search/impact_solutions)
- **Low Impact Development Center**  
[www.lowimpactdevelopment.org](http://www.lowimpactdevelopment.org)
- **NC Coastal Federation**  
[www.nccoast.org](http://www.nccoast.org)



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TYPICAL WET SWALE CROSS-SECTION  
NOT TO SCALE

# Stormwater Solutions: Planter Boxes

LOW IMPACT DEVELOPMENT: SIMPLE SOLUTIONS TO REDUCE STORMWATER IMPACTS



## What is a Planter Box?

Planter boxes use high flow rate soil filtration media to control and treat runoff from small parking lots or roadways. Runoff flows through the sandy soil mix, which traps solids and pollutants. As their name suggests, planter boxes also use vegetation to help absorb the water trapped by the soil. In addition, the plants also create a mini living ecosystem within the soil, fostering healthy microbes which aid in breaking down oil and grease.

## Did You Know?

- Planter boxes can be integrated into the existing storm drainage system with minimal disturbance, making them an excellent retrofit.
- Planter boxes are a great LID solution. They provide treatment at the source in a small footprint.

## Benefits

- More trees, flowers, and shrubs
- Reduced runoff volume and pollution
- Small footprint needs almost no land
- Great for retrofits

## Helpful Hints

- Think about using the planter box upstream of any underground stormwater device – the water that gets into the underground device will be cleaner, and the cistern won't need as much maintenance.
- Holes can be installed in the bottom of the box to encourage additional infiltration if the soil is suitable.

# Where to Start

## Location

- Site the planter box in the curb line, immediately upstream of a catch basin or inlet.
- Typical boxes are 3' deep – make sure there is a suitable outfall to drain the box between storms.
- The box should be oriented so flow comes across inlet throat, not directly at inlet opening.
- Use plants that are native to coastal North Carolina.

## Sizing

- The soil media should be at least 3' deep.
- The minimum soil infiltration rate should be 10" per hour or greater.

Planter Box Size	Max Impervious Area (acres)
4' x 6'	0.14
4' x 8'	0.19
4' x 12'	0.28
6' x 6'	0.21
6' x 8'	0.28
6' x 10'	0.35
6' x 12'	0.42
7' x 13'	0.54

## Installation

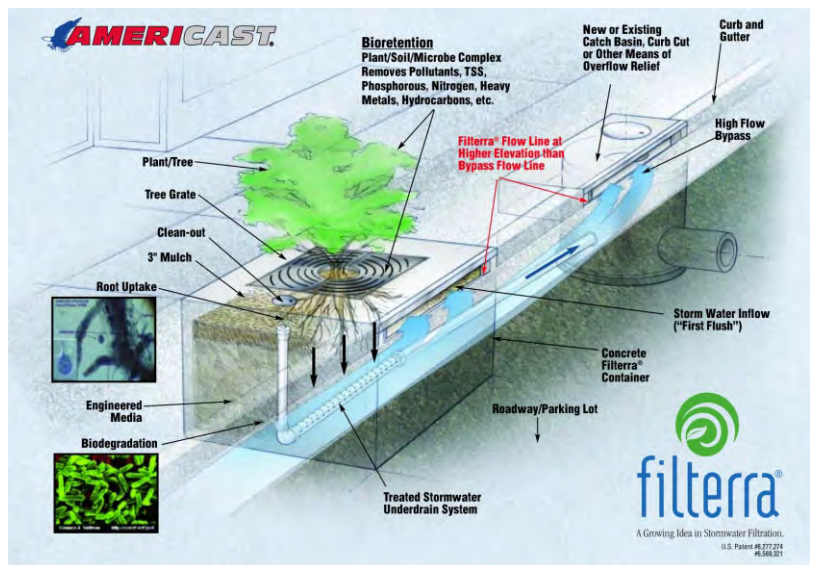
- Contractor assistance will be required.
- Many manufactured systems are available, contact a manufacturer for specific installation guidelines.

## References and Resources

- **Portland Oregon**  
[www.portlandonline.com](http://www.portlandonline.com) [click on/ living/ sustainable city/yard&garden/outdoor]
- **Low Impact Development Center**  
[www.lowimpactdevelopment.org](http://www.lowimpactdevelopment.org)  
[search planter box]



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# Stormwater Solutions: Permeable Paving

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## What is Permeable Paving?

Permeable pavement is any paving material that allows rainwater to soak through the pavement and infiltrate the soil. Permeable paving comes in various forms – pervious concrete, pervious asphalt, and concrete pavers are some of the most popular materials. The permeable paving system requires a washed stone base, which aids in adding runoff storage volume as well as structural support.

## Did You Know?

- The concrete industry has data on the long term performance and cost-benefit of using pervious pavement systems.
- Permeable pavement has been used in many locations in coastal North Carolina.

## Benefits

- Increased infiltration, reduced runoff
- Opportunity for artistic design if pavers are used
- Great way to reduce runoff without losing parking
- Great for retrofits

## Helpful Hints

- Permeable pavements can be used in conjunction with underground detention or rainwater harvesting systems to gain additional stormwater benefits.
- There are thousands of paver and material options – contact your contractor for more information.

# Where to Start

## Location

- Pervious pavement systems should be sited on generally flat areas.
- A concrete edging may be necessary.
- Obtain a soil test before installing pavements because an under drain might be needed.
- Only install permeable systems where the water table is deep enough to allow the system to drain completely.

## Sizing

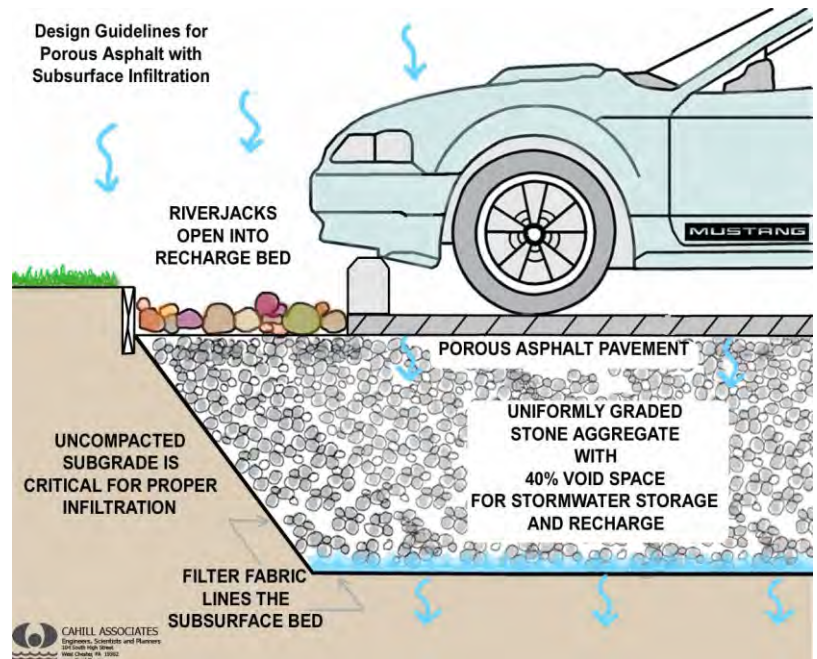
- Unless a permit is required, there is no surface area requirement. Consider using a thicker washed stone base to increase storage capacity and further reduce runoff volumes.

## Care

- The system should be checked regularly for proper drainage.
- If infiltration rate decreases, clean debris from surface layer.
- If system loses infiltration capabilities, contact an engineer or qualified contractor.
- Potholes, cracks, or damaged pavers should be repaired or replaced.

## References and Resources

- **Carolina Ready-Mix Concrete Association**  
[www.crmca.com](http://www.crmca.com)
- **Pervious Pavement**  
[www.perviouspavement.org](http://www.perviouspavement.org)
- **Concrete Network**  
[www.concretenetwork.com/pervious](http://www.concretenetwork.com/pervious)
- **Low Impact Development Center**  
[www.lowimpactdevelopment.org](http://www.lowimpactdevelopment.org)
- **NC DWQ Manual**  
[www.portal.ncdenr.org/web/wq/ws/su/bmp-manual](http://www.portal.ncdenr.org/web/wq/ws/su/bmp-manual)



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# Stormwater Solutions: Cisterns

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## What is a Cistern?

Cisterns are large water harvesting systems which collect rain water and store it for future use. In contrast to a rain barrel, which stores only a small volume of water, cisterns are sized to capture larger volumes of water and can be installed above or below ground. This water can then be reused for larger scale irrigation, industrial processes, and/or commercial reuse.

## Did You Know?

- For every inch of rain that falls on a 1,200 square foot area, approximately 748 gallons of stormwater runoff is produced.
- For high water consumption users, cisterns can be a financially profitable investment, paying for themselves by reducing or even eliminating water bills for non-potable uses.

## Benefits

- Lower water bills
- Reduced runoff and stormwater pollution
- Available water for use during drought conditions

## Helpful Hints

- Check Columbia's building codes before construction.
- Computerized water management systems can optimize performance.
- Cisterns are often some of the most visible green elements of a property and many aesthetic options are available.
- Low cost filters are available to prevent clogging and reduce long term maintenance needs.
- A cistern system that minimizes sunlight penetration can help prevent bacteria and mosquito growth.

# Where to Start

## Location

- Look for ways to connect multiple downspouts into a system.
- For especially large systems, water can be stored underground in vaults or other engineered systems.

## Equipment

- Heavy construction equipment is often required, but most commercial contractors have the equipment which would be needed.
- There are a number of specialized rainwater harvesting contractors who offer comprehensive design and installation services.

## Considerations

- Cisterns can be used on existing development or new construction.
- A full cistern is heavy and may require additional support, such as a concrete or gravel pad.
- If rainwater is to be used inside a building for non-potable uses, dual plumbing systems will be required.

## References and Resources

- NC Cooperative Extension**  
[www.ces.ncsu.edu](http://www.ces.ncsu.edu) [search cisterns]
- NC Community Conservation Assistance Program**  
[www.enr.state.nc.us/dswc](http://www.enr.state.nc.us/dswc)
- NC State University**  
[www.bae.ncsu.edu/topic/waterharvesting](http://www.bae.ncsu.edu/topic/waterharvesting)
- NC DWQ BMP Manual**  
[www.ncdenr.org/bmpmanual](http://www.ncdenr.org/bmpmanual)  
[search chapter – rooftop management]

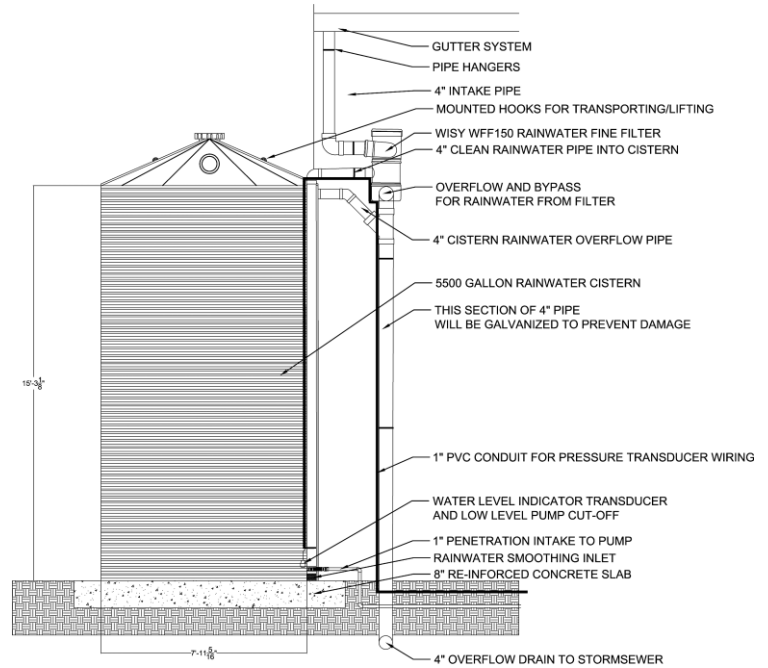


Diagram of an above-ground cistern. Source: Capitol Greenroofs.

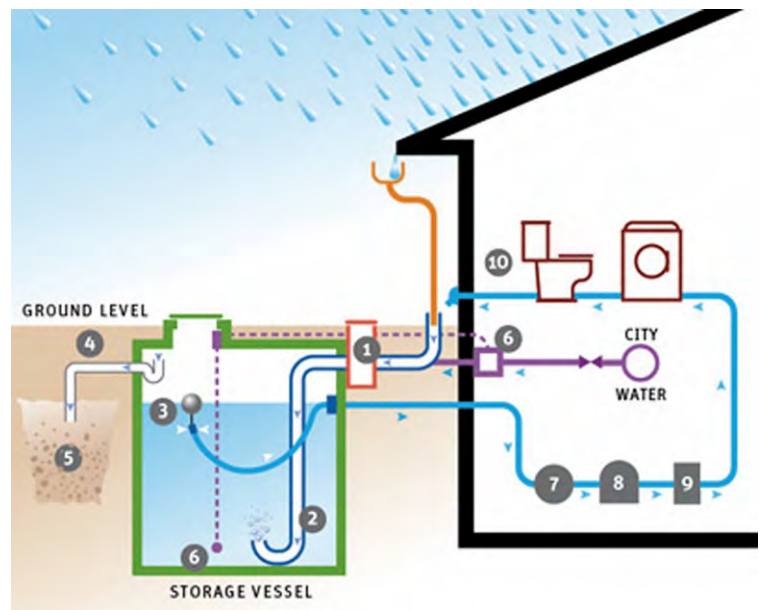


Diagram of a below-ground cistern: (1) Self-Cleaning Filter; (2) Calmed Inlet; (3) Floating Intake; (4) Overflow Siphon; (5) Infiltration; (6) Integration Controller; (7) Electronic Pump Control; (8) Pump; (9) Pressure Tank; (10) Rainwater for washing machine, toilets, lawn and gardens, etc. Source: RainKeeper.com.



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# Simple Solutions: Rain Gardens

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## What is a Rain Garden?

Rain gardens are small, shallow, vegetated areas where rainwater collects during storms. Rain gardens are typically 4-8 inches lower than the surrounding lawn and act as a bowl that collects runoff. The plants and soil soak up the rain water before it becomes polluted runoff.

## Did You Know?

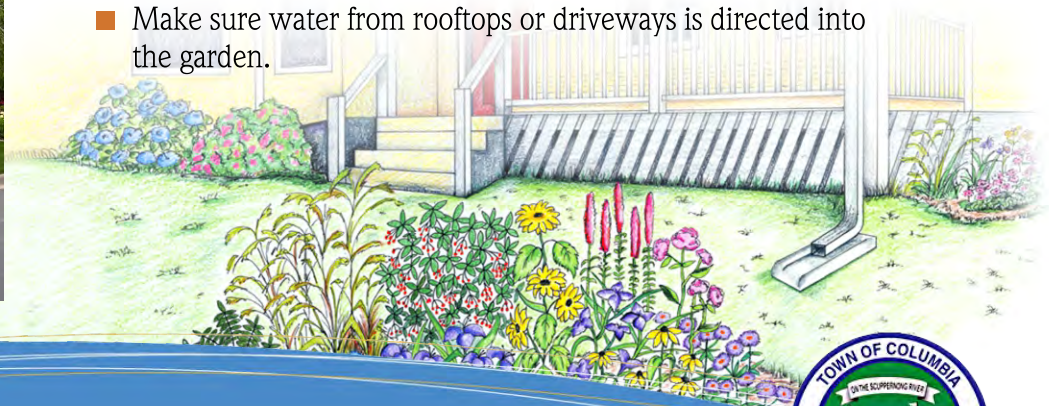
- Rain gardens can reduce stormwater runoff by 90% or more.
- Over 25% of the population lists gardening as a hobby.

## Benefits

- Reduced stormwater runoff
- Reduced pollutants
- Reduced flooding
- Natural stormwater treatment
- Enhanced curb appeal of your yard

## Helpful Hints

- Observe water flow patterns during rains to determine potential areas for rain gardens.
- Use native plants for lower maintenance.
- Rain gardens may not be suitable in areas with standing water [[see BACKYARD WETLAND fact sheet for options](#)].
- Make sure water from rooftops or driveways is directed into the garden.



# Where to Start

## Location

- Select an area that will capture and absorb runoff based on how water flows across your land.
- Site the garden at least 10' from your house, and 25' from wells or septic fields.
- Make sure the soil will drain.
- Plant flowers, shrubs, grasses or even turf.

## Equipment

- Small rain garden can be built by hand in a weekend, but, contact Town staff or a local contractor for additional assistance if needed.

## Planting

- Heavy double or triple shredded hardwood mulch works best because it won't float away. It also helps retain moisture for the plants.
- Choose native vegetation when possible.

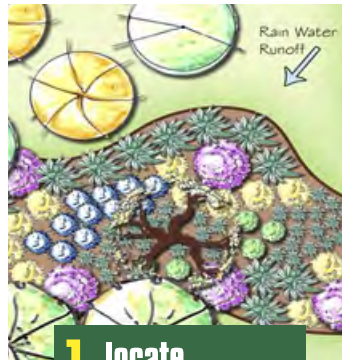
## Care

- Periodically water your garden until established.
- Mulch annually.

## References and Resources

- See **Simple Solutions: Native Landscaping and Tree Planting** fact sheet for more help.
- **NC State University Rain Garden Guide** [www.bae.ncsu.edu](http://www.bae.ncsu.edu) [search rain gardens]
- **NC Coastal Federation** [www.nccoast.org](http://www.nccoast.org) [search low impact development]

## BASICS FOR BUILDING A RAIN GARDEN



### 1 locate

Select an area that will capture and absorb runoff. The location will depend on the amount of hard surfaces, how water flows across the land and the type of soil on your property.



### 2 design

Rain gardens are shallow depressions, typically 4-8 inches lower than the surrounding lawn. They can be many shapes and sizes depending on the location you select and the amount of runoff you plan to capture.



### 3 build & plant

Dig a shallow depression for the outline and base of the rain garden, making sure the bottom depth is at least 2 feet above the water table. It is best to plant your rain garden with native plants in the spring or fall when the plants will establish most easily.



### 4 maintain

You may need to periodically water your garden for the first growing season until the plants are fully established. If you use native plants, maintenance of your rain garden may only include annual mulching and weeding.

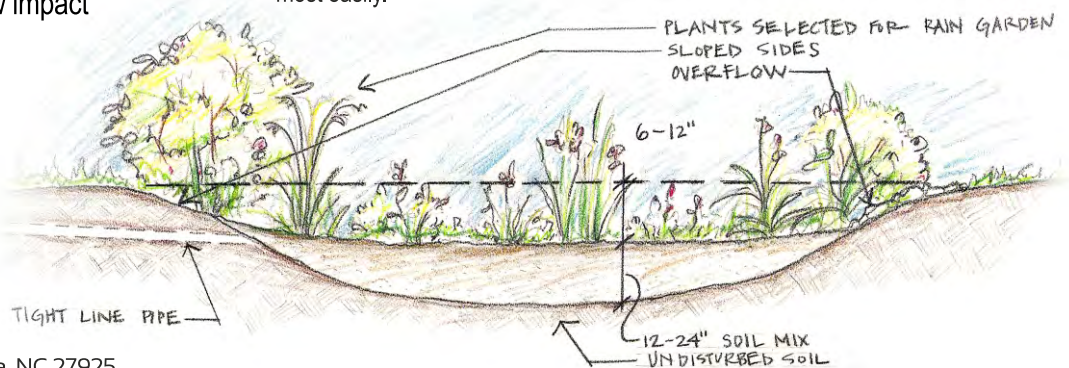


Diagram of a Rain Garden (Source: H2D Architecture + Design Blog)



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# Simple Solutions: Backyard Wetlands

LOW IMPACT DEVELOPMENT: SIMPLE SOLUTIONS TO REDUCE STORMWATER IMPACTS



## What Is A Backyard Wetland?

Backyard wetlands are depressed wet areas that are planted with native wetland plants. They are well suited for areas of your yard that are usually wet for several days following a rain event. Backyard wetlands are designed to capture and treat stormwater similar to a rain garden but in locations with high-water tables and soggy soils.

## Did You Know?

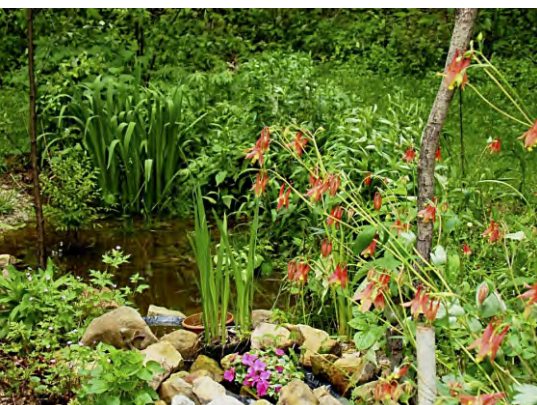
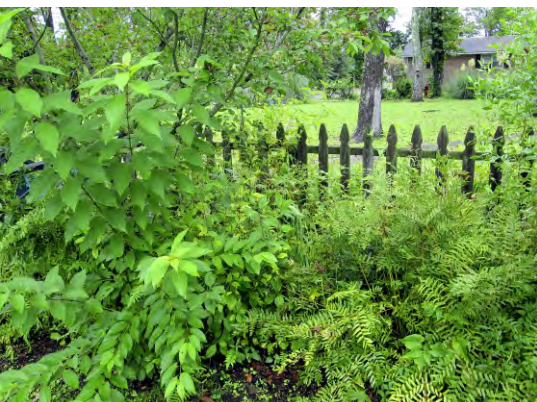
- Man-made backyard wetland gardens can provide many of the same benefits as natural wetlands.

## Benefits

- Capture, reduce and filter runoff
- Enhanced landscaping
- Bird and butterfly habitat

## Helpful Hints

- Locate the backyard wetland where it is not likely to attract unattended children.
- Check local safety ordinances and building ordinances for restrictions and permits.



# Where to Start

## Build and Construct

- Choose areas of your lawn that include naturally occurring wet spots for your wetland.
- Locate wetland at least 10 feet from any foundation.
- Build wetland at least 25 feet from septic fields and well heads.
- Ponding depth of wetland should be no more than 9 inches.
- Refer to *Common Wetland Plants of North Carolina*, to determine the type of native plants to use in your backyard wetland.

## References and Resources

- **Natural Resources Conservation Service**  
[www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?&cid=nrcs143\\_023525](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/features/?&cid=nrcs143_023525)
- **NCSU Urban Waterways – Designing Stormwater Wetlands for Small Watersheds**  
[www.bae.ncsu.edu/stormwater/PublicationFiles/WetlandDesignUpdate2007.pdf](http://www.bae.ncsu.edu/stormwater/PublicationFiles/WetlandDesignUpdate2007.pdf)
- **Common Wetland Plants of North Carolina**, produced by the NC Department of Environment and Natural Resources, Division of Water Quality  
[portal.ncdenr.org/c/document\\_library/get\\_file?uuid=d0f7bb32-5585-4acf-a399-8d484488d234&groupId=38364](http://portal.ncdenr.org/c/document_library/get_file?uuid=d0f7bb32-5585-4acf-a399-8d484488d234&groupId=38364)
- **Division of Soil and Water Conservation Community Conservation Assistance Program Manual**  
[www.enr.state.nc.us/dswc/pages/CCAP\\_Manual\\_SECTIONV08.pdf](http://www.enr.state.nc.us/dswc/pages/CCAP_Manual_SECTIONV08.pdf)

*A wetland in your backyard will temporarily store, filter, and clean runoff water from your roof and lawn. It will provide habitat for many interesting creatures – from butterflies and bees to salamanders, toads, frogs, and birds.*



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# Simple Solutions: Reroute Downspouts

LOW IMPACT DEVELOPMENT: SIMPLE SOLUTIONS TO REDUCE STORMWATER IMPACTS



## Why Reroute Downspouts?

Downspouts directed to driveways, sidewalks or parking lots increase the amount of polluted runoff by an average of 50 percent or more. Instead of contributing to stormwater pollution, you can put rain water to good use.

## Did You Know

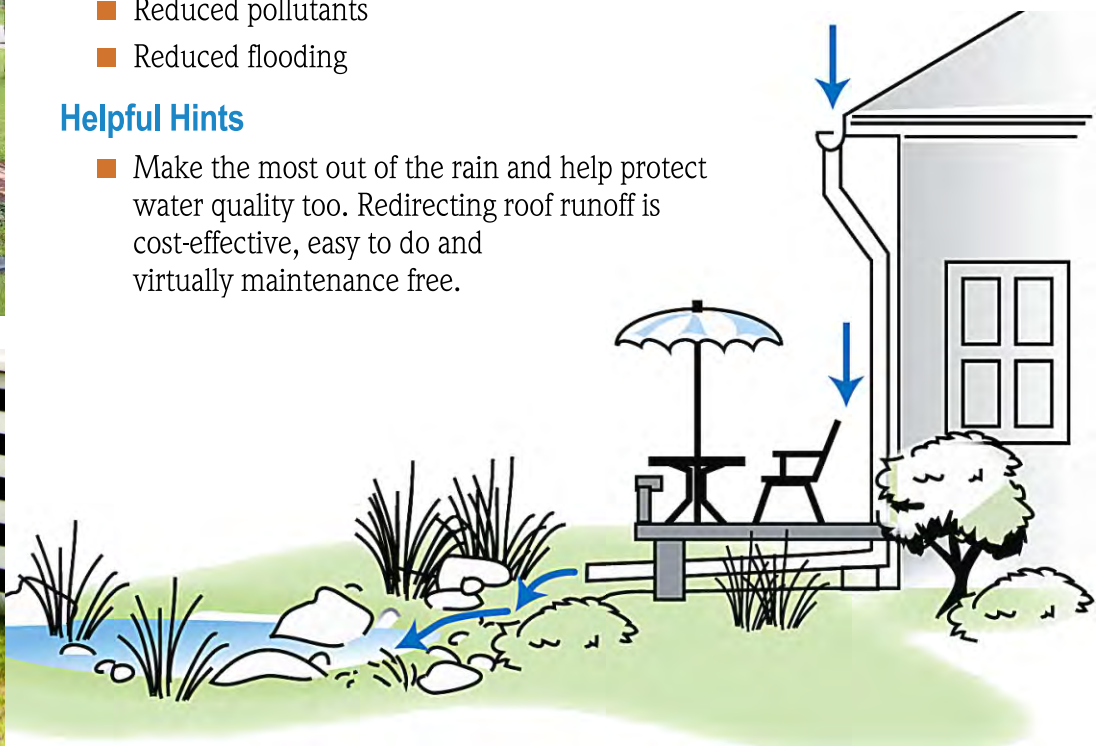
- During the summer months it is estimated that nearly 40 percent of household water is used for lawn and garden maintenance?

## Benefits

- Reduced runoff volume
- Reduced pollutants
- Reduced flooding

## Helpful Hints

- Make the most out of the rain and help protect water quality too. Redirecting roof runoff is cost-effective, easy to do and virtually maintenance free.



# Where to Start

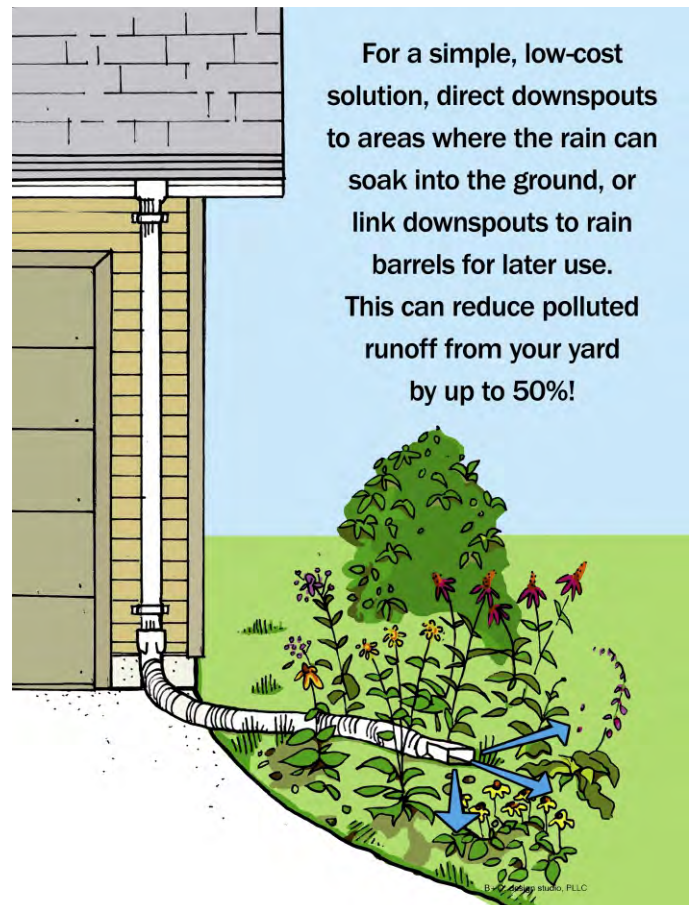
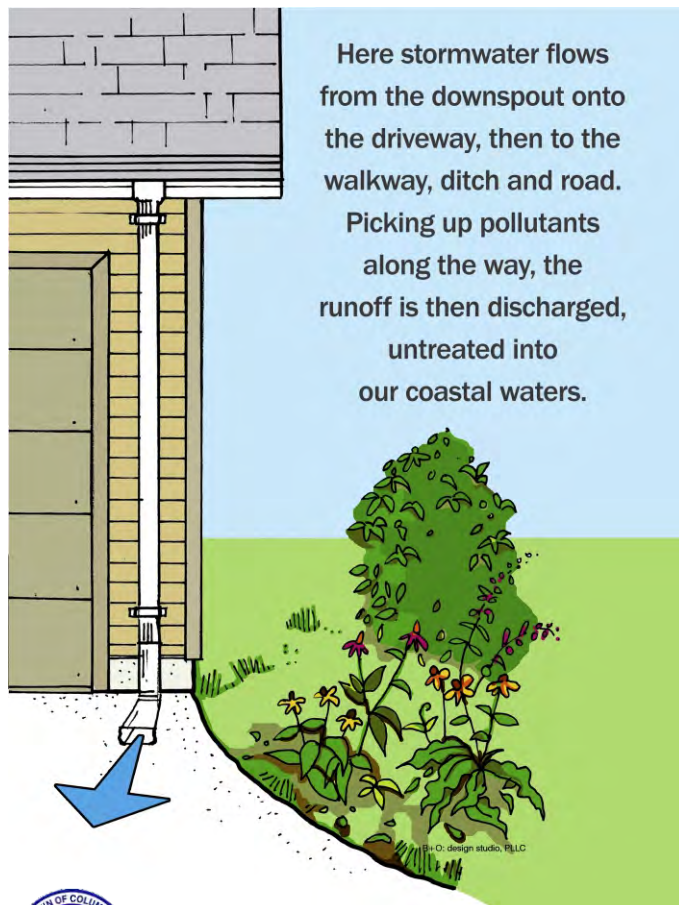
## Reroute Your Downspout

*Reroute your downspout with these few simple techniques:*

- Direct downspouts to areas that can infiltrate into the ground.
- Turn downspouts away from sidewalks and driveways into yards and other vegetated areas by using extension gutters to “disconnect” the impervious surfaces.
- Route downspouts to landscaped areas such as rain gardens.
- Link downspouts to rain barrels.
- Use extension gutters or splash blocks to help direct the flow of water.
- Re-route all stormwater at least five feet from your foundation.
- Avoid routing downspouts to neighboring property or directly over a septic system or drain field.

## References and Resources

- **Mid-America Regional Council**  
[www.marc.org/environment/water](http://www.marc.org/environment/water)
- **City of Portland Stormwater Solutions Handbook**  
[www.portlandonline.com](http://www.portlandonline.com)
- **North Carolina Coastal Federation**  
[www.nccoast.org](http://www.nccoast.org)
- **DC River Smart Homes**  
[www.ddoe.dc.gov](http://www.ddoe.dc.gov) [search downspout disconnection]



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## Simple Solutions:

# Native Landscaping and Tree Planting

LOW IMPACT DEVELOPMENT: SIMPLE SOLUTIONS TO REDUCE STORMWATER IMPACTS



## What is Native Landscaping and Tree Planting?

Native landscaping includes the use of plants that occur naturally in the northeast coastal region not having been introduced by human action. Native plants have adapted to the geography, hydrology, and climate of the region. Planting trees can help reduce stormwater by intercepting it and allowing it to evaporate, as well as dissipating the energy of runoff. They also provide shade, which helps keep surface temperatures lower, and they facilitate stormwater infiltration and groundwater recharge.

## Did You know?

- Native trees and plants are hardy and well suited to our soils and climate.
- Require little care once established as compared to non-natives.
- Absorb and slow the flow of stormwater runoff.
- Prevent erosion and increase soil permeability.
- Are part of our coastal natural heritage.

## Benefits

- Native plants provide beautiful, hardy, drought resistant and low maintenance landscapes while benefiting the environment. Native plants, once established, save time and money by eliminating or significantly reducing the need for fertilizers, pesticides, irrigation and lawn maintenance equipment. It is estimated that one hundred large mature trees intercept 1.2 million gallons of rainfall per year, and for every 5 percent tree cover added to a community, stormwater runoff is estimated to be reduced by approximately 2 percent. Properties with trees are estimated to be valued 5 to 15 percent higher than comparable properties without trees.

## Helpful Hints

- Direct runoff to a native landscaped feature such as a rain garden to capture stormwater and create beautiful habitats. Rain gardens are designed landscape features that include depressions with native plants. [\[See Rain Garden fact sheet.\]](#)

# Where to Start

## Build and Plant

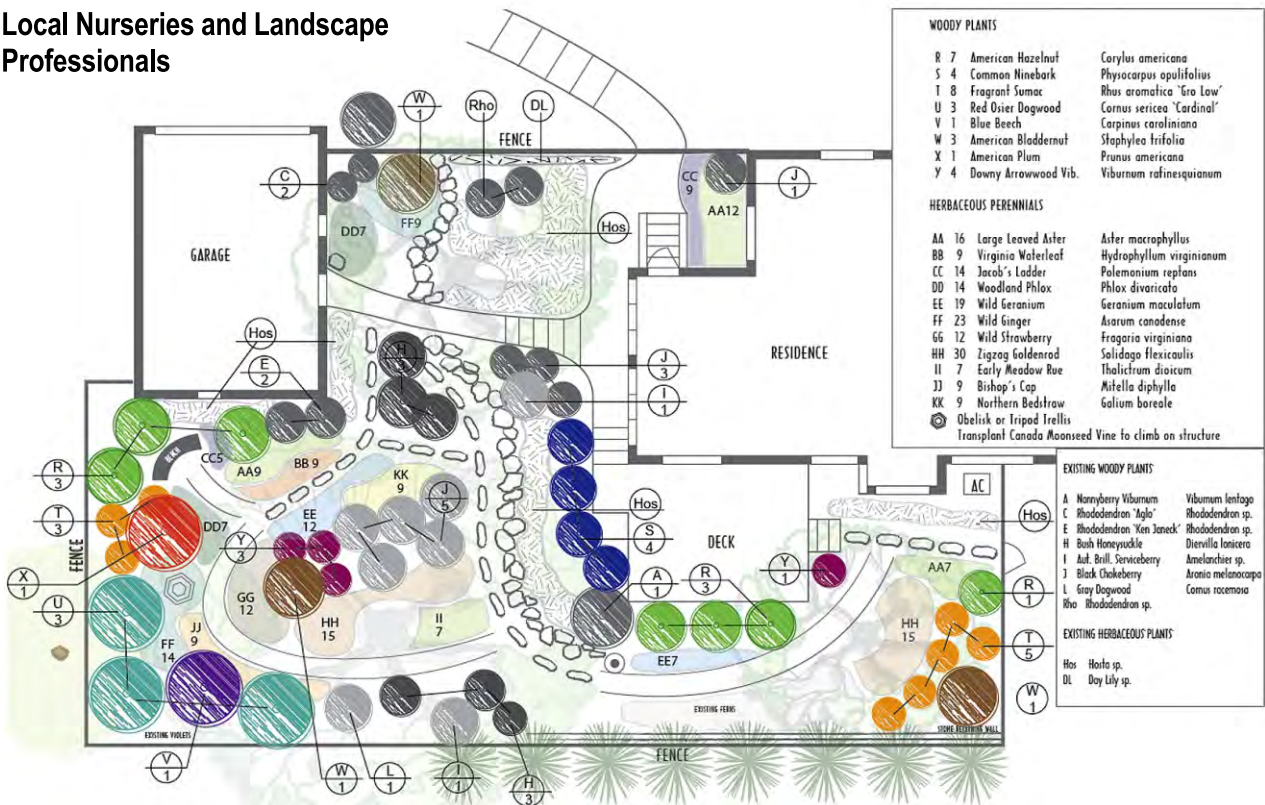
- Use the landscape to help keep rainwater on-site.
- Plant trees that maximize interception of rain.
- Plant native trees with higher growth rates.

## References and Resources

- For native landscaping design ideas and plant lists applicable to your community go to:  
[www.ncsu.edu/goingnative/howto/index.html](http://www.ncsu.edu/goingnative/howto/index.html)
- NC Cooperative Extension  
[www.ncsu.edu/goingnative](http://www.ncsu.edu/goingnative)
- NC Coastal Federation  
[www.nccoast.org](http://www.nccoast.org) [search native plants]
- NC Native Plant Society  
[www.ncwildflower.org](http://www.ncwildflower.org) [NE Coast]
- Water Forestry Guide  
[www.forestsforwatershed.org](http://www.forestsforwatershed.org)
- Local Nurseries and Landscape Professionals



Native plant nurseries are a great place to start looking for plants to fill out your native landscape design.



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**Backyard Landscape Plan**  
(source: Holm Design & Consulting)

# Simple Solutions: Rain Barrels

LOW IMPACT DEVELOPMENT: SIMPLE SOLUTIONS TO REDUCE STORMWATER IMPACTS

## What is a Rain Barrel?

A rain barrel is a container that collects and stores rainwater from your roof that would otherwise be lost to runoff. Rain barrels come in all shapes and sizes. They typically include the drum, a vinyl hose, PVC couplings and screen to keep debris and insects out. A rain barrel can sit conveniently under any residential gutter downspout.

## Did You know?

- One quarter-inch of rain produces enough runoff to fill a typical rain barrel hooked up to one downspout. If you and your neighbors all added just one rain barrel, it would have a significant impact on flooding and pollution in your community.
- One 55-gallon rain barrel holds a full week's worth of water for a 10' x 10' garden.

## Benefits

- Lower water bills
- Reduced runoff and stormwater pollution
- Available water for watering plants during drought
- The natural nutrients of rainwater needed for healthy plants

## Helpful hints

- Always keep the lid to your barrel tightly secured to avoid any accidents involving children or animals. Please do not ever consume water collected in barrel!

# Where to Start

## Size and Install Your Rain Barrel

- Most rain barrels are easy to install; however, actual installation methods may vary depending on the type of rain barrel. Installation of a typical barrel will involve disconnecting your downspout, cutting off a portion of the downspout and redirecting it into the top of the barrel. Most rain barrels have an overflow pipe that redirects the rainwater back into the downspout or onto your lawn or other surface in the event the barrel becomes full. Some rain barrels include safety features, spigots, connector barrels, mosquito proofing, and even water filters.



With some additional planning, a rain barrel can be incorporated into any landscape.  
Source: Diane Lazor, Franklin Soil & Water Storm Water Education.

## Care

- Use the water between rain events, or empty the barrel monthly.
- Once a year, tip over the rain barrel and wash it out with a hose.
- Clean your gutters regularly to prevent debris.
- If you start to see algae, add one cap of chlorine bleach to a full barrel of water; this small amount won't hurt plants.

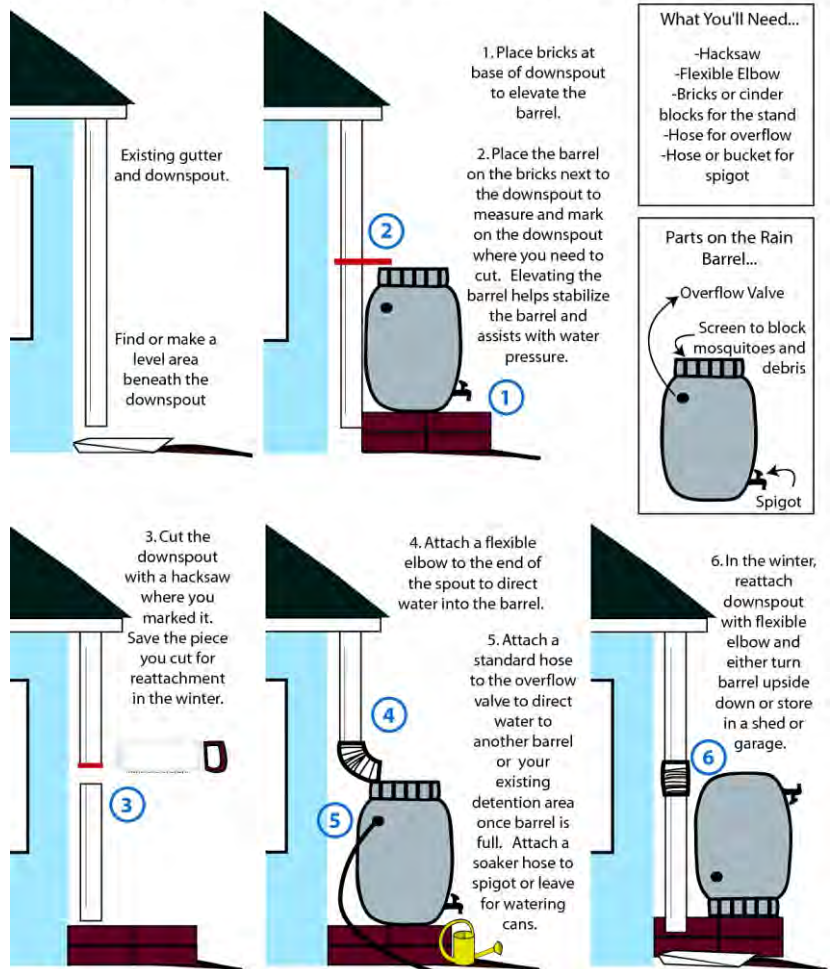
## References and Resources

- NC Cooperative Extension**  
[www.ces.ncsu.edu](http://www.ces.ncsu.edu) [search rainwater]
- NC State University**  
[www.bae.ncsu.edu/topic](http://www.bae.ncsu.edu/topic) [click waterharvesting]
- NC Coastal Federation**  
[www.nccoast.org](http://www.nccoast.org) [search low impact development]



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## How To Install Your Rain Barrel



Source: DuPage County Stormwater Management 1/2010

# Permitting and Maintaining LID Projects

Town staff and/or the project developer should consult with the Stormwater Permitting Unit of the N.C. Division of Water Quality for guidance in designing and permitting LID projects. Additional stormwater management tools are scheduled to be developed by the state in the near future that will aid engineers, planners, and developers in the northeast coastal region with the design and permitting of LID projects. For up-to-date information on the status of these tools and for other questions call Mike Randall at 919.807.6734, email [mike.randall@ncdenr.gov](mailto:mike.randall@ncdenr.gov) or visit the website at [h2o.enr.state.nc.us](http://h2o.enr.state.nc.us).



## Constructing LID Projects

### Training

- It is very important that contractors, vendors and inspectors have been properly trained in the design specification and construction requirements for all LID practices employed. The success of many LID techniques depend on accurately following the grading plan, the use of proper materials and the appropriate location of practices. In some cases certification training may be appropriate. For example, the design and construction of permeable paving requires the knowledge of several disciplines including engineering, landscape architecture and soil science to ensure the proper design and construction of the project.

### Communication

- LID uses innovative techniques, unique strategies and various combinations of practices. Consequently, each development

results in a unique design with its own set of issues and challenges. It is vital that everyone involved in the LID project (contractors, vendors, design engineers, permit staff and inspectors) understand the unique details of the LID project.

- A pre-construction meeting is the most useful approach to ensure that the project goals and issues are effectively communicated. Ideally the permit reviewer, contractor, vendor, design engineer and inspector should hold a meeting to go over the plans and discuss all aspects of the project. During the pre-construction meeting, the inspector may evaluate the proposed sequence of construction, sediment control requirements, and indicate when inspection points during construction of the LID practices are required as identified in the design manual.
- Throughout the construction process, proper lines of communication must be in place between the general contractor, site

engineer, inspector, and permit staff to ensure project success. After construction, a final inspection and walk-through of each LID practice is necessary to ensure its proper function.

### Maintenance and Long Term Success of LID Projects

- LID is a comprehensive approach that has built-in redundancy, which greatly reduces the possibility of failure. Many LID techniques have nothing to do with the actions or inaction of property owners. These include basic subdivision and infrastructure design features such as reducing the use of pipes, ponds, curbs and gutters; making use of grading strategies, and reducing impervious surfaces and disconnecting those that must be used; and conserving open space.
- The key factor in the success of LID is to ensure that the landscape practices (such as rain gardens) are attractive and perceived by the property owner as adding value to

the property. If these LID practices are viewed as assets, the primary motivation for their long-term maintenance is that of property owners protecting their vested economic interests.

- Maintenance agreements can be used to ensure proper operation and maintenance of LID projects. If agreements are used they should address the following:
  1. The expected maintenance needs for all proposed stormwater facilities and BMPs.
  2. The party/parties responsible for maintenance and operation.
  3. The long-term funding for operation and maintenance.
  4. How the operation and maintenance will be transferred with the property to the new owner.
  5. A maintenance log indicating the activity and actions taken.

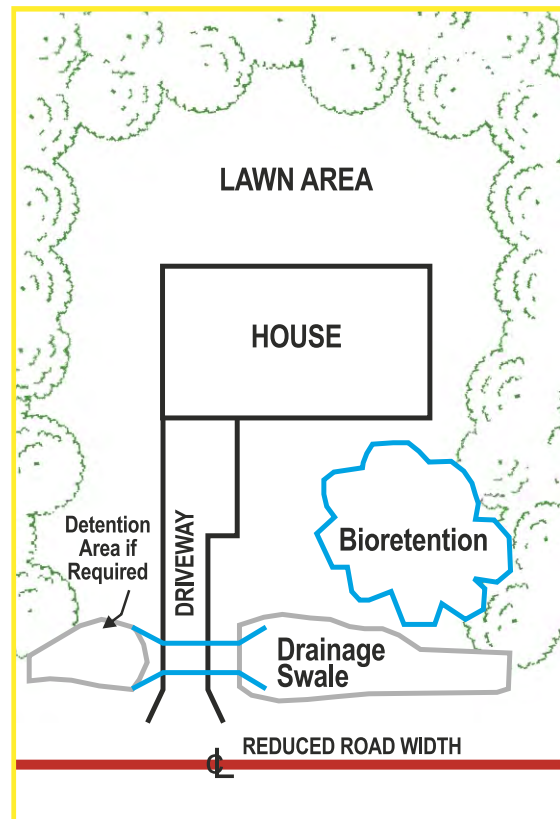
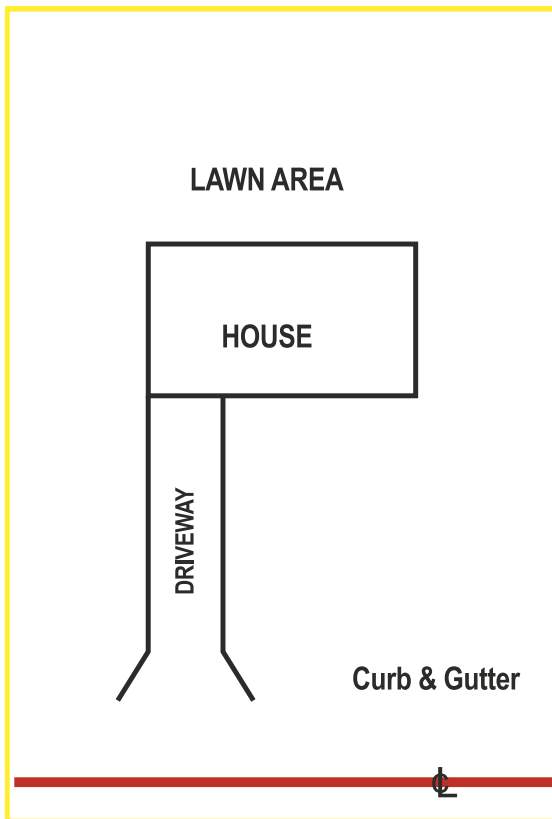
### References and Resources

- **Low Impact Development Center**  
[www.lowimpactdevelopment.org](http://www.lowimpactdevelopment.org) [search maintenance agreements]
- **Brunswick County**  
[www.brunswickcountync.gov/Departments/LandDevelopment/Planning](http://www.brunswickcountync.gov/Departments/LandDevelopment/Planning)  
 [search LID manual]



*It is very important that contractors, vendors and inspectors have been properly trained in the design specification and construction requirements for all LID practices employed.*

## CONVENTIONAL VS LID LOT CONTROLS



SOURCE: LARRY COFFMAN



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# Glossary

**annual plant:** A plant that completes its entire life cycle in a single growing season.

**base flow:** The flow in a stream between storm events. The flow is supplied by groundwater.

**best management practice (BMP):** A practice or combination of practices that are the most effective and practicable means of controlling pollutants at levels compatible with environmental quality goals.

**bioretention area:** A water quality practice that utilizes landscaping and soils to treat stormwater by collecting it in shallow depressions and then filtering it through a planting soil media. [also see rain garden]

**buffer:** An area of trees, shrubs and plants next to a waterbody designed to protect the receiving waterbody from sediment and pollutants contained in storm water runoff. Buffers also function as habitat for migratory birds and aquatic and terrestrial wildlife.

**check dam:** A small barrier built across the direction of water flow in a swale to retain excess water during heavy rains and to slow the speed of runoff traveling through the swale.

**deciduous plant:** A plant that sheds or loses its foliage at the end of each growing season.

**disconnected impervious surfaces:** Integration of treatment and management measures into developed areas to remove the links between hardscaped areas such as driveways, walkways, parking areas with the strategic placement of distributed lot-level controls that can be customized to more closely mimic a watershed's hydrology.

**ecosystem:** An interactive system that includes the organisms of a natural community together with their abiotic, physical, chemical and geochemical environment.

**easement:** A right, such as a right-of-way, afforded a person to make limited use of another's real property.

**estuary:** Brackish-water area influenced by the tides where the mouth of the river meets the sea. Estuaries are breeding grounds for many species of fish and shellfish.

**evergreen plant:** A plant that remains green and retains its foliage throughout the year.

**fecal coliform bacteria:** Bacteria that are present in the intestines or feces of warm-blooded animals. Often used as indicators of water quality.

**floodplain:** Areas that are periodically flooded by lateral overflow, such as river.

**forebay:** Stormwater design feature that uses a small basin to settle out incoming sediment delivered in runoff to a stormwater BMP.

**geographic information systems (GIS):** A computer system for capturing, storing, checking, integrating, manipulating, analyzing and displaying data related to positions on the Earth's surface. Typically, GIS is used for handling maps of one kind or another. These might be represented as several different layers where each layer holds data about a particular kind of feature (i.e. roads, waterbodies, etc). Each feature is linked to a position on the graphical image of a map.

**groundwater:** Water below the earth's surface, often between saturated soil and rock, that supplies drinking wells and springs. Runoff can seep into the soil and recharge groundwater supplies.

**habitat:** The specific area or environment where a plant or animal lives. A habitat must provide all of the basic requirements for life – food, water, shelter – and should be free of harmful contaminants and pollution.

**hydrology:** The science of dealing with properties, distribution and circulation of water.

**impervious surface:** Any surface that water cannot penetrate into (i.e. parking lots, streets, sidewalks, rooftops).

**infiltration:** The slow passage of a rainwater through the soil.

**low impact development (LID):** An innovative stormwater management approach with a basic principle that is modeled after nature – manage rainfall at the source using uniformly distributed decentralized micro-scale controls. LID's goal is to mimic a site's pre-development hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source.

**native plant:** A plant that naturally occurred in an area before disturbance by humans. Native plants are adapted to the weather, temperature and soil conditions of this region. Native plants require less (if any) fertilizers, pesticides or irrigation and tend to be disease and drought-tolerant.

**nonpoint source pollution (NPS):** Pollution that comes from many different sources in a watershed and is carried by storm water runoff into local waterways. Sources of NPS pollution are difficult to identify and control. Typical NPS pollutants are pet waste, lawn fertilizer, pesticides, car washing detergents, litter and sediment.

**nutrient:** A primary element necessary for the growth of living organisms. For example, nitrogen and phosphorous, are nutrients required for phytoplankton (algae) growth.

**outfall:** Point where water flows from a conduit, stream, pipe, drain, etc.

**perennial plant:** A plant that grows and persists for more than one year. Perennial plants persist as vegetation from year to year or resprout from their rootstock annually.

**pervious materials:** Pervious materials allow water to soak into the surface by virtue of their porous nature or by “void” spaces in the material.

**pervious paving:** Water-pervious materials such as gravel, crushed stone, open paving blocks or pervious paving blocks for driveways, parking areas, walkways, and patios that minimize runoff from those areas, as well as increase infiltration.

**point source pollution:** Water pollution entering the environment from a single point (i.e. factory pipe).

**pollution:** Any substance that exists in the environment that is undesirable or harmful for that environment.

**rain garden:** A rain garden is a shallow depression planted with native plants, flowers or grass that captures and infiltrates rain before it becomes polluted runoff.

**receiving waters:** Creeks, streams, rivers,, lakes, estuaries and other bodies of water into which stormwater flows into.

**river basin:** A river basin is the land that water flows across or under on its way to a river. As a bathtub catches all the water that falls within its sides, a river basin sends all the water falling on the surrounding land into a central river and out to an estuary or the sea.

**runoff volume:** The total volume of runoff is the amount of water that flows through the hydrometrically closed segment of a drainage basin. The total volume of runoff is usually determined graphically by constructing a hydrograph, that is, a diagram of change over time (t) of discharge (Q) for a year. Using the hydrograph it is possible to construct the integral curve of runoff, which gives a representation of the progressive accumulation of water volume (in a reservoir) with the passage of time. The modulus of runoff is the volume of runoff in a unit of time per unit of area of the watershed; it is usually expressed in //sec-km<sup>2</sup> or //sec-hectare.

**sediment:** Soil or dirt that washes into a body of water and contributes additional nutrients to the water. Sediment often comes from construction sites or bare lawns.

**storm drainage system:** The system built to collect and transport runoff to prevent flooding. This system consists of storm drains, drainage ditches, pipes and culverts. Anything that flows into the storm drainage system flows directly into local creeks and waterways (stormwater runoff is not treated). Storm drainage systems are completely separate from those that carry domestic and commercial wastewater (sanitary sewer system).

**stormwater runoff:** When rain falls on surfaces such as rooftops and parking lots it is not absorbed into the ground. Instead, it flows over these hard surfaces collecting pollutants along the way. This polluted stormwater runs into fragile coastal waters, degrading the health of creeks, rivers and sounds.

**surface water:** The water that rests on top of the earth in streams, lakes, rivers, oceans and reservoirs and is open to the atmosphere (i.e. rivers, lakes, creeks, streams, etc).

**TMDL:** Total maximum daily load of the amount of pollutants that can flow into the water without violating water-quality standards. Reductions are assigned to various sources.

**tributary:** A stream that flows into a larger stream or other body of water.

**watershed:** The land area that drains water to a particular stream, lake or river.

**water quality:** The biological, chemical and physical conditions of a waterbody; a measure of the ability of a waterbody to support beneficial uses.

**wetland:** Land whose soil is saturated with moisture either permanently or seasonally. They are generally distinguished from other water bodies or landforms based on their water level and on the types of plants that thrive within them. Specifically, wetlands are characterized as having a water table that stands at or near the land surface for a long enough season each year to support aquatic plants.

**Sources:** *City of Wilmington Stormwater Services Stormwater Glossary, Dictionary.com, Low Impact Development Center, NC Coastal Federation*





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