Improving Water Quality With Green Infrastructure

A Sustainable Framework for Growth and Development in the Central Midlands Region

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For Growth and Development In the
Central Midlands Region

Adopted by the
Central Midlands Council of Governments
Board of Directors
on October 27, 2011.

Project Sponsors

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About Central Midlands Council of Governments (CMCOG)

Created in 1969, CMCOG is a regional planning organization, which provides a forum in which local officials can work to resolve issues that transcend their own political boundaires. CMCOG currently consists of 14 member governments and serves in excess of 680,000 people in four midlands counties of Fairfield, Newberry, Richland and Lexington.

CMCOG works to develop area-wide plans and programs for addressing a wide range of issues that collectively affect local governments such as: regional urban & rural transportation planning; environmental and land use planning; community and economic development; workforce development; and aging services. CMOCG Staff also provides a wide of variety of research, planning and technical assistance to local governments, writes and administers a variety of grants, and serves as the Area Agency on Aging/ Aging & Disability Resource Center and the Long Term Care Ombudsman for the Central Midlands region.

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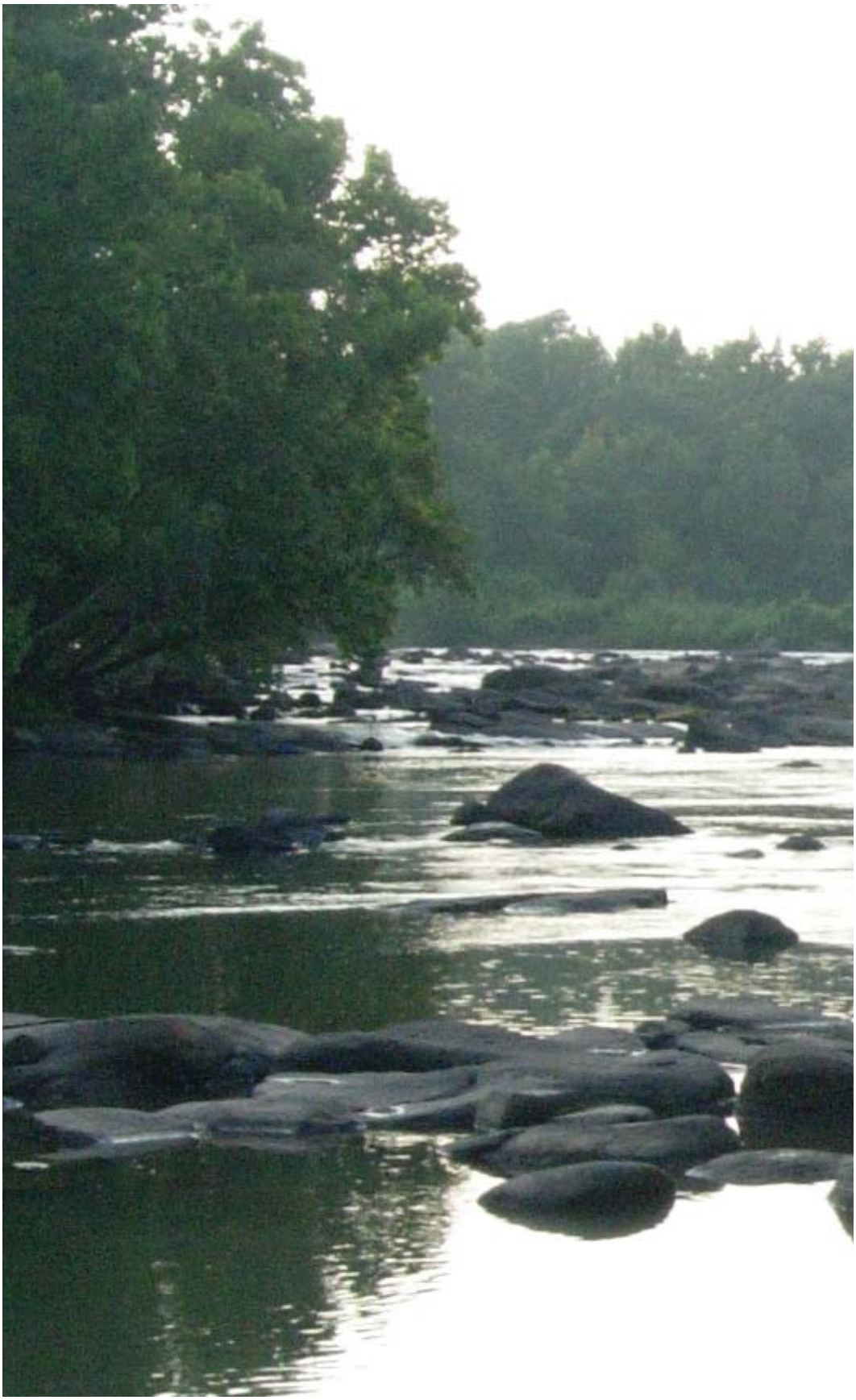


Introduction

In his 2005 book Infrastructure: A Field Guide to the Industrial Landscape, author Brian Hayes presents for the reader an informative and illustrative guidebook for identifying and understanding the everyday features of the built environment (i.e., the roads, dams, water and sewer systems, electrical grids, and other engineered structures that support our society). His purpose in writing the book was to cultivate in the reader a greater awareness, appreciation, and enthusiasm for all of the "miscellaneous hardware that goes into making a civilization." He further explains that such a field guide should provide more than just basic information for identifying this hardware, but it should ultimately lead to a better understanding of how the individual elements of this engineered landscape fit together as a "coherent whole."

This perceived lack of a general understanding of the engineered aspects of our daily lives suggests that for too long we have thought of infrastructure as something that is essential to our existence, but ultimately not in harmony with the natural and cultural landscapes in which we live. We have therefore made it a priority to hide this infrastructure from view and regulate its incompatibilities with the cultural resources it supports and the natural resources it depends on. The word infrastructure itself, as many authors have pointed out, is based on a combination of the Latin prefix "infra" which means "below" and the word "structure" which in this case refers to something that is constructed or built for a specific civil purpose. By using this word to refer to the essential components of the built environment we are acknowledging its importance to our existence, but at the same time suggesting it should be placed underground and out of sight.

Urban stormwater infrastructure provides a perfect example of this seemingly inherent tension within the built environment. Conventional stormwater management techniques are based on the principle that stormwater runoff should be transported away from its source as quickly and efficiently as possible. This is typically accomplished in an urban environment by a complex conveyance system of underground drains and pipes that eventually discharge directly into a natural drainage system or water body with little or no prior treatment.

Such systems typically drain impervious surface areas and intensively managed landscapes, such as parking lots and golf courses, and as a result can contribute high concentrations of chemicals, nutrients and sediment to local water resources. Because this infrastructure system is not highly visible, its positive functional value and negative water quality impacts go largely unnoticed by the average citizen.

So the question becomes, what can we do to increase the public visibility of our infrastructure system and at the same time strengthen its relationship to the natural and cultural environment? The concepts of Green Infrastructure (GI) and Low Impact Development (LID), both of which are quickly becoming an integral part of main stream planning and development practice, offer a viable solution to these issues.

Many urban streams have been channelized and routed underground in order to make way for residential and commercial development.

Rain Gardens are a type of Green Infrastructure project that can provide wildlife habitat, aesthetic enhancments, and water quality improvements.

Green Infrastructure for stormwater management in particular, seeks to utilize natural processes for retaining and treating stormwater where it falls and by doing so creates a functional but aesthetically pleasing landscaped environment that can become a part of the public realm. Because such site design features add aesthetic value to a project rather than take away from it, the public can more easily be engaged in the planning and development process and as result become more aware of the relationship a building program has to the natural environment in which it resides. The economic, social and environmental benefits of adopting GI and LID practices are numerous and can therefore greatly contribute to the building of community consensus around a sustainable, long-term vision for regional growth and development.

Over the past decade, the US Environmental Protection Agency (EPA) and state environmental regulatory agencies have expanded their outreach efforts to encourage local and regional governments to conduct green infrastructure planning and begin adopting green infrastructure practices. As a result, many local and regional entities across the country have developed green infrastructure plans that have traditionally taken the form of informational toolkits that describe common green infrastructure practices and the environmental, economic and social benefits of their adoption.

Purpose and Intent

The purpose of the following document is to follow the lead set by the EPA by providing a comprehensive source of general information on GI and LID Best Management Practices (BMPs) for improving water quality in the Central Midlands Region. Even though a wealth of this information is currently available online from a number of authoritative sources

such as the EPA, American Rivers and the Center for Watershed Protection, it is highly desirable to also have a local source of information where elected officials, planning commission members, private stakeholders and the general public can go to learn about these concepts and place them in a regional and local context.

Central Midlands Council of Governments (CMCOG), the primary author of this document, is well positioned to offer such a product because as a regional planning agency, CMCOG is responsible for examining issues and supporting solutions that have regional implications and impact multiple political jurisdictions. Water quality planning and green infrastructure best management practices fit neatly into this category.

Furthermore, CMCOG's board of directors is made up of local elected and appointed officials, all of whom are responsible for making local level project implementation decisions. Providing basic, non-technical information in support of green infrastructure, helps to make the case for more widespread adoption of these concepts within each member governments own planning and public works programs.

In addition to advocating for the local level implementation of GI and LID BMPs, this document is also intended to serve as a roadmap for how CMCOG can better integrate these and other environmental planning principles into each of its own regional planning programs. Though environmental planning has long been a part of CMCOG, in recent decades it has primarily centered on the 208 Regional Water Quality Management Program which has a strong focus on wastewater treatment and only marginally addresses other regional water quality issues such as stormwater management and non-point source pollution.

This document identifies opportunities and constraints for CMCOG to expand this somewhat narrow focus into a more comprehensive environmental planning process that can become an integral component of the agency's long range transportation and land use planning

Green Infrastructure can decrease the demands on existing stormwater infrastructure by reducing the volume and velocity of stormwater runoff.

programs, enhance the existing 208 Water Quality Planning Program, and move the agency one step closer towards the goal of developing a regional sustainability plan.

Organization

In order to meet the two primary objectives discussed above the document which follows is organized into five chapters including this introductory chapter that provides background information on the purpose, organization, and intended audience of the document. ***Chapter 2*** provides an overview of water quality planning and regulation, especially as it relates to the Federal Clean Water Act (CWA), which is administered by the EPA and the South Carolina Department of Health and Environmental Control (SCDHEC). ***Chapter 3*** provides a brief introduction to green infrastructure concepts related to water quality planning. ***Chapter 4*** serves as a BMP toolbox for specific green infrastructure techniques. The toolbox includes a discussion of planning policies and programs as well as site specific practices. ***Chapter 5*** presents a series of case studies that demonstrate how green infrastructure techniques are being implemented in South Carolina. ***Chapter 6*** presents a regional approach to green infrastructure planning for water quality in the Central Midland Region and as such provides a series of action strategies for implementation by CMCOG and its member governments. This chapter also provides an example concept plan for implementing green infrastructure projects in an impaired watershed.

Finally, the document concludes with several appendices that contain the following: model comprehensive plan language; model conservation subdivision and incentive zoning provisions; and a report on CMCOG wetlands mitigation banking activities. Also included throughout the document are listings of web and print resources that provide further information on each of the concepts presented in this document.

Intended Audience

The document which follows is intended to serve as a point of general reference for a variety of elected and appointed official;, public and private sector planning, design, and engineering professionals; commercial and residential property developers; environmental groups; community and neighborhood development organizations and the general public; all of which can have a vested stakeholder interest in the planning and development of green infrastructure projects across the Central Midlands Region.

As discussed above, one of the primary objectives of this document is to examine and define the role of CMCOG in encouraging the local level implementation of green infrastructure techniques. Therefore, another intended audience of this document is CMCOG board members, committee members and planning staff. The information presented here can be used as an internal reference document and guide for incorporating green infrastructure concepts into other regional planning projects and programs.

References

Hayes, Brian. 2005. *Infrastructure: A Field Guide to the Industrial Landscape*. New York: W.W. Norton and Company, Inc.

A Primer on Water Quality Planning

The purpose of this chapter is to provide a broad based introduction to water quality issues and the overriding regulatory framework for addressing them. This discussion is important for two primary reasons. First it provides a general context or framework for understanding the environmental benefits of implementing Green Infrastructure (GI) and Low Impact Development (LID) projects. Second, it provides a single, comprehensive source of water quality related information for use in CMCOG planning programs and by CMCOG board members, committee members and staff. For example, it is anticipated that the information presented here will be used in the development of the update to the Central Midlands Regional 208 Water Quality Management Plan. This chapter proceeds by giving an overview of the hydrologic cycle, the types of pollution that are typically found in the region's waterways, and the planning and regulatory framework provided by the Clean Water Act.

Watersheds

One of the primary components of water resource management, planning, and protection is the watershed. A watershed can be defined as the entire land area that contributes water, sediment, and dissolved substances to a stream, lake or estuary, forming a natural boundary for that particular water resource. Individual watersheds come in a variety of sizes based on local surface topography and can be delineated on a hierarchical order of different geographic scales. These scales are typically broken into the following categories:

- ***River Basin:*** A basin is defined by all of the land area contributing to a major river, lake or estuary and can cover several thousand square miles;
- ***Subbasin:*** Basins can be divided up into smaller subbasins defined by the individual rivers and streams that drain into the larger water feature. Subbasins generally cover several hundred square miles in area;
- ***Watersheds:*** A subbasin can be divided up into smaller watersheds which usually range in size from ten to a hundred squire miles;
- ***Subwatershed:*** Subwatersheds range in size from a few to several square miles and are often defined as the land area above the confluence of two smaller order, headwater streams;
- ***Catchment Area:*** Subwatersheds are made up of a series of catchment areas which are small areas of land measured in acres that drain into the headwaters of a stream.

The natural function of a watershed is to catch, store, and safely release water as a fundamental part of the hydrologic cycle.

The Hydrologic Cycle

The hydrologic cycle can be defined as the movement of water over the earth's surface which as described above is divided into river basins, subbasins, watersheds, subwatersheds and catchment areas. The components of the hydrologic cycle that facilitate the movement of water include: precipitation (i.e., rain, snow and hail); evaporation and transpiration which are processes that recycle water back into the atmosphere; surface runoff which is the movement of rainwater from the point where it falls to where it is discharged into a local waterway; and groundwater recharge, which refers to the infiltration of surface water into the soil where it moves downhill towards a discharge point, but at a much slower rate than surface runoff.

Impacts of Development

Water quality issues arise as a watershed is converted from its natural state to an area that supports varying degrees of agricultural activity or urban and suburban development. When this occurs the hydrologic cycle of that watershed is negatively impacted as changes occur in the quantity, quality and velocity of surface runoff, which in turn can decrease the amount of water emitted back into the atmosphere and infiltrated back into the soil. It can also decrease the quality of local water resources by allowing more sediment and pollutants to be carried with the surface runoff as it moves towards its final discharge point.

Figure 2.1 on the next page illustrates the changes that can occur when a watershed is converted from its natural state (i.e., populated with native vegetation) to a developed state, in this case a major metropolitan area. To help visualize this process in a local context it is helpful to think about

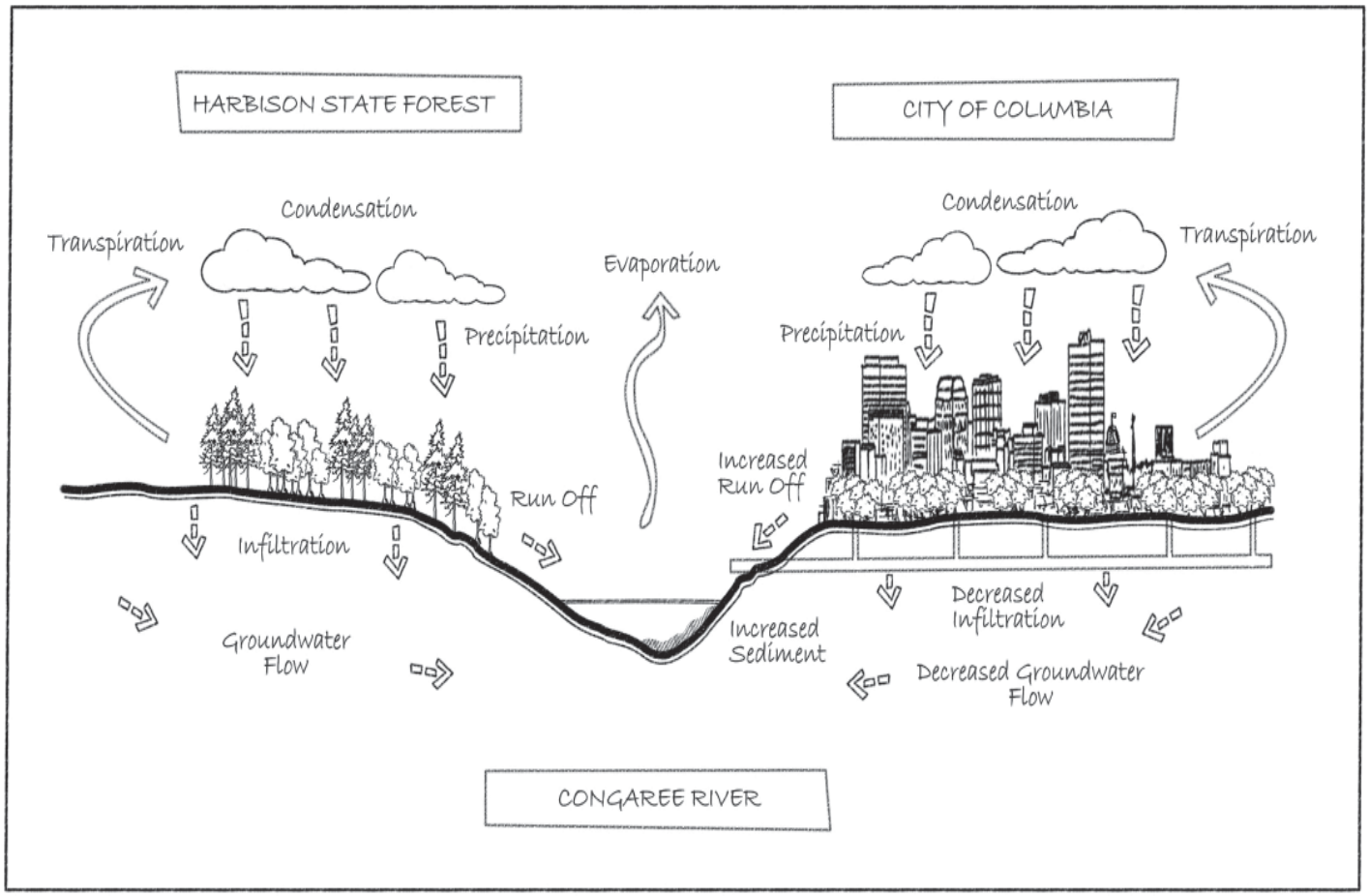


Figure 2.1: The Impacts of Development on the Hydrologic Cycle include increased runoff, increased pollutant loads, and decreased infiltration and groundwater flow.

the difference in watershed characteristics between a protected natural area such as Harbison State Forest and a developed area such as the City of Columbia, both of which contribute to the hydrologic cycle associated with the Congaree River Basin.

As discussed above, changes in land use as a result of growth and development pressures can drastically alter the natural drainage system of a particular land area and its ability to filter out pollutants. A water body becomes polluted when a chemical, biological or physical substance exceeds that water body's natural capacity to assimilate or breakdown that substance thereby causing harm to the aquatic ecosystem. This natural "assimilative capacity" of a water body varies greatly depending on a number of factors including the type of pollutant, the type and size of the water body, and seasonal variations in precipitation, which can impact the volume and velocity of water flowing through the system.

Types of Pollution

Pollution generally falls within one of four major categories, physical pollution, chemical pollution and thermal pollution.

Physical Pollution

The term physical pollution is often used to describe dramatic increases in the sediment loads or suspended solids in the water body. This state is most often the direct result of soil erosion which occurs when rain washes across an area of land that does not contain enough vegetation to keep the soil in place. As the soil washes

into a waterway, the increase in suspended solids can cause a dramatic decrease in aquatic vegetation and negatively impact vulnerable fish populations. This process can also increase the amount of chemical pollutants in the water if the soil being deposited also has high concentrations of chemical pollutants. Physical pollution comes from a number of common sources such as agricultural activity, timber harvesting and at construction sites where the natural protective vegetation has been removed.

Thermal Pollution

Thermal pollution refers to an increase in temperature of a water body as a result of warm waters entering the system. This can have a negative impact on aquatic resources that require a particular cool water temperature to survive. Sources of thermal pollution include industrial facilities that use local water resources for cooling purposes and as a result must discharge warm water back into a river, stream or lake. Thermal pollution can also can come from stormwater as runoff passes over hot pavement and enters the storm drainage system where it is discharged into a local waterway.

Biological Pollution

Biological Pollution refers to an increase in harmful biological activity in the water body as a result of discharges from both point and non-point sources. Fecal coliform is perhaps the most well know and widespread biological contaminant which can come from a variety of sources such as sanitary sewer spills and overflows, failing septic systems, runoff f from livestock operations and developed areas with large concentrations of pet waste.

Chemical Pollution

Chemical Pollution refers to pollutants that come from man-made organic and inorganic chemical products. Such pollutants can significantly increased nutrient levels in a waterbody by excess nitrates, phosphates, and potassium which come from sources such as lawn and agricultural fertilizers, livestock and pet waste, and failing septic and sanitary sewer systems. Increased nutrient loads can cause eutrophication of water bodies which reduces the oxygen content of the water thereby causing stress on vulnerable aquatic organisms.

Point and Non-Point Source Pollution

Finally it is important to make a distinction between point and non-point sources of these different types of pollution.

Point sources of pollution are stationary, easily identified discharge points such as industrial facilities and sanitary sewer outfalls. Point sources can be easily regulated for controlling specific pollutant loads in the receiving waters. Non point sources on the other hand come from non-stationary locations that are not as easily identified because they may be mobile, temporary, or extremely widespread from a number of small contributing sources. Examples of non-point source pollution include: agricultural and livestock activities, forestry activities, road building and construction sites, runoff from impervious surfaces such as roads and parking lots, failing septic systems, and chemically managed landscapes such as lawns and golf courses.

Stormwater runoff, though regulated to some degree as a point source (i.e., through stormwater system outfalls), is actually a large contributor to non-point source pollution because of the many types of

Construction sites and other types of land disturbance can significantly increase non-point source pollution loads in local waterways if not properly managed.

pollutants associated with different types and intensities of agricultural, urban and suburban land use.

The Clean Water Act

The primary regulatory means for addressing water quality issues in the United States stems from the Clean Water Act (CWA), which was enacted in 1977 as an amendment to the initial Water Pollution Control Legislation of 1972. The goal of the CWA is to restore and maintain the ability of the nation's waterways to support aquatic life by regulating and managing point and non-point sources of pollution. The CWA sets a regulatory framework for achieving its goals by (1) requiring water quality standards to be established for each waterway and (2) implementing a monitoring program to ensure these standards are being met. If these standards are being met, various strategies such as anti-degradation policies are used to maintain these standards in light of increasing demands for the use of these water resources. If water quality standards are not being met, other strategies such as developing Total Maximum Daily Load (TMDL) limits for pollutants are implemented.

The CWA is administered by the US Environmental Protection Agency (EPA) and implemented at the local level by designated state regulatory agencies. In South Carolina the primary implementing agency is the SC Department of Health and Environmental Control (SCDHEC). Under the CWA and the South Carolina Pollution Control Act, DHEC administers a number of water quality programs required by the legislation including but not limited to those listed below.

Wastewater Facility Construction

Under Section 201 of the CWA, federal grants were initially made available to localities for the planning, siting, and construction of wastewater treatment facilities. Prior to the CWA, many rapidly growing metropolitan areas across the country were served by numerous decentralized package sewer treatment plants that were built to serve individual subdivisions and were not a part of any larger public facility management plan. Section 201 provided municipalities and special purpose districts with funding to build large centralized sanitary sewer service systems that reduced the number of point source discharges and greatly enhanced regional water quality.

In 1987, congress decided to phase out this funding for construction grants and replace it with the Clean Water State Revolving Fund (CWSRF), which provides matching grants to states who provide low interest loans to local governments and private entities for the financing of water quality projects ranging from capital improvements to non-point source pollution control.

Regional Water Quality Management Planning

Section 208 of the CWA requires states to identify water quality standards and develop area-wide (regional) water quality management plans that ensure these standards through the utilization of best management practices (BMPs) for point and non-point source pollution. Though robust in scope, the overall focus of Section 208 activities have historically been concentrated around regional wastewater facilities planning which went hand in hand with construction funding available through Section 201 grants and later the CWSRF. For the urbanized areas of the state, DHEC works through the regional councils of governments to develop 208 Regional Water Quality Management Plans and to ensure all discharge and wastewater construction permits are in compliance with the policies set forth in that plan. These policies cover a range of topics from the consolidation and elimination of wastewater facilities to stormwater BMPs and support for wetland protection.

Water Quality Standards and Stream Classifications

The CWA requires states to establish water quality standards based on designated uses, water quality criteria and anti-degradation policies. These standards are used as a measure for defining permit limits for point source discharges and for guiding decisions that may increase the potential for nonpoint source pollution. These standards ultimately serve as a set of guiding principles for ensuring the long term health of the waterway.

Establishing water quality standards begins with classifying the water body based on the designated uses it should be able to support. In South Carolina this classification system of designated uses includes the following in descending order from those water bodies that receive the highest level of protection:

- ***Outstanding Resource Waters (ORW):*** the water body represents an outstanding recreational or ecological resource and/or they are freshwater suitable for supplying drinking water with minimal levels of treatment.
- ***Fresh Water (FW):*** the water body is suitable from primary and secondary contact recreation and as a source of drinking water with conventional levels of treatment. These waters also are suitable from fishing and the propagation of a balanced indigenous aquatic community.
- ***Trout Waters (TN):*** trout waters are classified into three levels depending on the water bodies ability to support reproducing trout populations and a balanced indigenous aquatic community, the ability to support growth of stocked trout populations and a balanced aquatic community, the ability to support stocked trout populations only in the cooler months and are protected by the fresh water standards.

The remaining three water quality classifications relate to saltwater bodies and their ability to provide aquatic habitats suitable for the survival of a balanced indigenous community of marine fauna.

Impaired Streams and TMDLs

Under section 303(d) of the CWA regulatory agencies are required to develop a list of the most impaired waterways in the state and to develop a program for addressing the issues causing the impairments. This list helps DHEC to prioritize those waterways most in need of protection. For these high priority waterways, a cleanup plan identifying all potential point and non-point sources of pollution is development. The plan establishes a Total Maximum Daily Load (TMDL) limit for the waterway, which is defined as the maximum amount of pollution an impaired waterway can assimilate and still meet state and federal water quality standards. These TMDLs place pollution limits on both point and non-point sources so that the maximum pollution levels are not exceeded.

A separate TMDL must be developed for each pollutant causing impairment. Once the acceptable pollutant loads are determined, a percentage of that total is allocated among all of the identifiable point and non-point sources in order to equitably distribute permissible discharge limits. Public participation is a key component of this process, especially because it sets limits on land use practices contributing the water body's pollutant load, thus impacting residential, commercial, and industrial stakeholders. In SC, TMDLs are developed on a watershed basis.

Antidegradation

In order to maintain or improve upon the existing water quality standards described above, the CWA requires that state water quality standard programs establish antidegradation policies to determine the point where one or more existing uses can no longer be supported or ambient water quality declines to a condition that barely meets established water quality standards for that water body.

In South Carolina the policy is to not allow for any lowering of water quality standards that would impact the water body's ability to support its designated use. Exceptions to this rule only exist when lower water quality cannot be avoided and allowing it to be lowered is necessary to accommodate important social and economic development. In order for this to occur the discharger must provide an alternative analysis to DHEC explaining why it is necessary and why other alternatives are not feasible. Even if the lowering of water quality is deemed necessary, however, antidegration rules state that water quality standards cannot be lowered to the point where existing uses are not supported.

National Pollutant Discharge Elimination System (NPDES)

Section 402 of the CWA requires state regulatory agencies to grant discharge permits as a means for regulating point sources of pollution. This process is called the national pollutant discharge elimination system or NPDES permitting process. NPDES permits are issued to all point sources ranging from industrial and municipal treatment facilities, to construction sites and agricultural facilities. While some permits are site specific, others may come in the form of a statewide or blanket permit covering a large number of similar facilities or operations, such as pesticide applications. These permits contain a number of important regulatory components such as measurable effluent limits for particular pollutants, as well as monitoring and reporting requirements.

Non-point Source Polllution

While not initially addressed in the CWA, the 1987 amendments added section 319 which required states to develop and implement non-point source pollution management plans and provided federal loans and grants for the implementation

of these plans. The plans, which identify water bodies and watersheds impaired by significant contributions from non-point sources, establish goals and objectives and identifies a set of appropriate Best Management Practices (BMPs) for addressing these issues. In SC, DHEC gives priority grant funding to those projects that are located within watersheds with existing TMDLs that have already identified non-point sources of pollution as major contributors to the water body's failure to meet water quality standards. Section 319 Non-point source pollution grants can be used for a number of different types of projects related to agriculture, silviculture, industrial and urban stormwater runoff.

Wetlands

Wetlands, which can be defined as areas that are temporarily or permanently inundated or saturated with water during different times of the year, contain soils that are saturated long enough to develop anaerobic conditions, and support specific plans and animal communities adapted to life in wet soil conditions. The CWA protects wetlands through section 404 which requires permitting for the placement of dredge of fill materials into waters of the US. The US Army Corps of Engineers has primary responsibility for administering the permitting program which involves a three step process of avoidance, minimization and compensation. Avoidance means that development projects must avoid disturbing wetlands when possible. If it is not possible to avoid disturbance, then the developer must take measures to minimize the impact. If all else fails, the developer must develop a mechanism for compensating for the impacts on the wetland through various mitigation measures that focus on restoring or creating wetlands of equal or greater value. In South Carolina the 404 permit must be in compliance with section 401 water quality standards, which means that DHEC also must review and certify the project before it can move forward. During the review process, DHEC looks at all potential water quality impacts of the project over the course of its life including the impacts on existing designated water uses.

Stormwater Management

Stormwater runoff is widely viewed as one of the most significant sources of water quality impairment because it can carry all of the pollutants that cross its path from its source to the receiving water. This can include all forms of physical, biological, chemical, and thermal pollution from various sources such as yards, golf courses,

Wetlands are regulated under Section 404 of the CWA. Development projects that impact wetlands must be permited by the US Army Corps of Engineers and be in compliance with Section 401 water quality standards which are regulated by DHEC.

Stormwater runoff from a municipal storm sewer system is regulated under the CWA as a point source discharge through the Municipal Seperate Storm Sewer System (MS4) permitting process.

parking lots, agricultural areas and industrial facilities.

Stormwater pollution is regulated at the federal and state level through an NPDES permit that is required by the CWA for municipal storm sewer systems that have a point source discharge. These are known as municipal separate storm sewer system (MS4) permits. In 1990 the EPA issued what was called the Phase I stormwater rule that required MS4 permits for operators of municipal storm sewer systems serving populations of 100,000 people or more. In 1999 the EPA issued a Phase II stormwater rule that expanded the requirements to smaller municipal stormwater sewer systems.

Under the rules there are generally two types of permits that are issued, individual permits and general permits. Individual permits which apply to a single discharger and are required for all systems covered under the Phase I rule. General permits are usually statewide permits that apply to all dischargers of a particular type or category, usually including those systems under Phase II rules. Under the regulations the permitee must develop a stormwater management plan that include a discussion of stormwater best management practices (BMPs) designed to address construction, post construction, illicit discharges, pollution prevent, and public education and outreach.

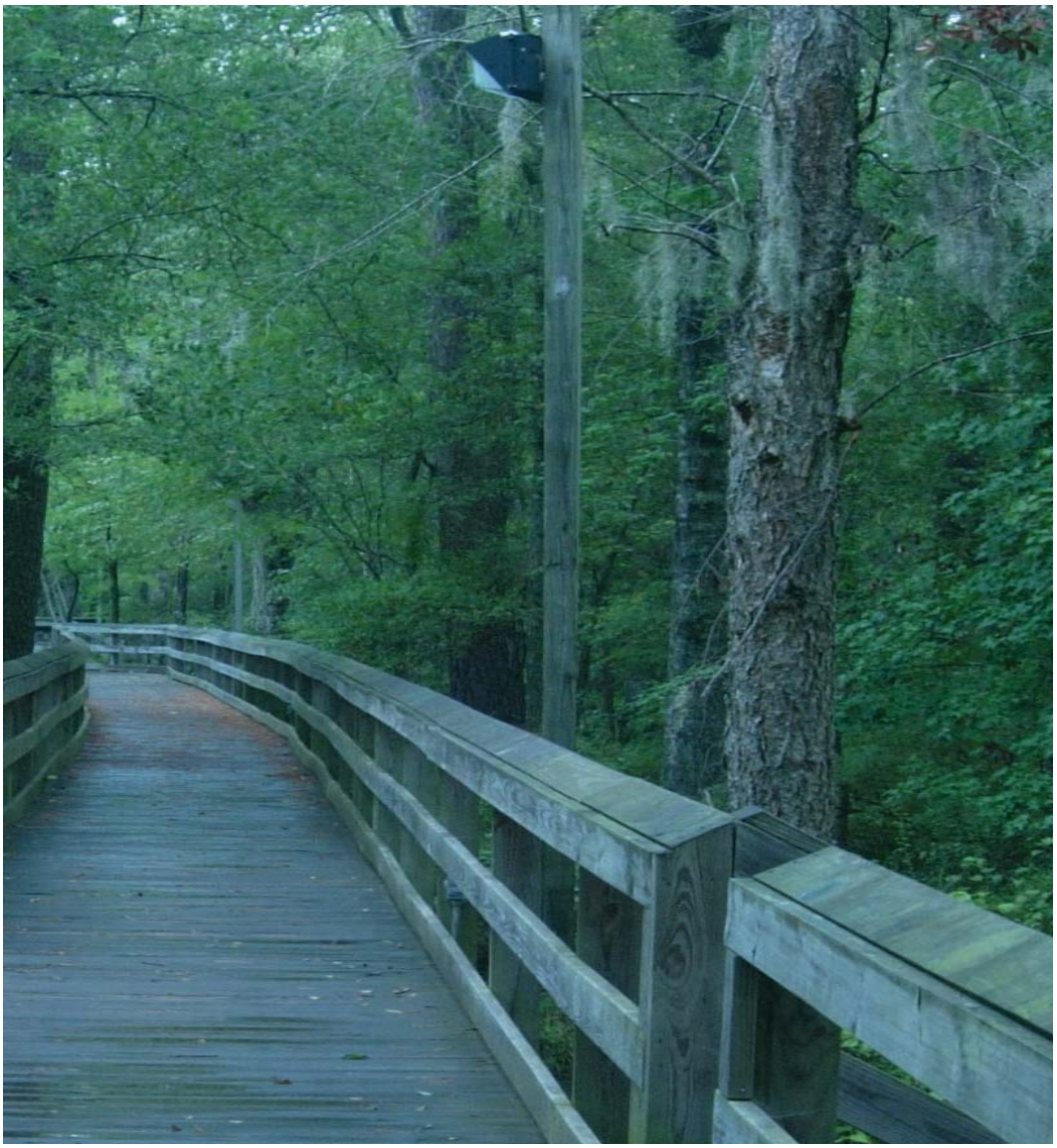
In addition to the requirements of the MS4 permitting process, many municipalities have also adopted stormwater management ordinances or other regulatory tools to implement stormwater pollution controls. These ordinances often apply to land development regulations which require a local stormwater management plan for all development and construction sites. Usually this is coordinated through and reviewed by a municipal or county department of public works.

Additional Resources

"Citizens Guide to Clean Water" is an information document prepared by the Palmetto Conservation Foundation and the SCDHEC.
www.scdhec.gov/environment/water/

The Clean Water Act in its entirety along with a range of supplemental information can be found on the EPA's website at:
www.epa.gov/lawsregs/

The SC regulations governing water quality standards (R.61-68) are available online at:
www.scdhec.gov/environment/water/reg.htm



An Overview of Green Infrastructure

The purpose of the previous chapter was to briefly introduce a wide range of concepts related to water quality planning and regulation. Since the establishment of the CWA, the nation's waterways have seen a dramatic improvement in overall water quality. Regulatory programs such as the NPDES and wetlands permitting process have had a considerable impact. Section 208 wastewater facility planning has also had a measurable impact as many smaller wastewater treatment plants have been eliminated and/or consolidated into larger regional systems. As evidenced by the 1987 amendments to the CWA, however, much work still needs to be done in terms of reducing the impacts of non-point sources of pollution.

The MS4 permitting process has been a step in the right direction, but many municipalities are beginning to realize that conventional development patterns and stormwater management techniques do not go far enough and can even be counterproductive towards mitigating water resource impairment. In recent years, however, increasing numbers of jurisdictions have started considering the more widespread application of Green Infrastructure (GI) and Low Impact Development (LID) techniques that encourage more sustainable land use practices and the onsite retention and treatment of stormwater runoff.

This chapter provides a working definition of the term Green Infrastructure and discusses the various benefits associated with adopting these polices, programs and site specific practices.

A Definition of Green Infrastructure

Green infrastructure is a term often applied to describe economical and environmentally friendly means for protecting and managing land and water resources. Over the past two decades separate but related conceptual definitions for Green Infrastructure have emerged, one centered on the protection of open space for its inherent natural value, and one centered on utilizing sustainable Low Impact Development (LID) strategies to address stormwater runoff related issues.

Open Space Preservation

In the case of the open space definition, green infrastructure is commonly described as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations." (Benedict and McMahon, 2006). This definition typically describes a hubs, links and sites approach to open space preservation. Hubs anchor green infrastructure networks and provide an origin or destination for wildlife and ecological processes moving to or through it. Different types of hubs can include:

- ***Reserves:*** Large protected areas, such as national and state parks and wildlife refuges;
- ***Managed Native Landscapes:*** Large publicly-owned lands, such as national and state forests, managed for resource extraction as well as natural and recreational values;
- ***Working Lands:*** Private farms, forests, and ranches that are managed for commodity production yet remain in a predominantly open and undeveloped state;
- ***Regional Parks and Preserves:*** Less extensive hubs of regional ecological significance.

Sites are smaller community parks and natural areas where natural features and ecological processes are protected and/or restored. Links are the connections that tie the system together and enable green infrastructure networks to work. They range in size, function and ownership, and can include the following:

- ***Landscape Linkages:*** Large, protected areas that connect existing parks, preserves, or natural areas and provide sufficient space for native plants and animals to flourish, while serving as corridors connecting ecosystems and landscapes;
- ***Conservation Corridors:*** Less extensive linear protected areas, such as river and stream corridors, that serve as biological conduits for wildlife and

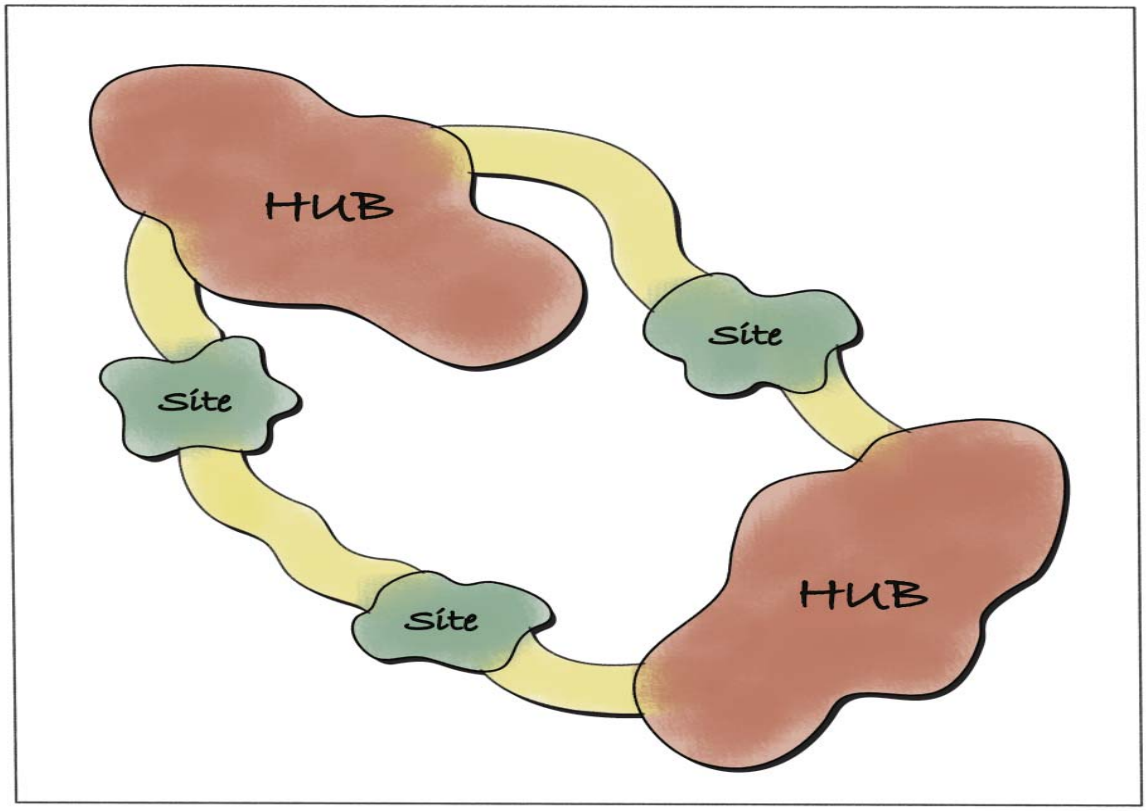


Figure 3.1: The Hubs and Links Approach to Green Infrastructure and Open Space Planning

may provide recreational opportunities;

- ***Greenways:*** Protected corridors of land managed for resource conservation and/or recreational use;
- ***Greenbelts:*** Protected natural lands or working lands that serve as a framework for development while also preserving native ecosystems and/or farms or ranchland;
- ***Ecobelts:*** Linear woody buffers that can ease the zone of tension between urban and rural land uses, while providing ecological and social benefits for urban and rural residents.

Figure 3.1 above illustrates the Hubs, Links, and Sites approach to green infrastructure planning.

Protecting Water Resources

The water resource definition of Green Infrastructure on the other hand refers more specifically to a natural or engineered system that uses soil and vegetation to manage stormwater runoff by retaining and treating it where it falls, allowing for less disruptions to the natural hydrologic cycle and contributing to improved health of the overall watershed. Low Impact Development (LID) concepts are often used interchangeably with this definition of Green Infrastructure because they also refer to a planning, design and development framework for using natural site features along with engineered facilities to better manage land and water resources.

GI at Multiple Scales

For the purposes of this document we will be using a definition of green infrastructure that incorporates both the land and water resource concepts. Even though the focus of the document is on water quality planning, the preservation and protection of an interconnected network of open space is an integral component of planning for healthy watersheds that can include small scale sites engineered to provide natural hydrologic functions. We can therefore

offer the following integrated definition of Green Infrastructure for use in this document:

> ***Green Infrastructure is an interconnected network of open space and engineered systems that use natural processes to better protect and maintain our land, water, and human resources.***

By this definition, Green Infrastructure becomes an important concept for use at multiple scales of geography.

At the regional and basin level, Green Infrastructure concepts relate to large hubs, and links that span multiple political jurisdictions and watersheds. Major protected lands such as national parks and forests as well as linear greenway trails fall into this category. At the sub-area or district level, Green Infrastructure concepts apply to projects that impact different political jurisdictions and groups of neighborhoods that fall within multiple sub-watersheds. Appropriate green infrastructure projects at this level might include more local parks, greenways, and smaller protected open spaces that enhance land and water resources.

At the neighborhood level, Green Infrastructure concepts relate to projects that impact neighborhoods within a single sub-watershed. These types of projects consist of pocket parks, bioswales and rain garden facilities that are accessible to multiple residential and commercial properties.

Finally, at the site specific scale, Green Infrastructure projects relate to a single catchment area and can come in the form of rain gardens or bioswales that drain a single residential or commercial development. ***Figure 3.2*** below llustrates these different scales of green infrastructure.

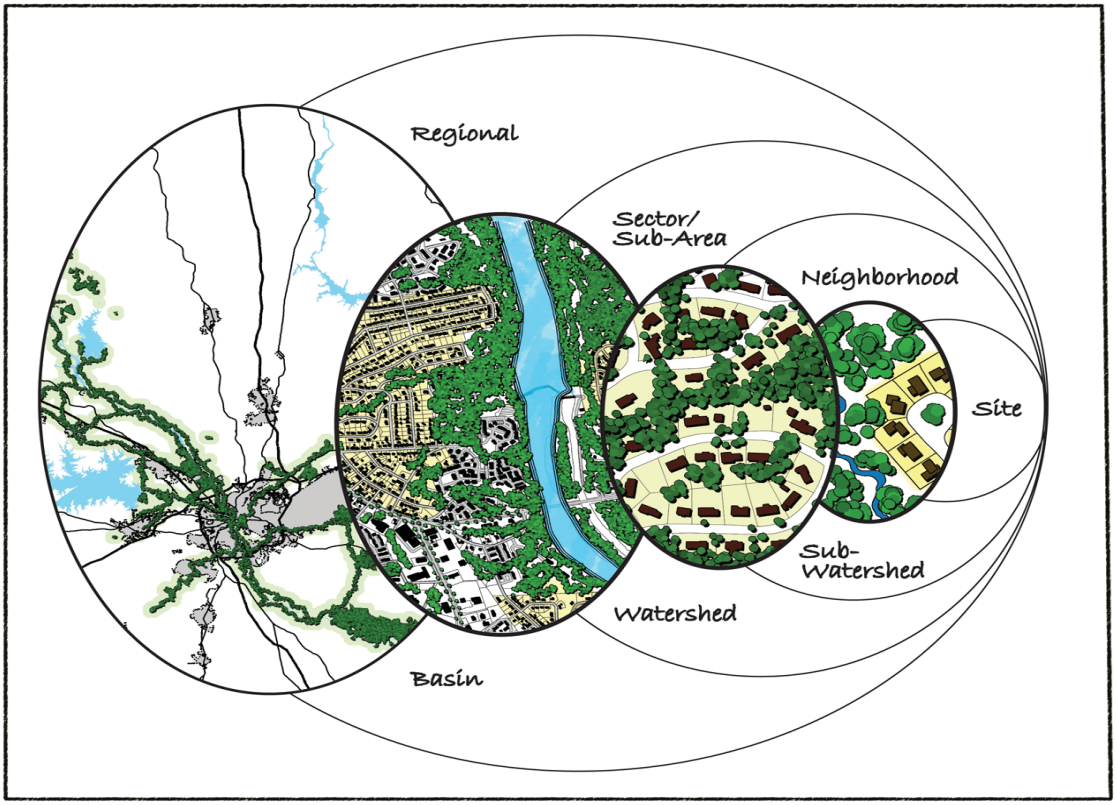


Figure 3.2: The Different Scales of Green Infrastructure

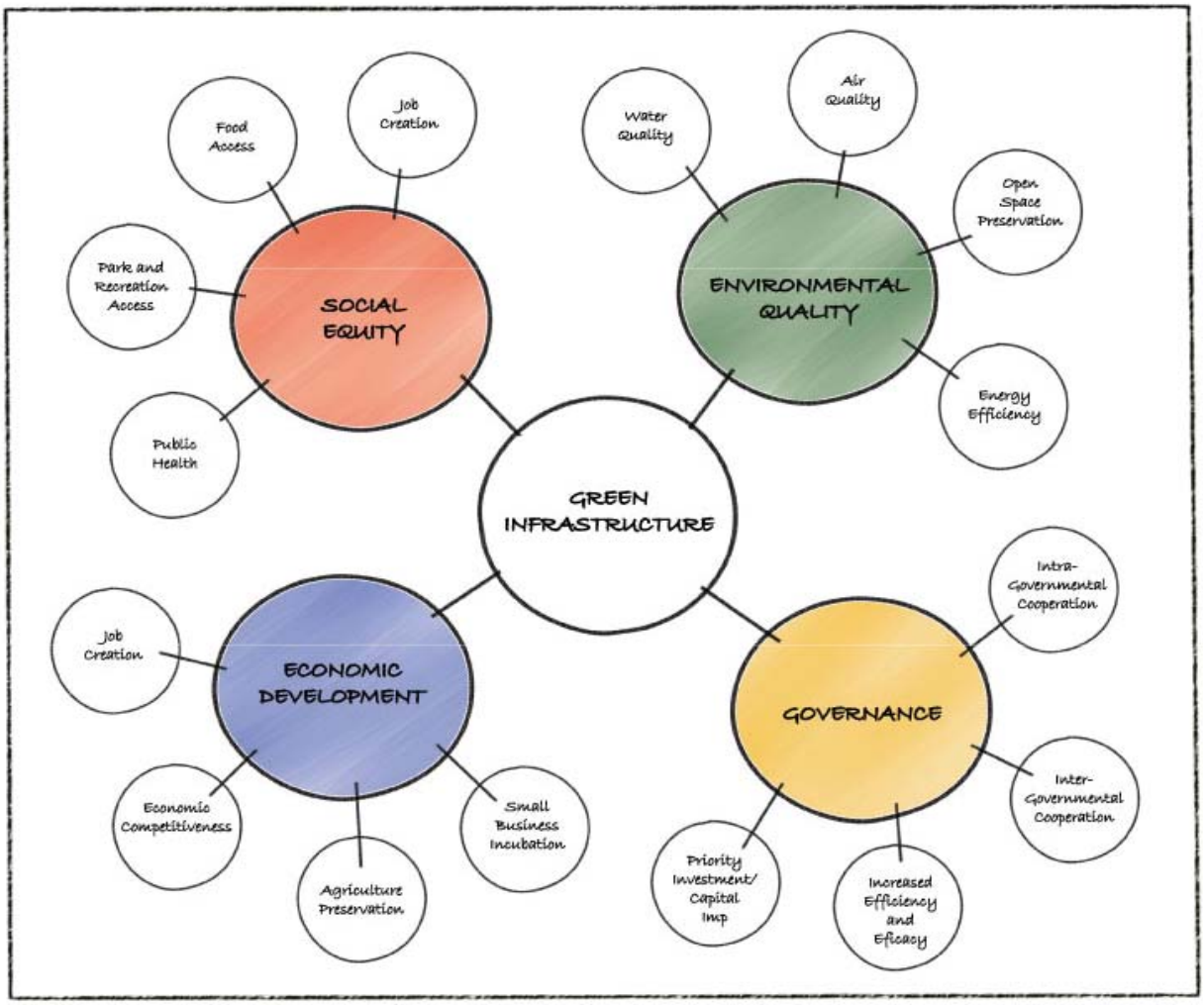


Figure 3.3: The Benefits of Green Infrastructure

The Benefits of Green Infrastructure

Green infrastructure at all scales provides numerous benefits to a community including improvements in environmental quality, social equity, economic development and governance. In terms of the environment, the widespread use of green infrastructure can create wildlife habitat, protect endangered species, reduce the amount of pollutants entering streams, rivers, and lakes, improve air quality, and increase energy efficiency.

Green Infrastructure can also improve the overall public health of residents by increasing access to park and recreation facilities, increasing access to healthy food sources, and improving local air and water quality. When implemented in low and moderate income areas, green infrastructure contributes to improved social equity and can mitigate social vulnerability to environmental justice concerns.

Green infrastructure improves intergovernmental coordination because implementing projects often requires participation by multiple jurisdictions. Municipal green infrastructure projects are usually planned at the watershed level and therefore ignore individual political boundaries.

Many local governments have discovered that projects can be expanded and therefore have a bigger cumulative impact, by partnering with neighboring jurisdictions. Green infrastructure also promotes increased intra-governmental coordination because the scope and scale of an individual project requires financial resources

and technical expertise from multiple governmental departments. For example, a single project may be identified by the planning department, approved by council, implemented by the parks and recreation department, and constructed and maintained by public works staff. Strong coordination between these departments can significantly increase the efficiency and efficacy with which a project is planned, financed, constructed and maintained over both short and long term horizons.

In terms of economic development, the widespread adoption of green infrastructure can create job opportunities and facilitate the growth of the green economy. By promoting green infrastructure concepts, local governments are also supporting the growth of related businesses such as native landscaping nurseries, planning and engineering firms that specialize in Low Impact Development design, and construction companies that know how to build these types of projects.

Green Infrastructure can also improve the overall economic competiveness of a city or region by protecting open space, adding park and recreational facilities, increasing air and water quality, and improving the public health and quality of life for area residents. Each of these factors is important for growing existing businesses and attracting future investment. ***Figure 3.3*** on the previous page summarizes the numerous benefits Green Infrastructure can have on a community.

Finally, this discussion of the benefits of Green Infrastructure, leads us back to the idea of making infrastructure more visible and integrating it into the design of public spaces. Because green infrastructure is intended to utilize or mimic natural conditions it is in most cases more aesthetically pleasing than conventional infrastructure and can therefore become a centerpiece of the community rather than a necessary evil that needs to be hidden from public view. Making green infrastructure a civic amenity can also go a long way towards educating public and private stakeholders about land and water quality issues as well as creating a sense of community ownership over these important natural resources.

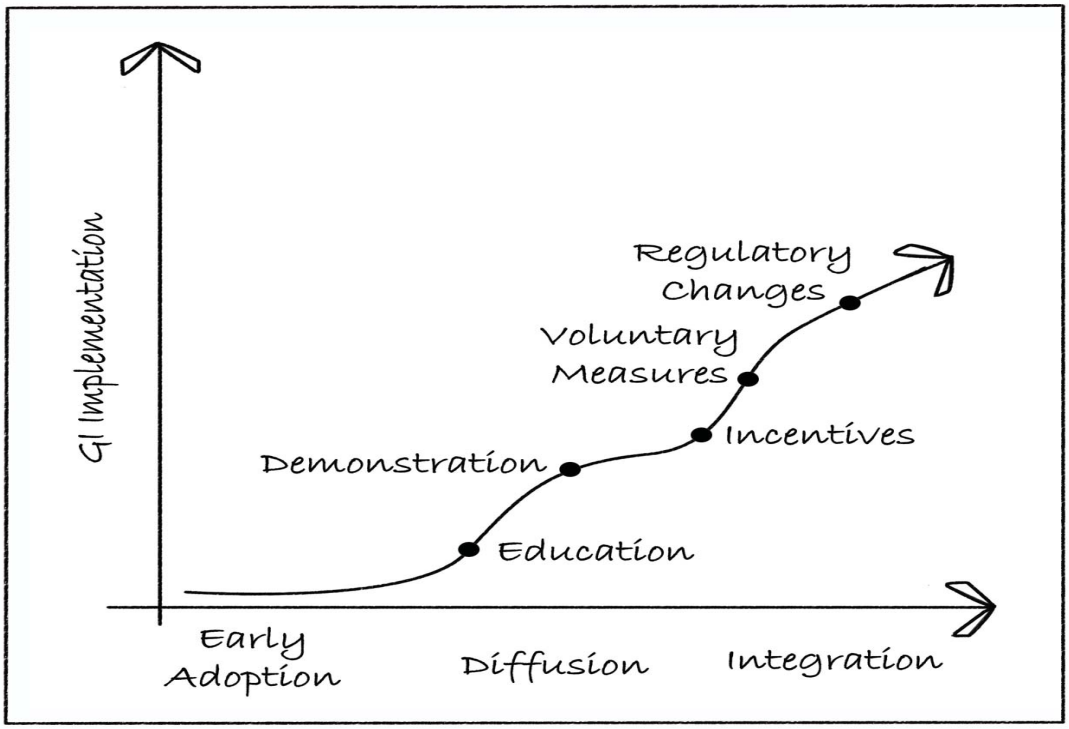


Figure 3.4: Green Infrastructure Implementation Over Time

Implementing Green Infrastructure

Implementing green infrastructure in public places can serve as a demonstration of what it is, how it can be implemented, and the positive impacts it can have, thus inspiring other public and private stakeholders to implement projects of their own. This process of diffusion and technology transfer takes considerable time and does not happen overnight.

It is important to note that many of the concepts discussed in this document are not new and in fact have been around for upwards of 30 years. As many books and articles on the subject acknowledge, the environmental and energy crises of the late 1970s and early 1980s produced a flurry of innovation in environmentally friendly and energy efficient building and site design practices. Aside from a small window of time during this period, however, many of these concepts were not widely adopted and have only in recent years begun to once again receive serious consideration by private developers and municipal officials, both of which represent the economic demand side of the equation.

The supply side, which consists of planning, design and engineering professionals, will invariably adapt and innovate to meet client demand, and in many cases work themselves to reshape and redefine the direction of public policy and private investment. This relationship is important to understand. Efforts to better educate municipal officials, private developers, and citizen interests on the economic, social and environmental value of green infrastructure will go a long way towards increasing innovation and understanding by designers and engineers.

It will also help to create a larger pool of qualified firms to implement these projects once they are commissioned by private development firms and governmental entities.

Over time, as more projects are implemented and professional expertise expands, the regulatory environment will change, and many local governments will move from voluntary project implementation to requiring the use of green infrastructure in new development and redevelopment projects. ***Figure 3.4*** on the previous page illustrates this trajectory from initial innovation to widespread acceptance and adoption.

References

Benedict and McMahon. 2006. Green Infrastructure: Linking Landscapes and Communities. Washington DC: Island Press.

Clemson University Strom Thurmond Institute. 2010. What Can Green Mean for South Carolina? Perspectives on the Green Economy. Clemson, SC: Clemson University.

Additional Resources

Environmental Protection Agency (EPA): Managing Wet Weather with Green Infrastructure
www.epa.gov/greeninfrastructure/

The Conservation Fund
www.greeninfrastructure.net

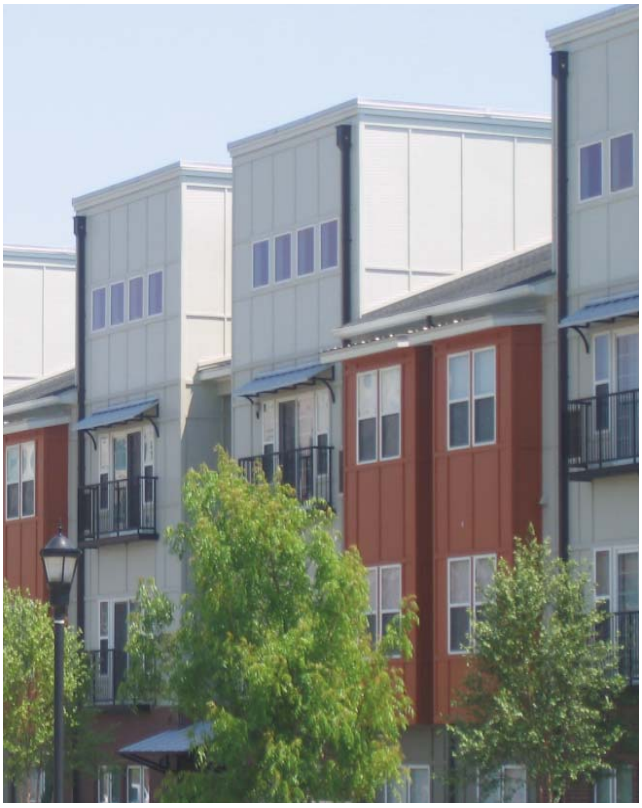
Green Infrastructure Wiki
www.greeninfrastructurewiki.com

Sustainable Sites Initiative
www.sustainablesites.org

American Society of Landscape Architects
www.asla.org/greeninfrastructure.aspx

A Green Infrastructure Toolbox

The intent of this chapter is to illuminate the green infrastructure concepts presented in the previous chapter by providing some general information on common green infrastructure programs, policies and site specific practices. Each section will include a brief description of the tool, a brief summary of opportunities and constraints to implementation in the Central Midlands Region, and a short list of additional information resources.



The Canal Side housing development in downtown Columbia promotes mixed uses, compact building design, walkability, and infill development.

Green Infrastructure Policies and Programs

The purpose of this section of the toolkit is to provide a brief overview of the different types of non-structural green infrastructure techniques different communities are using. They typically represent policies and programs that can be adopted by a community and integrated into local ordinances such as zoning and land development regulations.

A Smart Growth Context

Smart Growth, like Low Impact Development and Green Infrastructure is a planning, design and development framework that has gained tremendous ground in the past two decades as many jurisdictions across the country try to grapple with the environmental and social impacts of conventional development techniques. Smart growth concepts are commonly defined as a set of ten principles that include:

- support for mixing land uses;
- using compact building design;
- creating a range of housing choices;
- creating walkable communities;
- fostering a sense of place;
- preserving open space, farmland, natural beauty and critical environmental areas;
- directing development towards existing communities;
- developing a multi-modal transportation system;
- making development decisions predictable, fair, and cost effective; and
- encouraging community and stakeholder collaboration in decision making.

While water quality improvements are not explicitly mentioned it is considered to be a by-product or result of the adoption of one or more of these principles. For instance, supporting the mixing of land uses and the use of compact building and design generally results in higher density development which can lead to the preservation of more open space within the community.

Cluster and conservation design and development (discussed later in this chapter and in the Appendix) is a perfect example of how this principle can be implemented in a way that ensures the preservation of open space and the integration of other green infrastructure practices.

Directing development towards existing communities is also useful from a regional planning perspective because it encourages the re-use of land in areas where infrastructure already exists. It also promotes the redevelopment of sites with high levels of impervious surface coverage, such as old strip malls. These sites can then be redesigned to incorporate site specific green infrastructure techniques such pervious

pavement, bioswales, or rain gardens. Developing a multi-modal transportation system is an important principle for communities to embrace that can also have positive impacts on local land and water resources. Incorporating GI and LID BMPs into new road designs and existing road improvements can decrease impervious surface coverage and increase water quality.

Finally, encouraging broad based public participation in development decisions is important when implementing smart growth principles and green infrastructure projects, because many of these concepts are new to general audiences and therefore require considerable outreach and education initiatives in order to be effective. A good strategy for local governments to use is adopting green infrastructure policies and practices for municipal buildings, properties and rights-of-way. Placing publicly funded green infrastructure projects in highly visible locations such as streets, parks, and plazas can go a long way towards increasing public awareness of water quality issues and green infrastructure benefits.

Many local governments across the Central Midlands region have integrated at least some of these smart growth principles into their existing planning policies and programs. There are still many opportunities, however, to build on this momentum and expand the use of these concepts into more areas of local government policy and practice. By integrating green infrastructure concepts into smart growth policies, local governments can maximize the environmental, social, and economic benefits of public and private investments that facilitate long term regional growth and development.

Constraints

The biggest constraint to the widespread adoption of smart growth principles is the political fragmentation that exists over the four county region. Multiple jurisdictions with different regulatory frameworks and future land use plans can make it difficult to develop regional consensus on a long term vision for sustainable future growth and development.

Opportunities

Central Midlands Council of Governments provides an appropriate institutional framework for coordinating smart growth and green infrastructure between neighboring jurisdictions. Integrating smart growth and green infrastructure concepts into existing regional planning programs can facilitate the local level adoption of these principles and provide the foundation for developing a unified vision for regional growth and development.

Additional Resources

Smart Growth America
www.smartgrowthamerica.org

Smart Growth Online
www.smartgrowth.org

Environmental Protection Agency (EPA): Smart Growth Resources
www.epa.gov/smartgrowth/

Environmental Protection Agency (EPA): Using Smart Growth as Stormwater Best Management Practices
www.epa.gov/dced/stormwater.htm

Watershed Based Planning

Watershed based planning and management refers to an integrated approach for addressing water quality issues on the scale of an entire watershed as opposed to addressing only local level concerns. The process involves input from a wide variety of public and private stakeholders and expertise from a diverse set of professional disciplines. The process usually entails developing an inventory of water quality issues and an appropriate suite of prescriptive action strategies that usually include a number of relevant Green Infrastructure and Low Impact Development best management practices.

Governmental entities at all levels can utilize watershed based planning and management principles to improve water quality in the watersheds within their jurisdiction. Watershed based planning is particularly useful for bringing together different governmental entities who share the same watershed boundaries.

Watershed Based Planning can help to identify specific causes of stream impairment and offer appropriate locations for green infrastructure projects.

The Center for Watershed Protection, a national non-profit watershed research organization, has provided a recommended list of eight tools local governments can use to work towards the protection of their watersheds. These eight tools are shown on ***Figure 4.1*** and are summarized below.

- ***Watershed Planning*** refers to utilizing local regulatory tools such as zoning ordinances and land development regulations to help ensure compatibility between land use practices and water resource protection.
- ***Land Conservation*** refers to the preservation and protection of open space which can greatly enhance the health of a watershed.
- ***Aquatic Buffers*** are a regulatory tool for limiting development within a specified distance of rivers, lakes, streams and wetlands thus provided an added layer of vegetated filtration between developed areas and receiving waters.
- ***Site Design*** refers to the integration of GI and LID techniques into the planning and design process for development projects.
- ***Erosion and Sedimentation Control*** involves a number of BMPs for reducing erosion at construction sites.
- ***Stormwater BMPs*** involve using a number of different types of stormwater management practices for addressing runoff issues after construction is complete.
- ***Non-stormwater Discharges*** describes the identification and management of the accidental and illicit discharge of pollutants into local waterways.

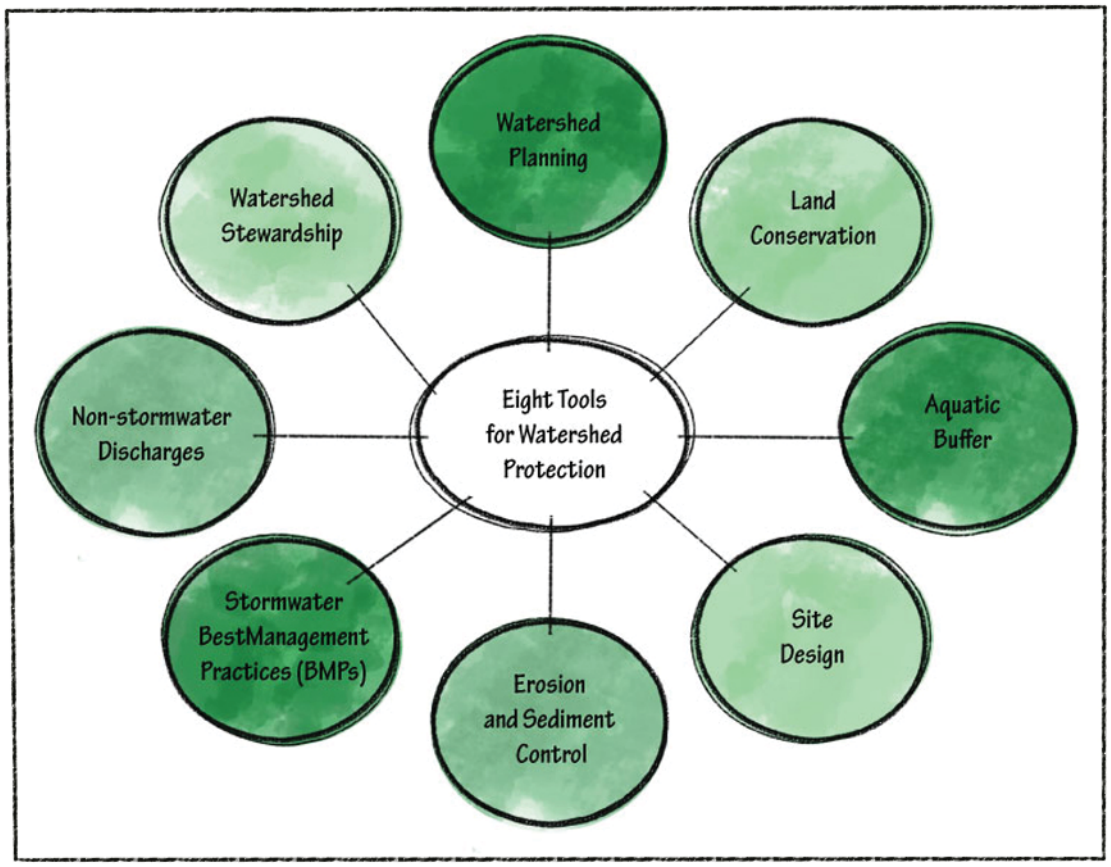


Figure 4.1: Eight Tools for Watershed Protection

- ***Watershed Stewardship*** involves community outreach and public participation measures geared towards involving citizens in watershed management activities and educating them on water quality issues.

Many of these tools are used by local governments and watershed organizations to develop watershed management and restoration plans for an impaired watershed. The EPA and state regulatory agencies generally like to see watershed management plans developed for watersheds with approved TMDLs. In 2003, EPA began to require that all watershed restoration projects receiving funding under Section 319 of the Clean Water Act, must have in place a watershed based plan that meets a number of defined criteria that includes identifying causes of impairment, estimating pollutant loads, describing NPS management strategies, estimating needed technical and financial resources, public outreach strategies, and schedule for implementation with measurable milestones.

In the Central Midlands Region, watershed management plans have only been developed for the Crane Creek and Gills Creek watersheds, both of which are located in Richland County. The Richland County Department of Public Works, which supports both of these plans, is also in the process of developing additional plans for other impaired waterways within their jurisdiction.

DHEC also has a statewide watershed management program under the CWA that designates a watershed manager for each of the major river basins in the state. The watershed manager is responsible for coordinating with stakeholders and keeping them informed of water quality issues

and development activities occurring within their respective basins. They also assist in the development of TMDLs for impaired sub-watersheds. The statewide watershed managers are themselves important stakeholders and should be included in the local government planning process.

Constraints

Watershed based planning initiatives are difficult to implement on a regional scale because of the significant financial and human resources required to develop plans and implement action strategies. The need for watershed based plans in impaired watersheds exceeds the capacity of any one governmental entity to development them. The public participation rate in such planning efforts also tends to be relatively low compared to other types of planning projects that more directly impact area residents (e.g., projects related to transportation, land use and zoning).

Opportunities

Intergovernmental coordination is imperative in order for watershed based planning initiatives to be successful. Regional agencies such as Central Midlands Council of Governments are especially well suited to adopt a watershed based planning approach for their own projects as well helping to facilitate watershed planning and management activities at the local level. By taking a regional approach to watershed based planning, local governments work together to share costs and leverage their resources, thus having a bigger cumulative impact. Existing partnerships such as the Richland and Lexington Countywide Stormwater Consortiums can serve as a model and framework for future collaborative watershed based planning projects.

Additional Resources

The Center for Watershed Protection
www.cwp.org

EPA: Introduction to Watershed Based Planning
www.epa.gov/owow/watershed/wacademy/acad2000/planning/

Gills Creek Watershed Association
www.gillscreekwatershed.org

Crane Creek Watershed Management Plan
www.richlandonline.com/departments/publicworks/

SC DHEC Watershed Planning Resources
www.scdhec.gov/environment/water/shed/tool.htm

Stormwater Regulations

The implementation of local stormwater regulations is perhaps one of the best ways to ensure the adoption of green infrastructure techniques for managing stormwater runoff. Such regulations are adopted by ordinance and as such set standards for site specific stormwater controls for both pre and post construction. Green infrastructure and low impact development based objectives for stormwater management should include efforts to reduce total runoff volume, control peak run off rates, maximize infiltration and groundwater recharge, maintain stream base flow, maximize evapotranspiration, and protect overall water quality. Such objectives are typically encouraged in regulations by setting specific performance standards for development projects that can best be met by using green infrastructure best manage-

ment practices. Examples of such performance standards include:

- Post development peak discharge rates shall not exceed pre development peak discharge rates;
- Annual groundwater recharge from the post development site shall approximate annual recharge from the predevelopment site;
- The stormwater management system shall remove a specified percentage of the average annual load of total suspended solids form the post development stormwater runoff.

In addition to setting stringent performance standards, stormwater regulations can also explicitly require the use of green infrastructure BMPs where site conditions allow. Such a measure, however, would require the development of technical and site specific specifications for the implementation of such projects.

A stormwater ordinance might also introduce the concept of a treatment train to allow developers to better meet performance standards. The treatment train refers to the application of a consecutive series of BMPs to more effectively retain and treat stormwater runoff. An example of this would be to design a site so that runoff would first pass over a filter strip before entering a bioswale that would then convey it to a stormwater wetland that would provide final treatment before being discharged into a conventional stormwater drain system or receiving waterway.

One final concept for consideration is the establishment of a stormwater utility fee that would be passed on to developers and residents as a means for funding the construction and maintenance of municipal stormwater management projects. This

Stormwater Management Regulations can be a valuable tool in providing incentives for using Green Infrastructure techniques to manage stormwater runoff and improve local water quality.

can be beneficial for more than just providing a much needed revenue stream. It can also allow a jurisdiction to offer incentives in the form of fee discounts to property developers who incorporate green infrastructure projects into their site design. The Charlotte/Mecklenburg Stormwater management provides an excellent example of a utility fee based stormwater program that has embraced the use of green infrastructure techniques in managing urban stormwater runoff.

Constraints

Many stormwater programs that do not have utility fees to support them are underfunded and do not have the financial or regulatory capacity to promote the widespread adoption of green infrastructure practices. Many smaller jurisdictions in particular delegate their stormwater management responsibilities to larger neighboring jurisdictions and therefore do not have the necessary incentives to take an active role in defining stormwater

regulations that might support green infrastructure techniques.

Opportunities

Many of the larger jurisdictions within the Central Midlands Region are already advocating for the more widespread adoption of green infrastructure practices, especially in relationship to meeting their MS4 NPDES permit requirements. Because of their relationship with smaller neighboring jurisdictions, this use of innovative green infrastructure practice has the potential to spill over into more rural areas. The stormwater consortiums described above area also a great mechanism for expanding the green infrastructure knowledge base. Stronger regional coordination on stormwater and water quality issues can pave the way for the regional implementation of green infrastructure techniques.

Additional Resources

Charlotte/Mecklenburg Stormwater Services
www.charmeck.org/stormwater/

EPA Stormwater Program
http://cfpub.epa.gov/npdes/home.cfm?program_id=6

SC DHEC Stormwater Program
www.scdhec.gov/environment/water/swnpdes.htm

Conservation Landscaping

Conservation landscaping refers to the use of native vegetation in traditional landscaping projects, especially in the site design and development of commercial and residential properties. Using native vegetation is preferable under most circumstances because native plants are naturally adaptive to local environmental conditions such as soil type, drought sensitivity, or seasonally saturated conditions. Native plants therefore reduce water demand for irrigation and the need for large amounts of pesticides and fertilizer. Native plants also have the ability to enhance a local sense of place and community because they bring with them a better awareness of the natural conditions in which a particular community is situated.

In addition to using in conventional landscaping treatments, native vegetation can also be used in the implementation of site specific green infrastructure practices such as bioswales and rain gardens. Many communities across the country, especially in drought prone areas such as the Southeastern and Southwestern United States are incorporating native landscaping provisions into their zoning ordinances and land development regulations. Promoting the use of native vegetation can also provide business opportunities for local nursery's and landscaping companies who specialize in native vegetation. Many non-governmental organizations and community groups also support the use of native vegetation in home landscaping and gardening.

Constraints

Many local governments and private developers are not aware of the environmental and economic benefits of using native landscaping for development projects. Furthermore, the emphasis on aesthetics means that many local governments invest considerable financial resources in planting and maintaining landscaping dominated by showy, non-native ornamental plants. Such treatments typically require more water and pesticide applications than non-native varieties. Aesthetic tastes are accustomed to these types of landscape

The use of native plants should be a key component of rain gardens, bioswales and conventional landscaping treatments in order to reduce water consumption and promote biodiversity.

features, thus making it more difficult to implement native landscaping projects.

Opportunities

Various Clemson Extension programs have been advocating for the use of native landscaping practices for a number of years and have produced some very useful educational materials. Even the popular master gardener program incorporates native landscaping principles into their curriculum. Such resources could be most effectively used by disseminating them to neighborhood groups and homeowners associations. The Carolina Yard program which recognizes homeowners for utilizing native landscaping principles represents a promising step in this direction. Local and regional planning efforts should utilize these programs and incorporate them into their public participation efforts. As more people become familiar with the principles of conservation landscaping, local governments can begin integrating them into their zoning and land development ordinances.

Additional Resources

South Carolina Native Plant Society
www.scnps.org

Clemson Extension: Creating and Environmentally Responsible Landscape
www.clemson.edu/extension/hgic/plants/other/landscaping

Clemson Extension: Carolina Yards and Neighborhoods
www.clemson.edu/extension/natural_resources/water/carolina_yards

Clemson Extension: Master Gardner Program
www.clemson.edu/extension/mg

Columbia Green
www.columbiagreen.org

Riparian Buffers

Riparian buffers are an important component of an overall watershed protection strategy. Buffer requirements set regulatory restrictions on development activity within a specified distance from a river, stream, lake or wetland. The purpose is to ensure that a protective layer of vegetation exists between a source of stormwater runoff and its receiving waters. When properly applied this protective layer provides for decreased velocity and increased infiltration.

Most local buffers are composed of a single uniform width on either side of the stream channel and are often enacted on top of existing floodplain regulations that limit development activity within the 100 year floodplain of a river or stream. More ambitious buffer regulations, however, provide tiered protection in three different zones extending out from the water body.

The streamside zone protects the stream itself with the buffer consisting of native riparian forest. The length of this buffer typically extends for a distance of 25 feet in which land use is highly restricted.

The middle zone extends from the streamside zone outwards for varying distances, usually to the extent of the 100 year floodplain. Land use is also highly restricted here but some clearing in the riparian forest may be allowed for utility easements or passive recreation purposes.

The outer zone provides a final layer of protection on top of the other two buffer zones and can extend as far out as the nearest permanent structure. Land use is not as highly restrictive but no permanent structures are allowed in this zone. Vegetation usually consists of turf or lawn and residents are encouraged to use native trees and other types of conservation landscaping.

Riparian buffers are an important green infrastructure best management practice that can benefit both urban and rural

Streams that do not have adequate riparian buffers are more vulnerable to flooding, erosion and water quality problems.

watersheds by protecting local water resources from non-point source pollution. Both Richland and Lexington Counties have adopted riparian buffers that extend 100 feet on either side of perennial streams and 50 feet on either side of intermittent streams. Newberry and Fairfield Counties also support the use of riparian buffers.

Constraints

Like many land use regulatory tools, stringent riparian buffers are difficult to implement because they are often viewed as infringements on individual property rights. It can be difficult to convey the importance of any measure that limits the development potential of a piece of property. The protection of intermittent streams are particularly difficult because they are often viewed as a part of the engineered stormwater infrastructure rather than as a part of the area's natural hydrology. In fact, many people refer to such streams as drainage ditches, thus making it all the more difficult illustrate the importance of these water resources, especially when they form the headwaters of local streams.

Opportunities

One strategy for addressing the property rights constraints identified above is tie riparian buffers to local and regional open space plans. When included as part of a regional open space/greenway network, impacted properties may actually increase in real estate value and development potential. Demonstrating the economic impacts of open space and greenway projects should be a fundamental part of any riparian buffer education and outreach initiative. Promoting the adoption of tiered or zone specific riparian buffer ordinances can also be a part of the open space/greenway planning process. While local governments can explore the different options for adopting and enforcing riparian buffers, Central Midlands Council of Governments should examining opportunities for integrating riparian buffer concepts into the existing open space and greenway planning process.

Additional Resources

Richland County
Riparian Buffer Brochure:
www.richlandonline.com/departments/publicworks/StormDocs/Buffer_Brochure.pdf

Lexington County
Riparian Buffer Brochure
www.lex-co.com/departments/publicworks/documents/WaterQualityBuffers.pdf

River Keeper Association:
Riparian Buffer Fact Sheet
www.riverkeepers.org/pdf/riparian_buffers_fact_sheet.pdf

South Carolina Statewide
Taskforce on Riparian Forest Buffers
www.scdhec.gov/environment/water/docs/npsrip.pdf

Tree Canopy Programs

Preserving existing tree canopies and planting new trees in both urban and rural environments can have numerous ecological, economic and social benefits including intercepting rainfall, increasing infiltration and storage capacity of soil, diminishing impacts of raindrops on barren surfaces, providing shade and wind barriers, absorbing air pollutants and particulate matter, reducing energy consumption, reducing the urban heat island, increasing wildlife

Tree Canopy programs can be an effective green infrastructure tool in both urban and rural settings.

habitat, and improving community livability and quality of life.

Local governments can work towards improving urban tree canopies and rural forest reserves in a number of ways. Open space planning and preservation is one of the most effective ways by establishing a long term plan of preservation priorities for a particular community. This strategy is most effective for the preservation of open space in more rural areas that have not been as significantly impacted by development pressures. As discussed in the first section of this chapter, Green Infrastructure has traditionally focused on open space planning efforts.

Urban and suburban communities on the other hand, can establish tree canopy preservation programs that seek to set development standards for ensuring the survival of significant trees meeting certain criteria. Local governments can also establish tree planting programs that have the goal of increasing the existing urban tree canopy. These programs often times encourage community participation and support through the donations of time, money and landscaping resources. Under such programs, trees should be strategically located to increase the natural and aesthetic appeal of important public spaces such as along streets and within parks and residential areas.

Constraints

In regards to open space planning most land is under private ownership therefore making it almost impossible to mandate certain land use and development restrictions. The most effective way to accomplish this goal is to make fee simple purchases that transfer ownership from private to public hands thus protecting the land in perpetuity. Such initiatives are

extremely costly, however, leaving many potential conservation areas vulnerable to development. Tree preservation programs and other regulatory tools such as riparian buffer ordinances (described above) can be an effective means for protecting existing tree canopies, but can also receive substantial resistance from property owners. Tree planting is a very costly activity. Many homeowners and local governments therefore have trouble committing to such activities on a large scale.

Opportunities

Fortunately, many local governments are increasingly viewing open space planning and tree canopy programs as a priority. They are often assisted in these endeavors by local non-governmental organizations such as the Nature Conservancy, the Community Open Land Trust, and Palmetto Conservation Foundation. Larger governments such as the City of Columbia have also initiated ambitions tree planting programs that seek to achieve a specific net increase in the jurisdictions existing tree canopy. Central Midlands Council

of Governments has been working with its member governments for several years now to develop a regional open space network. Such efforts can be strengthened by identifying ways to better integrate these and other green infrastructure concepts into the agency's other regional planning programs.

Additional Resources

City of Columbia 10,000 Trees Program
www.columbiagreen.org/10000_trees_program/

South Carolina Forestry Commission Urban/Community Forestry
www.state.sc.us/forest/urban.htm

Food Systems Planning

The food system can be broadly defined as the sequence of activities linking food production, distribution, access, consumption and other related activities. Sustainable food system planning, which is an emerging field that has received national attention in recent decades, places a priority on integrating sustainable agricultural activities into the urban environment and establishing stronger links between urban and rural areas that traditionally make up a supply and demand relationship between food production and consumption.

Some specific components of sustainable food system planning that can be integrated with some of the other green infrastructure concepts discussed in this document include agricultural preservation measures, urban agriculture, and community gardening. These activities create green space, increase urban biodiversity, reduce stormwater runoff, reduce urban heat island, preserve agricultural areas, and help to revitalize communities by providing a viable use for vacant or underutilized land.

Agriculture preservation is a fundamental part of open space planning which in addition to protecting undeveloped areas, also seeks to preserve working lands such as sustainable farming and timber harvesting operations. Communities wishing to preserve key agricultural land can include it in their open space plans, encourage its incorporation into conservation subdivision designs and support it as a working land by permitting a range of agricultural uses by right in that particular zoning district.

Another means for supporting sustainable agricultural activity is to sponsor and

Farmers markets and community gardens can be effective means for getting fresh and local food to communities throughout the region.

Sustainable agricultural preservation strategies not only have positive environmental benefits. They can also be a powerful economic develompent tool for struggling rural areas.

encourage community supported agriculture which is a system whereby residents can buy shares in a local organic farm that gives them access to a portion of the agricultural yields. Local governments can support such activities by creating incentives for the establishment of new community supported farms and providing support in the marketing of shares to community residents.

Urban agriculture can be defined as agricultural activities that take place within an urban or suburban environment. They can be either commercial activities where the products are sold for profit or they can be community gardening enterprises where gardening space is set up for personal use and consumption.

Local governments can support both types of activities by amending zoning ordinances to allow small scale farming activities in appropriate residential and commercial districts as well as providing community gardening space on publicly owned property such as parks and utility right of ways. Other site specific green infrastructure techniques can be incorporated into community garden sites such as using rain gardens to catch runoff and using rainwater harvesting techniques for irrigation purposes.

Because the food system is worth approximately $34 billion dollars in South Carolina and because it employs more than 200,000 people, the State Department of Agriculture has initiated an innovative program called Certified South Carolina. This program is a cooperative effort between the agency and producers, processors, wholesalers, and retailers to brand and promote South Carolina Grown and processed agriculture products. The program markets local products for consumption by local residents and grocery store chains. It also supports the sale of SC products at certified roadside and farmers markets. These programs represent an important first step in helping commercial and individual consumers recognize the benefits of supporting local agricultural producers.

Constraints

While the Central Midlands Region contains expansive rural areas, many acres of productive farmland are underutilized from an agricultural perspective. Many local farmers cannot compete with

produce being sold at large big box retailers thus making it difficult to stay competitive in the agricultural market. Many jurisdictions also have restrictive zoning ordinances that make it difficult for urban agricultural operations to operate, especially when they are located in urban and suburban residential areas.

Opportunities

Regional food system planning is an emerging topic area as many jurisdictions across the country are examing ways to help sustain agricultural industries and promote urban agricultural operations. Within the Central Midlands region there are many opportunities for supporting agriculture in both urban and rural settings. As a regional agency, Central Midlands Council of Governments is well positioned to work with the SC Department of Agricutlure to strengthen the economic relationship between these urban and rural areas and between local producers and consumers. The farmers market movement is also on the rise throughout the region providing increased consumer access to locally produced foods. Local governments should continue to embrace these facilities as a cornerstone of their local planning efforts.

Community Gardens at the USC Green Quad.

Finally, the City of Columbia has been in the process of amending their zoning ordinance to allow more flexiblity for the citing of urban agricultural operations. The City of Columbia has also created a very successful community garden program that has utilized vacant space in several different areas throughout the city to establish community gardens for area residents. Other jurisdictions will likely follow this lead as demand for urban agriculture and community gardening increases over the next few years.

Additional Resources

South Carolina Department of Agriculture: Certified SC Grown Program
www.agriculture.sc.gov/certifiedscgrown

South Carolina Department of Agriculture: Community Supported Agriculture
www.agriculture.sc.gov/CSA

American Planning Association: Food System Planning General
www.planning.org/nationalcenters/health/food.htm

American Planning Association: Community and Regional Food Systems Policy Guide
www.planning.org/policy/guides/adopted/food.htm

American Community Garden Association
www.communitygarden.org

The Comprehensive Plan

One of the most important tools a local government can use to establish a program for implementing green infrastructure is the comprehensive plan. This document is designed to serve as a general policy guide for town officials and citizens to use in planning for future growth and development. It relates existing conditions to a corresponding list of short, medium, and long term goals that reflect the vision and guiding principles of that jurisdiction.

State requirements for developing a comprehensive plan are set forth in the South Carolina Local Government Enabling Act of 1994. This legislation outlines the process that is to be used for developing and adopting the plan as well as defining a set of required planning elements including the following: population, economic development, natural resources, cultural resources, community facilities, land use, housing, transportation, and priority investment. For each of these elements the plan must include an existing conditions inventory and a discussion of relevant goals, objectives, and strategies.

In this context there are many opportunities to define a framework for implementing green infrastructure. To begin with ***Figure 4.2*** illustrates how each of the ten principles of smart growth can relate to the individual comprehensive plan elements. Defining a vision and guiding principles for the document provides an early opportunity for a jurisdiction to incorporate these principles into a long term vision for sustainable growth and development. Such a vision might discuss a desire to provide for growth that is in harmony with existing natural and cultural resources and

	Population	Economic Development	Natural Resources	Cultural Resources	Community Facilities	Housing	Land Use	Transportation	Priority Investment
Mix Land Uses	●	●				●	●	●	
Increase Density; Use Compact Design	●				●	●		●	●
Create a Range of Housing Opportunities		●				●	●		●
Create Walkable Communities	●	●					●	●	
Foster Distinctive, Attractive Communities with a Strong Sense of Place	●	●		●			●		
Preserve Open Space, Farmland, Natural Beauty, and Critical Environmental Areas			●		●				
Strengthen and Direct Development Toward Existing Communities	●	●			●		●		●
Provide a Variety of Transportation Options	●	●	●		●	●	●	●	●
Make Development Decisions Predictable, Fair, and Cost-Effective					●				●
Encourage Community and Stakeholder Collaboration in Development Decisions	●	●							●

Figure 4.2: How the Principles of Smart Growth Relate to the Elements of the Comprehensive Plan.

The natural resource element allows a community to identify sensitive environmental features and recommend strategies for preservation and restoration.

may even be specific enough to identify some environmental priorities such as the preservation of open space or protecting water quality. Associated guiding principles will support this vision by identifying specific things the community can strive to accomplish, such as promoting sustainable compact, mixed use development or protecting sensitive environmental areas through the use of green infrastructure and low impact development best management practices.

Specific considerations related to incorporating smart growth principles and green infrastructure into selected elements of the comprehensive plan are presented below. Additional model language for guiding the creation of related goals, objectives and strategies are contained in Appendix A.

The Natural Resources Element

The natural resources element of the comprehensive plan is intended to provide an inventory of significant physical and biological features of the landscape. The purpose is to provide a base from which to guide policy decisions that are related to the use and management of these natural resources, especially as they pertain to the need for protection, restoration, and/or impact the intensity and types of permissible land uses.

One of the most important parts of this element is the existing conditions inventory which should present detailed information on the location and quality of key environmental resources including but not limited to the following:

- Physiographic setting of the jurisdiction to include an inventory of the geologic setting, soil conditions, and dominant eco-regional characteristics.
- Climate setting to include information on annual precipitation rates, temperature ranges and drought conditions.
- Native vegetation characteristics to include general land cover characteristics and detailed information on the types and distributions of native plant species.
- Water resources to include a discussion of watershed and basin characteristics, a listing of intermittent and perennial streams, lakes, and wetlands, a discussion of local water quality issues including a list of impaired streams and existing TMDLs, general impervious surface coverage, a char-

acterization of point and non-point sources of pollution, flood zones, and existing ordinances that impact water quality such as riparian buffers and stormwater management regulations

- A list of environmentally sensitive areas to include protected conservation and open space areas, planned conservation and open space areas, critical wildlife habitats, and large contiguous tracts of forested areas and working lands.
- A list of public, private and non-governmental stakeholders that have an interest in environmental issues and natural resource elements. This list could include adjacent local governments, relevant municipal departments, property development companies and environmental organizations.

In general this information should include both detailed narrative discussions of these features as well as maps that depict their general locations in reference to the jurisdictional limits of the community. This information should then be used to develop the associated goals, objectives and strategies and to serve as a permanent reference point for informing future land use decisions. The discussion of water resources can also serve to create a framework for implementing watershed based planning initiatives within the town that may include assistance in the development of a watershed management plan or TMDL for a local impaired waterway.

The community facilities element can be an effective tool for coordinating green infrastructure investments with existing stormwater infrastructure improvements.

The Economic Development Element

The economic development element of the comprehensive plan inventories existing labor force characteristics and employment trends by place of work and industry type. This element can be used to support green infrastructure by identifying existing and future economic development opportunities in the green economy. The first step is to inventory existing industry sectors that could take advantage of market demand for green infrastructure related products and services. Types of relevant businesses would include nurseries; landscaping companies; planning, engineering and construction firms; as well as agricultural producers and processing facilities. The second step would be to identify opportunities for growing these industries, especially if they are not already well represented in the community. Identifying regulatory and market barriers to entry into these markets is also an important part of this element. If for instance the local zoning ordinance makes it difficult to establish sustainable agricultural operations within the jurisdiction, the removal of such obstacles should identified in the goals, objectives and strategies section.

The Community Facilities Element

The community facilities element of the comprehensive plan relates to the infrastructure necessary to provide adequate services that support the growth and development, health, safety and welfare of the jurisdiction. This infrastructure includes:

Water and Sewer Facilities, Solid Waste Disposal, Storm Water Drainage, Police and Fire Protection, Emergency Medical Services, Recreation, and Education.

In the context of green infrastructure, this element is particularly important because it addresses stormwater management issues as well as local government programs and facilities, school district facilities and park and recreation facilities, all of which can be important staging areas for implementing highly visible green infrastructure demonstration projects. The existing condition inventory should outline the strengths and weaknesses associated with each of these areas and the goals, objectives, and strategies section should identify opportunities for implementing innovative projects.

The Land Use Element

The land use element of the comprehensive Plan presents an inventory of existing land use, a description of current zoning practices, a future land use concept, and a goals and objectives section. The land use element to the comprehensive plan largely reflects and integrates the concepts presented in the other chapters of the document. Many existing conditions and future policy considerations related to population, housing, natural and cultural resources, community facilities, and transportation, have a direct impact on how land is, can, and should be used within the jurisdiction.

The best way for the land use element to reflect green infrastructure priorities, is by establishing a land use, zoning and future land use framework that is based on the smart growth, green infrastructure and low impact development principles discussed in this document. As such the future land use map should include mixed use development and conservation subdivision

The transportation element allows for opportunities to integrate green infrastructure practices into the existing street network.

areas as well as clearly delineate riparian buffers, flood zones, open space and priority conservation areas. The goals, objectives and strategies section should clearly state steps the jurisdiction needs to take in order to implement the future land use vision, such as amending the zoning ordinance to allow and encourage the implementation green infrastructure projects.

The Transportation Element

The transportation element of the comprehensive plan inventories and analyzes issues impacting the local transportation network. The SC Priority Investment Act, which amended the comprehensive planning act to require a separate transportation element, stipulates that this analysis be multi-modal in nature and therefore include a comprehensive needs assessment of road improvement projects, transit service, and bike and pedestrian facilities. This element also must be developed in accordance with the land use element to ensure compatibility and coordination between transportation priorities and existing and future land use policies.

The transportation element offers an excellent opportunity to encourage the use of green infrastructure through the establish-

ment of a Complete Streets/Green Streets program which seeks to provide bike, pedestrian and transit facilities on roadways that also include onsite green infrastructure stormwater management BMPs. Goals, objectives and strategies should reflect these priorities.

The Priority Investment Element

The Priority Investment Element (PIE) is intended to help prioritize and allocate funding for infrastructure improvement projects identified in the other elements of the Comprehensive Plan based on projected revenues for the next 10 years. One approach being utilized by many jurisdictions is to tie the PIE with a 5 year Capital Improvement Program (CIP). The traditional CIP is a way to schedule public physical improvements based on available fiscal resources. Linking the CIP process to the priority Investment process essentially extends the scope of the CIP to 10 years in the future, helps guide the CIP process based on the direction set forth in the Comprehensive Plan, and allows for the programming and prioritization of longer term projects based on projected fiscal resources.

The priority investment element provides a tool for coordinating planned infrastructure projects with available financial resources.

This element extremely important for the implementation of green infrastructure because it essentially sets priorities for the allocation of funds for capital improvement projects such as stormwater management infrastructure. High priority municipal green infrastructure projects should be clearly identified in this chapter in order to ensure adequate funding for implementation.

In order to promote better intergovernmental coordination, the priority investment act also requires that local governments maintain a database of adjacent jurisdictions, partnering agencies and non-governmental organizations. This database can then be used to ensure the adequate notification and coordination between stakeholders for large development projects. This requirement is particularly relevant to implementing green infrastructure projects because they are most successful when conducted with buy-in and support from a wide range of public and private stakeholders. This stakeholder database and project notification framework can be harnessed for use in the planning, construction, and long term maintenance of green infrastructure projects.

Constraints

The primary constraint for using the comprehensive planning process to support green infrastructure is the lack of awareness of the concepts presented in this document and a lack of awareness about how they can be integrated into the comprehensive planning process. Furthermore, many smaller jurisdictions do not have the resources to conduct in depth studies for comprehensive plan updates, making it difficult to impress the importance of including detailed inventories of water resource issues.

Opportunities

Through the publication of this document, it is the hopes of Central Midlands Council of Governments that information related to green infrastructure will be more accessible throughout the region. CMCOG is also actively engaged in provided technical planning assistance to member governments and as such intends to make water resource and green infrastructure related data available to local governments for use in updating their comprehensive plans.

Additional Resources

Municipal Association of South Carolina
www.masc.sc/Pages/Default.aspx

Comprehensive Planning Guide for Local Governments
www.masc.sc/SiteCollectionDocuments/

Zoning and Subdivision Regulations

The zoning ordinance is perhaps one of the most powerful regulatory tools a jurisdiction has to support the widespread adoption of green infrastructure concepts. The purpose of the zoning ordinance is to provide for the orderly development of land in accordance with the existing and future needs and desires of the community while promoting public health, safety, morals, convenience, order, appearance, prosperity and general welfare of citizens. The 1994 SC Comprehensive Planning and Enabling Legislation requires that a zoning ordinance give reasonable consideration to a number of factors including providing for adequate air, light and open space; facilitating the creation of a convenient, attractive and harmonious community; and protecting and preserving scenic, historic or ecologically sensitive areas; all of which indirectly support the principles of smart growth and green infrastructure.

The zoning ordinance is directly related to the Comprehensive Plan by providing a regulatory tool to implement the vision for future growth and development as illustrated on the future land use map. In fact a zoning ordinance cannot be legally adopted unless a community has adopted a land use element of the comprehensive plan. The zoning ordinance allows a community to regulate: the use of land, the density of development, the design of buildings, parking regulations, placement of infrastructure and other specific aspects of development such as landscaping, stormwater management, and the protection of natural resources.

Specific zoning techniques authorized by the enabling legislation that can support the implementation of green infrastructure include planned development districts, overlay zones, and cluster development. Planned Development Districts (PDD) have been the traditional means for allowing mixed use developments based on a unified site design concept. Traditionally, PDDs are contingent upon a zoning amendment to allow these types of developments to be built in other districts. Now many communities, however, are proactively designating mixed use zoning districts to try and encourage the wider spread adoption of these practices.

An overlay zone places a set of requirements or relaxes a set of requirements on an underlying zoning district. Such overlay zones can be used to require green infrastructure techniques such as riparian buffers, floodplain regulations and use

of native vegetation, bioinfiltration areas, pervious pavement, and rainwater harvesting.

Cluster and conservation development guidelines represent one of the best ways to require or encourage the implementation of green infrastructure projects in a particular jurisdiction. They are based on the principle of grouping intensive land uses such as residential, commercial, or industrial development in a designated area to allow for larger areas to be dedicated for the protection of open space and sensitive environmental features. They are most effective when they are based on the following general conservation design principles: flexibility in site design; protection and management of natural areas; reduction of impervious surface areas; and the use of green infrastructure and low impact development for stormwater management.

Cluster or conservation developments can typically be used in one of three ways, all of which create a regulatory environment where conservation design is permitted by right. First, the municipality can add conservation design guidelines to the list of permitted uses in an existing district. Second, the municipality can create a conservation design overlay district to selected locations that are appropriate for conservation uses. Usually in this case the developer has the option of complying with the underlying zoning requirements or those set forth in the overlay district. Finally, the municipality may designate particular conservation design districts where those guidelines are strictly required for any development projects. This last option is the strictest but it is also the most effective especially when trying to implement a pre-defined open space or conservation plan that contains designated conservation areas.

Cluster and conservation development guidelines are usually incorporated into a jurisdictions land development regulations which are a separate but related set of regulations that govern the change of land use characteristics when land is developed or redeveloped. These regulations can help to control site design, street layout, and provisions for open space and utilities such as water, sewer, and stormwater infrastructure.

A related tool that encourages the use of cluster development and conservation design is incentive zoning. This tool represents a voluntary exchange of development

incentives for public benefits such as the preservation of open space. In order for such incentives to be effective they have to benefit the developer through market incentives such as reductions in development costs or increases in return on investment.

Density bonuses are the most common type of incentive provided to developers, but other relaxations of zoning requirements such as lot setbacks, parking requirements, or building height can also prove to be economically desirable. Encouraging the use of green infrastructure projects in site design and development can be accomplished by exchanging density bonuses for the provision of such things as the following:

- increased river and wetland protection;
- the provision of open space and conservation areas;
- the implementation of green infrastructure stormwater management BMPs;
- connectivity to exiting trails and open space;
- the use of conservation landscaping; and
- utilizing green building standards and certification such as those provided by the United States Green Building Council (USGBC).

Model conservation design and incentive zoning provisions are included in Appendix B.

Constraints

The primary constraint associated with conservation/cluster design provisions is the fact that they underutilized despite being available for use in many jurisdictions across the region. Currently no adequate incentives exist for developers to use these strategies. Finally, despite the widespread inclusion in subdivision regulations, these tools are not directly tied to specific open space plans and/or open space networks delineated on existing future land use maps.

Opportunities

The fact that many jurisdictions in the Central Midlands region already have conservation subdivision provisions in place is a tremendous asset because of the cumbersome process associated with amending land development regulations. The next step, however, is to encourage the adoption of local level open space plans that provide direction and incentives for developers to use the conservation subdivision provisions. Central Midlands Council of Governments has developed a regional open space plan that can provide a framework for local level decision making. CMCOG should also continue to work with local governments to expand the open space planning program, ensure local and regional connectivity, and promote the use of green infrastructure tools such as conservation subdivision design.

Additional Resources

SC DHEC Model Conservation Subdivision/Open Space Development Ordinance:
www.scdhec.gov/environment/baq/docs/ModelOrdinances/Conservation-Subdivision-OpenSpaceDevelopmentOrdinance.pdf

Smart Communities Network: Conservation Subdivision Design
www.smartcommunities.ncat.org/greendev/subdivision.shtml

Site Specific Green Infrastructure Techniques

The purpose of this section of the Green Infrastructure toolbox is to provide a non-engineering/non-technical introduction to site-specific best management practices that promote water quality improvements through on-site retention and treatment. The section is organized into the following seven (7) categories:

- Bioretention and infiltration
- Pervious Pavement
- Rainwater Harvesting
- Stormwater Wetlands
- Green Roofs, Walls, and Planters
- Green Streets and Parking Lots
- Greenways, Green Parks and Green Plazas

This toolbox is not intended to be a design or specification manual for construction but rather a means for garnering state and local government support for more widespread applications of these techniques. It is the hope of CMCOG that as technology and research in these areas advance and as these concepts become more familiar to citizens, elected officials and other public and private stakeholders, both state and local governments will begin developing more technical design and specification manuals for project implementation at the local level.

This is important to keep in mind because each of the specific techniques discussed below may or may not be appropriate for implementation at a particular site because of local soil conditions, topography, adjacency to conflicting land uses, safety concerns, existence of adequate existing facilities, or a lack of public support. Such site specific considerations will also dictate the location and design (i.e., type, size and scope) of a particular green infrastructure facility and the appropriateness of various pre-treatment options and overflow facilities to accommodate larger rain events and bigger stormwater catchment areas.

It is also important in the planning and engineering phase of project implementation to examine and consider potential conflicts with or impacts on other existing infrastructure and utilities such as roads, buildings and water and sewer lines. In the case of roads, safety considerations are of the utmost importance to transportation agencies such as the SCDOT. Any potential for flooding or the siting of inadequately tested paving materials in the road right-of-way will likely create a public safety

Rain Barrels at the Columbia Riverfront Park.

conflict and prevent that project and any future green infrastructure projects from moving forward. Coordination with state and local government transportation officials should be conducted from the beginning of the project scoping process.

In the case of water and sewer infrastructure, one of the biggest problems associated with sanitary sewer overflows is a high rate of infiltration of storm and ground water into older sewer pipes. Therefore all infiltration practices outlined below should be properly sited to avoid any conflicts with water and sewer line easements. This of course will require a high degree of coordination with water and sewer utility departments and private utility providers.
In regards to buildings, stormwater has long been an enemy of both commercial and residential structures. Wet weather related issues cost South Carolina property owners millions of dollars in maintenance and abatement expenses every year. The conventional wisdom to convey stormwater as far away from buildings as possible is seemingly in conflict with some of the techniques discussed below such as stormwater planters, rain barrels, and green roofs which seek to retain roof runoff on-site so that it may be used for other functional purposes. In such cases, it is still important to make sure that projects are designed in such a way that they prevent water related damage to the structures with which they are associated. All green infrastructure projects of this nature should be coordinated with local building officials to ensure structures are adequately protected and the project is in compliance with local building codes.

Finally, one of the biggest obstacles to widespread adoption of low impact development green infrastructure projects is the perception that they will have considerably higher construction and maintenance costs than conventional techniques. It is sometimes also not entirely clear who will be responsible for incurring these expenses. In recent years, however, many entities who have implemented green infrastructure projects are beginning to report that maintenance requirements and costs for these projects are comparable to and in some cases less intensive than implementing conventional infrastructure projects. Up-front cost sharing agreements between impacted jurisdictions and private stakeholders can significantly improve the efficiency and efficacy with which a project is implemented, and provide better end results.

Native Vegetation used in a Stormwater Wetland.

As green infrastructure becomes more widely adopted, the laws of supply and demand tell us that an increase in demand for engineering, design, and the manufacturing of associated products will likely result in an increase in supply so that a point of equilibrium will be met and the overall cost of construction and maintenance will reach better parity with conventional techniques. This is especially the case with construction materials such as pervious pavement which are still evolving and not currently being mass produced. As advances in technology and research coincide with rising demand for

Stormwater captured in a Bioswale in Downtown Aiken.

these products, it is likely that many more manufacturers will begin developing larger scale production facilities and as a result production and purchasing costs will decline.

It should also be noted that there are many cost saving advantages for implementing green infrastructure projects that are not available for conventional techniques. Once such advantage is that vegetation intensive projects such as rain gardens, stormwater planters and bioswales can be used to satisfy both stormwater and landscaping objectives for a particular site and therefore take on both a functional and aesthetic role. Costs for stormwater facility and landscaping maintenance can be combined or stacked so that the property owner can essentially use a single line item expense to simultaneously achieve two separate but related goals. For local governments this same principle can be used for capital improvement programming and as a result allows for better coordination between departments such as planning, public works, utilities and parks and recreation.

Bioretention and Infiltration

Biorenteion and infiltration best management practices come in a variety of types and shapes and in general, are based on the same principles of conventional infiltration practices such as berms, trenches, and filter strips which are minimally vegetated slopes designed to convey, spread and infiltrate stormwater runoff. The difference, however, is that green infrastructure bioretention and infiltration practices utilize more intensive, native vegetation and reduce the conveyance slopes with the intention of promoting better onsite infiltration to decrease the quantity and velocity of stormwater runoff and to increase water quality and groundwater recharge.

Bioretention and infiltration facilities are typically installed within or next to paved areas and are designed to allow water to pool and infiltrate for a period of time before reaching an overflow drain that leads into a conventional storm drain system. The process allows for the effective trapping of silt and other pollutants that would otherwise be carried from the runoff source to the receiving waters. Typical bioretention applications include bioswales, filter strips, rain gardens and dry stream infiltration beds.

The most significant design consideration for each of these bioretention facilities, as well as with most other site specific green infrastructure practices, includes the proper siting and sizing of the facility based on the desired catchment area, and local slope and soil conditions. Multiple facilities can be used to treat larger drainage areas while slopes and soil conditions should be appropriate to ensure proper conveyance and drainage capacity. Siting should be far enough away from other incompatible infrastructure such as water and sewer utilities, buildings foundations and septic systems. These practices should also not be used to treat surfaces with high pollutant loads when there is a high water

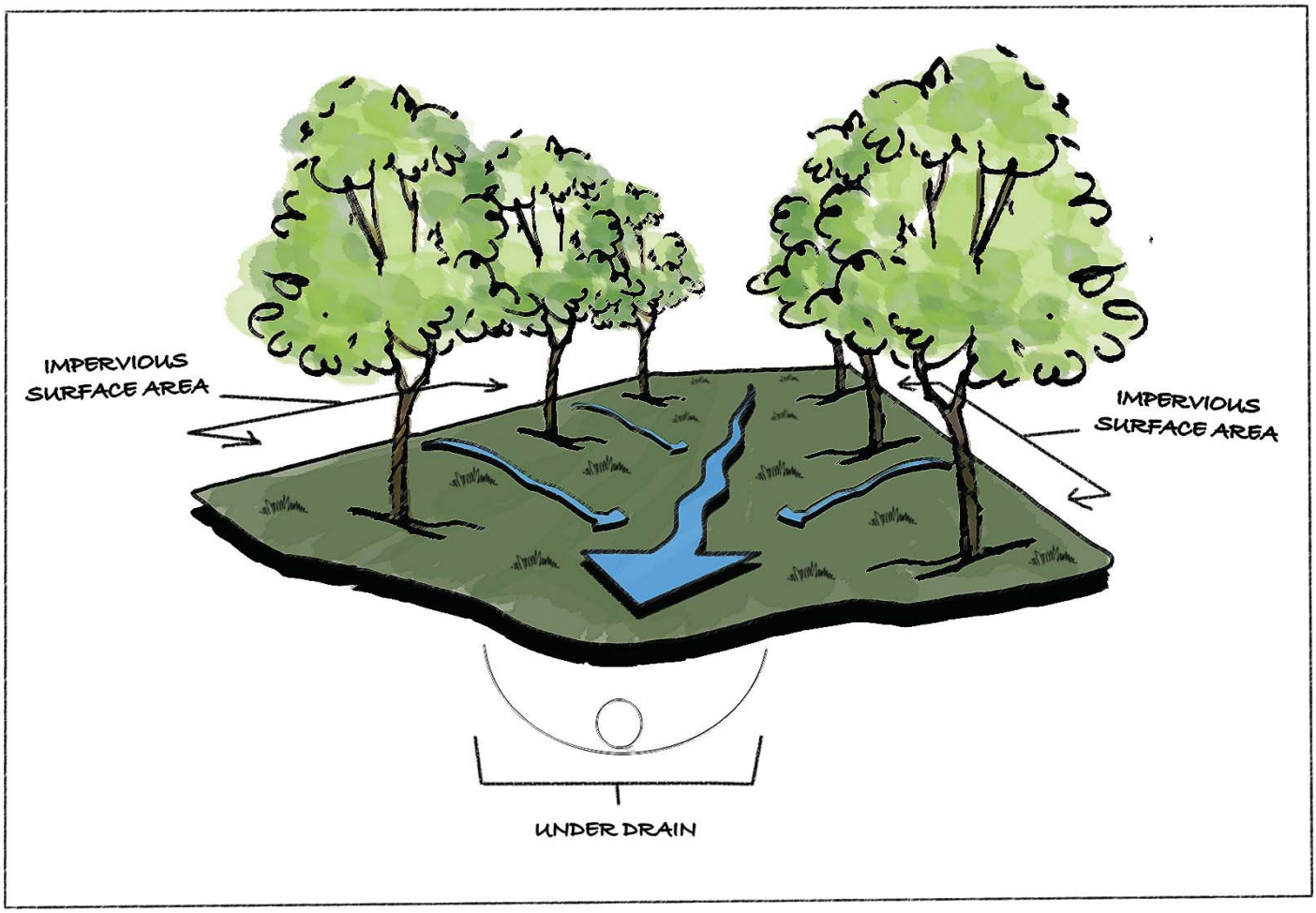
table or extremely permeable soils, unless a protective liner is used.

Bioswales

Bioswales, otherwise known as vegetated swales, are linear planted drainage channels designed to move stormwater at a slower rate, allowing it to infiltrate into the ground and be filtered through the vegetation. They often include a conventional drain inlet at the end of the bioswale to provide for overflow during large storm events. The planted medium and soil structure are beneficial for pollutant removal through biological, chemical and physical processes. Because bioswales are linear in nature, they are well suited for placement next to transportation facilities and parking lots where their filtration function can improve the quality of runoff which often contains considerable residues from petroleum based products. Because of their use of native vegetation, bioswales are aesthetically pleasing and provide the added functionality of reducing the urban heat island effect by creating shaded, heat absorbing vegetative cover. By promoting better onsite infiltration, bioswales also contribute to improvements in local groundwater resources.

Filter Strips

Filter Strips are strips of vegetated areas that extend between impervious surface areas and a receiving water body or other bio-retention/infiltration facility. They should be designed and sited based on existing natural buffer strips where



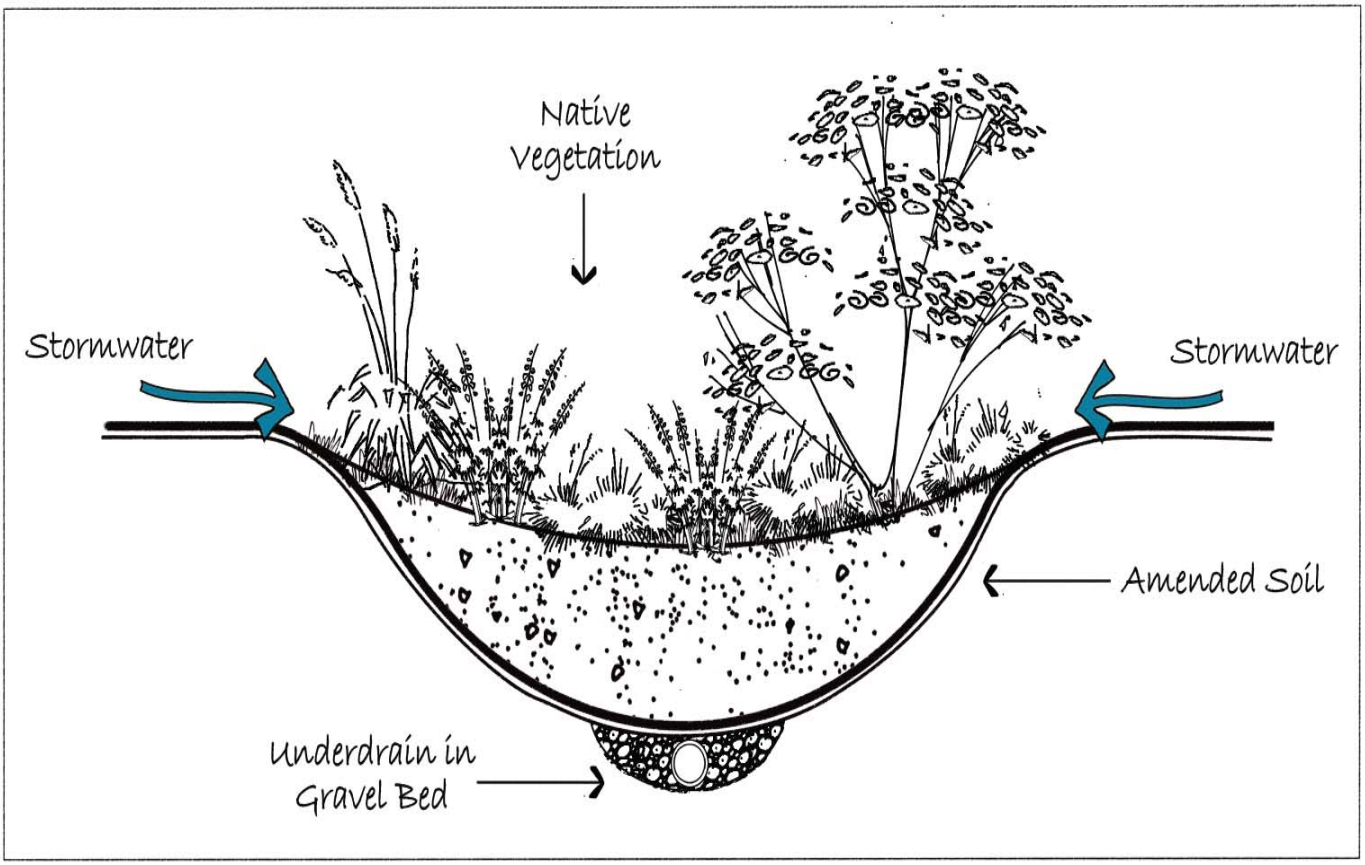
Bioswales come in many shapes and sizes but are all designed with the intention of slowly moving water over a vegetated area.

they can protect sensitive areas such as wetlands, woodlands and erodible soils. Like bioswales, filter strips trap sediment and allow for increased infiltration. They are typically sited parallel to and sloping away from an impervious surface area and are designed to function as an overland flow system that evenly distributes stormwater across the vegetated area. They generally range from 10-20 feet in width and provide a good first step in a treatment train. Like bioswales, filter strips use vegetation to filter out pollutants, reduce runoff volumes, and prevent sediment and other materials from reaching and clogging downstream facilities.

Infiltration or Retention Garden (Rain Garden)

An infiltration or Retention Garden, otherwise known as a Rain Garden is a landscaped areas that is designed as a shallow depression that traps stormwater and allows it to infiltrate into the soil. Like bioswales they typically have side slopes and flat bottoms, however, they are not designed to convey stormwater, but rather to retain it to the maximum extent possible in a single location. Pollutants are filtered through the native vegetation and broken down by microbial and bacterial activities in the soil.

The design and siting of the rain garden is dependent on the size of the desired catchment area, local topography, and soil and groundwater conditions. Because of the priority for onsite infiltration, they are best sited in locations with well draining soils. They can, however, be used in other locations, as long as adequate underlying soil amendments are implemented.



Rain Gardens are designed to capture stormwater runoff so that it may filter through a planting of native vegetation before infiltrating into the soil.

Rain gardens come in many sizes and shapes and are often molded to fit in left over landscape spaces surrounding parking lots, streets, and driveways. They can be used for the treatment of small areas in the public domain or they can be used to treat runoff from private residential properties. Because they are vegetation intensive, they can become a landscaping centerpiece wherever they are used. Typically a wide variety of native plants can lend a wealth of colors and textures to the aesthetic appearance. Separate planting zones within the structure can be created to support plants of complementing treatment efficiency and appearance.

General design considerations include estimating proper storage volume within the reservoir area, selection of appropriate vegetation to meet site specific conditions (e.g., use in wetland or upland areas), and under layer soil amendment requirements to maximize the effectiveness of the facility. Larger applications may require more than one treatment area to hold the require ponding volume and sediment loads. These facilities usually require more regular maintenance than less vegetated facilities to ensure the health and long term viability of the plants. Because of their widespread application and ability to be used in residential settings, rain gardens are well suited as community demonstration projects providing a means for public participation, education and outreach.

Dry Stream Infiltration Beds

Dry stream infiltration beds are large structures designed to contain and infiltrate large volumes of stormwater by employing a dry riverbed themed landscaping treatment. While these facilities are essentially large, linear infiltration channels, they are softened by being designed to look like a natural intermittent stream channel.

Dry Stream Infiltration Beds also promote the slow movement and infiltration of rainwater. They are often complemented by native landscaping treatments.

Ornamental bridges and picnic tables can also allow the area to be used as an informal outdoor area during good weather when water is not ponded or flowing through the system. Dry stream infiltration beds can be used in a number of locations including next to streets, parking lots, and in parks and residential yards where significant runoff occurs. Design considerations include the addition of a mulching or vegetative material to the perimeter and interior areas of the bed to provide a pretreatment filter strip. While a lack of significant vegetation in this BMP prevents it from having pollutant removal advantages, it still promotes high levels of onsite infiltration, and because it is designed with an attractive landscaping treatment, it allows the stormwater infrastructure to be integrated into a site as a public amenity.

Constraints

The biggest constraint to implementation of bioinfiltration practices is with the perceived maintenance costs of the land-

Pervious Asphalt (darker) next to conventional asphalt paving.

scaping features, especially when implemented by homeowners who have limited resources for maintaining landscaped areas. Site specific soil conditions can also be in issue, especially when large portions of the central midlands region have areas with poorly drained soils.

Opportunities

Rain gardens in particular can be implemented as community projects. In the Central Midlands Area, rain garden projects have been built through partnerships between local governments, churches, schools and neighborhood groups. While small in scale, many such individual applications can have a cumulative impact on water quality within a watershed, especially one where impairment is related to high levels of non-point source pollution. The abundance of active community and church groups throughout the region means that there are many opportunities to build on this momentum with additional projects. School districts are also vital partners in this campaign and can implement projects on their own properties as well as incorporate green infrastructure concepts into their existing curriculum.

Additional Resources

Urban Design Tools: Bioretention
www.lid-stormwater.net/bio_benefits.htm

Clemson University, Carolina Clear Rain Garden Manual
www.clemson.edu/newsroom/articles/2009/march/rain%20_garden_manual.php5

Washington State University: Dry Stream Beds
www.clark.wsu.edu/volunteer/mg/gm_tips/drystreambeds.html

Pervious Pavement

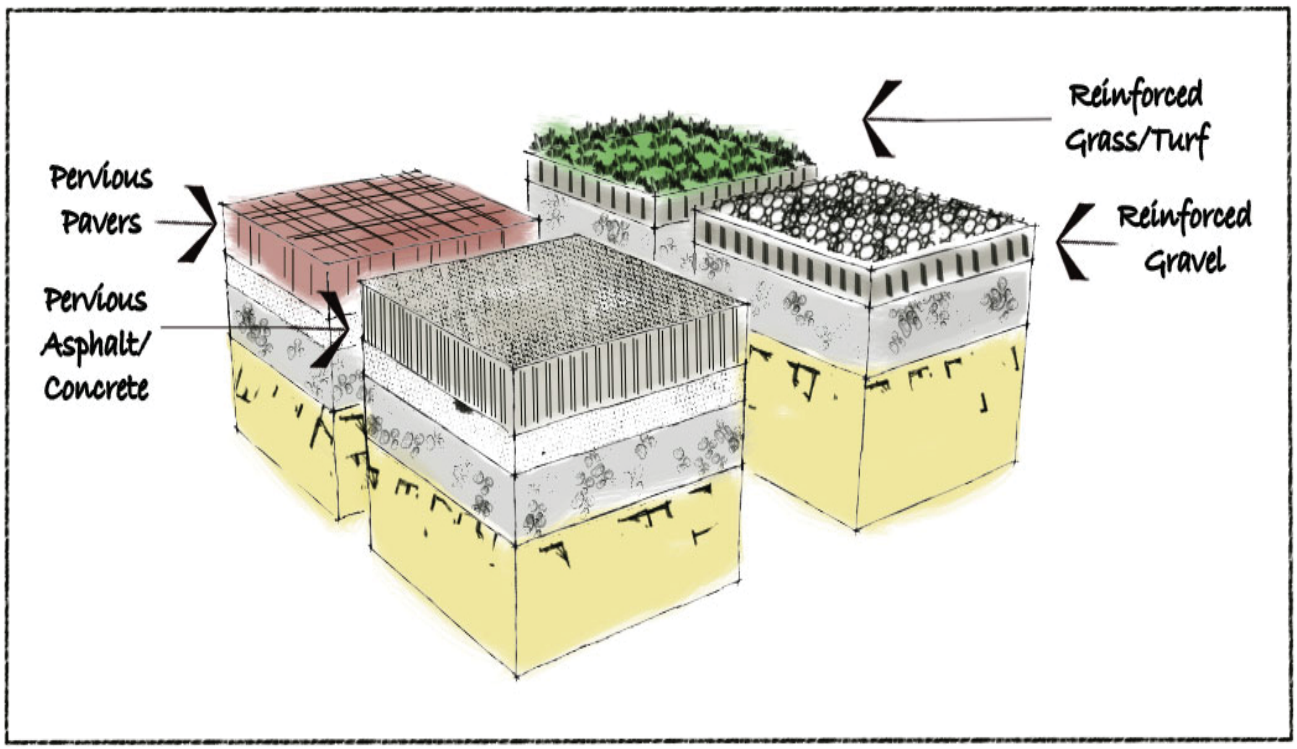
Permeable pavement is a paving surface that contains small voids to allow for the absorption and infiltration of stormwater through the paving material where it is allowed to drain into an aggregate reservoir and eventually into the underlying soil base or conventional drain system. Pervious paving comes in many forms ranging from those that look like traditional paving materials such as pervious asphalt and concrete, to those that mimic turf grass or gravel surfaces but provide more structural integrity.

Like traditional asphalt and concrete, pervious varieties also consist of a stone aggregate that is held together with either asphalt or Portland cement as a binder. The difference, however, is that the fines, which typically fill the pores in traditional mixes, are left out so small pore spaces can form and allow water to drain through. While some interstates make limited use of porous concrete varieties to decrease the ponding potential of water on the roadway, the application of these mixes are limited in their use on high volume thoroughfares. One of the primary limitations is the ability for these materials to withstand the weight and wear associated with high volume vehicle traffic. They are therefore primarily being used in parking areas and on low capacity collector streets.

A more commonly used pervious surface is interlocking pavers that allow water to pass through the pavers themselves (if they are made with pervious concrete) and the sand and gravel mixture that fills the joints. As with traditional pavers, they are laid on sand, crushed stone, and stone screenings or some other permeable material. What results is a system that allows for the efficient infiltration of water through the paving system to the underlying soil base or conventional drain system. This type of paving can withstand limited vehicle loading and can therefore be used for small parking or pedestrian areas.

Reinforced grass and gravel paving consists of traditional turf or gravel surfaces integrated with a reinforced plastic or concrete support system. This system is typically designed as an open cell array that is filled gravel or a turf grass growing medium. The reinforced grid allows for increased vehicle loading that would not otherwise be supported. Because these systems do not make for pleasant travel experiences and because they cannot withstand daily traffic use, they are typically used as overflow parking areas or primary parking areas in predominantly rural locations.

One of the primary constraints of using pervious paving materials is the cost associated with implementation. When used as a retrofit, the underlying soil must be adequately prepared for the system to be effective, therefore requiring the demolition of the existing pavement structure, in which case traditional repavement strategies will likely prevail. Furthermore, because this is still an emerging technology not many firms are technically equipped to design and construct pervious pavement systems, thus adding to implementation costs. Such a cost comparison, however, can be misleading, because if the pervious pavement system is intended to replace conventional stormwater infrastructure the municipality may actually save money by combining construction and main-



Pervious paving systems, which can come in a variety of forms, allow for a higher rate of stormwater infiltration than conventional paving materials.

tenance costs from transportation and stormwater management projects.

One other important consideration mentioned earlier in this chapter relates to coordination with water and sewer utility departments. Because water and sewer lines are often constructed in road right of ways, it is important to make sure pervious pavement that promotes infiltration, does not conflict with existing water and sewer infrastructure. Planning, design and construction of pervious paving systems will require a high level of coordination between public works and utility departments.

Finally, maintenance considerations are also important when planning a pervious pavement system. One of the biggest challenges is keeping the surface free from sediment which can clog the pores and prevent adequate infiltration. Regular street sweeping is encouraged as well as providing adequate pre-treatment options. Because the technology is still, it is not clear how these paving materials compare to traditional paving materials when it comes to lifespan and resurfacing requirements. Future advancements and technological innovation, however, will likely result in comparable, if not reduced, maintenance requirements.

Despite these modest limitations, pervious pavement systems offer a range of benefits including: the potential for cost savings if adequately coordinated with other capital improvement projects; decreased stormwater velocity and increased groundwater recharge; reduced urban heat island (pervious paving materials tend to absorb less heat than conventional pavement); aesthetic and community character benefits; clear delineation of on-street parking areas; and public education and outreach opportunities related to green infrastructure and stormwater management.

Constraints

A lack of knowledge about the benefits of pervious pavement and the prohibitive costs associated with retrofits has prevented early adoption of this practice by local governments in the Central Midlands region. The lack of local demonstration projects and scientific literature has prevented SCDOT and County transportation agencies from widely adopting pervious pavement systems.

Opportunities

Some high profile demonstration projects that have included participation by SCDOT are underway in other parts of the state. The City of Aiken project discussed in the next chapter provides a good example of one that has received considerable attention by numerous jurisdictions and has even been profiled on SCETV's popular television show Making it Grow. The new Walmart in the Blythewood area has also used previous pavement for portions of their parking lot creating an invaluable demonstration site.

As more communities begin using pervious paving systems, it will be easier to demonstrate the benefits of implementation and will likely begin driving down costs as demand increases supply. Pervious paving concepts can also be incorporated into local government comprehensive plans and capital improvement programs. They can also be incorporated into the CMCOG transportation planning program which will help convey information to local governments facilitate discussions with SCDOT and the Federal Highway Administration.

Additional Resources

North Carolina Cooperative Extension Service: Urban Waterways Publication: Permeable Pavement Maintenance
www.bae.ncsu.edu/stormwater/PublicationFiles/PermPaveMaintenance2011.pdf

Permeable Pavement: Research Update and Design Implications
www.bae.ncsu.edu/stormwater/PublicationFiles/PermPave2008.pdf

Urban Design Tools: Permeable Paver Specifications
www.lid-stormwater.net/permpaver_specs.htm

Pervious Pavement: When it rains, it drains
www.perviouspavement.org/index.html

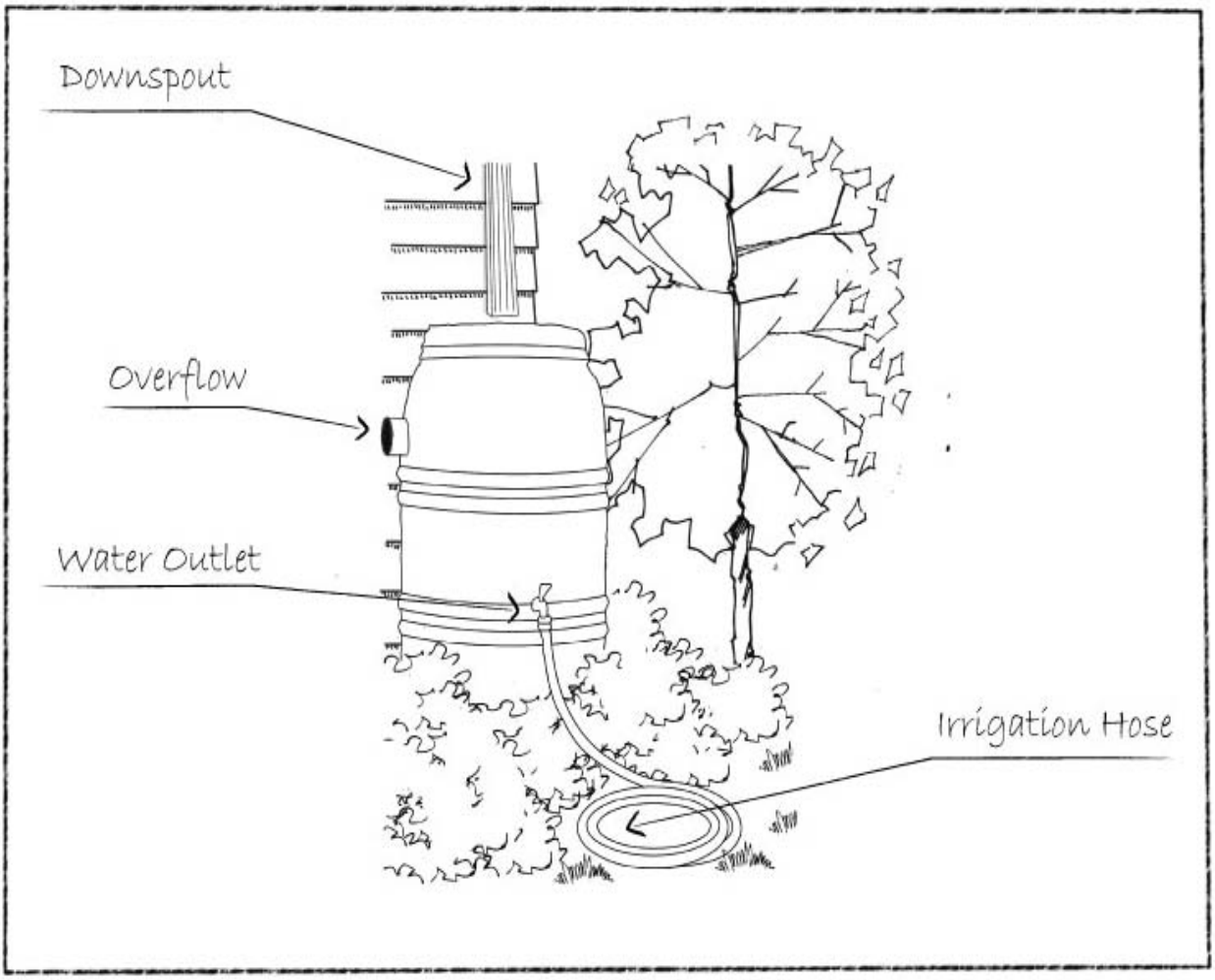
Rainwater Harvesting

The interception and storing of stormwater runoff for reuse is a commonly referred to as rainwater harvesting. This is perhaps one of the most common site specific green infrastructure practices that is an age old technique for conserving water in drought prone areas. The two most commonly used rainwater harvesting applications are rain barrels and cisterns. They both rely on the same engineering concept but differ in scale.

Rain barrels are small scale rainwater harvesting units that typically hold less than 1000 gallons and are installed at individual residences and small commercial and office building locations. The gutter downspout is directly connected to a barrel so that the rainwater falling on roof and entering the gutter system is captured in the barrel where it can be used at a later time for landscape irrigation purpose. The rain barrel is designed with an irrigation spout and overflow outlet that can be connected to a conventional drain system or a hose that directs excess water away from the building structure. Rain barrels are sold in many retail outlets and can be constructed by do-it-yourselfers from a variety of different receptacles including pickle barrels and trash cans.

Cisterns on the other hand typically hold several hundred to several thousand gallons of rainwater and are installed in a variety of locations including single and multi-family residences, offices, commercial buildings and in larger campus settings. Cisterns have even been constructed underneath active recreation areas such as baseball, soccer and football fields. They are ideal in these situations because they allow for the reuse of nutrient rich water that has passed through already fertilized turf surfaces. This strategy reduces demand for irrigation water and fertilizer and decreases the amount of nutrient rich water entering the local stream and river network.

Rain Barrel at the Richland County Department of Public Works.



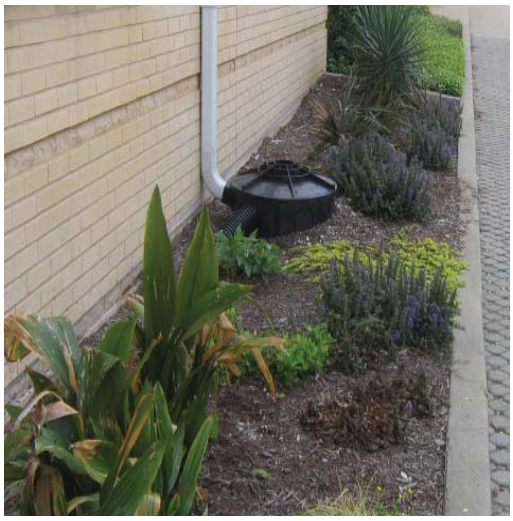
Rain Barrels are one of the most common forms of rainwater harvesting and can be used in a variety of settings including residential areas, commercial developments and public facilities such as parks, schools and municipal buildings.

Primary design considerations when installing a rainwater harvesting system include proper siting and sizing based on the desired catchment area and overflow considerations. Roof gutters and the harvesting system need to be adequately fitted with leaf screens to prevent debris from clogging the collection system or negatively impacting the harvested water.

One of the biggest benefits of rainwater harvesting is the fact that it treats rainwater as a resources rather than something that needs to be disposed of. This way of thinking gives individuals and communities a stronger sense of ownership over their water resources. By promoting the reuse of rainwater for irrigation purposes, rainwater harvesting is also decreasing the demand for treated and piped fresh water, which can be expensive and energy intensive. Capturing and reusing rain water also reduces the quantity and velocity of stormwater runoff entering the conventional storm drain system. After being used for irrigation, excess water is allowed to infiltrate back into the soil and recharge groundwater resources. Because rainwater harvesting is a highly visible practice, it contributes towards public education and outreach related to green infrastructure and water quality management.

Constraints

While rainwater harvesting is growing in popularity, it needs to be more widely



A Small Cistern at the USC Green Quad.

adopted at the individual site level to have any kind of significant impact on potable water demand and stormwater pollution. The cost of buying commercially made rainwater harvesting systems can be cost prohibitive for many families and businesses. If not properly maintained, rainwater harvesting systems can be rendered ineffective.

Opportunities

Because of the growing popularity of rainwater harvesting, this green infrastructure technique represents one of the most cost effective and implementable means for getting home and private business owners to participate in the implementation of green infrastructure practices. Rain barrel workshops are a highly effective means for educating the public and providing them with the expertise to construct and maintain their own rain water harvesting systems.

Both the Richland and Lexington Countywide Stormwater Consortiums, in partnership with Carolina Clear of Clemson University have hosted a number of successful rain barrel workshops that provide materials and training to homeowners. Such outreach efforts to neighborhood and community groups regionwide should be encouraged. There are also a number of opportunities for large commercial developments to implement rainwater harvesting systems. The new SCANA campus in the City of Cayce, has reportedly implemented such a system.

Additional Resources

Clemson University, Carolina Clear: Rain Barrel Manual
http://media.clemson.edu/public/restoration/carolina%20clear/toolbox/cc_rainbarrel_manual_may11.pdf

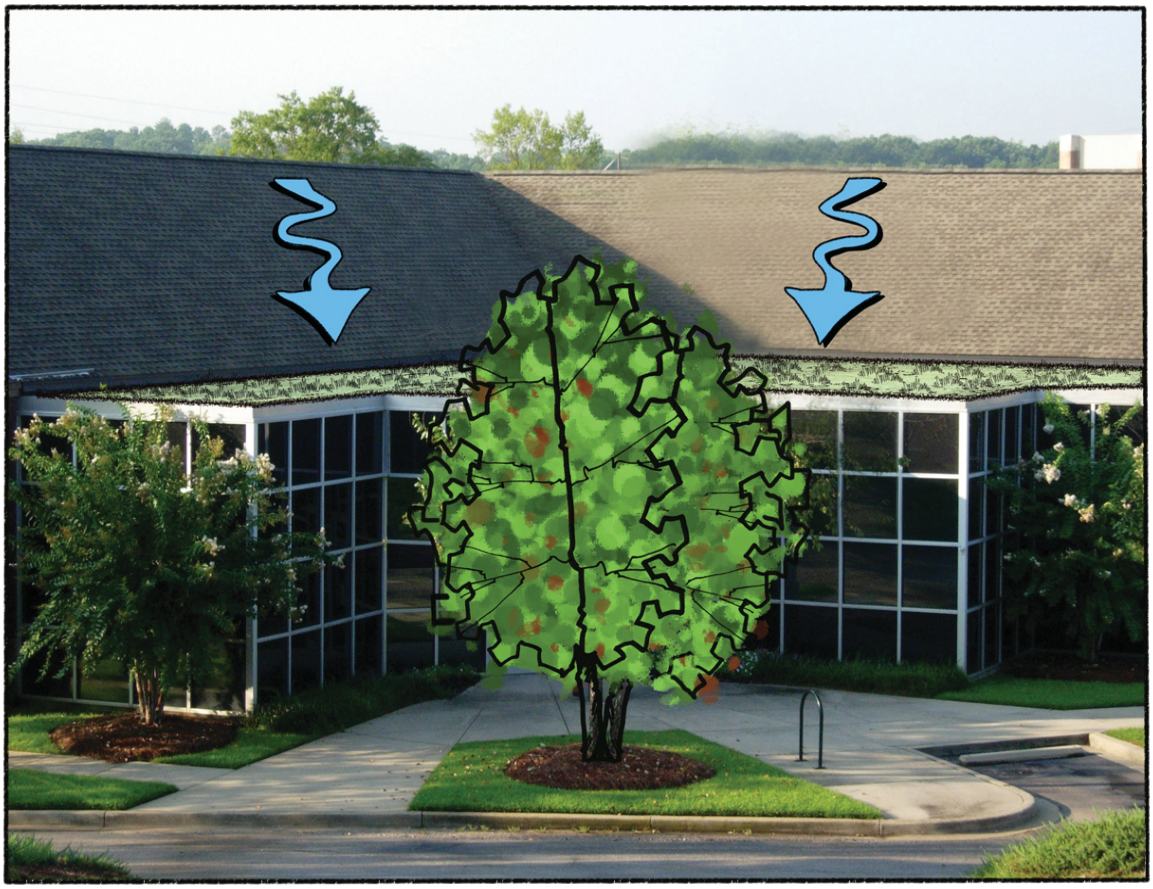
Urban Design Tools: Rain Barrels and Cisterns
www.lid-stormwater.net/raincist_home.htm

Rainwater Harvesting Guide
www.rain-barrel.net/

Green Roofs, Walls, and Planters

Green roof, walls and planters consist of structural additions to buildings that contain some sort of growing medium and associated vegetation that allow for the interception, absorption and filtering of rain water. The excess water that does runoff into a conventional drainage system takes longer to do so and may be post-treated in a bioswale or rain garden before entering a drain or waterway. Green walls, roofs and planters also have the added benefit of insulating the buildings they are a part of, thus reducing temperatures and energy costs.

Green roofs can be constructed on different types of buildings and building surfaces and can host a variety of vegetation types. They typically fall into one of two catego-



Potential green roof retrofit opportunity.

ries, extensive and intensive. Extensive roofs have a small growing medium depth and support smaller scale vegetation landscapes. Intensive green roofs have larger growing medium depths and can support more intensive types of vegetation. The type of medium and vegetation the roof supports impacts the green roofs ability to manage stormwater. Intensive roofs, with intensive vegetation can manage higher volumes of rainfall than what extensive roofs systems are capable of. The type of system implemented depends on the ability of the building structure to support the added weight of the saturated soil medium and vegetation.

Green walls are similar to green roofs in that they are built as an amendment to existing structural components of the building. In its simplest form, the green wall can be retrofitted on any building as a lattice system that supports climbing/vine type vegetation. Other types of green walls consist of engineered blocks, cribs or frames that have spaces for a planting medium and vegetation. These types of walls can be substituted for traditional retaining walls in landscaped areas.

Stormwater planters are another means for treating rooftop or surface runoff. They usually take the shape of long, narrow boxes that can be imbedded in sidewalks or attached to building foundations. The planters contain a growing medium and varying types of vegetation. Rainwater is directed into these planters from rooftop downspouts or other types of drainage systems. The stormwater passes through the planters where some of it is absorbed into the soil and filtered through the plants. The planters are designed with overflow outlets so excess water from large rain events can be directed into the conventional storm drain system. Planters are best

used in small areas where space is limited, but can be implemented in a variety of different settings such as parking lots, next to buildings, or along sidewalks and other public spaces.

As with most of the green infrastructure techniques discussed in this document, green roofs, walls and planters combine aesthetic landscaping features with a stormwater management function. When properly planted they can be a welcome addition to existing landscaped areas and can soften areas that are in need of aesthetic improvements.

As already indicated, they have many environmental benefits such as reducing stormwater runoff, reducing energy use, improving air quality, reducing the urban heat island effect, and providing much needed biodiversity and wildlife habitat. They also have social benefits such as improving aesthetic appeal, reducing noise pollution levels, and providing open space and urban agriculture opportunities on buildings that can structurally sustain these activities. Because of their aesthetic appeal and visibility, they are also useful for public outreach and education efforts on green related to green infrastructure and water quality issues.

Constraints

Green roofs, walls, and planters can be cost prohibitive and there is a lack of expertise in designing, constructing and maintaining these facilities. Few currently exist within the Central Midlands Region making demonstration and education difficult. Retrofit projects are also difficult because many buildings may not be designed to support green roof and wall accessories. Close coordination with a licensed engineer or architect is imperative before trying to implement a green roof, wall or planter project.

Opportunities

As technology advances and more communities across the country begin to implement green roof, wall and planter projects, technical expertise will expand and education and outreach opportunities will be easier to implement. Some commercial providers of green roof products are

Potential green wall retrofit opportunity.

located in the state. These vendors provide custom designed products as well as out of the box container products that can be easily used for retrofit projects on buildings that can structurally support them. It appears that the large retaining walls located in Finley Park in downtown Columbia were designed to be green walls. The concrete blocks used for construction have spaces for a soil and vegetation. This could provide an excellent opportunity to implement a highly visible green wall project in a well used public space. Steps should be taken to assess whether or not this wall can structurally support such a project.

Additional Resources

Urban Design Tools: Green Roofs
www.lid-stormwater.net/greenroofs_home.htm

Green Roofs for Healthy Cities
www.greenroofs.org

Low Impact Development Center
www.lowimpactdevelopment.org

Stormwater Wetlands

Stormwater or constructed wetlands consist of shallow, man-made vegetated systems that are designed to mimic natural wetland conditions, but are built for the purpose of detaining stormwater and removing pollutants through biological, chemical and physical processes. Pollution removal occurs through the settling of larger solids and course organic material and by filtering through the vegetation. These facilities are typically designed to treat stormwater runoff from a small (5-10 acre) drainage area and are sited in more upland areas where they cannot have any negative impacts on natural wetland systems. They are typically designed with three distinct zones that include a forebay for receiving the stormwater, a wetland area, for storing water, and a micropool immediately prior to the outfall to allow for sediment control. Site soils are also an important consideration because highly permeable soils that facilitate rapid rates of infiltration may prevent the development of hydrological conditions suitable for sustaining vegetation adapted to wetland conditions.

Stormwater wetlands have numerous benefits including slowing the rate of runoff, decreasing its quantity, and increasing its quality. Stormwater wetlands also reduce surface runoff temperatures, preventing thermal pollution, create wildlife habitat, and improve site aesthetics. The improved biodiversity, pollutant removal functions, and aesthetic considerations can make this type of facility more community friendly than traditional wet and dry pond detention and retention systems.

Constraints

Stormwater wetlands can be extremely cost prohibitive and require large land areas for construction. Site conditions limit the applicability of this technique especially in areas such as Lower Richland County that may be suitable for wetland development, but have the potential to threaten naturally occurring wetland systems.

Opportunities

The Irmo-Chapin Recreation Commission has constructed a wetland in the Saluda Shoals Park for environmental education purposes. Though it is not being used primarily for stormwater management purposes it can still be used as a demonstration for effective planning, design, and construction practices. Constructed wetlands for both stormwater and environmental education purposes should be

Stormwater Wetlands can mitigate flooding, improve water quality, and create wildlife habitat.

considered for other park and public spaces where site conditions permit.

Additional Resources

Environmental Protection Agency (EPA):
Stormwater Wetlands
www.epa.gov/npdes/stormwater/

The Stormwater Center:
Stormwater Wetlands
www.stormwatercenter.net

Green Streets and Parking Lots

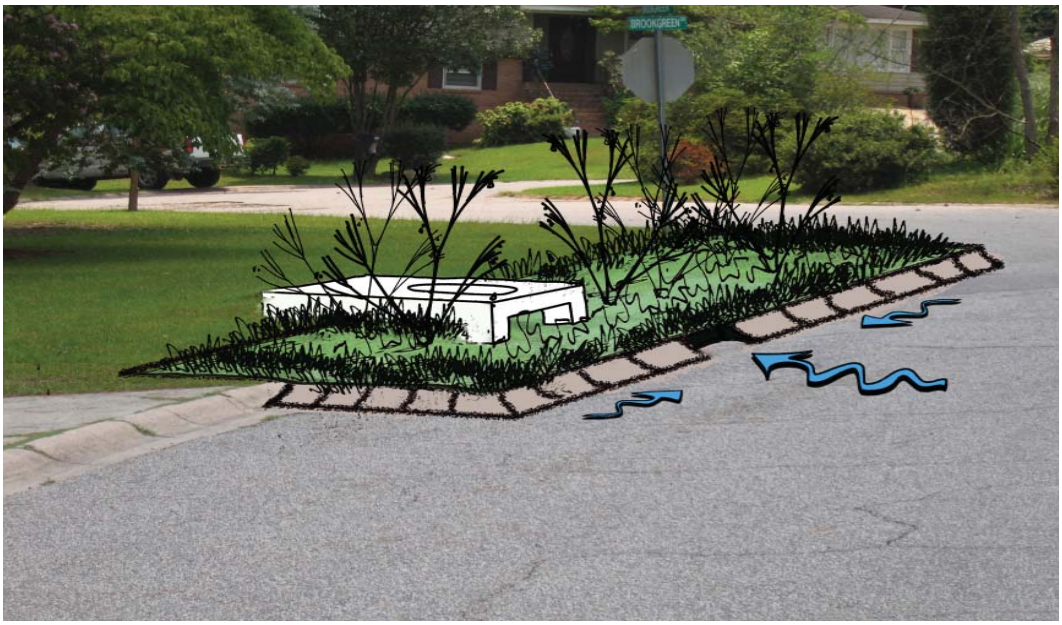
When it comes to transportation planning, many jurisdictions across the country and within the Central Midlands Region, have in recent years embraced the "complete streets" concept. Complete streets refers to the idea that the road network should be consistently designed with the needs and safety of all users in mind to include the following:

- Safe, adequate and appropriate driving lanes for vehicles;
- Sidewalks;
- Bicycle lanes;
- Intersection and cross-walk designs that are safe for pedestrians;
- ADA-compliant curb cuts and street crossings for people in wheelchairs;
- Traffic-calming features such as on-street parking; and
- Safe and convenient transit stops

The overarching goal of this movement is to build an inter-connected, multi-modal network characterized by safe accommodation of all persons, regardless of age or ability. While this is a worthy goal, stormwater management, which is an integral part of the road system, is left out of the concept, leaving it somewhat "incomplete." The "green streets" concept on the other hand, which has also gained significant momentum in recent years, inadvertently to fills in this gap by advocating for a road network that uses a natural systems approach to reduce stormwater runoff and improve local water quality. This is a very important concept because roads make up a large percentage of impervious surfaces in urban and suburban watersheds and state departments of transportation often hold some of the largest MS4 permits.

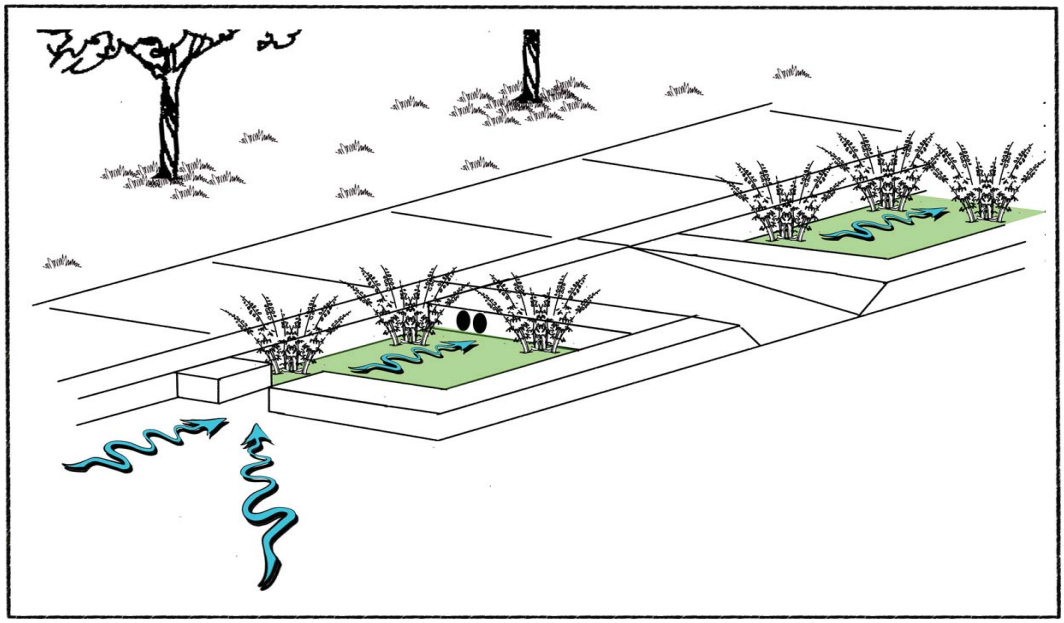
The green streets concept uses many of the green infrastructure policies, programs and site specific techniques already outlined in this document. The Institute of Transportation Engineers has defined a series of green streets principles and guidelines for transportation agencies to use. These guiding principles include:

- Minimizing street widths;
- Providing pervious surfaces where possible;
- Incorporating aesthetic design into retention and detention facilities;
- Providing mechanical traps to capture pollutants and particulate matter;
- Directing runoff into biofilters or swales where appropriate rather than relying solely on conventional storm drain systems.

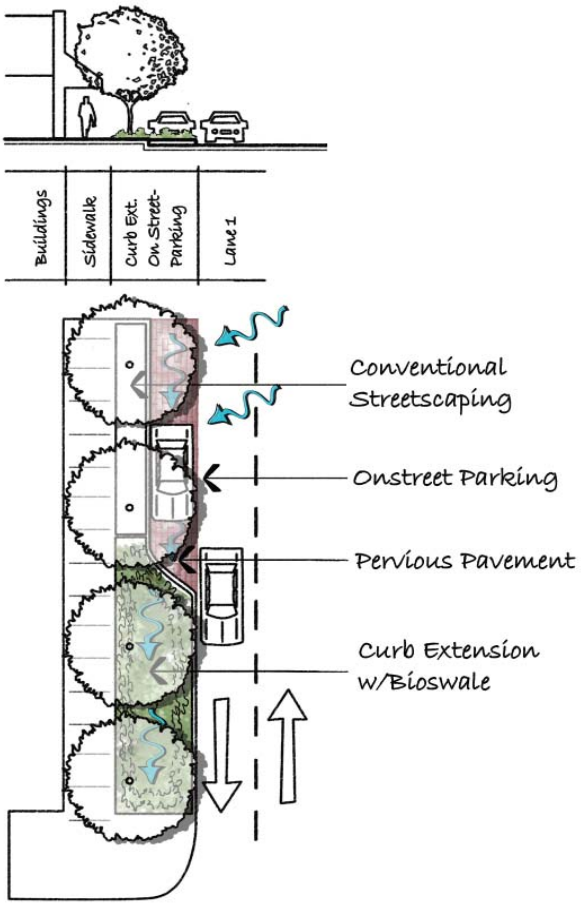


Rain Gardens and Bioswales can be used in curb extensions as a means for retrofiting existing stormwater infrastructure

In regards to this last bullet point, bioswales can be appropriate in many different locations and in many different transportation facility contexts. They can be used in medians, planting strips, curb extensions, islands, and other areas of significant size where runoff can be collected and detained. They can also be employed in areas that slope downward from the curb or sidewalk. Stormwater is allowed to enter bioswale areas by employing frequent curb and gutter cuts in down slope locations. As with bioswales and rain gardens in non-transportation settings, they can and should become an integral part of the existing landscaping treatment. Municipalities spend a great deal of public funds on streetscaping and beautification projects. By embracing green infrastructure and greet street concepts, jurisdictions can better leverage these scarce financial resources.



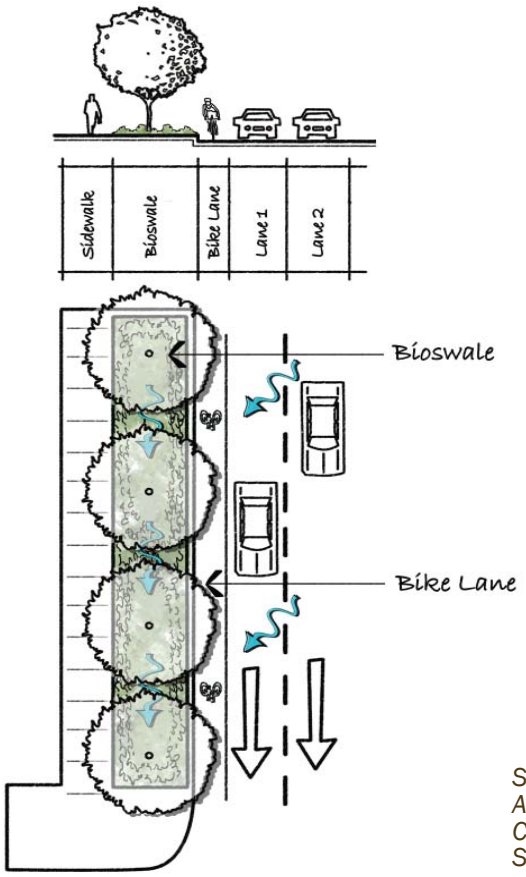
Stormwater planters, rain gardens and bioswales can be used in most street designs including those with pedestrain facilities.



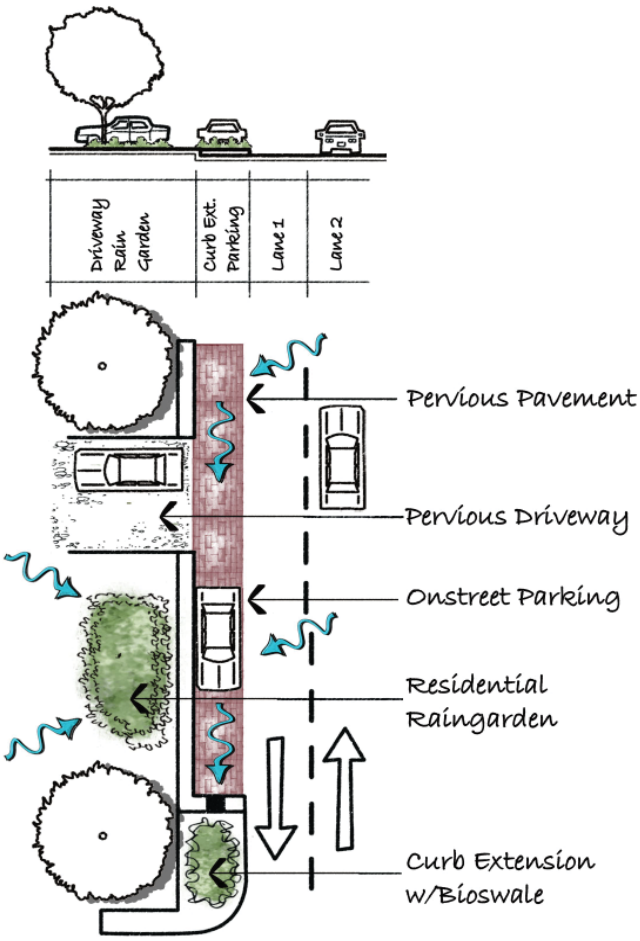
Urban Commercial Cross Section

In addition to bioswales, green street designs also rely heavily on pervious pavement systems. As discussed earlier, pervious pavement can be used in a variety of settings including on-street parking areas, off-street parking areas, alley ways and on low volume collector streets. Sidewalks and pedestrian crosswalks can also use pervious pavement systems.

Green street concepts are typically applied to the following five transportation facility types: urban commercial streets, arterial streets, residential streets, alley ways and parking lots. ***Urban Commercial*** streets offer opportunities for pervious pavement in on-street parking areas, bioswale curb extensions, and stormwater planters around native street trees. ***Suburban Arterial*** roads which have much higher traffic volumes and often have two travel lanes in each direction, can use continuous bioswale features parallel to the road. The landscaped bioswale can provide a much needed separation between the vehicle travel lanes and the sidewalks, making for a much safer and aesthetically pleasing pedestrian experience. ***Residential Streets*** offer numerous green infrastructure opportunities. Pervious pavement can be implemented along the edges of wide residential streets that can be used for on street parking (which provides the added benefit of calming traffic). Pervious pavement, such as gravel and turf, can also be used on residential driveways. Homeowners can also site rain gardens next to driveways and along the street frontage to serve as a filter strip and/or infiltration area. Curb extensions with bioswales or larger bioswale systems can also be used on residential streets. ***Urban Alleyways***



Suburban Arterial Cross Section



Residential Street Cross Section

which often provide a connection to off street parking can use pervious pavement in access and parking areas. When implemented in tandem with urban commercial green street designs, it can have a positive cumulative impact on stormwater runoff. ***Parking Lots*** represent one of the biggest contributions to impervious surface areas in any given watershed. Fortunately, bioswales and rain gardens are well suited to capture, store, and filter runoff from parking lots. Bioswales can be implemented in the center of a large parking area where frequent curb cuts allow stormwater to enter the bioswale system. If used in tandem with policies that promote shared parking and reduced parking requirements, the negative water quality impacts associated with these types of impervious surfaces can be dramatically reduced.

Urban Alleyway

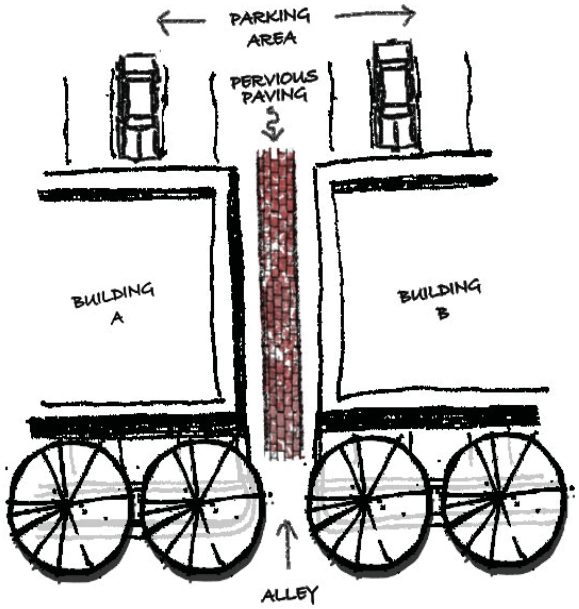
The green street concept represents a way to reduce impervious surface coverage, increase regional water quality, and support smart growth urban design strategies that facilitate the development of a "complete" street network.

Constraints

One of the biggest constraints to green street development is a lack of existing technical specifications for planning, design, and construction. Because few projects currently exist in the state of South Carolina, there are a limited amount of benchmarks for demonstrating the effectiveness of these types of projects. As already discussed, many of these techniques can be cost prohibitive for retrofit projects unless they are a part of a complete road redesign or capacity improvement project.

Opportunities

The City of Aiken project discussed in the next chapter represents a successful implementation of bioswales and pervious pavement treatments in an urban commercial setting. The success of this project can provide momentum for future projects in other areas of the state. As the designat-



Pervious Pavement retrofit opportunity for a residential street.

ed Metropolitan Planning Organization (MPO) for the Columbia area, CMCOG can play an instrumental role in advocating for the use of complete street/green street concepts. As will be discussed in Chapter 5, CMCOG is in the process of assessing ways to better integrate green infrastructure concepts (including green streets) into the regional transportation planning process.

References

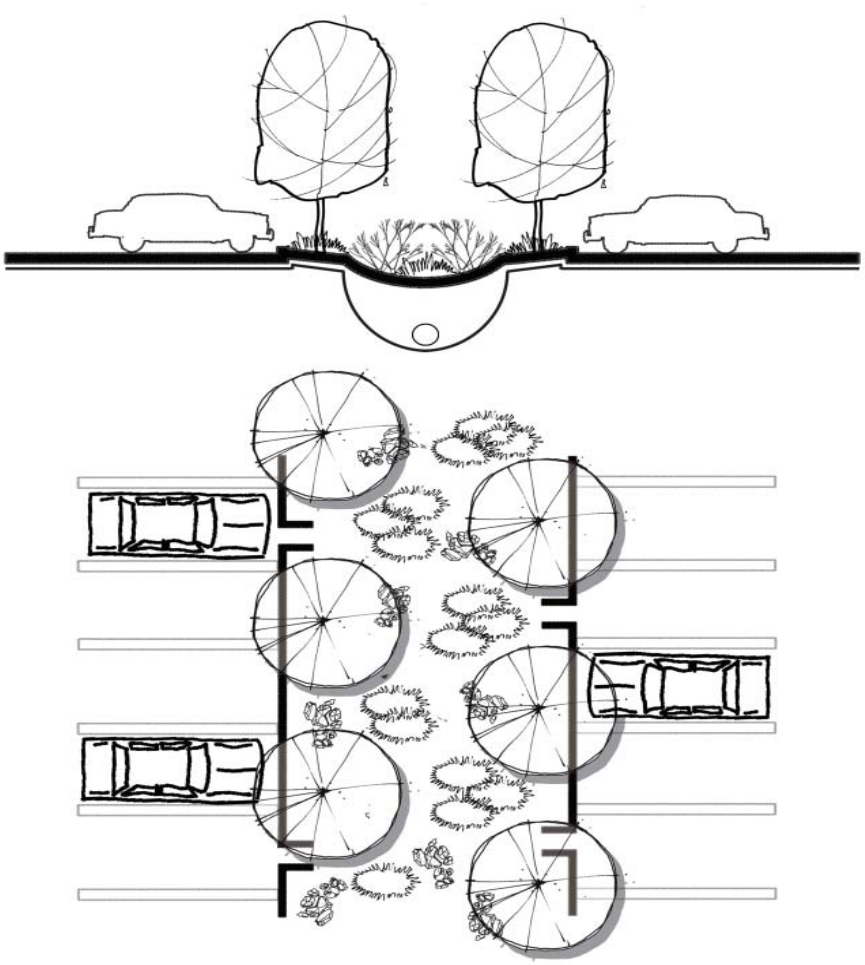
Institute of Transportation Engineers. 2010. Designing Walkable Urban Thoroughfares: A Context Sensitive Approach. Washington D.C.: Institute of Transportation Engineers.

Additional Resources

Environmental Protection Agency (EPA): Green Streets
www.epa.gov/owow_keep/podcasts/greenstreetsusa.html

San Mateo County, CA: Green Streets and Parking Lots Design Guidebook
www.flowstobay.org/ms_sustainable_streets.php

Green Highways Partnership
www.greenhighwayspartnership.org/



Parking lot with bioswale cross section.

Greenways, Parks, and Plazas

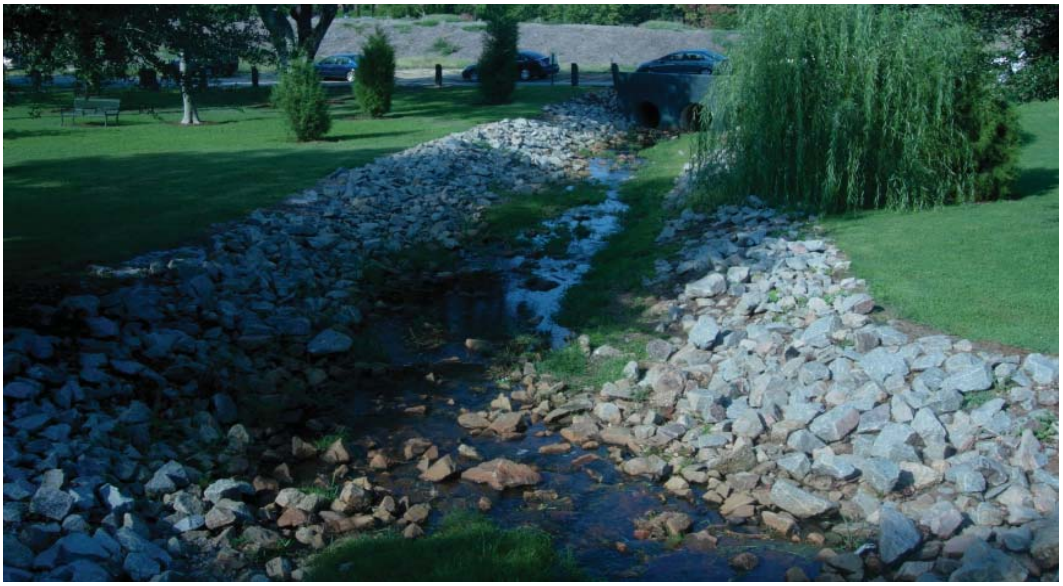
Like green streets, many of the green infrastructure policies, programs, and site specific techniques can also be used in other important public settings such as greenways, parks and urban plazas. These public facilities are often highly used and historically sited in locations that are not suitable for development because they are in low lying areas that are frequently flooded during storm events. Greenways in particular are often strategically located along riparian corridors that are already protected by a riparian buffer ordinance.

As discussed earlier in this chapter, the ideal riparian buffer ordinances will actually encourage this type of passive recreation in designated areas. As illustrated on the next page a greenway corridor can fit in with a riparian buffer ordinance. Other types of green infrastructure techniques, such as rain gardens, bioswales and rain barrels can also be used in the greenway corridor to help with stormwater management from parking lots, restrooms and maintenance facilities. Such strategies will also offer significant public education and outreach opportunities if complimented with appropriate interpretive signage.

The public park system in general offers many opportunities for implementing highly visible green infrastructure projects. The City of Philadelphia has made this a primary objective of their stormwater management plan and as a result has implemented numerous site specific green infrastructure projects in both large and small parks throughout the city. When connected with greenway and green street projects, a jurisdiction can begin to develop a regional network of green infrastructure hubs (large city parks), links (greenways and green streets) and sites (pocket parks and urban plazas) that not only provide much needed open space and recreation opportunities, but also serve as an integral component of the stormwater management system.

Constraints

Because of limited public resources, many jurisdictions see are not adding to their existing park and greenway network and see the addition of green infrastructure to existing parks as a separate, additional expense. The adequate integration of green infrastructure techniques into the greenway and park system requires highly technical engineering and design expertise.



The City of Columbia has many community parks that are often sited in natural drainage ways. These parks, such as the Vietnam Veterans Memorial, can easily be retrofitted with interpretive material to educate the public on stormwater management and green infrastructure techniques.

Opportunities

Local governments should focus on ways to fund green infrastructure projects by combining resources between public works and park and recreation departments. By treating the addition of these amenities as an infrastructure improvement rather than an aesthetic improvement, they can justify higher priority funding in municipal capital improvement programs. With the success of Three Rivers Greenway, many jurisdictions throughout the Central Midlands region are trying to implement greenway projects of their own. The 14 Mile Creek Greenway that is currently in the planning design phase offers an excellent opportunity to incorporate site specific green infrastructure techniques such as bioswales and rain gardens.

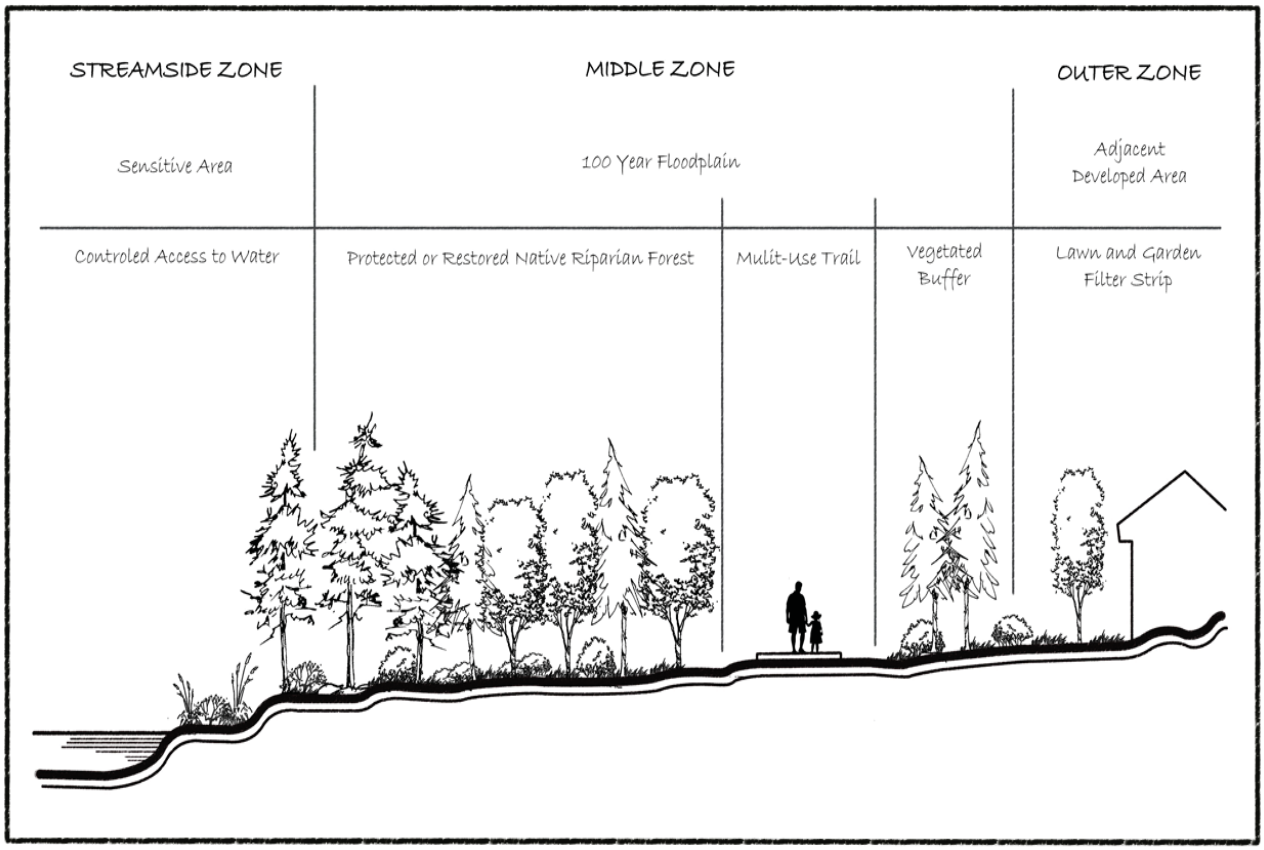
Downtown Columbia also represents an excellent opportunity for developing a green infrastructure network because of the abundance of city parks sited in low lying areas. Finley Park and the Vietnam Veterans Memorial are both great locations for high visibility bioswales and rain gardens. These stormwater parks could also be connected by a network of green streets and greenways. Assembly Street and the proposed Vista Greenway would both adequately serve this purpose. The downtown area also has a number of urban plazas (such as Boyd Plaza at the Art Museum) that could become a destination site with green infrastructure amenities such as filter box planters and pervious paving.

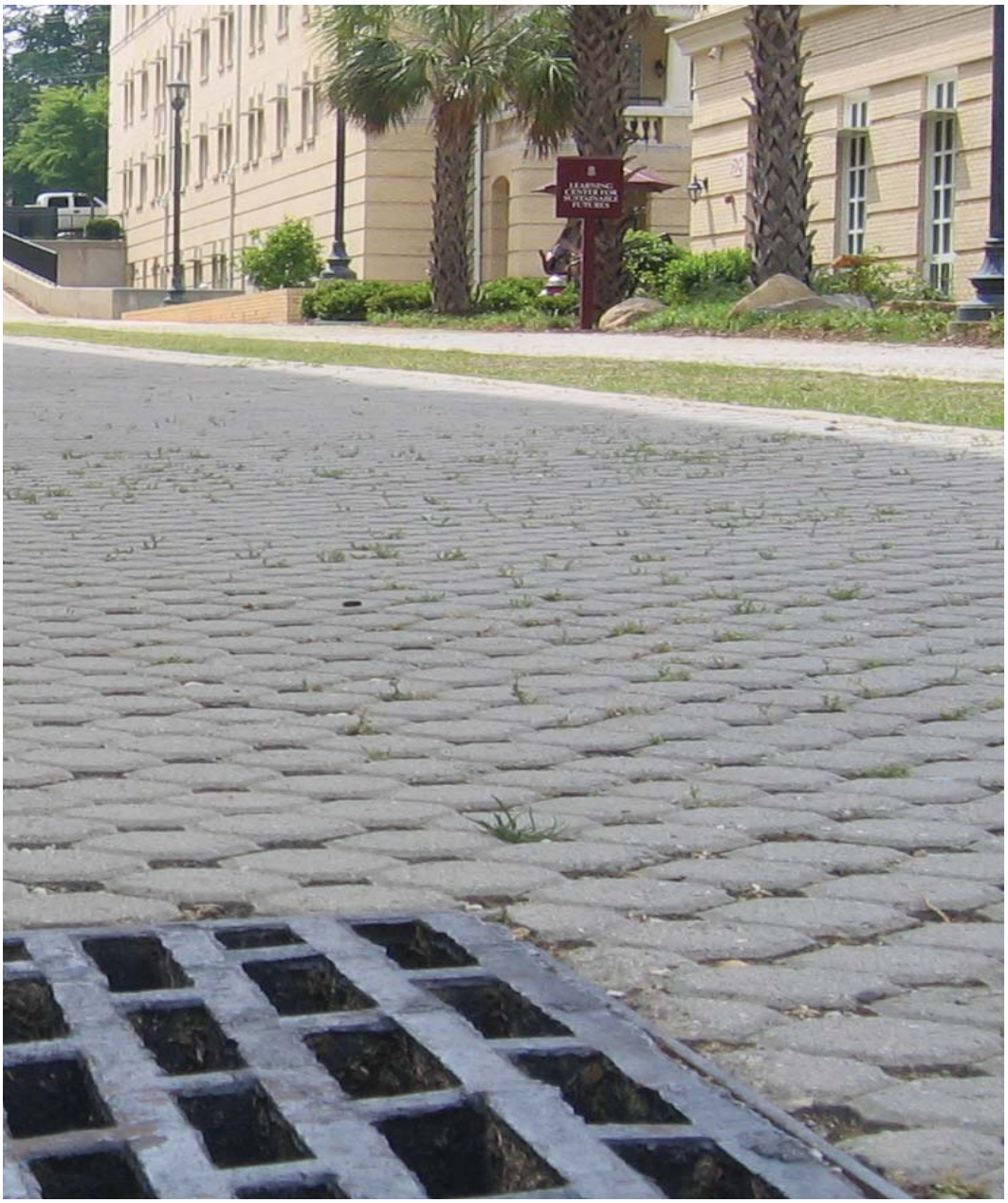
Additional Resources

Philadelphia Water Department: Green Stormwater Infrastructure
www.phillywatersheds.org/what_were_doing/green_infrastructure

Environmental Protection Agency (EPA) Green Infrastructure Case Studies: Philadelphia
www.epa.gov/npdes/greeninfrastructure/

Greenways can be implemented within riparian buffers allowing for the protection of the stream corridor as well as creating opportunities for recreation and public education and outreach.





Green Infrastructure Case Studies

This chapter is intended to introduce innovative GI and LID projects that have been implemented in the Carolinas. There are a many more examples to choose from besides what is presented here, especially when looking at pier towns and cities in other parts of the country. A concerted effort was made, however, to pick several projects close to home, that utilize a number of different techniques and have a high potential for transferability to the Central Midlands Region.

City of Aiken

One of the best and increasingly notorious examples of a GI and LID project in South Carolina is located in downtown Aiken. Over the past ten years the City has been facing a stormwater crisis as conventional stormwater management techniques have threatened to severely impact Hitchcock Woods, a beautiful urban forest that serves as a major equine recreational facility and is one of the City's most important economic assets.

To address downtown flooding issues, the City has historically used conventional stormwater management techniques that consist of a collection system of underground pipes that have a single massive discharge point in Sand River, a small creek that flows through nearby Hitchcock Woods. This strategy ultimately created a massive erosion problem as the regions' sandy soils could not support the sheer volume and velocity of the water coming out of the pipe. Initially the city considered solving the issue by using other conventional techniques such as decentralizing the discharge through a series of detention basins that would decrease the peak discharge volume and velocity. This solution was rejected, however, because no suitable sites for the structures were found in downtown Aiken. As a result the City, in partnership with Clemson University and the South Carolina Department of Transportation, have embarked on an ambitious program to integrate a series of GI and LID BMPs into the existing urban fabric of this historic city.

Bioswales

One of the most prominent features of the GI program for downtown Aiken is the bioswales that have been created within the existing landscaped medians that divide the City's wide thoroughfares. Both vegetated swales and grass swales have been implemented, where runoff from the surrounding streets can slowly move towards the overflow drains, infiltrating

The wide medians in Downtown Aiken have been retrofitted with Bioswales that use native vegetation to help filter out pollutants.

into the soil and being absorbed by the plants along the way. Curb cuts are spaced along the medians to allow water to flow from the streets into the bioswale system. Water quality monitoring sites are set up throughout the system to allow researchers to investigate the impact these techniques are having on the quantity and quality of the water leaving the system.

Pervious Pavement

Before passing into the bioswales, surface runoff from the impervious travel lanes pass over a pervious surface zone that makes up on- street, parallel parking bays. Surface runoff from the streets is allowed to infiltrate into the soil before it enters into the bioswale system. In addition to pervious asphalt paving on the roads, some parking lots in the area are surfaced with pervious concrete, and some alley ways and sidewalks are surfaced with pervious pavers. These treatments are not only effective in reducing runoff, but they are also aesthetically pleasing and blend in nicely with the surrounding landscaping.

Pervious pavement is used for onstreet parking areas.

Green Alley Way between two commercial buildings in Downtown Aiken.

Green Streets and Parks

Integrating the bioswale system into the existing landscaped medians has the benefit of enhancing an already well used public space which serves as both a green street and green park system. Because of the high visibility and heavy pedestrian traffic in downtown, the bioswales and pervious pavement treatments also serve as valuable public outreach and educational tools.

Stream/Wetland Restoration

In addition to addressing the root cause of the erosion issue by installing pervious pavement and a bioswale system, the project team is also in the process of reversing the damage done to Sand River and an associated wetland through a stream bank and wetland restoration program.

Transferability

While the City of Aiken has embarked on this innovative program to address a single, targeted issue that is threatening the local economy and natural resource base, the prescriptive measures they have implemented are extremely transferrable to the Central Midlands Region. Because the City of Columbia has also been historically

blessed with a system of wide thoroughfares, the potential exists for implementing a comprehensive green streets program that could simultaneously mitigate urban stormwater runoff and provide an interconnected network of urban open space.

Additional Resources

Additional information can be found on the City of Aiken's website at: *www.cityofaikensc.gov.*

University of South Carolina Green Quad

The mission of the University of South Carolina's Green Quad is to serve as a model for sustainability on campus and in the larger community. GI building techniques guide all aspects of its programs, operations, management, and facilities. Green Quad serves as an inspiration and motivation for other campus and community organizations. It was one of the first buildings on campus to be constructed with its ecological impact in mind. The Quad implemented many conventional approaches to green building management, as well as employed many innovative sustainable techniques. The key GI techniques used are listed below.

Conservation Landscaping

The Green Quad site design uses conservation landscaping as a method of controlling water use in most landscaped areas including decorative gardens. The plants used are slow-growing, drought-resistant, and require very little watering. The gardens are still pleasant to look at without needing wasteful irrigation systems which can cause excess runoff by watering plants at inappropriate times (such as during or just after a storm), or by over-watering due to issues with calibration or leakage. Xeriscaping helps prevent this excess water from entering the stormwater system, and eliminates the need to supply water for garden irrigation.

Permeable Sidewalks

Many of the sidewalks surrounding the buildings are paved with loosely-fitted stones or bricks made of permeable materials. Water may also pass through the margins of the bricks directly into the soil. The visual effect is much like cobblestone. Permeable sidewalks help to further reduce surface runoff. Much of the surface water during storms can pass through the stones or into the soil instead of being concentrated by conventional engineering, potentially causing flooding. This also helps to reduce the amount of water entering the stormwater system.

Rainwater Harvesting

A series of rain barrels and small cisterns are located next to many of the buildings to capture rainwater from the rooftops so it

Native Landscaping with interpretive material.

Stormwater Wetland area with overflow into the existing conventional stormdrain system.

can be reused to irrigate landscaped areas. This water is fed into slow release watering systems, keeping the rainwater on-site rather than discharging it directly into the storm drain system.

Green Roofs

These are gardens and grassy turf areas planted over the roofing in the lower portions of the Quad. The soil and vegetation of these turfs absorb rainwater runoff helping to reduce the amount of water that would otherwise enter the stormwater system. The turfs are also able to absorb some heat during summer and are aesthetically pleasing.

Bio-Swales

The bioswales at the Green Quad are sited at low-elevation points to act as natural water traps during storms. The swales are planted with water-tolerant vegetation providing an aesthetically pleasing landscaped area that also conceals the conventional overflow storm drain. The use of bioswales lessens the quantity of stormwater runoff coming off of the site and increases water quality by allowing the vegetation and soil to naturally filter out pollutants.

Community Benefits

As discussed throughout this document there are numerous benefits for utilizing the different GI techniques implemented at the Green Quad . From a water quality perspective, the Green Quad effectively reduces the quantity and improves the quality of the stormwater that is entering into the City of Columbia's conventional storm drain system. By employing rain water harvesting and xeriscaping techniques, it is also reducing the demand on the public water system and the Universities overall carbon footprint. Because the Green Quad is located in a flood prone area, reducing the peak volume runoff from major storm events can also mitigate against future flooding. A final benefit lies with the public education opportunities provided by the site. The Green Quad operates as a visible demonstration of GI techniques providing an invaluable educa-

Terraced Ampitheatre that serves as a Public Open Space within the Green Quad.

tion opportunity for both students and other public and private community stakeholders.

Transferability

The USC Green Quad can serve as a model for implementing GI techniques by large public and private institutions with considerable building resources. This type of comprehensive GI project could be replicated by some of the Midlands largest employers who have significant office park campuses that can be either retrofitted with GI techniques or implemented as new construction occurs. SCANA Corporation, one of the region's top ten employers, is a perfect example of the type of institution that could transfer some of the lessons learned from the USC Green Quad example. In fact, it has been reported that the company, which is in the processes of finishing their new corporate headquarters across the river in Cayce, has adopted some GI practices such as rain water harvesting with underground cisterns.

Additional Resources

Additional information on the USC Green Quad can be found online at: *www.housing.sc.edu/westquad.asp.*

Saluda Shoals Park Constructed Wetland

Saluda Shoals Park, which is one of the Irmo Chapin Recreation Commissions most popular facilities, has constructed a wetland to primarily serve as an environmental education tool and to provide much needed wildlife habitat. The park which was developed within the Saluda River floodplain has always had pockets of intermittently wet areas signifying the presence of remnant wetlands. The site for the new wetland park was one such area that served as a natural wetland before being drained for agricultural purposes in the 1920s. The property was then acquired by SCE&G where it became part of a utility right-of-way easement. After becoming a part of the Saluda Shoals Park, the Irmo Chapin Recreation Commission decided to restore this wetland and turn it into an environmental, educational and recreational asset. The project was funded through a public/private partnership and grew to encompass an approximately 10 acre site. In addition to being a functioning wetland, the site also contains a boardwalk, an outdoor learning area, and picnic shelters.

Transferability

This project is highly transferrable to other areas in the Central Midlands Region and is reflects one of the recurring themes of this report, which is implementing GI and LID techniques in areas that have high resident visibility and therefore serve an important public education and outreach purpose. Integrating such features into other public park and recreation facilities throughout the midlands should be a regional priority.

Boardwalk at the Saluda Shoals Constructed Wetland.

Additional Resources

More information can be found on the Irmo Chapin Recreation Commission website at: *www.icrc.net.*

Noisette Community Master Plan

The Noisette Community is a master planned development in North Charleston that has a strong sustainability focus which centers on linking social and community goods with the health of the area's ecological systems. By creating and nourishing these connections through the utilization of GI practices, the Noisette development will strive overtime to grow into a healthy, sustainable, and livable community.

The broad premise behind the GI component of the master plan is to incorporate local environmental resources as an interconnected focal point for the community. In order to accomplish this, several key GI techniques were used including: open space preservation, conservation landscaping, stormwater management and an innovative ecological enterprise/economic development strategy.

Open Space Preservation

A key component of the master plan is the preservation of open space and the restoration of sensitive environmental features. A centerpiece of this effort is the Noisette Preserve, which is a 1,400 acre restored marshland that serves as a watershed and habitat restoration as well as a public use area. The preserve is designed to be utilized as a primary focal point of the entire development, essentially functioning as a "Central Park" of the entire community. The master plan also utilizes linear open space features such as riparian areas to increase pedestrian and recreational connectivity within the community, an amenity that was historically lacking because of the dominance of conventional auto-oriented development patterns. This new system of greenways interlinks the entire community and connects back to the focal point of the Noisette preserve.

Conservation Landscaping

Much of the community's public and open spaces – such as curb cuts, parks, old railway beds, and open fields utilize conservation landscaping principles, such as planting non-native and drought tolerant

plants, for all community beautification efforts. The landscaping component of the master plan also integrates GI stormwater management techniques, thus bringing these concepts into the public realm and making them an integral part of the communities' network of public space.

Stormwater Management

Historically the community has suffered from poor water management practices which have resulted in frequent flooding events and significant soil erosion which have a detrimental impact on sensitive environmental features such as the Filbin Creek area. GI stormwater management strategies such as bioretention and infiltration gardens are therefore utilized for the purpose of reducing the volume and velocity of runoff entering the existing conventional storm drain system. Rainwater harvesting at both the neighborhood and household scale are used and encouraged to facilitate the reuse of rainwater for the irrigation of public and private landscaping features. Permeable pavers are also used in key areas to help promote onsite infiltration of rainwater.

The master plan also addresses local policy and regulatory issues by suggesting revisions to the local zoning ordinance to set maximum impervious surface limits and to institute tougher stormwater construction regulations for future building activity.

Economic Development

The master plan also addresses economic development issues by promoting the creation of a local green business/enterprise incubation program. This effort includes providing office space and business development assistance to help grow and develop green businesses that can provide valuable services to the Noisette community as well as the greater Charleston Area. Many of these green businesses such as native landscaping, hydrology, aquaculture, and ecotourism are promising economic growth areas with an increasing demand for services by both public entities and private firms.

Transferability

The Noisette Community Master Plan offers Midlands area governments and private developers a comprehensive model for fully integrating GI concepts into a site planning and development program. One of the most innovative aspects of the project is recognition and support for institutional capacity building. By providing an organizational framework based on public/private partnerships, the Noisette Community Master Plan creates an effective mechanism for implementing many of the ambitious goals of the overall program. This model for development could easily be transferred to the Central Midlands region, especially in the context of redevelopment initiatives for some of the areas aging inner ring suburbs.

Additional Resources

More information on the Noisette Community can be found online at: *www.noisettesc.com.*

The master plan document can be downloaded from: *www.noisettesc.com/res_keyproject.html.*

Boardwalk leading to the Arcadia Lakes Tree of Life Rain Garden.

Arcadia Lakes Tree of Life Rain Garden

The Arcadia Lakes/Tree of Life Rain Garden is a small bioretention cell located behind the Tree of Life Congregation Church located in the Town of Arcadia Lakes. The rain garden collects and treats stormwater draining from the church parking lot and rooftop prior to it flowing into adjacent Cary Lake which has had water quality issues in the past. The rain garden is planted with a wide variety of native trees, shrubs, herbs and groundcover. It also contains a boardwalk and interpretive materials to help educate visitors on GI and non-point source pollution. The project was implemented through a partnership between the Town of Arcadia Lakes, the Tree of Life Congregation, and the Richland County Conservation Commission. It was also developed with assistance from the Gills Creek Watershed Association.

Transferability

Though this project only impacts a small part of the Cary Lake watershed it is important because these are the types of small projects that can have a larger cumulative impact if implemented on a wider scale. It also demonstrates the type of project that can be built by church and neighborhood groups, especially when conducted in partnership with willing government and non-profit organizations. This type of project should be encouraged in neighborhoods and commercial areas across the Central Midlands Region. The City of Cayce, Richland and Lexington Counties have already started down this path with similar projects of their own.

Additional Resources

For more information contact the Town of Arcadia Lakes. They can be found online at:
www.arcadialakes.net/.

Additional information about this project is also available from Carolina Clear and the Richland Countywide Stormwater Consortium:
www.clemson.edu/public/carolina-clear/consortiums/.

Town of Fairbluff, NC: Lumber River Riverwalk

Located just across the North Carolina state line halfway between Cheraw and Myrtle Beach, the Town of Fair Bluff hugs the banks of the Lumber River as it meanders into South Carolina where it becomes the Little Pee Dee. This small town of approximately 1,100 residents has for the past decade been engaged in a project to build a boardwalk trail along this beautiful black water river and through the vast bottomland forest that defines the riparian zone. This trail system which was partially funded through a federal aid grant for former tobacco dependent communities has proven to be widely popular with area residents as well as with the steady flow of tourists stopping by on their way to and from the beach. The riverwalk has allowed the community to reconnect with the river and has the potential to bring higher visibility to water quality issues within a predominantly agricultural part of the state.

Transferability

This particular case study was chosen because it was implemented by a small rural town surrounded by agricultural and silvicultural activities. This project is particularly relevant and transferable to small rural communities in the Central Midlands Region that suffer from agricultural related water quality issues.

A perfect example of an appropriate location for this type of activity is in the Town of Swansea in the southern portion of Lexington County. Swansea is located within the Bull Swamp Creek watershed which drains into the North Fork of the Edisto River. This is a black water stream system surrounded by extensive bottomland hardwood forests much like the Lumber River in Fairbluff (but on a much smaller scale). This stream system has three water quality monitoring stations in the vicinity of Swansea, all of which are identified as impaired. It is anticipated that the primary cause of impairment is

Boardwalk through the bottomland hardwood forests along the Lumber River.

The Lumber River as it flows through the Town of Fair Bluff, NC.

agricultural runoff considering that the predominant land use surrounding the town is dedicated to agricultural activities.

The town has also on previous occasions expressed an interest in developing a greenway trail along the stream. Such a project would be extremely beneficial for a number of reasons including providing outdoor recreational opportunities for area residents, increasing the community connection to the river system, and creating an opportunity for increased education and outreach related to water quality and agricultural BMPs. These types of projects can create community ownership over a local water resource and as a result assist in changing behaviors that contribute to water quality impairment.

The riverwalk was partially funded through the Tobacco Trust Fund Commission.

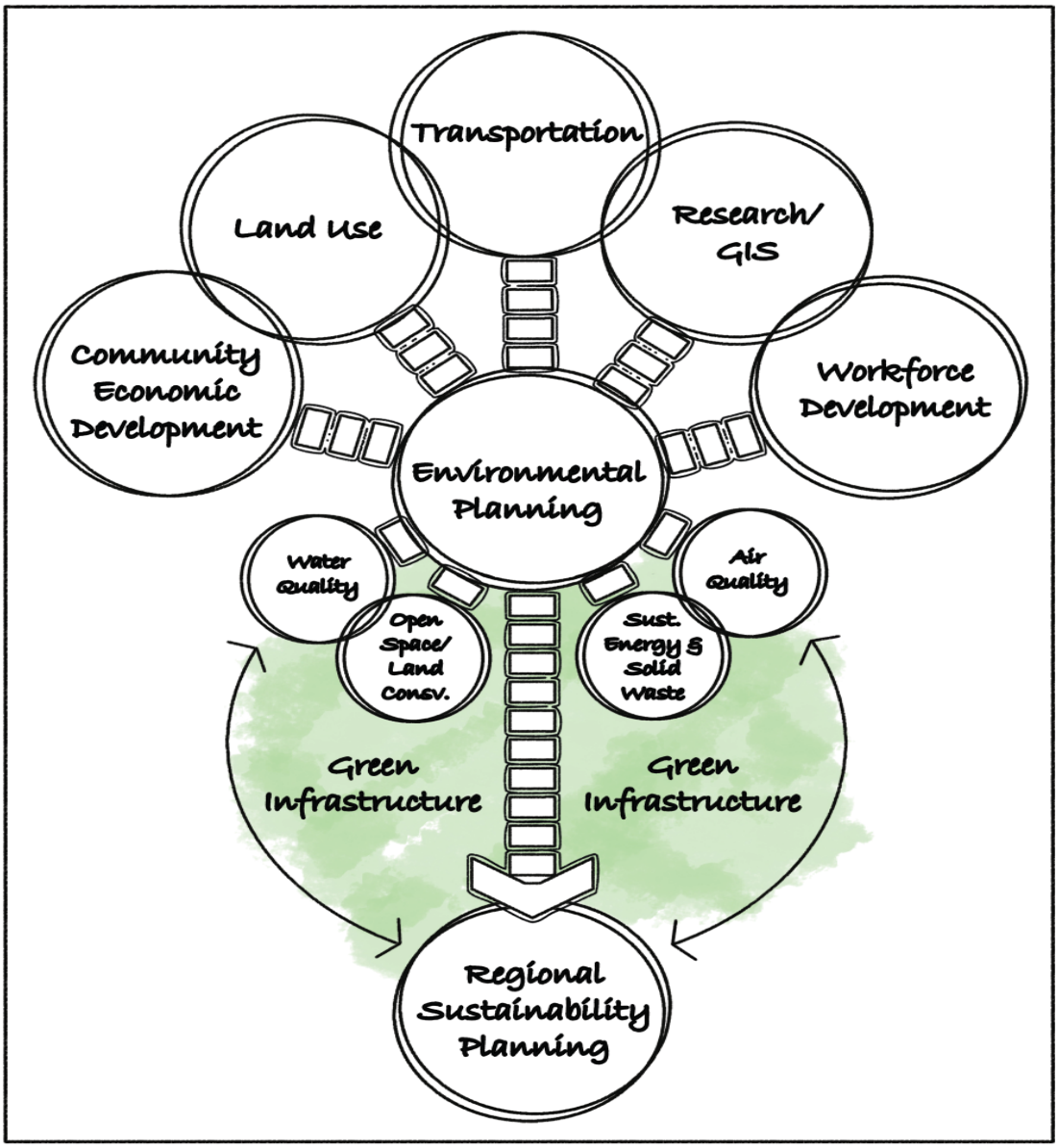
Additional Resources

For more information visit the Town of Fair Bluff's website at: *www.fairbluff.com.*

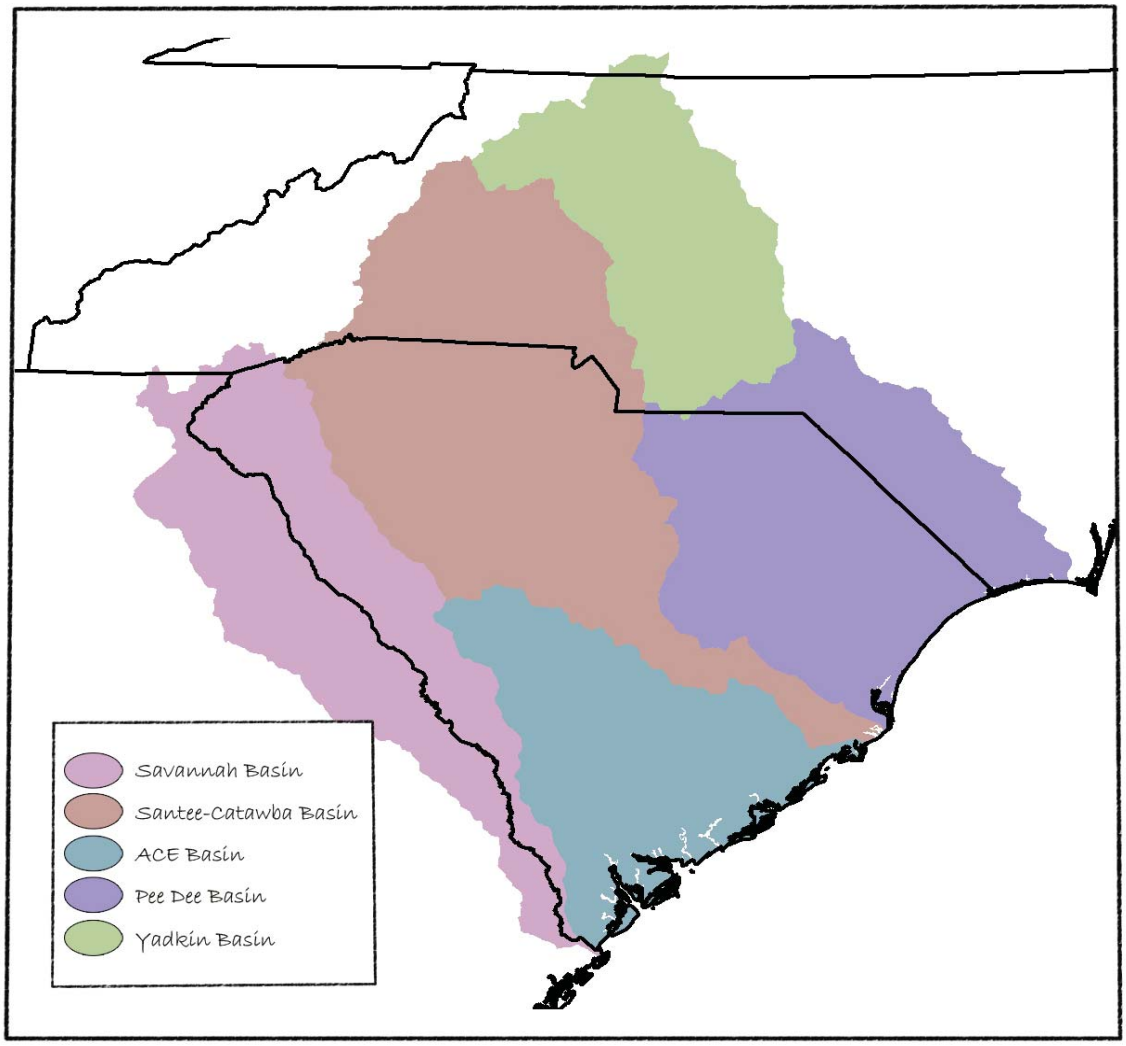
Putting Green Infrastructure To Work In The Central Midlands Region

The green infrastructure toolbox and case studies discussed in the previous chapters demonstrates the many opportunities for implementing green infrastructure projects in the Central Midlands Region. In most cases it is up to state and local governments and private sector developers to adopt and implement these policies, programs, and site specific strategies. As a regional planning agency, Central Midlands Council of Governments (CMCOG) also has a significant role to play in this process. CMCOG intends to continue working closely with state agencies, local jurisdictions, private stakeholders, and community groups to advocate for the local level implementation of green infrastructure projects.

One of the best strategies CMCOG can use to accomplish this goal is to identify ways to better integrate green infrastructure and environmental planning principles into each of its core planning programs. The end result will hopefully be the development of a more comprehensive environmental planning process that can become an essential component to the agency's regional transportation, land use, community and economic development, research and GIS, and workforce development programs. The planning process will also enhance the agency's 208 Water Quality Management Program and provide information that can be used in the update to the 208 Water Quality Management Plan. Finally, it is the hopes that the information contained in this document will complement other ongoing environmental planning initiatives in the region and help to provide the framework for the development of a regional sustainability plan.



Environmental Planning and Green Infrastructure can greatly enhance other core reigonal planning programs and contribute to the development of a Regional Sustainability Plan.



Map 6.1: Major River Basins of South Carolina

This chapter proceeds by first discussing the potential for expanding CMCOG's environmental planning program to include a watershed based approach to regional planning. This will then lead to a discussion of how watershed management and green infrastructure principles can be integrated into each of the other planning programs discussed above and illustrated on the previous page. Each section will include a discussion of tangible action strategies that the agency can implement to work towards accomplishing this goal. The chapter concludes by presenting a regional green infrastructure vision map and a concept plan for implementing green infrastructure in an impaired watershed.

A Watershed Based Approach to Regional Planning

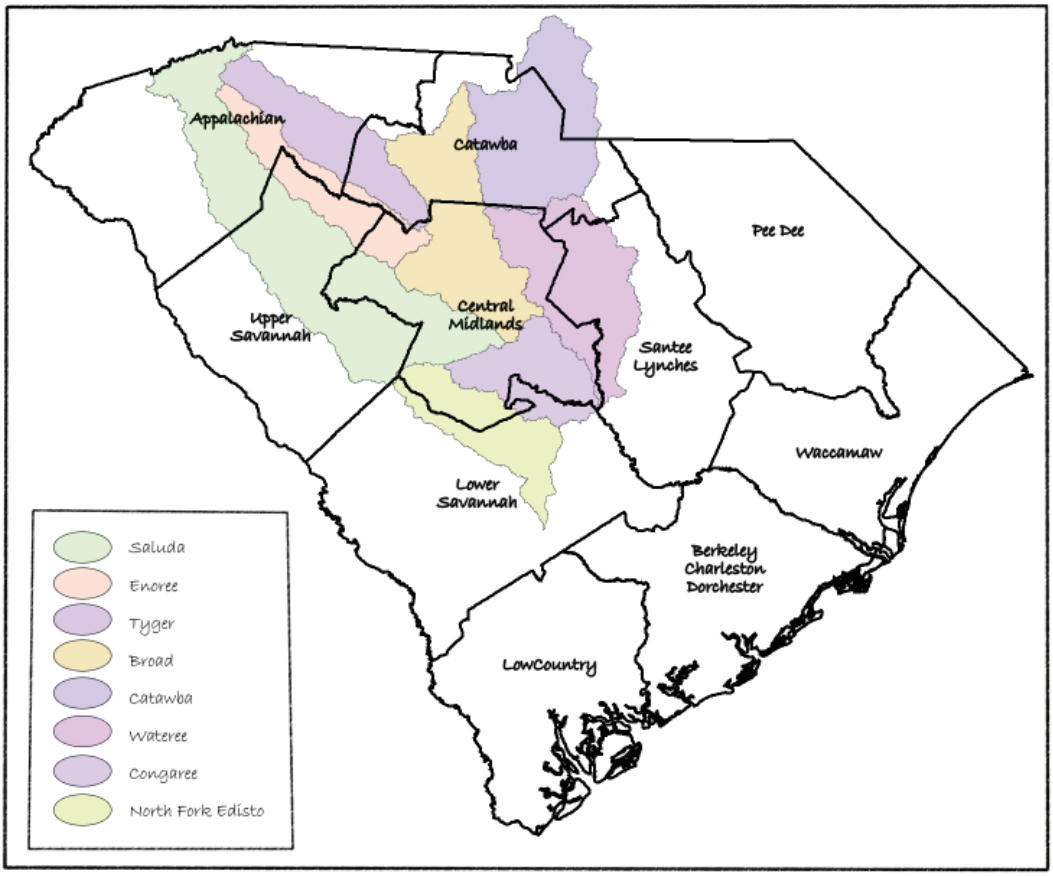
One of the first steps in defining a regional green infrastructure strategy is to begin thinking about the Central Midlands region in terms of watersheds as opposed to political boundaries. By taking this approach it becomes apparent that the four counties around Columbia do not exist in isolation but are directly connected to neighboring states and other regions within the state depending on the watershed scale that is being used. As illustrated in ***Map 6.1*** the state of South Carolina can be divided into four major river basins consisting of:

- the Santee-Catawba basin which drains approximately 34% of the state's land area;
- the Yadkin-Pee Dee Basin which drains 25 % ;
- the Savannah River Basin which drains 15%;
- and the ACE (Ashepoo, Combahee, Edisto) Basin which drains approximately 26%.

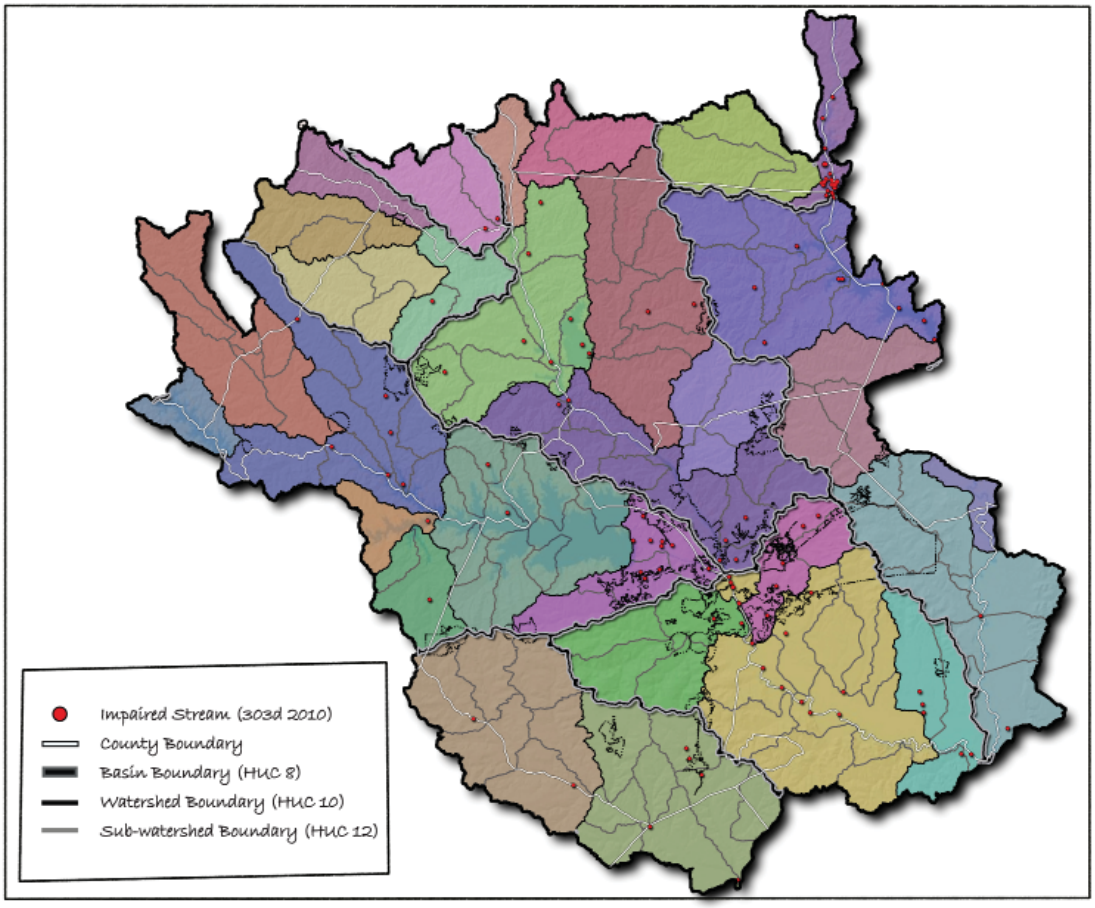
The boundaries of these drainage basins connect the state of South Carolina with the neighboring states of North Carolina and Georgia. As illustrated in ***Map 6.2***, the four counties that make up the Central Midlands region fall within the major sub-basins of the Saluda, the Broad, the Congaree, the Wateree and the North Fork of the Edisto River, which forms the south western boundary of Lexington County. By looking at the region in terms of these sub-basin boundaries the Central Midlands is directly connected to the planning areas of the following Councils of Governments: Appalachian, Catawba, Upper Savannah, Lower Savannah and Santee Lynches.

Map 6.3 on the following page illustrates how these sub-basin boundaries within the Central Midlands Region can be broken down even further into 10 and 12 digit hydrologic unit codes. When conducting analysis at this level of geography it is important to note that these boundaries, though more refined than at the basin and sub-basin levels, still encompass a much larger land area than when using the four county boundary that traditionally defines CMCOG's regional planning jurisdiction.

For the purposes of developing a framework for regional watershed based planning activities, it is best to define the boundary of the region in terms of watershed boundaries. This makes it easier to



Map 6.2: Major River Sub-Basins in the Central Midlands Region



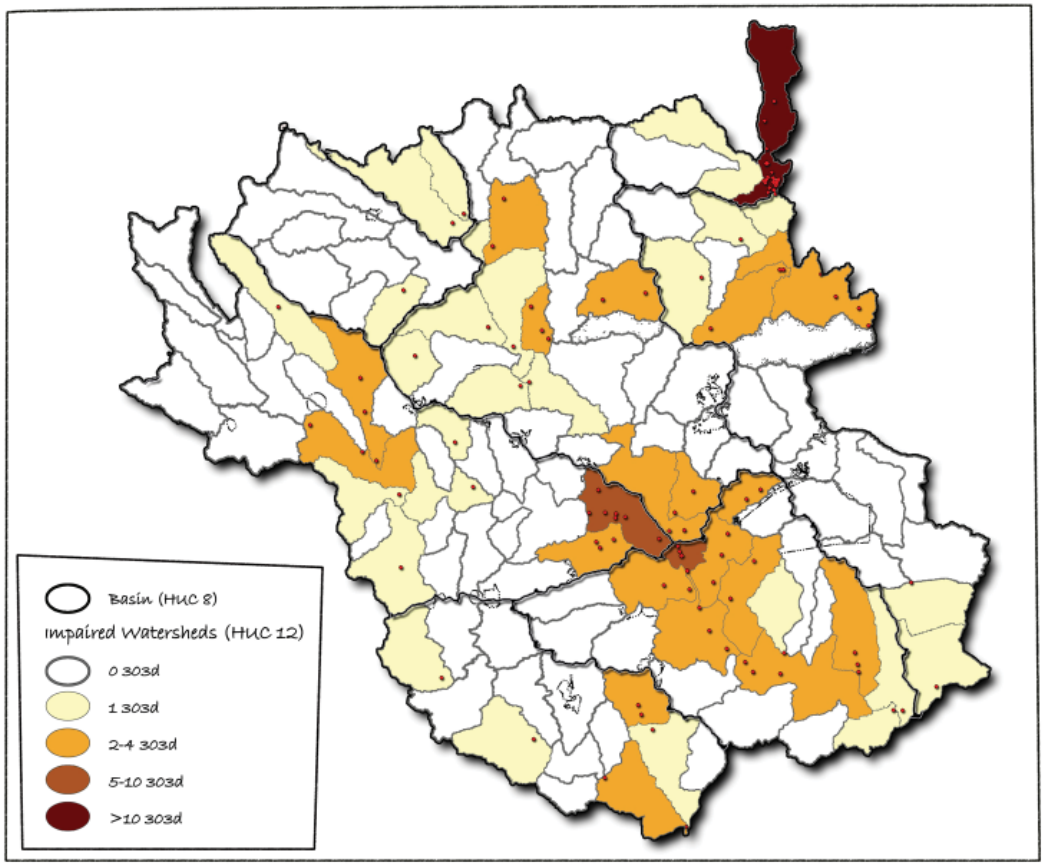
Map 6.3: The Central Midlands Region defined by 10 and 12 Digit HUC Watershed Boundaries.

examine water quality data and better identify the various point and non-point sources of stream and watershed impairment. Such watershed based maps should become an integral component of all regional planning programs and products.

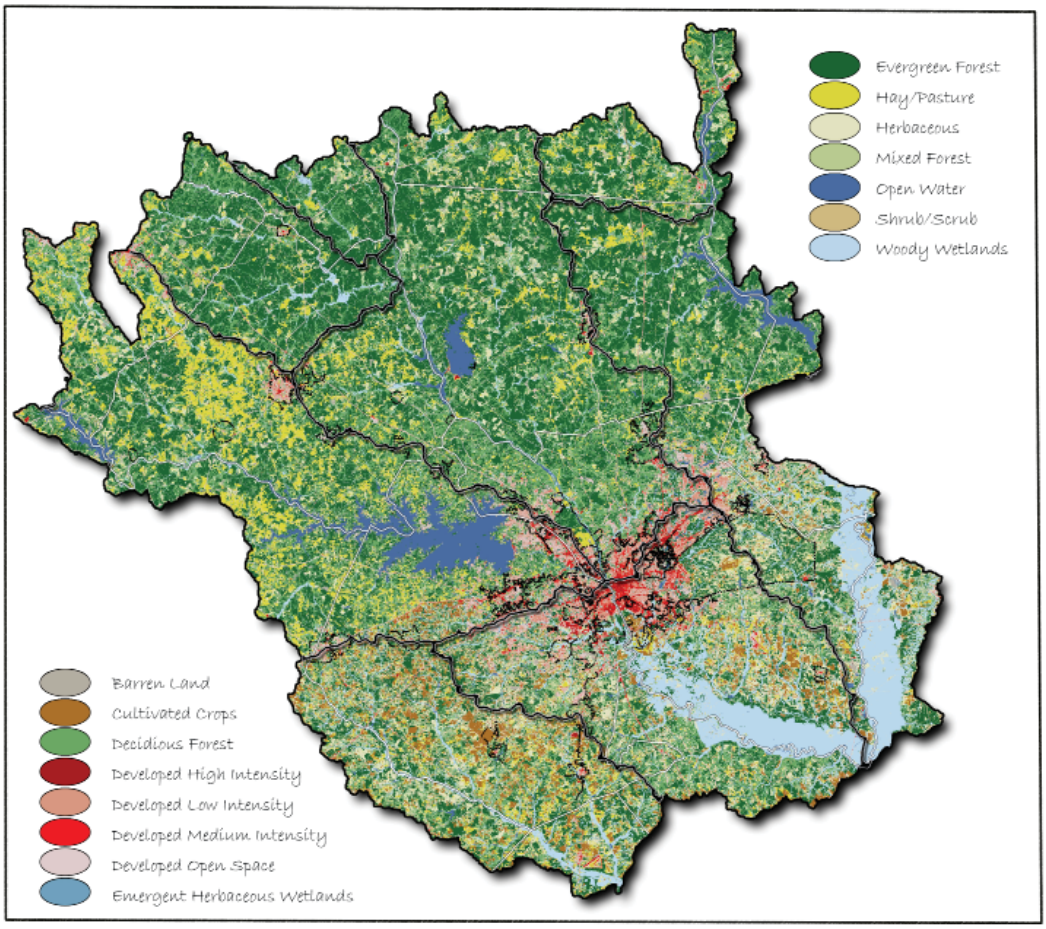
As illustrated in ***Map 6.4***, the quality of the surface water resources in the sub-watersheds that touch the four county region varies greatly depending on the types of land uses that dominate within each watershed. Of the approximately 209 water quality monitoring stations, 49% are impaired and do not support their designated use. The sub-watersheds with the highest concentrations of impaired streams are mostly located in the developed areas surrounding the City of Columbia, thus indicating that non-point source pollution from urban stormwater runoff is a significant source of regional water quality impairment. This point is reinforced by looking at land cover distributions on ***Map 6.5*** which clearly illustrates portions of the region that have a high probability of contributing to non-point source pollution such as urban/suburban and agricultural areas.

CMCOG can begin to take an active role in improving regional water quality by adopting a watershed based approach to environmental planning. Such an approach would entail routinely evaluating the impact of local and regional planning initiatives on the region's water resources at the beginning of the planning process. In many ways it is simply a matter of integrating current and up to date water resource data into existing conditions inventories and using that data to make planning and policy recommendations that help to mitigate water quality issues. Other strategies

Map 6.4: Impaired Streams and Watersheds in the Central Midlands Region



Map 6.5: Land Cover in the Central Midlands Region (2006 National Landcover Data Center)



include working with local government staff to facilitate a framework for fostering regional cooperation and coordination on water quality initiatives such as developing watershed management plans for impaired streams that have TMDLs. The following sections will discuss in more detail how to integrate a watershed based approach to regional planning into the agency's other existing regional planning programs.

Research and GIS

The primary purpose of the CMCOG Research and GIS department is to provide data and mapping support services to the agency's other regional planning programs. One of the primary functions of this department is to track regional growth and development by collecting data such as building permits and conducting original surveys such as the commercial real estate inventory. The department also produces thirty year population projections and maintains a robust GIS database of demographic, land use and environmental data.

The Research and GIS program plays an important role in regional watershed based planning because it is the primary source of data that can be used in developing watershed management plans and in siting potential locations for implementing green infrastructure projects. One area of opportunity for CMCOG is to establish a One-Stop Shop for regional environmental initiatives that may serve as a clearing house for GIS data, resource inventories, regulatory policies, and available conservation incentives. A readily identifiable and accessible source of environmental information for the Central Midlands Region would assist governmental entities and private sector stakeholders in a number of initiatives that might have an impact on regional water quality. Such a clearing house should be placed online and CMCOG staff should actively market it as a resource for member governments and other local stakeholders to use.

Transportation

As the Metropolitan Transportation Planning Organization (MPO) for the Columbia Area, CMCOG plays an active role in regional transportation planning and decisions making. There are a number of opportunities for integrating watershed based planning and green infrastructure principles into the various transportation planning programs CMCOG is involved with.

To begin with, federal transportation legislation, which influences how the CMCOG and SCDOT transportation planning programs function, supports and requires the adoption of various environmental mitigation measures by MPOs and other transportation planning agencies. As one of the eight planning principles mandated by SAFETEA-LU, the federal highway bill, MPOs must:

"Consider projects and strategies that protect and enhance the environment, promote energy conservation, improve the quality of life, and promote consistency between transportation improvements and state and local planned growth and economic development patterns."

SAFETEA-LU legislation further defines the environmental mitigation roles and requirements of MPOs by stating in [Sec.450.322(a)(f)(7)] that the LRTP shall:

- Include a discussion of potential environmental mitigation activities and potential areas to carry out these activities including activities that have the greatest potential to restore and maintain environmental functions affected

There are many opportunities for Green Street retrofits in the Central Midlands Region.

by potential transportation projects
- Focus on policies, programs, or strategies, rather than the project level.
- Develop this discussion in consultation with Federal, State, and Tribal land management, wildlife, and regulatory agencies

A regional watershed and green infrastructure based planning approach would immediately help to satisfy each of these requirements. By using the environmental data clearing house described in the previous section, CMCOG staff will have ready access to water resource data such as impaired streams and watersheds, TMDL locations, wetlands, and riparian buffer ordinances.

The early evaluation of the location of proposed projects in relationship to sensitive environmental and cultural features is also an essential component of transportation planning and provides the framework for later, more detailed pre-construction project specific analysis that is required by the National Environmental Policy Act (NEPA).

In the state of South Carolina, the primary instrument for conducting early environmental screening for transportation projects is the Advanced Project Planning Process (APPR) developed and implemented by SCDOT.

The APPR is an informational document intended to pro-actively identify potential environmental or social issues that could impact the implementation of road improvement projects proposed in the Long Range Transportation Plan (LRTP). The purpose is to address major problems or "showstoppers" early on in the project development process so that appropriate mitigation activities and/or alternatives can be considered before a project enters the pre-construction phase. The APPR process facilitates enhanced coordination between agencies, assists in setting realistic cost and construction estimates, and prepares projects for the NEPA review process. CMCOG should work with SCDOT to include a water quality assessment as a major component of this process. This could be facilitated by first examining all of the projects on the COATS cost constrained list in terms of their potential impacts on impaired streams and watersheds.

In addition to environmental screening,

CMCOG can also be a strong advocate for the Green Streets concept discussed in Chapter 4. There are a number of opportunities for CMCOG to accomplish this goal, all of which will require close coordination with the Federal Highway Administration and the South Carolina Department of Transportation. First, CMCOG should incorporate Green Street concepts into the upcoming update to the Regional Long Range Transportation Plan. The information provided in this document can be used for this purpose. Second, CMCOG should begin discussions with other MPOs across the state and SCDOT on strategies for planning and implementing road projects with green street components.

Finally, CMCOG should work with SCDOT to identify ways Green Street concepts can be incorporated into the statewide Transportation Enhancement Program administered by SCDOT and CMCOG. This program provides matching grants for local governments to conduct street-scaping and beautification projects that often times entail constructing sidewalks and landscaping treatments. This provides an excellent opportunity to encourage local governments to consider integrating bioswales, raingarden and native plants into their landscaping and beautification plans.

Land Use

Since the agency's creation in 1969, CMCOG has provided land use planning and general technical administrative support to its member local governments. Today, CMCOG continues to provide these services in the form of Comprehensive Plans, Zoning Ordinances, Land Development Regulations. Additionally, the CMCOG Land USe Planning Program also periodically conducts regional studies such as the original green infrastructure/ open space plan, and a regional inventory of natural, cultural, and recreational resources.

Because of the work CMCOG staff does with local governments on comprehensive planning and land development regulations, there are a number of opportunities for encouraging the local level adoption of watershed based and green infrastructure planning principles. CMCOG should promote the use of the model comprehensive plan and conservation subdivision language provided in the appendix of this document. CMCOG staff should also encourage member governments to use the conservation/cluster subdivision tool as a mechanism for encouraging the implementation of projects identified in regional and local open space preservation plans. Finally, CMCOG staff should make extensive use of the water quality related data resources discussed above and make this information readily available to member governments.

Because of its relationship to land use planning, the CMCOG regional land use planning program should also take an active role in advancing concepts related to regional food system planning. CMCOG should pursue funding opportunities for developing a regional food system plan and establishing a governing food system policy council.

Community and Economic Development

The CMCOG community and economic development program provides assistance to local governments in obtaining grants and loans for their communities from a wide variety of sources. The primary source of funds utilized in this program is the Community Development Block Grant (CDBG) provided by the SC Department

of Commerce and the US Department of Housing and Urban Development. This program provides funding for community facility and infrastructure projects such as building rehabilitations, streetscape enhancements, and stormwater infrastructure. CDBG funding can also be used for other community projects that support workforce development and increase economic competitiveness.

Like the Transportation Enhancement program discussed earlier, there are many opportunities for incorporating watershed based and green infrastructure planning concepts into grant proposals. CMCOG staff should work with the SC Department of Commerce and the Richland and Lexington County Entitlement Programs to explore different types of green infrastructure projects that can meet program eligibility requirements, such as using bioswales and rain gardens to mitigate flooding issues. These programs could also examine opportunities for funding economic development projects based on the green economy.

In addition to CDBG funding, the CMCOG community and economic development program also administers Economic Development Administration (EDA) funds and is responsible for developing and updating the Comprehensive Economic Development Strategy (CEDS) for the Central Midlands Region. CMCOG staff should use this regional planning process to explore opportunities for increasing economic development opportunities in the Green Economy, engaging in regional food system planning efforts, and promoting sustainable solutions to regional solid waste issues (e.g., landfill siting, waste reduction, recycling and energy recovery).

Workforce Development

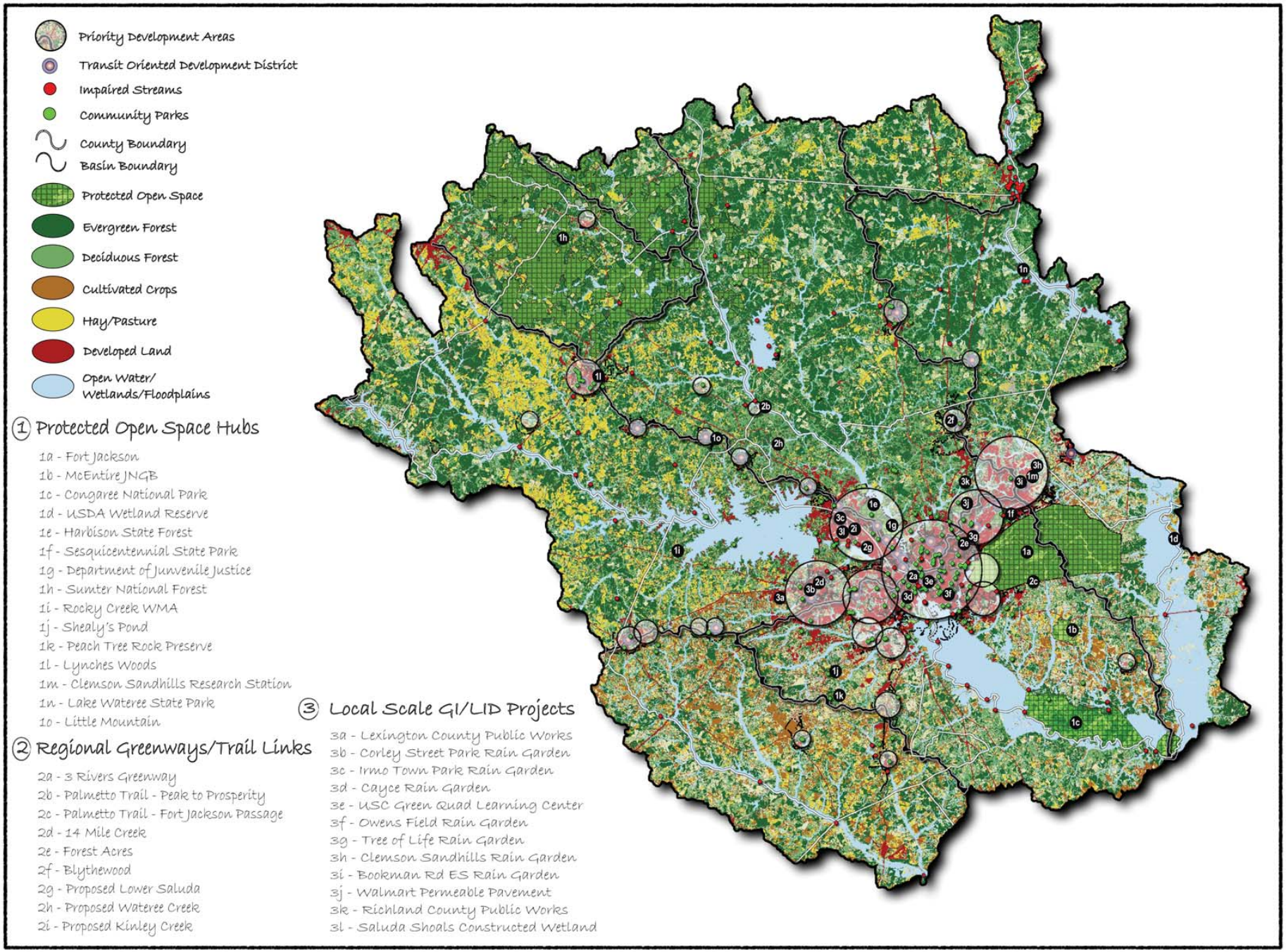
The Midlands Workforce Investment Area (WIA) which is a core CMCOG program, operates the One Stop system for employment and job training services. The primary functions of Midlands WIA are as follows:

- Develop and maintain a quality workforce.
- Serve as a focal point for workforce development initiatives.
- Foster coordination and collaboration between economic development and employment training programs.

This program could be a valuable resource in promoting workforce development opportunities in the green economy. CMCOG staff should work with the workforce staff to build partnerships with area colleges and universities and area businesses to promote green jobs and green job training. CMCOG staff should also routinely attend local green conferences such as the Columbia and Lexington County Green is Good For Business and promote WIA workforce development services to area business.

Regional Green Infrastructure Concept

In addition to identifying action strategies CMCOG can implement to work towards supporting a regional watershed and green infrastructure approach to planning, it is also useful to develop a concept plan map to provide a basis for regional planning, development, and intergovernmental coordination. ***Map 6.6*** provides such a concept by identifying: protected and public lands; local level green infrastructure projects that have been implemented or are in the planning stages; and areas where green infrastructure projects are appropriate for



Map 6.6: Regional Green Infrastructure Concept

future implementation. The land cover provides a basis for this as existing agricultural areas should be targeted for sustainable agricultural preservation initiatives and existing urban areas should be targeted as priority growth centers where bioswales, rain gardens, rainwater harvesting, and green streets, parks and plaza initiatives are appropriate. Greenways provide the links to the green infrastructure hubs and sites and are appropriate for areas in existing floodplains and protected riparian corridors.

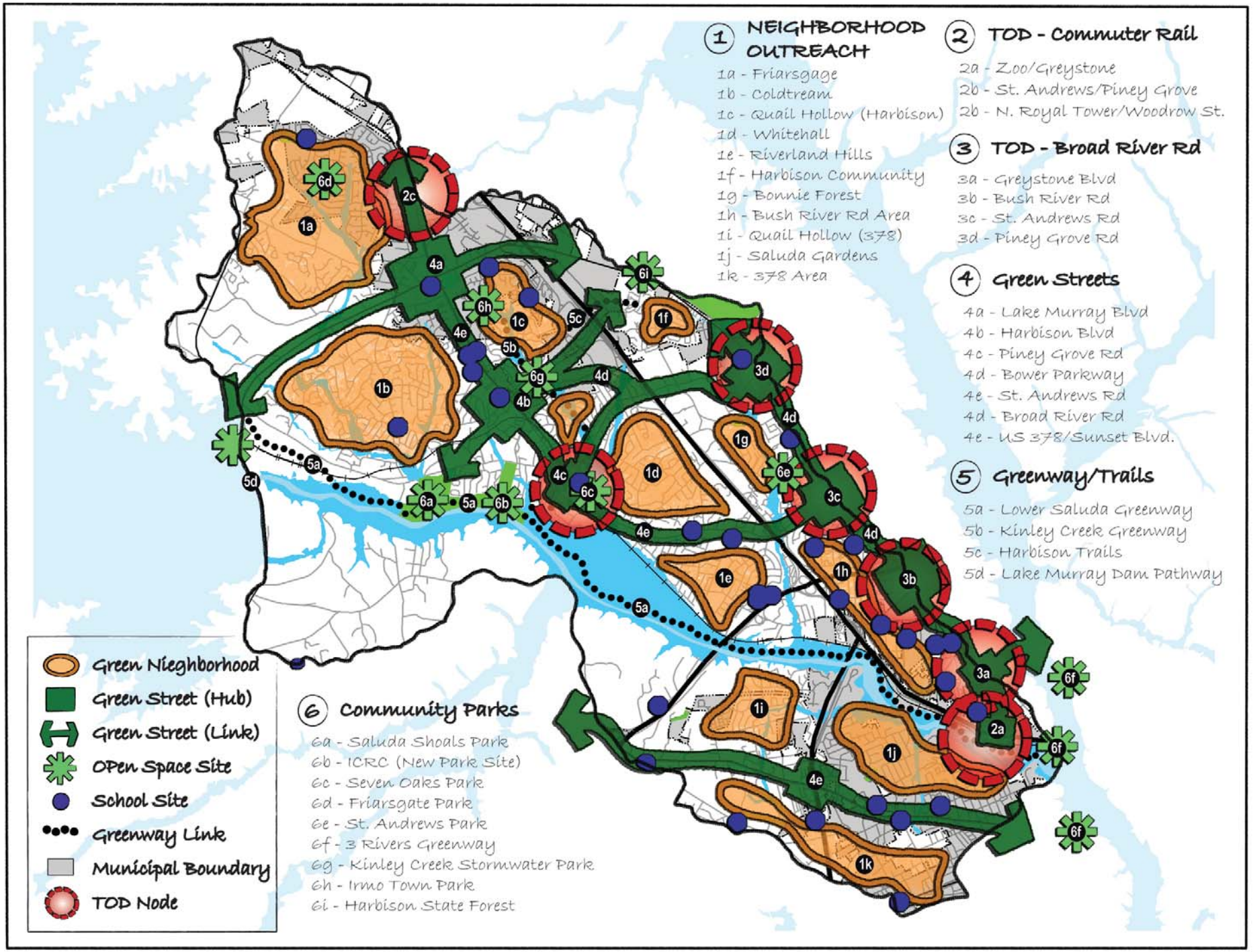
Concept Plan for an Impaired Watershed

It is also instructive to demonstrate a conceptual planning process for implementing green infrastructure planning principles in an impaired watershed. ***The*** Lower Saluda is one such watershed which has been the focus of many plans through the years and currently contains several sub-watersheds that are impaired and have existing TMDLs developed for them, inlcuding Rawls Creek and Kinley Creek, which both drain large suburban residential and commercial developments.

Map 6.7 illustrates a green infrastructure concept that identifies appropriate locations for green street, greenway, and green park projects. In addition to these sites, it also identifies major neighborhood areas and school locations where site specific practices such as rain gardens and rainwater harvesting could have a positive impact on local water quality.

Map 6.8 illustrates a green infrastructure concept for a new park within the Lower Saluda, Kinley Creek Watershed. Irmo Chapin Recreation Commission is currently working on a strategic plan for the development of this site. The concept plan presented here does not reflect their intentions for development, which will largely be dictated by available resources and public input, but does provide some useful ideas on how green infrastructure concepts can be worked into the master planning process.

The Kinley Creek Watershed, a tributary of the Lower Saluda River, drains all of Harbison Boulevard which contains a high concentration of impervious surfaces.



Map 6.7: Lower Saluda Watershed Green Infrastructure Concept Plan

Map 6.8: Green Infrastructure Concept Plan for A New Community Park

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Key Terms

Best Management Practice (BMP) - A term used to define standardized professional practices for best achieving a particular result. In the case of Green Infrastructure for stormwater management it refers to the use of different methods to control the discharge of pollutants and to minimize runoff to the greatest extent possible.

Bioretention - The practice of using vegetated basins to provide water quality management through the biological filtering of pollutants before they are released into the storm drain system.

Cistern - Containers that store large quantities of stormwater above or below ground. Stored water can then be reused for other purposes such as irrigating landscaped areas. Cisterns are appropriate for use in residential, commercial and industrial settings.

Clustering - A land use planning term to describe the development practice the clustering of buildings and infrastructure in one area of a site in order to conserve open space and sensitive natural features in other areas.

Drainage Basin - A large land area that contributes water, sediment, and dissolved substances to a stream, lake or estuary of significant size forming a natural boundary for that particular water resource. A drainage basin is made up of numerous watersheds and sub-watersheds.

Drainage Divide - The physical ridge line separating neighboring drainage basins, watersheds or catchment areas. The drainage divide may be in the form of a single range of hills, mountains, or modestly sloping land so that rain falling on one side of the divide will flow into a different water body than rain falling on the other side.

Detention - A stormwater management term used to describe the practice of temporarily detaining stormwater runoff on site before it is released in order to decrease runoff volume and velocity.

Disturbed Area - An area in which natural vegetation has been removed or altered for development purposes and is therefore vulnerable to soil erosion.

Ecoregion - A term used to describe the physiography of a large geographic area that contains similar landforms, ecosystems, and other associated environmental resources.

Erosion - The wearing away of soil surfaces by running water, wind, ice or other geological agent.

Evaporation - The change of liquid water to water vapor. Evaporation is a fundamental component of the hydrologic cycle.

Evapotranspiration - The combined process of evaporation and transpiration.

Filter Strip - A grassed area that accepts runoff from adjacent surfaces to slow water velocities and filter out sediment and other pollutants.

Flood Plain - A relatively level surface of land adjacent to a river that is submerged during times of flooding. Most types of intensive land uses are heavily regulated in floodplains by federal, state and local governments to mitigate repetitive flood damage.

Green Infrastructure - Green Infrastructure is an interconnected network of open space and engineered systems that use natural processes to better protect and maintain our land, water, and human resources.

Green Roof - A conventional rooftop that contains a vegetated surface. Green roofs come in many sizes and shapes and have many benefits including increased infiltration of rainwater and increased energy efficiency.

Green Wall - A conventional building wall or retaining wall that contains a vegetated surface. Green walls come in many sizes and shapes and have many benefits including increased infiltration of rainwater and increased energy efficiency.

Green Street - A street or network of streets that are designed to treat stormwater runoff on site with the use of green infrastructure such as bioswales or rain gardens rather than directing it to a conventional storm drain system.

Headwater Stream - The source of a river or stream. Headwater streams are typically small, permanent or intermittent waterways.

Hydrologic Cycle - A process that describes the movement of rainfall from the atmosphere to the land, to receiving waters and then back to the atmosphere.

Impairment - A term used to describe poor water quality in a hydrologic feature such as a stream, river or wetland. Impairment is a term specifically used in the U.S. Clean Water Act to classify surface waterbodies with poor water quality.

Impervious Surface - A hard surface that prevents the infiltration of water into the ground. Paved parking lots and roads are the most common type of impervious surface.

Infiltration - The percolation of water into the ground allowing for groundwater flow and the recharge of aquifers.

Infiltration Practices - Green Infrastructure techniques that promote better infiltration of rainwater on site as opposed to sending into an engineered drainage system.

Intermittent Stream - A stream that only flows for part of the year or during large precipitation events.

LEED - Leadership in Energy Efficiency and Environmental Design. LEED is a measuring system created by the US Green Building Council to rate buildings and neighborhoods that are designed using principles of sustainability and Low Impact Development.

Low Impact Development (LID) - A planning, design and development framework that uses existing on site natural features and engineered facilities to minimize development impacts and mimic predevelopment hydrologic conditions.

Metropolitan Planning Organization (MPO) - A federally-mandated and federally-funded transportation policy and decision-making body that is made up of representatives from local governments. Federal funding for transportation projects and programs are channeled through this planning body to ensure that existing and future expenditures of governmental funds for transportation projects and programs are based on a continuing, cooperative, and comprehensive ("3-C") planning process.

MS4 - MS4 stands for Municipal Separate Storm sewer System and generally refers to a storm sewer system that is owned by a state, city, town, village, or other public entity that discharges to waters of the U.S. Such systems are not a combined sewer; and not part of a Publicly Owned Treatment Works (sewage treatment plant).

Mitigation - Minimizing the severity or impacts of a particular event or process. Green infrastructure and Low Impact Development techniques mitigate the negative water quality impacts of stormwater runoff.

Native Vegetation - Plant species that naturally occur in a particular geographic area. These species are extremely well adapted to local environmental conditions and therefore are more tolerant of climate and soil extremes, such as drought.

Non-point Source Pollution (NPS) - Pollution that does not come from an identifiable point source, such as a wastewater treatment plant. Examples include stormwater runoff from parking lots, streets and residential lawns.

Perennial Stream - A permanent stream which flows continuously all year long.

Pervious Surface - A surface that allows water to infiltrate the surface layer and enter a sub-base layer where it is stored until it either infiltrates into the underlying soil or is routed into an overflow drainage system.

Pervious Pavement - Paving materials that are engineered to allow liquid to pass through them to promote infiltration of rainwater into the underlying soil or drainage system.

Point Source Pollution - Pollution that comes from an identifiable source such as a wastewater treatment plant.

Pollutant - A waste material that is the cause of pollution or impairment in a waterway.

Rain Barrel - A barrel designed to retain small volumes of stormwater runoff to reuse for various purposes such as irrigating gardens or landscaped areas.

Rain Garden - A small depression planted with native vegetation where stormwater runoff collects and infiltrates into the underlying soil.

Rainwater Harvesting - The process of using a receptacle such as a rain barrel or cistern to capture rainwater to reuse for various purposes such as irrigating gardens or landscaped areas.

Riparian Buffer - An area defined by state or local regulation that prohibits or restricts land use activities within a specified distance from a stream, lake or wetland to protect local water quality.

Retention - The permanent storage of stormwater in an on-site facility to prevent it from entering an off-site drainage system.

Sanitary Sewer Overflow (SSO) - The accidental discharge of untreated or partially treated sanitary sewage from a sanitary sewer system that has been overloaded by stormwater or is the result of some other cause such as inadequate maintenance, design flaws or vandalism.

Smart Growth - A planning, development and design framework that strives to preserve open space and critical environmental features by promoting sound growth principles such a higher density, transit oriented development and redevelopment.

Stormwater Runoff - Rainwater that runs off the land and is released into streams, rivers and lakes carrying with it all the sediment and pollutants it picks up along the way.

Swale - A depressed area or channel used to slowly convey stormwater runoff allowing it to infiltrate into the soil on its way to a local water body. Bioswales are more intensively vegetated than conventional grass swale systems.

Treatment Train - A series of BMPs used to better achieve water quality improvements by allowing stormwater to run through a sequence of different treatment and infiltration practices.

Vegetated Filter Strip - Uniformly graded vegetated surface located between pollutant source areas and downstream receiving waters. Vegetated filter strips help to improve water quality by slowing stormwater runoff and allowing it to filter through plants and infiltrate into the soil before entering a conventional storm drainage system.

Vegetated Swale - A depressed area or channel that is planted with vegetation to slowly convey stormwater runoff allowing it to filter through plants and infiltrate into the soil on its way to a local water body. Vegetated swales (also known as bioswales) are more intensively vegetated than conventional grass swale systems.

Watershed - The entire land area that contributes water, sediment, and dissolved substances to a stream, lake or estuary, forming a natural boundary for that particular water resource.

Watershed Plan - A plan that identifies and implements action strategies needed to resolve water quality concerns. The plan assesses the current nature and status of the watershed, establishes short and long term goals for improving water quality, and identifies specific action strategies that will work towards reaching these established goals.

Wetland - An area that is saturated by surface or groundwater for a long enough period of time during the year to allow for the growth and development of vegetation adapted to these conditions. The term wetlands are often used to describe environmental conditions associated with swamps, bogs, fens, and marshes.

Wetland Treatment System (Constructed Wetland) - A constructed or engineered system of shallow, vegetated ponds used to treat stormwater or wastewater. This type of system relies on natural physical, biological and chemical processes as the primary treatment mechanism.

Appendix A:
Model Comprehensive Plan Language

The model language provided in this appendix is intended to serve as a general reference or guide for developing goals, objectives and strategies for selected elements of the comprehensive plan. The language included here only covers those goals, objectives, and strategies that specifically relate to the GI and LID concepts and BMPs discussed in Chapters 3 and 4 of this document. This information should be used at the jurisdiction's own discretion and should be adapted as necessary to meet local priorities, environmental conditions and regulatory requirements. It is anticipated that the use of this information will be coordinated with the jurisdiction's planning commission and legal counsel where appropriate.

Natural Resources Element

Goals:

To provide for the enhancement, projection, and long term maintenance of all water resources impacting the [jurisdiction] to include intermittent and perennial streams, wetlands, lakes, groundwater recharge areas, and riparian zones.

To provide for the enhancement, protection, and long term maintenance of critical habitats and ecosystems necessary to support healthy populations of native species.

To encourage the sustainable use of working lands that depend on the area's natural resource base such as agricultural and silvicultural activities.

Objectives:

- Encourage the use of watershed based planning principles that protect riparian areas and contribute to the overall health of watersheds the [jurisdiction] resides in.
- Encourage the use of green infrastructure and low impact development techniques such as conservation design regulations and bioinfiltration practices to help protect sensitive environmental resources and improve area water quality.
- Establish a network of open space and greenways that connect with parks, protected riparian areas, and commercial activity centers within the [jurisdiction].
- Examine regulatory standards necessary to support and grow sustainable agriculture operations within the [jurisdiction].

Strategies:

- Work with SC DHEC to create an in-house database of key water resource related data and information to assist in making development decisions that could potentially impact area waterways.
- Participate in the TMDL development process for impaired streams and watersheds.
- Sponsor a community watershed organization and/or the development of a watershed management plan for impaired watersheds.
- Adopt a local riparian buffer ordinance and wetland protection standards.

- Explore options for creating a wetlands mitigation banking instrument to offset the loss wetlands to area development.
- Work with municipal planning staff, the planning commission, and the general public to identify priority conservation areas for inclusion on the zoning and future land use maps and to direct decisions related to implementing conservation design and development regulations.
- Develop and adopt a comprehensive greenways and open space plan that includes the identification of priority conservation areas and passive recreational facilities such as greenways and trails.
- Work with state and federal agencies, private land trusts, and watershed associations to create a plan for purchasing critical and threatened land parcels identified in the open space plan.
- Adopt a woodland preservation ordinance to minimize the loss of tree cover in areas that cannot be regulated through other means.
- Promote the adoption of green infrastructure and low impact development best management practices for agriculture and silviculture on all working lands within the [jurisdiction].
- Coordinate with state governments on the status of right-to-farm laws and the establishment of agricultural use districts and use-value property tax assessments.
- Promote and support small family farming operations within the jurisdiction.
- Update the zoning ordinance to allow urban farming activities in appropriate residential and commercial districts.

Community Facilities Element

Goal:

Provide the highest quality of services, meet and maintain high quality of life standards, ensure fiscal responsibility, and encourage sustainable growth and development practices.

Objectives:

- Encourage a high level of communication and cooperation between all levels of municipal government, service providers, neighboring jurisdictions, state and regional entities, and the general public.
- Encourage the adoption and implementation of green infrastructure best management practices for all public facilities and programs.
- Develop opportunities for expanding passive park and recreation opportunities in accordance with priority conservation and open space areas.

Strategies:

- Develop and adopt a public participation plan to encourage citizen input and participation in all green infrastructure community facilities projects.
- Develop a public and private stakeholder database and stakeholder notification protocol for use in soliciting input, coordination, and cooperation on all green infrastructure public facilities projects.
- Coordinate with the area school districts and adjacent governmental entities on devel-

oping and adopting green infrastructure standards for community facility projects.
- Develop strategies for encouraging the use of green infrastructure practices for all future private developments occurring within the [jurisdiction].
- Draft or update a community wide stormwater management ordinance to ensure the use of green infrastructure techniques for storm-water management in all new public and private developments.
- Develop a design and specification manual for implementing green infrastructure techniques that are appropriate for meeting local environmental conditions.
- Identify appropriate areas for implementing green infrastructure retrofits for town owned properties and County maintained roads.
- Conduct an energy audit of municipal buildings and consider implementing a capital improvement program for procuring an energy efficient fleet of municipal vehicles.

Land Use Element

Goal:

Ensure that land use patterns and decisions support and encourage the development of a sustainable community that places a priority on protecting open space and improving local water quality.

Objectives:

- Provide a land use framework for creating residential and commercial developments that utilize conservation design principles and green infrastructure and low impact development best management practices.

Strategies:

- Develop and adopt an open-space/greenway plan that will designate specific areas for protection and set priorities for implementation.
- Update zoning and future land use maps to reflect open space and conservation priorities established in the open-space/greenway plan.
- Update zoning ordinance to establish conservation zoning districts that are consistent with the priorities established in the open space/greenway plan.
- Review and revise zoning ordinance and stormwater regulations to encourage the use of green infrastructure and low impact development best management practices.
- Develop market based incentives within development codes to encourage the use of conservation design principles, green infrastructure and low impact development best management practices, and LEED certified buildings.

Transportation Element

Goal:

To provide a safe and efficient multi-modal transportation system that provides adequate bike, pedestrian, and transit facilities and is in harmony with its natural surroundings.

Objectives:

- Integrate complete street and green street concepts into the local road network to create safe and sustainable transportation facilities that are pedestrian, bike and transit friendly.
- Make complete streets/green streets practices a routine part of [jurisdictions] everyday operations.

Strategies:

- In planning, designing and construction of all new street projects and existing street improvements:
  - Include infrastructure that promotes a safe means of travel for all users including bikers, pedestrians and transit riders.
  - Include green infrastructure best management practices where appropriate along the right-of-way to include bioswales, pervious pavement, and conservation landscaping.
- Develop policies and programs to improve the [jurisdictions] complete streets/green streets practices:
  - Work with the public works department to create a green streets manual that provides design considerations and construction specifications for green infrastructure best management practices appropriate for road projects.
  - Review and revise zoning ordinance and land development regulations to encourage and require (where appropriate) the use of green infrastructure practices in transportation projects associated with new residential and commercial developments.
  - Develop a checklist for the review of site plans for new developments to ensure the inclusion of green infrastructure in new transportation projects.
- Work with the Council of Governments or Metropolitan Planning Organization to change transportation investment criteria to ensure existing transportation funds are available for complete streets/green streets projects.
- Formalize the development of a right-of-way preservation program to ensure that future road improvement projects have enough rights of way to include complete streets facilities and green infrastructure best management practices.
- Make training available to planning and public works personnel and consulting firms on the importance of adopting complete streets/green streets practices.
- Encourage coordination among agencies and departments to develop joint prioritization, capital planning and programming and implementation of complete street/green street improvement projects and programs.
- Encourage outreach and public participation concerning decisions related to complete streets/green streets projects.

Economic Development Element

Goals:

Create opportunities for economic growth by growing existing green businesses and providing incentives for the recruitment of new green industries.

Objectives:

- Identifying specific gaps and niches in the local and regional green economy to assist in building a diversified range of specialized green industry clusters that draw on local advantages.
- Explore opportunities for attracting new green industries to the [jurisdiction].
- Continue to work towards identifying and improving quality of life issues relevant to the recruitment of green industries to the town (e.g., green building standards, conservation subdivision designs, open space and recreational opportunities).

Strategies:

- Create an economic development plan to identify strengths, weaknesses, opportunities, and threats within the local green economy. This plan could include the following:
    - A detailed market analysis of the area to identify green commercial and industrial opportunities as well as green industry leakages.
    - A pier town review of green economic development activities in neighboring communities (in-state and out-of- state) with similar socio-economic and growth and development characteristics.
    - A commercial building stock survey to assess status of condition and building tenure and ownership and opportunities for green retrofits.
    - A strategic action plan for developing a green industry cluster in the [jurisdiction].
- Consider the creation of a local Community Development Corporation (CDC) to help implement the goals and strategies identified in the Green Economic Development Plan.
- Work with the Chamber of Commerce and School District to identify areas of emphasis that will improve town's attractiveness to potential green businesses and residents.

Appendix B: Model Conservation Subdivision and Incentive Zoning Provisions

The model language provided in this appendix is intended to serve as a general reference or guide for developing a conservation subdivision provision to be included in a jurisdiction's land development regulations. This information should be used at the jurisdiction's own discretion and should be adapted as necessary to meet local priorities, environmental conditions, and regulatory requirements. It is anticipated that the use of this information will be coordinated with the jurisdictions planning commission and legal counsel where appropriate.

The South Carolina Comprehensive Planning and Enabling Act of 1994 authorizes the jurisdiction to implement land development regulations, including subdivision regulations to provide for the harmonious, orderly and progressive development of land as required by considerations of public health, safety, economy, good order, appearance, convenience and general welfare. As such these regulations may include a number of requirements and standards that could potentially be met with conservation design guidelines.

As noted in the Conservation Design section of Chapter 3 of this document, such regulations should relate to the conservation goals and objectives set forth in the comprehensive plan and may relate to specific areas designated for conservation and open space preservation in the zoning ordinance and official map.

Incentive zoning provisions are included within the conservation design provisions as a means for encouraging developers to go above and beyond those requirements set forth in the ordinances. These same incentives can also be applied to more conventional types of land development activities and to other zoning districts for the purpose of encouraging the more widespread adoption of green infrastructure best management practices throughout the entire jurisdiction.

Section 1: Purpose

It is the intent of this article to allow development that will meet future growth needs while preserving and protecting agriculturally, environmentally and historically significant features of [jurisdiction] and surrounding areas. In order to achieve this goal in accordance with the South Carolina Comprehensive Planning and Enabling Legislation of 1994, the purpose of this article shall be to:

- Support the environmental, agricultural, and historical preservation goals outlined in the [jurisdiction] comprehensive plan;
- To preserve and protect important natural resources such as groundwater, streams, lakes, wetlands, woodlands, and floodplains for the purpose of providing natural flood control, stormwater runoff management, watershed protection, and wildlife habitat;
- Preserve the unique agricultural character and working landscapes of the Town and County;

- Preserve the scenic and natural beauty of the Town and County;
- Promote sustainable residential development that provides flexibility in design in order to protect and preserve areas of agricultural and historic significance;
- To permit clustering of residential dwelling units and structures in a compact development pattern which will reduce the overall amount of needed infrastructure, such as impervious surfaces and extensive utility networks, as well as promote social interaction;
- To permit the mixing of residential and commercial uses in order to encourage a reduction in auto dependency;
- To reduce non-point source pollution and improve water quality in nearby water bodies by reducing land disturbance and encouraging the use of green infrastructure for managing stormwater runoff (e.g., bioinfiltration swales, pervious pavement, and rainwater harvesting where appropriate);
- To create an interconnected network of open space within the [jurisdiction] and in surrounding areas for the purpose of promoting interconnected communities and wildlife habitat corridors;
- To encourage complete street and green street designs to reduce auto dependency with the provision of alternative transportation options and to reduce stormwater runoff with the provision of green infrastructure best management practices where appropriate;
- To promote the use of native vegetation to meet landscaping requirements for the purpose of reducing tap water demand;
- To protect scenic views that can be enjoyed by all rather than individual property owners.

Section 2: Definition of Terms

For the purpose of this article, certain terms and words are hereby defined.

Agriculturally Significant: Generally, any land deemed to be agriculturally significant by the United States Department of Agriculture or the South Carolina Department of Agriculture for the purpose of this article.

Clustering: A subdivision design method that concentrates development in specific areas on the proposed site. The purpose of clustering is to allow increased density on a portion of the site, while preserving the rest as permanent open space. The density of the entire site will not exceed the required density, the houses will just be grouped together in one or more specified areas, unless a density bonus is granted by the Planning Commission, which will allow increased building density on the site. The concept of clustering provides for flexibility in subdivision design that fits the natural characteristics of the land and permits more useable open space and the preservation of prime agricultural land and land containing one or more environmentally sensitive areas.

Conservation Subdivision Design: A residential development where fifty percent or more of the developable land area is designated as undivided, permanent open space; thereby permanently protecting agriculturally, environmentally or historically significant

areas. The remaining developable land is subdivided into buildable lots.
Developer/Applicant: One proposing to undertake the action.

Environmentally Significant: Any tract of land that contains one or more of the following sensitive areas as defined by the S.C. Department of Natural Resources: critical wildlife habitats, erodible land, flood hazard areas, natural prairies, stream corridors, wetlands or woodlands, or that contains a scenic natural area.

Historically Significant: Any tract of land that contains an archaeological or historical resource as defined by the Comprehensive Plan and any related historic preservation ordinances of the [jurisdiction].

Hydric Soils: Soils susceptible to saturation by water, as defined by the USDA Natural Resources Conservation Service.

Scenic Natural Areas: Any tract of land which contains a unique feature of the rural landscape including, but not limited to, large rock formations, hill crests, mature tree stands, and/or any other feature deemed to be significant to the [jurisdiction].

Sensitive Areas: Areas containing one or more of the following unique or locally significant resources: archaeological resources, critical wildlife habitats, erodible land, flood hazard areas, natural prairies, stream corridors, wetlands, or woodlands.

Site Map: A document identifying: location of the parcel, legal description of the parcel, proposed area of development, potential sensitive areas, septic provisions, and topography of the parcel.

Section 3: General Regulations

Applicability

The conservation subdivision option is permitted for use by right in the following zoning districts [list of applicable zoning districts or overlay districts]. Applicant shall comply with all other provisions of the zoning code with the exception of those that are incompatible with the provisions contained herein.

The conservation subdivision option is required for use by right in the [applicable conservation zoning district]. Applicant shall
The use of conservation subdivision design may also be required of all residential subdivisions where initial site inventories reveal potential impacts on sensitive historical and environmental resources or where fifty percent (50%) or more of the parcel is identified as agriculturally, environmentally or historically significant.

Density Determination

Density of conservation subdivisions shall be determined by dividing the total land area of the development by the total number of family dwelling units, which provides an average

land area per family dwelling unit. Total land area of the development shall include all open space, including agricultural land; common ground, recreation areas, and land set aside for ponds and lakes, but shall not include the traffic surface area of subdivision roads. The allowable density is determined by the parcel's underlying zoning requirements unless a density bonus is awarded to the developer by the [jurisdictions] Planning Commission.

Application Requirements

The application process for the conservation subdivision follows the same procedures as required in the general land development regulations for the [jurisdiction]. In addition to meeting these basic requirements the applicant is also required to submit the following documents during the plat approval process:

- A site analysis map identifying existing natural resource assets to be protected as well as other development constraints and sensitive environmental features such as riparian buffers, streams, wetlands, flood zones, hill slopes, soil types, and general vegetation characteristics;
- A site concept plan that identifies the planned locations of developed areas, protected open space, existing and planned infrastructure, and potential connections with existing greenspace and trails;
- An open space management plan that includes the following: a site plan showing all protected areas; an instrument of permanent protection including identification of permanent ownership; an allocation of responsibilities for the long term maintenance and operation of the open space/conservation areas; cost estimates for meeting long term maintenance and operation responsibilities; and provisions for ensuring the implementation of the plan.

Section 4: Open Space Requirements

Definition

Open space or conservation area is defined as the portion of land that is to be set aside for permanent protection. Activities within this area are restricted in perpetuity through the use of an approved Instrument for Permanent Protection and Open Space Management Plan.

Minimum Open Space Area

A minimum of fifty percent (50%) of the parcel must be designated as permanent open space. Above ground utility right-of-ways and small areas of impervious surfaces may be included within the protected open space but cannot be counted towards the 50% minimum area requirement.

The portion of the parcel designated as permanent open space shall not be further subdivided and must be protected by a conservation easement held by the homeowners association, local conservation commission, land trust, or [jurisdiction] that is recorded in the office of the County Registrar of Deeds. The protected features meeting the open space requirement shall include the following:

- 100 year floodplain;
- Riparian areas and adjacent buffer zones including perennial and intermittent streams, sensitive wetland not under the jurisdiction of the US Army Corps of Engineers, and other bodies of water;
- Habitats of rare, threatened and endangered species as listed by the SC Department of Natural Resources;
- Archeological or other historic and cultural resources identified by the State Historic Preservation Office or the [jurisdiction] as being worthy of protection;
- Undisturbed contiguous tracts of forests and existing individual specimen trees;
- Areas of scenic viewsheds;
- Agricultural lands and soils of statewide importance (as indicated by the USDA or the SC Department of Agriculture).
- Areas that connect to existing trails, protected open spaces, or sensitive environmental features.

Permitted Uses of Open Spaces

Permitted uses of the protected open space include the following:

- Conservation of natural, archeological or historic resource;
- Passive recreation trails and greenways;
- Active recreation areas provided they do not comprise more than ten percent (10%) of the entire open space area. Active recreation areas in excess of this limit must be located outside of the protected open space.
- Agriculture or silvicultural uses provided that non-point source pollution BMPs are used to mitigate negative environmental consequences;
- Green Infrastructure BMPs for stormwater management practices including bioretention areas and protected riparian zones;
- Other conservation uses compatible with the purposes of this ordinance.

Prohibited Uses of Open Spaces

The following uses are prohibited in protected open space areas:

- Golf courses;
- Impervious surface areas such as roads and parking lots;
- Agricultural and silvicultural uses that do not utilize non-point source pollution BMPs to mitigate against negative environmental impacts;
- Other uses that are incompatible with the purposes of this ordinance as deemed by the planning commission.

Section 5: Incentives

The following incentives can be applied for and pursued by the developer in exchange for development credits that allow for increased densities beyond requirements set forth in the underlying zoning ordinance:

- River and wetland protection buffers that go beyond existing riparian buffer requirements providing additional water quality protection and opportunities for public passive recreational use. Where greenway trails are to be developed for this purpose within the protected riparian zone, they should be developed on the highest land avail-

able, should minimize impact on existing vegetation, and should be constructed from pervious paving materials to mitigate against stormwater runoff. A density bonus for additional riparian protection includes (x) additional dwelling units per 0.5 five acre of provided buffer area;

- Additional provision of open space beyond the 50% gross land area requirement can be used to receive a density bonus of (x) additional dwelling units for every 1 acre of additional open space;
- Green Infrastructure (GI) and Low Impact Development (LID) Best Management Practices (BMPs) for stormwater management can be incorporated into the development to improve local water quality and optimize the infiltration of rainwater into the soil. Such practices include bioinfiltration areas, use of pervious pavement, use rainwater harvesting practices, and development of green streets, roofs, walls, parks and plazas where appropriate. A density bonus includes (x) additional dwelling units per 1 acre of impervious surface area treated with GI and LID BMPs. In lieu of the density bonus the developer may alternatively apply for a reduction of (x) dollar on applicable utility fees (e.g., water, sewer, stormwater), for each 1 acre of impervious surface area treated with GI and LID BMPs.
- Connecting Trails and Open Spaces between the proposed development and adjacent existing trails and open spaces are also encouraged for the purpose of developing a larger interconnected network of such areas that go beyond the individual site scale. When such connections are made, the developer may apply for a reduction in side yard setbacks to (x) feet to allow for smaller lot developments.
- Conservation Landscaping with either native or drought tolerant plants that are suitable for local conditions are encouraged to reduce demand for tap water used in irrigating landscaped areas. All existing landscaping and tree preservation requirements for the underling zoning district apply. Density bonuses of (x) additional dwelling units per 0.5 acres of conversation landscaped areas will be granted.
- Green Building Practices are encouraged for all structures built within the conversation subdivision. Meeting building standards set by organizations such as the US Green Building Council (USGBC) should be used wherever possible. Incentives for incorporating these principles into building and site design include an (x) foot increase in maximum height restrictions not to exceed (x) feet for proven implementation of USGBC or other applicable standards for all dwelling units and commercial buildings within the development. To be eligible for this credit, the applicant must demonstrate certification for meeting the defined standards by the appropriate organization.

Section 6: Compliance

Failure to comply with the requirements of the Conservation Subdivision Design shall be cause for a "Stop Work" order on applicable permits. New permits or "Resume Work" orders shall not be issued until all requirements of this ordinance are met and the required fines are paid to the town.

Section 7: Appeals

Appeal of the requirements of this ordinance shall be processed in accordance with State Law.

Appendix C: Report on CMCOG Wetlands Mitigation Banking Activities

Central Midlands Council of Governments has been working for a number of years to establish a mitigation banking program within the four county region. The intent was to set up a program that could be utilized by member governments to compensate for the wetlands impacts of public works and infrastructure projects as well as to provide a bank that could be utilized by private sector developers. CMCOG also recognized that as a regional planning agency and water quality stakeholder, the agency could take a regional resource management approach to wetlands mitigation and therefore explore the potential for establishing multiple mitigation banks in different watersheds and eco-regions throughout the four counties of the central midlands region. Furthermore, such an approach would not only benefit all member governments but would also complement the agency's other regional planning programs such as transportation, 208 planning and economic development.

From the beginning of the project CMCOG decided to take a comprehensive, systematic watershed based approach to finding potential mitigation bank sites. Such an approach was not possible for one local government to undertake due to inconsistencies between watershed/eco-region boundaries and political jurisdictions. As a result CMCOG set out to evaluate mitigation opportunities in various ecosystems and watersheds within Richland, Lexington, Fairfield, and Newberry counties.

The first step in this process was to hold a series of stakeholder meetings with Federal, State, County, and local natural resource professionals to develop conservation goals and target watersheds within the CMCOG region. One of the things upon which group members agreed was an approach that would locate restoration/protection opportunities in rural areas instead of urban ones due to land costs, storm water runoff issues, and the likelihood of long-term success relative to future urban sprawl. To increase the likelihood of finding properties in need of restoration, CMCOG focused study efforts on rural areas approximately one watershed away from the edge of moderately populated areas. Various GIS layers were then selected, revealing ecological patterns and preferred watersheds that appeared ideal for further bank feasibility studies. The result was a set of maps and narrative descriptions for several sites assumed to contain the top restoration and protection opportunities for each of the three major eco-regions. The three selected focus areas watershed included the following:

- Piedmont Ecoregion – Broad River Basin – Cedar Creek Watershed
- Sandhills Ecoregion – Congaree River Basin – Congaree Creek Watershed
- Loam Plains – Congaree River Basin – Cedar Creek Watershed

Further analysis for each of these focus areas yielded a list of potential mitigation bank sites. CMCOG worked closely with local Soil and Water Conservation Districts to find the best way to contact property owners of these sites to gauge their interest in participat-

ing in a mitigation bank project. Some owners were interested in discussing conservation opportunities on their land, while others were nonresponsive.

In the end, a property owner in the Loam Plains site was contacted and asked whether he and the other owners of adjacent/nearby family lands might be interested in working with the CMCOG to explore the possibility of mitigation banking. He was very receptive to further discussions, indicating that his family had deep ties to the land dating back to the late 1770's and that they would like to leave a positive legacy in the Lower Richland Community.

Several studies were conducted on the land to investigate its conservation potential. Delineations of aquatic areas indicated a few hundred acres of wetlands and about 2 miles of streams to be present on the property. This delineation was approved by the Corps of Engineers for all of the sites studied at the time. The condition of these wetlands varied greatly - those along the streams were in almost pristine condition, while many of the Carolina Bay wetlands had man-made alterations, such as ditches, fill, and replacement of native hardwood species with pine trees and nuisance grass species. Wetland boundaries were surveyed using a GPS, and the acreages of both pristine and restorable wetlands were quantified. In addition, botanical studies indicated the presence of several rare statewide species of concern that were being overshadowed by the grasses. These studies suggested that removing planted pines and invasive grasses by cutting, controlled burning, and ditch plugging could allow these rare species to flourish. This could also create ideal habitat for a few federally listed endangered plants. These studies led the CMCOG team to conclude that the properties contained an ideal number of viable conservation projects. Subsequent financial analysis indicated that if the properties were combined, they would also make a good wetland mitigation bank.

At this point, the CMCOG team began working with Richland County and the property owner to pursue the development of a mitigation bank at this site. As a first step the team prepared a draft mitigation plan and presented it to the South Carolina Interagency Review Team (IRT) which is a group made up of representatives of about 10 Federal/State natural resource agencies. Their charge is to review mitigation proposals, construction of restoration projects, and monitoring to make sure that they meet all the criteria established by the US Army Corps of Engineers (Corps), US Environmental Protection Agency (EPA), and South Carolina Department of Health and Environmental Control (SCDHEC).

Their initial response from the IRT was positive, and they appreciated the eco-region and watershed based site selection process as well as the magnitude of the Bank's size and its conservation opportunities. Since then, the IRT has also visited the site and requested the following additional information: a delineation of boundaries of any additional wetlands that would be included in the Bank; baseline monitoring to demonstrate how some of the wetlands are impaired; and a draft prospectus based on the new Corps of Engineers standards outlining the proposed conservation projects.

The next step was to prepare an analysis of the preferred 4 options with various mitiga-

tion bank boundaries and assumptions. Based on an analysis of these options, the team recommended the inclusion of all mitigation sites on the property. This would generate the most credits, especially the restoration/enhancement type which can generate more revenue. To keep upfront costs down, restoration projects could be done using a phased approach. Projects that are predicted to have the highest probable economic yields and ecological restoration success rates would be included in the first phase. The analysis was then completed based on the assumption that all previously studied Sites would be included within the Bank boundaries and that the highest possible mitigation credits would be awarded to these conservation projects by the South Carolina Interagency Review Team (IRT). A summary of the proposed phases is presented below:

- Phase 1 would consist of approximately 377 acres of wetlands and upland buffers combined and could generate about 560 wetland mitigation credits.
- Phase 2 would consist of approximately 70 acres of wetlands and upland buffers combined in the Carolina Bay sites and could generate at least 135 wetland mitigation credits.

In total the team estimated that about 700 wetland mitigation credits could be generated within the Phase 1 and 2 wetland sites that have been delineated, which could generate substantial revenues for the County.

The next step in the process is for the team to finalize the prospectus based on the final bank boundaries. An additional meeting with the Corps of Engineers is also anticipated to informally discuss the content of the final Prospectus and make sure we are providing all information necessary to get it on Corps Public Notice and ultimately approved by the IRT. In this Prospectus, roles and responsibilities for ownership, sponsorship, and stewardship will be suggested. The entities associated with each role, however, are still yet to be determined as particular aspects of the business relationship are still being negotiated between CMCOG, the County, and the property owners.