SOUTH WHITE STREET IMPROVEMENTS
PHASES II AND III

SUSTAINABLE DESIGN ANALYSIS

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PREPARED FOR:

TOWN *of* WAKE FOREST

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INTRODUCTION

This document provides an analysis of potential sustainable design elements for South White Street Improvements Phases II and III. The report includes identification and discussion of potential sustainable design elements that could be integrated with the project, including their impacts to the cost, maintenance, and life cycle of the proposed improvements. Of the many elements that constitute a street, two can directly affect the level of sustainability that a street or roadway achieves.

The first is the degree of modality that a street affords. Simply put, the more safe modes of travel a street allows within its public transportation right-of-way, the more sustainable it can become. Allowing more modes of travel generally decreases the number of traditional vehicle trips per day, which in turn reduces fossil fuel emissions (especially to the extent that non-fossil-fuel modes of travel are used instead of traditional vehicles). Buses and other forms of transit also will reduce vehicles trips per day, thereby reducing emissions and the use of natural resources. When these things happen, the function of the street becomes more "complete." Transportation planners have termed a street that includes multiple modes of travel a "complete street." This term is further described in Section I.

The second element in the creation of a more sustainable street involves the physical materials and practices used in the design and construction of the street itself and the streetscape elements. The effects of these efforts are described in Section II.

The following analysis describes both of the aforementioned sustainability aspects; however, it focuses on ways that green strategies (as described in Section II) can be implemented for improvements made to South White Street as a part of Phases II and III implementation. In addition, this analysis of green street practices for South White Street can be applied to future sustainable streetscape design projects throughout the Town of Wake Forest.

SECTION I – COMPLETE STREETS

A "Complete Street" provides a safe environment for everyone—vehicle drivers, public transportation users, bicyclists, and pedestrians of all abilities—and contributes to more livable, welcoming communities. Countless policies on federal and local levels have been adopted nationally that begin to provide the building blocks needed to create complete streets, including a policy currently being developed by the North Carolina Department of Transportation. A complete street encourages alternative methods of transportation, such as bicycling or walking, by providing the needed amenities. These alternatives lead to increased physical activity, a reduction in transportation costs for individuals, and more livable communities. A complete street begins to form when spaces for multiple types of users and alternative modes of transportation are allocated appropriately.

Below is a list of the components of a complete street:

- Sidewalks – safe zones for pedestrians
- Bicycle lanes (or wide, paved shoulders)
- Bus lanes
- Accessible public transportation stops
- Safe crossing opportunities – raised table tops, center island medians, ADA accommodations
- Pedestrian signals
- Traffic calming measures – curb extensions, narrowed lane widths, street trees, on-street parking
- Medians – two-stage crossings for pedestrians, limited left-turn movements, opportunities for landscaping
- Lighting – vehicular- and pedestrian-scale lighting

A complete street can contain one or all of these components. What is most critical for a street to be complete is how it functions in its setting. A rural road is considered complete in a different way than a street through a dense urban area. Each street is unique and requires a special application of these features in order to be complete within its setting. A complete street contributes to the green street approach in the following ways:

- Allocates areas for alternative modes of transportation, which reduces emissions from personal vehicular trips
- Promotes human health and safety
- Emphasizes the use of landscaping, which reduces urban "heat island" effects and noise pollution

South White Street is the main street for the Town of Wake Forest. In order for it to become a destination, it must provide a safe environment for all users, specifically pedestrians. Although in its existing condition, South White Street offers amenities for vehicles and pedestrians, it is difficult to safely navigate and enjoy the main street environment, specifically due to the narrow, poor condition of the sidewalks and grade changes between some businesses and the roadway. When developing the proposed typical section for South White Street all modes of transportation were considered. A bus route passes through the corridor, however there are no designated stops within the project limits. Likewise, there is a marked bicycle route along Franklin Street three blocks east of the project, so amenities for bicycles are made within the streetscape for bicycle parking only, and there are not designated bicycle amenities within the typical section.

The following complete street components were proposed for the South White Street corridor:

- *Sidewalks* – Sidewalks will remain on both sides of the road and will be widened to a minimum of six feet. Additional ramps and steps are added to improve access to grade separated business entries.
- *Verge/Buffer* – On all blocks, except between Owen Avenue and Jones Avenue where the building setback is narrower, street trees will provide an additional four feet of buffer between the vehicular zone and the pedestrian zone/sidewalk.
- *Bicycle accommodations* – Bicycle racks will be incorporated along the corridor for storage of bicycles.
- *Raised tables* – At the Jones Avenue intersection, and at a mid-block crossing between Elm Avenue and Owen Avenue, raised tables will slow traffic and improve pedestrian safety at crossings.
- *Curb Extensions* – Curb extensions at most intersections will narrow the roadway, calm traffic, provide protection for parking and most importantly improve site distance and shorter crossing distances for pedestrians.
- *Lighting* – Both vehicular and pedestrian scale lighting will be upgraded along the corridor.

SECTION II – GREEN STREET ELEMENTS

By definition, a "green street" uses a natural systems approach to reduce stormwater flow, improve water quality, reduce urban heating, enhance pedestrian safety, reduce carbon footprints, and beautify neighborhoods (Source: *A Conceptual Guide to Effective Green Streets Design Solutions – Green Streets EPA August 2009*). In addition to these defined effects, green streets can optimize pavement system life cycles, maximize reuse of materials, and incorporate sustainable construction practices and materials. The approach to creating a green street is not holistic; inclusion of any number of these practices helps to create a more sustainable streetscape than would historical practices.

The decision on how green street principles are applied must be project based; aesthetics, feasibility, and budget must be taken into account. Recently, an emphasis on sustainability has been placed on buildings using the LEED® certification system. In an effort to apply a similar system to streets, a document used to guide implementation of greenroads has been created by the University of Washington and CH2M Hill, Inc. The *Greenroads v 1.0 Rating System* provides a ranking system for a "greenroad," which is defined as *a roadway project that has been designed and constructed to a level of sustainability that is substantially higher than current common practice.*

The components of green streets can be broken down into five general categories: Low Impact Development (Environment and Water), Access, Materials, Pavement Technologies, and Construction Activities. There are multiple items within each category. The following sections describe all of the green street initiatives that can be used to create sustainable streets.

Low Impact Development (Environment and Water)

In most cases, streetscape projects are implemented on existing infrastructure. Even though the street already may impact the surrounding environment, improvements to the street can include treatments that lessen those impacts. The following are some examples:

Stormwater quantity and quality treatments (Best Management Practices)

Managing stormwater runoff quality and controlling flow can be achieved through a number of strategies, which range greatly in cost, effectiveness, and aesthetic appeal. During design of a streetscape, any of the following stormwater management techniques could be implemented:

Bioretention/rain gardens	Vegetative swales/strips	Flatter slopes
Grass swales	Drainage pattern maintenance	Flatter/wider swales
Stormwater wetlands	Catch basin/seepage pits	Maximization of sheet flow
Infiltration swales/trenches	Elimination of curb and gutter	Shoulder vegetation
Detention basins	Alternative impervious surfaces	Surface roughness technologies

Rain gardens, vegetated swales, and stormwater wetlands have unique plant types and designs that make them extremely "visible" green street components. One of the biggest considerations with these treatments is determining how each one will be maintained and understanding the maintenance capabilities of responsible parties.

Site Vegetation

Landscaping should always be included wherever possible in a streetscape project. However, the use of native and/or drought-tolerant plant species results in a landscape that requires little or no water for maintenance. This contributes to increased life cycle savings for the street and, if street trees are used, reduced urban heat island effects.

Light Fixtures

By simply reevaluating light fixture types, light pollution into the sky and adjacent residential areas can be reduced. Using cut-off light fixture types or lamp styles that better direct light limits light pollution.

Access

The accessibility of a street is closely related to the complete street component, but it also encompasses other aspects that contribute to the street's sustainability. These aspects include the following:

Intelligent Transportation Systems

Intelligent transportation systems (ITS) offer real-time traveler information and allow for traffic monitoring and signal timing support. Implementing ITS for a street reduces congestion and creates a safer environment for motorists by informing them of roadway conditions. Moving cars more efficiently also reduces emissions.

Pedestrian, Bicycle, and Transit Access

Providing means for alternative transportation types (applying a "complete streets mentality") reduces the dependence on personal vehicles, which results in fewer trips. This not only reduces emissions but also increases access and mobility and improves human health and safety.

Cultural Outreach

Promoting culture and art along a street to harbor awareness and create a sense of community inherently makes it more sustainable. Longevity of a street is directly related to the connection it has within the community. This is achieved by providing locations for art and incorporating community values in the streetscape. Examples include a special paving pattern, unique bus shelters, and neighborhood markers—the list of opportunities is endless.

Materials

Countless materials contribute to the construction of a streetscape, including the existing materials and those used during the lifetime of the street. How materials are treated during construction also is an important consideration. The following materials-related considerations apply to green streets initiatives:

Pavement Reuse

Assessment of existing pavement and the practicality of its reuse wherever possible reduces use of raw materials and the use of fossil fuels to create and transport them.

Earthwork Balance

When roads are being widened or realigned and earthwork activity occurs, balancing cut and fill reduces the use of fossil fuels to transport earth.

Regional Materials

Using regional materials (raw or recycled) reduces the energy used in transporting materials such as asphalt, concrete, aggregate, metal, wood, and plastic to the site. Additionally, paving materials and site furnishings such as benches, trash receptacles, and lights can originate regionally. For green buildings to be considered for LEED® certification materials must be provided from within a 500-mile radius; however, there is no specified distance in the *Greenroads* manual.

Recycled Materials

The use of recycled materials limits the consumption of raw material and the energy used in extracting and transporting it. Recycled materials can be used in the following paving applications:

- Using crushed concrete as base material
- Adding supplementary materials such as slag, crushed glass, and ternary mix to concrete mixes
- Using recycled asphalt pavement to reduce asphalt material

In addition, recycled tires can serve as walking surfaces or as landscape mulch material; retaining walls can be created

from recycled concrete slabs; and some site furnishings, such as benches and trash receptacles, can be constructed using recycled plastic or faux wooden slats (from recycled materials).

Alternative Materials

In addition to using regionally sourced materials or materials with recycled content, any creative use of materials that promotes longevity and reduction of energy for the overall project should be considered. Weighing these alternatives is a critical aspect of sustainable design. For example, a decorative stamped asphalt crosswalk adds to the pedestrian safety and aesthetics of design; however, it requires heavy maintenance to maintain the paint and stamp wear within the asphalt. Recent improvements in stamped asphalt design incorporate new materials and installation techniques that add longevity to the product and reduce maintenance requirements.

Energy Efficiency

New advances in lighting technology have created lighting options that offer superior lighting output while reducing the amount of energy consumption. LED fixtures last longer between re-lamping—thus reducing maintenance costs—and they run more efficiently by providing a more directional light. Reduced energy costs and increased life cycle savings by using more energy-efficient lighting contribute to a more sustainable street.

Pavement Technologies

Permeable Paving

Permeable paving allows a certain level of water to permeate the surface of the street and percolate back into the ground water supply, and it also can slow the rate of surface runoff. Streets are almost 100% impervious systems due to the way they function. Incorporating any level of pervious pavement goes a long way in reducing the amount of impervious surface area collecting stormwater and overflowing stormwater systems.

Permeable pavements are best installed in lower-volume areas to limit the amount of clogging. If not properly maintained, clogging will limit the pavement's efficiency and reduce its benefits. Permeable pavement also requires a special subgrade section that includes clean stone for infiltration, geotextile fabric, and in some cases underdrains.

Long-Life Pavement

The life cycle cost of a road can be increased by providing a long-life pavement. Adding subgrade and base thickness to the pavement section increases the life of the pavement. Pavement used in this application must be hot mix asphalt or Portland cement concrete and only heavily traveled lanes can be considered for use of this pavement type.

Alternative Pavement Options

Other alternative pavement options that add sustainability to a street can be considered:

Pavement Type	Purpose	Benefits
Warm Mix Asphalt	Reduces the mixing temperature of asphalt by a minimum of 50°F	Reduces fossil fuel use and emissions at the asphalt plant and improves human health and safety for workers
Cool Pavement	Increases pavement reflectance	Reduce localized air temperatures and stormwater runoff temperatures
Quiet pavement	Surface course of pavement produces a level of noise reduction	Reduces tire pavement noise, optimizes surrounding habitats, and improves human health and safety

Construction Activities

Noise Mitigation

Noise is a type of pollution that typically does not receive as much attention as other types, but it can be detrimental to human health and safety and destructive to habitats. Efforts to understand locations of "sensitive receivers," mitigate noise at the source and employ noise abatement techniques can greatly improve health and human safety during construction activities. The project owner also can instate noise policies to reduce noise pollution.

Erosion Control

Without proper erosion control measures, unhealthy amounts of sediment can seep into the stormwater system, putting human health and safety and habitats at risk. Closely monitoring the site during construction and having an educated contractor that understands local requirements are keys to ensuring a secure, well functioning erosion control plan.

Reduction of Emissions

Emissions during construction activities can be further reduced by ensuring that a certain percentage of fuel consumed by nonroad construction equipment is a biofuel blend. This also will reduce fossil fuel use.

Quality Control Plan

During construction activities, the contractor can identify environmental issues and best practice methods to minimize impacts to the environment and properties adjacent to the street. In some cases, this requires training construction personnel. Once training is complete, the contractor can lay out a plan that addresses some of the following potential construction-related environmental issues (reference the *Greenroads Manual v1.0* for complete list):

- Environmental regulations specific to the project
- Environmental monitoring
- Unexpected discoveries (i.e., historical, environmental, utility)
- Oil spill prevention
- Construction stormwater management
- Reduction of air pollution
- Waste management, recycling, and housekeeping practices
- Noise mitigation practices

Site Recycling

To minimize the amount of waste during construction activities, the contractor can establish a litter management plan describing the expected quantities of waste and proper handling of those items. Beyond the construction site, a plan for disposal of waste from the site office or job trailer also can be created. Such plans will reduce the site's solid waste emissions and, more importantly, increase the public's awareness of the project's implementation of sustainable strategies.

SECTION III – SOUTH WHITE STREET GREEN INITIATIVES

As design moves forward on the South White Street Improvements Phases II and III project, green street initiatives also can begin to progress. The project team's initial analysis identified the following areas where green technologies can best be applied in this project:

- Storm Water Quantity and Quality Treatments (Best Management Practices) – Green Street Element
- Site Vegetation – Green Street Element
- Light Pollution – Complete Street Component

- Cultural Outreach – Green Street Element
- Regional Materials – Green Street Element
- Recycled Materials – Green Street Element
- Energy Efficiency – Green Street Element
- Permeable Paving – Green Street Element
- Construction Activities – Green Street Element

The brief analysis below, which includes a magnitude of cost, describes how each of these components could be applied to the streetscape. The Town can use this information in deciding whether or not to move forward with any or all of these components.

Stormwater Quantity and Quality Treatments (Best Management Practices)

A brief analysis was conducted to determine how any of the stormwater within the site limits could be treated. Part of this analysis identified locations where the existing site conditions were favorable based upon existing drainage patterns and spaces affording the room for a stormwater treatment area.

As defined by the NCDENR Stormwater BMP Manual, a bio retention cell consists of a depressed area filled with soil media and vegetation that allows for ponding of runoff which eventually exits by filtering through the media and exfiltrating into surrounding soil, flows out to an underdrain and evapotranspiration. A bio-retention cell would be the most feasible stormwater treatment facility to implement on the South White Street Improvements Phases II and III project.

The primary location along the corridor for a possible bio-retention cell is in the Chamber of Commerce parking lot. An existing catch basin in the SE corner of the Cotton Company parking area currently collects stormwater run-off from the parking lot. The 25% design plans designate a landscape area to buffer the Chamber of Commerce parking area from the sidewalk. By creating a bio-retention area within this landscape buffer, stormwater run–off from these parking areas can be treated before entering into the storm drain system. Figure 1 in the Appendix shows the location of this possible treatment. *COST:* A bioretention cell including media and landscaping would cost approximately $15,000. *MAINTENANCE:* Periodic trash collection and removal, replacement of 10% of the plant materially annually, and replacing the soil media and underdrains about every 10 years would need to occur to keep the bioretention cell maintained and capable of treating stormwater runoff and would cost around $2000/year.

Site Vegetation

The street trees from Phase I of the South White Street improvements projects are Bosque Elms, a variety of tree that is highly tolerant of urban conditions and drought. The subsequent phases of the project would continue use of this variety for consistency. For other planting areas within the project, a plant palette has not yet been determined. A selection of native species and drought-tolerant plants will be considered as the plant list is developed. *COST:* The cost of implementing plant material that meets these needs does not add any additional cost to the project.

Light Pollution

Lights for the South White Street corridor have already been selected by the Town of Wake Forest. The style of fixture has a cap that directs all light towards the sidewalk and roadway areas being lit. Thus, measures for light pollution have already been made in previous phases of the project and will continue for the subsequent phases. *COST:* There is no additional cost to the project. *MAINTENANCE:* While there is a certain level of maintenance for any light fixture, the Town is already familiar with the maintenance program for the fixtures for White Street because the selected light has been used elsewhere within the Town.

Cultural Outreach

The Renaissance Plan of Wake Forest followed by the Master Plan for the South White Street corridor laid the groundwork for design of the street. Citizen and stakeholder input were critical components of these plans and the merchants along the corridor have a vested interest in the appearance of White Street. Opportunities for artwork, especially at the plaza area at Jones Avenue were considered during the Master Plan phase. Incorporating artwork into the design and engaging the public in the design will further enhance the awareness and ownership of the project.

Artwork: South White Street has already been identified as an area where the Public Arts Commission will engage an artist to incorporate an art piece into the project. As the design progresses, locating areas where art opportunities lie should be a priority. *COST:* The cost of this artwork would include the coordination efforts to determine its location and type; however, donations and grants can help cover costs of public art projects.

Planting Area Program: Due to the tight spacing between buildings in the block between the Owen and Jones Avenues, there is not room for street trees. In an effort to add green elements to soften the space, planter pots could be incorporated into the design. Because the maintenance requirements of an above ground pots can overload the capability of Town maintenance, a program to maintain these pots by local merchants or citizens with vested interest could be enacted. By engaging the public in the project, it brings a feeling of ownership and will directly affect the longevity of the project. *COST:* The cost of above grade planter pots can range from $150 to$500 depending upon size, material, weight, etc. Accessible water sources for ease of watering the pots should be added, which also adds cost to the project. *MAINTENANCE:* Due to the limited soil area to retain moisture and replacement of annual plant material during the change of seasons (although some perennials can be used in pots), a high level of maintenance is required for above grade planters. With the engagement of local citizens, the maintenance of these pots may not rely solely upon the Town.

Regional Materials

When determining the materials to be used for the project, careful attention can be paid to ensuring that specified products are supplied from regional sources. This includes materials for the roadway as well as products used for streetscape amenities such as the pavers and site furnishings. *COST:* Although buying locally and regionally can be more expensive, the benefits gained from supporting the local/regional economy combined with savings on freight outweighs the increase in the actual unit price of the materials. The cost for implementing this method is negligible. *MAINTENANCE:* There should be no substantial difference in maintenance of items constructed with local/regional materials versus those constructed with materials from other sources.

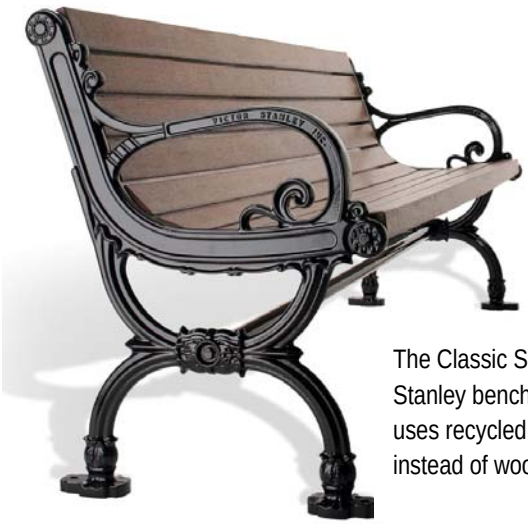
Recycled Materials

There are two aspects to this category that should be considered for South White Street: recycling of existing materials and the recycled content of proposed materials.

Material recycling: There is existing granite curbing along the South White Street corridor. Every effort should be made to

carefully remove the granite curbing and place it in storage so that any pieces that can be reused in future projects within the Town. *COST:* Cost of recycling the granite curbing is negligible; however the Town must consider the costs in storing the granite curbing. There may be a slight cost incurred by the transport of the curbing to its stored location, however it may be offset by the cost of disposing the curb. *MAINTENANCE:* Storing the curb may add a slight amount of maintenance to ensure the safety of the storage site.

Recycled Content: During selection of site furnishings such as benches and trash receptacles, the recycled material content in the products will be considered. Many site furnishing manufacturers now publish information on the recycled content in their products, and many of them are members of the U.S. Green Building Council. By including furnishings with recycled content, the consumption of raw materials is lowered. *COST:* Site furnishings that incorporate recycled material are comparable in cost to furnishings without recycled content. The cost added to the project is negligible. *MAINTENANCE:* There should be no substantial difference in maintenance of items constructed with recycled content versus those constructed without it.



The Classic Series Victor Stanley bench shown here uses recycled plastic slats instead of wood

Energy Efficiency

Energy efficiency is directly related to light pollution. Utilization of directional light and concentration of the light from the source makes light fixtures more efficient. In addition to these measures, using a more efficient light type such as LED can further improve fixture efficiency. LED lamps have been proven to last up to two times longer than high pressure sodium lamps (orange-tinted light output) and up to four times longer than metal halide lamps (white light output). This benefit reduces the burden placed on maintenance departments. Additionally, the efficiency of LED bulbs means they use less energy, a key component to sustainability. The responsible reduction of energy outweighs the initial cost of implementing efficient lighting.

The pedestrian light fixtures along South White Street have already been designated as high pressure sodium lamps, however LED or more efficient light sources should be considered in other lighting features along the corridor such as proposed wall lighting or lighted bollards. *COST:* Generally, an LED-type pedestrian light fixture (the lamp itself, not including the base or pole) will add 25-30% to the cost of each fixture. An LED street light fixture may cost up to 35% more than a standard fixture. Currently, the payback period for the investment in LED lighting is 10+ years; however, the lower demands for maintenance and on the overall energy grid could be considered worth the initial investment. *MAINTENANCE:* As previously stated, the maintenance demands of LED lighting are less than those of traditional lighting.

Permeable Paving

The prime locations for permeable paving applications are areas that see limited traffic and are easily accessed for maintenance. An area where the Town may want to explore use of permeable paving would be in the Chamber of Commerce parking area. There are multiple options for permeable pavement in this parking area. The entire parking area could be permeable pavers, or pervious asphalt/concrete. If it is not desirable for the entire lot to be

pervious, a permeable paver strip could be implemented as a divider between the parking stalls in the middle of the lot. By implementing pervious pavers between stalls where vehicles do not travel, the frequency of cleaning the pavers is reduced. As design continues, the best pervious solution for this lot can be decided based upon design and cost.

Critical to the successful use of permeable pavement, however, are the maintenance and scheduled cleaning of the surface to ensure the material's permeability is maintained. *COST:* A majority of the added cost of permeable pavement is in the base materials — the stone base needed for the infiltration process can increase the costs. In the Piedmont region, existing clay soils must be replaced with a more porous soil type in addition to the base material. The cost for materials and base (not including existing soil removal) can cost up to three times as standard paving. The cost for maintenance must also be considered when choosing permeable paving options. *MAINTENANCE:* The maintenance of permeable paving depends mainly on the amount of traffic on the pavement and the type of runoff infiltrating the pavement. Because the permeable pavement is located in a parking lot which receives debris from parked cars, it may require more routine cleaning. Permeable pavement should be inspected *at least* once per year, and in this application it may require cleaning every year. Cleaning is done with a vacuum sweep that removes encrusted sediment and should be performed in dry weather. The Town also could consider a maintenance agreement with a private consultant to inspect the pavement if the Town does not have the internal resources to monitor and maintain the pavement.

Construction Activities

All of the construction activities critical to the making of a green street should be considered by the Town as a means to start the green street initiative in Wake Forest.

SUSTAINABLE DESIGN ANALYSIS

SOUTH WHITE STREET IMPROVEMENTS PHASE II AND III

Appendix

Kimley-Horn and Associates, Inc.

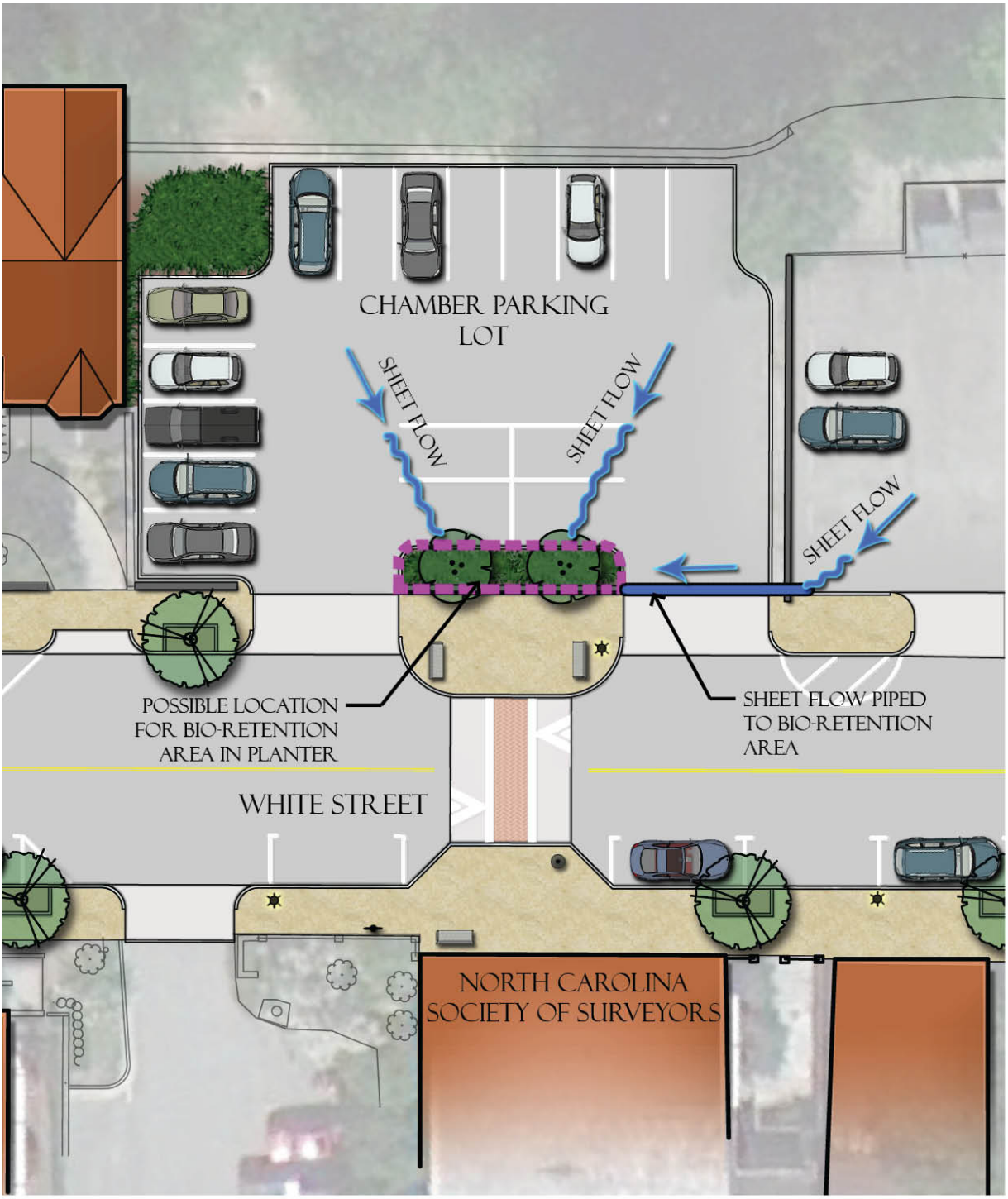


Figure 1 – BMP Location Diagram