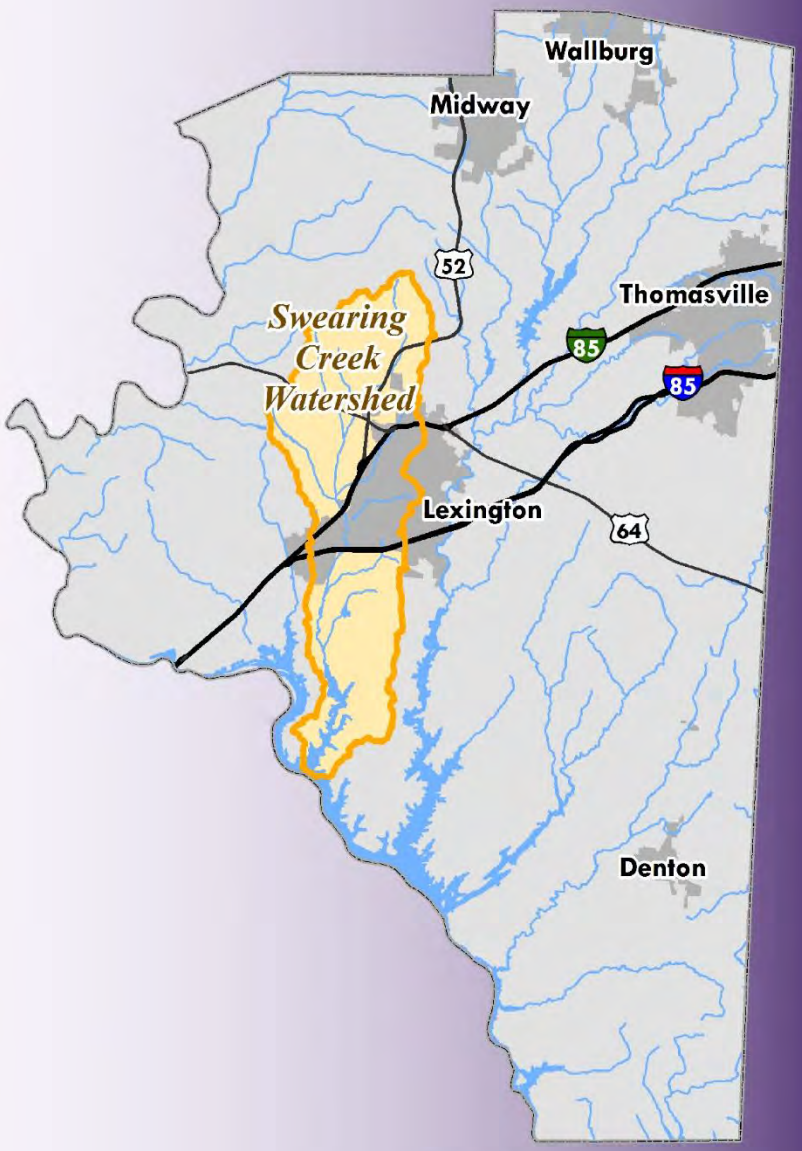
Swearing Creek Watershed

Restoration Plan

January 2018



Davidson County, NC

PIEDMONT TRIAD
REGIONAL COUNCIL

Swearing Creek Watershed Restoration Plan

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Section 1: Introduction

Swearing Creek is a 49-square mile watershed in central Davidson County, North Carolina. It includes the western half of the City of Lexington, NC, and drains directly to High Rock Lake, the first of the "chain of lakes" on the Yadkin River system. This watershed has a history primarily defined by an urban furniture industry and rural agriculture – largely smaller cattle and crop farms. It is not a water supply, nor does it receive wastewater discharges from the City of Lexington. The main impacts to the creek appear to be from rural and urban non-point sources of pollution.

Swearing Creek was first listed as an impaired waterbody in 2004 by the NC Department of Environmental Quality's (DEQ) Division of Water Resources (NC DWR) after fish community sampling revealed "Fair" biological integrity within the stream. Benthic macroinvertebrate surveys conducted by NC DWR since that time have also demonstrated that biological conditions within the Creek are not representative of a healthy stream system. These degraded water quality conditions appear to be a result of non-point source pollution, likely stemming from urban stormwater runoff and/or agricultural practices within the surrounding watershed.

Swearing Creek is a direct tributary of High Rock Lake in Davidson County, which has also been listed as an impaired waterbody since 2004 due to high chlorophyll-*a* concentrations. Since that time, High Rock Lake has also been listed for high pH levels, high turbidity, and polychlorinated biphenyls (PCB) fish tissue advisories (NC DWR 2014a). NC DWR conducted a special study of the Lake's water quality to determine the sources of nutrient pollution. Their analysis of tributary water quality data showed consistent, weather dependent pollution levels, indicating the likeliest sources of pollution for Swearing Creek to be non-point source pollution and/or intermixing with other parts of the lake that become more available due to weather conditions (e.g. heavy rains) (Tetra Tech 2004). A stakeholder process to develop a nutrient management strategy that can be implemented by either state or federal regulatory authorities could be scheduled soon. For detailed information, please visit https://deq.nc.gov/about/divisions/water-resources/planning/modeling-assessment/special-studies#HRL.

The Piedmont Triad Regional Council (PTRC) was awarded a grant in September 2014 from the NC Clean Water Management Trust Fund (CWMTF) to assess present water quality impacts and watershed restoration needs for Swearing Creek in order to develop a strategic plan for the City of Lexington and Davidson County to better address water quality issues. Throughout the process, PTRC partnered with Davidson County, the City of Lexington, and various other stakeholders to assess present water quality impacts and identify watershed restoration goals for Swearing Creek.

The initial step in the watershed restoration planning process was a comprehensive characterization and assessment of the current watershed conditions. This included a land use impacts assessment, an analysis of water quality data, and a review of local policies using the Center for Watershed Protection's Codes & Ordinance Worksheet and the US Environment Protection Agency's (EPA) Water Quality Scorecard. All of these characterizations and analyses can be found in the *Swearing Creek Watershed Assessment* (2017). The conclusions found in this document are the basis and guiding principles for this Restoration Plan.

Results from the *Swearing Creek Watershed Assessment* suggest that Swearing Creek's degraded waters are a collective result of multiple non-point sources, such as stormwater runoff, new development, existing land uses, and agricultural practices within the watershed. Many small impacts spread throughout the watershed can have a significant impact on water quality. In order to adequately address Swearing Creek's current impaired status, it will require a multi-pronged approach that addresses non-point source pollution at multiple levels, through both projects and policy changes.

The purpose of this restoration plan is to coordinate watershed needs identified in the Watershed Assessment with the feasibility to create new projects or programs and outline a comprehensive strategy for their implementation. The Implementation Timeline featured in this plan coordinates a series of steps in management policies and project investments that will most effectively restore watershed functions and health.

Section 2: Watershed Policy Goals

Watershed policies and programs play an essential role in sustainable watershed management. A network of local ordinances, rules, and programs determine how we develop, protect, and use our lands. These same local laws ultimately impact the function of a watershed and the quality of its waters. They work in tandem with restoration and conservation projects to mitigate the impacts of existing land uses and future growth on local waterbodies. This comprehensive watershed management approach ensures consistent stewardship by all actors within the watershed and enables local jurisdictions to effectively coordinate efforts to protect water resources.

A detailed review of existing codes, ordinances, rules, and programs administered by Davidson County and the City of Lexington that impact watershed health and function was conducted as part of the *Swearing Creek Watershed Assessment* (2017). Upon review, it is apparent Davidson County and the City of Lexington have taken initial steps to protect and conserve water resources within their existing policies and programs. However, there are several opportunities for both jurisdictions to improve their policies to benefit watershed conditions for Swearing Creek. Now is the perfect opportunity to reexamine existing legislation and initiatives as the City of Lexington has been identified for the US Environmental Protection Agency's (EPA) National Pollutant Discharge Elimination System (NPDES) Phase II stormwater program. This program requires Lexington to have a plan of action to address stormwater pollution that incorporates pollution reduction, illicit discharge detection and elimination (IDDE), construction stormwater management, post-construction stormwater management, community education, and public involvement. The City is in the process of drafting a new stormwater ordinance to meet these requirements, which is expected to be adopted in late 2017. The watershed management strategies prescribed in this section are intended to work in congruence with these recent ordinance changes and provide additional goals to further improve watershed health and function.

Swearing Creek Watershed Management Strategies

1. Update Ordinances to Specifically Address Stormwater
2. Strengthen Design Standards to Better Protect Natural Resources
3. Retrofit Existing Development
4. Restore Riparian Buffers
5. Promote Infill Development to Conserve Water Resources and Reduce Stormwater Runoff
6. Protect Rural Land
7. Encourage Agricultural BMPs
8. Continue Enforcement of Existing Erosion Control & Illicit Discharge Rules
9. Increase Watershed Education & Outreach Opportunities
10. Continue and Expand Water Quality Monitoring

There are ten management strategies that are recommended as the most effective policy tools to address the bioclassification impairments and restore sustainable health and function to the Swearing Creek watershed. These goals are based upon current water quality impacts, probable pollutant sources, the needs of the watershed, implementation feasibility, and community benefit. The goals are informed by the data and observations collected through fieldwork, computer-based watershed analysis, monitoring data provided by NC DEQ, YPDRBA, and the City of

Lexington, and discussions held with the Stakeholders Committee. These strategies are intended to be coordinated with on the ground projects, using a two-pronged approach, to improve water quality and sustainably manage healthy watershed conditions long into the future.

The top ten management strategies and other policies should be enacted consistently amongst all jurisdictions affecting water quality in Swearing Creek to be truly effective, including those communities upstream of the Creek itself. Having cooperation from all parties within the watershed will also benefit stakeholders in preparing for impending nutrient reduction legislation coming out of NC DEQ's TMDL assessment of High Rock Lake. Coordination of efforts now to implement these policies and projects in a timely manner will help save considerable money, resources, and time.

Goal 1: Update Ordinances to Specifically Address Stormwater

Existing Conditions

Non-point source pollution and stormwater runoff were identified as the primary causes of impairment by the NC DEQ in its assessment of Swearing Creek. Isolated impacts throughout the watershed are having a cumulative degrading effect on its waterbodies. Findings from the *Swearing Creek Watershed Assessment* also suggest that existing urban development and land uses throughout the watershed are exacerbating stormwater impacts and negatively impacting water quality. Thus, stormwater runoff should be a primary target for future watershed management strategies.

A detailed review of existing codes, ordinances, rules, and programs administered by Davidson County and the City of Lexington that impact watershed health and function was conducted as part of the *Swearing Creek Watershed Assessment* (2017). Using the Center for Watershed Protection's (CWP's) Codes and Ordinance Worksheet (COW) to rate the watershed management of both jurisdictions, Davidson County and Lexington received scores of 51 and 76, respectively. These scores reflect that Lexington has taken additional steps to protect its waters from development impacts.

The City of Lexington has a unified development ordinance (UDO) regulating land development. This document provides regulations for future development and outlines procedures for the design, review, approval, development, and use of land within Lexington. While there are several policies throughout this document that are intended to protect natural resources and encourage the use of BMPs, few explicitly address stormwater runoff and non-point source pollution.

In 2015, Lexington was selected for the Environmental Protection Agency's (EPA) NPDES Phase II Program. This program requires communities over 20,000 people to comply with six minimum measures to address non-point source pollution and stormwater runoff: public involvement, community education, good housekeeping, illicit discharge detection and elimination (IDDE), on-site construction controls, and post-construction site controls. Lexington already has most of the regulations and programs in place for this new status, and simply needs to adopt ordinances to improve IDDE and identify a need for stormwater controls during and after construction. The City is in the process of drafting a new stormwater ordinance to meet these requirements, which is expected to be adopted in late 2017.

Davidson County has a *Land Development Plan* (LDP) that was updated in 2009 in collaboration with PTRC, which examines the social, environmental, and economic growth of the County, and establishes several goals to protect natural resources, such as "Water and Sewer Services," "Agricultural and Rural Area Preservation," "Parks, Recreation and Open Space," "Water Quality," and "Air Quality". Although the LDP provides great recommendations for improving watershed quality, such as maintaining predevelopment

watershed conditions, preserving natural features, creating a comprehensive drainage and flood management plan, and reducing stormwater impacts including erosion and sedimentation, it has limited enforceability outside of water supply watersheds. An exception to this is the 100-year floodplain, in which development is limited to low-impact or non-intensive recreational uses. The County's Watershed Protection Ordinance also provides explicit language to protect water resources. However, again, these regulations only apply to public water supply watersheds, and not Swearing Creek.

While both jurisdictions have clearly taken steps to protect natural resources, there are several opportunities to strengthen existing ordinances and adopt new ones that more adequately address Swearing Creek's primary source of impairment, stormwater. Updating ordinances to require stormwater improvements could provide significant benefits to overall watershed health and provide the authority needed to enforce watershed protections and mitigate stormwater impacts.

One resource that may be useful to both parties as they work to address policy gaps is the Green Growth Toolbox, which was developed by the North Carolina Wildlife Resources Commission (NCWRC). This suite of tools provides North Carolina towns, cities, and counties with various resources and information, land use planning methods, and case studies to conserve wildlife and natural resources as they grow. As part of this resource, the NCWRC also provides free training and technical assistance for local government staff and officials that are interested. Workshops can cover topics such as planning guidance, ordinance writing, development incentives, and other strategies to protect wildlife, habitat, and other natural resources as communities continue to grow.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Relevant UDO Chapter	Potential Resources
1. Draft and adopt a Comprehensive Stormwater Management Ordinance	N/A	UNC School of Governments Model Ordinance, NC DEQ Stormwater Design Manual
2. Coordinate stormwater ordinance with landscaping/parking requirements	Chapter 4 & Chapter 9	Green Growth Toolbox, NC LID Guidebook, U.S. EPA LID Guidance

Davidson County

Recommended Strategy	Relevant UDO Chapter	Potential Resources
1. Consider adopting a Comprehensive Stormwater Management Ordinance	N/A	UNC School of Governments Model Ordinance, NC DEQ Stormwater Design Manual
2. Reassess landscaping, parking, street design and other standards to better address stormwater concerns	Section 6.06 & Section 6.07	Green Growth Toolbox, NC LID Guidebook, U.S. EPA LID Guidance

3. Expand Watershed Protection Ordinance to apply to non-water supply watersheds	Watershed Protection Ordinance	N/A

The primary strategy to address stormwater impacts on Swearing Creek is to draft and adopt a stormwater ordinance that will meet Lexington's NPDES Phase II requirements. Although Davidson County does not have such requirements, it would be well served to adopt a similar or unified ordinance with Lexington to meet shared watershed goals. A stormwater ordinance is an extremely powerful tool that is often appreciated by the private sector and development community, as it explicitly addresses the values a local entity places upon water quality, and provides clear guidance on development procedures and design. A good stormwater ordinance includes sections addressing illicit discharge detection and elimination, illegal dumping, or soil and erosion control, as well as managing stormwater flows from new construction and redevelopment. A stormwater ordinance will be able to address persistent but difficult pollution sources such as pet waste and lawn fertilizers as well. Non-point source discharge codes, stormwater BMP design requirements, floodplain codes, and open space requirements should also be included. Ordinances should be designed and implemented uniformly throughout a jurisdiction, avoiding a patchwork of land use regulations that ultimately prove frustrating for developers and planning staff.

Goal 2: Strengthen Design Standards to Better Protect Natural Resources

Existing Conditions

Traditional site designs and developments are, at least to some degree, responsible for Swearing Creek's current impairments. Although a majority of the watershed is rural, sprawling commercial and residential developments have contributed to an overall increase in impervious surface cover, especially in Subwatershed 6 and 7 (see Figure 1). These paved surfaces prevent soils from absorbing water, which instead flows over the ground carrying nutrients, metals, pesticides, and organic pollutants in its runoff. This increased volume and velocity of runoff can cause flash flooding and erode stream banks and streambeds. Although there is a need to retrofit existing development to better manage stormwater onsite, these issues must also be addressed proactively through improved site design and development standards. Until recently, there have been few requirements for developers to offset these impacts through stormwater BMPs or riparian buffers, outside of public water supply watersheds. In 2015 the City of Lexington adopted 50-foot buffer requirements for all new development and has required stormwater BMPs as part of their Phase II requirements since 2016. Phase I runoff control measures have been used since the 1990's. The City will have to adopt ordinances that establish post-construction stormwater controls within the next five years as part of their NPDES contract.

Design regulations within the City of Lexington are outlined in the Land Use Ordinance (LUO), which serves as the unified development ordinance for the City. The LUO requires that all new development be landscaped, both along building and parking lot perimeters, as well as within parking lot interiors. Building perimeter landscaping must be at least 5 feet wide and have one small tree per 30 feet and eight small shrubs per 100 linear feet. However, there are no clear standards for interior landscaping or any recommended ratio of impervious to pervious cover. In addition, parking lots less than 5,000 square feet are exempt from any landscaping requirements and those less than 36 spaces are not required to have interior landscaping. Periodic vegetated zones that allow for infiltration of stormwater could yield great benefits and would only require minor adjustments in design practices. The City does encourage landscaping to be "designed in such a way that water is captured naturally and absorbed by landscaped areas" and

allows the incorporation of green roofs/walls and on-site water retention and reuse (City of Lexington Land Use Ordinance, 2010, p. 77). However, these recommendations rely on developers going the extra mile, who would benefit from clear guidelines.

Davidson County's Zoning Ordinance sets development standards for new and enhanced development. All site plans are required to have at least 5% vegetated cover. Landscaping regulations require there be at least 1 tree for every 12 parking spaces and vegetated street buffers to provide shading and improve aesthetics, rather than explicitly for environmental benefits. Planting areas must be 7 feet wide and at least 200 square feet in area. Parking lots less than 12 spaces and multi-family developments with 4 or fewer dwelling units are exempt. The Davidson County LDP also addresses a number of watershed management needs, but primarily as vague concepts, barring the explicit restrictions on density and stream buffers detailed in the water supply watershed protection ordinance which is not applicable to the Swearing Creek watershed. Generally, Davidson County does not use a regulatory approach to environmental resource protections and sprawl management. Instead they use negotiations in the Technical Review Committee (TRC) to serve these purposes. While this permits flexibility in the permitting and design process, it also de-prioritizes water quality protection in the development process, which can have long-term consequences and costs for the watershed.

The land use assessment of the watershed determined a number of areas throughout the watershed that are environmentally-sensitive (steep slopes, wetlands, etc.) that could be valuable open space and recreational areas, providing water quality benefits, if protected from intensive development. There are also enormous opportunities to redevelop the urban core using available infrastructure, which would help conserve resources and reduce increases in impervious surface cover within the watershed. GIS modeling conducted during the Swearing Creek Watershed Assessment also prioritized several sites that are likely impacted as a result of high impervious surface cover and inadequate stream buffers. These top priority sites are outlined in the Project Atlas section of this report, which also identifies on-the-ground projects to improve water quality. Many of the impacts on these sites could have been prevented through more thoughtful site design during the development process. Strengthening Lexington and Davidson County's design standards will help better protect natural resources and proactively address stormwater concerns by providing clear standards for developers.

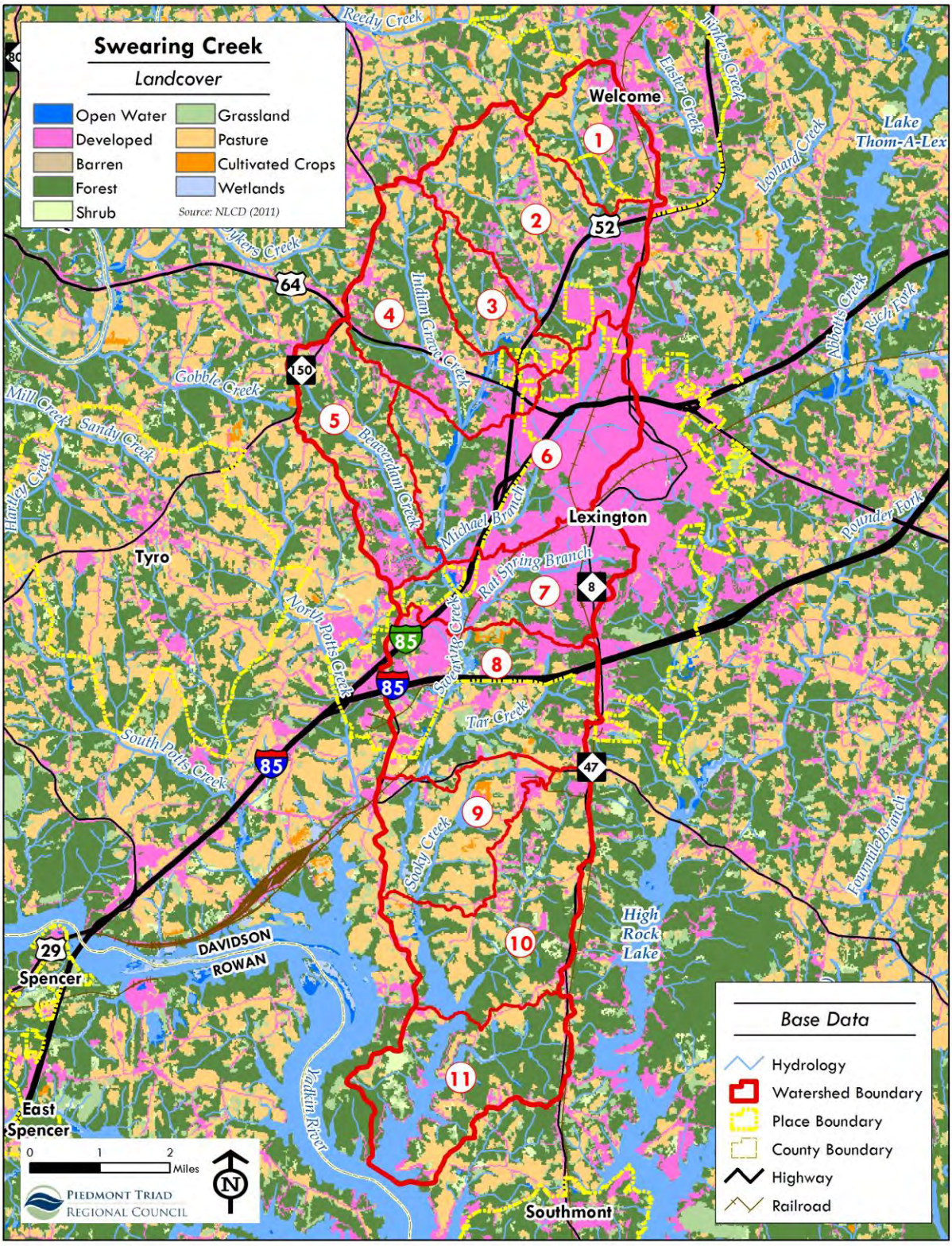


Figure 1: Swearing Creek Watershed Landcover Map

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Draft and adopt a Comprehensive Stormwater Management Ordinance	Davidson County, PTRC, Neighboring Cities with Stormwater Programs	UNC School of Governments Model Ordinance, NC DEQ Stormwater Design Manual
2. Reassess landscaping, parking, street design and other standards to better address stormwater concerns	PTRC, NCWRC, Neighboring Cities with model development standards	Green Growth Toolbox, NC LID Guidebook, U.S. EPA LID Guidance
3. Draft and/or adopt a development manual detailing desired LID features to streamline the development approval process	PTRC, Davidson County	NC DEQ Stormwater Design Manual, NC LID Guidebook, U.S. EPA LID Guidance
4. Consider providing development incentives for LID or other stormwater controls	PTRC, NCWRC, or neighboring cities with similar incentives	Encouraging Low Impact Development (US EPA, 2012)

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Consider adopting a Comprehensive Stormwater Management Ordinance	City of Lexington, PTRC, Neighboring Counties with Stormwater Programs	UNC School of Governments Model Ordinance, NC DEQ Stormwater Design Manual
2. Reassess landscaping, parking, street design and other standards to better address stormwater concerns	PTRC, NCWRC, Neighboring Counties with model development standards	Green Growth Toolbox, NC LID Guidebook, U.S. EPA LID Guidance
3. Draft and/or adopt a development manual detailing desired LID features to streamline the development approval process	PTRC, City of Lexington	NC DEQ Stormwater Design Manual, NC LID Guidebook, U.S. EPA LID Guidance
4. Consider providing development incentives for LID or other stormwater controls	PTRC, NCWRC, or neighboring counties with similar incentives	Encouraging Low Impact Development (US EPA, 2012)

One way that design standards could be strengthened to address water quality impairments is through a Stormwater Management Ordinance, which the City of Lexington is in the process of drafting and adopting as of 2017. NPDES Phase II standards require that permittees adopt and enforce a program to reduce pollutants in post-construction runoff from new development and redevelopment projects that disturb greater than or equal to 1 acre of land. This typically involves establishing design and review criteria for stormwater BMPs and post-development stormwater management, but approaches may vary.

One design approach that has proven effective at addressing stormwater concerns is low impact development (LID), which should be encouraged when drafting post-construction requirements. LID is commonly defined as systems and practices that use or mimic natural processes to foster infiltration, evapotranspiration, or use of stormwater in order to protect water quality and associated aquatic habitat. This typically includes green stormwater infrastructure or constructed stormwater BMPs, however, site designs can also make use of natural features to treat stormwater onsite. Additional vegetated areas help slow the flow of runoff so that it has an opportunity to be absorbed back into the ground or up into the atmosphere through evapotranspiration. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed (US EPA, 2017b).

There are multiple resources available that provide technical and policy guidance to local government staffs, building professionals, and consultants on low impact development principles and practices. Many of these resources can be found on the NCDEQ's Stormwater Program webpage at https://deq.nc.gov/about/divisions/energy-mineral-land-resources/energy-mineral-land-permit-guidance/stormwater-lid-storm-ez, including an LID Guidebook developed by NC State University, NCDEQ's BMP Manual, and LID guidance by the U.S. EPA. Each provides visual and policy examples for local governments to use in ordinance and standard development. Visuals are especially valuable to developers and can help streamline the approval process.

A wide variety of development policies can impact how stormwater is treated and managed beyond those included within a Stormwater Management Ordinance. Ordinances and standards must therefore be examined holistically to ensure consistency and that policies are effectively addressing water quality concerns. Many communities have ordinances or standards that actually interfere with effective site design and planning for stormwater management. For example, curb & gutter requirements may increase directly connected impervious areas that discharge directly into the stormwater conveyance system or street design standards may provide for overly generous pavement widths in low-traffic areas. While each of these standards play individual roles in overall community design, they have cumulative impacts throughout the watershed on stormwater and water quality.

If the City of Lexington and Davidson County do not wish to take a regulatory approach, they may consider providing development incentives to help encourage LID practices or other stormwater control measures. This strategy has proven successful in other cities and counties across the United States. In cities where a stormwater fee has been adopted, local governments can provide discounts or credits if property owners decrease a site's imperviousness or add LID practices to reduce the amount of stormwater runoff that leaves the site. However, development incentives can take many forms, including other permit fee reductions, expediting the permit approval process, or allowing higher density developments. Some communities have also found success using cost-share or award programs to help subsidize stormwater BMPs and recognize property owners that make use of LID practices (US EPA, 2012).

Plant selection also plays an important role in the treatment and storage of stormwater, as certain species of plants are able to absorb more water than others. Plants that are native to the region are generally better suited to survive in local climate conditions and superior to exotic plants in terms of stormwater management, because they often have deeper and more extensive root systems that prevent erosion and provide extra filtration. In addition, native plants require less fertilizer or chemical applicants in order to survive, which helps further protect water quality. The City of Lexington currently encourages the use of native plants as part of their riparian buffer requirements. However, Davidson County has no such provision in their development guidelines. Encouraging the use of native species in stormwater BMPs, but also in general landscaping standards, could help reduce the amount of invasive species and improve water storage throughout the watershed. Providing a list of native species for developers and their contractors, such as the one found at http://www.ncwildflower.org/native_plants/recommendations, may also prove useful in streamlining the development approval process.

Goal 3: Retrofit Existing Development

Existing Conditions

Development within the Swearing Creek Watershed has led to stormwater problems that are impacting the biological integrity of the stream. When land is developed, natural land cover is replaced with impervious surfaces, through the paving of roads and parking lots, compacting of soil, and construction of buildings. These hardened surfaces reduce the amount of water that can naturally infiltrate the ground, causing a larger volume and faster accumulation of surface runoff that erodes nearby stream banks and causes downstream flooding (Dunne & Leopold, 1978; Randolph, 2012). As stormwater runoff travels through urban environments, it also picks up several pollutants along the way, such as oil off of roadways, trash, organic waste, and other urban byproducts. Rather than being filtered and cooled naturally through permeable soil or vegetation, this water enters nearby waterways directly, altering water chemistry and negatively impacting aquatic habitat (Walsh et al., 2007). While updating development ordinances and design standards helps mitigate stormwater impacts that result from new development, it does not address stormwater issues being caused by existing development. Both will need to be solved if watershed health and function are to be restored.

Currently, within the Swearing Creek watershed, there are several areas that would benefit from stormwater improvements, especially within the City of Lexington. Using GIS modeling that considered the amount of impervious cover, size of existing buffers, soil types, and other factors, PTRC identified 19 areas that are under high stress as a result of development. These top priority project areas have been outlined in more detail in the Project Atlas. All but one of the 19 top-stressed sites identified within the watershed, are located within Lexington city limits – most of which are concentrated in Subwatersheds 6 & 7 (See Figure 13). Redevelopment of many of Lexington's commercial and industrial properties offer a wide variety of opportunities to affordably retrofit sites with stormwater practices that offset runoff and pollution. Incorporating stormwater BMPs and other vegetative cover on these sites would help improve infiltration and reduce the amount of surface runoff effecting Swearing Creek.

Stormwater retrofits are not a one-size-fits-all solution, however. Specific site conditions will need to be taken into account when designing and implementing stormwater solutions. Sites that are rich in clay are relatively impermeable, and thus, would have fewer benefits for stormwater capture and treatment. Based on soil-type mapping from the *Swearing Creek Watershed Assessment*, most of the soil within city limits is classified in the Type-A hydrologic soil group, which includes sand, loamy sand, or sandy loam types of soils. These soil types have low runoff potential and are well suited for stormwater retrofits.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Draft and adopt post-construction stormwater control measures	Davidson County, PTRC, Neighboring Cities with stormwater programs	UNC School of Governments Model Ordinance
2. Secure funding to implement identified restoration projects	PTRC, Davidson County, NCDEQ, DC Soil & Water, Piedmont Triad Conservancy, NC Land Trust, etc	NC DWR Watershed Funding Sources List, EPA Manual for Stormwater Funding
3. Implement restoration projects as outlined in the Project Atlas	PTRC, Davidson County, DC Soil & Water, Private Home/Business Owners	Project Atlas
4. Consider adopting a stormwater fee to help fund restoration projects	PTRC, Davidson County, Neighboring Cities with stormwater programs	EPA Manual for Stormwater Funding (US EPA 2006), Example Programs such as Puget Sound Raingarden Program
5. Incentivize private home/business owner investment in water quality projects	Stormwater SMART, Neighborhood Associations, Chamber of Commerce, etc	Example Stormwater Incentive Programs, Encouraging LID (US EPA, 2012)

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Consider adopting post-construction stormwater control measures	City of Lexington, PTRC, Neighboring Counties with stormwater programs	UNC School of Governments Model Ordinance
2. Secure funding to implement identified restoration projects	PTRC, City of Lexington, NCDEQ, DC Soil & Water, Piedmont Triad Conservancy, NC Land Trust, etc	Clean Water §319 grants, CWMTF, Stormwater Fees
3. Implement restoration projects as outlined in the Project Atlas	PTRC, City of Lexington, DC Soil & Water, Private Home/Business Owners	Project Atlas
4. Consider adopting a stormwater fee to help fund restoration projects	PTRC, City of Lexington, Neighboring Counties with stormwater programs	EPA Manual for Stormwater Funding, Example Programs such as Puget Sound Raingarden Program
5. Incentivize private home/business owner investment in water quality projects	Stormwater SMART, Lexington, Neighborhood Associations, Chamber of Commerce, etc	Example Stormwater Incentive Programs, Encouraging LID (US EPA, 2012)

As part of the development of this watershed restoration plan, several areas were identified and prioritized based on their potential for stormwater retrofits and restoration projects using GIS modeling. In general, sites that were located in urban areas that also had permeable soils were better suited for retrofit projects. This analysis resulted in a total of 16 top-priority restoration sites, which are outlined in the Project Atlas section of this report. Specific BMPs and restoration projects were then identified, using environmental data, aerial imagery, and field visits. These on-the-ground projects range from bioretention cells, to riparian buffer enhancements, to cattle exclusion fencing and have been estimated to provide water quality benefits by reducing overall nutrient and sediment loads.

While a few of the top-priority sites are located on public property, many are on privately owned land. Implementation will therefore require some coordination between public officials and private property owners, as well as an effort to inform residents about the need and benefits of water quality projects. Many communities have developed innovative ways to incentivize private participation in watershed restoration projects. Stakeholders in the Puget Sound area started the 12,000 Rain Garden campaign, which provides rebates and technical assistance for private citizens that wish to construct raingardens on their property (Stewardship Partners, 2018). This initiative has helped fund 3,845 raingardens to date. Other communities have started award programs to recognize property owners that take steps to improve water quality.

Funding will also be a significant factor in the implementation process. Retrofit projects can be expensive depending on the type of project and whether or not it requires any engineering expertise. Luckily, there are several grants available for stream and wetland restoration, stormwater BMPs, and general water quality projects. Some of the most notable are Section 319 Grants, which are administered by the U.S. EPA, and Clean Water Management Trust Fund (CWMTF) Grants. A comprehensive list of financial resources, including grants, cost shares, and loans, has been compiled by NCDWR's Use Restoration Watershed Program and can be found at https://deq.nc.gov/about/divisions/water-resources/planning/basin-planning/use-restoration-watershed-programs/funding.

Some communities have established their own programs to help fund stormwater retrofit projects. One of the most common approaches is to implement a stormwater fee. Like other utility fees, a stormwater fee assesses property owners based on the amount of stormwater generated from their properties. This is typically based on the amount of impervious cover on site. However, stormwater retrofits and restoration projects can be funded in many different ways, including property taxes/general funds, special assessment districts, or other funding structures. The U.S. EPA has several valuable resources available, including a factsheet of potential funding structures for stormwater programs which can be found at https://www3.epa.gov/npdes/pubs/region3_factsheet_funding.pdf, as well as a municipal handbook on green infrastructure retrofit policies (Bitting & Kloss, 2008).

Goal 4: Restore Riparian Buffers

Existing Conditions

There is broad scientifically-based consensus that contiguous, intact riparian buffers are essential for the healthy functioning of streams (McNaught, et al., 2003). Vegetated buffers help filter debris, nutrients, sediment, and other pollutants from surface flow before it reaches catchment waters. Perhaps most importantly, riparian buffers have the ability to reduce the velocity and disperse the volume of stormwater runoff before it reaches streams and erodes their banks and beds. Alternatively, streambanks in urban subwatersheds that have been "stabilized" using concrete or other materials, not only see increased risks of flash flooding and poor surface water filtration, but also have more degraded aquatic habitat due to more intense stormflow velocity downstream.

Sufficient riparian buffer widths vary greatly depending on the site's soil type, slope, and land use, as well as what resource the buffer is intending to protect. For example, a riparian buffer of 30 feet may be sufficient for sediment and erosion control, while a riparian buffer of over 300 feet may be required to preserve wildlife habitat (Hawes & Smith, 2005). Generally, wider buffers are more effective at filtering pollutants and protecting water quality up a certain extent (around 100 ft), and some buffer is better than no buffer at all. The NCWRC recommends preserving 50 foot native, forested buffers on each side of intermittent streams and 100 foot buffers on each side of perennial streams in subwatersheds without federally listed aquatic species (NCWRC 2002). Although variable widths may be more applicable in some circumstances, they are often more difficult to understand, implement, and enforce. Thus, many jurisdictions have generalized buffer requirements.

In North Carolina, local governments are limited by general statute in the extent and size of riparian buffers that they can enforce. The state requires 30 feet of undisturbed riparian buffer and up to 20 feet of managed area outside the 30-foot undisturbed areas in its protected watersheds. However, the High Rock Lake watershed, which Swearing Creek is a part of, has not yet fallen under such state restrictions. The City of Lexington, however, has taken proactive steps to adopt their own riparian buffer requirements. All new development is required to maintain a 50-foot vegetated buffer along both sides of all watercourses and 25-foot buffers around impoundments. This is a strict regulation, only permitting development "…limited to flood control, stream bank stabilization, water dependent structures and other projects such as road crossings and greenways where no practical alternative exists" (City of Lexington 2010). If these controls are used, they are required to minimize built-upon surface area, direct runoff away from the surface waters, and maximize the utilization of BMPs.

Davidson County encourages open space and buffer preservation, but does not mandate these features for new or enhanced development. The Federal Emergency Management Agency (FEMA) National Flood Insurance Program (NFIP) delineates the 100-year floodplains nationwide in an effort to discourage development in these environmentally-sensitive and hazardous areas. Both Davidson County and Lexington discourage, but do not prohibit, construction within the 100-year floodplain. Although no riparian buffers are required in Davidson County, development within them is limited to "Low Impact" and "Recreational" uses (Davidson County, 2009).

Despite recent efforts by both jurisdictions to improve local riparian protections, several opportunities remain to further strengthen and restore buffers throughout the watershed. Some sections of Swearing Creek and its tributaries have minimal to no vegetation, while others have been completely built upon. These developments likely took place prior to riparian buffer requirements, but require addressing if substantial watershed improvements are to be made.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Continue to enforce local riparian buffer requirements for new development and redevelopment projects	N/A	N/A
2. Implement riparian buffer and conservation improvements identified in the Project Atlas	PTRC, Davidson County, DC Soil & Water, Private Business/Home Owners	§319, CWMTF, or Duke Water Resources grants, NCSU Guide for Riparian Vegetation
3. Coordinate conservation efforts with Davidson County Greenway Master Plan	PTRC, Davidson County, Central Land Trust of NC, Piedmont Land Conservancy	Davidson County Greenway Master Plan
4. Incentivize private home/business owner investment in riparian buffers	Stormwater SMART, Davidson County, Private Business/Home Owners	Example Stormwater Incentive Programs, Encouraging LID (US EPA, 2012)
5. Restore buffers on all public easements and City-Owned property where possible	N/A	NCSU Guide for Riparian Vegetation

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Expand Watershed Protection Ordinance to apply to non-water supply watersheds	N/A	N/A
2. Implement riparian buffer and conservation improvements identified in the Project Atlas	PTRC, City of Lexington, DC Soil & Water, Private Business/Home Owners	§319, CWMTF, or Duke Water Resources grants, NCSU Guide for Riparian Vegetation
3. Coordinate conservation efforts with Davidson County Greenway Master Plan	PTRC, City of Lexington, Central Land Trust of NC, Piedmont Land Conservancy	Davidson County Greenway Master Plan
4. Incentivize private home/business owner investment in riparian buffers	Stormwater SMART, City of Lexington, Private Business/Home Owners	Example Stormwater Incentive Programs, Encouraging LID (US EPA, 2012)
5. Restore buffers on all public easements and County-Owned property where possible	N/A	NCSU Guide for Riparian Vegetation

Restoring riparian buffers within the Swearing Creek watershed will require a two-pronged approach that incorporates replanting vegetation in needed areas while ensuring riparian zones are not further disturbed by new development or redevelopment. Similar to implementing retrofit projects, this will require a joint effort between both public and private entities. One of the best places to start is to examine City and County-owned property to assess existing buffers and reevaluate vegetative maintenance practices. It may be appropriate to establish low (areas that are only mowed one to two times a year) or "no-mow" zones to allow native plants and grasses to regrow. These natural areas help stabilize streambanks, reduce stormwater runoff, and provide valuable shade and wildlife habitat. Davidson County may also want to consider expanding the riparian buffer protections that exist within the Watershed Protection Ordinance for water-supply watersheds to all watersheds within the county. This would create consistent standards throughout the watershed, simplify the development approval process, and improve water quality in non-water-supply watersheds.

The City of Lexington and Davidson County should also seek creative solutions that incentivize private participation in riparian buffer programs. There are multiple examples of successful riparian buffer programs that have used a variety of incentives, ranging from cost-share programs and tax credits to awards and recognition. Landowners (primarily farm owners) in North Carolina can receive financial assistance for establishing riparian buffers through programs such as the NC Conservation Reserve Enhancement Program and the NC Agricultural Cost Share Program (Osmond & Burchell, 2017). The NC Conservation Reserve Enhancement Program (CREP) is a conservation program administered by the U.S. Department of Agriculture's (USDA) Farm Service Agency (FSA) that is targeted to address water quality, soil erosion, and wildlife habitat concerns. The program offers annual rental payments, cost-share payments, and other incentive payments to landowners under 10, 15, or 30 year conservation contracts. Permanent conservation easements are also possible. To qualify, the land must be either cropland that was row cropped 2 of the past 7 years or marginal pastureland adjacent to a perennial or seasonal stream that was grazed 2 of the past 7 years. The NC Agriculture Cost-Share Program is a competitive cost-share program administered by local soil and water conservation districts to develop and develop and approve conservation plans and implement best management practices.

Goal 5: Promote Infill Development to Conserve Water Resources and Reduce Stormwater Runoff

Existing Conditions

Stormwater is a significant source of water quality pollution in the Swearing Creek watershed, of which the City of Lexington is the most significant source. The city occupies a large percent of subwatershed 6, 7, & 8 on the eastern side of Swearing Creek (see Figure 1). Though it represents only a small percent of the entire watershed, the amount of impervious surfaces result in additional stormwater loads entering Swearing Creek, leading to increased erosion, temperature, nutrients, and other pollutants. The level of impervious cover in subwatersheds 6 and 7 are 17.6% and 19.9% respectively. The Center for Watershed Protection has found that stream quality in a watershed begins to decline when that watershed is covered by more than 10% impervious surface. In order to improve watershed conditions, it will be essential to limit the amount of impervious cover generated by new development and redevelopment or ensure that stormwater is treated onsite through stormwater BMPs, which will be required by the City of Lexington's new stormwater ordinance. Another way to achieve this goal is to discourage sprawl around the City of Lexington and, instead, prioritize redevelopment of the existing urban core.

The City of Lexington has been hit hard economically for the past couple of decades, which has resulted in a series of abandoned businesses and vacant houses. Once a thriving furniture production capitol, it lost 6% of its population between 2000 and 2010, and at one point had a home vacancy rate up to 4,253 homes per square mile, below 0% business growth rate, and was in the bottom 5th percentile for median household income in the twelve-county Triad region. However, economic conditions are improving. The Uptown Lexington district is seeing commercial growth again and residential growth in the city is recovering from the 2008 recession as well. This renewed momentum in development presents several opportunities to make use of existing infrastructure and restore many of the vacant buildings within the city. Additionally, the City of Lexington has dedicated resources to an Uptown Lexington urban revitalization and reinvestment program, and invested money and staff to implement Brownfield redevelopment at abandoned furniture factories within the City.

The City of Lexington utilizes a Land Use Plan (LUP) and Land Use Ordinance (LUO) to manage development and growth within the City, as dictated by the Land Use Goals and Policies detailed in the LUP. There are multiple instances throughout the Ordinance that explicitly addresses the City's interest in redevelopment and infilling underutilized property throughout Lexington. The City helps guide development within its jurisdiction using five distinct planning districts. These districts include the Central Planning Area, the North-East Planning District, the South-East Planning District, and the South-West Planning District, and are primarily located east of the railroad tracks, which bisect the City along the ridgeline that separates the Lower Abbotts and Swearing Creek watersheds. They have been recommended for urban redevelopment, focusing on Urban Infill, Primary Growth, and Secondary Growth (mainly in the South-East and South-West Planning Districts). The development recommended for these zones are "Traditional Neighborhood Development," and "Neighborhood Center" and "Village Center Districts," with Conservation Corridors promoted to connect various development nodes spread out in the greater Lexington area (PTCOG 2004).

Uptown Lexington is a mixture of commercial, high density residential, and institutional parcels, but many commercial and industrial properties are now vacant. Light and heavy industrial parcels and heavy commercial areas are focused in the City and the main transit thoroughfares. Commercial growth in the watershed is focused on the three main transit arteries that transect Lexington (I-85, I-85 BUS, & US-64). There are scattered commercial zones throughout the rural areas of the watershed in expected ways (i.e. crossroads, near High Rock Lake). Residential growth has occurred just north of Lexington's City limits (Subwatershed 6 & 7), and to its southwest in the Swearing Creek watershed. Perhaps most significant, though, are the large areas of suburban and traditional residential zones, which encourage both mixed-use development as well as denser, more innovative neighborhood design approaches. Such flexibility and explicitly detailed in the LUO will strongly serve the City's economic and redevelopment aspirations, while also benefiting watershed conditions.

Zoning in the watershed's rural areas is almost entirely classified for large area, low-density residential use. There are no ordinances limiting subdivision or altering use through application in either Davidson County or Lexington (PTCOG 2004). Given these conditions, the unregulated sprawl of decentralized residences and businesses relying on uninspected septic tanks for their waste disposal is a likely and unfortunate future without better land use regulations and enforcement capacity. Such developments contribute to suburban sprawl, as planners realize the environmental and public costs of rural residents who must rely upon urban services (e.g. ambulance, fire, etc.). However, if expanded strategically, these same urban services, especially the provision of water and sewer, can help concentrate development and reduce sprawl.

The City and Davidson County staffs often share information and perspectives on land use and its impacts, and there is a high level of coordination between municipal and county policies. However, few County ordinances discourage low-density growth patterns, or mention the issue explicitly. Creating incentives to make use of existing infrastructure would provide several benefits to the Swearing Creek watershed. Infill development was strongly recommended in the Lower Abbotts Creek Watershed Restoration Plan, as it is cost-effective for the city to use its existing infrastructure to serve residential and economic growth while also reducing the burden that sprawling development places upon the surrounding watershed.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Inventory vacant and underutilized properties and identify potential barriers to development	Lexington Area Chamber of Commerce, PTRC	EPA Attracting Infill Development in Distressed Communities Guide
2. Consider providing incentives for developers that invest in infill locations	PTRC, NC Wildlife Resources Commission	EPA Attracting Infill Development in Distressed Communities Guide
3. Partner with PTRC to reestablish a Brownfield Cleanup Program	PTRC, NC DEQ	EPA Superfund, NC DEQ Brownfield Redevelopment Toolbox
4. Develop an Economic Development Plan to stimulate redevelopment and protect natural resources	Lexington Area Chamber of Commerce, Davidson County, PTRC	US Department of Commerce Economic Development Support Grant, Sustainable Communities Regional Planning Grant

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Amend LDP, subdivision regulations, and/or zoning ordinance to discourage sprawl	PTRC, NC Wildlife Resources Commission	Smart Growth America Policy Guide, EPA Smart Growth Guide, APA Smart Growth Policy Guide
2. Develop an Economic Development Plan to stimulate redevelopment and protect natural resources	City of Lexington, Lexington Area Chamber of Commerce, PTRC	US Department of Commerce Economic Development Support Grant, Sustainable Communities Regional Planning Grant
3. Modify Infrastructure Improvement Plan to meet economic and watershed restoration goals	PTRC	EPA Protecting Water Resources with Smart Growth Guide

There are a variety of planning policies and strategies that can be utilized to encourage infill development and reduce sprawl. One of the most common, is to increase density and flexibility for mixed-use zones through zoning and land use planning in order to better cluster development. Loosening density restrictions often creates more development opportunities because developers are able to make a greater return with less land. Local governments can also utilize an adaptive reuse ordinance, which helps make it easier to convert older and historic buildings to new uses. Adaptive reuse ordinances provide tailored zoning and code requirements that recognize the development challenges of reuse. The key is to allow flexibility within development regulations in order to make adaptive reuse projects more financially feasible.

Communities can also provide certain incentives to encourage infill development. Forms of incentives can range from expediting development review for qualified proposals, to easing parking requirements in infill locations, or providing density bonuses. Local governments can also utilize a tiered impact fees to more adequately offset the costs of new capital facilities and services. Typically fee structures are based on the size of development, whereas tiered impact fees also take into account distance from existing infrastructure, creating lower fees for development within already urbanized areas. Other communities have chosen to invest in public transportation to encourage development along transit lines.

It is recommended that the City of Lexington and Davidson County work together to align future land use plans, economic development plans, and infrastructure improvements to conserve existing natural resources and mitigate sprawl and increases in impervious surface. This will require a shared vision of where and how these two communities would like to grow. By identifying certain areas, where development would be most suitable, the City and County can better target policies to encourage development and mitigate sprawl in other areas of the watershed.

There are several resources available that provide guidance on developing policies that encourage infill development. The US EPA, in particular, has written multiple reports on smart growth policies to assist local governments, including "Attracting Infill Development in Distressed Communities" (2017), in which they outline 30 different strategies for planners to utilize. The NCWRC also provides development regulation guidance within their Green Growth Toolbox. As part of this resource, the NCWRC provides training and technical assistance for local government staffs upon request.

Goal 6: Protect Rural Land

Existing Conditions

Conserving open space provides several benefits to local communities. It protects biodiversity and habitat for local wildlife, improves air quality, and provides access to parks, trails, and greenways for recreation. Conservation can also have substantial benefits to water quality, as it helps reduce the amount of overall impervious cover within the watershed, and will be an essential tool to help restore Swearing Creek. Protecting forests and meadows along rivers and creeks prevents polluted runoff and sediment from contaminating waterways, helping to ensure clean drinking water supplies downstream. Conservation can also have substantial economic benefits. Agriculture and tourism, North Carolina's two largest industries rely on immediate access to undeveloped land.

Natural open spaces not only protect water quality and ecological habitat, they are integrated into the historical culture of Davidson County and its cities. Though Lexington was an industrial center for furniture production throughout much of the twentieth century, it was always a city within a larger natural and agrarian landscape. Davidson County clearly states that it values its identity as a rural community of open spaces and farms, and the few land use regulations it does have are designed to protect that legacy, including

mandatory visual buffers on residential developments that could disrupt the County's otherwise rural character. Davidson County recently cited the need to create a Farmland Preservation Committee to protect agricultural uses and spaces in this urbanizing county. The creation of such a Committee would certainly benefit this effort to conserve rural land in Davidson County into the future.

Currently, there is little protected land within the Swearing Creek watershed, and most of those lands that are present are either dedicated to public use as municipal parks and golf courses. Municipal parks are fantastic investments that also yield multiple economic and public health benefits, but they are generally sites of compacted soils and intensive use. In the Swearing Creek watershed, none of these parks are in particularly valuable areas for watershed and water quality protection, although their presence is more helpful than their absence. Golf courses can be huge benefits to a watershed and the two in this watershed are in strategic locations that could be very valuable to water quality protection in this watershed. However, similar to farms, if not managed properly, golf courses can also be intense sources of pollution due to the over-application of fertilizers and pesticides while not maintaining vegetated buffers along streams on the course. It will be crucial to work with course managers and farm operators to discuss these concerns and acknowledge their role as watershed stewards to the larger watershed population.

The Davidson County Tax Department has a tax-deferment program for lands that obligate themselves to use conservation practices in their farming, forestry, or conservation operations. North Carolina recently reduced its requirements for tax deferment so that only 20 acres must be committed to conservation practices in order to have tax obligations reduced. Voluntary agriculture districts (VADs) are also used in the County, with several already in place throughout the Swearing Creek watershed. VAD programs are an effective incentive that preserves Davidson County's agrarian heritage in this fast-growing County.

Landowners of 11 individual parcels are participating in the VAD program, and thereby dedicated to rural uses. VAD lands must be certified by the Davidson County Tax Department in order to receive a property tax deferment or credit, and are inspected regularly to ensure that they are meeting VAD requirements. These dedicated parcels occupy a small area of the entire watershed area. The NC Wildlife Resources Commission offers similar benefits through their Wildlife Conservation Land Program, whose requirements can be found at http://www.ncwildlife.org/Conserving/Programs/Land-Conservation-Program. As the urban centers within Davidson County grow in population, conserving open spaces and agricultural land will help preserve the County's agrarian heritage and maintain high quality waters. Davidson County's status as one of the fastest-growing counties in the Upper Yadkin River Basin only emphasizes the need to protect these lands.

For the purposes of this project, PTRC identified 15 potential conservation projects, using GIS modeling, in environmentally sensitive areas that would benefit watershed conditions. Variables considered when identifying these top priority conservation sites included: high biodiversity and wildlife, low impervious cover, large parcel sizes, existing stream buffers, soil types, population density, land ownership, canopy cover, floodplains, steep slopes, and low impact zoning. Each of these top priority projects have been outlined in more detail in the Project Atlas. Taking steps to contact individual property owners and encourage them to participate in existing VAD or other conservation programs would be a great way to inform private property owners about these incentives and increase the amount of dedicated land.

Although conservation projects will benefit any ground or surface water source, they are particularly effective in communities where tracts of unprotected forest or grasslands are still privately owned and where there are overlapping benefits, such as flood control or recreation. Davidson County is well suited for such conservation projects, since it has a rich rural heritage, with large tracts of undeveloped land still held in

private ownership, and interest in multiple overlapping goals such as conserving farmland, improving water quality, and expanding recreational opportunities.

The PTRC's Green Infrastructure Network (2016) offers additional guidance for future investment in conservation and open space protection in the Swearing Creek watershed. This report outlines areas that were determined, through GIS modeling, to have the highest potential or real value for all environmental assets (including agriculture) within the 12-county Piedmont Triad region. It is intended for use by all local governments, as well as non-profit groups who are engaged in conservation efforts.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Contact land owners of top priority conservation projects to gauge interest in donating land for conservation	LandTrust for Central NC, NC Wildlife, Davidson County	Project Atlas
2. Coordinate conservation efforts with Davidson County Greenway Plan	Davidson County, NC DOT	NC Parks and Recreation Trust Fund, Transportation Equity Act Funding, CWMTF, LWCF
3. Encourage infill and cluster development	Davidson County, PTRC, NC Wildlife	EPA Attracting Infill Development in Distressed Communities Guide
4. Enhance ecological function of city-owned parks through additional plantings and buffers	NC Wildlife	Green Growth Toolbox, NC Wildflower Native Species List

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Contact land owners of top priority conservation projects to gauge interest in donating land for conservation	LandTrust for Central NC, NC Wildlife, City of Lexington	Project Atlas
2. Implement Davidson County Farmland Preservation Plan	LandTrust for Central NC, DC Soil & Water, NC Cooperative Extension, NC Wildlife	NC Agriculture Development and Farmland Preservation Trust Fund
3. Create a Farmland Preservation Committee Working Group	NC Cooperative Extension, DC Soil & Water	N/A
4. Coordinate conservation efforts with Davidson County Greenway Plan	City of Lexington, NC DOT	NC Parks and Recreation Trust Fund, Transportation Equity Act Funding, CWMTF, LWCF

Goal 7: Encourage Agricultural BMPs

Existing Conditions

Davidson County has a rich agricultural heritage, with an emphasis on dairy cattle and hay and a history of subsistence agriculture and dairy and tobacco farms. Despite increasing urbanization from Winston-Salem to the north and growth along I-85, the county retains a strong rural identity. 64% (31 square miles) of the Swearing Creek watershed is outside of the City of Lexington, although 71% of the land is dedicated to non-urban uses. Farming is still one of the largest uses of land within the watershed and will likely continue to be a dominant practice for the foreseeable future. However, if mismanaged, agricultural practices can negatively impact surface water.

Traditional farming practices incorporate the use of fertilizers and pesticides to boost crop growth and resistance to pests and disease. Excessive use of either commercial fertilizer or manure, improper application methods or timing, or inadequate BMPs to minimize leaching or runoff can contribute nutrients, such as phosphorus and nitrogen, that cause excessive plant and algae growth in lakes and streams. Row-crop production can also cause increases in sediment load in lakes and rivers, as exposed soil is more susceptible to wind and water erosion. If livestock have continuous, unrestricted access to streams and lakes, manure ends up in the water and riparian vegetation may be severely damaged, exposing compacted soils to erosion. High Rock Lake has been impaired for high chlorophyll-*a* concentrations, as well as high turbidity, which could partially be a result of excess nutrients and exposed soils from farming operations.

Water quality data collected during the *Swearing Creek Watershed* Assessment also suggest that fecal coliform is a substantial water quality concern for Swearing Creek (2017). Data was collected from the Yadkin-Pee Dee River Basin Association (YPDRBA), which has had a permanent monitoring station just south of Jersey Church Rd for the past several decades. Since 2013, there have been several instances where fecal coliform levels at the YPDRBA site have exceeded NC DEQ standards. The largest spike occurred in July 2014, when levels reached 8600cfu/100ml, 43 times NC DEQ's limit. Acute violations of the 200 cfu/100mL water quality standard have not led to an impairment rating of these waters by NC DEQ due to the requirements that all fecal coliform bacteria impairments be declared only following a protocol that requires five samples within 30 days (NC DWR 2014b). However, if not addressed, contaminants could pose substantial health concerns for downstream users.

There are a few potential sources of fecal coliform contamination. Livestock or wild animals may be accessing Swearing Creek, leading to fecal waste entering the stream. Excessive fertilizer or manure application could also be picked up by stormwater runoff if exposed to heavy rains. In the more rural parts of the county, most residential and commercial properties are served by on-site septic systems. If these systems fail, they could be a potential source of fecal coliform. However, this seems unlikely due to the low concentrations of residential developments. All wastewater complaints or septic failures are reported to Davidson County's Health Department or forwarded to NC DEQ's Winston-Salem Regional Office.

Davidson County presumably follows the State O200 animal regulations with regards to animal feed lots and waste regulation as there is no county ordinance that addresses this concern. Poultry operations are exempt from regulatory oversight. There is one poultry farm in the watershed, but the stakeholders and water quality data indicate that it is not a significant source of agricultural pollution (Personal correspondence with Davidson County Soil & Water Conservation District). The County offers a wide variety of conservation programs and services to private land owners to provide financial and technical assistance. Some of these programs include the North Carolina Agriculture Cost Share Program (NCACSP), USDA

Environmental Quality Incentives Program (EQIP), and several local financial assistance programs for measures that reduce water consumption, improve water quality, and protect wildlife habitat. Participation in any benefits program requires a site specific conservation plan to preserve land and water quality.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Consider addressing the use of fertilizers/pesticides and animal waste to reflect state regulations within stormwater ordinance	Davidson County	Nutrient Reduction Model Stormwater Ordinances
2. Partner with DC Soil & Water to identify and implement BMP projects, as well as monitor existing systems	DC Soil & Water, DC Cooperative Extension	CWMTF, §319, stormwater fees, or other water quality grants
3. Continue educational programs to increase awareness about BMPs	DC Soil & Water, DC Cooperative Extension, Stormwater SMART	N/A

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Consider adopting an ordinance to address the use of fertilizers/pesticides and animal waste to reflect state regulations	City of Lexington	Nutrient Reduction Model Stormwater Ordinances
2. Partner with DC Soil & Water to identify and implement BMP projects, as well as monitor existing systems	DC Soil & Water, DC Cooperative Extension	CWMTF, §319, or other water quality grants
3. Increase marketing and awareness of agricultural BMP cost-share and technical assistance programs	DC Soil & Water, DC Cooperative Extension	CWMTF, §319, or other water quality grants
4. Continue educational programs to increase awareness about BMPs	DC Soil & Water, DC Cooperative Extension, Stormwater SMART	N/A

There are several practices that can help reduce nutrient pollution from agricultural activities, including:

Nutrient management: Applying fertilizers in the proper amount, at the right time of year and with the right method can significantly reduce the potential for pollution.

Cover crops: Planting certain grasses, grains or clovers can help keep nutrients out of the water by recycling excess nitrogen and reducing soil erosion.

Buffers: Planting trees, shrubs and grass around fields, especially those that border water bodies, can help by absorbing or filtering out nutrients before they reach a water body.

Conservation tillage: Reducing how often fields are tilled reduces erosion and soil compaction, builds soil organic matter, and reduces runoff.

Managing livestock waste: Keeping animals and their waste out of streams, rivers and lakes through exclusion fencing keeps nitrogen and phosphorus out of the water and restores stream banks.

Drainage water management: Reducing nutrient loadings that drain from agricultural fields helps prevent degradation of the water in local streams and lakes.

According to Davidson County's Soil & Water Conservation District, several farm operators are already incorporating BMPs where possible, including exclusionary fencing and no-till practices, which greatly helps mitigate water quality impacts. There are, however, remaining opportunities to improve farm management practices within the watershed. Lexington and Davidson County should coordinate with Davidson County Soil & Water in order to identify and implement agricultural BMP projects, particularly on properties that do not currently utilize conservation measures, and continue to monitor existing systems. Davidson County Soil & Water currently offers a wide variety of financial and technical assistance programs to assist land owners with conservation measures and BMPs. The City and County should seek to increase awareness and use of these programs through targeted marketing efforts. Continued partnerships with Davidson County Cooperative Extension, Soil & Water, and Stormwater SMART to provide educational opportunities to farmers will also help boost awareness of best management practices and conservation programs.

Goal 8: Continue Enforcement of Erosion Control & Illicit Discharge Rules

Existing Conditions

Sediment and erosion control practices at all new development and redevelopment sites are of high importance to water quality in the Swearing Creek watershed. High Rock Lake has been impaired for exceeding turbidity standards since 2014 and will require more effective soil and erosion controls within its watershed and all tributaries. The state has a fairly rigorous erosion and sediment control program, with an extensive field manual for design and implementation of controls and measures (NC SCC, et al., 2009). Lexington and Davidson County use the NC Erosion & Sedimentation Control Design Manual when directing developers during new development or redevelopment that disturbs more than 1 acre of land. Lexington's recent designation as a NPDES Phase II community will require them to expand these controls to include post-construction soil and erosion and stormwater control as well.

Developers must create a comprehensive soil erosion and sedimentation control system, minimizing their land grading, disturbance to the riparian buffer, efficacy of stormwater control BMPs, and fill material. NC DEQ has a manual, last updated in 2009, that addresses all of these issues (NC SCC et al., 2009). The DEQ Division of Energy, Mineral, and Land Resources (DEMLR) updates the field manual and employs inspectors

to enforce rules and regulations based upon the North Carolina Sedimentation Pollution Control Act passed in 1973 and amended in 1989 (NC SCC, et al., 2009).

Both Davidson County and the City of Lexington rely upon the NC DEQ Winston-Salem regional office to oversee and enforce their federal soil and erosion control requirements for new construction. The regulators at the Winston-Salem office generally only inspect stormwater controls on newly-constructed sites. While they do respond to public complaints or concerns, they simply do not have the staff capacity to regularly inspect sites for post-construction stormwater controls, nor are they federally-obligated to do so. Although this helps remove a middle-man, this partnership between DEQ and local governments, unfortunately, tends to result in poor enforcement and, consequently, degrading water quality. Lexington and Davidson County may want to consider establishing an inspections and enforcement program of their own to help enforce sediment control and IDDE regulations.

The City of Lexington's Water Resources Department provides information about the harmful effects of illicit discharges on water quality in its annual Water Quality Report. Community members are requested to report any violations to the City. Community monitoring is a valuable resource to help detect illicit discharges, however, due to the size of the watershed and limited resources, it is difficult to monitor every storm drain or stream access point. Educational outreach would be a good way to increase community awareness about proper watershed stewardship and where to report any water violations.

Davidson County has an ordinance that prohibits the disposal of regional waste or hazardous waste within its boundaries (Davidson County, 2009). This ordinance is complimented by the Davidson County Hazard Mitigation Plan, which specifically addresses disaster response, hazardous materials spills, hazardous waste storage, and other emergency concerns for all county jurisdictions and citizens, which was revised in 2009.

Davidson County is largely disconnected from any centralized wastewater system in the Swearing Creek watershed. Most residential and commercial properties are served by on-site septic systems. All wastewater complaints or septic failures are reported to Davidson County's Health Department or forwarded to NC DEQ's Winston-Salem Regional Office. This situation is representative of all the non-urban areas of the watershed - about 71% of its total area. This is of particular concern for recreational housing along High Rock Lake, where anecdotal information indicates that septic failure and illicit discharges of gray water and sewage are a significant source of nutrient inputs to the watershed and High Rock Lake. Illegal dumping and litter have also been a recent concern of Davidson County. Although there is not substantial evidence to indicate that litter is impacting water quality, this waste eventually makes its way into local water bodies due to stormwater runoff, likely having negative impacts. Improved enforcement of sediment control regulations, as well as better detection and elimination of illicit discharges will help strengthen construction related stormwater controls and reduce the amount illegal dumping occurring within the watershed.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Draft and adopt a Comprehensive Stormwater Management Ordinance to address erosion control and IDDE	Davidson County, PTRC, Neighboring Cities with Stormwater Programs	UNC School of Governments Model Ordinance
2. Consider establishing an inspections and enforcement program separate from NC DEQ	Davidson County	EPA IDDE Guidance Manual, Stormwater Fees, EPA Manual for Stormwater Funding
3. Increase public awareness about report hotline and illicit discharge detection	Stormwater SMART, NCDWR	EPA Environmental Education Grants
4. Partner with Stormwater SMART & Keep Davidson County Beautiful to schedule regular clean-ups	Stormwater SMART & Keep Davidson County Beautiful	N/A

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Partner with City of Lexington to draft and adopt a Stormwater Management Ordinance to address erosion control and IDDE	Davidson County, PTRC, Neighboring Cities with Stormwater Programs	UNC School of Governments Model Ordinance
2. Consider establishing an inspections and enforcement program separate from NC DEQ	City of Lexington	EPA IDDE Guidance Manual, Stormwater Fees, EPA Manual for Stormwater Funding
3. Increase public awareness about report hotline and illicit discharge detection	Stormwater SMART, NCDWR	EPA Environmental Education Grants
4. Partner with Stormwater SMART & Keep Davidson County Beautiful to schedule regular clean-ups	Stormwater SMART & Keep Davidson County Beautiful	N/A

Goal 9: Increase Watershed Education & Outreach Opportunities

Existing Conditions

While strengthening regulations and creating incentives are useful tools to improve watershed management and reduce the amount of pollutants entering Swearing Creek, increasing public awareness through education and outreach can be one of the most effective ways to enhance watershed stewardship. Most people do not realize that simply because they do not live adjacent to a stream or river does not mean that their actions do not have an impact on water quality within the region. All activities including development, construction, landscaping, forestry, and agricultural practices can affect the health of a watershed and everyone has a vested interest to protect it. Outreach and education can help instill an environmental ethic and improve awareness about the impacts of stormwater and watershed stewardship.

The City of Lexington and Davidson County both participate in PTRC's Stormwater SMART program, which provides hands-on stormwater education opportunities around the region. This program was founded in 2005 through NC Division of Water Quality 205j grant funding in order to help local governments meet NPDES Phase II outreach and education requirements. The program has blossomed since this time and consistently partners with schools and other groups around the region to increase stormwater awareness and environmental programming. Although Stormwater SMART is very active throughout the Swearing Creek watershed, the program must divide its time evenly between its 19 member communities. Increasing the number of local partnerships, educational materials, and outreach opportunities would help spread awareness of Swearing Creek's current impaired status and how we all can work together to improve its water quality.

Stakeholder meetings that were held throughout the development of the Watershed Assessment and Restoration Plan, yielded several ideas to increase watershed outreach and education. The most popular of which was to strategically place educational signage at local parks and popular stream access points to alert people about the Swearing Creek watershed, its impaired status, and how actions throughout the watershed shape the creek's future. Other potential ideas were to develop brochures for local landowners and businesses, increase social media presence, increase partnerships with local school programs, organize regular clean-ups, and re-ignite DC FISH and citizen science water quality monitoring programs.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Work with PTRC to develop watershed signage	PTRC	Sign Examples
2. Install signs at parks and other popular access points	N/A	N/A
3. Continue partnership with Stormwater SMART to provide hands-on learning opportunities	PTRC, Stormwater SMART	EPA Environmental Education Grants
4. Seek Additional Partnertships to Expand Stormwater Education	DC TRIP, Keep Davidson County Beautiful, Davidson County School System, etc	N/A

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Work with PTRC to develop watershed signage	PTRC	Sign Examples
2. Install signs at parks and other popular access points	N/A	N/A
3. Continue partnership with Stormwater SMART to provide hands-on learning opportunities	PTRC, Stormwater SMART	EPA Environmental Education Grants
4. Seek additional partnertships to expand stormwater education	DC TRIP, Keep Davidson County Beautiful, Davidson County School System, etc	N/A

Goal 10: Continue and Expand Water Quality Monitoring

Existing Conditions

Water quality monitoring is a critical aspect of any watershed restoration plan. Initial monitoring, such as the monitoring conducted during the watershed assessment, provides an initial baseline to gauge watershed conditions. This helps inform what type of restoration strategies need to be implemented in order to reduce certain pollutants. However, monitoring is also important during and after the watershed restoration plan's implementation. Continued water quality monitoring allows local jurisdictions, and those involved throughout the implementation process, to gauge whether restoration efforts have had the positive impacts that were expected, or if management strategies need to be modified or adapted to meet changing water quality or watershed conditions. This better informs decision making, saving resources and resulting in more desired and effective outcomes.

There are currently three primary sources of water quality data for Swearing Creek. The first is NC Department of Water Resources (NC DWR) Bioassessment Branch that conducts benthic macroinvertebrate and fish community samples near NC 47 periodically. However, this sampling rotates regions throughout the state and therefore, is not taken on a consistent basis. Water chemistry monitoring is conducted by the YPDRBA, who oversees one permanent ambient monitoring station where the creek crosses Jersey Church Rd. This station monitors temperature, dissolved oxygen (DO), acidity (pH), nutrient loads, suspended solids, turbidity, and fecal coliform. For the purposes of the watershed assessment, the City of Lexington's water resources staff, took samples at five additional locations throughout the watershed from 2014 to 2015. However, the City does not have the time or resources to permanently monitor water quality at these locations. Having only 1 permanent monitoring site limits the amount of data available on Swearing Creek and does not provide an accurate representation of the watershed as a whole. Expanding the number of collection sites would help better inform future management decisions. These efforts do not have to be undertaken solely by the City, County, or NC DEQ. Instead, they could be supplemented by citizen science programs, such as DC FISH, if this program was reestablished.

Recommended Management Strategy

City of Lexington

Recommended Strategy	Potential Partners	Potential Resources
1. Petition NC DEQ to conduct up-to-date fish community samples at Swearing Creek	Davidson County, NC DEQ	N/A
2. Discuss monitoring of chlorophyll-a with YPDRBA	Davidson County, YPDRBA	N/A
3. Seek funding to increase number of ambient monitoring sites throughout watershed	NC DEQ, YPDRBA	CWA §106 Grants Z. Smith Reynolds Foundation, or other water quality grants
4. Supplement monitoring data with citizen science	NC DEQ, Stormwater SMART	CWA §106 Grants, Z. Smith Reynolds Foundation, or other water quality grants

Davidson County

Recommended Strategy	Potential Partners	Potential Resources
1. Petition NC DEQ to conduct up-to-date fish community samples at Swearing Creek	City of Lexington, NC DEQ	N/A
2. Discuss monitoring of chlorophyll-a with YPDRBA	City of Lexington, YPDRBA	N/A
3. Seek funding to increase number of ambient monitoring sites throughout watershed	NC DEQ, YPDRBA	CWA §106 Grants, Z. Smith Reynolds Foundation, or other water quality grants
4. Supplement monitoring data with citizen science	NC DEQ, Stormwater SMART	CWA §106 Grants, Z. Smith Reynolds Foundation, or other water quality grants

Section 3: Watershed Modeling and Methodology

Sediment & Nutrient Loading Analysis

PTRC used GIS modeling software to help prioritize potential project implementation efforts. The model allows users to quickly estimate the effect of changing land uses, implementation projects or other scenarios to track potential benefits. PTRC chose to use a model called GWLF (Generalized Watershed Loading Function) that runs in an environment called MapShed, developed by Penn State University. These models are in the public domain, free of charge and use data already available to the project team.

All Forested Scenario

The first step in the model was to create a comparison analysis between the existing land covers of the Swearing Creek watershed and an all forested representation of the watershed. The forested analysis provides insight into baseline conditions as if the entire watershed were forested, isolating the effect of terrain, soils and stream processes.

Sediment is generated by water moving across the terrain (landscape erosion) and water flowing through channels (streambank erosion). Under completely forested conditions, streambank erosion is estimated to contribute 71% of sediment while the forested landscape contributes 29%.

The figure and map below shows the distribution of existing land covers (according to the 2016 Cropland Dataset) in the Swearing Creek watershed. Nearly 43% of the total watershed remains under forested conditions. 28% was found to be in mixed urban/residential land uses; 18% hay/pasture; and 9% cropland. Subwatersheds 6 and 7 (around the City of Lexington) are about two-thirds mixed urban/residential. Subwatershed 9 contains the most cropland (31%); while subwatersheds 10 and 11 contain the most forest land (50% and 58% respectively).

Figure 2: Sediment Sources - All Forested Condition

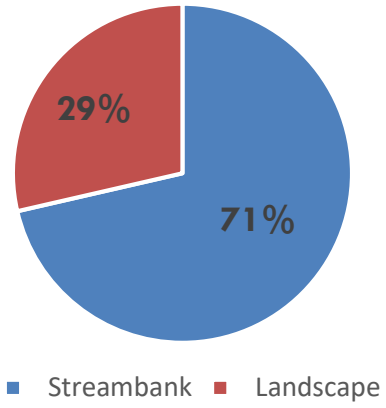
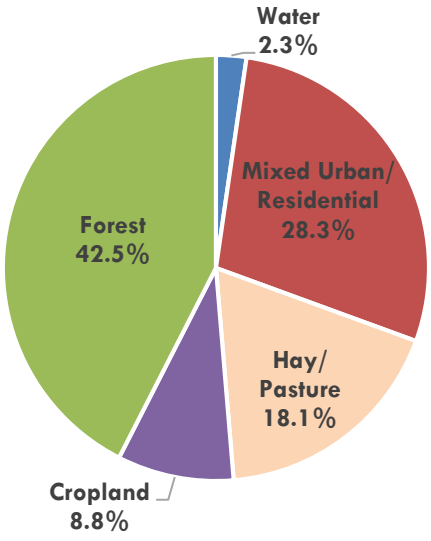


Figure 3: Watershed Landcover (2016 CDL)



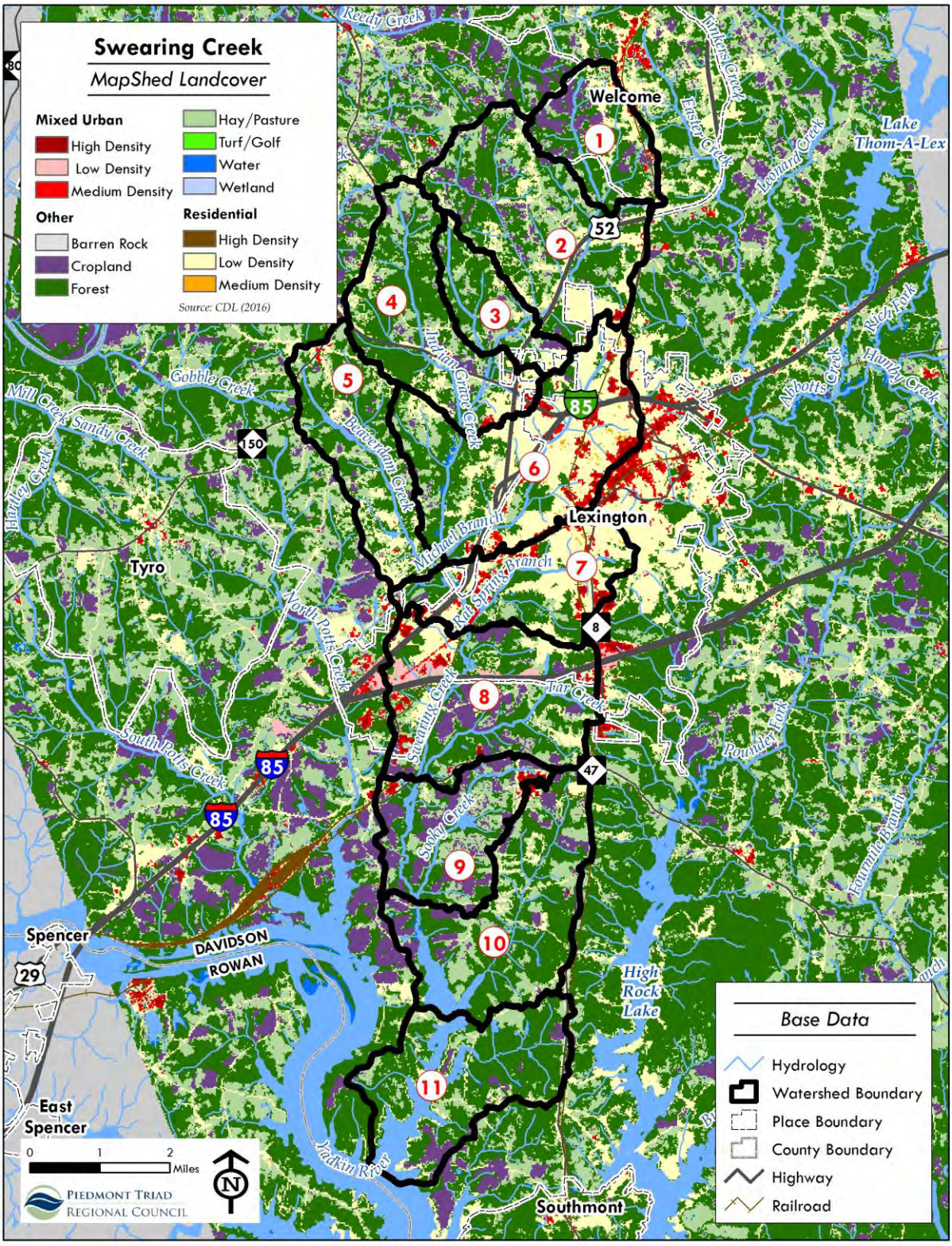
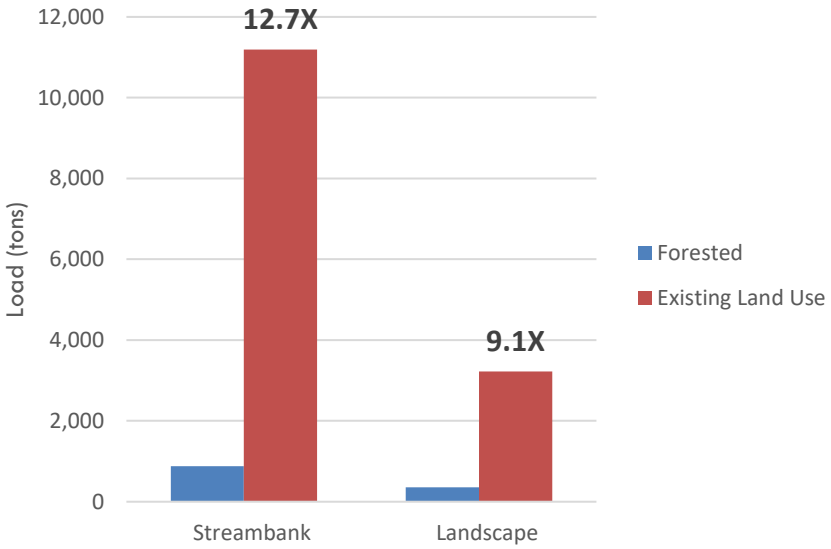


Figure 4: Swearing Creek Watershed MapShed Landcover Map

The modeling results for existing conditions show a substantial increase in the predicted transport of sediment. The current land uses are predicted to generate 9.1 times the amount of landscape sediment and 12.7 times the amount of streambank sediment as in the all forest scenario. The rate of increase in sediment from streambanks is much greater than that from the landscape. Streambank erosion increases are largely due to increases in runoff and streamflow. In current conditions, the urban subwatersheds around Lexington (6 and 7) have high amounts of impervious cover, indicating that runoff volumes have outpaced problems from land erosion. The next step in the analysis is to compare results between the urban subwatersheds (6 and 7) and an agricultural subwatershed (9).

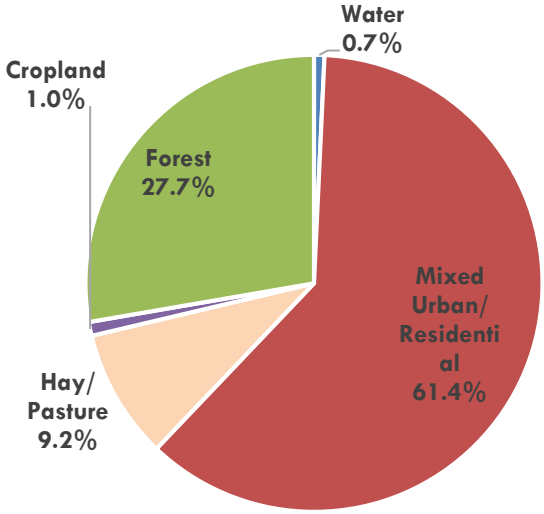
Figure 5: Sediment Estimates for the Total Watershed



Urban Subwatersheds

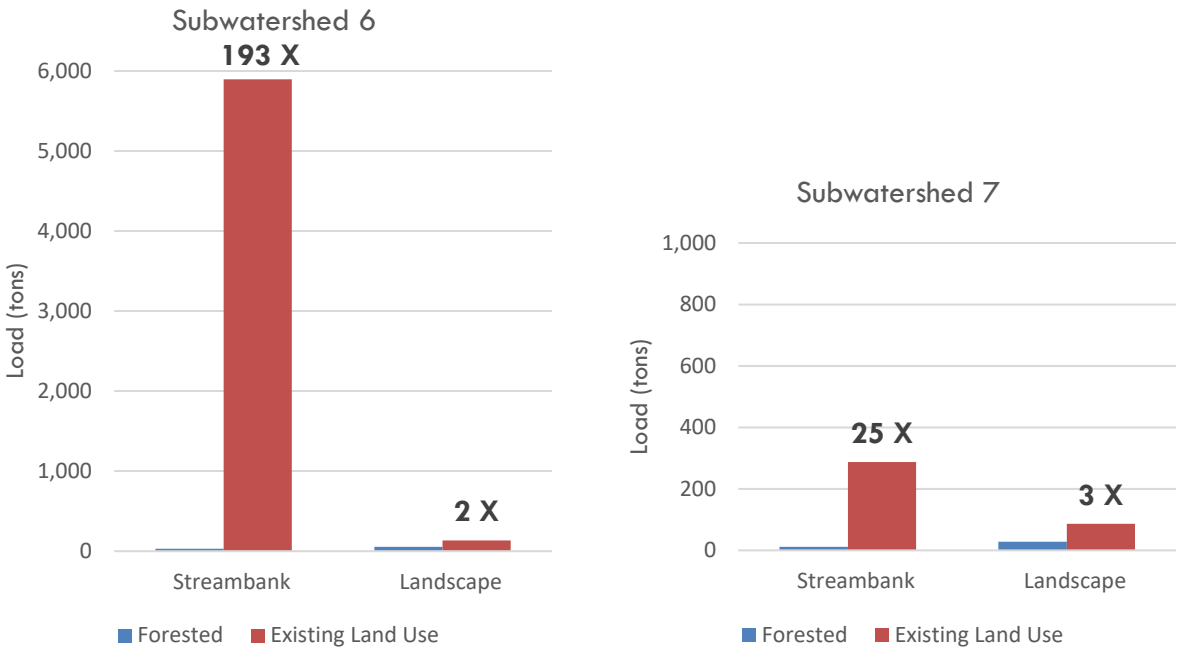
Both subwatersheds 6 and 7 contain the areas of Lexington that span the Swearing Creek watershed. Subwatershed 6 covers the northern part of the City and is 6.6 square miles and contains 14.7 linear stream miles. Subwatershed 7 covers the southern part of the City and is much smaller than subwatershed 6 – only 3.7 square miles in size and contains only 7.6 linear stream miles. The figure below shows the distribution of existing land covers in subwatershed 6. Roughly 61% of the subwatershed was found to be in mixed urban/residential land uses; 28% forest; 9% hay/pasture; and 1% cropland. Subwatershed 7 has a similar land cover distribution.

Figure 6: Landcover in Subwatershed 6



Because subwatershed 7 is smaller and has fewer linear stream miles, it also has a smaller sediment load than subwatershed 6. However, in both subwatersheds, the rate of increase in sediment from streambanks is much greater than that from the landscape. Streambank erosion increases are largely due to increases in runoff and streamflow in these urban settings. In subwatershed 6, the predicted streambank sediment load is 193 times greater with existing land uses compared to the forested scenario. Landscape erosion only contributes two times more sediment load than the all forested scenario. This points to a priority for projects addressing runoff (stormwater BMPs) over projects that might control land erosion (agricultural BMPs).

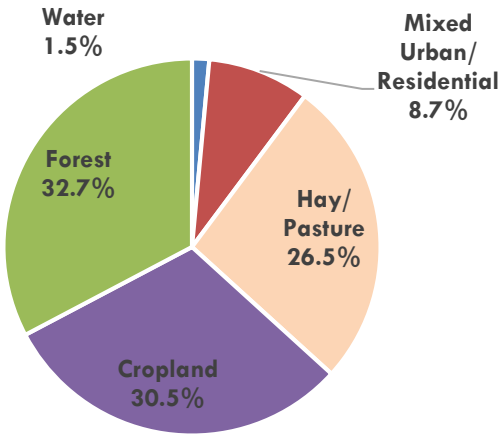
Figure 7: Sediment Estimates for Subwatersheds 6 & 7



Agricultural Subwatersheds

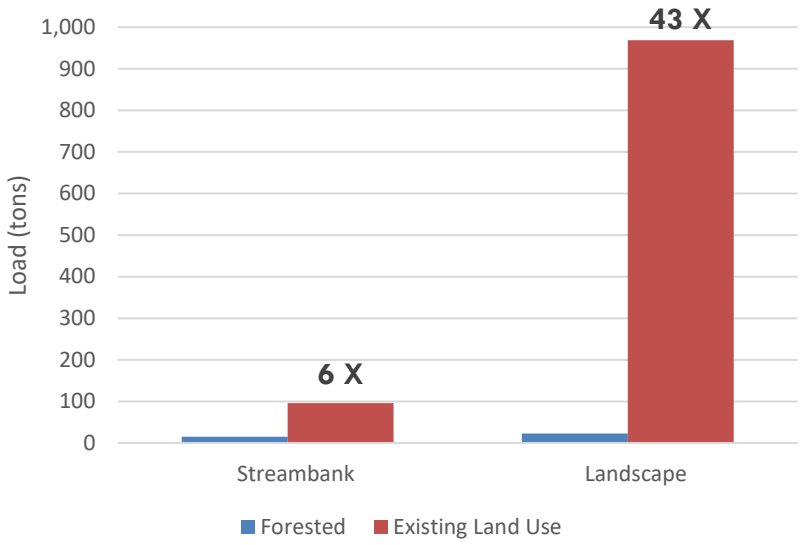
Subwatershed 9 lies further south in the Swearing Creek watershed and contains several farms and animal operation permit facilities. Subwatershed 9 is 3.5 square miles and contains 9.1 linear stream miles. The figure below shows the distribution of existing land covers in subwatershed 9. Roughly 33% of the subwatershed was found to be forested; 31% cropland; 27% hay/pasture; and only 9% in mixed urban/residential land uses.

Figure 8: Landcover in Subwatershed 9



In subwatershed 9, landscape erosion contributes much more to sediment load than streambank erosion. Compared to the all forested scenario, landscape erosion contributes 43 times more sediment while streambanks only contribute 6 times more, when not including current best management practices. Development is less dense in this subwatershed and runoff volumes are not as much of an issue as in the urban subwatersheds. This points to a priority for projects addressing land erosion (agricultural BMPs) over projects that might control runoff (stormwater BMPs). This subwatershed is very sensitive to land cover changes.

Figure 9: Sediment Estimates for Subwatershed 9



Impacts of Agricultural BMPs

Subwatershed 9 (and other parts of the watershed) already contain a large number of agricultural BMPs, including no-till crop rotation, rotational grazing, sod-based rotation and animal waste management systems. In subwatershed 9, an estimated 85% of the CDL cropland area and 42% of the hay/pasture area contain agricultural BMPs. Incorporating these BMPs into the MapShed analysis predicts that sediment loads are reduced by 22% (mostly due to preventing landscape erosion); total nitrogen loads are reduced by 2%; and total phosphorus loads are reduced by 17%. These agricultural BMPs are imperative to the watershed health and should be maintained.

Conclusions

Table 1: Predicted Sediment Loading Rates

Land Use	Sediment (tons/acre)
Hay/Pasture	0.10
Cropland	0.83
Forest	0.02
Mixed Urban/Residential	0.02
Overall Average	**0.10**

Although cropland only covers roughly 9% of the total watershed, it is responsible for about 72% of the landscape sediment. Cropland has the highest sediment load per acre in the Swearing Creek watershed at 0.83 tons per acre, compared to the overall average of 0.10 tons per acre. Forested areas and the mixed urban/residential landscape have lower sediment rates (when looking at landscape erosion only).

Buffer Analysis

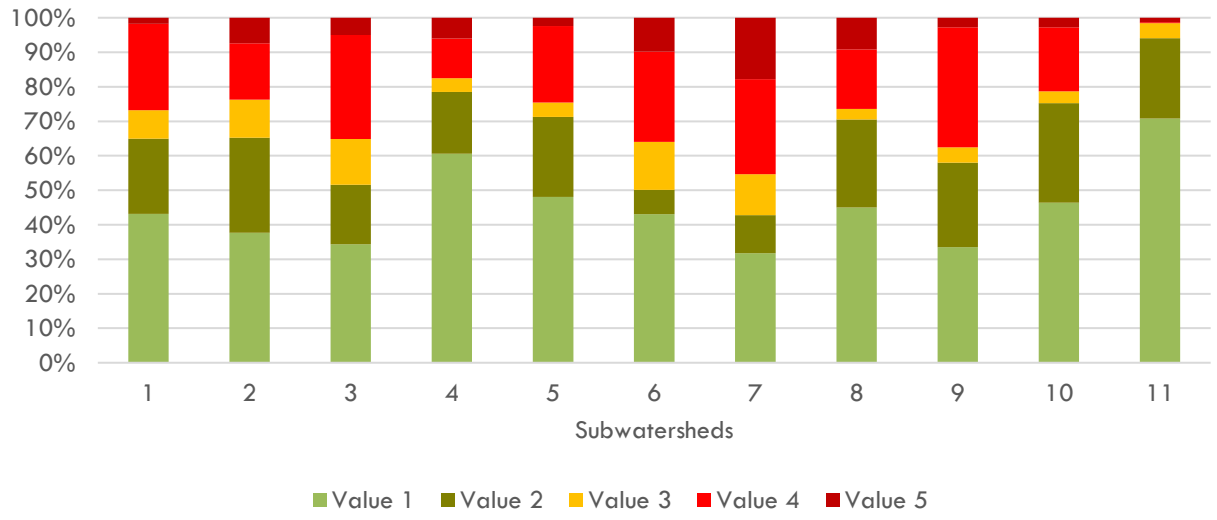
PTRC conducted a stream buffer assessment, reviewing the vegetated cover within the 100-foot buffer zone for the 2,040 stream segments identified in an ArcHydro Analysis. These riparian buffers are critical to protecting water quality conditions and ensuring safe habitat conditions for ecology. The process was based on the analysis from previous watershed plans: Elkin and Jonesville Water Supply Protection Plan (PTRC, 2015) and the Eden Area Watershed Plan (PTRC, 2016). PTRC ranked each stream buffer on a five-tiered system:

1. Pristine – completely untouched by human activity
2. Impacted – mild to moderate human activity, including small roads, utility right of ways, single-family homes and some farms
3. Managed – human activity is actively degrading the stream buffer on at least one side of the stream. The stream buffer is completely absent on one side of the stream, but not both.
4. Degraded – buffers on both sides to the stream area absent with very little vegetation present.
5. Absent – streams have no vegetated buffer at all due to agricultural practices, paving or piping.

Subwatershed 11 in the southern part of the watershed contains the most linear feet of streams with a pristine riparian buffer (14.4% of the streams in the subwatershed). The urban subwatersheds (6 and 7) contain the most linear feet with an absent buffer (21.0% and 22.4% respectively). Subwatershed 9, which contains the most agricultural cover, consists of 11.5% streams with a degraded buffer.

These results will be used in the parcel assessment in the next section. Pristine and impacted streams will be input into the conservation analysis and degraded and absent streams into the stress analysis.

Figure 10: Buffer Analysis by Subwatershed



Project Selection and Prioritization

In order to identify specific projects within the watershed that would provide water quality benefits, PTRC chose to use a GIS-based model (described below). Two models were developed; one assessed the suitability of land for conservation, while the other was used to identify areas for retrofit or restoration projects. In creation of the Project Atlas, the top 51 parcels with the highest conservation potential and the top 50 parcels with the highest restoration potential were selected. Parcels in close proximity and with similar land uses were combined into the final 16 conservation projects and 17 restoration projects features in the Project Atlas.

Conservation Analysis

Thirteen data layers were used to identify areas in the watershed with the highest conservation value (see Table 2). These layers were also identified in the Lower Abbotts Creek Watershed Restoration Plan (2011) - the watershed just to the east of the Swearing Creek Watershed.

Four of the layers (Biodiversity/Wildlife Habitat, Impervious Surface Cover, Canopy Cover and Slope) were obtained in raster format and were resampled and projected (as needed) to the NAD 1983 StatePlane North Carolina FIPS 3200 coordinate system with a resolution of 30 meters. All other layers were obtained in vector format and were converted to rasters with an ArcGIS conversion tool with the same coordinate system and cell size as the other three rasters.

All layers were given a value based on the analysis from the Abbotts Creek project. A weight was then applied to these layers based on the Piedmont Triad Regional Watershed Assessment (2013). All layers were input into the ArcGIS Weighted Sum Tool. This tool overlaid the multiple rasters using the weighted values specified in Table 2 and summed the value of each cell into one output conservation raster. This process identifies areas within the watershed with the highest conservation value for watershed health and function so that these areas can continue to be preserved in future projects.

The total possible points for the conservation raster was 76.8, but in reality values only ranged from 0 to 60.7 (see Figure 11). Once the landscape was characterized by these potential conversation values, parcel boundaries were layered over the conservation raster. Only parcels greater than 0.5 acres were used because smaller parcels do not provide enough potential for conservation or restoration benefit. The ArcGIS Zonal Statistics as a Table Tool was used with the parcels as the input zones and the conservation raster as the input value raster. This tool reported the mean conservation value for each parcel. The top 51 parcels were selected that had the highest mean conservation value as input for the final projects layer (see Figure 11).

The top-ranking conservation parcels are generally located outside the City limits and represent a variety of land uses, but are primarily larger agricultural or forested tracts adjacent to a stream.

*Note: After further field analysis, stress project S-18 was converted to a conservation project (C-16). Therefore, there are 16 conservation projects described in the project atlas and 51 conservation parcels. This additional parcel is owned by NCDOT and is in a wetland/floodplain area with a wide buffer.

Table 2: Swearing Creek Conservation Layers

Swearing Creek Conservation Layers					
Criteria	**Data Source**	**Factors**	**Value**	**Weight**	**Total Possible Points**
High Biodiversity/ Wildlife Habitat	NCDENR CPT	8 - CPT (SNHA)	3	4	12
		1 to 4 - CPT (Wetlands and streams)	1		
Low Impervious Surface Cover	NLCD 2011 Percent Developed Imperviousness	0 - 4%	3	4	12
		5 - 9%	2		
		10-19%	1		
High Canopy Cover	NLCD 2011 Percent Canopy	> 50%	1	9	9
Large Parcel Size	County Data (Dissolved by owner name)	> 50 Acres	3	3	9
		20-49 Acres	2		
		10-19 Acres	1		
Stream Buffer Analysis	PTRC	1 - Pristine, complete cover	2	4	8
		2 - Impacted, majority cover with some human activity	1		
Hydric Soils	SSURGO	All Hydric	2	3	6
		Partially Hydric	1		
High Soil Erodibility	SSURGO (K factor)	0.40 - 0.49	2	3	6
		0.24 - 0.39	1		
Existing BMPs	County/City	Ag BMP Parcels	2	2	4
		Stormwater BMP Parcels	2		
Low Population Density (Persons Per Square Mile)	Census Bureau, 2010	Low (1 -49)	2	1.5	3
		Med (50-249)	1		
Steep Slope	USGS NED (1 arc second)	> 15%	1	3	3
Publically Owned Lands	County	Public Parcel	2	1.3	2.6
Floodplain	NC Floodplain Mapping Program	Within 500 Year Floodplain	1	1.2	1.2
Low Impact Zoning	Counties/Municipalities	RA, RS, CC 5+ acres; vacant; VAD	1	1	1
		Total Possible Points			**76.8**

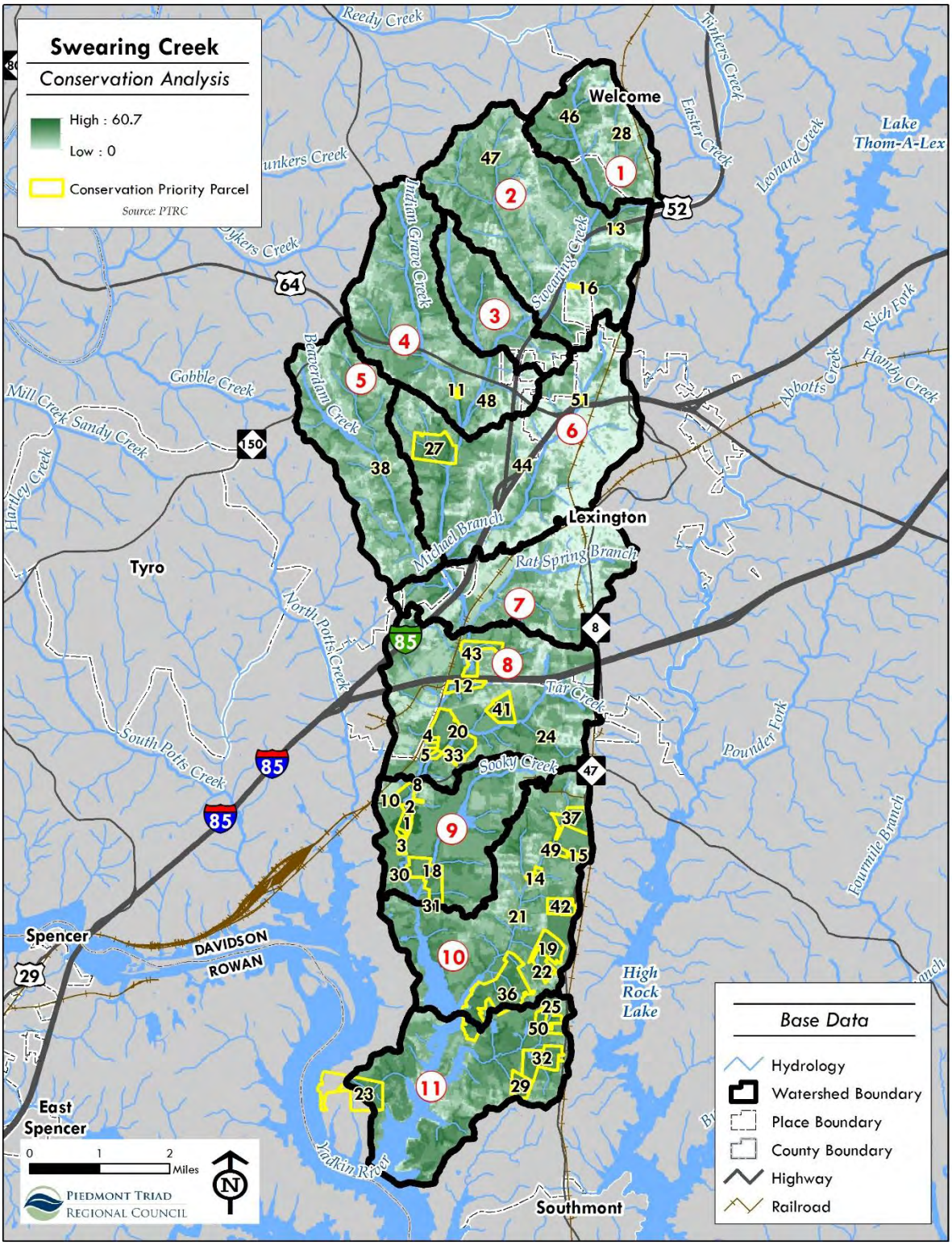


Figure 11: Output Conservation Raster and Parcels Map

Restoration Analysis

A similar process was applied to the watershed landscape in order to select the top 50 parcels that would benefit from restoration efforts, using 15 data layers (see Table 3). Several of these data layers represent the same data and value as the conservation analysis (high soil erodibility, hydric soils, steep slopes, public land and floodplains) because they identify the most vulnerable locations that are also potentially most impacted by land use changes. Several of these data layers represent the same data, but opposite value as the conservation analysis (impervious surface cover, stream buffer analysis, canopy cover, population density, and zoning).

All data layers were formatted as a raster layer in the NAD 1983 StatePlane North Carolina FIPS 3200 coordinate system with a resolution of 30 meters. Values were assigned similar to the conservation analysis, based on previous stakeholder development during the Lower Abbotts Creek Watershed Restoration Plan. Weights were based on research that was developed during PTRC's Piedmont Triad Regional Watershed Assessment. All layers were input into the Weighted Sum Tool. The total possible points for the stress raster was 66.5, but in reality values only ranged from 0 to 53.9 (see Table 3). Once the landscape was characterized by these potential stress values, parcel boundaries were layered over the stress raster. Only parcels greater than 0.5 acres were used because smaller parcels do not provide enough potential for conservation or restoration benefit. The ArcGIS Zonal Statistics as a Table Tool was used with the parcels as the input zones and the stress raster as the input value raster. This tool reported the mean stress value for each parcel. The top 50 parcels were selected that had the highest mean stress value as input for the final projects layer (see Figure 12).

The top-ranking stress parcels are generally located inside the Lexington City limits and along highway corridors. The stress parcels tend to be smaller in size than the conservation parcels and also represent a variety of land uses, but mainly industrial, office and institutional uses.

Table 3: Swearing Creek Restoration Layers

Swearing Creek Stress Layers					
Criteria	**Data Source**	**Factors**	**Value**	**Weight**	**Total Possible Points**
High Impervious Surface Cover	NLCD 2011 Percent Developed Imperviousness	20% +	3	4	12
		10-19%	2		
		5-9%	1		
Stream Buffer Analysis	PTRC	5 - Absent	2	4	8
		4 - Degraded	1		
Large Parcel Size	County Data (Dissolved by owner name)	> 20 Acres	3	2	6
		10-19 Acres	2		
		5-9 Acres	1		
High Soil Erodibility	SSURGO (K factor)	0.40 - 0.49	2	3	6
		0.24 - 0.39	1		
Hydric Soils	SSURGO	All Hydric	2	3	6
		Partially Hydric	1		
Low Canopy Cover	NLCD 2011 Percent Canopy	< 50%	1	5.5	5.5
High Density of Impact Sites	NC DWQ	High (8-48 per sq mi)	2	2.25	4.5
		Low (1-7 per sq mi)	1		
Potential BMPs	PTRC GIS Analysis	Riparian Plantings (330 ft buffer)	2	1.75	3.5
		Wetland Restoration			
		Urban Stormwater (50 foot buffer)			
		Cattle Exclusion Sites (330 ft buffer)			
High Population Density (Persons Per Square Mile)	Census Bureau, 2010	High (250+)	3	1	3
		Med (50-249)	2		
		Low (1 -49)	1		
Steep Slope	USGS NED (1 arc second)	> 15%	1	3	3
Publically Owned Lands	County	Public Parcel	2	1.3	2.6
High Impact Zoning	Counties/Municipalities	Commercial, Industrial, AOP	2	1.2	2.4
		Institutional, Office, Multifamily	1		
High Percent Population Density Change (2000-2010)	Census Bureau, 2010	20%+	2	1	2
		10-20%	1		
Streams & Wetlands	NCDENR CPT	1 to 4 - CPT (Wetlands and streams)	1	1	1
Floodplain	NC Floodplain Mapping Program	Within 500 Year Floodplain	1	1	1
		Total Possible Points			**66.5**

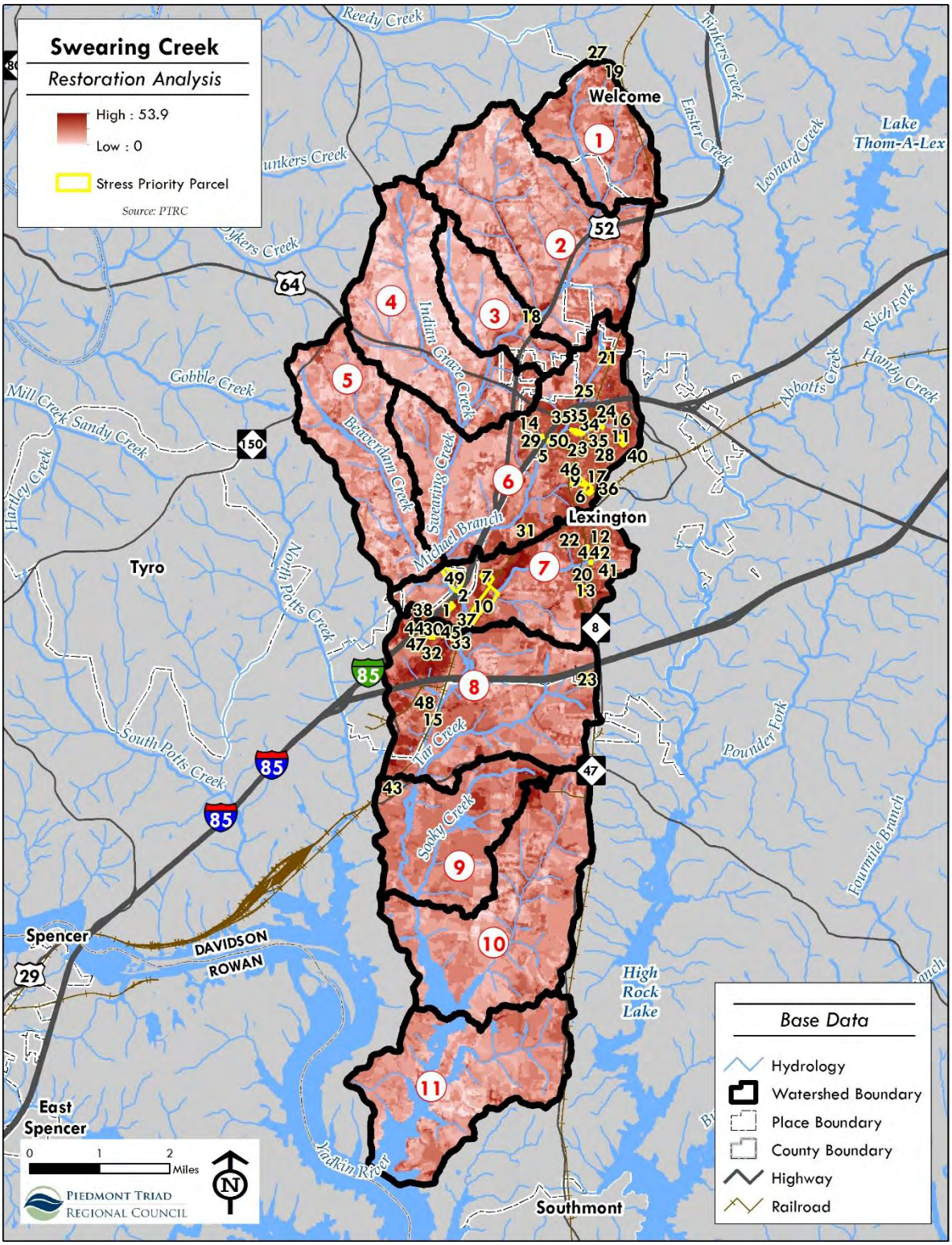


Figure 12: Output Restoration Raster and Parcels Map

Final Project Selection

Generally, parcels within 0.25 miles of each other and with similar land uses were grouped into projects. The only project where restoration and conservation parcels are adjacent is Project C-01. Stress parcel ranked #43 was included due to proximity in this case. All of these projects would be ideal investments of any of the Swearing Creek Watershed stakeholders to improve and/or preserve watershed conditions.

Upon site visits to the top restoration sites, several modifications were made to the top project selection:

- Project S-03 (containing stress parcels ranked 4, 20 and 41) was removed. These were small residential and church properties along Rat Spring Branch in Lexington. The GIS model identified these parcels due to floodplains and high impervious cover. Upon the field visit, impervious surface cover was found not to be an issue. This error was likely due to the 30-meter resolution in the impervious surface cover dataset.
- Project S-10 was removed. These were small residential parcels (stress parcels ranked 15 and 48).
- Project S-16 was removed. These were also small residential parcels in a neighborhood adjacent to the airport (containing stress parcels ranked 30, 32, 33, 38, 44, 45, 47).
- Project S-18 (containing stress parcel ranked 39) was converted to a conservation project (C-16). This is a small parcel owned by NCDOT in a wetland/floodplain area at the confluence of two streams. The parcel already contains a great stream buffer. There is significant office, industrial and multi-family development around the parcel, therefore, making it a priority to conserve.
- Several parcels were added to the several top priority projects because they were either adjacent with the same parcel owner, or a stakeholder requested the addition due to local knowledge about the site. The following projects (new project number after above changes) each had an additional parcel added: S-01, S-03, S-11, S-12, S-17, C-04, C-15

With these modifications, 31 final projects were selected (16 conservation projects and 15 restoration projects) (see Figure 13).

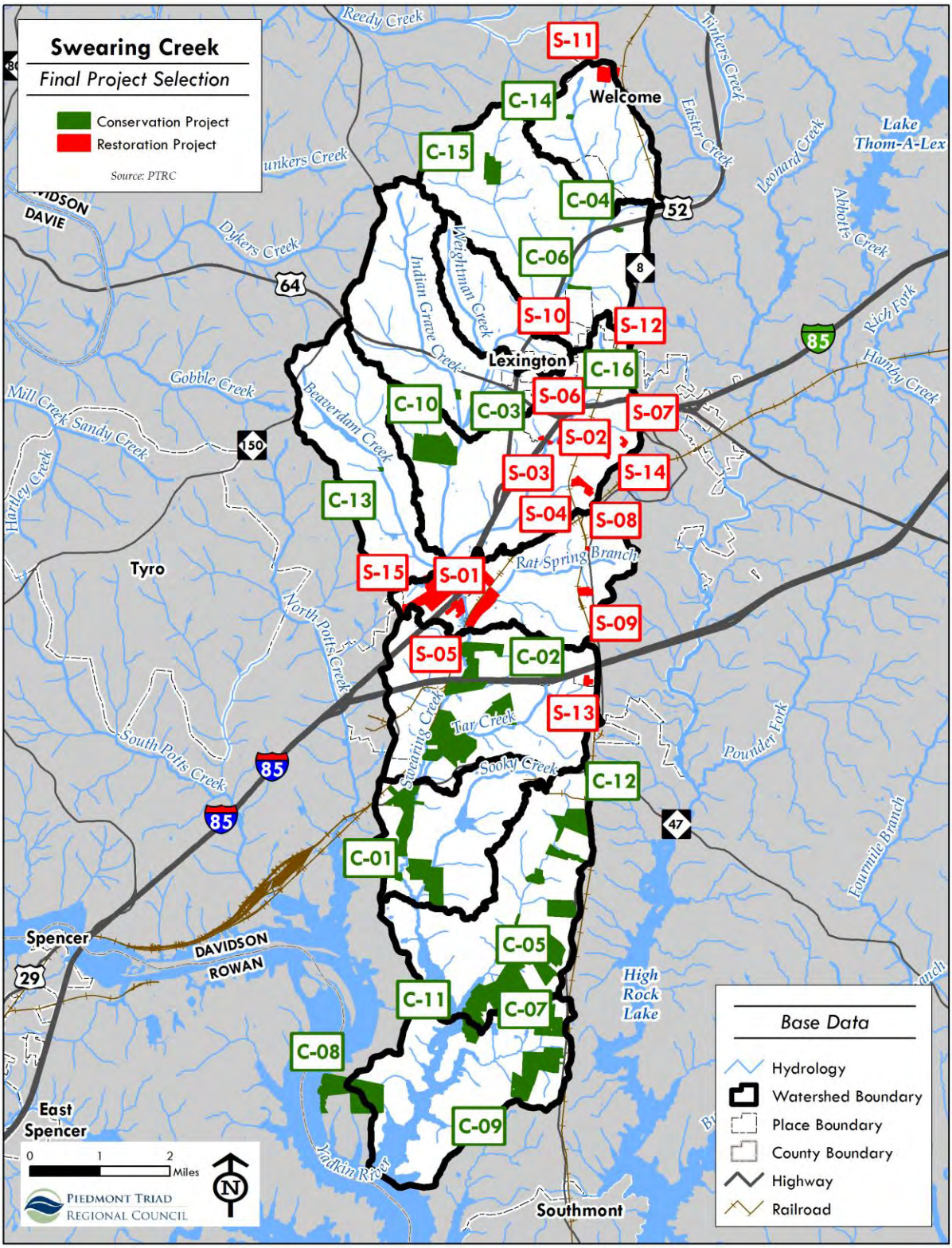


Figure 13: Final Project Selection Map

Restoration Project Design and Estimates

The 15 top priority stress/restoration sites were further investigated to develop more detailed project options. Kris Bass Engineering developed a plan to provide concept plans, benefit predictions, and cost estimates for potential projects. Initial analysis of the sites was performed using GIS desktop software. Sites were analyzed for appropriate topography, soils, potential utility conflicts, existing stormwater infrastructure, environmental impact, and construction access in order to develop an initial list of stormwater control measures (SCMs). Site visits were made to 12 of the 15 sites for field verification and design improvement. Most of the SCMs were sized to capture and treat 1-inch (First Flush) of runoff during storm events. However, a few SCMs were intentionally undersized due to site spacing constraints. These undersized SCMs would only treat a percentage of the first flush runoff as is noted in the nutrient reduction calculations.

Nutrient removals were calculated using the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool spreadsheet developed by the North Carolina Department of Environmental Quality (NCDEQ). The tool is calibrated to specific precipitation regions (Lexington, NC in this case) and various inputs are set in order to calculate anticipated nutrient reductions. Required inputs include the total SCM drainage area, hydrologic soil grouping, residential and non-residential land uses, SCM type, and impervious cover. Using this tool, total nitrogen (TN) and total phosphorus (TP) reductions were estimated for the proposed SCMs.

The final results included summary tables with eight parameters for each proposed SCM. These parameters include the SCM type, location, footprint area, drainage area, percent impervious area, TN and TP reductions, and a cost estimate. In addition to the SCM, recommendations were made for other water quality-related projects including stream restoration, vegetated buffers, and educational features. Included with the summary tables are concept plans for proposed SCMs and a photo atlas with on-site photographs of select locations.

The concept maps feature aerial imagery with detailed layouts of the proposed SCMs showing the main components in relation to any relevant existing stormwater infrastructure. The concept plans include some of the parameters detailed in the summary table as well as a write-up describing the SCM, its intended function, and any potential site constraints. The final result included almost 75 recommended SCMs, seven stream restorations, and 17 additional water quality-related projects. All concept plans developed for this project are based on limited investigation and our best professional experience. The plans were developed to communicate initial design ideas, accelerate potential site selections, and facilitate cost estimates. A detailed design process might uncover constraints or conditions that require a different SCM type or approach. It should be expected that some sites have a variety of options that might be suitable and result in excellent benefits.

Cost estimates for SCMs were developed using unit costs from recently completed projects. Where actual bid cost data was not available, prices were researched from government and published sources. Cost estimates include our best estimates for earthwork, materials, planting and other items based on the concept plans. The cost estimates for common SCMs such as wetlands, swales, bioretention areas, and rain gardens have the highest confidence levels. More innovative or less common SCMs such as green roofs rely heavily on published costs and might vary greatly. All total cost estimates include a 20% contingency and 30% for engineering design, administration, and permitting to provide an inclusive estimate for project budgeting.

Section 4: Project Atlas

Conservation Projects

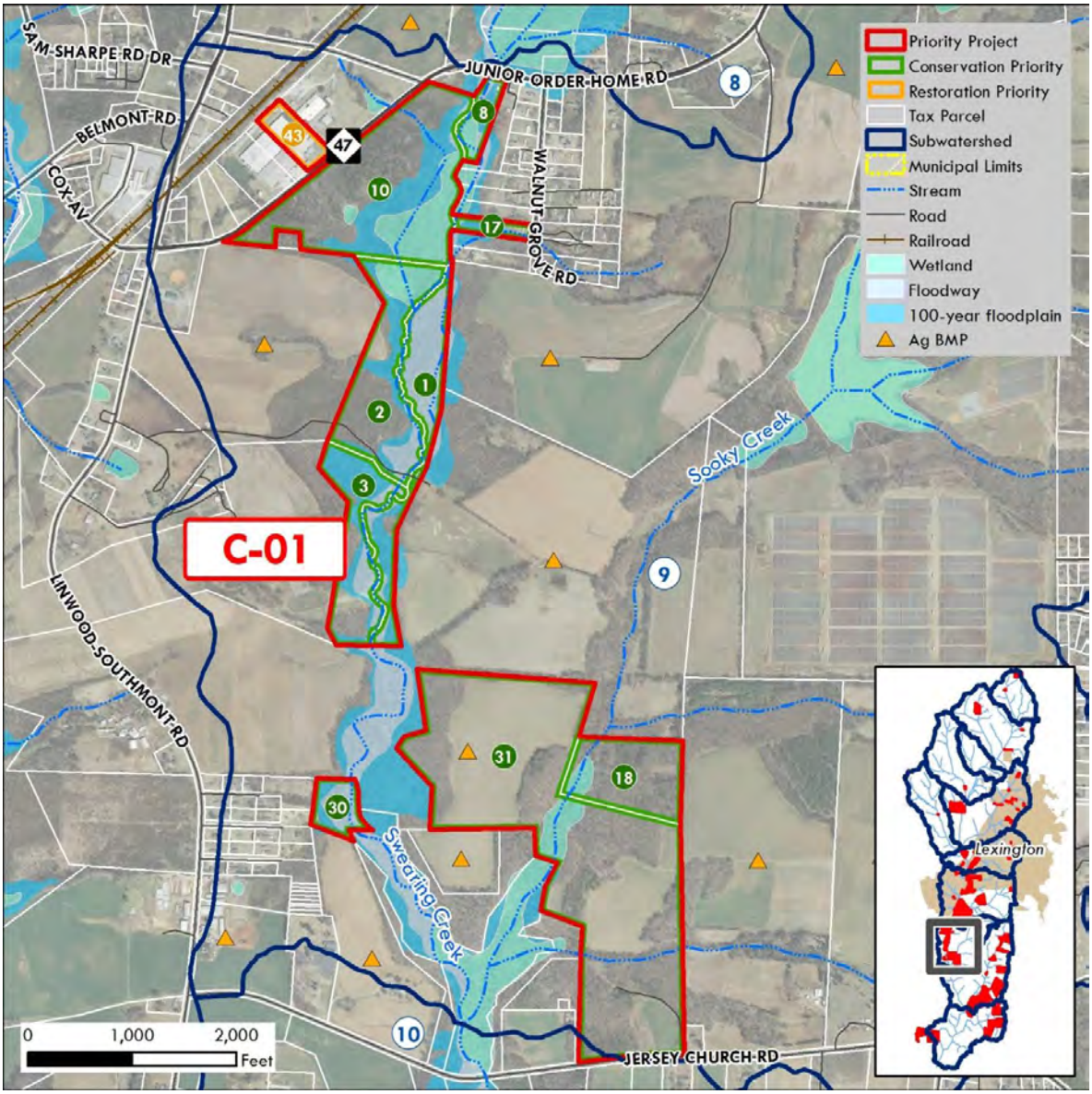
Table 4 shows top priority conservation projects in the Swearing Creek Watershed. These priorities were developed through a combination of GIS modeling, Soil and Water Extension BMP locations and stakeholder committee input.

Each of the 16 conservation projects described on the following pages contains a map, a summary of recommended actions, and a table of summary statistics. The runoff curve number was calculated for each conservation project. This calculation combines the effects of soils, watershed characteristics and land use into a single parameter to compare direct runoff volumes. Higher curve numbers correlate with a higher runoff potential. A land use scenario was also modeled for each conservation project where all pasture, agricultural, forested and/or other vacant lands were converted to 1-acre residential lots (this is the typical land use in the rural developed areas in the County parts of the watershed). A default value of a 5-inch rainfall event was used in all project comparison calculations to estimate the increased runoff from this type of new development. On average, runoff is estimated to increase by 23% in these conservation projects if pasture, agricultural, and forested lands were lost to residential development.

Table 4: Top Priority Conservation Projects

Project	Site Name	Conservation Parcels
C-01	Swearing Creek Agricultural	1, 2, 3, 8, 10, 17, 18, 30, 31 (and Stress 43)
C-02	Old Linwood Road Agricultural	4, 5, 7, 12, 20, 33, 34, 41, 43
C-03	Indian Grave Creek Buffer	6,9, 11, 40
C-04	Sunset Ridge Headwaters	13, 39 (additional parcel by same owner)
C-05	Jersey Church Forested Buffer	14, 15, 21, 26, 35, 42, 45, 49
C-06	Northside Drive Forested Buffer	16
C-07	Hugh Miller Road Forested Buffer	19,22
C-08	Fisher Farm Agriculture	23
C-09	NC-8 Forested Buffer	25, 29, 32, 50
C-10	Little Babe Farm	27
C-11	Longview Farm	36
C-12	D&M Farms	37
C-13	Beaverdam Creek Confluence	38
C-14	Swearing Greek Headwater Buffer	46
C-15	Kapstone Crossing Subdivision	47 (additional parcels by same owner added)
C-16	NCDOT Floodplain	51

Project C-01 – Swearing Creek Agricultural

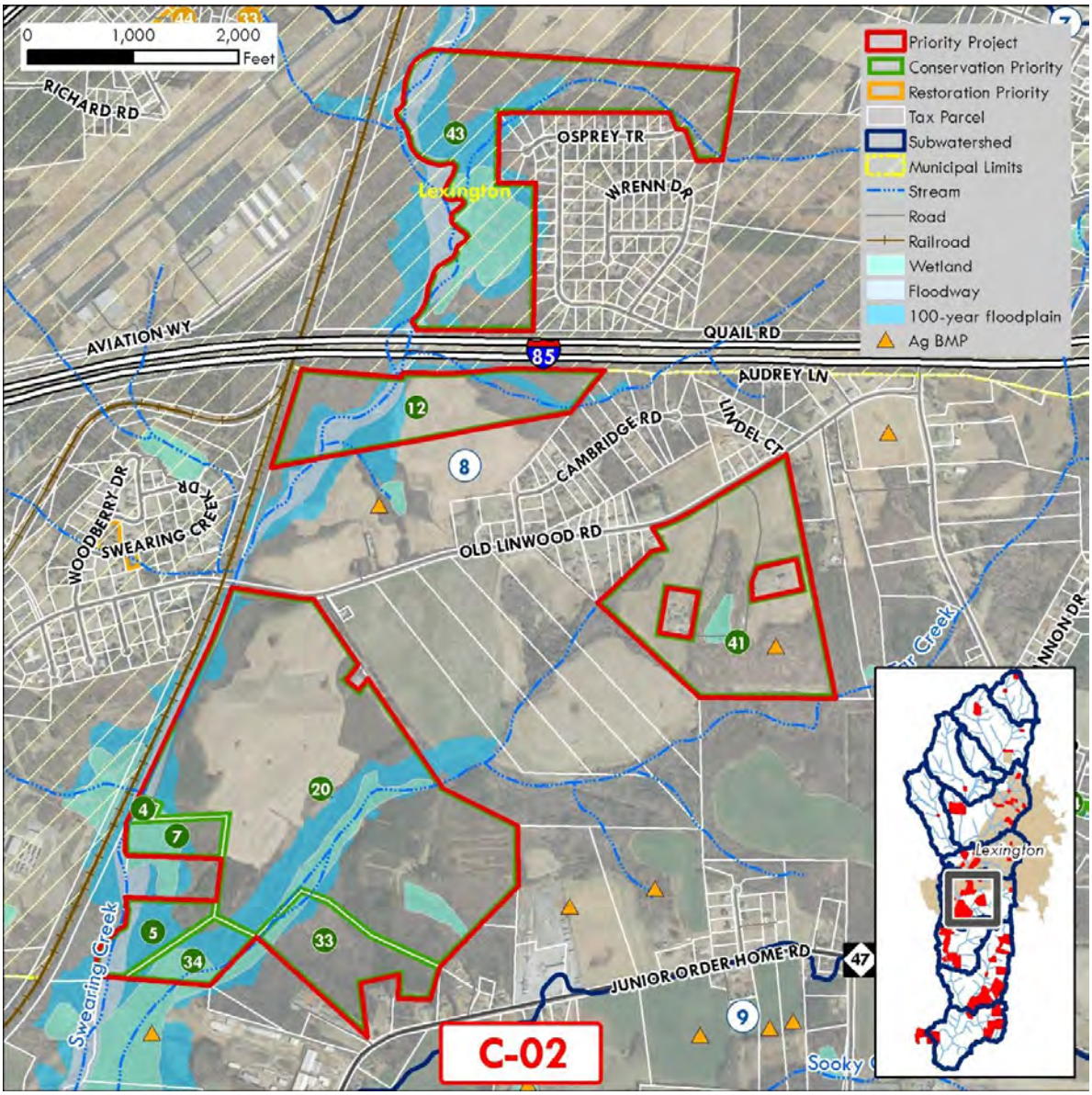


Attribute	C-01
Site Location	County
Subwatershed	9
Land Use	Agricultural, Forest, Industrial
Linear Stream (Feet)	12,953
Area (Acres)	257.6
Floodplain Area (Acres)	86.0
Wetland Area (Acres)	21.9
Percent Impervious Surface Cover	1.75%
Percent Forest Cover	72.2%
Curve Number	75
Curve Number Scenario	83
Runoff Increase	21%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Note: Several parcels in this area have also been identified in the Davidson County Greenway Plan
2. Contact Leggett & Platt Inc (#43) to gauge interest in retrofitting property
   - Note: 1 stormwater pond onsite, but opportunities for other stormwater BMPs

Project C-02 – Old Linwood Road Agricultural

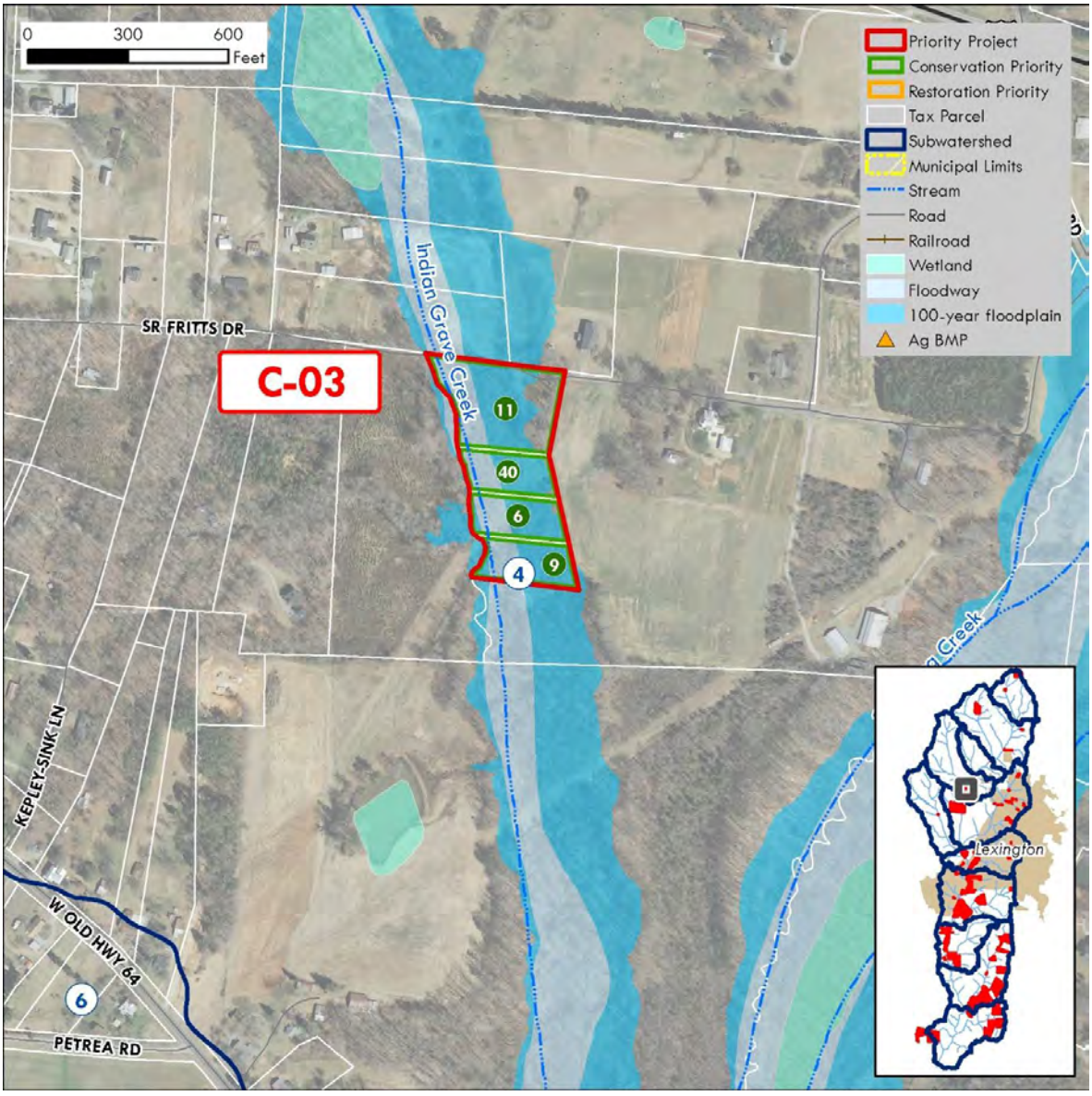


Attribute	C-02
Site Location	City, County
Subwatershed	8
Land Use	Agricultural, Forest
Linear Stream (Feet)	14,809
Area (Acres)	403.0
Floodplain Area (Acres)	115.1
Wetland Area (Acres)	38.8
Percent Impervious Surface Cover	0.15%
Percent Forest Cover	59.4%
Curve Number	67
Curve Number Scenario	73
Runoff Increase	17%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Note: Several parcels in this area have also been identified in the Davidson County Greenway Plan. Parcel #43 provides valuable wildlife habitat.
2. Get Soil & Water to examine opportunities to incorporate agricultural BMPs on parcel #20
3. Restore stream buffers where applicable

Project C-03 – Indian Grave Creek Buffer

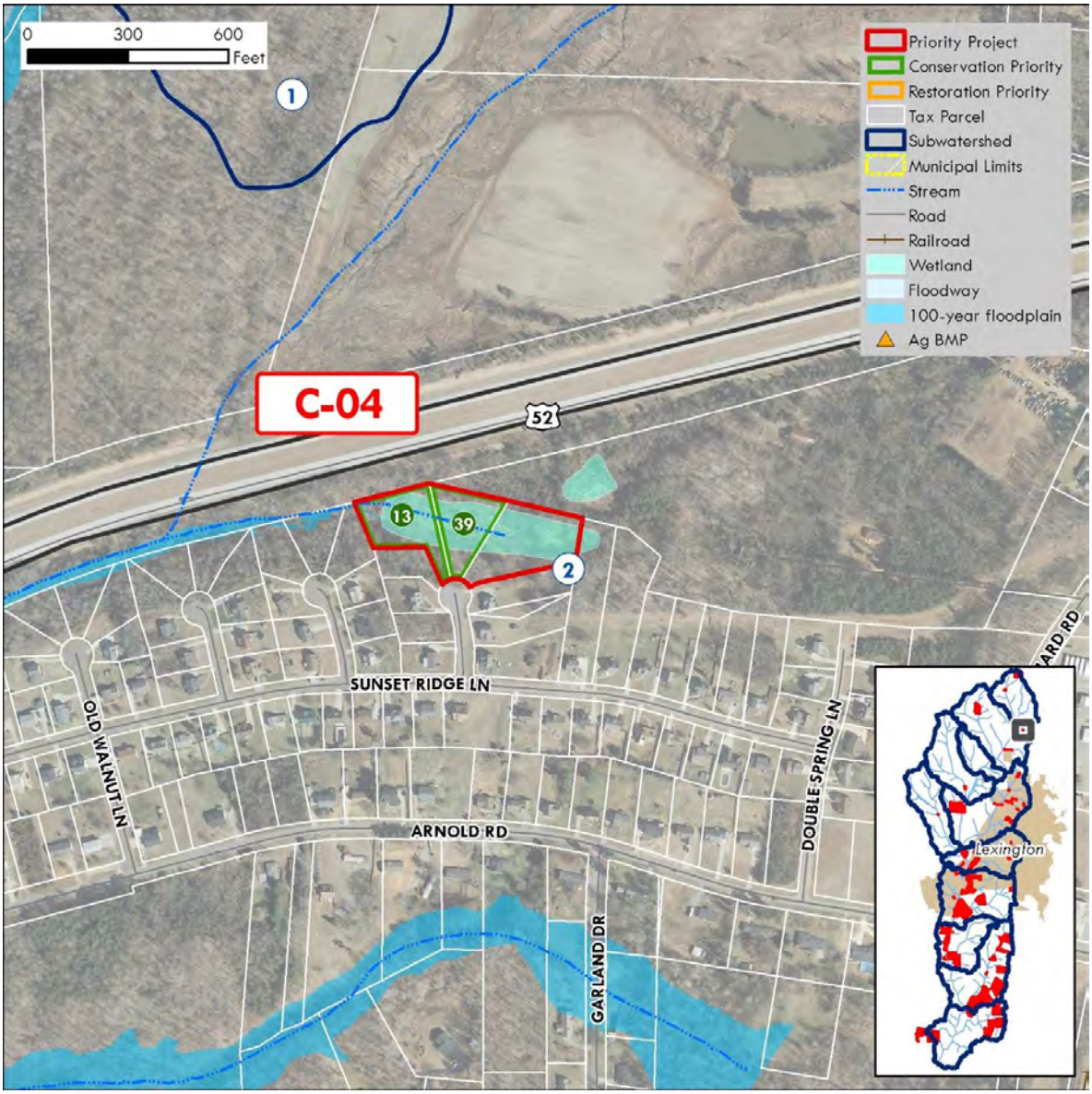


Attribute	C-03
Site Location	County
Subwatershed	4
Land Use	Forest
Linear Stream (Feet)	703
Area (Acres)	4.5
Floodplain Area (Acres)	4.0
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	n/a
Percent Forest Cover	81.6%
Curve Number	76
Curve Number Scenario	84
Runoff Increase	21%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Emphasize tax benefits
2. Have Soil & Water contact adjacent farm owners to discuss potential for agricultural BMPs
3. Restore stream buffers where applicable

Project C-04 – Sunset Ridge Headwaters

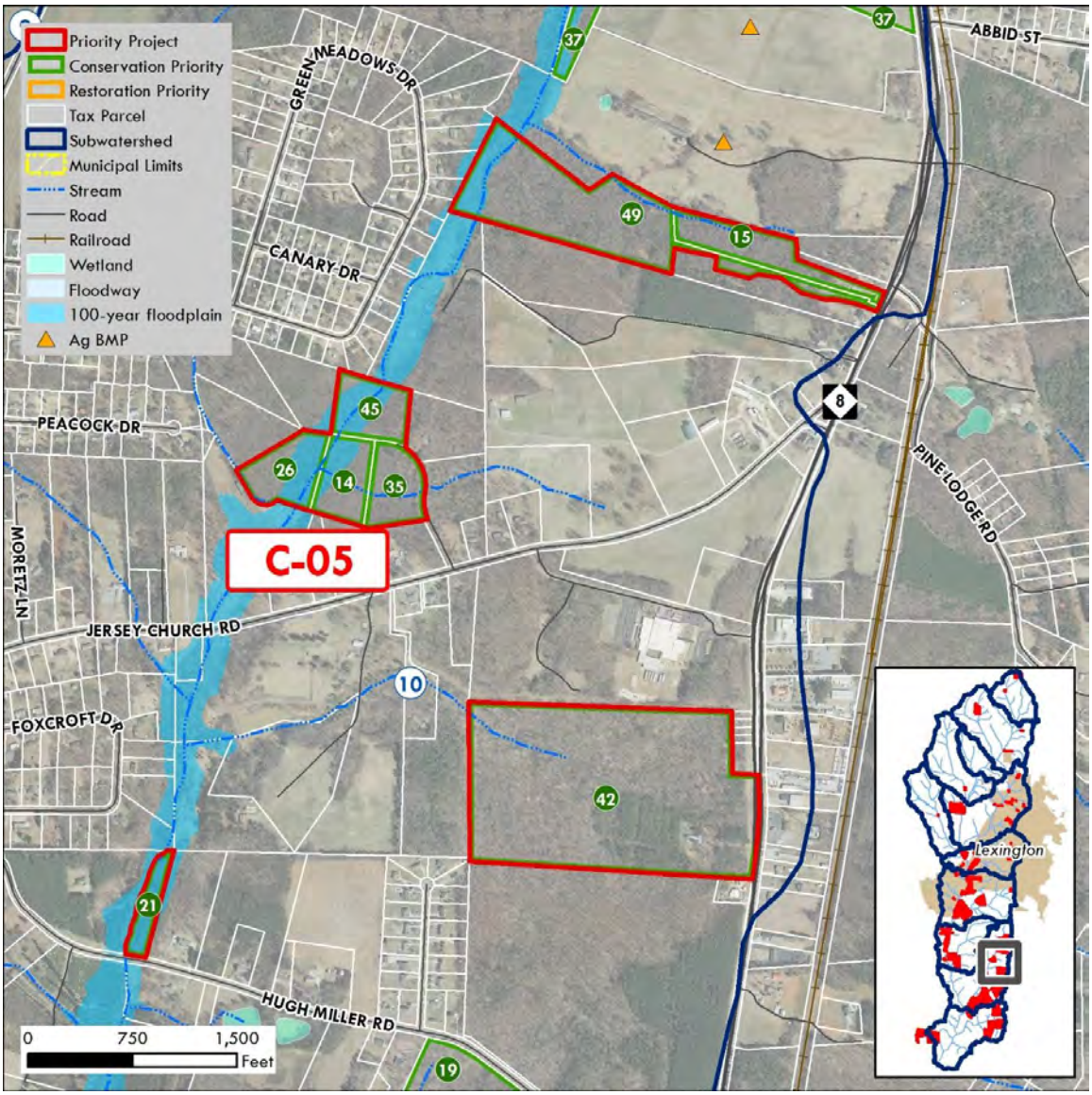


Attribute	C-04
Site Location	County
Subwatershed	2
Land Use	Forest
Linear Stream (Feet)	460
Area (Acres)	3.0
Floodplain Area (Acres)	0.9
Wetland Area (Acres)	1.7
Percent Impervious Surface Cover	1.00%
Percent Forest Cover	83.4%
Curve Number	67
Curve Number Scenario	77
Runoff Increase	29%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Note: Critical buffer and headwater wetland area
2. Explore opportunities to incorporate upland BMPs to address subdivision runoff

Project C-05 – Jersey Church Forested Buffer

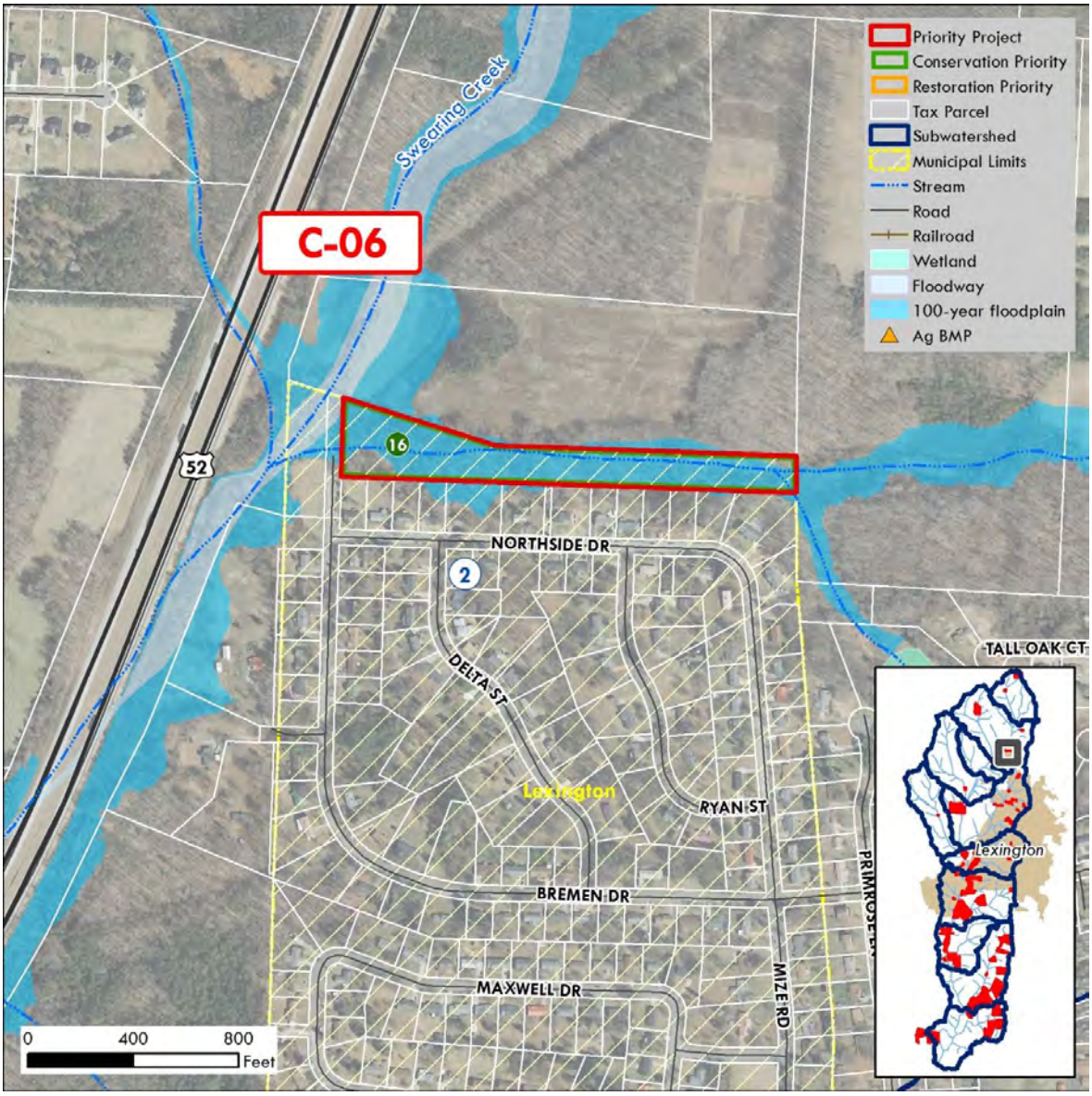


Attribute	C-05
Site Location	County
Subwatershed	10
Land Use	Forest, SFR
Linear Stream (Feet)	5,729
Area (Acres)	105.8
Floodplain Area (Acres)	12.7
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	0.11%
Percent Forest Cover	94.1%
Curve Number	71
Curve Number Scenario	79
Runoff Increase	22%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Note: Several parcels in this area have also been identified in the Davidson County Greenway Plan.
2. Have Soil & Water contact adjacent farm owners to discuss potential for agricultural BMPs
3. Restore stream buffers where appropriate

Project C-06 – Northside Drive Forested Buffer

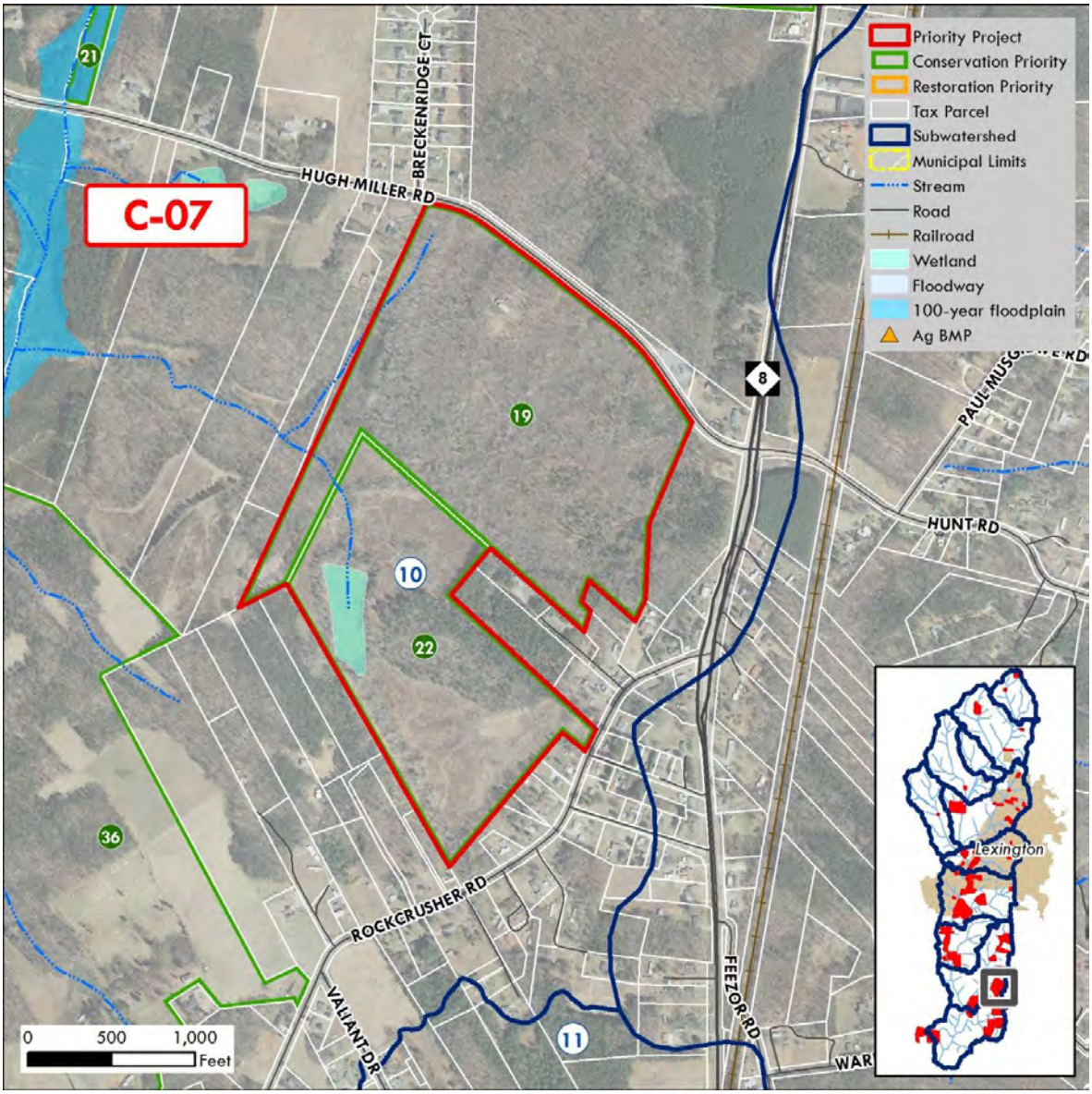


Attribute	C-06
Site Location	City
Subwatershed	2
Land Use	Forest
Linear Stream (Feet)	1,856
Area (Acres)	6.6
Floodplain Area (Acres)	5.9
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	1.83%
Percent Forest Cover	83.8%
Curve Number	73
Curve Number Scenario	81
Runoff Increase	21%

Recommended Actions:

1. Partner with conservation groups to contact property owner and gauge interest in donating land for conservation
   - Note: This parcel has also been identified in the Davidson County Greenway Plan. Critical buffer between residential development and tributary of Swearing Creek.
2. Explore opportunities to incorporate stormwater BMPs to reduce impacts from residential runoff
3. Restore stream buffers where appropriate

Project C-07 – Hugh Miller Road Forested Buffer

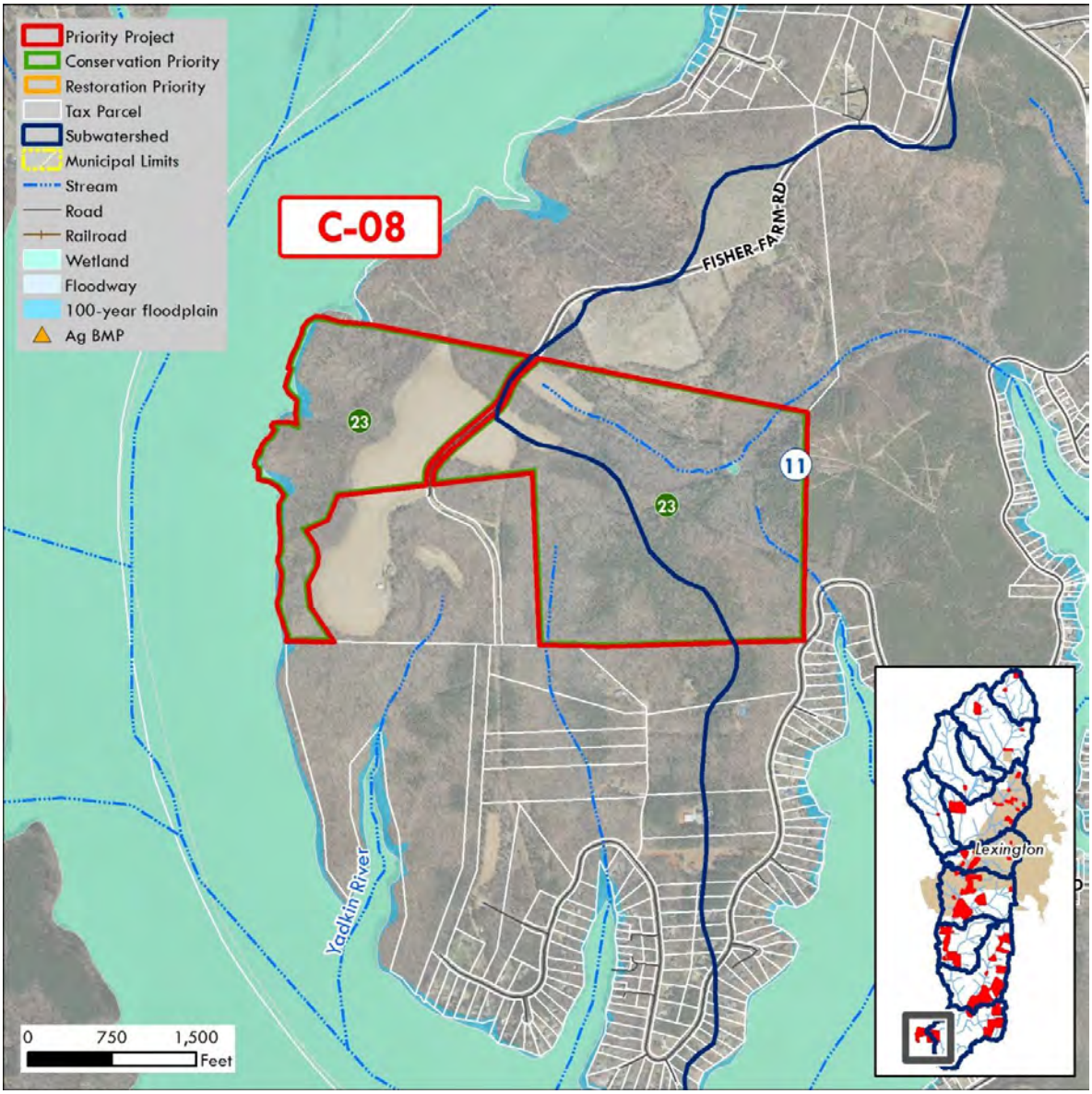


Attribute	C-07
Site Location	County
Subwatershed	10
Land Use	Forest, SFR
Linear Stream (Feet)	1,719
Area (Acres)	124.2
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	2.8
Percent Impervious Surface Cover	0.04%
Percent Forest Cover	92.8%
Curve Number	71
Curve Number Scenario*	79
Runoff Increase**	22%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Critical headwater area
2. Improve buffer surrounding impoundment and determine what type of retention system exists
3. If land is being used for agricultural practices, determine potential for agricultural BMPs

Project C-08 – Fisher Farm Agriculture

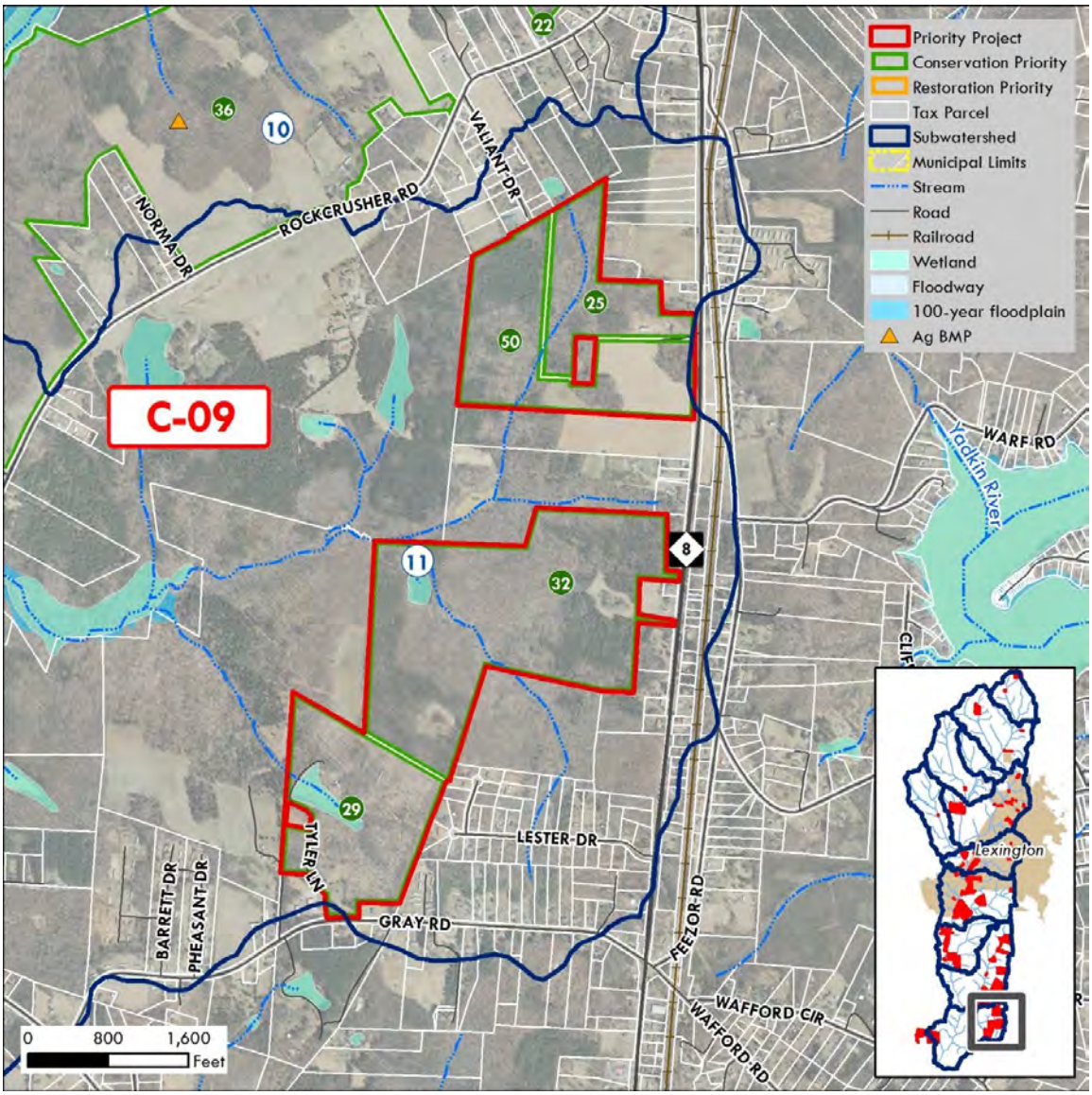


Attribute	C-08
Site Location	County
Subwatershed	11
Land Use	Agricultural, Forest
Linear Stream (Feet)	4,277
Area (Acres)	206.7
Floodplain Area (Acres)	4.7
Wetland Area (Acres)	1.6
Percent Impervious Surface Cover	n/a
Percent Forest Cover	77.7%
Curve Number	60
Curve Number Scenario*	69
Runoff Increase**	28%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Emphasize tax benefits.
   - Note: This property may has potential as a river access point or rest area
2. Have Soil & Water contact property owner to discuss potential for agricultural BMPs

Project C-09 – NC-8 Forested Buffer

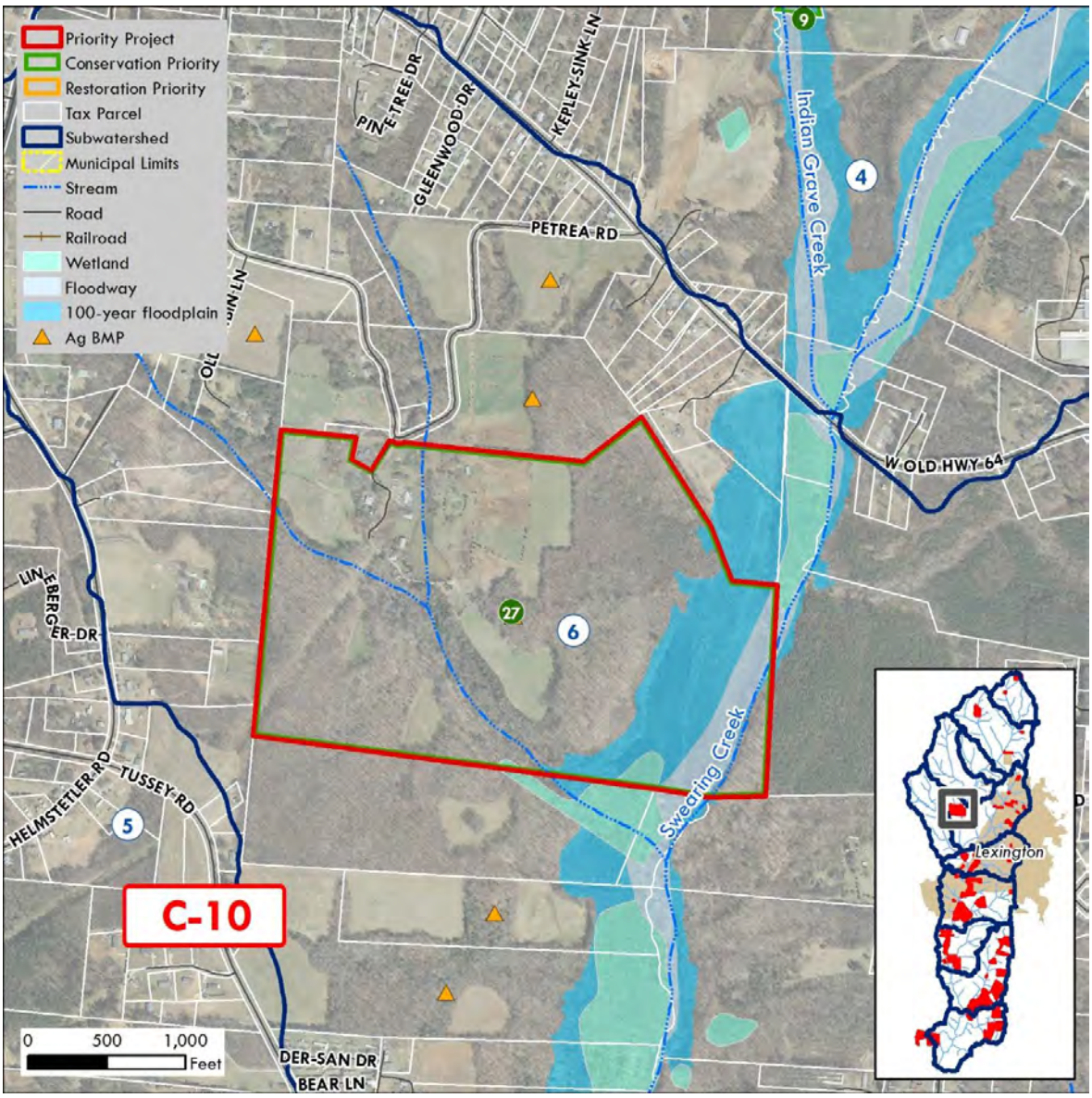


Attribute	C-09
Site Location	County
Subwatershed	11
Land Use	Agricultural, Forest, SFR
Linear Stream (Feet)	5,209
Area (Acres)	252.5
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	5.2
Percent Impervious Surface Cover	0.06%
Percent Forest Cover	86.1%
Curve Number	61
Curve Number Scenario	71
Runoff Increase	31%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Emphasize tax benefits
2. Have Soil & Water contact adjacent farm owners to discuss potential for agricultural BMPs

Project C-10 – Little Babe Farm

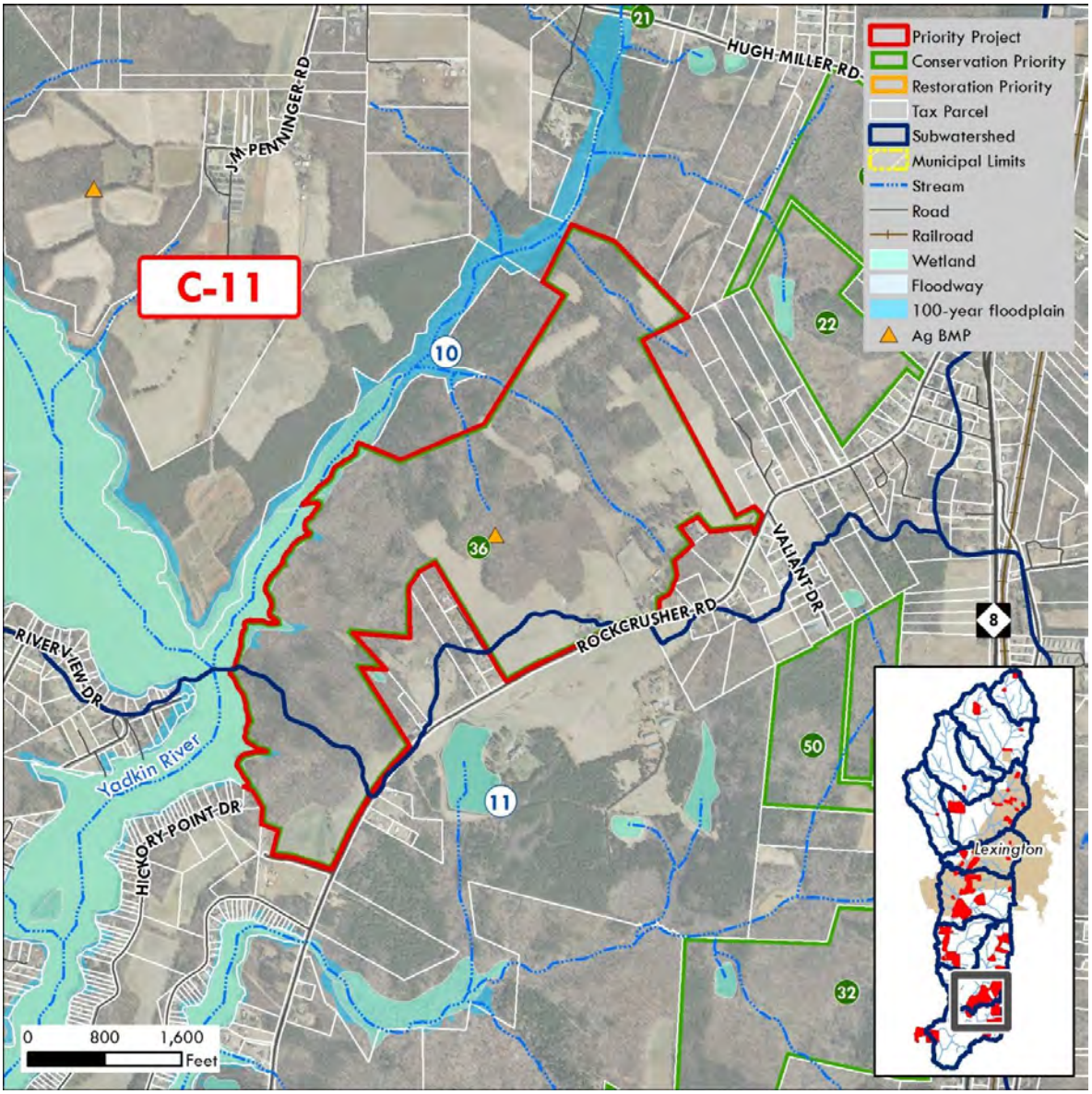


Attribute	C-10
Site Location	County
Subwatershed	6
Land Use	Agricultural, Forest, SFR
Linear Stream (Feet)	4,609
Area (Acres)	142.8
Floodplain Area (Acres)	26.5
Wetland Area (Acres)	1.2
Percent Impervious Surface Cover	n/a
Percent Forest Cover	60.3%
Curve Number	60
*Curve Number Scenario**	*70*
*Runoff Increase***	*31%*

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Note: This property has also been identified in the Davidson County Greenway Plan
2. Have Soil & Water contact property owner to discuss potential for agricultural BMPs
3. Restore stream buffers where appropriate

Project C-11 – Longview Farm

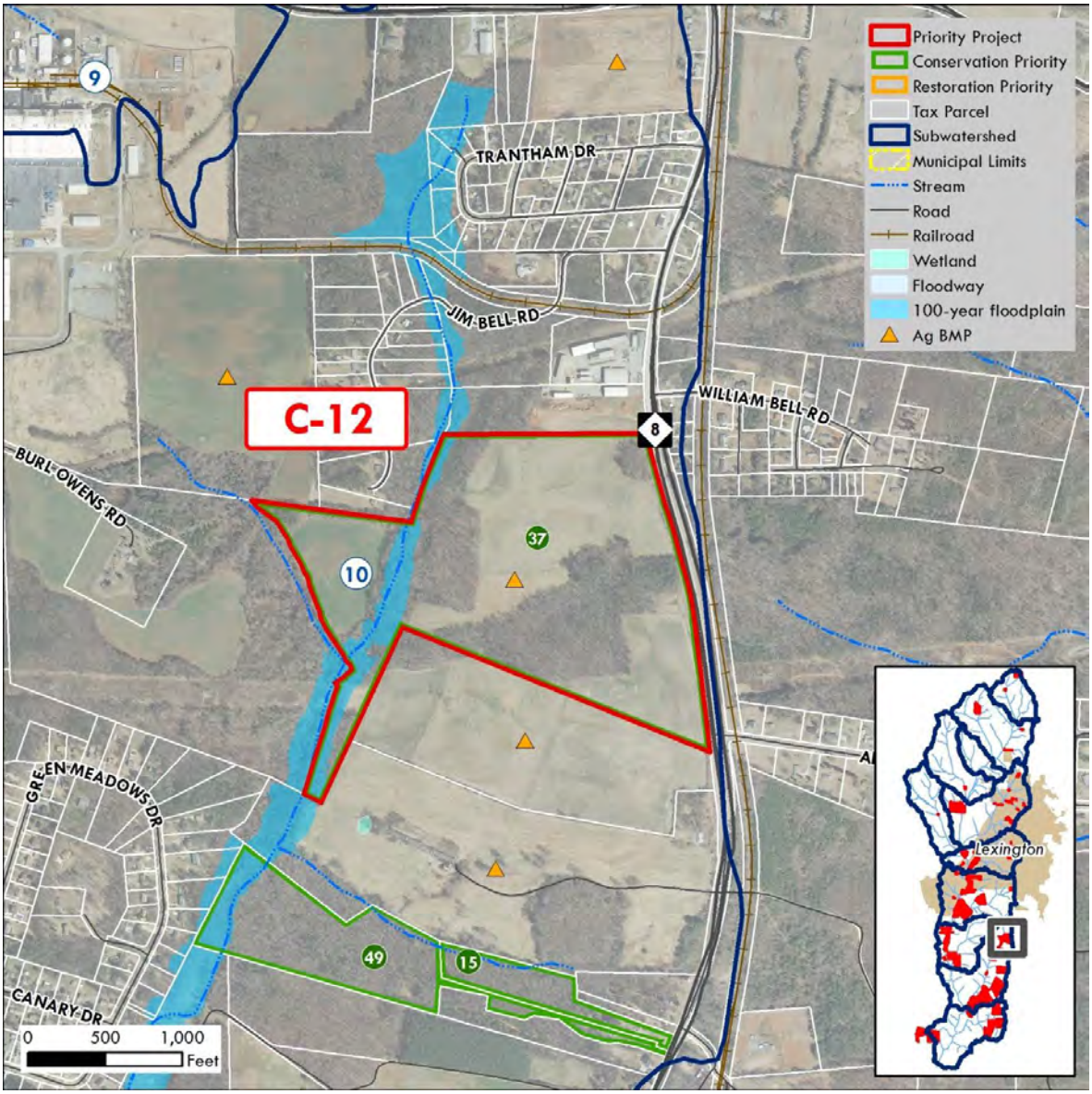


Attribute	C-11
Site Location	County
Subwatershed	10, 11
Land Use	Agricultural BMP, Forest, SFR
Linear Stream (Feet)	4,959
Area (Acres)	326.0
Floodplain Area (Acres)	7.5
Wetland Area (Acres)	5.7
Percent Impervious Surface Cover	0.13%
Percent Forest Cover	67.3%
Curve Number	57
Curve Number Scenario	69
Runoff Increase	40%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Note: This property has also been identified in the Davidson County Greenway Plan. May be suitable as boat access point/rest area.
2. Restore stream buffers along tributaries where appropriate

Project C-12 – D&M Farms

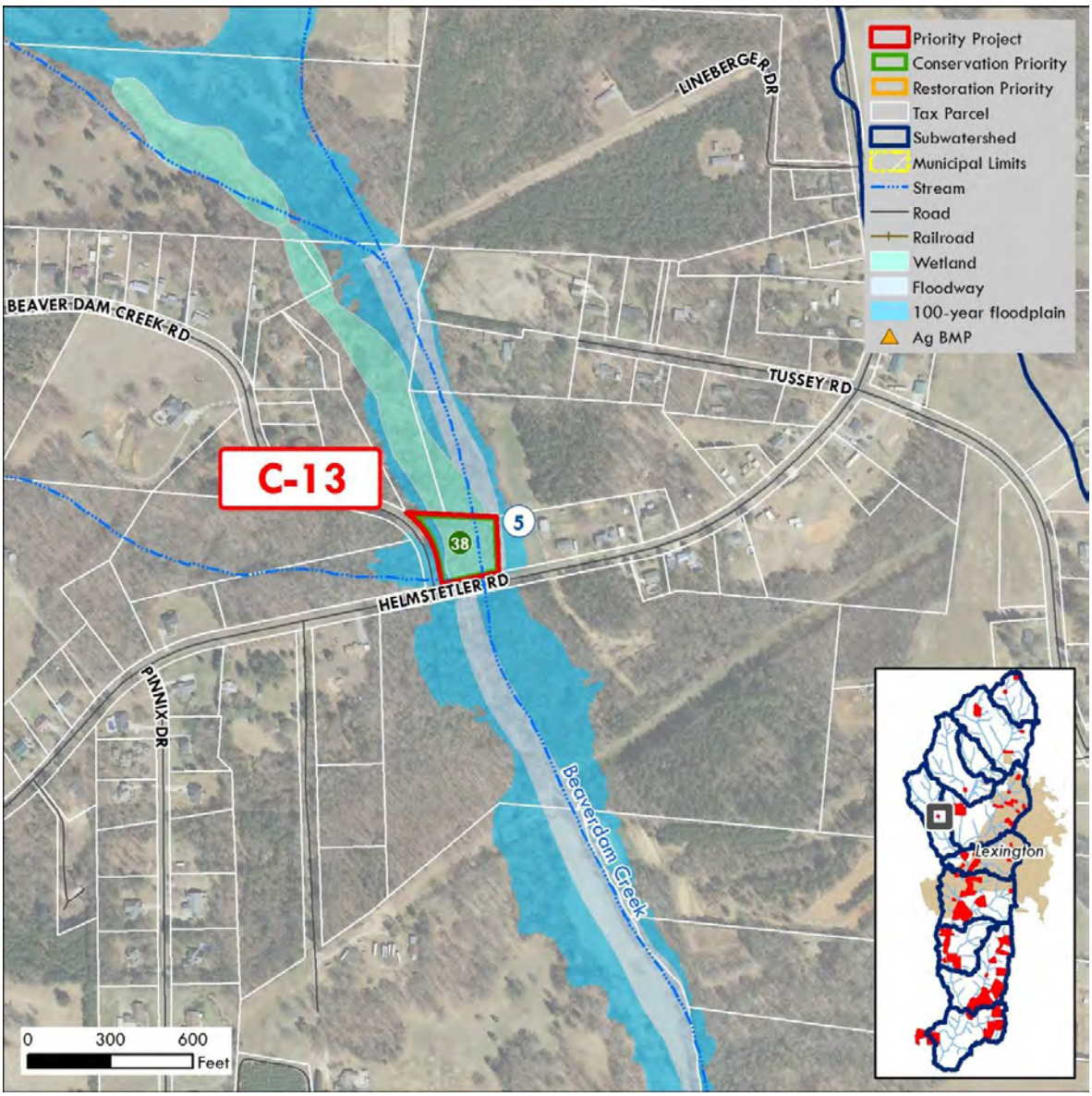


Attribute	C-12
Site Location	County
Subwatershed	10
Land Use	Agricultural BMP, Forest
Linear Stream (Feet)	1,016
Area (Acres)	83.2
Floodplain Area (Acres)	6.7
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	0.13%
Percent Forest Cover	48.5%
Curve Number	61
Curve Number Scenario	70
Runoff Increase	28%

Recommended Actions:

1. Partner with conservation groups to contact property owners and gauge interest in donating land for conservation
   - Emphasize tax benefits
2. Have Soil & Water contact property owner to monitor existing and discuss potential for additional agricultural BMPs
3. Restore stream buffers where appropriate

Project C-13 – Beaverdam Creek Confluence

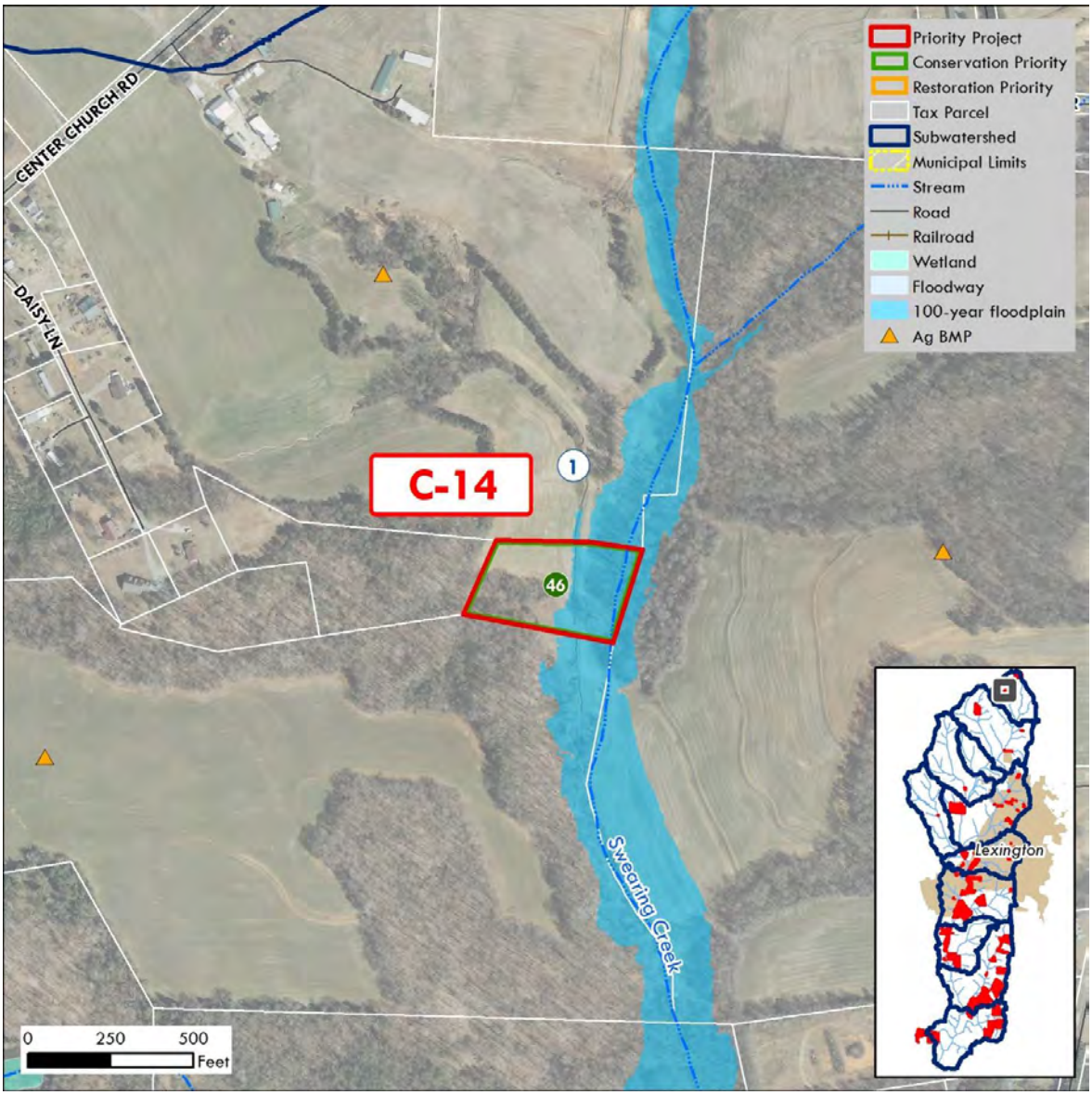


Attribute	C-13
Site Location	County
Subwatershed	5
Land Use	Forest
Linear Stream (Feet)	293
Area (Acres)	1.3
Floodplain Area (Acres)	1.3
Wetland Area (Acres)	1.0
Percent Impervious Surface Cover	2.80%
Percent Forest Cover	91.6%
Curve Number	77
Curve Number Scenario	84
Runoff Increase	18%

Recommended Actions:

1. Partner with conservation groups to contact property owner and gauge interest in donating land for conservation
   - Note: This property has also been identified in the Davidson County Greenway Plan. Property is directly in floodplain, which may ease negotiations.

Project C-14 – Swearing Greek Headwater Buffer

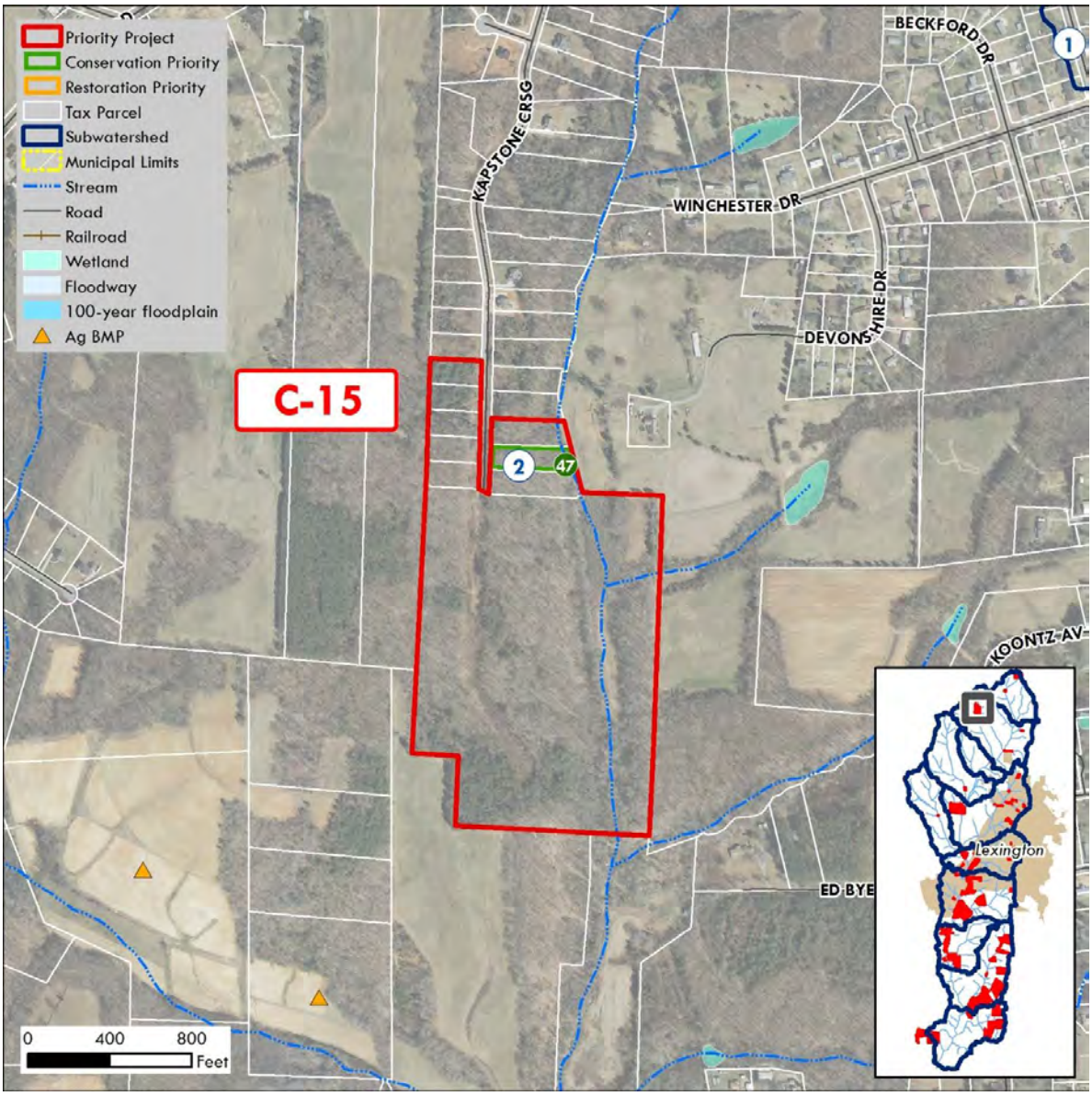


Attribute	C-14
Site Location	County
Subwatershed	1
Land Use	Agricultural, Forest
Linear Stream (Feet)	293
Area (Acres)	2.8
Floodplain Area (Acres)	1.2
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	n/a
Percent Forest Cover	39.5%
Curve Number	84
Curve Number Scenario	83
Runoff Increase	-2%

Recommended Actions:

1. Partner with conservation groups to contact property owner and gauge interest in donating land for conservation
   - Note: This property has also been identified in the Davidson County Greenway Plan.
2. Have Soil & Water contact surrounding farm owners to monitor existing and discuss potential for additional agricultural BMPs
3. Restore stream buffers where appropriate

Project C-15 – Kapstone Crossing Subdivision

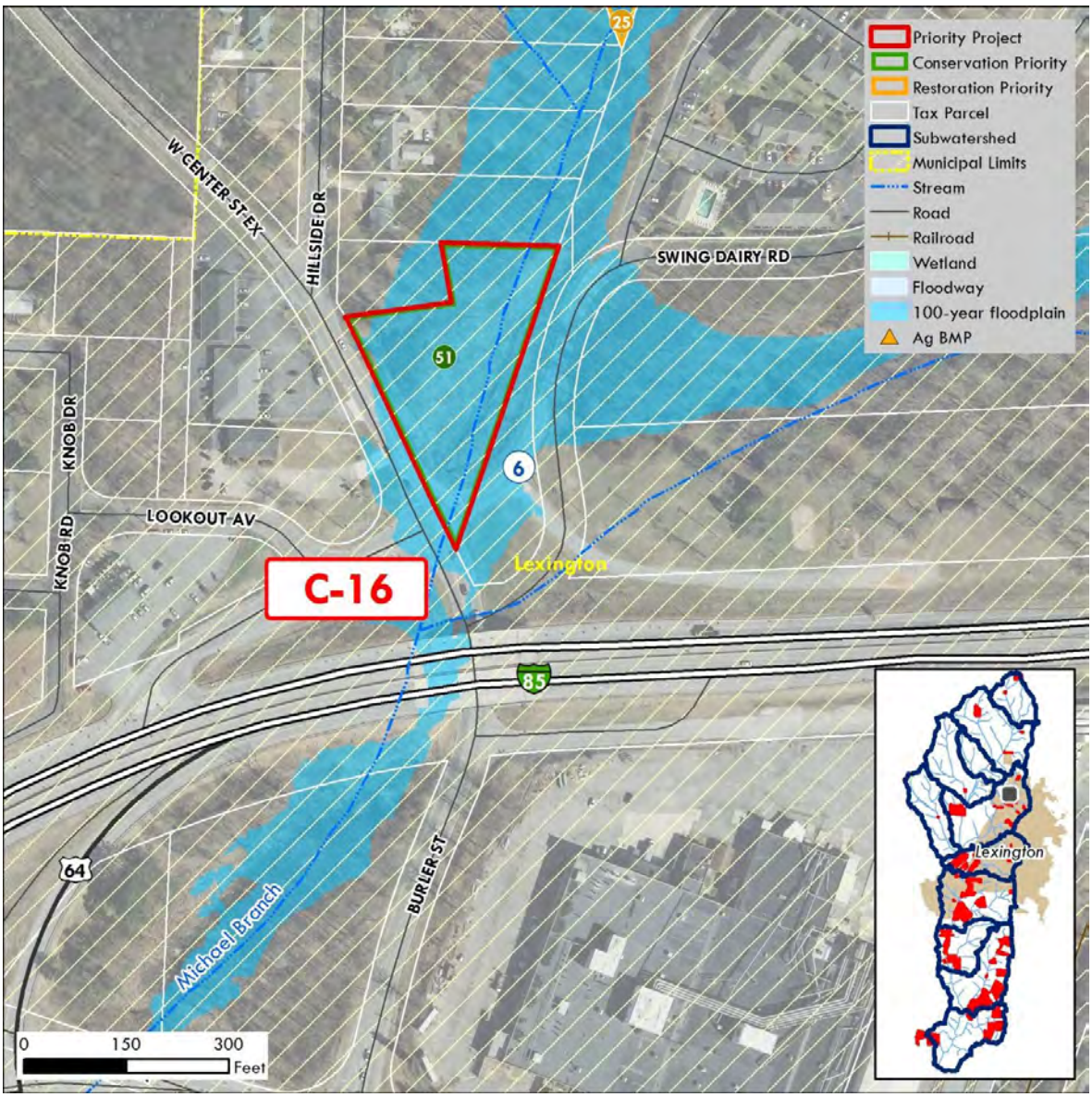


Attribute	C-15
Site Location	County
Subwatershed	2
Land Use	Forest, SFR
Linear Stream (Feet)	2,359
Area (Acres)	49.5
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	n/a
Percent Forest Cover	91.1%
Curve Number	60
Curve Number Scenario	71
Runoff Increase	35%

Recommended Actions:

1. Partner with conservation groups to contact property owner and gauge interest in donating land for conservation
   - Note: Subdivision not fully built upon. Opportunity to leave as fully vegetated and forested buffer.
2. Have Soil & Water contact adjacent farm owners to discuss potential for agricultural BMPs

Project C-16 – NCDOT Floodplain



Attribute	C-16
Site Location	City
Subwatershed	6
Land Use	Vacant
Linear Stream (Feet)	435
Area (Acres)	1.5
Floodplain Area (Acres)	1.4
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	20.20%
Percent Forest Cover	29.0%
Curve Number	79
Curve Number Scenario*	84
Runoff Increase**	12%

Recommended Actions:

1. Partner with conservation groups to contact property owner and gauge interest in donating land for conservation
   - Critical floodplain area. Could potentially serve as stormwater catchment area for surrounding development.

Restoration Projects

Table 5 provides an overview of identified retrofit/restoration projects. These priority projects were developed through a combination of GIS modeling, field visits, and stakeholder committee input, and are intended to provide Lexington and Davidson County with several ideas to begin watershed restoration and implementation.

Each of the 15 restoration projects described on the following pages contains a map, a summary statistics table, a summary of recommended actions, detailed BMP conceptual designs, and cost and nutrient estimates. The BMP conceptual plans provide details about recommended stormwater control measures (SCMs) to reduce onsite runoff. Nutrient removals were calculated for each project using the Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool spreadsheet developed by the North Carolina Department of Environmental Quality (NCDEQ). Costs were also estimated for SCMs using unit costs from recently completed project. Where actual bid cost data was not available, prices were researched from government and published sources. Cost estimates include the best possible estimate for earthwork, materials, planting and other items based on the concept plans.

Table 5: Top Priority Restoration Projects

Project	Site Name	Stress Parcels
S-01	Green Needles Drive	1, 2, 37 (additional parcel added by stakeholder request)
S-02	Jaycee Park	3, 35
S-03	Michael Branch	5, 14, 29, 50 (extra parcel added by same owner)
S-04	Holt-Moffitt Field, Radcliff Park & Brownfield	6, 9, 17, 36, 46
S-05	Schwarz Industrial	7, 10
S-06	North Town Offices	8, 16, 24, 26, 34
S-07	Davidson County Courthouse	11, 40
S-08	Black Concrete Inc.	12, 22
S-09	Condumex Industrial	13
S-10	Estates Drive Residential	18 (extra parcel added by same owner)
S-11	Welcome Elementary School	19, 27 (extra parcel added by same owner)
S-12	Carolina Drawers Industrial	21
S-13	Cedar Lane Drive Industrial	23
S-14	First Baptist Church	28
S-15	Regents Center	49 (extra parcel added by stakeholder request)

SWEARING CREEK WATERSHED PLAN

List of Potential Watershed Projects at Selected Sites

Site-SCM No.	SCM Type	Location
1-01	Bioretention	Green Needles Drive
1-02	Bioretention	Green Needles Drive
1-03	Tree Planting	Green Needles Drive
1-04	Educational Feature	Green Needles Drive
2-01	Bioswale	Jaycee Park
2-02	Bioswale	Jaycee Park
2-03	Vegetated Buffer	Jaycee Park
2-04	Vegetated Buffer	Jaycee Park
2-05	Stream Restoration	Jaycee Park
2-06	Educational Feature	Jaycee Park
3-01	Bioretention	Michael Branch
3-02	Bioswale	Michael Branch
3-03	Stormwater Wetland	Michael Branch
3-04	Bioswale	Michael Branch
3-05	Bioswale	Michael Branch
3-06	Permeable Pavement	Michael Branch
3-07	Bioswale	Michael Branch
3-08	Bioswale	Michael Branch
3-09	Permeable Pavement	Michael Branch
3-10	Permeable Pavement	Michael Branch
4-01	Bioswale	Holt-Moffitt Field, Radcliff Park & Brownfield
4-02	Stormwater Wetland	Holt-Moffitt Field, Radcliff Park & Brownfield
4-03	Stream Restoration	Holt-Moffitt Field, Radcliff Park & Brownfield
4-04	Vegetated Buffer	Holt-Moffitt Field, Radcliff Park & Brownfield
4-05	Stream Restoration	Holt-Moffitt Field, Radcliff Park & Brownfield
4-06	Educational Feature	Holt-Moffitt Field, Radcliff Park & Brownfield
5-01	Green Roof	Schwarz Industrial
5-02	Bioswale	Schwarz Industrial
5-03	Stormwater Wetland	Schwarz Industrial
5-04	Stream Restoration	Schwarz Industrial
5-05	Vegetated Buffer	Schwarz Industrial
5-06	Bioretention	Schwarz Industrial
6-01	Vegetated Buffer	North Town Offices
6-02	Vegetated Buffer	North Town Offices
6-03	Stormwater Wetland	North Town Offices
6-04	Bioretention	North Town Offices

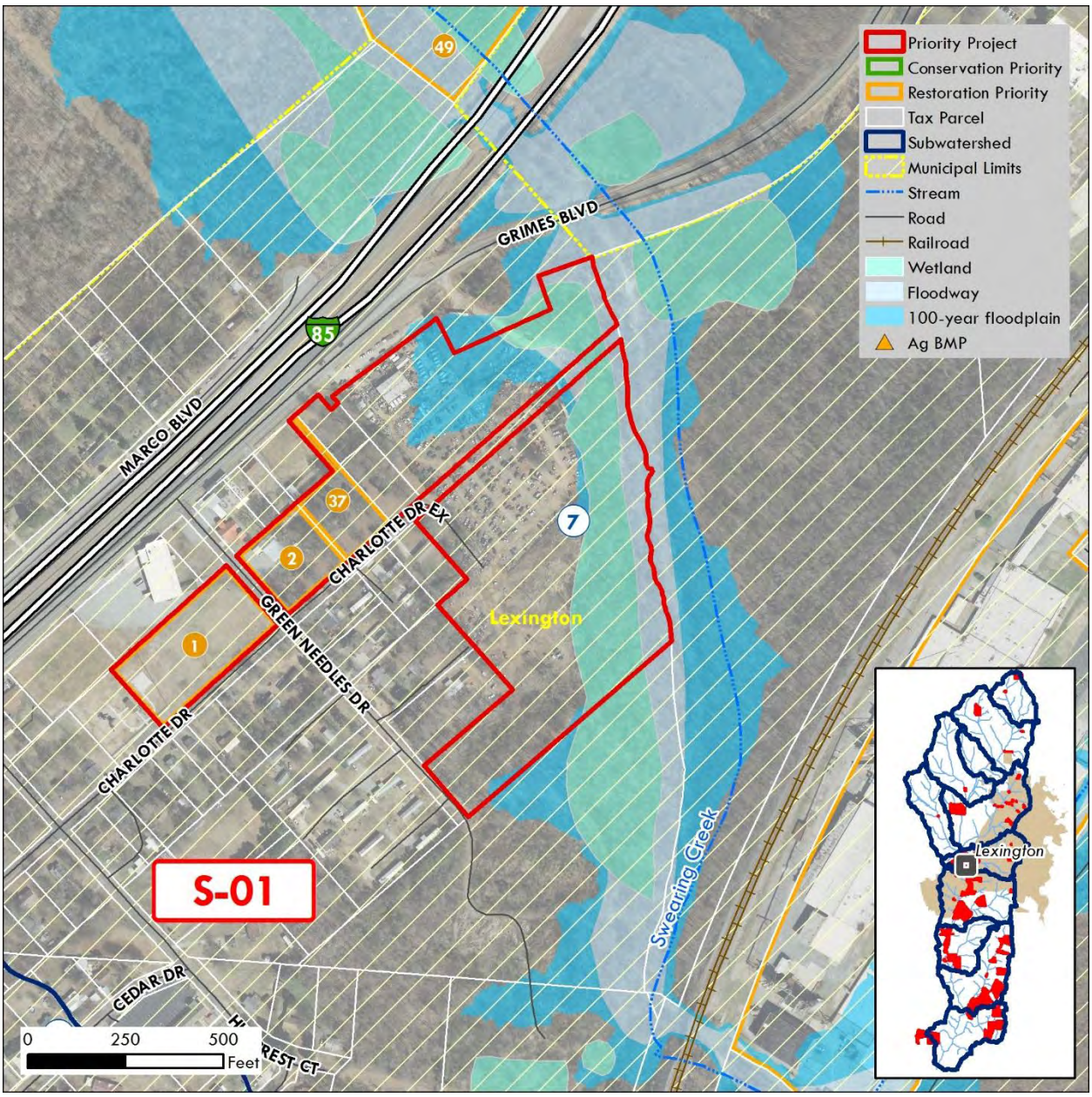
List of Potential Watershed Projects at Selected Sites (cont.)

Site-SCM No.	SCM Type	Location
6-05	Permeable Pavement	North Town Offices
6-06	Bioretention	North Town Offices
6-07	Stream Restoration	North Town Offices
6-08	Bioretention	North Town Offices
7-01	Bioretention	Davidson County Courthouse
7-02	Permeable Pavement	Davidson County Courthouse
7-03	Green Roof[2]	Davidson County Courthouse
7-04	Permeable Pavement	Davidson County Courthouse
7-05	Green Roof	Davidson County Courthouse
7-06	Bioretention	Davidson County Courthouse
8-01	Sand Filter	Black Concrete Inc.
9-01	Permeable Pavement	Condumex Industrial
9-02	Green Roof	Condumex Industrial
9-03	Stormwater Wetland	Condumex Industrial
9-04	Stream Restoration	Condumex Industrial
9-05	Educational Feature	Condumex Industrial
10-01	Permeable Pavement	Estates Drive Residential
10-02	Cistern	Estates Drive Residential
10-03	Filterra Box	Estates Drive Residential
10-04	Educational Feature	Estates Drive Residential
11-01	Permeable Pavement	Welcome Elementary School
11-02	Permeable Pavement	Welcome Elementary School
11-03	Cistern	Welcome Elementary School
11-04	Bioretention	Welcome Elementary School
11-05	Stormwater Wetland	Welcome Elementary School
11-06	Rain Garden	Welcome Elementary School
11-07	Green Roof	Welcome Elementary School
11-08	Green Roof	Welcome Elementary School
11-09	Grassed Swale	Welcome Elementary School
11-10	Grassed Swale	Welcome Elementary School
11-11	Educational Feature	Welcome Elementary School
12-01	Green Roof	Carolina Drawers Industrial
12-02	Cistern	Carolina Drawers Industrial
12-03	Stormwater Wetland	Carolina Drawers Industrial
12-04	Educational Feature	Carolina Drawers Industrial
13-01	Permeable Pavement	Cedar Lane Drive Industrial

List of Potential Watershed Projects at Selected Sites (cont.)

Site-SCM No.	SCM Type	Location
13-02	Cistern	Cedar Lane Drive Industrial
13-03	Cistern	Cedar Lane Drive Industrial
13-04	Bioretention	Cedar Lane Drive Industrial
13-05	Stormwater Wetland	Cedar Lane Drive Industrial
13-06	Stormwater Wetland	Cedar Lane Drive Industrial
13-07	Stream Restoration	Cedar Lane Drive Industrial
13-08	Educational Feature	Cedar Lane Drive Industrial
14-01	Permeable Pavement	First Baptist Church
14-02	Permeable Pavement	First Baptist Church
14-03	Cistern	First Baptist Church
14-04	Cistern	First Baptist Church
14-05	Cistern	First Baptist Church
14-06	Bioretention	First Baptist Church
14-07	Educational Feature	First Baptist Church
15-01	Rain Garden	Regents Center
15-02	Rain Garden	Regents Center
15-03	Rain Garden	Regents Center
15-04	Rain Garden	Regents Center
15-05	Rain Garden	Regents Center
15-06	Rain Garden	Regents Center
15-07	Permeable Pavement	Regents Center
15-08	Permeable Pavement	Regents Center
15-09	Cistern	Regents Center
15-10	Bioretention	Regents Center
15-11	Educational Feature	Regents Center

Project S-01 – Green Needles Drive



Attribute	S-01
Site Location	City
Subwatershed	7
Land Use	Vacant, Commercial
Linear Stream (Feet)	n/a
Area (Acres)	18.2
Floodplain Area (Acres)	6.9
Wetland Area (Acres)	3.2
Percent Impervious Surface Cover	29.95%
Percent Forest Cover	33.1%

Recommended Actions:

1. Seek funding to support BMP construction as outlined in conceptual plan, contact adjacent property owners, and submit for bid
   - Note: Use as pilot project to increase support for other water quality projects. Supplement with educational signage.
2. Contact Leonard's Auto Salvage to discuss maintaining property to minimize any potential impairments to nearby water

SCM 1–1 through 1–3: Bioretention and Tree Planting Concept Plan
This existing horse pasture could be easily converted into a bioretention SCM. Currently, runoff from the pasture and the upstream drainage area is delivered overland into a grated yard inlet. Nutrients from the pasture are likely carried into the receiving stream via this yard inlet. A properly maintained bioretention area could effectively reduce these nutrient loadings into the stream.

The approximate watershed draining through this area is 4 acres consisting of mostly pervious grassed areas. One bioretention area could be used to capture this runoff. This bioretention area would be sized to capture the first flush for peak attenuation as well as nutrient reduction. Due to the soils in this area an Internal Water Storage compartment may not be suitable for this site, and due to the high solids and nutrient content of the surrounding field a forebay pretreatment area is required.

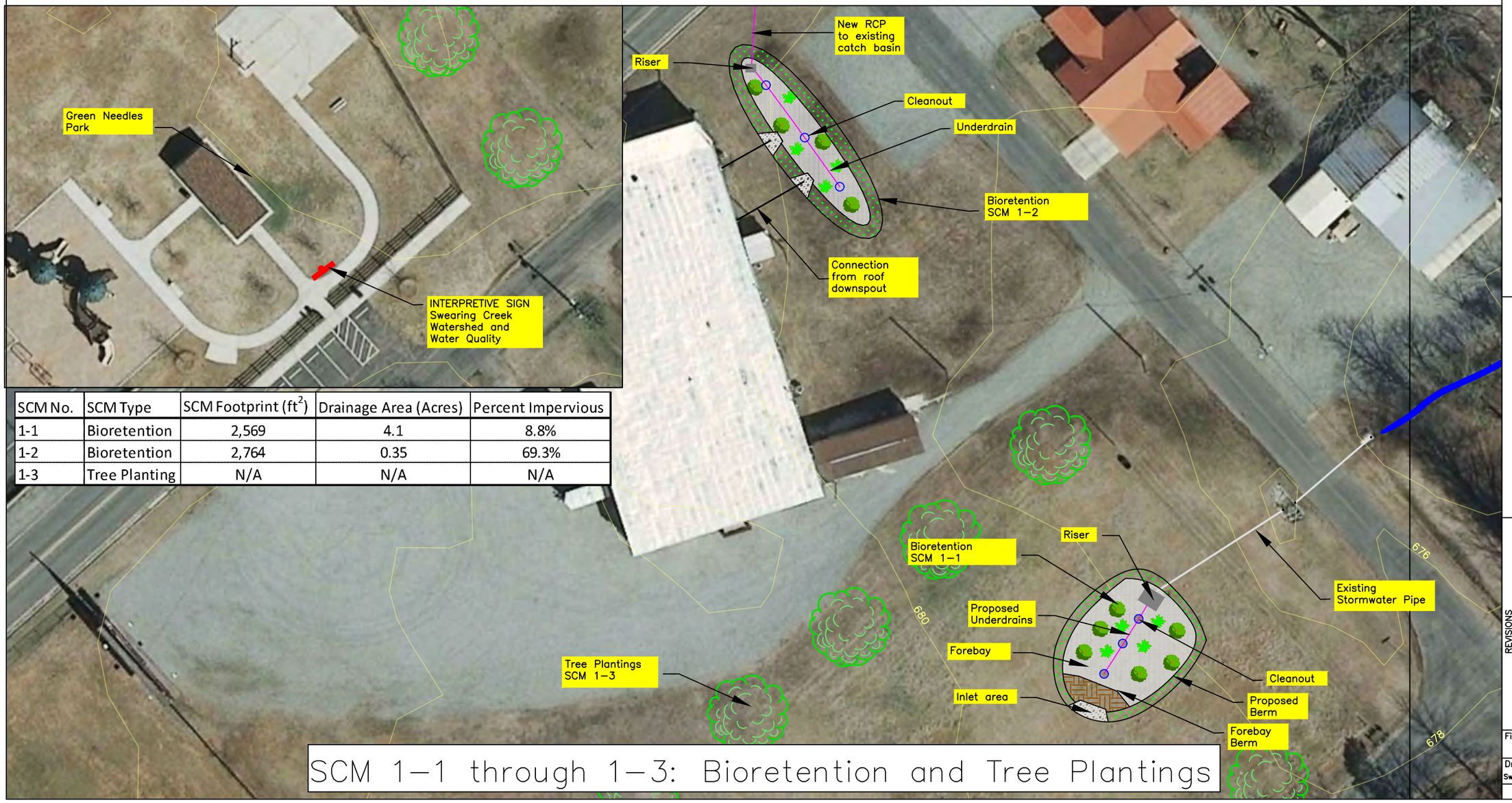
This concept plans breaks the bioretention area up into 2 potential sections. A pre–treatment unit consists of a rock inlet and a sediment forebay. This forebay would be used to trap sediments before they could reach the bioretention media section. The second section, which would be separated from the first via an inner berm, would consist of bioretention media, a riser, and underdrains. This bioretention media section would allow water to infiltrate which would remove nutrients. The water would drain through the media into the underdrain then into the riser and out through an outlet pipe that would be connected to an existing stormwater pipe.

N

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.



SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
1-1	Bioretention	2,569	4.1	8.8%
1-2	Bioretention	2,764	0.35	69.3%
1-3	Tree Planting	N/A	N/A	N/A

SCM 1–1 through 1–3: Bioretention and Tree Plantings

Designed KLB,YB
Drawn YB
Checked KB
Approved
Date
Job Class JC

Site 1 Stormwater Concept

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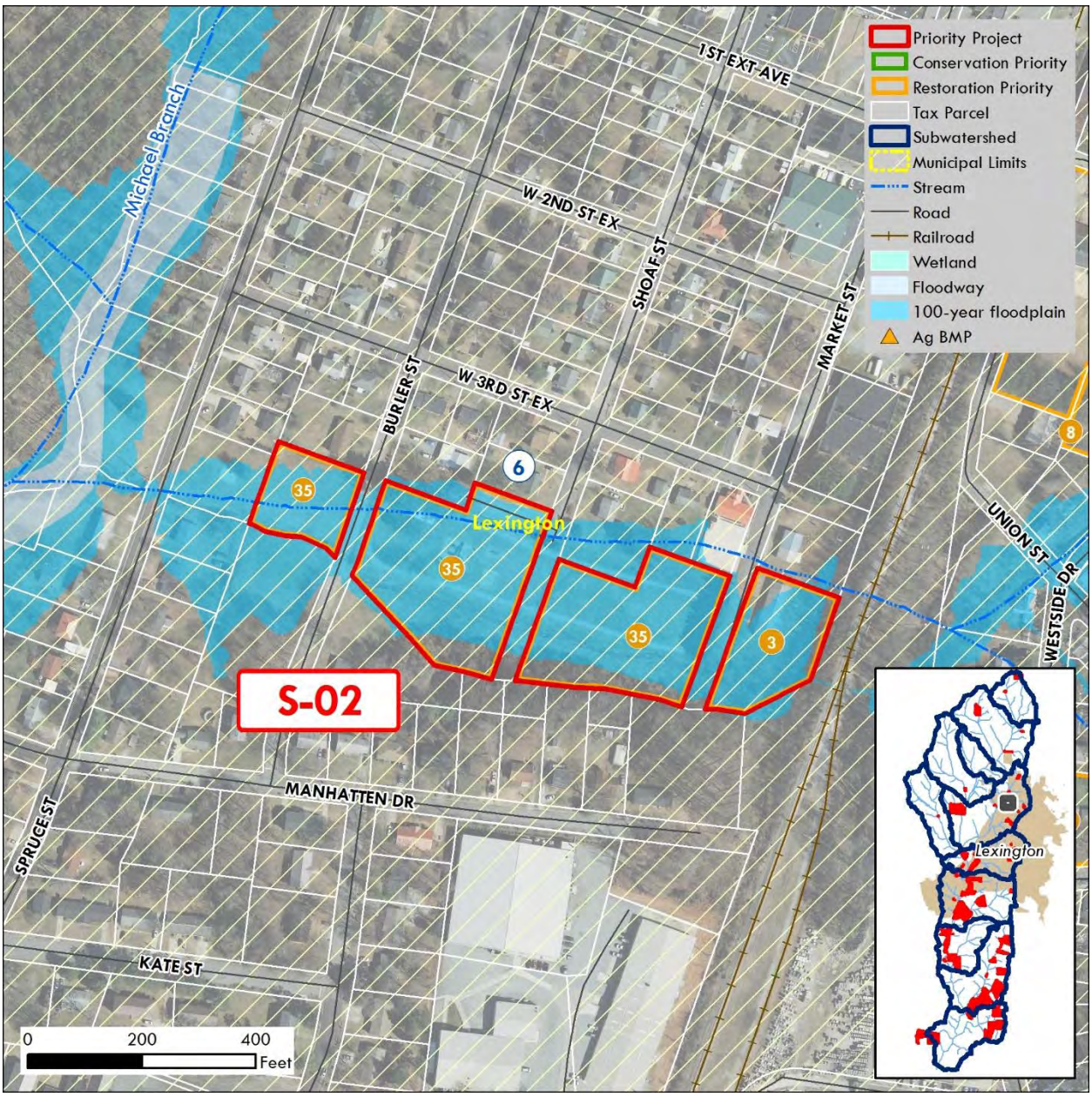
Drawing:
SwearingCk_Concept.dwg

Project S-02 – Jaycee Park



Attribute	S-02
Site Location	City
Subwatershed	6
Land Use	Recreation
Linear Stream (Feet)	469
Area (Acres)	4.7
Floodplain Area (Acres)	4.0
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	10.64%
Percent Forest Cover	29.0%

Recommended Actions:

1. Seek funding to support BMP construction as outlined in conceptual plan, contact adjacent property owners, and submit for bid
   - Note: Could be used as a pilot project along with S-01, since publically owned. Supplement with educational signage.
2. Increase riparian buffers if possible

SCM 2–1 through 2–5: Bioswales, Vegetated Buffers, and Stream Restoration Concept Plan
The area draining to Jaycee Park could benefit from a bioswale SCM. Currently, runoff from the upstream drainage area is conveyed directly to Royal Park Branch without treatment. A properly maintained bioswale with check dams could intercept and effectively reduce nutrient loadings and peak flows going into the stream. A vegetated buffer around and additional restoration improvements to Royal Park Branch are also recommended.

The approximate drainage area is 5 acres of urban residential homes. Retrofitting the two drainage ditches with bioswales could be used as a way to capture and treat this runoff. These bioswales would be sized to capture the first flush for peak attenuation as well as nutrient reduction.

These bioswales would consist of bioretention media, a riser, and underdrains. The bioretention media section would allow water to infiltrate which would remove nutrients. The water would drain into the underdrain then into the riser and through an outlet pipe that would be connected to an existing stormwater pipe.

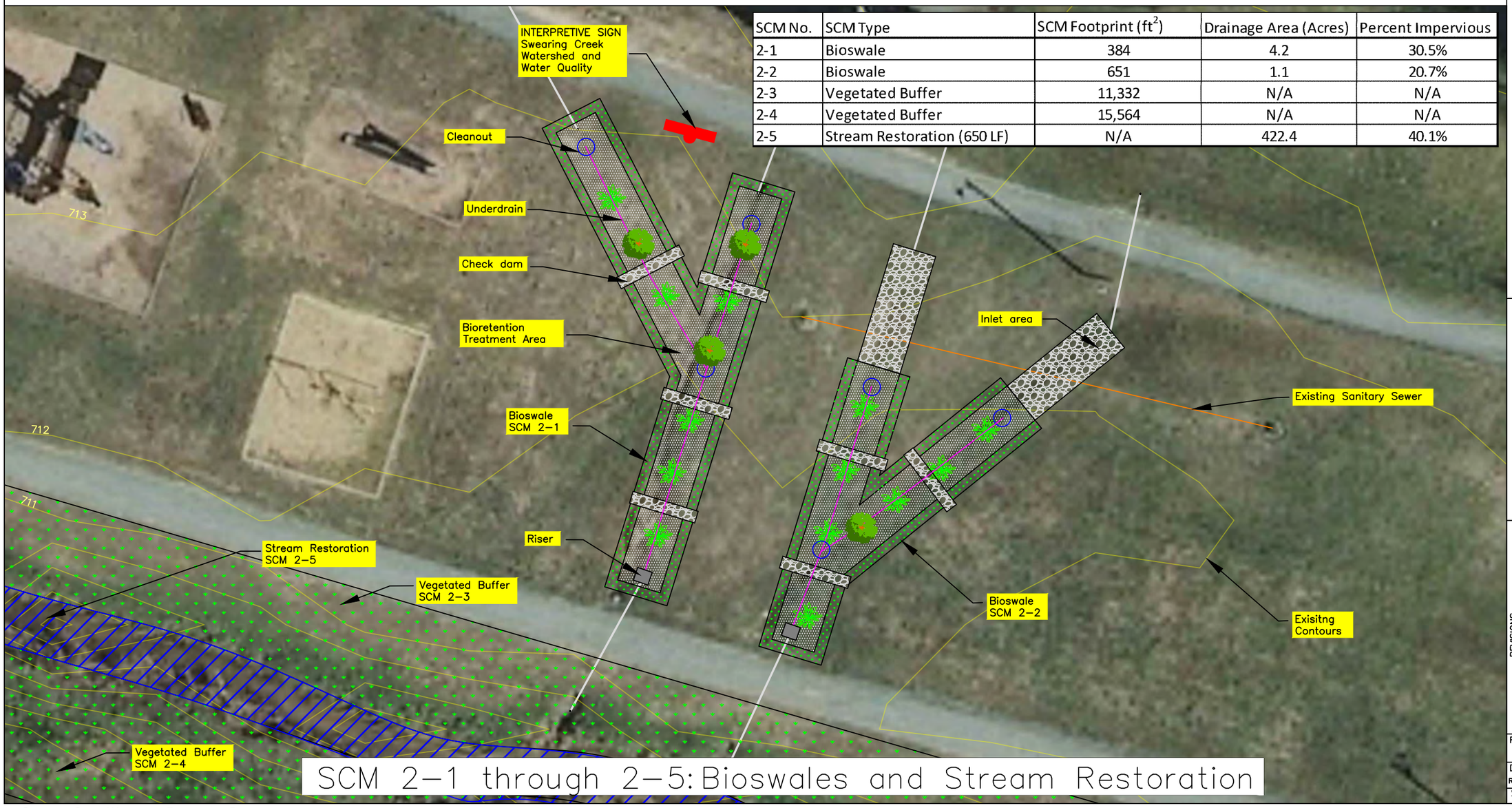
N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
2-1	Bioswale	384	4.2	30.5%
2-2	Bioswale	651	1.1	20.7%
2-3	Vegetated Buffer	11,332	N/A	N/A
2-4	Vegetated Buffer	15,564	N/A	N/A
2-5	Stream Restoration (650 LF)	N/A	422.4	40.1%



SCM 2–1 through 2–5: Bioswales and Stream Restoration

Designed KLB,YB
Drawn YB
Checked KB
Approved
Date
Job Class JC
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Site 2 Stormwater Concept

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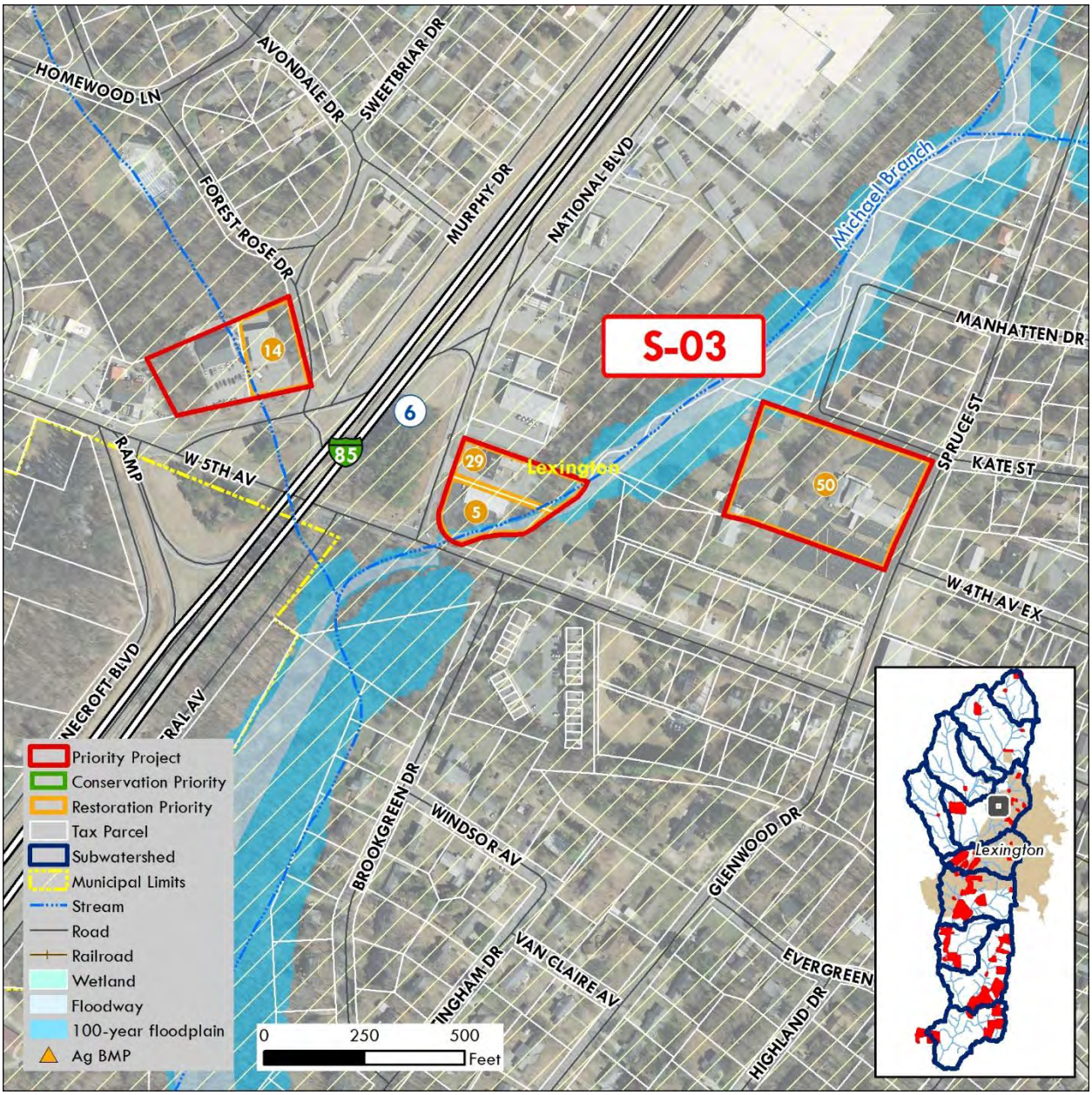
Drawing:
RevMill_Concept.dwg

Sheet 2 of 15

Project S-03 – Michael Branch



Attribute	S-03
Site Location	City
Subwatershed	6
Land Use	Institutional, Commercial, Office
Linear Stream (Feet)	575
Area (Acres)	5.9
Floodplain Area (Acres)	0.6
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	47.46%
Percent Forest Cover	24.5%

Recommended Actions:

1. Contact property owners to gauge interest in implementing suggested stormwater BMPs
   - Note: Some of these parcels were also identified in the Davidson Greenway Plan
2. Seek funding to support implementation
3. May need to phase projects, since there are three different property owners

SCM 3–1 and 3–2: Bioretention and Bioswale Concept Plan
The area draining through the Spruce Street Baptist Church could benefit from a bioretention–bioswale SCM system. Currently, parking lot and roof runoff from the upstream drainage area is conveyed to the existing drainage system without treatment. A properly maintained bioretention area could intercept and effectively reduce nutrient loadings and peak flows draining from the parking lot. Effluent from this bioretention area could be routed into the downstream bioswale for further treatment.

The approximate drainage area is 1 acre of impervious parking lot. Retrofitting one of the parking islands as a bioretention area could be a way to capture and treat this runoff. This bioretention area would be sized to capture the first flush for peak attenuation as well as nutrient reduction. The existing downstream drainage ditch could be retrofitted into an engineered bioswale for additional treatment of parking lot and roof runoff.

This bioretention/bioswale system would consist of bioretention media, a riser, and underdrains. The bioretention media section would allow water to infiltrate through the media which would remove nutrients. The water would drain through the media into the underdrain then into the riser and out through an outlet pipe that would be connected to an existing stormwater pipe.

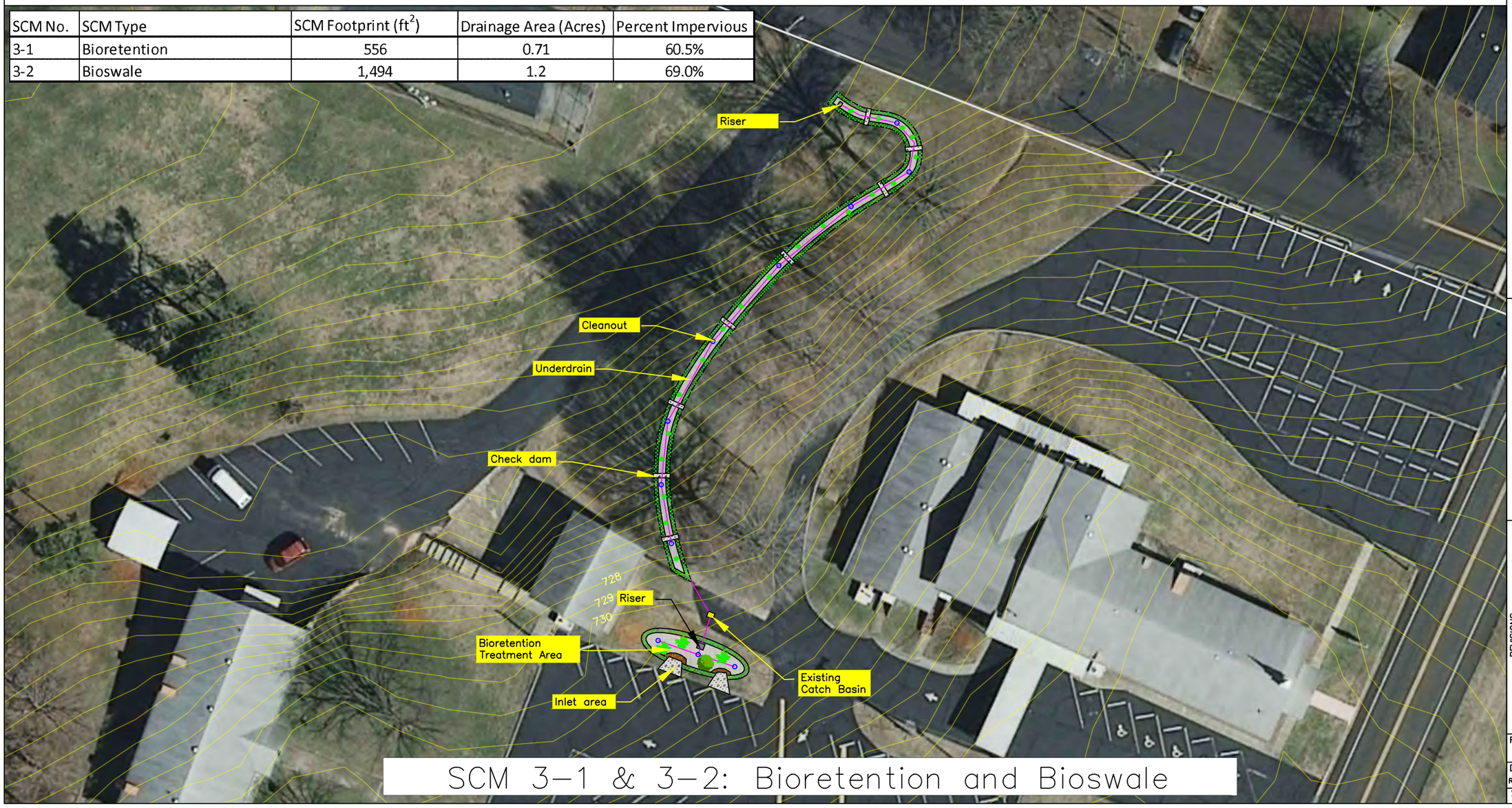
N

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
3-1	Bioretention	556	0.71	60.5%
3-2	Bioswale	1,494	1.2	69.0%



SCM 3–1 & 3–2: Bioretention and Bioswale

Designed KLB,YB
Drawn YB
Checked KB
Approved
Date
Title
Job Class JC

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Drawing:
RevMill_Concept.dwg

Sheet 3 of 15

SCM 3–3: Wetland Concept Plan
The area upstream of Spruce Street Baptist Church could benefit from a constructed stormwater wetland. Currently, runoff from the upstream drainage area is conveyed directly to Michael Branch through the existing stormwater system without treatment. A properly maintained stormwater wetland with check dams could intercept and effectively reduce nutrient loadings and peak flows going into the stream.

The approximate drainage area is 7 acres of urban residential homes. A wetland could be used to intercept and treat 30% of the first flush runoff for peak attenuation as well as nutrient reduction. This wetland would be sized to capture the first flush for peak attenuation as well as nutrient reduction.

This wetland would consist of wetland vegetation, a riser, and a forebay. The wetland is designed to maximize retention time in order to allow for nutrient uptake by the wetland plant species. These plants also reduce flows and allow for sedimentation. After treatment stormwater flows exit through the riser and out through an outlet pipe that would be connected to an existing stormwater pipe which empties into Michael Branch.

N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
3-3	Wetland	2,638	7.22	32.5%

SCM 3–3: Wetland

Designed YB
Drawn YB
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Sheet 3 of 15

SCM 3–4, 3–5, & 3–6: Bioswales and Permeable Pavement
The area upstream of the Chronic Cycles business could benefit from bioswale and permeable pavement SCM retrofits. Currently, runoff from the upstream drainage area is conveyed directly to Michael Branch through the existing stormwater drainage ditches without treatment. Runoff from the Chronic Cycles parking lot is conveyed directly to Michael Branch as well. Properly maintained bioswales with check dams and a permeable pavement retrofit could intercept and effectively reduce nutrient loadings and peak flows going into the stream.

The approximate drainage area is 1.3 acres of commercial businesses. A retrofit of the drainage ditches into bioswales could be used as an effective method to intercept and treat this runoff. Drainage from the parking lot could also be effectively intercepted and treated by permeable pavement retrofits in some of the existing parking areas. These SCMs would be sized to capture the first flush for peak attenuation as well as nutrient reduction.

The bioswale would consist of bioretention media, check dams, a riser, and vegetated embankments. The permeable pavement would consist of pervious concrete or asphalt with an optional underdrain and observation well. After treatment stormwater flows exit through the riser or underdrain and out through a pipe that would outfall into Michael Branch.

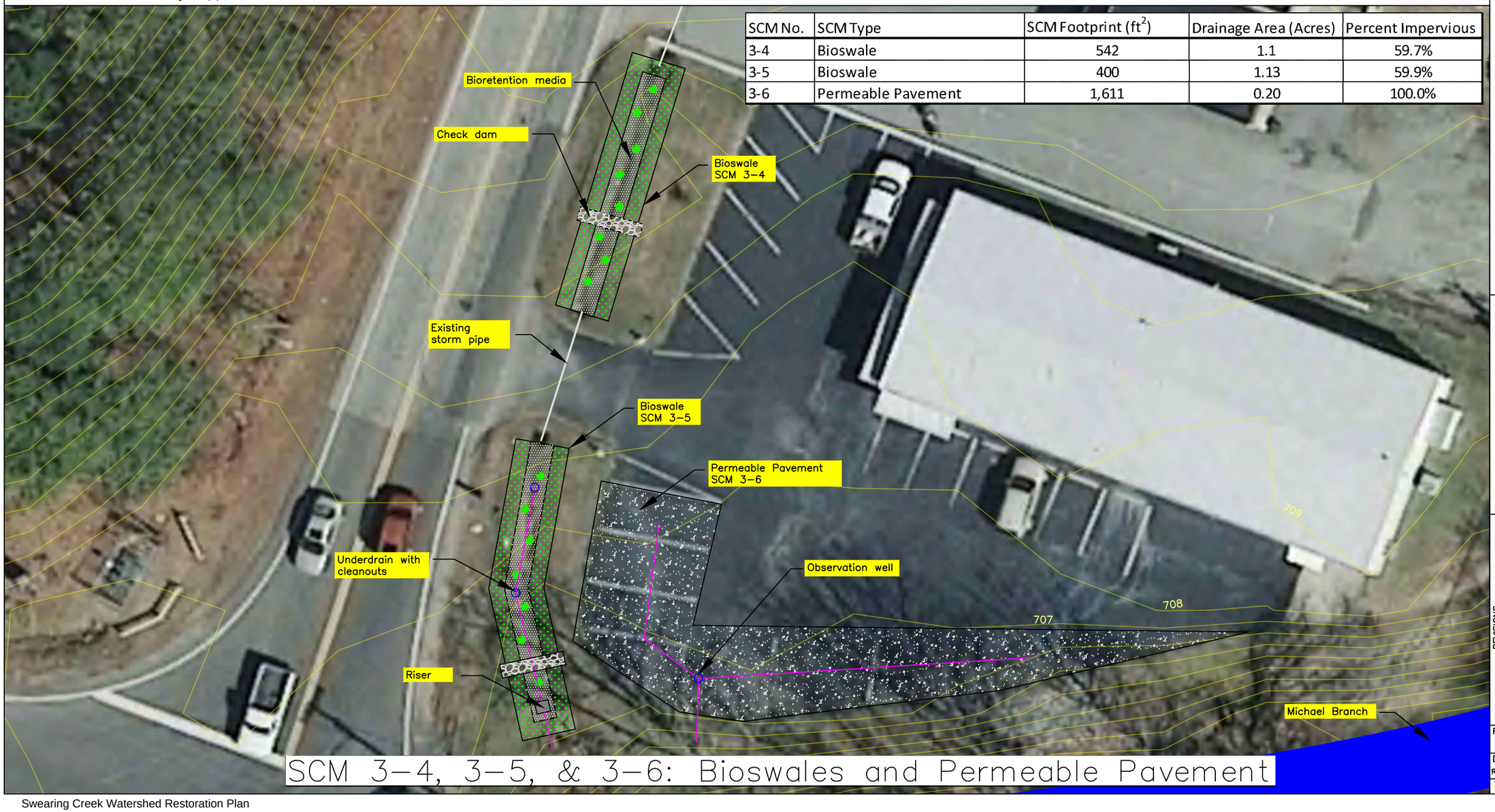
N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
3-4	Bioswale	542	1.1	59.7%
3-5	Bioswale	400	1.13	59.9%
3-6	Permeable Pavement	1,611	0.20	100.0%



SCM 3–4, 3–5, & 3–6: Bioswales and Permeable Pavement

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JC
Title

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RevMill_Concept.dwg

Sheet 3 of 15

SCM 3–7 through 3–10: Bioswales and Permeable Pavement
The Amedisys Home Health Care lot and its upstream drainage area could benefit from bioswale and permeable pavement SCM retrofits. Currently, runoff from the upstream drainage area is conveyed directly an Unnamed Tributary to Michael Branch through the existing stormwater drainage ditches without treatment. Additionally, runoff from the Amedisys Home Health Care parking lot is conveyed directly to the Unnamed Tributary as well. Properly maintained bioswales with check dams and a permeable pavement retrofit could intercept and effectively reduce nutrient loadings and peak flows going into the stream.

The approximate drainage area is 1 acres of commercial businesses and parking lot. A retrofit of the drainage ditches into bioswales could be used as an effective method to intercept and treat this runoff. Drainage from the parking lot could also be effectively intercepted and treated by permeable pavement retrofits in some of the existing parking areas. These SCMs would be sized to capture the first flush for peak attenuation as well as nutrient reduction.

The bioswale would consist of bioretention media, check dams, a riser, and vegetated embankments. The permeable pavement would consist of pervious concrete or asphalt with an optional underdrain and observation well. After treatment stormwater flows exit through the riser or underdrain and out through a pipe that would outfall into the Unnamed Tributary to Michael Branch.

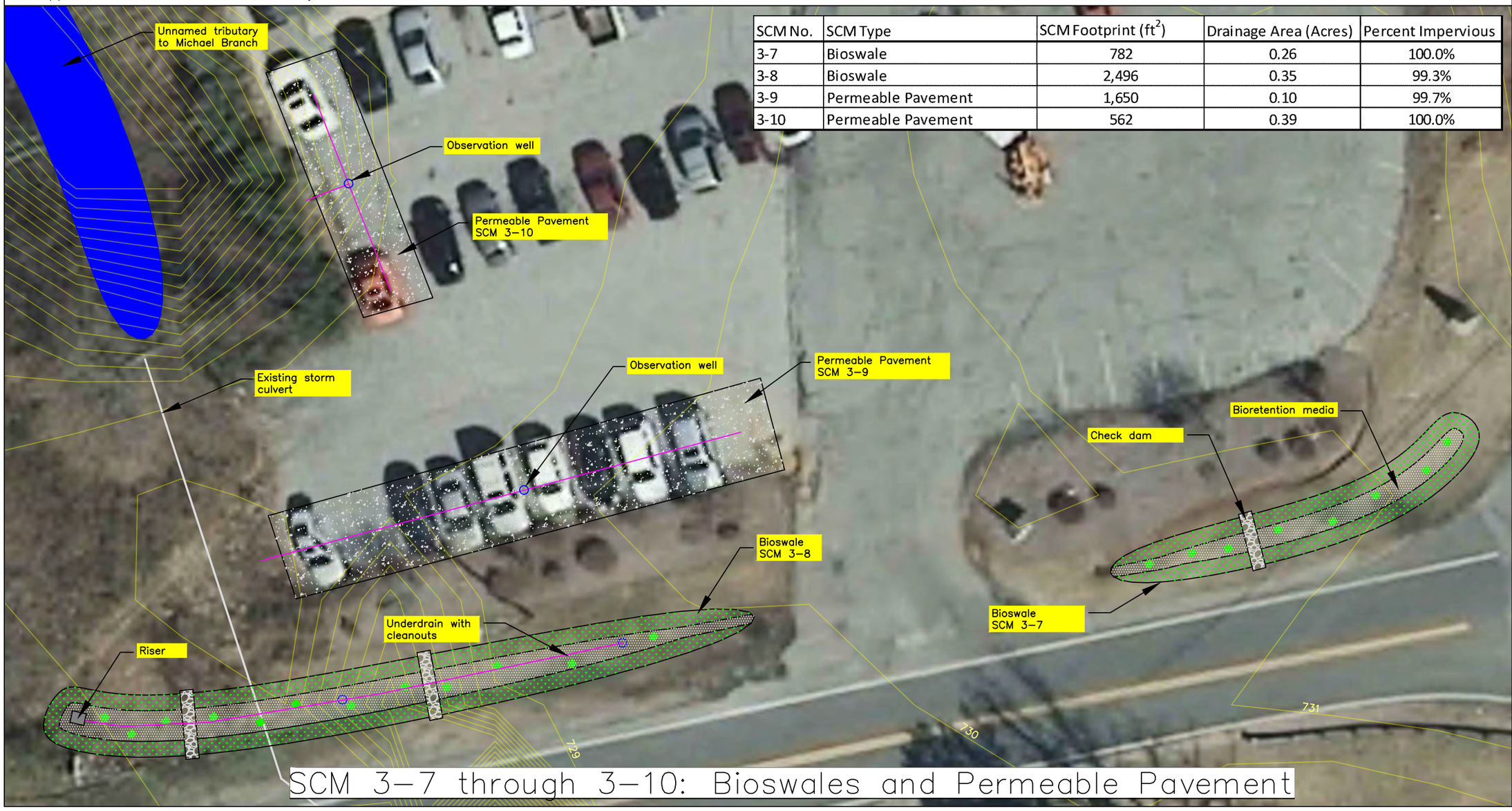
N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
3-7	Bioswale	782	0.26	100.0%
3-8	Bioswale	2,496	0.35	99.3%
3-9	Permeable Pavement	1,650	0.10	99.7%
3-10	Permeable Pavement	562	0.39	100.0%



SCM 3–7 through 3–10: Bioswales and Permeable Pavement

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JJC

Site 3 Stormwater Concept

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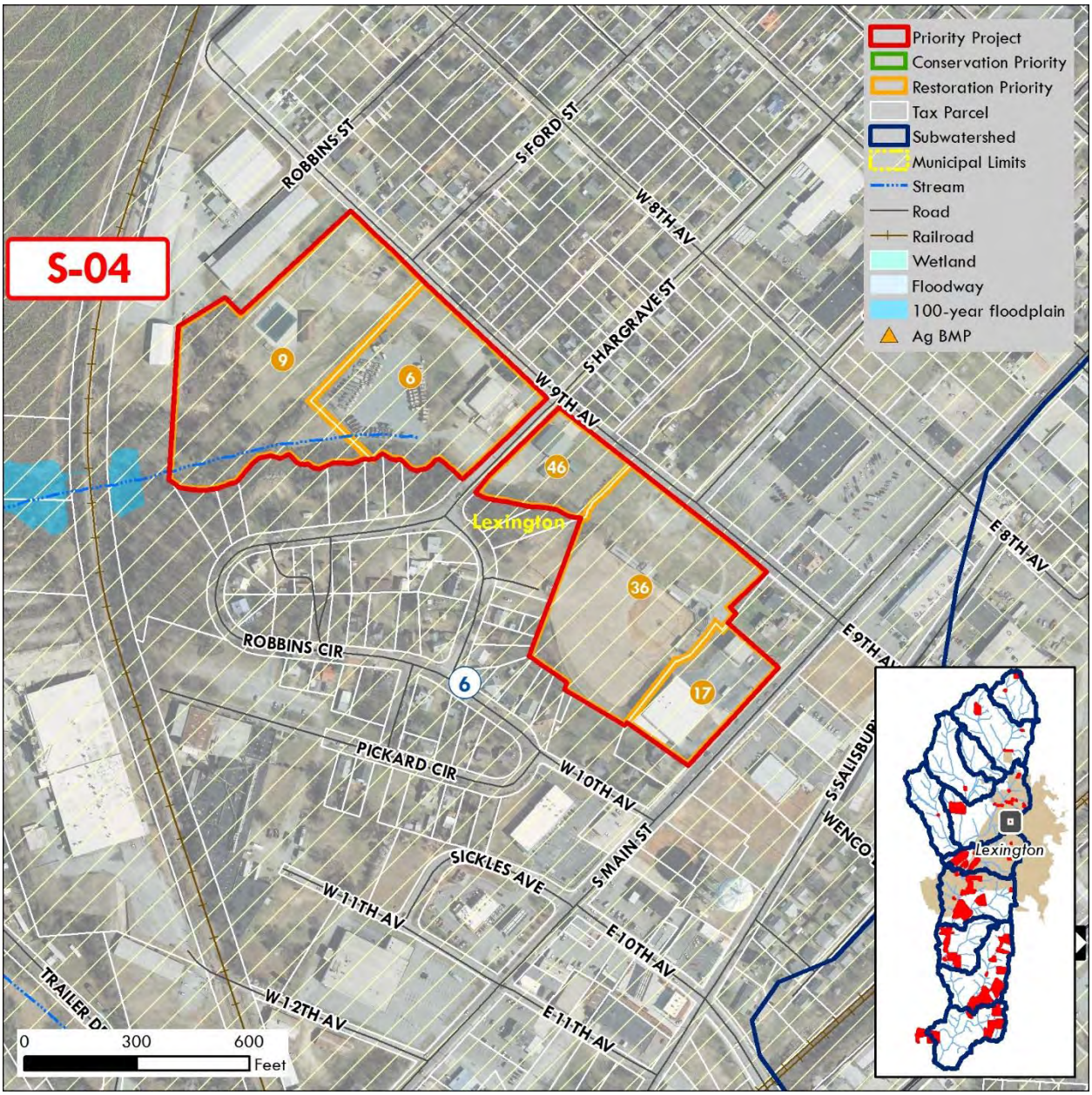
Sheet 3 of 15

Project S-04 – Holt-Moffitt Field, Radcliff Park & Brownfield



Attribute	S-04
Site Location	City
Subwatershed	6
Land Use	Recreation, Institutional
Linear Stream (Feet)	678
Area (Acres)	18.8
Floodplain Area (Acres)	0.5
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	31.77%
Percent Forest Cover	11.9%

Recommended Actions:

1. Contact property owners to gauge interest in implementing suggested stormwater BMPs
   - Note: Some of these parcels were also identified in the Davidson Greenway Plan
2. Seek funding to support implementation
   - Supplement project with educational component at Radcliffe Park or ballpark
3. May need to phase projects, since there are two different property owners

SCM 4–1, 4–2, and 4–3: Bioswale, Stormwater Wetland, and Stream Restoration Concept Plan

The area draining through Radcliff Park could benefit from a bioswale/engineered wetland SCM system. Currently, urban impervious runoff from the upstream drainage area is conveyed to the existing drainage system without treatment. A properly maintained bioswale conveying flows into a stormwater wetland could intercept and effectively reduce nutrient loadings and peak flows draining from the upstream drainage area.

The approximate drainage area is 12 acre of urban residential as well as parking lot runoff. A retrofit of the existing natural swale into an engineered bioswale would be a good way to achieve pretreatment of the runoff prior to entering into a stormwater wetland. These two SCMs would be sized to capture the first flush for peak attenuation as well as nutrient reduction. These two SCMs may also be implemented individually (e.g. the wetland with a grassed swale instead of a bioswale) with similar nutrient removals. Additional opportunities for stream restoration of Wennon Mill Drain exist as well.

The bioswale would consist of bioretention media, a riser, check dams and underdrains. The bioretention media section would allow water to infiltrate through the media which would remove nutrients. The wetland would consist of wetland vegetation, a riser, and a forebay. The wetland is designed to maximize retention time in order to allow for nutrient uptake by the wetland plant species. These plants also reduce flows and allow for sedimentation. After treatment stormwater flows exit through the riser and out through an outlet pipe which empties into Wennon Mill Drain.

N

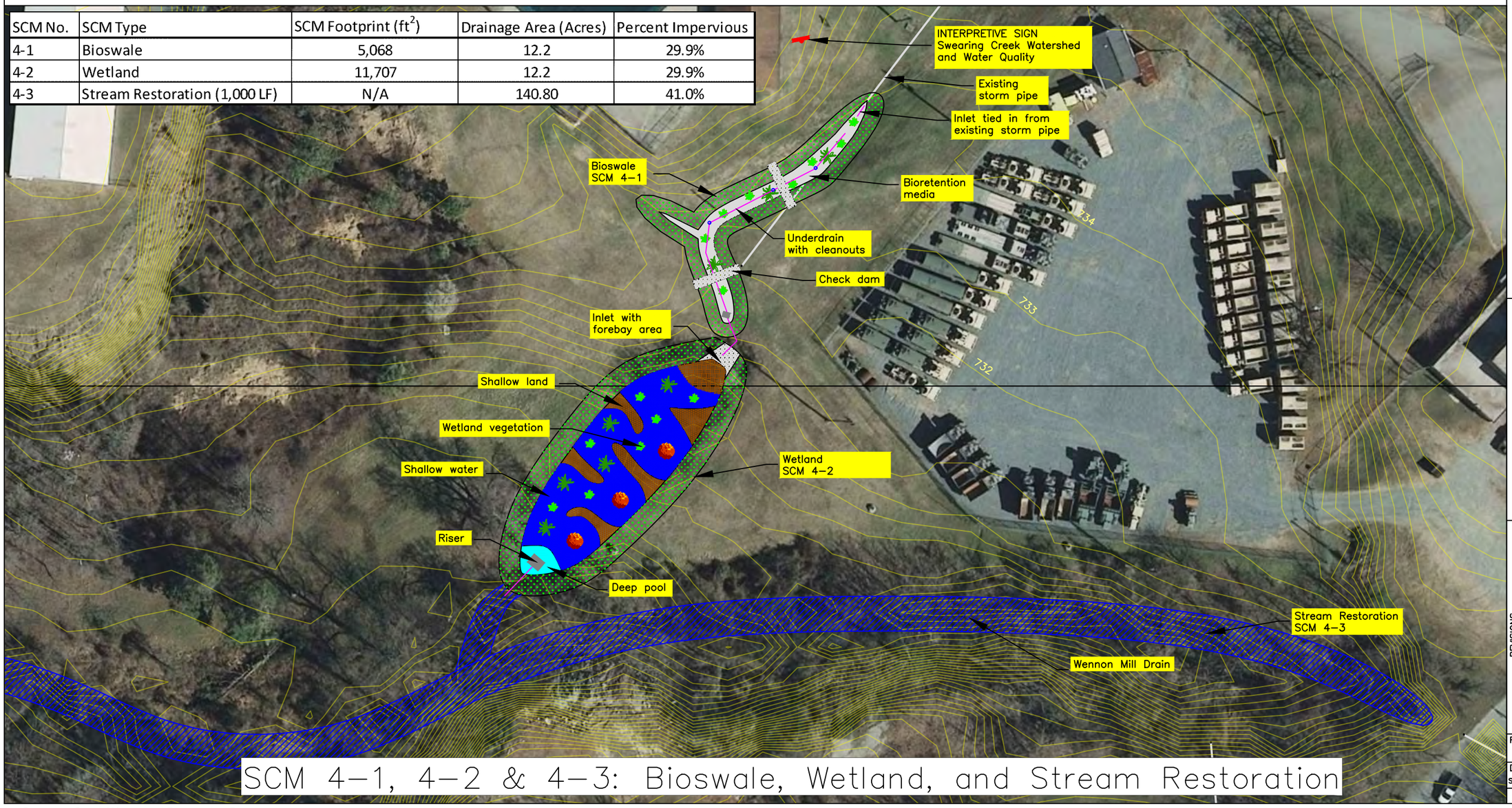
GRAPHIC SCALE

60 0 30 60 120 240

(IN FEET)

1 inch = 60 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
4-1	Bioswale	5,068	12.2	29.9%
4-2	Wetland	11,707	12.2	29.9%
4-3	Stream Restoration (1,000 LF)	N/A	140.80	41.0%



SCM 4–1, 4–2 & 4–3: Bioswale, Wetland, and Stream Restoration

Designed KLB,YB
Drawn YB
Checked KB

Site 4 Stormwater Concept

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Approved
Title
Date
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REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site4.dwg

SCM 4–4 & 4–5: Vegetated Buffer and Stream Restoration Concept Plan
The ball park on S. State Street could benefit from slope stabilization and vegetation. Currently, the steep slope on the west side of the ball field is eroding into the nearby Wennon Mill Drain. Vegetated slope stabilization and tree plantings could be used to reduce sediment loads coming from this area and flowing into the stream. Additionally, the reach of Wennon Mill Drain could benefit from bank stabilization and other stream restoration features.

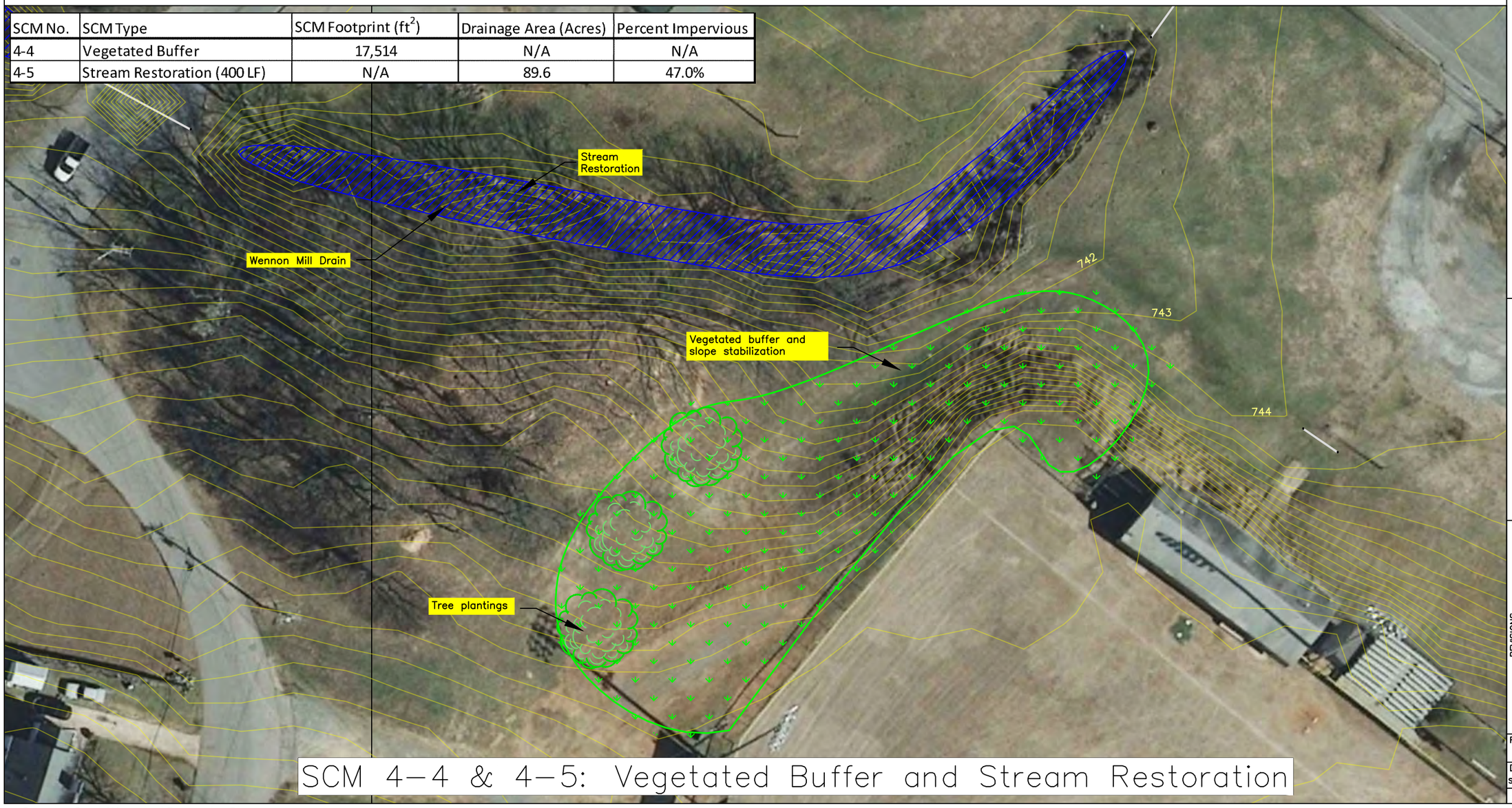
N

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
4-4	Vegetated Buffer	17,514	N/A	N/A
4-5	Stream Restoration (400 LF)	N/A	89.6	47.0%



SCM 4–4 & 4–5: Vegetated Buffer and Stream Restoration

Designed KLB,YB
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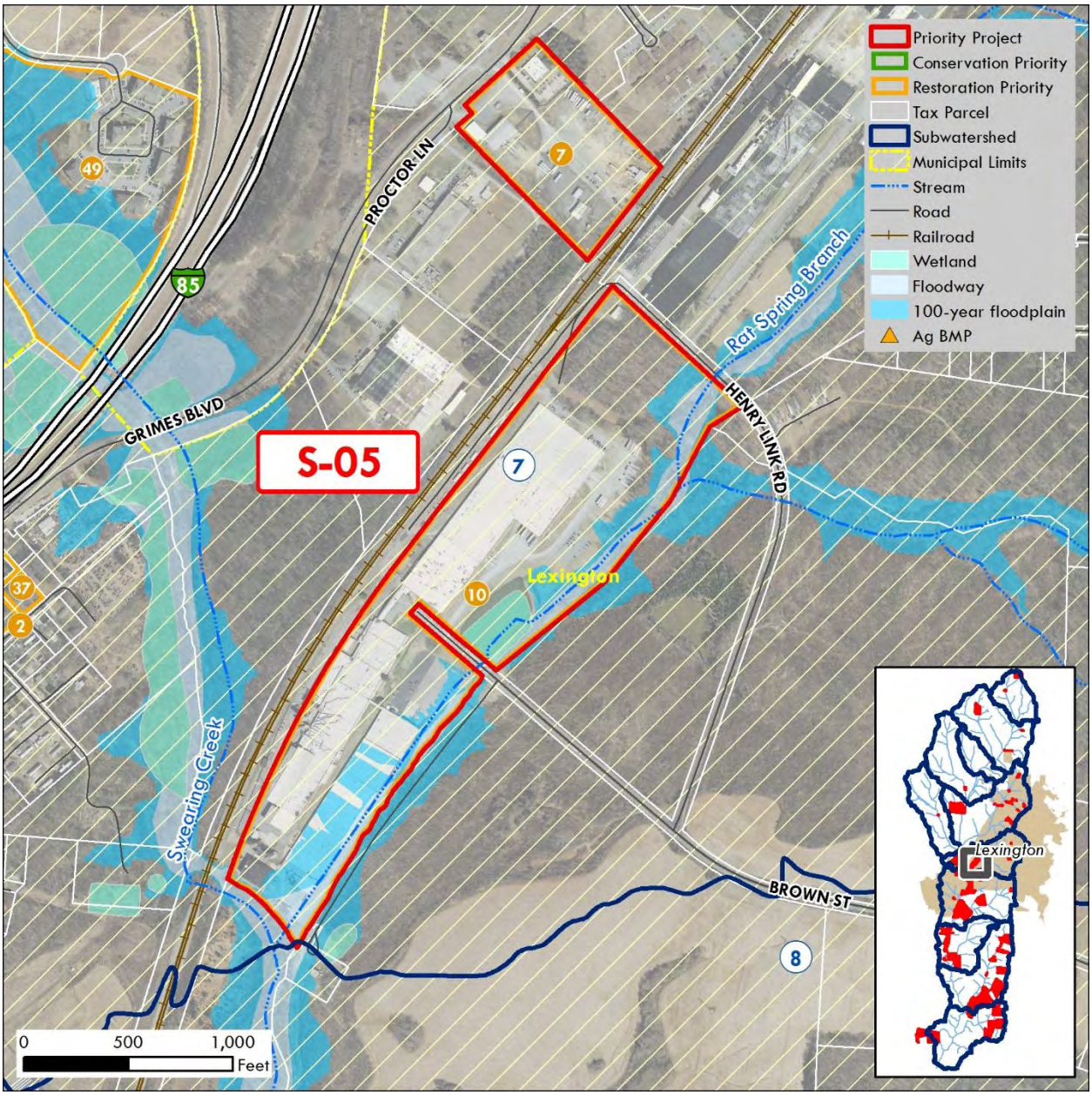
File No.

Drawing:
SwearingCk_site4.dwg

Project S-05 – Schwarz Industrial



Attribute	S-05
Site Location	City
Subwatershed	7
Land Use	Industrial
Linear Stream (Feet)	3,323
Area (Acres)	64.3
Floodplain Area (Acres)	16.3
Wetland Area (Acres)	1.5
Percent Impervious Surface Cover	57.35%
Percent Forest Cover	12.6%

Recommended Actions:

1. Contact property owners to gauge interest in implementing suggested stormwater BMPs
2. Seek funding to support implementation
3. May need to phase projects, since there are two different property owners

SCM 5–1 Green Roof Concept Plan
The roof of the Schwarz Industrial plant could benefit from a green roof SCM. Currently the nearly 8 acre roof drains untreated into the Rat Spring Branch via the existing storm drainage system. The effects of high flows from the roof are seen in the incised drainage ditches leading into the equally incised Rat Spring Branch. A properly maintained green roof could reduce the runoff from the roof area and thereby reduce peak flows draining into the Branch.

The green roof would consist of vegetative cover plants overtop of 2 – 6 inches of lightweight growth media. This media would sit on the roof's waterproofing membrane on top of a layer of geotextile fabric and provide storage for roof runoff, nutrient reduction as well as supporting the life of the plants. One of the main constraints of green roof retrofits is the structural capacity of the roof to support the additional loads (e.g. weight of SCM, additional water storage, as well as construction and maintenance crews). Consultation with a North Carolina licensed structural engineer would be necessary to evaluate the required structural support in accordance with state and local building codes and standards.

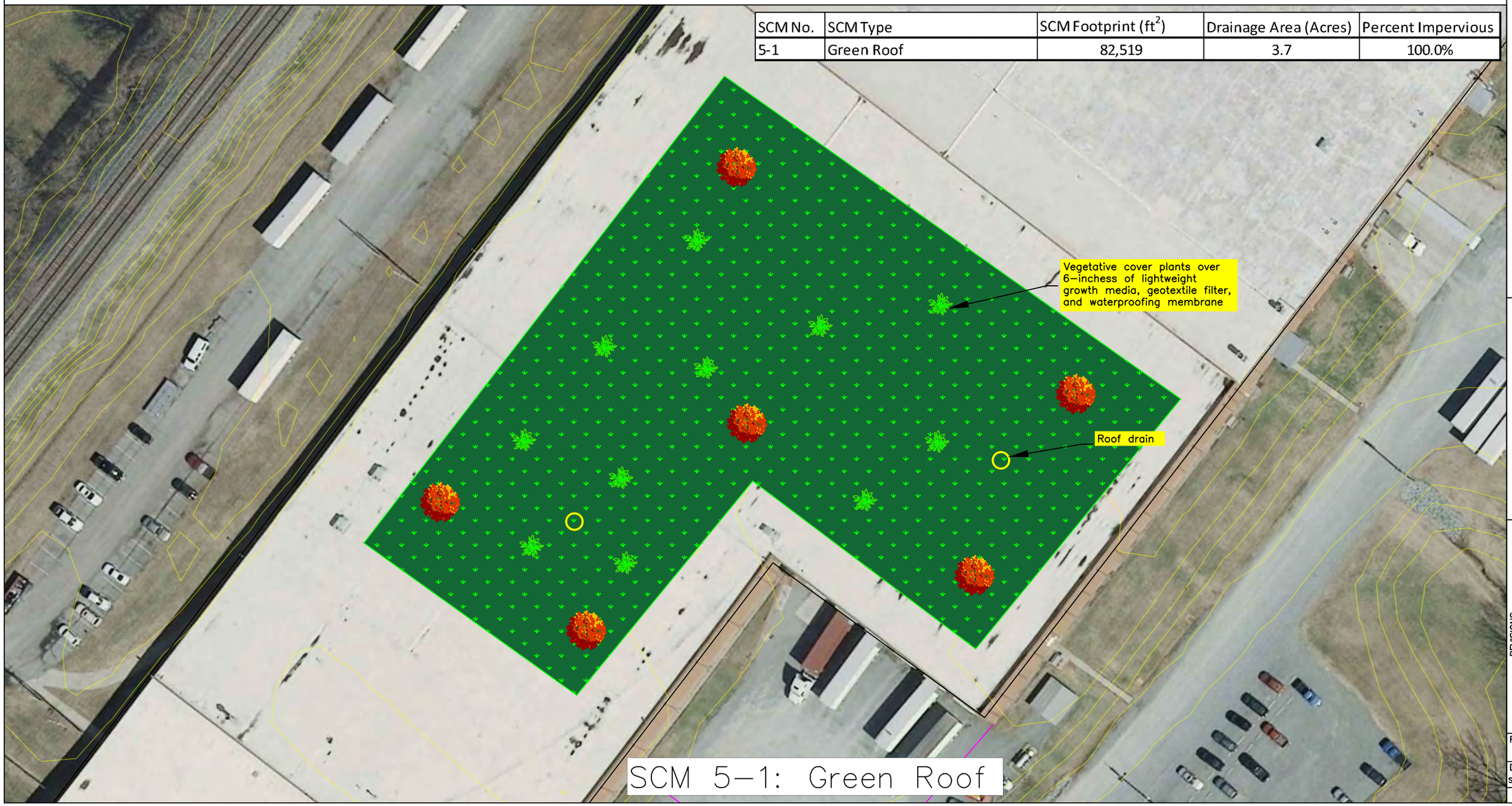
N

GRAPHIC SCALE

60 0 30 60 120 240

(IN FEET)
1 inch = 60 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
5-1	Green Roof	82,519	3.7	100.0%



SCM 5–1: Green Roof

Designed YB
Drawn YB
Checked KB

Site 5 Stormwater Concept

1893 Brown St.
Lexington, NC 27292

Approved ____ Date ____
Title ____ Job Class JC

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REVISIONS
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File No.

Drawing:
SwearingCk_site5.dwg

SCM 5–2: Bioswale Concept Plan
The existing drainage ditch at the north end of the Schwarz Industrial plant could benefit from a retrofit into an engineered bioswale. Currently, runoff from the upstream industrial areas drains under the railroad tracks and through this ditch prior to emptying into Rat Spring Branch. A properly maintained bioswale could effectively intercept and reduce nutrient loadings and peak flows draining into the Branch.

The approximate drainage area is 41 acres of industrial and parking lot runoff. A retrofit of the existing natural swale into an engineered bioswale would be a good way to achieve treatment of the runoff prior to entering into Rat Spring Branch. This SCMs would be sized to capture a percentage of the first flush for peak flow attenuation as well as nutrient reduction.

The bioswale would consist of bioretention media, and check dams. The check dams would allow water to infiltrate through the bioretention media which would remove nutrients. After treatment stormwater flows continue into the existing natural swale which finally empties into Rat Spring Branch.

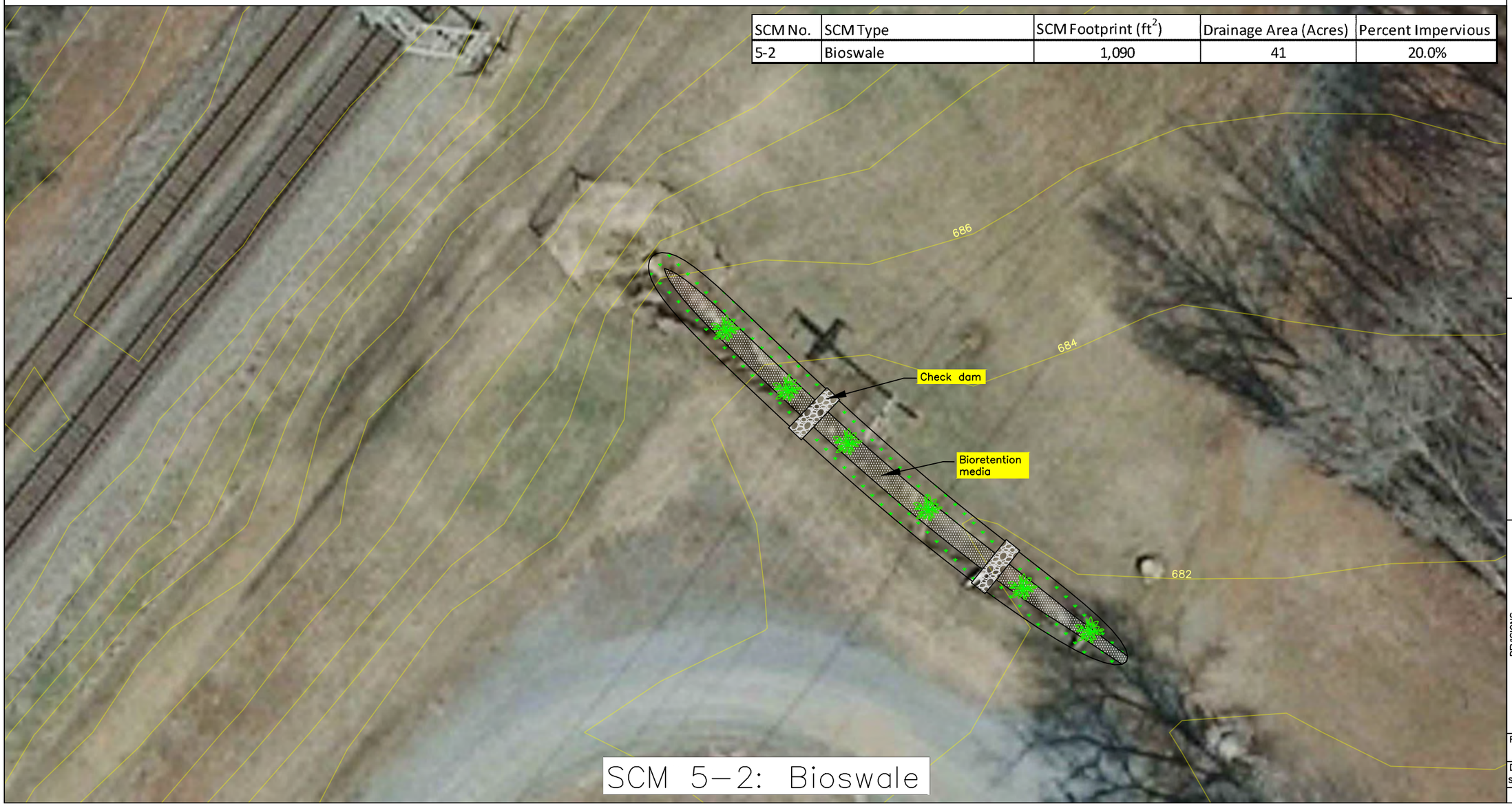
N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
5-2	Bioswale	1,090	41	20.0%



SCM 5–2: Bioswale

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JC

Site 5 Stormwater Concept

1893 Brown St.
Lexington, NC 27292

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REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site5.dwg

SCM 5–3 & 5–4: Stormwater Wetland and Stream Restoration Concept Plan
The existing pond at the Schwarz Industrial plant could benefit from a retrofit into an engineered wetland SCM system. A stormwater wetland could offer improved treatment benefits for the impervious runoff from the upstream drainage area. Currently runoff from the highly impervious plant are contributing to channel erosion in both the drainage channels and the receiving Rat Spring Branch. This stream, thus could benefit from stream bank stabilization, and a vegetated buffer. A properly maintained stormwater wetland conveying treated flows into a restored and stabilized Rat Spring Branch could be a good method to effectively reduce nutrient loadings and peak flows draining from the upstream drainage area.

The approximate drainage area is 3 acres of mostly impervious roof and parking lot runoff. A retrofit of the existing pond into an engineered wetland would be a good way to achieve pretreatment of the runoff prior to entering into Rat Spring Branch. These two SCMs, possibly in combination with a green roof, would be sized to capture the first flush for peak attenuation as well as nutrient reduction.

The wetland would consist of wetland vegetation, a riser, and a forebay. The wetland is designed to maximize retention time in order to allow for nutrient uptake by the wetland plant species. These plants also reduce flows and allow for sedimentation. After treatment stormwater flows exit through the riser and out through an outlet pipe which empties into Rat Spring Branch.

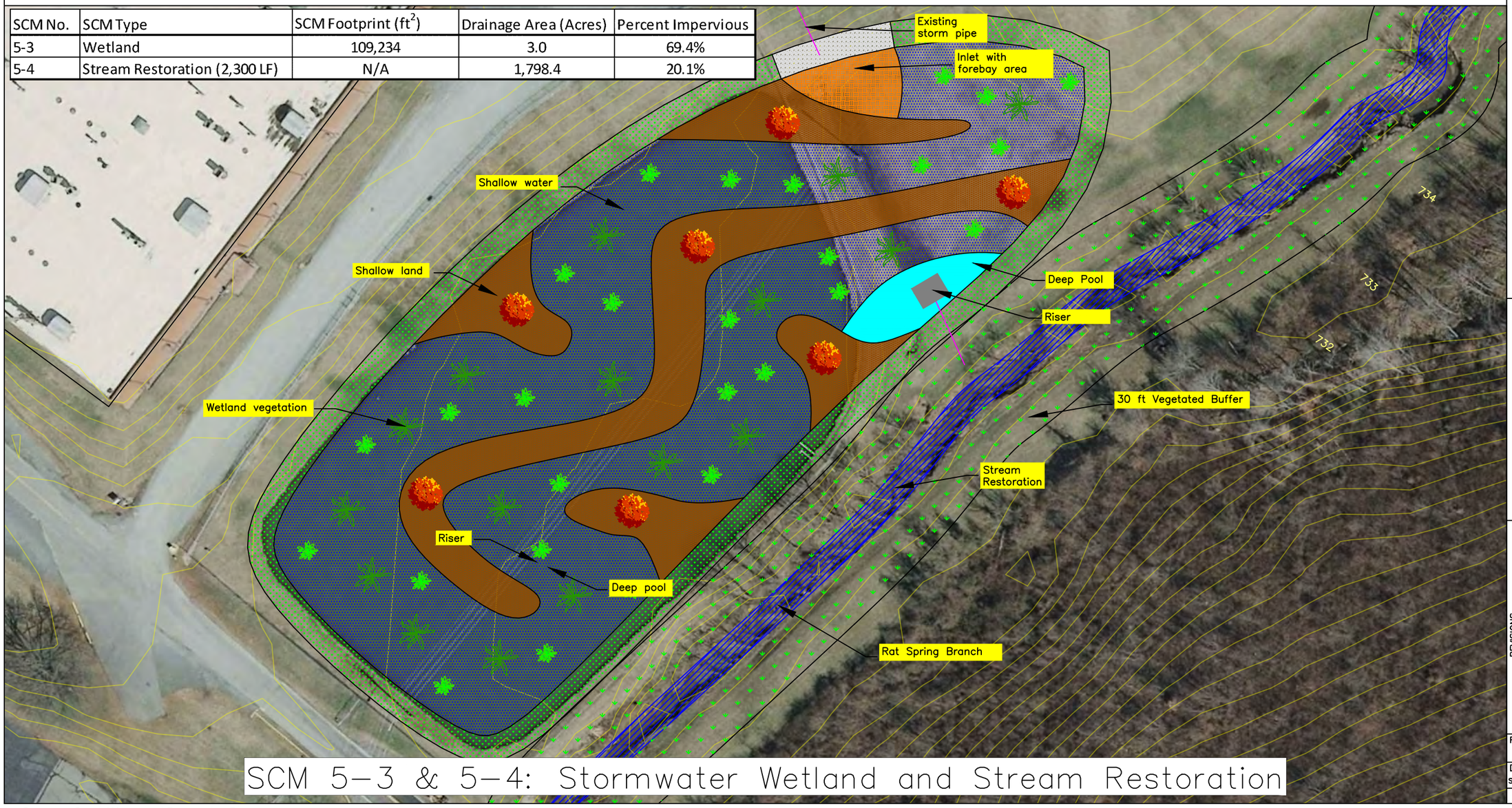
N

GRAPHIC SCALE

60 0 30 60 120 240

(IN FEET)
1 inch = 60 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
5-3	Wetland	109,234	3.0	69.4%
5-4	Stream Restoration (2,300 LF)	N/A	1,798.4	20.1%



SCM 5–3 & 5–4: Stormwater Wetland and Stream Restoration

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JC
Title

Site 5 Stormwater Concept

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REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site5.dwg

SCM 5–5 and 5–6: Vegetated Buffer and Bioretention Concept Plan
The roof area of the Direct Wood Products hardware store could benefit from a bioretention SCM and enhanced vegetated buffer. Currently the roof drains overland into existing stormwater conveyance ditches. Through a network of these ditches, runoff eventually outfalls into the nearby Rat Spring Branch. A properly maintained bioretention area could intercept and effectively reduce nutrient loadings and peak flows draining from the roof area.

The approximate drainage area is 0.25 acre of rooftop runoff. The bioretention area would be sized to capture the first flush for peak attenuation as well as nutrient reduction. The bioretention cell would consist of bioretention media and plantings, underdrains with cleanouts, a stone inlet area to receive flow from the roof downspouts, and a riser. The bioretention section would allow water to infiltrate through the media which would remove nutrients. After treatment stormwater flows exit through the riser and through an outlet pipe which empties into a level spreader which facilitates sheet flow onto the adjacent vegetated area.

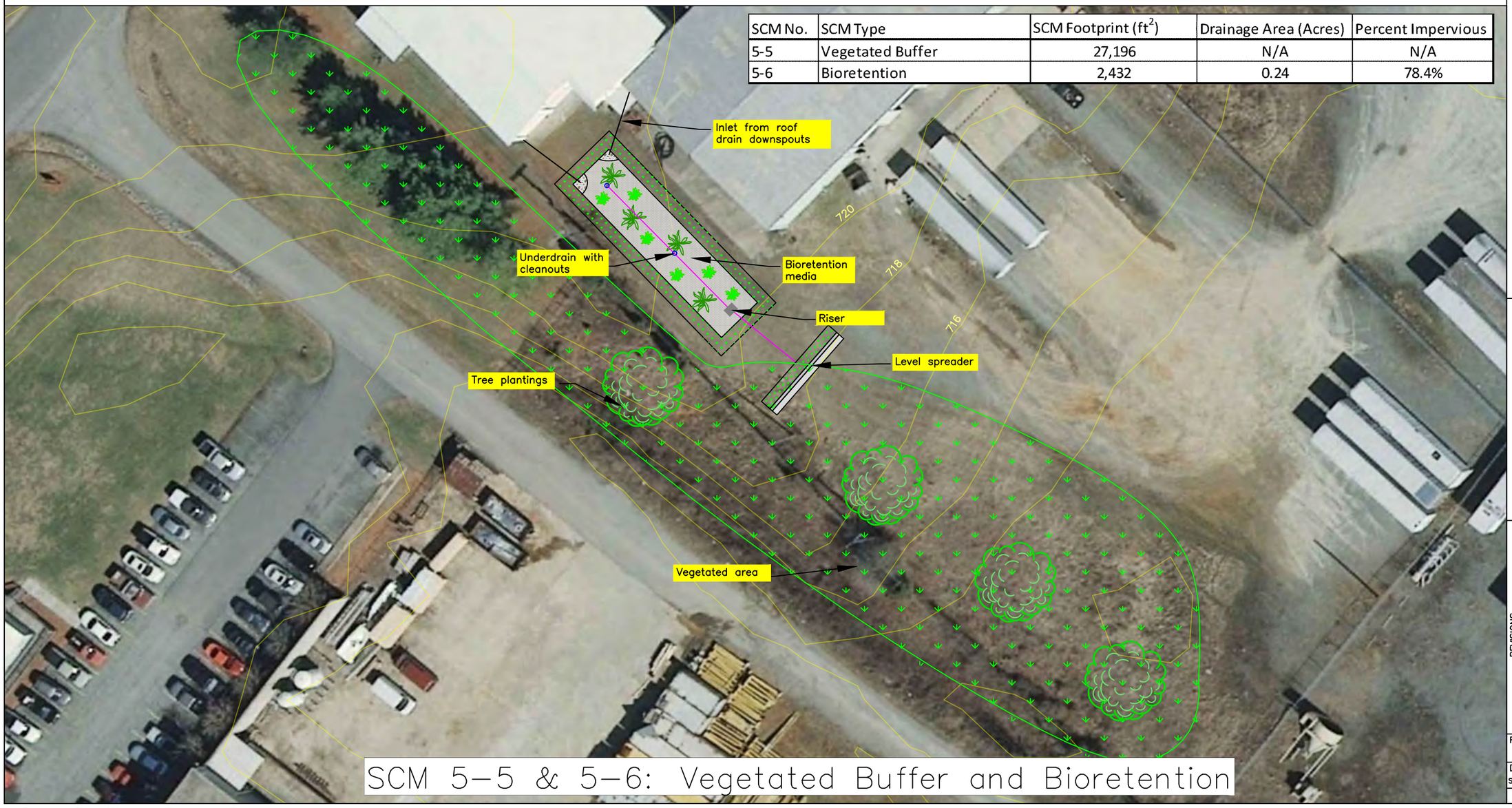
N

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
5-5	Vegetated Buffer	27,196	N/A	N/A
5-6	Bioretention	2,432	0.24	78.4%



SCM 5–5 & 5–6: Vegetated Buffer and Bioretention

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JC

Site 5 Stormwater Concept

808 Grimes Blvd.
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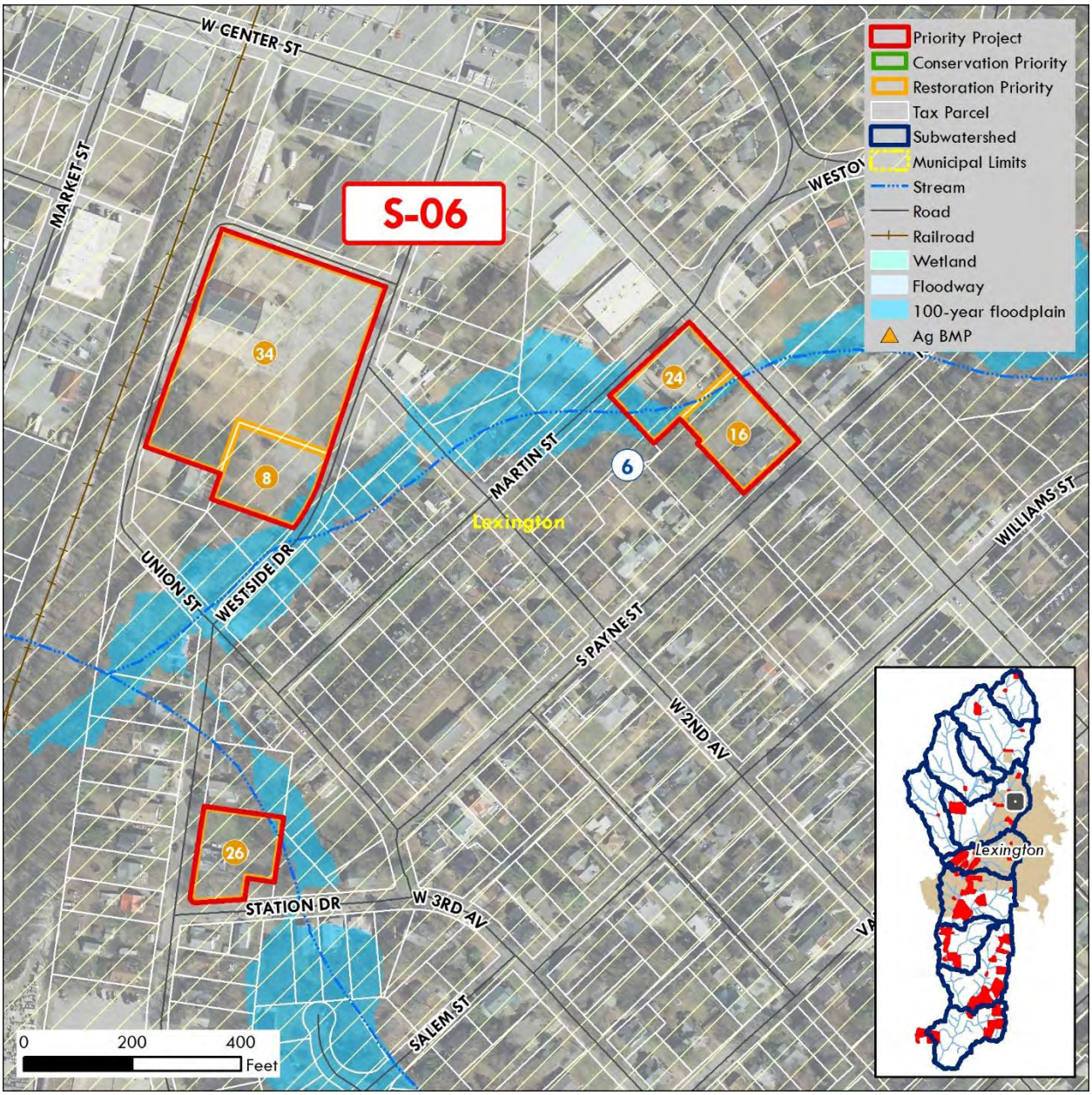
REVISIONS
Description
Date
Approved

File No.

Drawing:
SwearingCk_site5.dwg

Project S-06 – North Town Offices



Attribute	S-06
Site Location	City
Subwatershed	6
Land Use	Industrial, Office, SFR
Linear Stream (Feet)	278
Area (Acres)	5.0
Floodplain Area (Acres)	0.3
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	37.25%
Percent Forest Cover	19.3%

Recommended Actions:

1. Contact property owners to gauge interest in implementing suggested stormwater BMPs
   - Note: Some of these parcels were also identified in the Davidson Greenway Plan
2. Seek funding to support implementation
3. May need to phase projects, since there are multiple property owners

SCM 6–1, 6–2, & 6–3 Vegetated Buffer and Stormwater Wetland Concept Plan
The lot of S&K Auctions could benefit from vegetated buffers and a stormwater wetland SCM. Currently the lot drains through a stormwater drainage system into the Royal Park Drain, which is a tributary to Michael Branch. The impervious area of the lot could be reduced through revegetation and establishment of vegetated buffers. A properly maintained stormwater wetland could be a good method to effectively reduce nutrient loadings and peak flows draining from the upstream drainage area.

The approximate drainage area is 8 acres of mostly impervious roof and parking lot runoff. An engineered wetland would be a good way to achieve pretreatment of the runoff prior to entering into Royal Park Drain. This SCM would be sized to capture 40% of the first flush for peak attenuation as well as nutrient reduction.

Soil analysis should be conducted within the area of the proposed wetland to ensure soil types are appropriate for infiltration rates and adequate vegetation growth. Depending on the results of this soil analysis, a clay or synthetic liner may be recommended for this potential SCM.

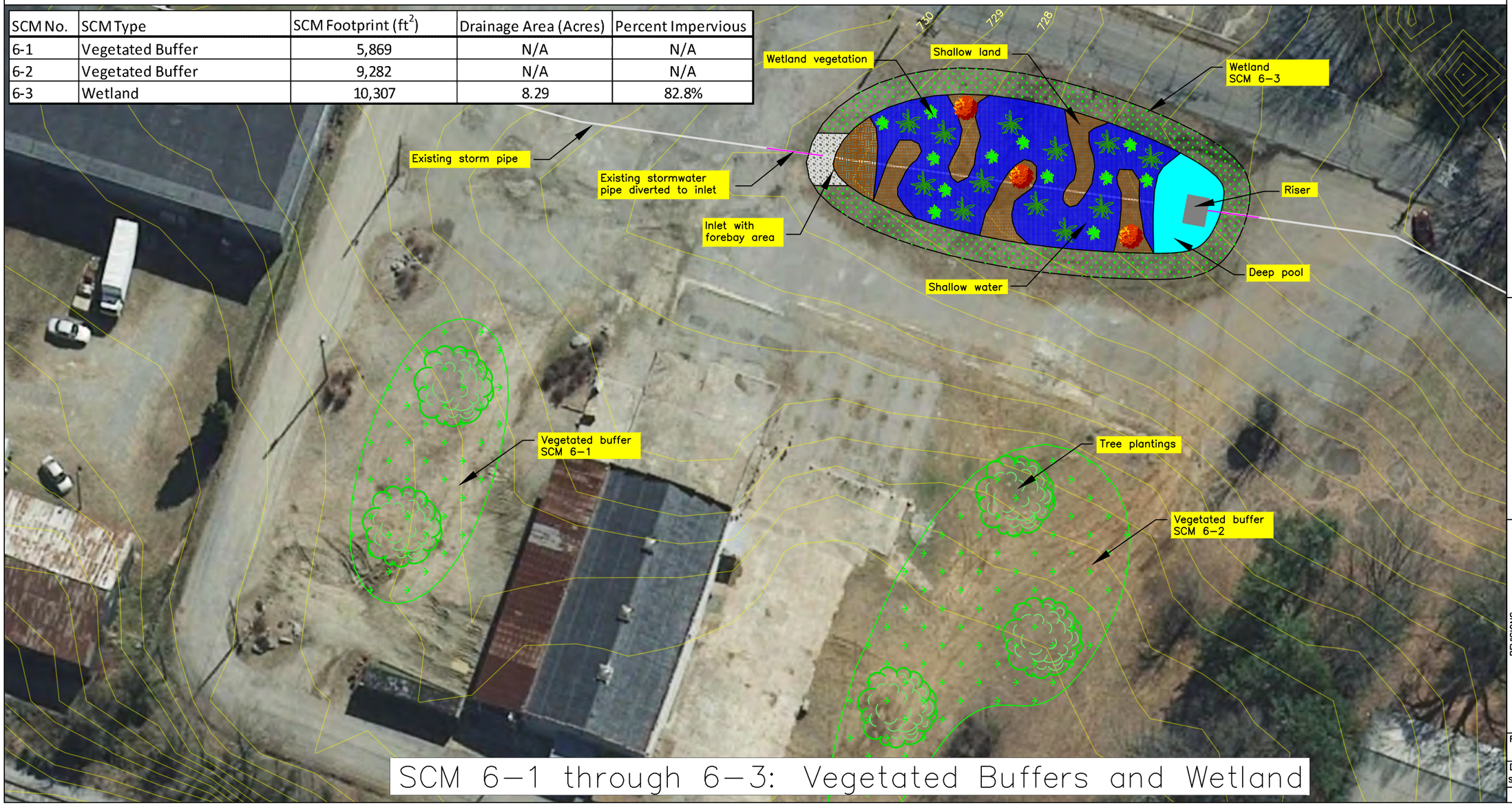
N

GRAPHIC SCALE

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
6-1	Vegetated Buffer	5,869	N/A	N/A
6-2	Vegetated Buffer	9,282	N/A	N/A
6-3	Wetland	10,307	8.29	82.8%



SCM 6–1 through 6–3: Vegetated Buffers and Wetland

Designed YB
Drawn YB
Checked KB
Date
Approved
Title
Job Class JC

Site 6 Stormwater Concept

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REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site6.dwg

SCM 6–4, 6–5, and 6–6: Bioretention and Permeable Pavement Concept Plan
The office building at 507 W. Center Street could benefit from bioretention rain gardens and permeable pavement parking spaces. Currently, runoff from the building's roof and parking lot are conveyed directly into Royal Park Drain without treatment. A properly maintained rain garden and permeable pavement parking spaces could effectively intercept and reduce nutrient loadings and peak flows draining into the Drain.

The approximate drainage area is 0.4 acre of roof area and parking lot runoff. A retrofit of the existing landscaped areas would be a good way to achieve treatment of the roof runoff prior to entering into Rat Spring Branch. This SCM would be sized to capture the first flush for peak attenuation as well as nutrient reduction. Additionally, permeable pavement parking spaces would reduce the impervious area and thus the volume of runoff from the site.

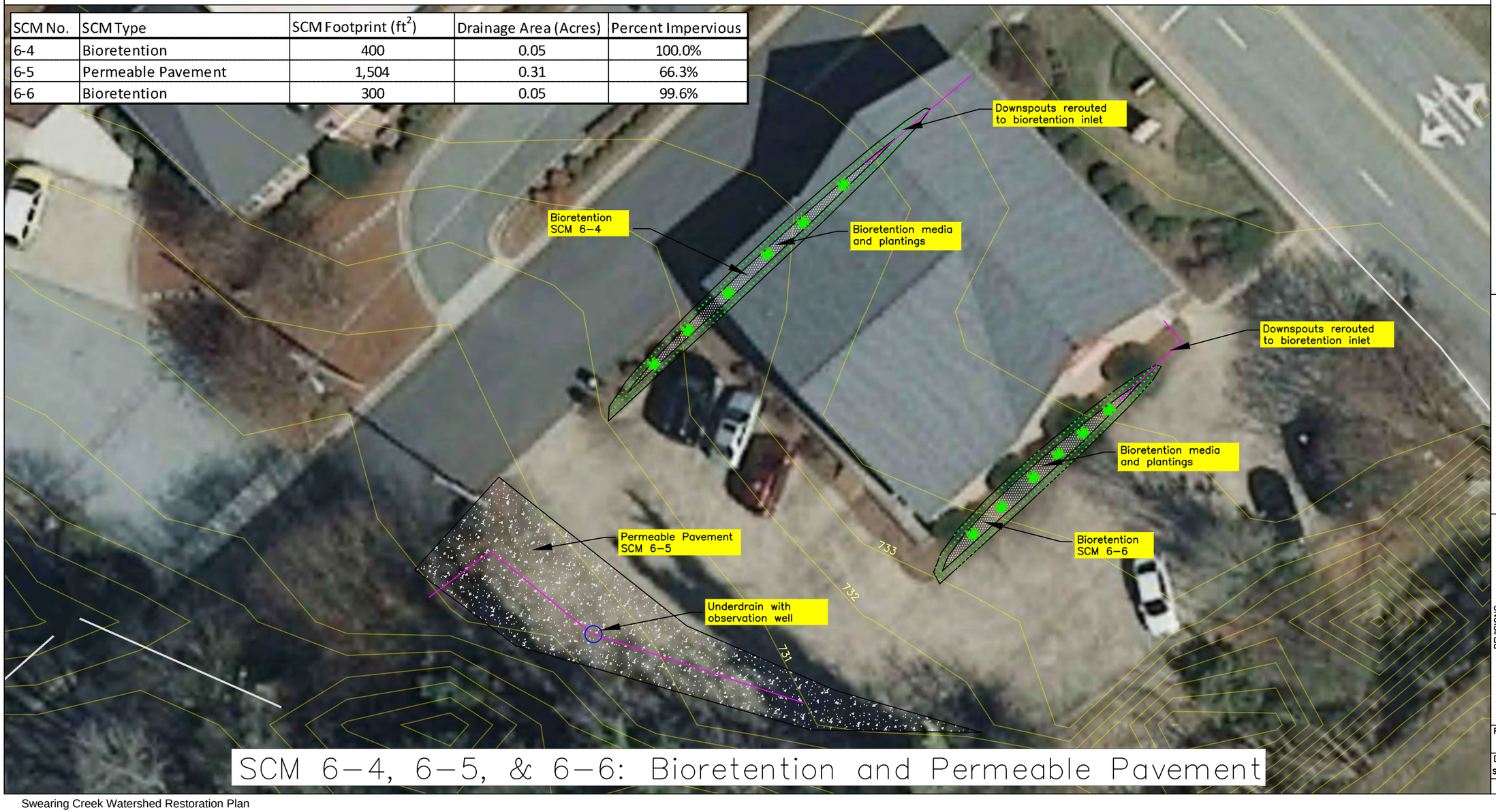
N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
6-4	Bioretention	400	0.05	100.0%
6-5	Permeable Pavement	1,504	0.31	66.3%
6-6	Bioretention	300	0.05	99.6%



SCM 6–4, 6–5, & 6–6: Bioretention and Permeable Pavement

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JC

Site 6 Stormwater Concept

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REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site5.dwg

SCM 6–7 & 6–8: Stream Restoration and Bioretention Concept Plan
The private residence on the corner of Westside Drive and Station Drive could benefit from a bioretention rain garden as well as stream restoration of approximately 150 linear feet of the degraded urban stream located adjacent to the property. Currently roof and driveway runoff enters into the stream untreated via overland flows. A properly maintained rain garden could effectively intercept and reduce nutrient loadings and peak flows draining into Royal Park Branch, a tributary of Michael Branch.

The approximate drainage area is 0.1 acre of roof and driveway runoff. A rain garden placed in the rear of the property receiving roof runoff from redirected downspouts would be a good way to achieve treatment of the runoff prior to entering into Royal Park Branch. This SCM would be sized to capture he first flush for peak attenuation as well as nutrient reduction.

The rain garden would consist of bioretention media to allow water to infiltrate through to the pervious subgrade in order to mimic pre–development hydrologic conditions. Overflows in the case of large storms would be directed into the downstream Royal Park Branch.

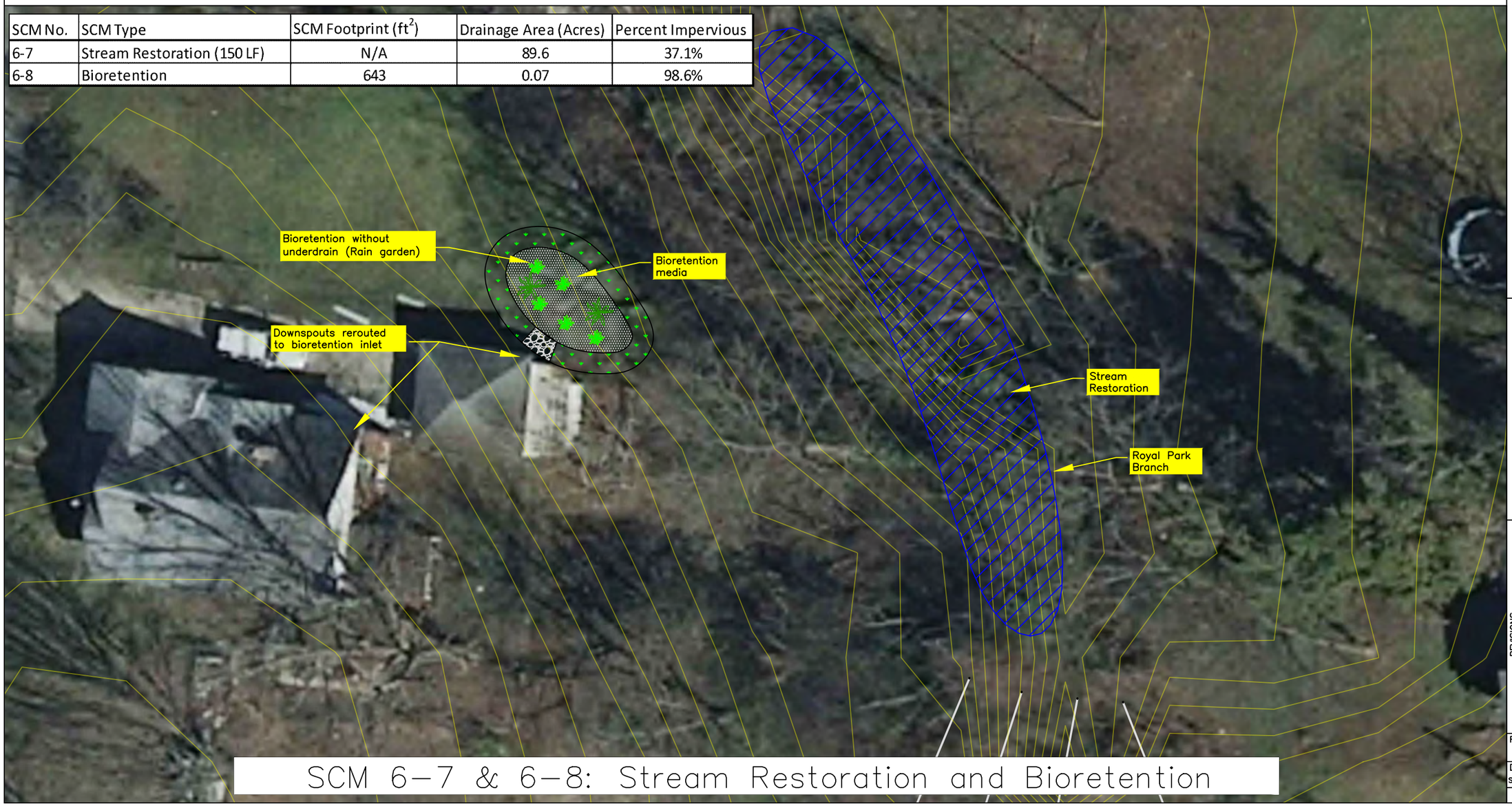
N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
6-7	Stream Restoration (150 LF)	N/A	89.6	37.1%
6-8	Bioretention	643	0.07	98.6%



SCM 6–7 & 6–8: Stream Restoration and Bioretention

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JC
Title

Site 6 Stormwater Concept

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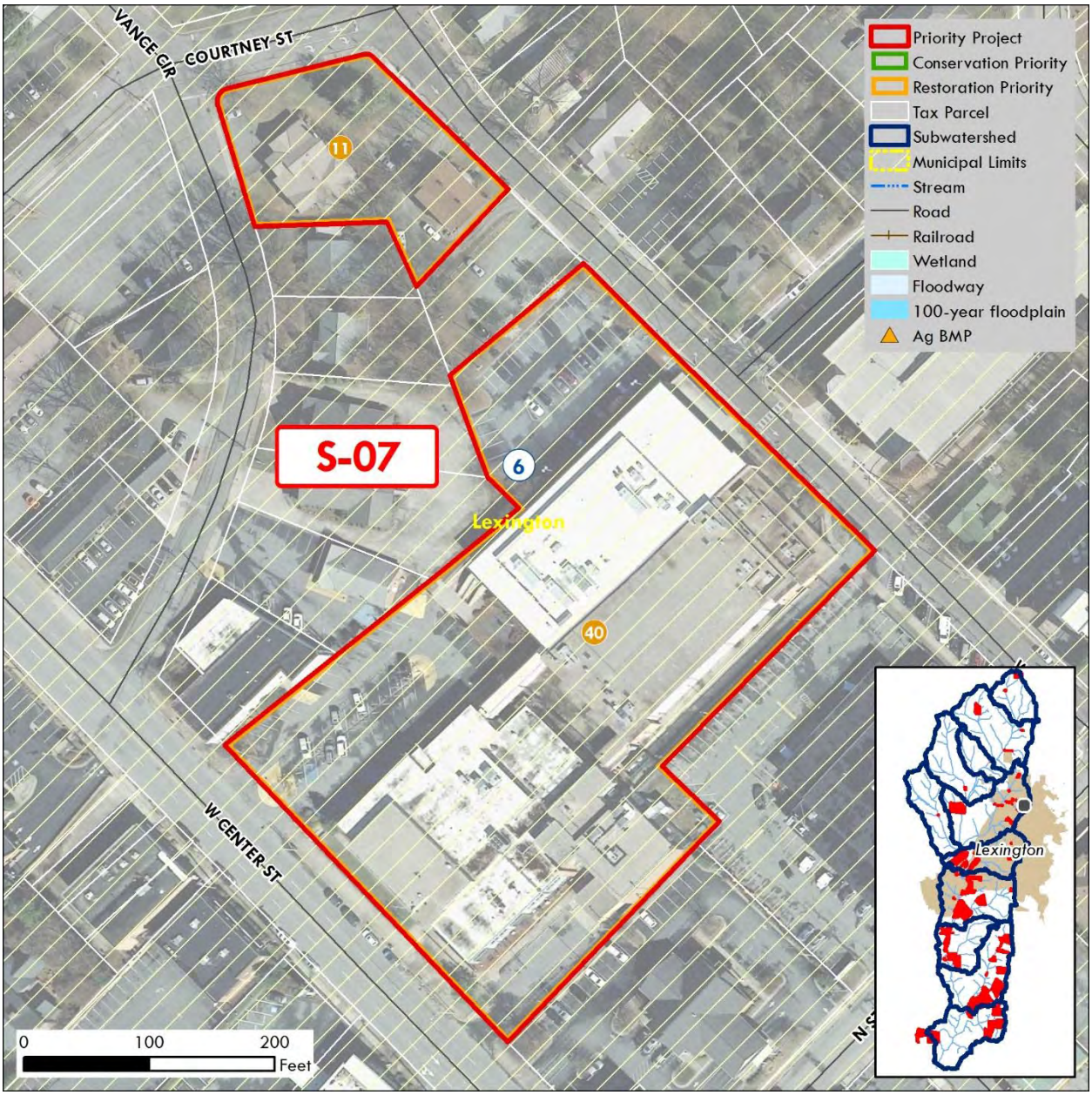
REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site5.dwg

Project S-07 – Davidson County Courthouse



Attribute	S-07
Site Location	City
Subwatershed	6
Land Use	Institutional, Office
Linear Stream (Feet)	n/a
Area (Acres)	3.9
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	77.87%
Percent Forest Cover	3.3%

Recommended Actions:

1. Contact property owner of #11 to gauge interest in implementing suggested stormwater BMPs
2. Assess feasibility of Courthouse green roof
3. Seek funding to support implementation
4. Submit for bid

SCM 7–1: Bioretention Concept Plan
This concept plan for the Law Firm near the Davidson County Courthouse includes the addition of a bioretention area to intercept and treat roof runoff from the existing building. Currently the roof area drains to the existing storm drainage system and into the Royal Branch Drain. Rerouting downspouts into a bioretention treatment area would provide nutrient reduction and peak flow attenuation to otherwise untreated runoff.

N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
7-1	Bioretention	897	0.05	99.6%

SCM 7–1: Bioretention

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JJC
Title

Site 7 Stormwater Concept

28 Vance Cir.,
Lexington, NC 27292

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REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site6.dwg

SCM 7–2 through 7–5: Permeable Pavement and Green Roofs
This concept plan for the Davidson County Court House building includes retrofitting of existing parking spaces into permeable pavement areas as well as green roof installations. Currently the roof areas drain untreated into Royal Branch Drain via the existing storm drainage system. The effects of runoff from highly impervious areas include increased stormwater flows and nutrient conveyance into receiving water bodies. A properly maintained green roof could reduce the runoff from the roof area and thereby reduce peak flows draining into the receiving waters.

The green roof would consist of vegetative cover plants overtop of 2 – 6 inches of lightweight growth media. This media would sit on the roof's waterproofing membrane on top of a layer of geotextile fabric and provide storage for roof runoff, nutrient reduction as well as supporting the life of the plants. One of the main constraints of green roof retrofits is the structural capacity of the roof to support the additional loads (e.g. weight of SCM, additional water storage, as well as construction and maintenance crews). Consultation with a North Carolina licensed structural engineer would be necessary to evaluate the required structural support in accordance with state and local building codes and standards.

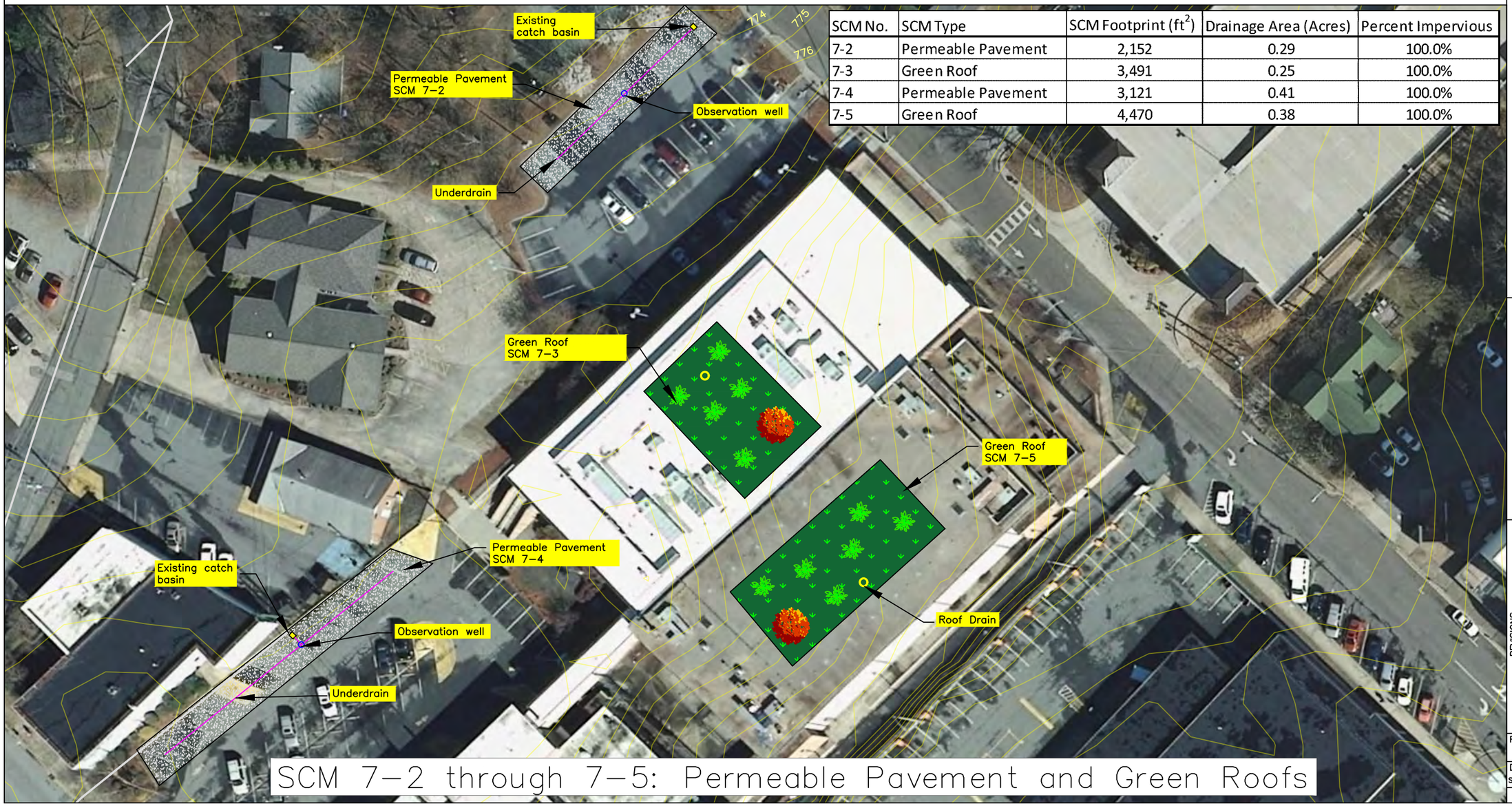
Permeable pavement attempts to mimic natural hydrology by creating internal storage that allows runoff to infiltrate into the subgrade. Permeable pavements are a good SCM for highly impervious urban areas such as parking lots because, upon completion of construction, they do not require any additional footprint. Permeable pavement parking areas are a common and successful SCM and thus a recommended option for this site.

N

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.



SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
7-2	Permeable Pavement	2,152	0.29	100.0%
7-3	Green Roof	3,491	0.25	100.0%
7-4	Permeable Pavement	3,121	0.41	100.0%
7-5	Green Roof	4,470	0.38	100.0%

SCM 7–2 through 7–5: Permeable Pavement and Green Roofs

Designed YB
Drawn YB
Checked KB
Approved
Date
Job Class JC
Title

Site 7 Stormwater Concept

110 W. Center St.
Lexington, NC 27292

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REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site6.dwg

SCM 7–6: Bioretention Concept Plan
The sidewalk in front of the Davidson County Court House presents a unique opportunity for a sidewalk bioretention SCM. This SCM would not only function as a stormwater control measure, but also as an street beautification amenity, a traffic calming feature and an educational opportunity. Currently runoff in this area is conveyed untreated into Royal Branch Drain via the existing storm drain network. A properly maintained sidewalk bioretention SCM could be a good method to achieve nutrient reduction as well as peak flow attenuation for a portion of this highly impervious downtown area.

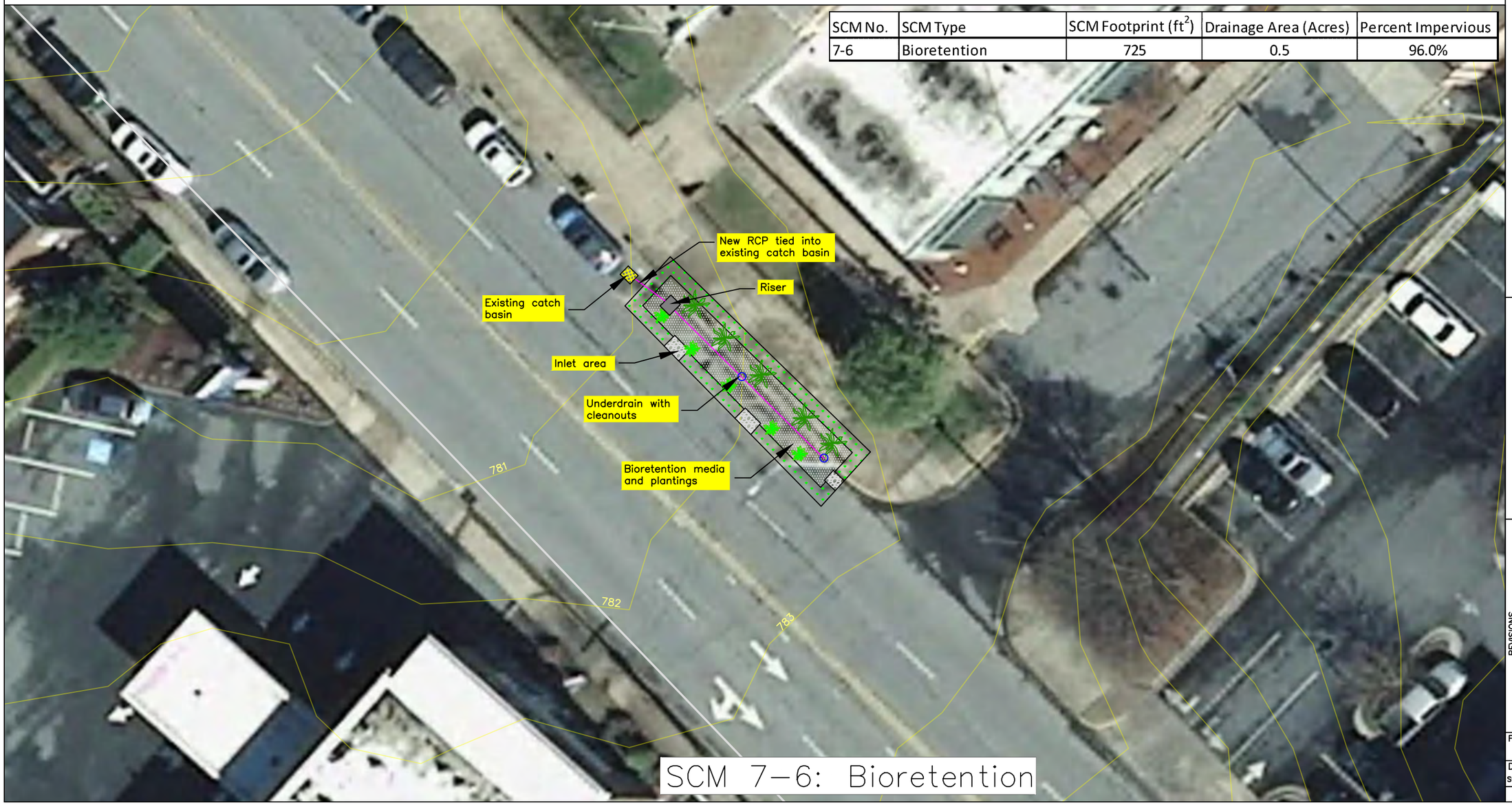
N

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
7-6	Bioretention	725	0.5	96.0%



SCM 7–6: Bioretention

Designed YB
Drawn YB
Checked KB
Approved
Date
Title
Job Class JC

Site 7 Stormwater Concept

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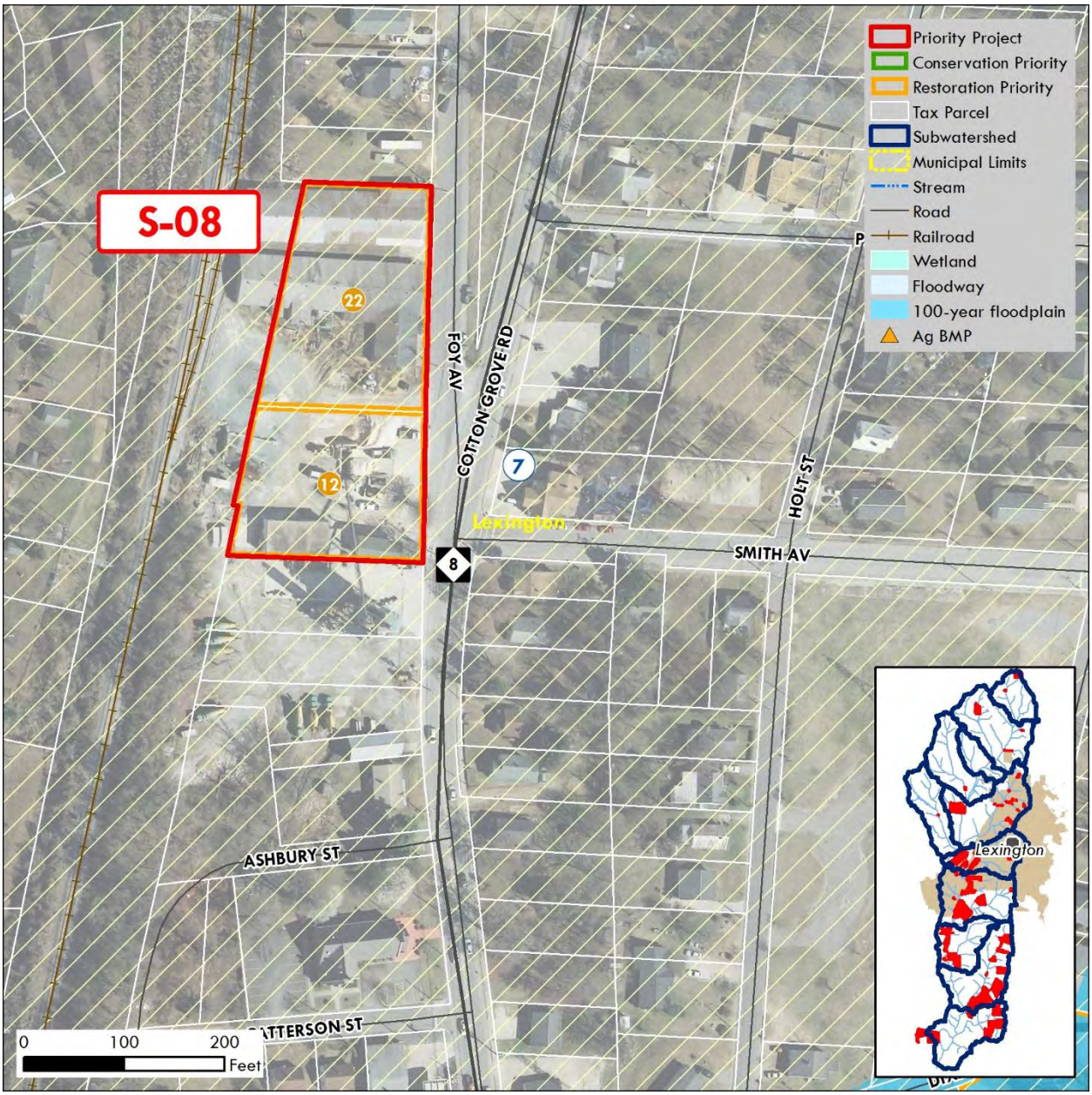
REVISIONS
Date | Description | Approved

File No.

Drawing:
SwearingCk_site6.dwg

Project S-08 – Black Concrete Inc.



Attribute	S-08
Site Location	City
Subwatershed	7
Land Use	Industrial
Linear Stream (Feet)	n/a
Area (Acres)	1.4
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	67.33%
Percent Forest Cover	7.3%

Recommended Actions:

1. Contact property owners to gauge interest in implementing suggested stormwater BMPs
   - Note: Encourage property owner to create indoor warehouse to store sand and other materials to prevent excess sediment runoff
2. Seek funding to support implementation

Stormwater Concept Plan
This existing wooded area could be easily converted into a stormwater sand filter SCM. Currently, a system of curb drains and stormwater pipes delivers runoff from a concrete production company parking lot, nearby roadways and buildings to the area. The runoff is delivered to the site through pipes and overland flows.

The approximate watershed draining through this area is 17.5 acres. One above ground stormwater sand filter could be used to capture this runoff. This sand filter would be sized to capture the first flush for peak attenuation as well as nutrient reduction.

This concept plans breaks the sand filter area up into 2 potential sections. A pre-treatment unit consists of a rock inlet and a sediment forebay. This forebay would be used to trap sediments before they could reach the sand section. The second section, which would be separated from the first via a inner berm, would consist of sand, a riser, and underdrains. This sand section would allow water to infiltrate through the sand which would remove nutrients. The water would drain through the sand into the underdrain then into the riser and through an outlet pipe that would be connected to an existing stormwater pipe.

In addition to this new stormwater device this concept plan also proposes adding an educational sign to the site. This educational sign will serve to educate the public on the added benefit of the new stormwater device.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
8-01	Sand Filter	5,960	17.7	49.5%

N

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

Designed KLB,KG
Drawn KG
Checked KB

Site 8 Stormwater Concept

613 Foy Ave.
Lexington, NC 27292

Approved ____ Date ____
Title ____ Job Class JJC

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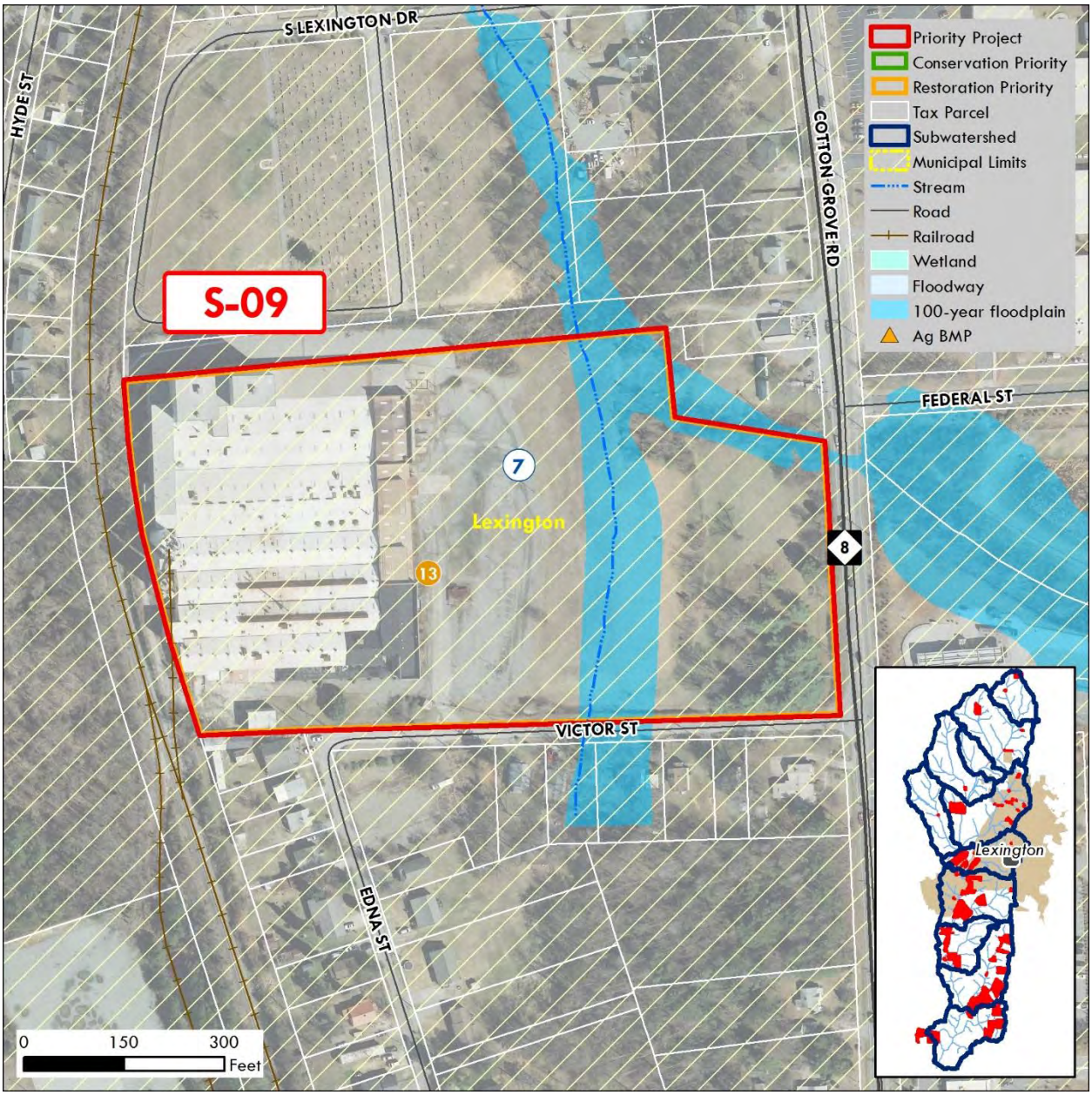
REVISIONS
Date | Description | Approved

File No.

Drawing:
SWC_Site8.dwg

Project S-09 – Condumex Industrial



Attribute	S-09
Site Location	City
Subwatershed	7
Land Use	Industrial
Linear Stream (Feet)	591
Area (Acres)	12.4
Floodplain Area (Acres)	1.7
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	66.50%
Percent Forest Cover	5.3%

Recommended Actions:

1. Contact property owner to gauge interest in implementing suggested stormwater BMPs
   - Note: Property is currently vacant and could be a potential brownfield site. Property would benefit from redevelopment.
2. Consider providing incentives to encourage redevelopment of site that includes LID practices

Stormwater Concept Plan
This existing parking lot, roof, and grassed lawn could be converted into several stormwater devices.

A portion of the parking lot that wraps around the side of the existing building would make a good site for permeable pavement due to the natural drainage of the parking lot. This permeable pavement could be installed without disrupting too much of the traffic flow.

A portion of the northern most side of the roof would be a good site to add a green roof. It would capture and treat rainfall that previously would have ran off site. The section of roof that is proposed would need to be checked by a structural engineer to determine if it can support the extra weight of the proposed device.

The northern side of the lawn surrounding the parking lot would make an ideal site for a stormwater wetland due to the natural drainage of the front parking lot. It would be used to capture and treat a first flush event from this parking lot. The approximate watershed that would drain to this stormwater wetland is 2.4 acres. This wetland is accurately sized to capture and treat the runoff.

The final piece of this stormwater plan would be to daylight an existing stream that has previously been piped through the site. This stream design would incorporate natural stream features as well as replant a stream buffer.

In addition to these new stormwater devices and stream restoration this concept plan also proposes adding an educational sign to the site. This educational sign will serve to educate the public on the added benefit of each new stormwater device as well as the stream restoration.

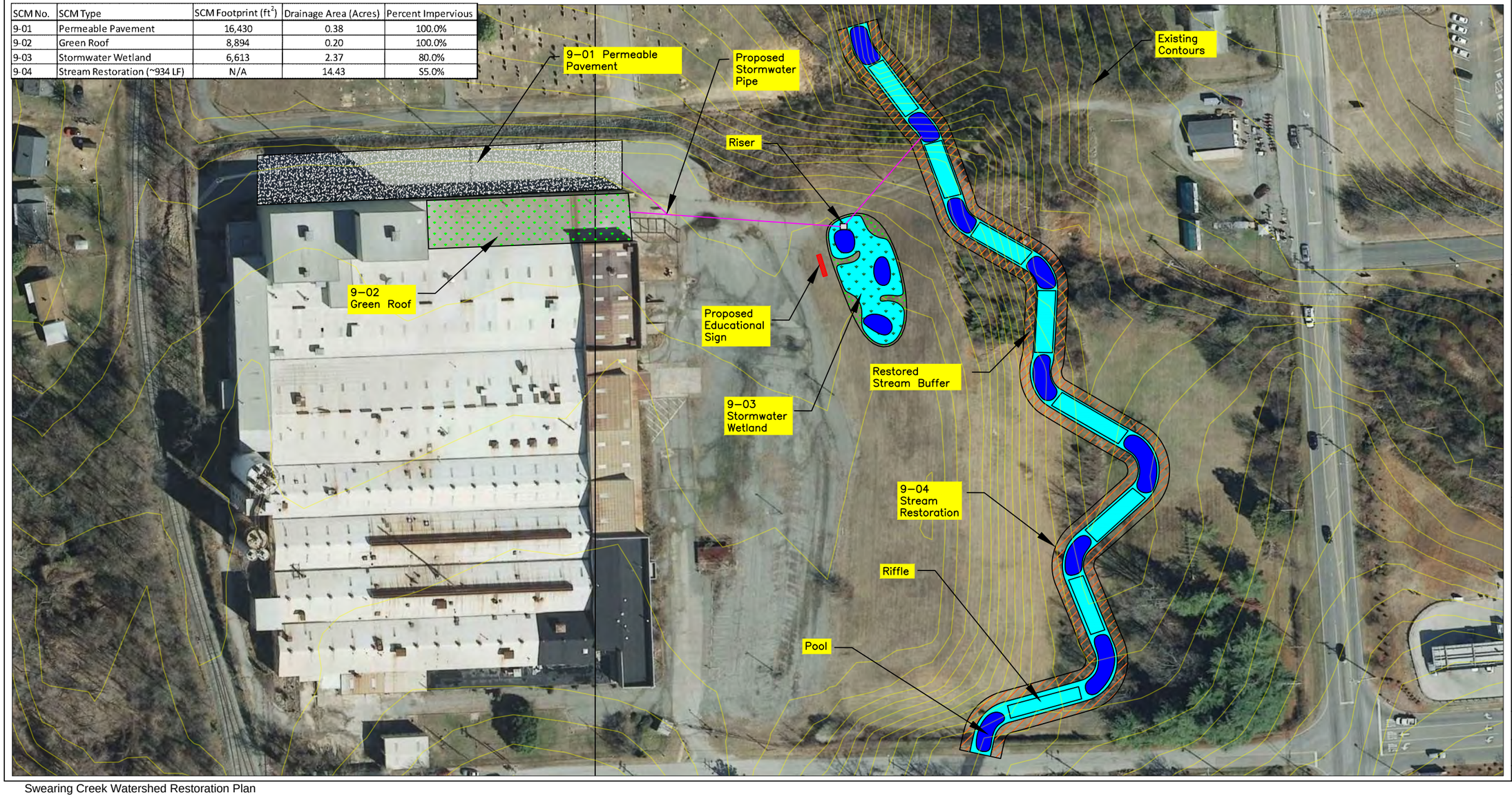
N

GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)
1 inch = 100 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
9-01	Permeable Pavement	16,430	0.38	100.0%
9-02	Green Roof	8,894	0.20	100.0%
9-03	Stormwater Wetland	6,613	2.37	80.0%
9-04	Stream Restoration (~934 LF)	N/A	14.43	55.0%



Designed KLB,KG
Drawn KG
Checked KB

Site 9 Stormwater Concept

1 Edna St.
Lexington, NC 27292

Approved ____ Date ____
Title ____ Job Class ____

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kbass@kbeng.org

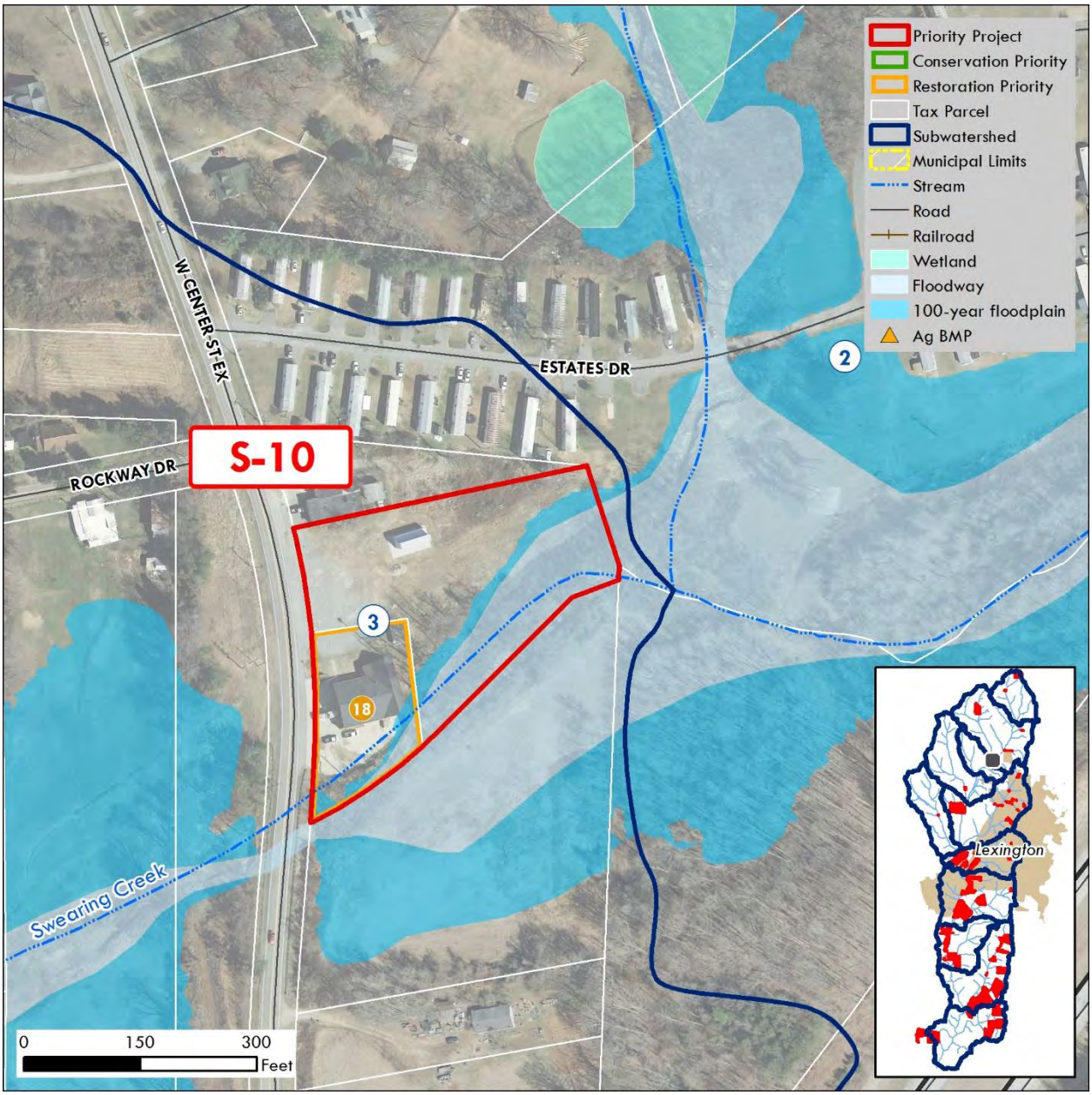
REVISIONS

Date	Description	Approved

File No.

Drawing:
SCW_Site9.dwg

Project S-10 – Estates Drive Residential



Attribute	S-10
Site Location	County
Subwatershed	3
Land Use	SFR
Linear Stream (Feet)	499
Area (Acres)	2.4
Floodplain Area (Acres)	0.9
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	27.82%
Percent Forest Cover	21.6%

Recommended Actions:

1. Contact West Lexington Fire Station 71 to gauge interest in implementing suggested stormwater BMPs
   - Note: There is an oil pipeline that runs through the adjacent property, which may limit stormwater improvements
2. Seek funding to support implementation

Site 10 stormwater Concept Plan
The stormwater runoff from the existing parking lot, roof, and gravel lot adjacent could be captured and treated by three different stormwater devices.

A cistern would be used to capture the stormwater runoff from the roof of the firehouse. The existing gutters system would be modified to drain into the cistern. This cistern could be used to recycle the collected water to wash the firetrucks and equipment.

A strip of permeable pavement could be installed where the current parking spaces on the south side of the firehouse are located. The parking lot naturally drains to these parking spots. The permeable pavement outlet could be tied into an existing area drain box and then drain into the adjacent stream. The top of the area drain box would be blocked off to prevent bypassing of the permeable pavement.

A filterra box (a proprietary device similar to a bioretention cell) would be installed in the northwest corner of the parking lot. This box would capture the runoff from the gravel lot adjacent to the firehouse as well as some of the road. The filterra box has an under drain below engineered media. A tree is planted in this box and the top is covered in mulch. From the street this box would appear as a curb inlet with a tree in the top. The box would tie in to an existing stormwater pipe allowing the runoff to filter and then drain into the adjacent stream.

In addition to these new stormwater devices this concept plan also proposes to add an educational sign to the site. This educational sign will serve to educate the public on the new stormwater devices.

N

GRAPHIC SCALE

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
10-01	Permeable Pavement	1,625	0.59	100.0%
10-02	Cistern	N/A	0.07	100.0%
10-03	Filterra Box	N/A	0.19	30.0%

Designed KLB,KG
Drawn KG
Checked KB

Approved ____ Date ____
Title ____ Job Class JC

Site 10 Stormwater Concept

1600 W. Ctr. St. Ext.,
Lexington, NC 27295

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Kris Bass
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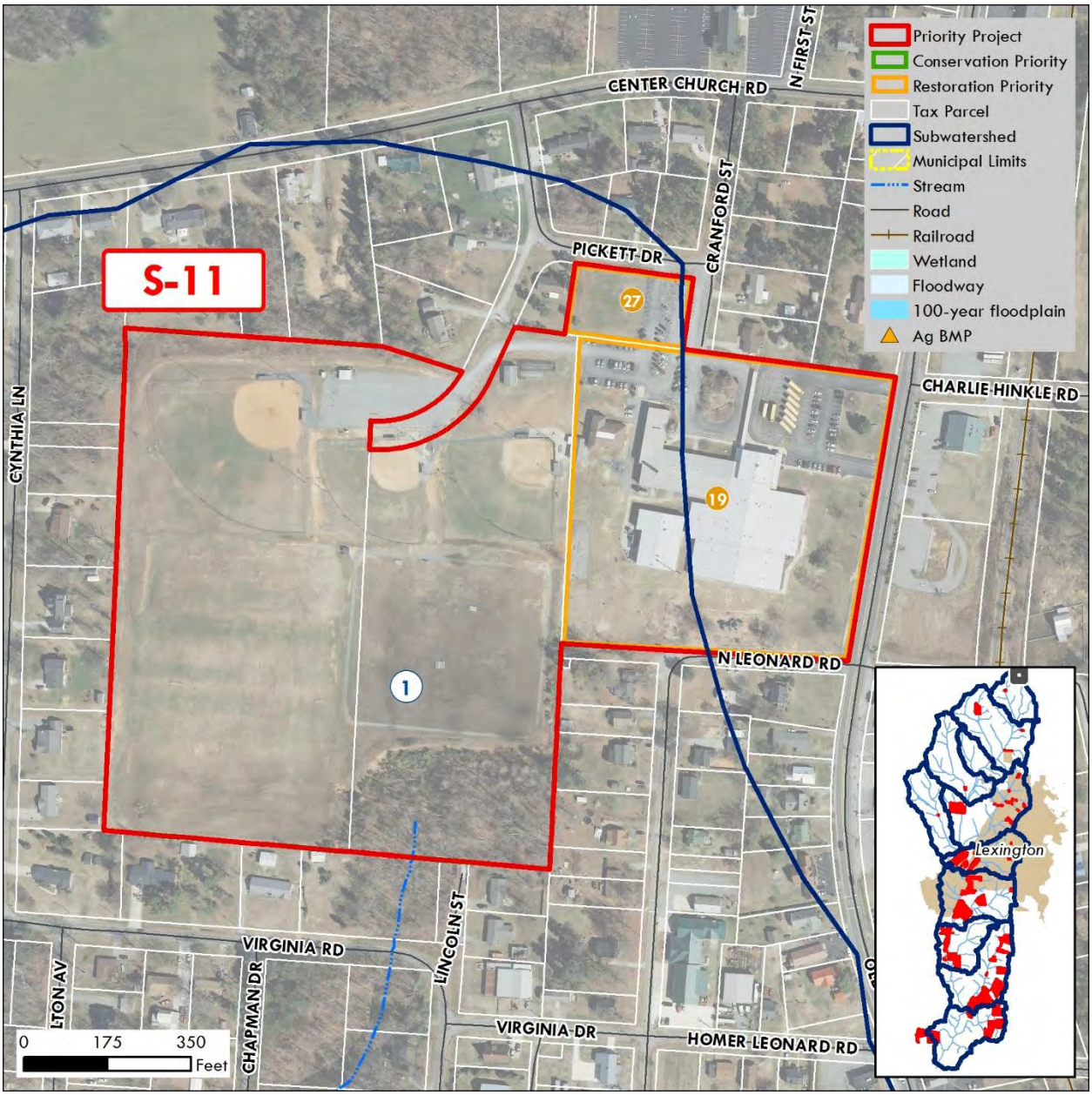
kbass@kbeng.org

REVISIONS
Date | Description | Approved

File No.

Drawing:
SCW_Site10.dwg

Project S-11 – Welcome Elementary School



Attribute	S-11
Site Location	County
Subwatershed	1
Land Use	Institutional
Linear Stream (Feet)	76
Area (Acres)	32.5
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	19.95%
Percent Forest Cover	6.9%

Recommended Actions:

1. Contact school district to gauge interest in implementing suggested stormwater BMPs
   - Note: Could be framed as an educational opportunity for students
2. Seek funding to support implementation

Stormwater Concept Plan

This existing parking lot, roof, and grassed lawn could be converted into several stormwater devices. These stormwater devices would capture runoff from the existing parking lots, roofs, and surrounding areas. This concept plan is proposing two sites for permeable pavement. This site would be ideal due to the natural drainage of the parking lots. Permeable pavement provides water quality treatment while also allowing the space to still be utilized for its original purpose.

A cistern is being proposed to capture and treat the runoff from a portion of the roof. The existing gutter system would be modified to drain into the proposed cistern. This cistern would be placed on the southeast side of the building allowing it to outlet away from the existing structure. A bioretention cell is being proposed on the northwestern side of the site in an existing grassed area. This bioretention cell would capture and treat the runoff from a portion of the existing parking lots as well as some of the adjacent properties. The runoff would enter the bioretention cell through an existing swale. The outlet structure of the bioretention cell would be piped into an existing swale on the site.

A stormwater wetland is being proposed on an existing grassed lawn area south of the baseball field. This wetland would capture the runoff from the school, parking lots, and surrounding areas. The runoff would exit the wetland through a new riser and be piped to an existing stream on site. A rain garden is being proposed on an existing grassed lawn area near the southwest corner of the school. This rain garden would capture the runoff from a portion of the existing roof. The existing gutter system would be modified to be extended into the rain garden. The rain garden would allow the runoff to naturally infiltrate into the existing soils. Two green roofs are being proposed to provide peak flow attenuation and nutrient reduction. The outlet for these green roofs would be connected to the existing gutter system. The roof would need to be checked by a structural engineer to determine if the existing roof could support the added weight of the green roof systems.

Finally two grassed swales are being proposed to capture and transport runoff from the western most parking lot and baseball fields to the proposed wetland. These swales would have a thick stand of grass in the bottom and on the side slopes. These swales would outlet through pipes and drain into the proposed wetland. In addition to these new stormwater devices this concept plan also proposes adding an educational sign to the site. This educational sign will serve to educate the public on the added benefit of each new stormwater device.

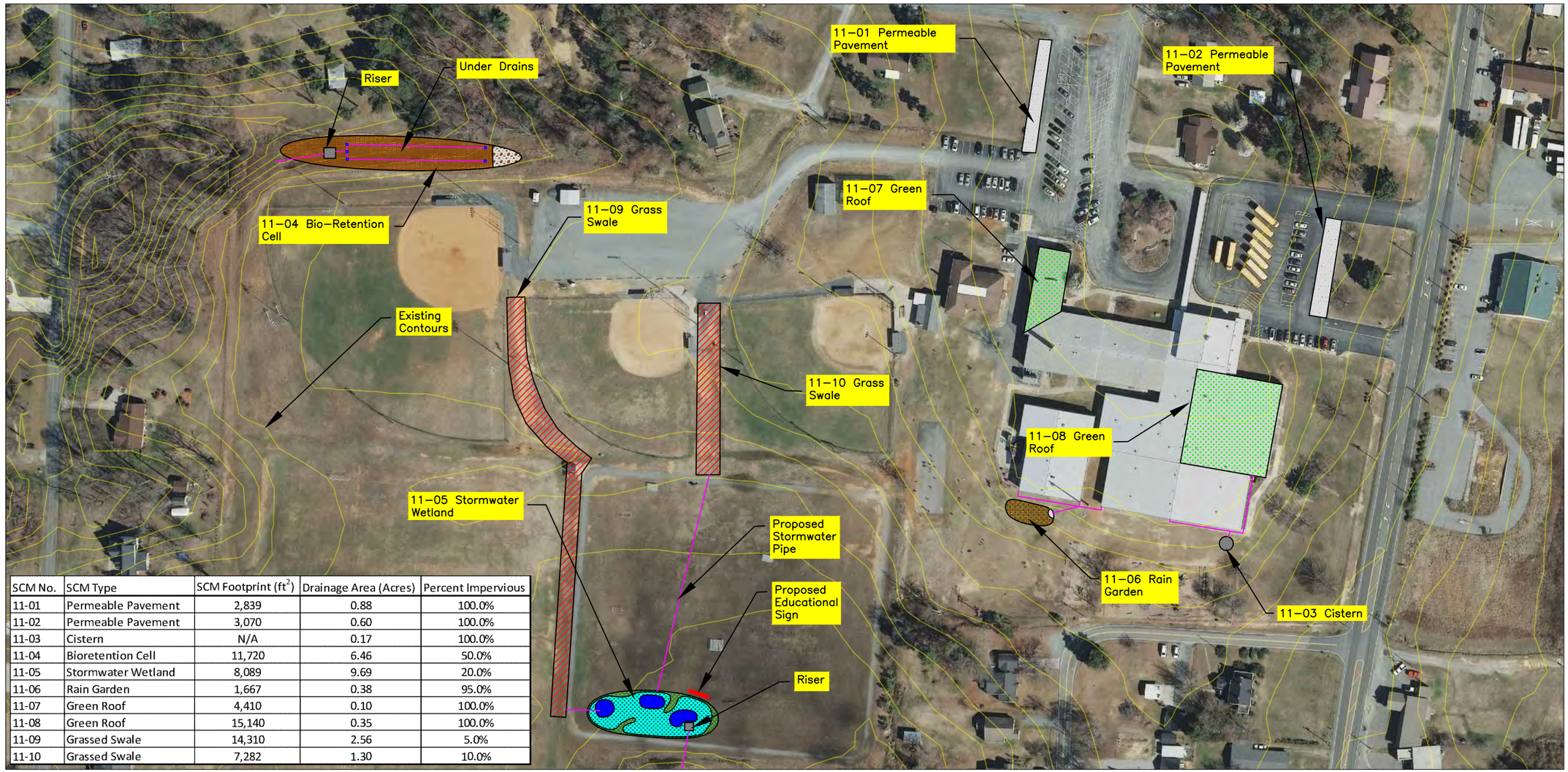
N

GRAPHIC SCALE

150 0 75 150 300 600

(IN FEET)

1 inch = 150 ft.



SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
11-01	Permeable Pavement	2,839	0.88	100.0%
11-02	Permeable Pavement	3,070	0.60	100.0%
11-03	Cistern	N/A	0.17	100.0%
11-04	Bioretention Cell	11,720	6.46	50.0%
11-05	Stormwater Wetland	8,089	9.69	20.0%
11-06	Rain Garden	1,667	0.38	95.0%
11-07	Green Roof	4,410	0.10	100.0%
11-08	Green Roof	15,140	0.35	100.0%
11-09	Grassed Swale	14,310	2.56	5.0%
11-10	Grassed Swale	7,282	1.30	10.0%

Designed KLB,KG
Drawn KG
Checked KB

Approved ____ Date ____
Title ____ Job Class JC

Site 11 Stormwater Concept

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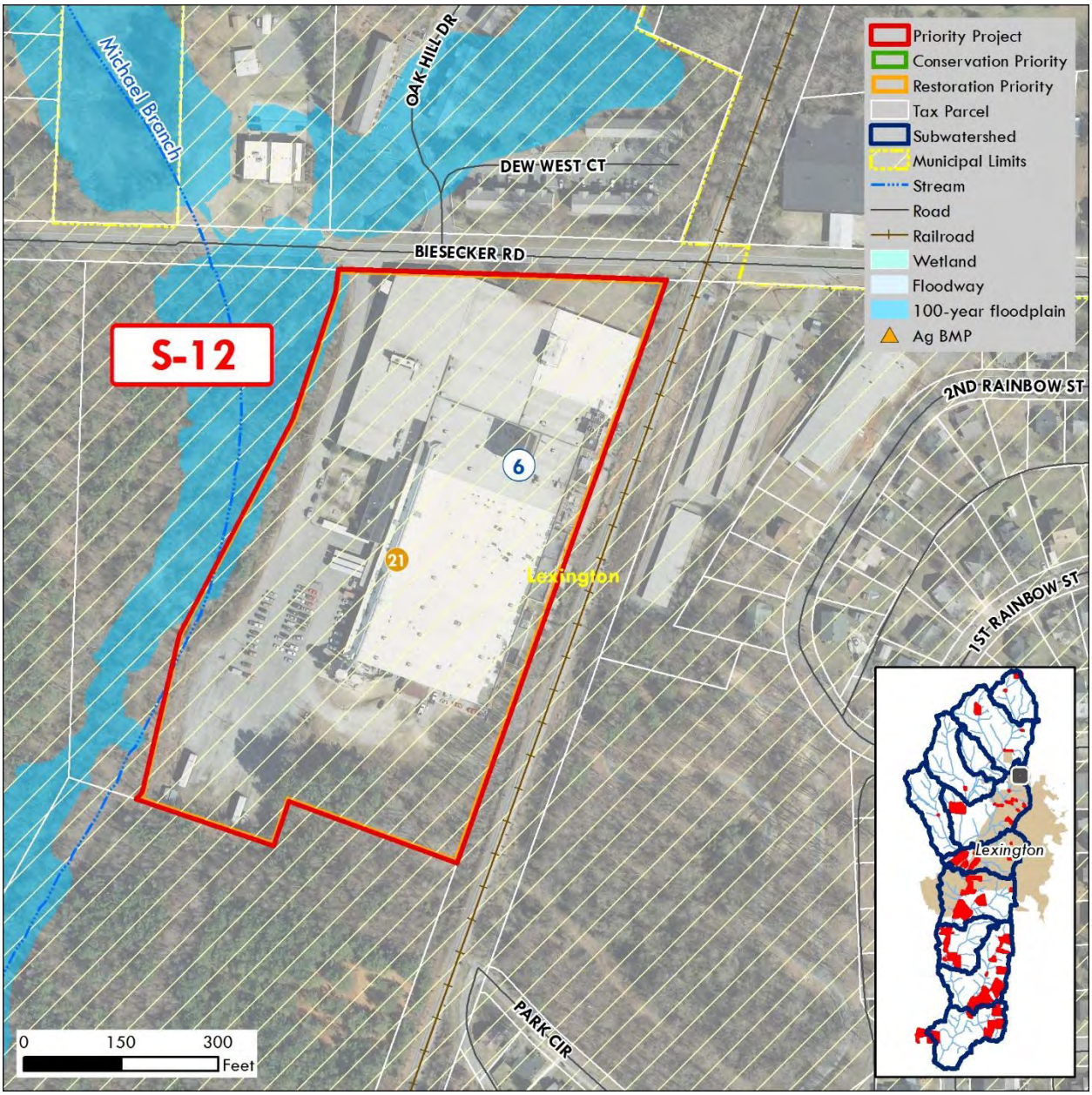
REVISIONS
Description
Date
Approved

File No.

Drawing:
SCW_Site11.dwg

Project S-12– Carolina Drawers Industrial



Attribute	S-12
Site Location	City
Subwatershed	6
Land Use	Industrial
Linear Stream (Feet)	185
Area (Acres)	10.3
Floodplain Area (Acres)	0.2
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	60.24%
Percent Forest Cover	25.7%

Recommended Actions:

1. Contact property owner to gauge interest in implementing suggested stormwater BMPs
   - Note: This parcel was also identified as part of the Davidson County Greenway Plan
2. Seek funding to support implementation

Stormwater Concept Plan
This existing parking lot, roof, and landscaped areas could be converted into several stormwater devices. These stormwater devices would capture runoff from the existing parking lot, roofs, and surrounding areas.

This concept plan is proposing a portion of the roof on the northern side of the building be converted into a green roof. This green roof would capture the rain that would normally runoff from the area. The outlet of the green roof would be tied into the existing gutter system. The roof would need to be checked by a structural engineer to determine if it could support the added weight of the green roof system.

A cistern is being proposed to capture and treat the runoff from a portion of the existing building's roof. The existing gutter system would be modified to drain into the proposed cistern. The cistern would be placed near the primary entrance of the building and would outlet toward the parking lot.

Finally a stormwater wetland is being proposed at the southern end of the existing parking lot. This wetland would capture and treat runoff from the parking lot and surrounding areas. The existing gutter system would be modified to allow for the southern part of the roof to drain into the proposed wetland. It would be outlet through a new riser structure that would tie into an existing stream on site.

In addition to these new stormwater devices this concept plan also proposes adding an educational sign to the site. This educational sign will serve to educate the public on the added benefit of each new stormwater device.

N

GRAPHIC SCALE

150 0 75 150 300 600

(IN FEET)
1 inch = 150 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
12-01	Green Roof	41,267	0.95	100.0%
12-02	Cistern	20,365	0.47	100.0%
12-03	Stormwater Wetland	8,507	7.32	30.0%

Designed KLB,KG
Drawn KG
Checked KB

Site 12 Stormwater Concept

67 Biesecker Rd.
Lexington, NC 27295

Approved
Date
Title
Job Class JJC

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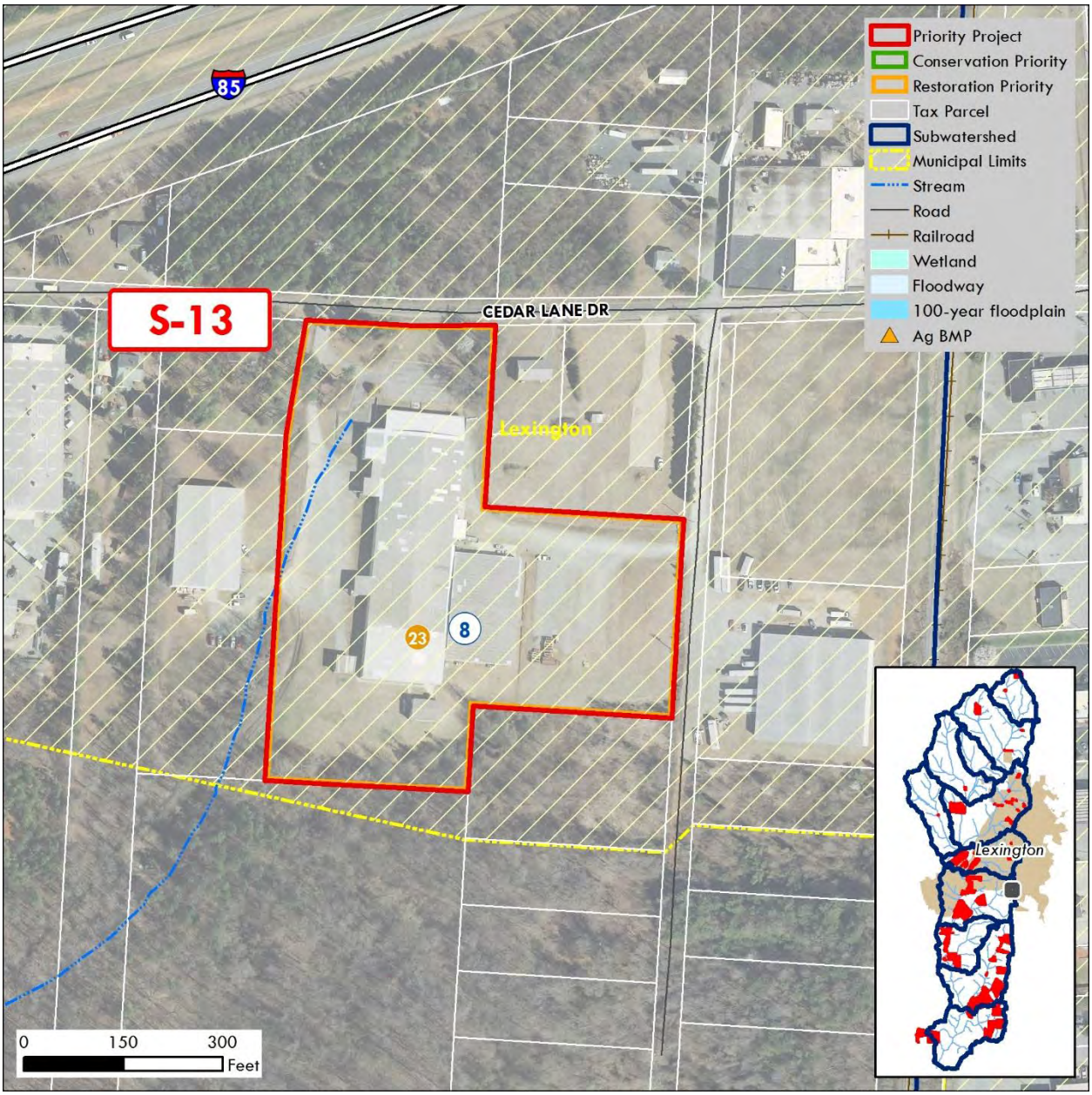
REVISIONS
Date | Description | Approved

File No.

Drawing:
SCW_Site12.dwg

Project S-13– Cedar Lane Drive Industrial



Attribute	S-13
Site Location	City
Subwatershed	8
Land Use	Industrial
Linear Stream (Feet)	278
Area (Acres)	6.9
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	50.55%
Percent Forest Cover	15.6%

Recommended Actions:

1. Contact property owner to gauge interest in implementing suggested stormwater BMPs
   - Note: This parcel was also identified as part of the Davidson County Greenway Plan
2. Seek funding to support implementation

Stormwater Concept Plan
This existing parking lot, and grassed lawn areas could be converted into several stormwater devices. These stormwater devices would capture runoff from the existing parking lots and roofs.

This concept plan is proposing one site for permeable pavement. This site would be ideal due to the natural drainage of the parking lots. Permeable pavement provides water quality treatment while also allowing the space to still be utilized for its original purpose.

Two cisterns are being proposed to capture and treat the runoff from a portion of the roof. The existing gutter system would be modified to drain into the proposed cistern. The cistern would be placed on the south side of the building allowing it to be outlet toward an existing wooded area.

A bioretention cell is being proposed on the southern most side of the building in an existing lawn area. This bioretention cell would capture and treat the runoff from a portion of the roof. The existing gutter system would be extended to drain into the proposed bioretention cell. The outlet structure of the bioretention cell would be piped into the nearby stream on the site.

Two stormwater wetlands are being proposed near the parking lot on the northern side of the site. These stormwater wetlands would be in series and would treat runoff from the road as well as other off site areas. Wetland 1 would drain into wetland 2 and then drain away from the site using an existing stormwater pipe.

Finally approximately 400 linear feet of stream restoration is being proposed with this concept plan. An existing ditch on the western side of the site would be restored to a natural stream design. This stream restoration would include a natural riffle–pool design. In addition to a natural in stream design the restoration would provide floodplain and a more natural planting plan. This planting plan would include trees, grasses, and wetland plants.

In addition to these new stormwater devices and stream restoration this concept plan also proposes adding an educational sign to the site. This educational sign will serve to educate the public on the added benefit of each new stormwater device as well as the stream restoration.

N

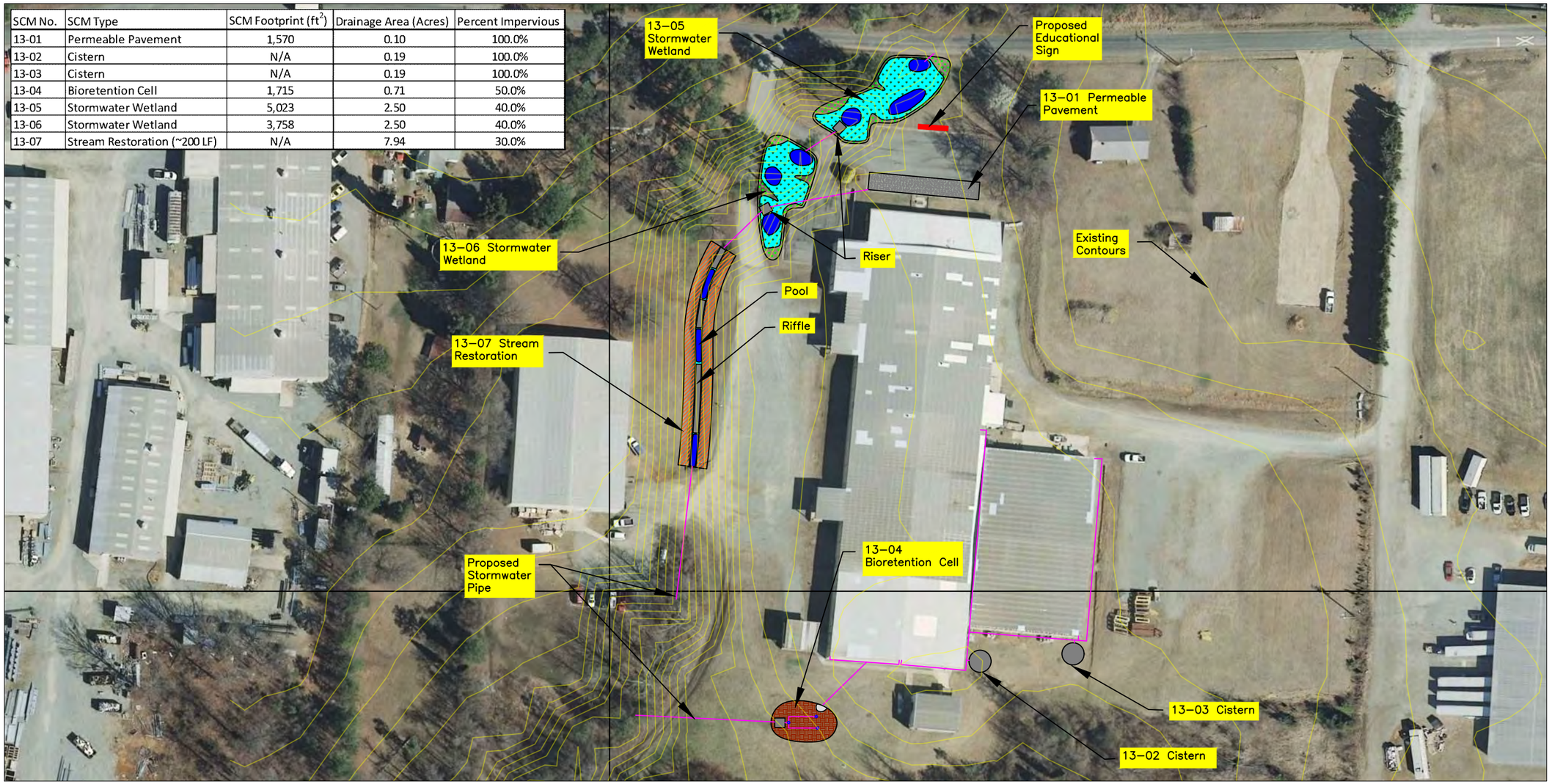
GRAPHIC SCALE

100 0 50 100 200 400

(IN FEET)

1 inch = 100 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
13-01	Permeable Pavement	1,570	0.10	100.0%
13-02	Cistern	N/A	0.19	100.0%
13-03	Cistern	N/A	0.19	100.0%
13-04	Bioretention Cell	1,715	0.71	50.0%
13-05	Stormwater Wetland	5,023	2.50	40.0%
13-06	Stormwater Wetland	3,758	2.50	40.0%
13-07	Stream Restoration (~200 LF)	N/A	7.94	30.0%



Designed KLB,KG
Drawn KG
Checked KB

Site 13 Stormwater Concept

117 Cedar Lane Dr.
Lexington, NC 27292

Approved ____ Date ____
Title ____ Job Class JJC

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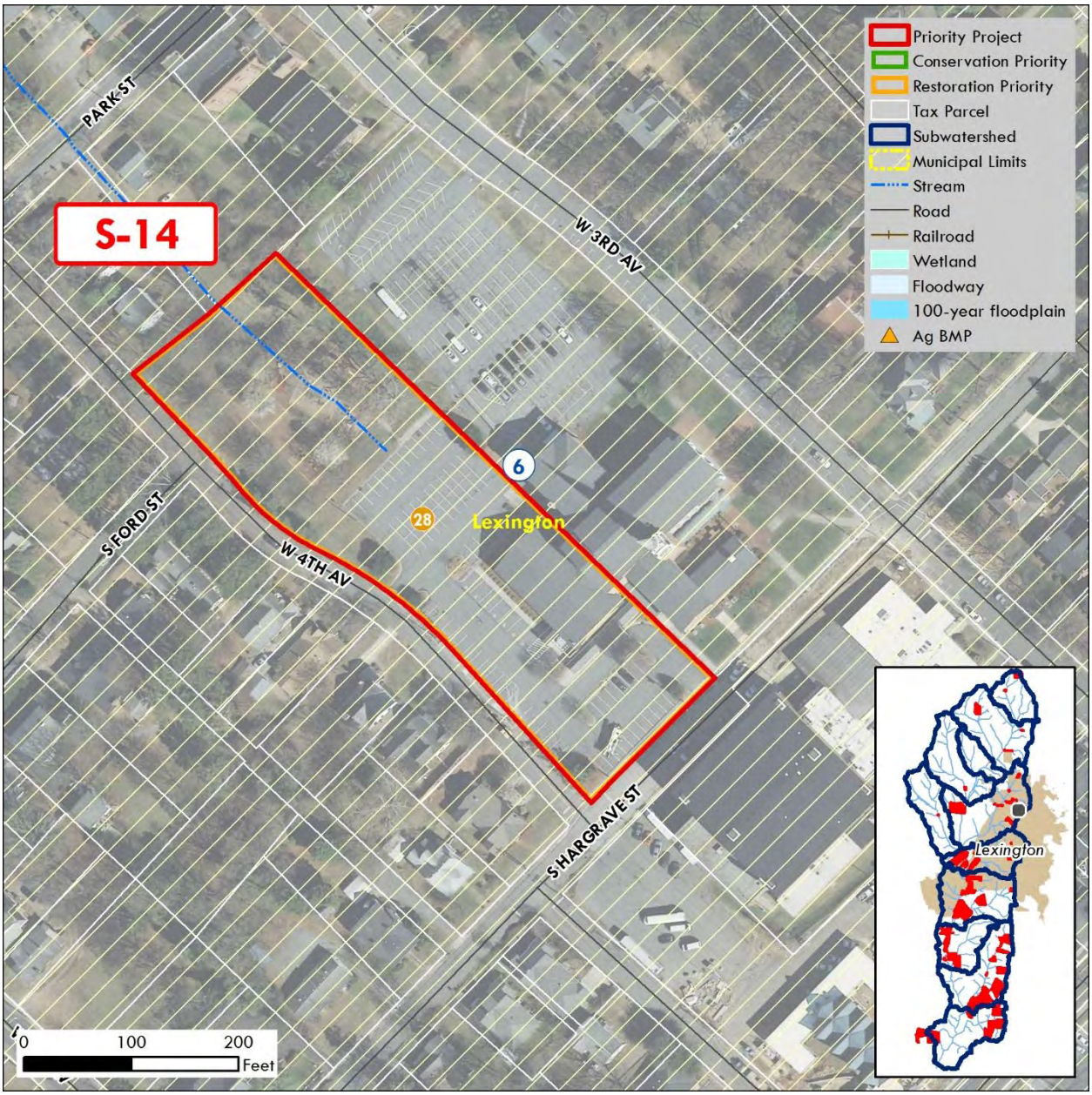
REVISIONS
Date | Description | Approved

File No.

Drawing:
SCW_Site13.dwg

Project S-14 – First Baptist Church



Attribute	S-14
Site Location	City
Subwatershed	6
Land Use	Institutional
Linear Stream (Feet)	208
Area (Acres)	2.2
Floodplain Area (Acres)	n/a
Wetland Area (Acres)	n/a
Percent Impervious Surface Cover	37.30%
Percent Forest Cover	31.8%

Recommended Actions:

1. Contact property owner to gauge interest in implementing suggested stormwater BMPs
   - Note: Could be supplemented by educational signage near church playgrounds
2. Seek funding to support implementation

Stormwater Concept Plan
This existing parking lot and landscaped areas could be converted into several stormwater devices. These stormwater devices would capture runoff from the existing parking lot and roof.

This concept plan is proposing two primary sites for permeable pavement. These sites would be ideal due to the natural drainage of the parking lot. Permeable pavement provides water quality treatment while also allowing the space to still be utilized for its original purpose.

In addition this concept plan is proposing three small cisterns to be attached to existing gutter downspouts on the southwest side of the building. The existing gutter system would need to be slightly modified to attach to the cisterns. The cisterns would outlet away from the building and into the existing parking lot.

A bioretention cell is being proposed in the parking lot where two current parking lot islands already exist. This bioretention cell would result in the loss of six parking spaces. It would capture and treat the runoff from the adjacent road as well as the eastern side of the parking lot. The outlet structure for the bioretention cell would be attached an existing area drain box located in the existing parking lot.

In addition to these new stormwater devices this concept plan also proposes to add an educational sign to the site. This educational sign will serve to educate the public on the added benefit of each new stormwater device.

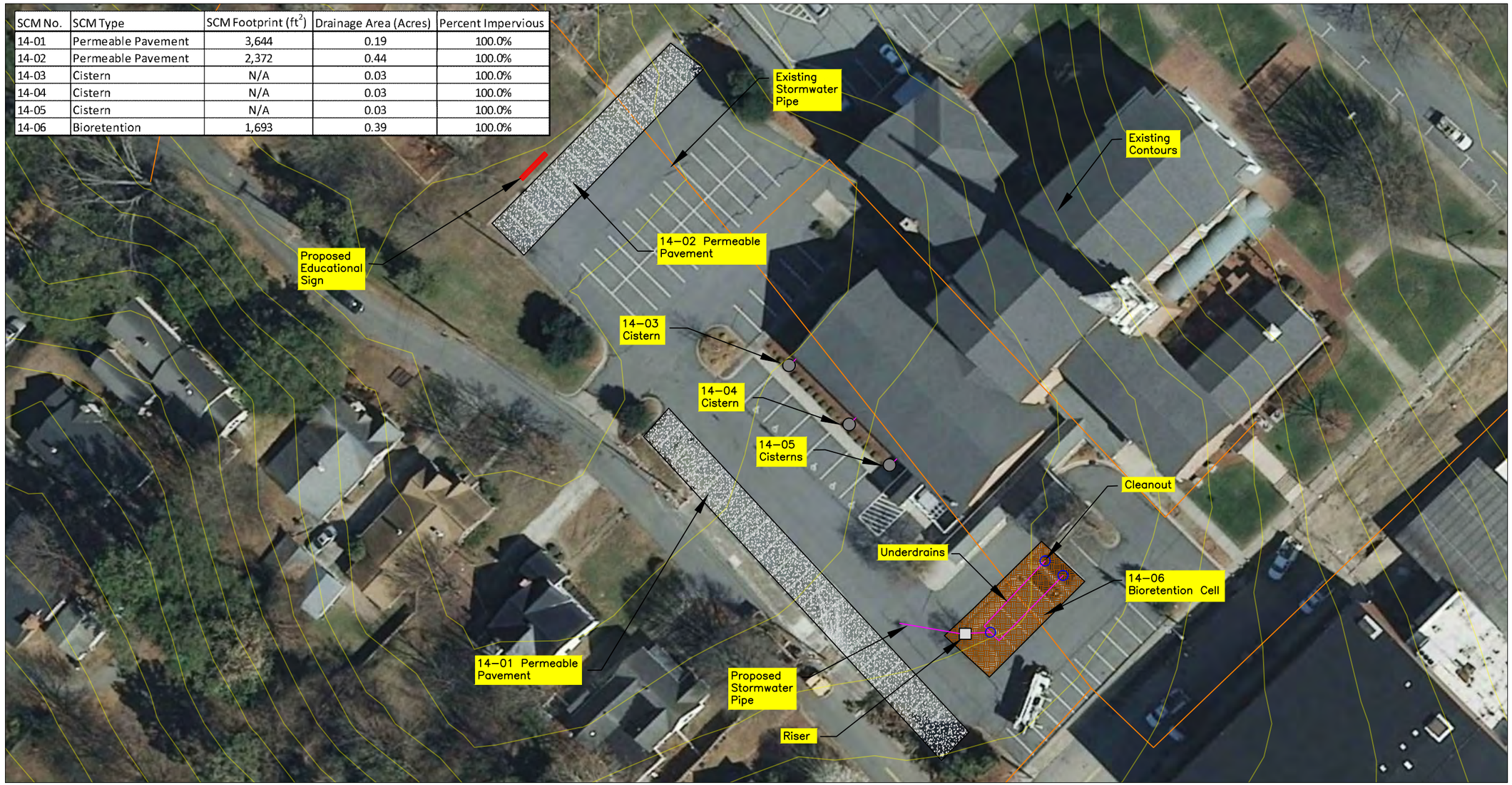
N

GRAPHIC SCALE

50 0 25 50 100 200

(IN FEET)
1 inch = 50 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
14-01	Permeable Pavement	3,644	0.19	100.0%
14-02	Permeable Pavement	2,372	0.44	100.0%
14-03	Cistern	N/A	0.03	100.0%
14-04	Cistern	N/A	0.03	100.0%
14-05	Cistern	N/A	0.03	100.0%
14-06	Bioretention	1,693	0.39	100.0%



Designed KLB,KG
Drawn KG
Checked KB

Site 14 Stormwater Concept

Approved Date
Title Job Class

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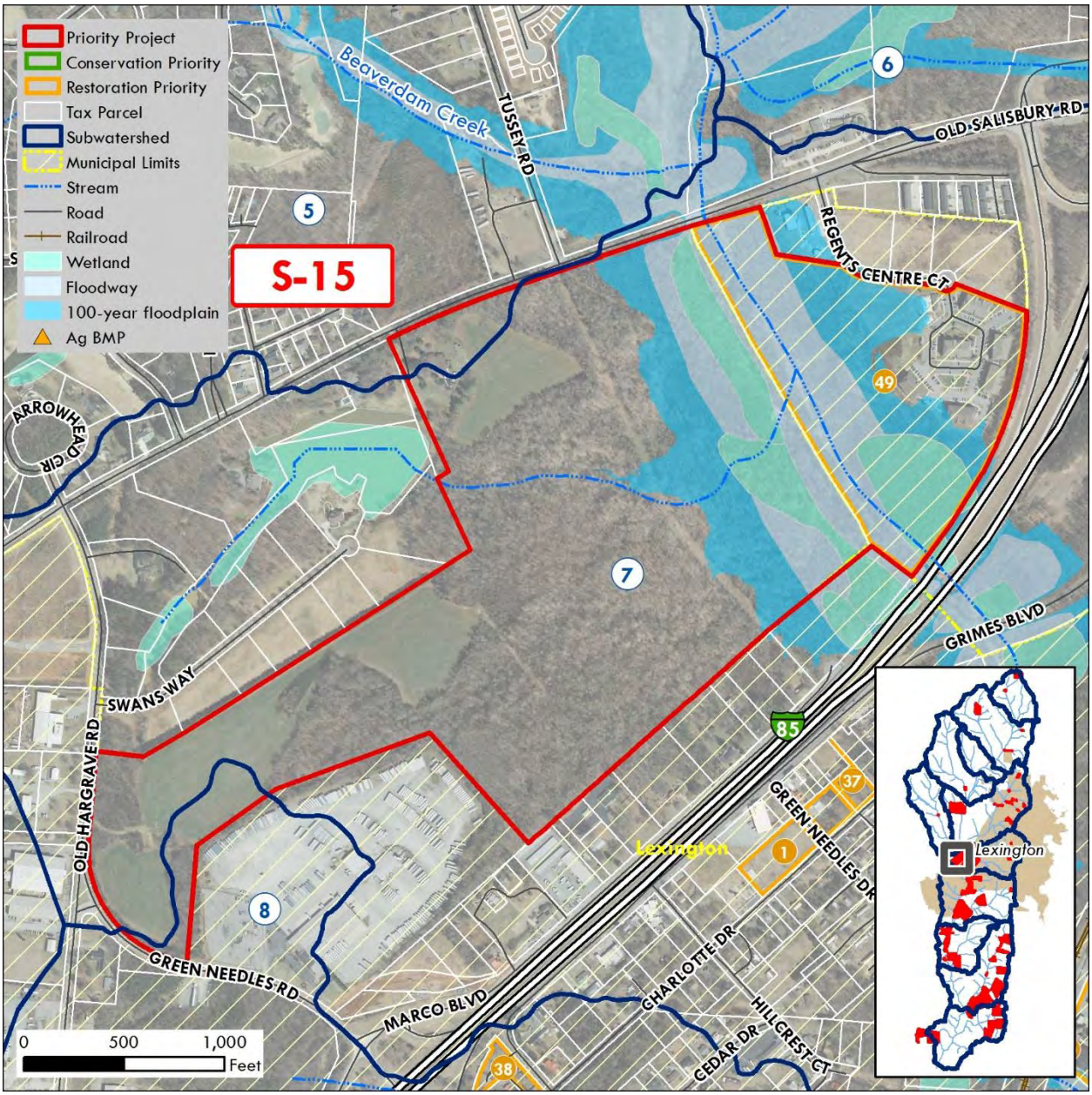
REVISIONS
Date | Description | Approved

File No.

Drawing:
SCW_Site14.dwg

Project S-15 – Regents Center



Attribute	S-15
Site Location	City, County
Subwatershed	7
Land Use	Forest, Multi-Family
Linear Stream (Feet)	4,227
Area (Acres)	161.4
Floodplain Area (Acres)	59.0
Wetland Area (Acres)	12.2
Percent Impervious Surface Cover	4.43%
Percent Forest Cover	58.3%

Recommended Actions:

1. Contact property owner to gauge interest in implementing suggested stormwater BMPs
   - Note: Apartments are currently expanding, which will increase impervious cover. Construction has resulted in exposed soil.
2. Seek funding to support implementation
3. Property owners of parcel #7 have dedicated land for conservation with Davidson County Soil & Water

Stormwater Concept Plan

This existing parking lot, and grassed lawn areas could be converted into several stormwater devices. These stormwater devices would capture runoff from the existing parking lots and roofs.

There are six potential parking lot islands that could easily be transformed into rain gardens. The rain gardens would provide runoff a place to collect and naturally infiltrate into the existing soils. Building these rain gardens would be a great benefit to the water quality leaving this site.

This concept plan is proposing two primary sites for permeable pavement. These sites would be ideal to the natural drainage of the parking lots. Permeable pavement provides water quality treatment while also allowing the space to still be utilized for its original purpose.

A cistern is being proposed to capture and treat the runoff from a portion of the eastern most apartment building roof. The existing gutter system would be modified to drain into the proposed cistern. This cistern would be placed behind the building to allow overflows to drain away from the existing structure.

Finally a bioretention cell is being proposed behind the southern most apartment building. This bioretention cell would capture the runoff from the adjacent parking lot as well as the apartment building. The existing gutter system would be extended to drain into the proposed bioretention cell. The outlet structure for the bioretention cell would be attached to the existing storm sewer system.

In addition to these new stormwater devices this concept plan also proposes to add an education sign to the site. This educational sign will serve to educate the public on the added benefit of each new stormwater device.

N

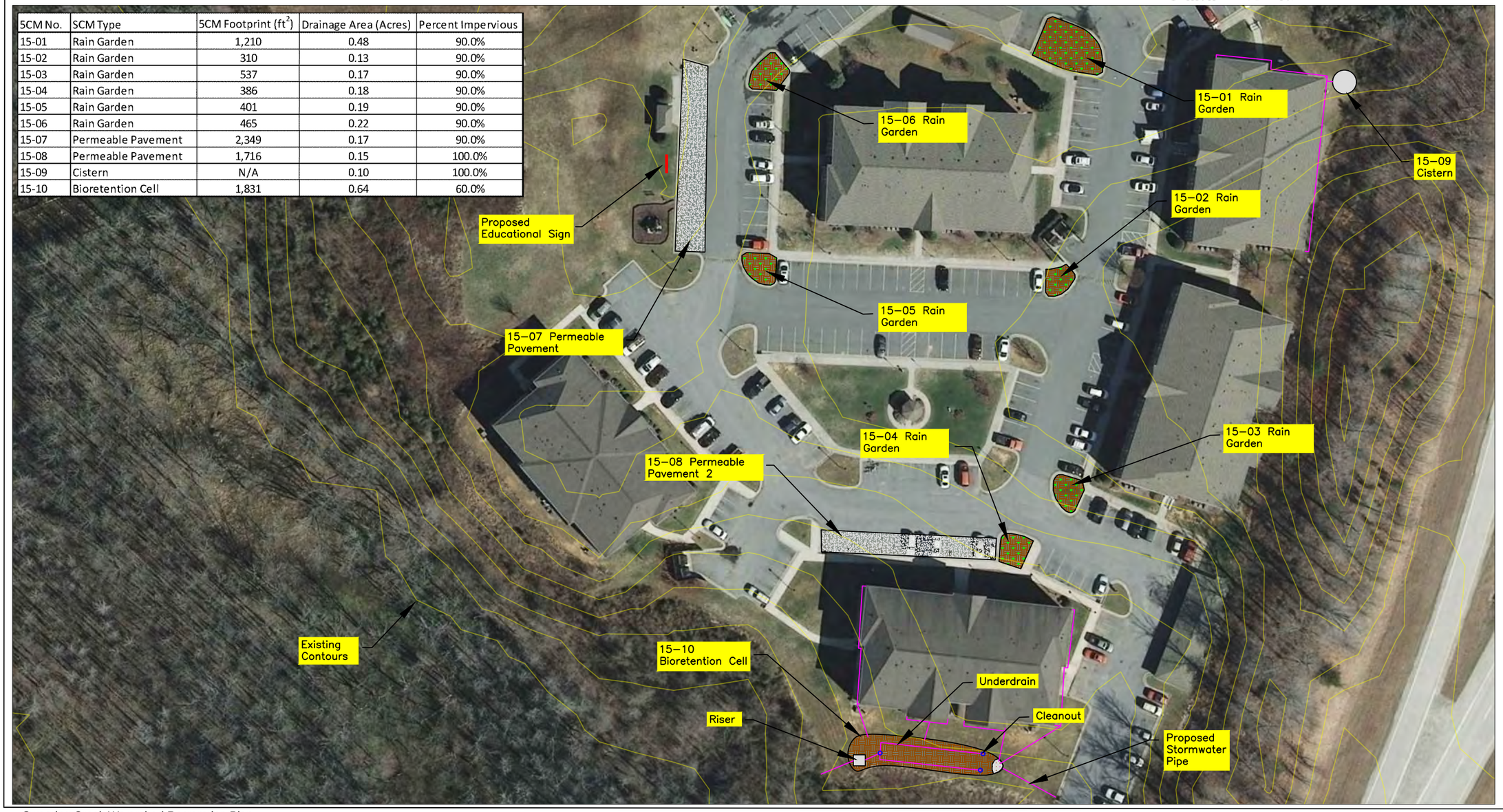
GRAPHIC SCALE

70 0 35 70 140 280

(IN FEET)

1 inch = 70 ft.

SCM No.	SCM Type	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious
15-01	Rain Garden	1,210	0.48	90.0%
15-02	Rain Garden	310	0.13	90.0%
15-03	Rain Garden	537	0.17	90.0%
15-04	Rain Garden	386	0.18	90.0%
15-05	Rain Garden	401	0.19	90.0%
15-06	Rain Garden	465	0.22	90.0%
15-07	Permeable Pavement	2,349	0.17	90.0%
15-08	Permeable Pavement	1,716	0.15	100.0%
15-09	Cistern	N/A	0.10	100.0%
15-10	Bioretention Cell	1,831	0.64	60.0%



Designed KLB,KG
Drawn KG
Checked KB

Approved ____ Date ____
Title ____ Job Class JJC

Site 15 Stormwater Concept

100 Regents Center Ct.
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REVISIONS

Date	Description	Approved

File No.

Drawing:
SCW_Site15.dwg

Photo Atlas of Potential Restoration Projects


Potential site for SCM 4-2
Potential site for SCM 4-4 and 4-5
Potential site for SCM 5-2
Potential site for SCM 5-3 retrofit


Potential site for SCM 6-1 through 6-3


Potential site for SCM 6-4 through 6-6


Potential site for SCM 7-1


Potential site for SCM 7-6


Potential site for SCM 8-1


Potential site for SCM 10-1 through 10-3


Potential location for site 14 SCMs


Potential site for SCM 15-5

SWEARING CREEK WATERSHED PLAN

Predicted Performance and Cost Estimates for Potential Stormwater Control Measures

Site-SCM No.	SCM Type	Location	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious	TN Reduction[3] (lb/ac/yr)	TP Reduction[3] (lb/ac/yr)	Cost Estimate[1]
1-01	Bioretention	Green Needles Drive	2,569	4.1	8.8%	1.34	0.23	$127,000
1-02	Bioretention	Green Needles Drive	1,976	0.35	69.3%	6.49	0.71	$116,000
2-01	Bioswale	Jaycee Park	384	4.2	30.5%	3.33	0.42	$79,000
2-02	Bioswale	Jaycee Park	651	1.1	20.7%	2.54	0.34	$88,000
3-01	Bioretention	Michael Branch	556	0.71	60.5%	2.90	0.32	$77,000
3-02	Bioswale	Michael Branch	1,494	1.2	69.0%	6.47	0.70	$106,000
3-03	Stormwater Wetland	Michael Branch	2,638	7.2	32.5%	2.17	0.31	$98,000
3-04	Bioswale	Michael Branch	542	1.1	59.7%	4.69	0.53	$37,000
3-05	Bioswale	Michael Branch	400	1.1	59.9%	5.73	0.64	$43,000
3-06	Permeable Pavement	Michael Branch	1,611	0.20	100.0%	2.46	0.27	$56,000
3-07	Bioswale	Michael Branch	782	0.26	100.0%	7.34	0.77	$41,000
3-08	Bioswale	Michael Branch	2,496	0.35	99.3%	8.94	0.94	$85,000
3-09	Permeable Pavement	Michael Branch	1,650	0.10	99.7%	5.15	0.58	$57,000
3-10	Permeable Pavement	Michael Branch	562	0.39	100.0%	0.48	0.05	$20,000
4-01	Bioswale	Holt-Moffitt Field, Radcliff Park & Brownfield	5,068	12.2	29.9%	3.28	0.41	$146,000
4-02	Stormwater Wetland	Holt-Moffitt Field, Radcliff Park & Brownfield	11,707	12.2	29.9%	2.04	0.30	$125,000
5-01	Green Roof[2]	Schwarz Industrial	82,519	1.9	100.0%	5.31	0.74	$1,200,000
5-02	Bioswale	Schwarz Industrial	1,090	41.3	20.0%	2.07	0.29	$37,000
5-03	Stormwater Wetland	Schwarz Industrial	109,234	3.0	69.4%	3.89	0.48	$430,000
5-06	Bioretention	Schwarz Industrial	2,432	0.24	78.4%	5.92	0.64	$126,000
6-03	Stormwater Wetland	North Town Offices	10,307	8.3	82.8%	2.27	0.27	$66,000
6-04	Rain Garden	North Town Offices	400	0.05	100.0%	9.00	0.94	$21,000
6-05	Permeable Pavement	North Town Offices	1,504	0.31	66.3%	0.16	0.05	$52,000
6-06	Rain Garden	North Town Offices	300	0.05	99.6%	8.96	0.94	$19,000
6-08	Rain Garden	North Town Offices	643	0.07	98.6%	8.89	0.93	$17,000
7-01	Bioretention	Davidson County Courthouse	897	0.05	99.6%	4.50	0.48	$56,000
7-02	Permeable Pavement	Davidson County Courthouse	2,152	0.29	100.0%	2.28	0.25	$84,000

Predicted Performance and Cost Estimates for Potential Stormwater Control Measures (cont.)

Site-SCM No.	SCM Type	Location	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious	TN Reduction[3] (lb/ac/yr)	TP Reduction[3] (lb/ac/yr)	Cost Estimate[1]
7-03	Green Roof[2]	Davidson County Courthouse	3,491	0.08	100.0%	1.17	0.16	$53,000
7-04	Permeable Pavement	Davidson County Courthouse	3,121	0.41	100.0%	2.34	0.26	$117,000
7-05	Green Roof[2]	Davidson County Courthouse	4,470	0.10	100.0%	5.31	0.74	$67,000
7-06	Bioretention	Davidson County Courthouse	725	0.53	96.0%	8.68	0.92	$80,000
8-01	Sand Filter	Black Concrete Inc.	3,025	17.66	49.5%	2.76	0.18	$39,900
9-01	Permeable Pavement	Condumex Industrial	16,430	0.38	100.0%	0.00	0.00	$173,000
9-02	Green Roof[2]	Condumex Industrial	8,894	0.20	100.0%	8.57	0.80	$236,000
9-03	Stormwater Wetland	Condumex Industrial	6,613	2.37	80.0%	3.85	0.46	$21,000
10-01	Permeable Pavement	Estates Drive Residential	1,626	0.59	100.0%	0.00	0.00	$24,000
10-02	Cistern	Estates Drive Residential	--	0.07	100.0%	0.03	0.00	$8,000
10-03	Filterra Box	Estates Drive Residential	--	0.19	30.0%	7.34	0.77	$15,000
11-01	Permeable Pavement	Welcome Elementary School	2,839	0.88	100.0%	0.06	0.02	$38,400
11-02	Permeable Pavement	Welcome Elementary School	3,070	0.60	100.0%	0.00	0.00	$41,500
11-03	Cistern	Welcome Elementary School	--	0.17	100.0%	0.03	0.00	$10,000
11-04	Bioretention	Welcome Elementary School	11,720	6.46	50.0%	4.72	0.54	$189,000
11-05	Stormwater Wetland	Welcome Elementary School	8,090	9.69	20.0%	1.58	0.26	$24,000
11-06	Rain Garden	Welcome Elementary School	1,667	0.38	95.0%	7.01	0.73	$24,000
11-07	Green Roof[2]	Welcome Elementary School	4,410	0.10	100.0%	8.56	0.80	$75,100
11-08	Green Roof[2]	Welcome Elementary School	15,140	0.35	100.0%	8.57	0.80	$258,000
11-09	Grassed Swale	Welcome Elementary School	14,310	2.56	5.0%	0.00	0.00	$64,000
11-10	Grassed Swale	Welcome Elementary School	7,282	1.30	10.0%	0.00	0.00	$33,000
12-01	Green Roof[2]	Carolina Drawers Industrial	41,267	0.95	100.0%	8.57	0.80	$703,000
12-02	Cistern	Carolina Drawers Industrial	--	0.47	100.0%	0.03	0.00	$23,000
12-03	Stormwater Wetland	Carolina Drawers Industrial	8,507	7.32	30.0%	2.05	0.30	$65,000
13-01	Permeable Pavement	Cedar Lane Drive Industrial	1,570	0.10	100.0%	0.00	0.00	$31,000
13-02	Cistern	Cedar Lane Drive Industrial	--	0.19	100.0%	0.03	0.00	$10,000
13-03	Cistern	Cedar Lane Drive Industrial	--	0.19	100.0%	0.03	0.00	$10,000
13-04	Bioretention	Cedar Lane Drive Industrial	1,715	0.71	50.0%	4.66	0.53	$54,000
13-05	Stormwater Wetland	Cedar Lane Drive Industrial	5,023	2.50	40.0%	2.41	0.34	$72,000
13-06	Stormwater Wetland	Cedar Lane Drive Industrial	3,758	2.50	40.0%	0.88	0.10	$64,000

Predicted Performance and Cost Estimates for Potential Stormwater Control Measures (cont.)

Site-SCM No.	SCM Type	Location	SCM Footprint (ft^2)	Drainage Area (Acres)	Percent Impervious	TN Reduction[3] (lb/ac/yr)	TP Reduction[3] (lb/ac/yr)	Cost Estimate[1]
14-01	Permeable Pavement	First Baptist Church	3,644	0.19	100.0%	0.00	0.00	$49,000
14-02	Permeable Pavement	First Baptist Church	2,372	0.44	100.0%	0.00	0.00	$38,000
14-03	Cistern	First Baptist Church	--	0.03	100.0%	0.03	0.00	$7,000
14-04	Cistern	First Baptist Church	--	0.03	100.0%	0.03	0.00	$7,000
14-05	Cistern	First Baptist Church	--	0.03	100.0%	0.03	0.00	$7,000
14-06	Bioretention	First Baptist Church	1,693	0.39	100.0%	8.60	0.90	$40,000
15-01	Rain Garden	Regents Center	1,479	0.48	90.0%	5.45	0.58	$21,000
15-02	Rain Garden	Regents Center	413	0.13	90.0%	5.05	0.53	$6,000
15-03	Rain Garden	Regents Center	537	0.17	90.0%	4.73	0.50	$8,000
15-04	Rain Garden	Regents Center	550	0.18	90.0%	4.73	0.50	$8,000
15-05	Rain Garden	Regents Center	579	0.19	90.0%	4.66	0.49	$8,000
15-06	Rain Garden	Regents Center	685	0.22	90.0%	4.59	0.49	$9,800
15-07	Permeable Pavement	Regents Center	2,350	0.17	90.0%	0.00	0.00	$31,800
15-08	Permeable Pavement	Regents Center	1,716	0.15	100.0%	0.00	0.00	$23,000
15-09	Cistern	Regents Center	--	0.10	100.0%	0.03	0.00	$9,000
15-10	Bioretention	Regents Center	1,831	0.64	60.0%	5.43	0.60	$84,000

1 - The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgement as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer. Cost estimates include 20% contingency and 30% design and permitting costs.

2 - The cost estimate for green roofs does not include additional costs associated with structural analysis performed by an NC licensed structural engineer and any required improvements found from the structural engineer's analysis. Installation of green roofs will likely require additional roof support infrastructure and these costs are not reflected in the estimates given above.

3 - Total Nitrogen (TN) and Total Phosphorus (TP) nutrient reductions were calculated using the Jordan/Falls Lake Nutrient Load Accounting Tool

SWEARING CREEK WATERSHED PLAN

Summary and Cost Estimates for Potential Stream Restoration Projects

Site-SCM No.	SCM Type	Location	Length (ft)	Drainage Area (Acres)	Percent Impervious	Cost Estimate[1]
2-05	Stream Restoration	Jaycee Park	650	422.40	40.1%	$163,000
4-03	Stream Restoration	Holt-Moffitt Field, Radcliff Park & Brownfield	1,000	140.80	41.0%	$250,000
4-05	Stream Restoration	Holt-Moffitt Field, Radcliff Park & Brownfield	400	89.60	47.0%	$100,000
5-04	Stream Restoration	Schwarz Industrial	2,300	1798.40	20.1%	$575,000
6-07	Stream Restoration	North Town Offices	150	89.60	37.1%	$38,000
9-04	Stream Restoration	Condumex Industrial	940	14.43	55.0%	$234,000
13-07	Stream Restoration	Cedar Lane Drive Industrial	200	7.94	30.0%	$50,000

Summary and Cost Estimates for Additional Potential Projects

Site-SCM No.	Type	Location	Quantity	Cost Estimate[1]
1-03	Tree Planting	Green Needles Drive	11 EA	$500
1-04	Educational Feature	Green Needles Drive	1 EA	$2,500
2-03	Vegetated Buffer	Jaycee Park	11,332 SF	$4,000
2-04	Vegetated Buffer	Jaycee Park	15,564 SF	$5,000
2-06	Educational Feature	Jaycee Park	1 EA	$2,500
4-04	Vegetated Buffer	Holt-Moffitt Field, Radcliff Park & Brownfield	17,514 SF	$6,000
4-06	Educational Feature	Holt-Moffitt Field, Radcliff Park & Brownfield	1 EA	$2,500
5-05	Vegetated Buffer	Schwarz Industrial	27,196 SF	$8,000
6-01	Vegetated Buffer	North Town Offices	5,869 SF	$2,000
6-02	Vegetated Buffer	North Town Offices	9,282 SF	$3,000
9-05	Educational Feature	Condumex Industrial	1 EA	$2,500
10-04	Educational Feature	Estates Drive Residential	1 EA	$2,500
11-11	Educational Feature	Welcome Elementary School	1 EA	$2,500
12-04	Educational Feature	Carolina Drawers Industrial	1 EA	$2,500
13-08	Educational Feature	Cedar Lane Drive Industrial	1 EA	$2,500
14-07	Educational Feature	First Baptist Church	1 EA	$2,500
15-11	Educational Feature	Regents Center	1 EA	$2,500

1 - The Engineer's opinions of probable construction costs are made on the basis of the Engineer's experience and qualifications and represent the Engineer's best judgement as a professional generally familiar with the construction industry. Since the Engineer has no control over the cost of labor, materials, equipment, or services furnished by others, over the contractors methods of determining prices or over competitive bidding or marketing conditions, the Engineer's cannot and does not guarantee that proposal, bids or actual construction costs will not vary from opinions of probable construction costs prepared by the Engineer. Cost estimates include 20% contingency and 30% design and permitting costs.

Section 5: Implementation Plan

The Swearing Creek Watershed Restoration Plan provides a clear strategy for water quality benefits by identifying, policy goals, on-the-ground projects, and other watershed management tools that stakeholders can implement to reduce nonpoint source pollutants. Many of these strategies can be applied immediately following the completion of this plan. Other watershed efforts will require some additional time to coordinate with property owners or other partners, secure funding, and complete construction or policy development.

The following implementation plan provides a detailed schedule for stakeholders to follow as they begin implementing recommended watershed management strategies. This resource is intended to help stakeholders better focus time and resources to provide the greatest overall benefits to watershed health. The implementation plan has been divided into four phases, with *Phase I* and *Phase II* being 5 years in length, while *Phase III* and *Phase IV* are 10 years in length, to ensure a reasonable schedule. Watershed managers should attempt to follow this schedule to the best of their abilities, while also recognizing that there needs to be flexible to adapt to unexpected variables that may come up over the course of the implementation process.

Swearing Creek Implementation Timeline

Phase I (year 5)	Phase II (year 10)	Phase III (year 20)		Phase IV (year 30)	
2018 – 2023	**2023 – 2028**	**2028 – 2033**	**2033 – 2038**	**2038 – 2043**	**2043 – 2048**
Watershed Outreach & Education					
Water Quality Monitoring					
Update Greenway Plan	Phase I of Davidson County Greenway Master Plan		Phase II of Davidson County Greenway Master Plan		
Draft and adopt a Stormwater Ordinance to address non-point source pollutants	Strengthen site design requirements to better protect natural resources	Continue to enforce and improve upon Stormwater Ordinance		Continue to enforce and improve upon Stormwater Ordinance	
Expand Davidson County Watershed Protection Ordinance to protect non-water supply watersheds	Amend Davidson County LDP, Subdivision Regulations, and Zoning Ordinance to discourage sprawl	Seek partners to expand programs that protect rural agricultural land		Continue to invest in open space, farmland, & natural resources	
Order and install informational watershed signage	Establish a stormwater utility fee to help fund top priority restoration projects	Continue stormwater programs and seeking grants to help fund restoration project implementation		Continue stormwater programs and seeking grants to help fund restoration project implementation	
Partner with PTRC to restablish brownfield cleanup program	Develop economic development plan to stimulate redevelopment and protect natural resources	Modify infrastructure improvement plan to meet economic development and watershed restoration goals		Continue to stimulate development that incorporates low impact techniques and minimal stormwater impacts	
Contact NC DWR to schedule an up-to-date bioassessment of Swearing Creek	Establish program to monitor sediment control and IDDE	Continue to monitor sediment control & IDDE		Continue to monitor sediment control & IDDE	
Contact YPDRBA to discuss adding Chlorophyll-*a* as a monitoring station parameter	Seek partnerships through NC DWR, Monitoring Coalitions, and Citizen Science to increase monitoring sites	Assess water quality data to determine success of management programs and adapt accordingly		Assess water quality data to determine success of management programs and adapt accordingly	
Begin contacting property owners to gauge interest in land conservation	Implement Conservation Projects 1, 2, 3, & 4	Implement Conservation Projects 5, 6, 7, & 8	Implement Conservation Projects 9, 10, 11, & 12	Implement Conservation Projects 13, 14, 15, & 16	Begin Identifying Future Conservation Projects
Seek funding sources for top priority restoration projects	Implement Restoration Projects 1, 2, 3, & 4	Implement Restoration Projects 5, 6, 7, & 8	Implement Restoration Projects 9, 10, 11, & 12	Implement Restoration Projects 13, 14, & 15	Begin Identifying Future Restoration Projects

Phase I (2018-2023)

The first five years following this report (2018-2023) will serve as Phase I of the implementation process for the Swearing Creek Watershed Prioritization Plan. Time and resources during this period should primarily be dedicated toward completing foundational work for implementation. This includes: simple policy updates or changes, such as Lexington adopting an NPDES Phase II ordinance or expanding County riparian buffer protections, and contacting property owners and necessary partner to begin laying the foundational work for project implementation. Phase I should also be used to tackle "low-hanging fruit projects" that require minimal funding or technical expertise, but that have substantial impacts on water quality improvements.

Action Steps

1. Draft and adopt a stormwater ordinance to address non-point source pollutants
    - Lexington has begun work drafting an ordinance to meet their NPDES Phase II requirements, which will be adopted shortly following completion of this plan. Although Davidson County does not have similar requirements, they may want to consider adopting similar standards, so that there are consistent natural resource protections throughout the Swearing Creek Watershed.
2. Expand Davidson County Watershed Protection Ordinance to protect non-water supply watersheds
    - Davidson County's existing Watershed Protection Ordinance does not protect non-water supply watersheds, such as Swearing Creek. Davidson County should consider expanding these watershed protections, so that there can be consistent guidelines and riparian buffer requirements throughout the entire watershed.
3. Order and install informational watershed signage
    - Several sites have been identified that would benefit from educational watershed signage. Lexington and Davidson County should continue their stormwater educational programs by installing signage at BMP locations, parks, and other high traffic areas.
4. Partner with PTRC to reestablish brownfield cleanup program
    - This program could help fund redevelopment projects in many of the old mills and other industrial sites within the watershed, providing both economic and water quality benefits.
5. Contact NC DWR to schedule an up-to-date bioassessment of Swearing Creek
    - The most recent biological assessment of Swearing Creek was conducted in 2004. Having more up-to-date information about the status of existing fish communities would help better inform watershed management strategies.
6. Contact YPDRBA to discuss adding Chlorophyll-a as a monitoring station parameter
    - Chlorophyll-a is one of the primary impairments for High Rock Lake, however, this parameter is not being sampled within many of its tributaries. This data would provide a better indicator of water quality conditions and sources of excess nutrients.
7. Begin contacting property owners to gauge interest in land conservation
    - Lexington and Davidson County should partner with conservation groups, such as Davidson County Soil & Water and the Land Trust of Central NC to contact property owners of top priority conservation projects and gauge their interest in donating land for conservation.
8. Seek funding sources for top priority retrofit projects
    - Lexington and Davidson County should seek grant funding to implement the top priority projects that were identified on public property. These could serve as pilot projects to increase awareness about watershed protection efforts.

Phase II (2023-2028)

The second five years following this report (2023-2028) will serve as *Phase II* of the implementation plan. Efforts during this period of time should primarily focus on carrying out recommendations from the Project Atlas. By this time, property owners should have been contacted and funding sources secured in order to ease implementation. As far as project order, it is recommended that stakeholders begin with the highest priority projects, which are primarily located on public land and will have the largest benefits to water quality. Public projects will likely have fewer challenges than private ones and make for an excellent catalyst project. Some initiatives started in *Phase I* will also be continued throughout *Phase II*, such as outreach and education, water quality monitoring, and implementing the Davidson County Greenway Master Plan.

Action Steps

1. Strengthen site design requirements to better protect natural resources
    - There are opportunities within both the City of Lexington and Davidson County's land development ordinances to improve natural resource protections and design requirements. The City of Lexington is currently updating their post-construction stormwater BMP requirements as part of their NPDES Phase II permit. Both jurisdictions should ensure that parking and landscaping requirements are aligned with water quality goals of the watershed.
2. Amend Davidson County LDP, Subdivision Regulations, and Zoning Ordinance to discourage sprawl
    - Making use of existing infrastructure can help save costs of providing public utilities, as well as preserve water resources. Smart growth policies help ensure that communities are able to grow, while making efficient use of existing resources.
3. Establish a stormwater utility fee to help fund top priority restoration projects
    - Grant funding is typically short term and not guaranteed. Lexington and Davidson County should seek to establish a permanent funding structure, such as a stormwater utility fee, to help fund watershed protection measures into the future.
4. Develop economic development plan to stimulate redevelopment and protect natural resources
    - An economic development plan would help create a shared vision for growth within the Swearing Creek Watershed in order to develop strategies to attract new business to the region, redevelop abandoned industrial sights, and protect natural resources.
5. Establish program to monitor sediment control and IDDE
    - NC DEQ currently inspects sediment control measures and IDDE cases, but primarily on a complaint basis, since they do not have the staff or time to monitor all tributaries and construction sites. This, unfortunately, tends to result in poor enforcement. Lexington and Davidson County may want to consider establishing an inspections and enforcement program of their own to help supplement enforcement.
6. Seek partnerships through NC DWR, Monitoring Coalitions, and Citizen Science to increase monitoring stations
    - Accurate water quality data helps determine existing impairments and how effective watershed management strategies are in addressing the issue.
7. Implement Conservation Projects 1-4
    - Lexington and Davidson County should partner with conservation groups, such as Davidson County Soil & Water and the Land Trust of Central NC, to secure conservation easements within the top 4 project areas.
8. Implement Restoration Projects 1-4
    - Lexington and Davidson County should prioritize projects on public property and secure grant funding to support a few pilot projects within this time.

Phase III (2028-2038)

The second ten years following this report (2028-2038) will serve as *Phase III* of the implementation process. This phase is primarily dedicated toward continuing implementation of the Project Atlas, analyzing the effectiveness of previous projects, and ensuring that a sustainable program for water quality improvements is established. In order to accomplish these goals, water quality data will need to be reassessed and efforts will need to be made to create an ongoing funding stream for future water quality projects. During this time, local governments should also seek to update their infrastructure improvement plans to ensure they are aligned with newly developed economic development and watershed restoration goals. Priority should be given to update aging/failing wastewater and sewer pipes and limit sprawl.

Action Steps

1. Continue to enforce and improve upon stormwater ordinance
    - By this time, ordinance updates should have occurred and should only require continued enforcements. Other updates may occur over time as new solutions arise.
2. Seek partners to expand programs that protect rural agricultural land
    - Some state tax credit programs for conservation have ended in recent years. Davidson County should establish a Farmland Preservation Committee to help inform farmland protection policies and consider providing local tax benefits for such programs.
3. Continue stormwater programs and seeking grants to help fund restoration project implementation
4. Modify infrastructure improvement plan to meet economic development and watershed restoration goals
    - After an economic development plan and shared vision for growth has been established, local governments can modify their infrastructure improvement plans accordingly. This will help preserve existing resources and reduce impacts within the watershed.
5. Continue to monitor sediment control & IDDE
6. Assess water quality data to determine success of management programs and adapt accordingly
    - After the first 10 years, it will be beneficial to reevaluate water quality data to ensure that water management projects are achieving water quality benefits.
7. Implement Conservation Projects 5-12
8. Implement Restoration Projects 5-12
    - These projects are primarily on private land, which will likely require negotiation and effective outreach and education. Some grant funding may be available to help leverage private improvements.

Phase IV (2038-2048)

The next ten years (2028-2038) will serve as *Phase IV* of the implementation process. This phase is primarily dedicated toward completing implementation of the Project Atlas, determining whether watershed management programs have been effective, and identifying future projects within the watershed. In order to accomplish these goals, stakeholders will need to continue to secure funding for restoration projects and reassess the watershed to gauge its overall health.

Action Steps

1. Continue to enforce and improve upon stormwater ordinance
2. Continue to invest in open space, farmland, & natural resources
3. Continue stormwater programs and seeking grants to help fund restoration project implementation

4. Continue to stimulate development that incorporates low impact techniques and minimal stormwater impacts
5. Continue to monitor sediment control & IDDE
6. Assess water quality data to determine success of management programs and adapt accordingly
7. Implement Conservation Projects 13-16 and begin identifying future conservation projects
8. Implement Restoration Projects 13-15 and begin identifying future restoration projects

Funding & Financial Assistance

Locating available funding sources is a critical component of any implementation process. While some of the proposed management measures are relatively inexpensive, such as crop conversion and other non-structural BMPs, watershed restoration can be an expensive undertaking. In addition, local government budgets are typically strained by a variety of sources. Thus, it is beneficial to locate potential streams of funding early on to help leverage local funding.

One potential source of funding is local, state, and federally administered grants – many of which are specifically designated for projects that improve water quality. Some of the most commonly used grants for water quality projects include:

§319 Grant Program

Through the Section 319 Grant Program, the U.S. Environmental Protection Agency provides states with funding to reduce nonpoint source pollution. Funds may be used to implement watershed restoration projects, such as stormwater and agricultural best management practices or stream restoration. Projects must benefit waterbodies that are currently impaired by nonpoint source pollution (303(d) listed) and be in an area with an approved watershed restoration plan, which, once approved, the Swearing Creek Watershed Restoration Plan will qualify for. §319 grants require 40% match.

Clean Water Management Trust Fund (CWMTF) Grants

The Clean Water Management Trust Fund provides grant assistance to conservation non-profits, local governments and state agencies for the protection of surface waters in North Carolina. CWMTF funds projects that (1) enhance or restore degraded waters, (2) protect unpolluted waters, and/or (3) contribute toward a network of riparian buffers and greenways for environmental, educational, and recreational benefits, (4) provide buffers around military bases to protect the military mission, (5) acquire land that represents the ecological diversity of North Carolina, and (6) acquire land that contributes to the development of a balanced State program of historic properties. Match varies depending on the project, but is recommended to be at least 40-50% for projects to be competitive.

Another commonly used funding stream for watershed restoration projects is a stormwater utility fee. This is similar to water, sewer, or other utility fee and is used to support the construction, operation, and maintenance of a stormwater system, which can include constructed BMPs. Rates are typically assessed based on the amount of impervious surface on a property. While some counties have adopted such fees, they are more commonly used in incorporated areas, where development is more concentrated.

A comprehensive list of financial resources, including grants, cost shares, and loans, has been compiled by NCDWR's Use Restoration Watershed Program in order to aid water quality project implementation. This list can be found at https://deq.nc.gov/about/divisions/water-resources/planning/basin-planning/use-restoration-watershed-programs/funding.

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