NORTH CAROLINA
Department of Environmental Quality

2.6 3.15

Subtask 3.15: Recommendations for Developing and Maintaining Local Stormwater Management Programs

North Carolina Flood Resiliency Blueprint

Prepared for the North Carolina Department of Environmental Quality by AECOM

July 2024

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Acronyms

ARPA – American Rescue Plan Act

BMP – Best Management Practice

DWI – Division of Water Infrastructure

DWR – Division of Water Resources

EFC – Environmental Finance Center

ERU – Equivalent Residential Unit

LASII – Local Assistance for Stormwater Infrastructure Investments

MS4 – Municipal Separate Storm Sewer System

NC – North Carolina

NCDEQ – NC Department of Environmental Quality

NCDOT – NC Department of Transportation

RBA – River Basin Association

SCM – Stormwater Control Measure

SWIA – State Water Infrastructure Authority

TAG – Technical Advisory Group

UNC-CH – University of North Carolina at Chapel Hill

WRRI – Water Resources Research Institute

Definitions

A comprehensive list of definitions applicable to multiple Flood Resiliency Blueprint documents is provided in a separate document.

- **Stormwater Control Measures**: “permanent structural devices that are designed, constructed, and maintained to remove pollutants from stormwater runoff before the water reaches our streams and drinking water supply reservoirs.” (NCDEQ)
- **Retrofits**: “SCMs that provide nutrient and/or sediment loading reduction from existing development that is currently untreated or is inadequately treated by an existing SCM. Besides providing stormwater treatment, retrofits can help alleviate flooding and erosion problems, and some can become an attractive community amenity.” (NCDEQ Stormwater BMP Manual 2017)
- **Floodplain Management**: a community-based effort to prevent or reduce the risk of flooding, resulting in a more resilient community. (FEMA)

1 Local Stormwater Maintenance Programs

This report provides recommendations for developing and maintaining local stormwater management and maintenance programs associated with developing the North Carolina (NC) Flood Resiliency Blueprint (Blueprint). The recommendations include the level of resources required to maintain these programs, possible funding sources, and ways to address the funding gaps of small, under-resourced communities.

1.1 Background of Stormwater Management and Maintenance Program Development

Previous work under the following subtasks was considered a basis for the recommendations herein. As discussed in these previous subtasks, stormwater maintenance programs are essential for protecting the success of flood resilience projects.

- **Subtask 1.1** - Literature Review and Data Collection Inventory
- **Subtask 1.4** - Catalogue of Government and Organization Watershed Planning Efforts in the Neuse River Basin
- **Subtask 1.7** - Statewide Planning Efforts with Flood Resilience Recommendations
- **Subtask 2.6** - Flood Risk Reduction Project Funding Analysis
- **Subtask 2.9** - Project Restrictions Analysis (forthcoming)

Stormwater programs ensure drainage systems remain clear and functional, reducing the risk of blockages and overflow from heavy rainfall. This proactive management can reduce the impacts of flooding by protecting infrastructure and safeguarding communities from flood-related damages. However, due to their complexity and cost, they can be challenging to organize and finance.

Stormwater maintenance programs can provide oversight and ongoing maintenance of a community's various stormwater-related responsibilities, such as storm drainage, water quality regulations, retrofits, floodplain management, and open space amenities. Any one of these functions can involve multiple local government departments or entities responsible for urban drainage, floodplain management, stormwater quality regulations, parks and open space, and transportation. Communities use stormwater maintenance programs to achieve multiple sustainability, quality of life/livability, and flood resiliency goals. However, incorporating flood resiliency goals can be a complex process with the potential to add additional challenges if mismanaged.

Stormwater maintenance programs generally follow one of two funding management approaches for storm drainage, water quality, mitigation of land-use impacts, and floodplain management, including:

1. The tax-supported public works model
2. The fee-based stormwater utility model

The tax-supported public works model generates funding through local government-levied tax revenue. This approach has the challenge of competing with other departments for tax funding; however, it may not receive public criticism for charging a fee or a "rain tax." Recent stormwater utility data collected by the Environmental Finance Center (EFC) at the University of North Carolina at Chapel Hill (UNC-CH) in 2023 reported the average service population of a jurisdiction using a tax-supported public works model to be approximately 25,800. Conversely, the stormwater utility model generates revenue through fees charged to properties that are part of the municipality's stormwater system. The stormwater utility model enjoys having a relatively stable funding source (stormwater fee) but also incurs the additional administrative costs and burden of setting up and maintaining the billing and collection data associated with charging a stormwater fee. The average service population of approximately 53,000 for communities using a fee-based model, more than double the size of communities using a tax-supported public works model, reflects the burden of additional costs and staff required to operate this funding management approach. The fee-based model typically uses one of three different fee structure types: flat fees, tiered flat fees, or uniform rates.

1. **Flat fees** charge all properties the same fee, regardless of land use/imperviousness, and have the benefit of reducing data collection and administrative costs.
2. **Tiered flat fees** are charged to properties based on the estimated impervious surface area of the parcel, which is grouped into different tiers.
3. A **uniform rate**, also called an Equivalent Residential Unit (ERU), is like tiered flat fees in that it charges properties based on impervious surface area. Unlike tiered flat fees, uniform rates are determined by dividing the impervious surface area of a property by a standard measure of expected runoff based on the property's land uses and then multiplying that by the monthly fee per ERU.

Each financing structure can have one of four billing periods: bi-monthly, monthly, semi-annually, and annually. The distribution of stormwater fee structures by the fiscal year 2022-23 billing period can be reviewed by land use type in **Figure 1** below.

It is essential to point out that a hybrid approach can be taken. There is no prohibition of charging a stormwater fee to generate revenue to support a tax-supported public works department. Care must be taken to ensure the revenues generated from the stormwater fee cover costs associated only with the operation and maintenance of the stormwater system.

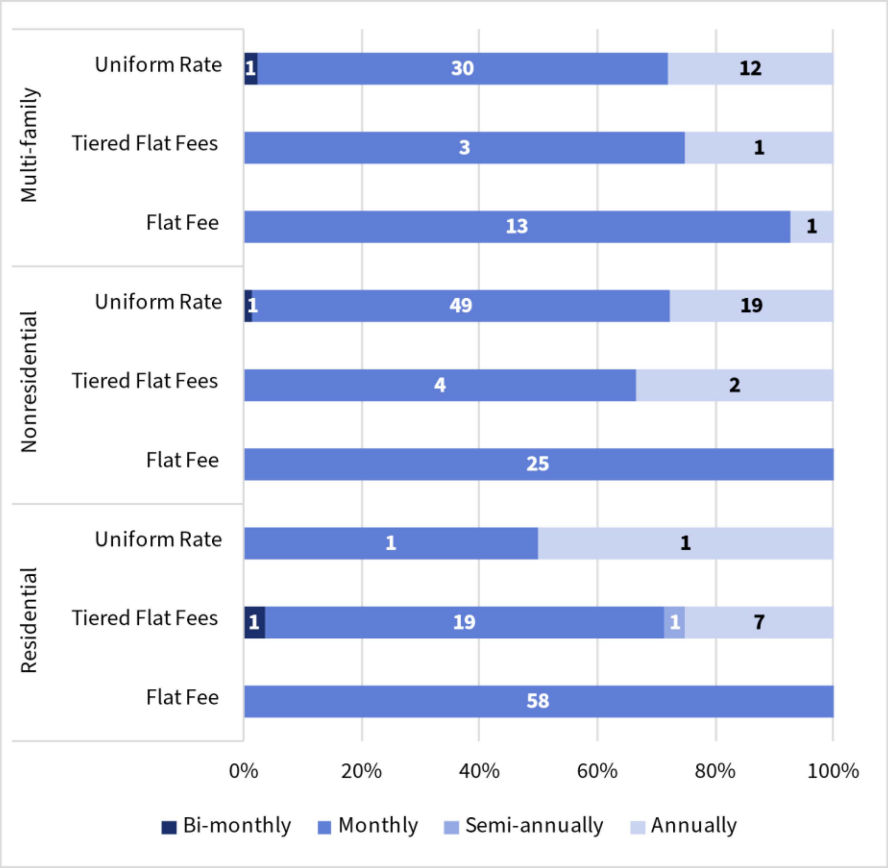

Figure 1. Distribution of stormwater fee structures in NC communities by billing period (UNC-CH EFC 2023)

Stormwater utility data collected by UNC-CH EFC in 2023 reported billing methods based on 93 reporting utilities; of these, 64 charge their customers through a combined utility bill (fee-based model), 21 charge for their services on the customer's property tax bill (tax-supported model), and an additional eight utilities send separate stand-alone bills; the latter broadly represents counties and municipalities where other utilities, such as water, sewer, or electric, may not be offered (UNC-CH EFC and NCDEQ-DWR 2020; Sanchez 2023). Five of the six large Municipal Separate Storm Sewer Systems (MS4) regulated under Phase I of the National Pollutant Discharge Elimination System in NC – Fayetteville being the exception – have implemented the fee-based stormwater utility model (**Figure 2**). Of the 73 medium-sized MS4 communities included in Phase II, a majority (47) use utility bills, compared to only 13 Phase II communities that use property tax bills. All four reporting counties (Camden, Granville, Mecklenburg (unincorporated), and Person) use stand-alone utility billing.

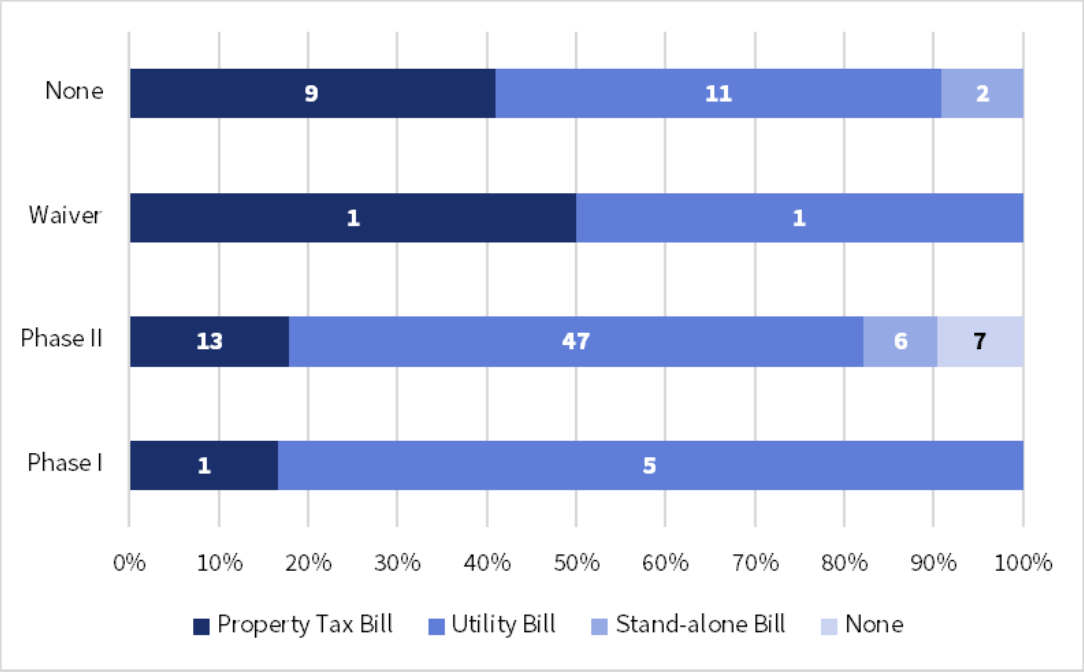

Figure 2. Fee collection methods used by MS4 permit communities in NC (UNC-CH EFC 2023)

The costs to maintain, repair, and eventually replace stormwater infrastructure can be substantial depending on the number and types of stormwater assets. Developing and financing robust programs can pose significant challenges in small communities where these costs represent a significant portion of a municipality's operating budget. When planning for stormwater asset maintenance, communities must consider the types of stormwater infrastructure, routine and restorative maintenance costs, personnel and training requirements, service life, and eventual replacement costs. Key considerations are included in the following sections.

1.1.1 Maintenance Activities

Different stormwater assets (e.g., pipes, culverts, inlets, etc.) and stormwater control measures (SCMs) require different maintenance to meet their intended functions. Maintenance of stormwater assets and documentation of standard maintenance procedures are requirements for permitted MS4s. Personnel performing inspection and maintenance should be familiar with the specific requirements for each inspected asset and device, including maintenance activities, equipment, and frequency. Resources allocated for stormwater maintenance activities should consider staff training and/or certification expenses. Common maintenance issues and related activities for NCDEQ-approved SCMs can be reviewed in **Table 1** below. Additional specific maintenance tasks for common NCDEQ-approved SCMs (Hunt, Waickowski, and Lord 2021) can be reviewed in **Table 4** of the Appendix.

Table 1. Common maintenance issues and tasks for NCDEQ-approved SCMs

SCM Element	Issue	Maintenance Task
Entire SCM	Trash/debris present	Remove trash/debris
Perimeter of SCM	Areas of bare soil and or erosive gullies; surrounding vegetation (if applicable) is too short or too long.	Regrade the soil to remove the gully, plant, and water ground cover until established, and apply a one-time fertilizer.
Inlet device (pipe or swale)	A pipe is clogged or damaged (e.g., cracked); erosion occurring in swale	Unclog or replace pipe; regrade swale and provide erosion control devices
Forebay or pretreatment area	Sediment accumulation reduces the depth to 75% of the original design depth or depth greater than six inches; erosion occurs, or riprap is displaced; weeds are present; runoff bypasses pretreatment.	Identify the sediment source and remedy; remove and dispose of sediment; provide additional erosion control devices; remove plants by hand; regrade to direct runoff to the pretreatment area.
Main treatment area	Visible layer of accumulated sediment; standing water for more than five days after storm event (SCM dependent)	Identify sediment source and remedy; remove and dispose of sediment; replace the top few inches of media and revegetate; consult a professional if the issue persists.
Embankment	Shrubs or trees present; rodents present; annual inspection shows need for repair	Remove shrubs or trees; use traps to remove rodents; make necessary repairs.
Outlet device	Clogging: the device is damaged	Unclog the device; repair or place the device
Receiving water	Erosion or other signs of damage have occurred	Contact the NC Division of Water Resources (NC DWR)

1.1.2 The Costs of SCM Maintenance

When budgeting for stormwater asset maintenance and replacement, communities should consider replacement cost, estimate service life, and set up a fund to budget for eventual asset replacement spread across the expected service life. The total annual budget for the stormwater asset or facility would incorporate anticipated yearly inspection and maintenance costs plus the annual replacement budget spread across an asset's service life.

A 2021 study by researchers at the North Carolina Water Resources Research Institute (NC WRRI) reported maintenance costs for SCMs in NC (see the **Appendix** – **Tables 7-11**) for common SCM cost estimates in dollars per acre of SCM site). The study also cited relevant cost considerations and various reporting methods for annual operation and maintenance costs (e.g., as a percent of construction cost, as a function of SCM drainage area or footprint, etc.) for NC and other geographies (Hunt, Waickowski, and Lord 2021). A summary of annual routine maintenance costs, inflation-

adjusted to 2023 dollars, from the NC WRRI study can be reviewed below in **Figure 3**. These costs include labor, equipment, and material considerations. The study also found that private contractors or multiple municipal departments usually maintain municipal SCMs. Further, larger municipalities often share maintenance responsibilities across departments, making collecting and tracking costs more challenging. Smaller, more resource-limited communities with fewer staff may be more likely to hire private contractors to perform stormwater maintenance activities.

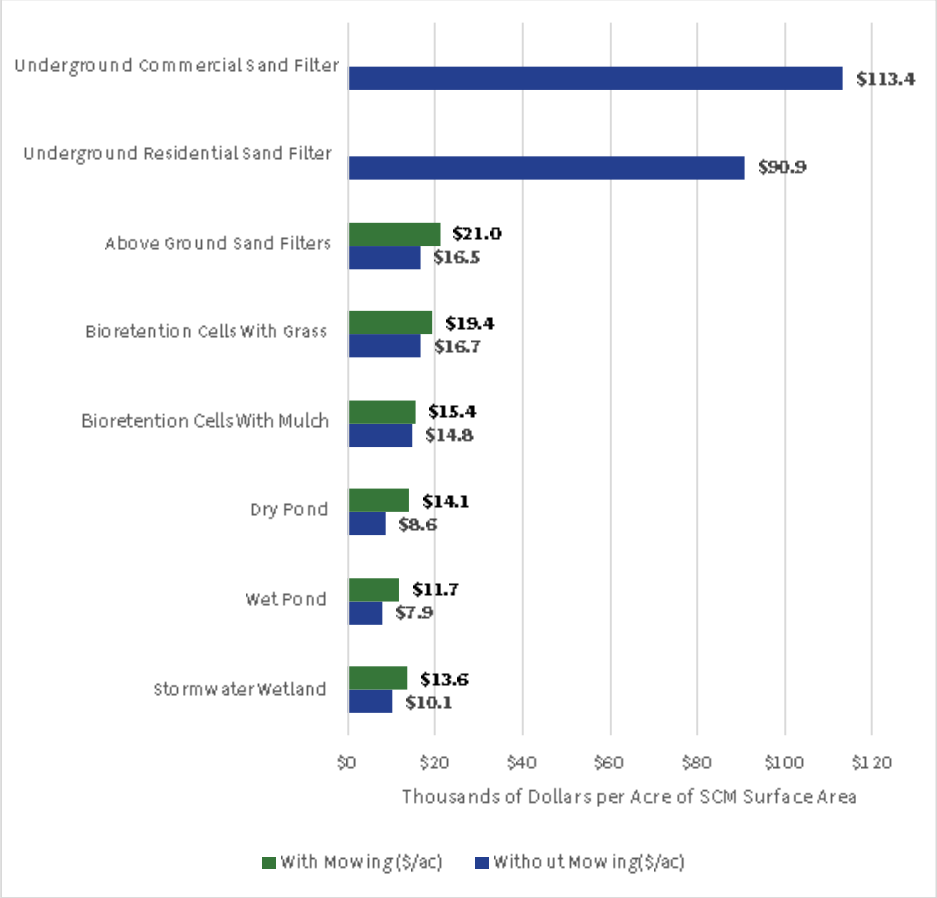

Figure 3. Annual routine maintenance costs of common NC SCMs (inflation-adjusted to 2023 dollars)

1.1.3 Maintenance Strategies

Annual costs to maintain stormwater assets such as SCMs should consider routine (i.e., preventative/proactive) and restorative (i.e., remedial, more significant, and typically more costly) maintenance (**Figure 4**). Routine/preventative maintenance represents general, usually relatively low-cost, and more frequent upkeep, such as trash removal, mowing, and mulching; routine maintenance activities are intended to prevent the costliest maintenance and/or replacement activities. Restorative maintenance includes relatively more costly tasks to restore an SCM or other stormwater asset's functionality, often due to a lack of proper or routine maintenance. It should be

noted that in the context of this report, with or without mowing refers to mowing an SCM's surrounding landscape. Mowing the surrounding landscape of an SCM is a common maintenance practice. However, the practice is more applicable to certain SCMs than others. For example, mowing is commonly conducted around wet and dry ponds to ensure typical landscaping activities do not negatively impact the ponds and that the immediate upstream watershed remains stable.

In contrast, stormwater wetlands tend not to have perimeter mowing due to the different ecological sensitivities, soil conditions, and intended functions. In the case of bioretention cells, cells with grass refer to the estimated cost of mowing both the SCM's surrounding landscape and the SCM's interior area. Bioretention cells with mulch slightly reduce the overall maintenance cost as only the surrounding landscape would be mowed, excluding the mulched interior area of the cell. Though the routine maintenance activity of mowing is relatively inexpensive compared to proactive and restorative practices, mowing can be a major cost consideration. As this report provides estimated costs and common proactive, routine, and restorative maintenance practices, the cost associated with these practices will depend on the implementor's intended function for the SCM in question and requires site-specific details to determine.

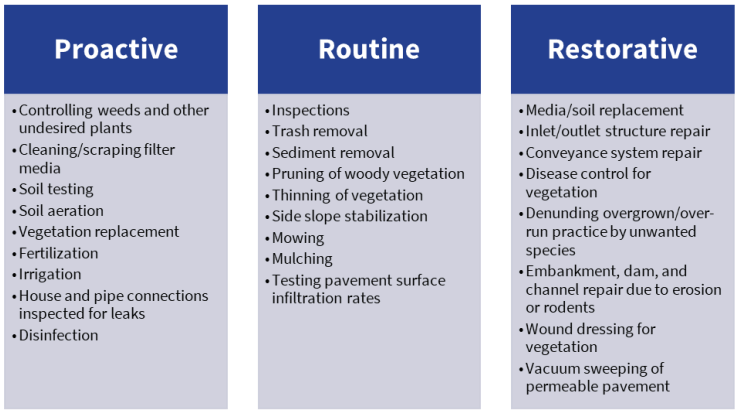

Figure 4. Maintenance activities by strategy type (Hunt, Waickowski, and Lord 2021)

In addition, merging services into an existing program, from parks to open spaces and sustainability components, necessitates different paradigms for financing. The merged stormwater program development and funding decisions must consider both discretionary and mandated services as well as the following key components necessary to develop and maintain a stormwater maintenance program:

- Planning efforts and stakeholder engagement (e.g., impacted communities, experts, etc.)
- Basin-specific knowledge
- Community-specific knowledge (e.g., hazards, vulnerability, economic conditions, etc.)
- Data and modeling
- Understanding of state and federal requirements and restrictions
- Stormwater retrofits that fit the individual community needs and challenges
- Inspection, maintenance, and operations for stormwater retrofits
- Technical training and certification

- Staffing, resource administration, and allocations
- Identify long-term program funding and provide funding administration and assistance

Generally, the most common process for considering whether to fully or partially fund a local stormwater program is as follows:

- Establish an advisory committee or similar diverse group to advise the elected officials during and at the end of the process
- The advisory committee defines the following in an iterative process:
    - **Extent of Service**: this is the geographic area where the stormwater program will provide services (watershed(s), municipality-wide, county-wide, etc.). State General Statute has restrictions when there is more than one entity providing stormwater services within the same jurisdiction.
    - **Level of Service**: to what degree services are provided by the public system is determined in this step. Are all services provided just within the road right-of-way, outside the right-of-way, both, etc.? Are some services only available outside the right-of-way, like maintenance of SCMs?
    - **Cost of Service**: how the fees are calculated (flat fees, tiered fees, and uniform rate/ERU), and the billing system (included in the annual tax bill, municipal services bill, or water-sewer bill) are usually identified in this step.
- The advisory committee and local government staff report back to elected officials with progress and recommendations. The elected officials can support the recommendations, modify them, and then provide additional direction to the advisory committee and staff on the next steps. Another option for this step is for the elected officials to decide not to pursue a stormwater fee.
- Local government staff, contractors, or a combination of the two, create draft stormwater ordinances that codify policy decisions to date and provide more specifics on stormwater fees – for example, the stormwater fee credits, waivers, or exemptions that will be provided and under what conditions these are provided.
- Elected officials consider adopting the draft stormwater ordinance and endorse staff recommendations on staffing and organizational structure of the stormwater program.

Refer to previous sections under Task 2 for specific details and context of areas and items listed above.

- **Subtask 2.6:** Flood Risk Reduction Project Funding Analysis
- **Subtask 2.9:** Project Restrictions Analysis

Given stormwater maintenance programs' complexity and operation costs, from basic drainage networks to complex multifunctional systems, the two standard funding approaches may not be practical for small, under-resourced communities. Therefore, in alignment with the Blueprint's goal of building flood resilience statewide, the following recommendations are made to provide a development process for stormwater maintenance programs and activities that apply to NC communities of all sizes and compositions.

2 Recommendations

2.1 Funding Recommendations

Local governments face various choices when organizing stormwater maintenance programs; no single model fits every community. The program's organization will depend on the community's values and the conditions (good, failing, aging, undersized, etc.) of its utilities and public works services. Smaller programs that address limited functions like drainage and water quality services would be easier to finance with user charges than full-featured programs that include floodplain management, parks, and recreation.

Combining stormwater, floodplain management, and community services creates challenges for policymakers who work with impacted property owners in communities where the economics of stormwater programs blend the financing and floodplain management of excess water. Drainage can be individual when attached to single parcels, but further down the line, the stormwater runoff becomes increasingly public as it serves larger areas. Stormwater quality is a mandated environmental service impacted by a mixture of public and private sector facilities. Floodplain management considers public and private interests by benefitting individual properties and the wider community.

Below are recommendations to provide funding support for the development and/or maintenance of stormwater maintenance programs across NC. These recommendations apply to NC communities of all sizes and compositions as well as regional organizations composed of multiple local, county, and/or NGO organizations.

2.1.1 Recommendation 1: Develop Standard Finance Methods

Program finance depends on the community size, resources, scale of operation, organization, approach to taxation, and use of fees. Generally, using fees has the advantage of creating a new revenue stream to relieve the burden on general taxes. Although community members still pay the charge, it assigns charges according to the impact an individual property has on the community. The following are recommended potential standard finance methods that can be used during the program development stage:

4. Traditional methods:
    - Tax-supported public works model
    - Fee-based stormwater utility model based on impervious area
5. Alternatives or modified methods:
    - Municipal development of a small storm drain fee by rate-setting. The community would use water service bills with a rate schedule based on land uses, and area use multipliers for impervious areas that exceed the community's stormwater, development, and/or other governing ordinances. This water service bill rate schedule would also be adjusted based on

indicators of vulnerable and under-served communities. Following this approach, communities can link land use decisions to charges and influence the shape and sustainability of the community.

- Municipal development of a fee-based stormwater utility with maintenance and operations where stormwater control measures or infrastructure fees paid by private development are required for municipalities to take over ownership.
- Development of a stormwater enterprise utility in a community, in multi-communities, for a regional area, or an entire basin or watershed.
    - A **stormwater enterprise utility** is where a town, city, regional government, etc., establishes a dedicated fund to be used only for stormwater work. The fund is supported through a fee collected at regular intervals (often quarterly) from individual properties to recover the cost of safely collecting, conveying, detaining, treating, and disposing of stormwater. This enables stormwater enterprise utilities to operate independently from general fund appropriations, supporting consistent operations that are essential for the long-term monitoring and maintenance requirements of operating stormwater infrastructure.

2.1.2 Recommendation 2: Develop Supplemental Finance Methods

In jurisdictions where fees are not feasible, creating supplemental finance methods can reduce the financial burden for smaller, under-resourced communities while maintaining and supporting the long-term needs of the stormwater maintenance program. Potential methods can include one of the following:

- Develop a supplemental finance method similar to the State Street-Aid (Powell Bill) Program or increase the Powell Bill Program amounts based on the community stormwater program's SCMs. The Powell Bill Program provides state aid to municipalities to resurface streets annually. 75% of the funding is based on population, and 25% is based on the number of municipality-maintained street miles. In 2022, the total appropriation for the program was $154,891,601, with an average appropriation to municipalities of $305,000 (NCDOT 2022).
- Develop supplemental local stormwater credit trading systems that fund stormwater control measure maintenance, expansion, or new measure development. The concept is that a stormwater credit trading system is established where negative, unavoidable impacts to stormwater systems occur because of the increased volume of stormwater runoff. Increasing the volume of stormwater runoff subsequently increases the severity or frequency of local flood events due to the impacts of new developments (residential, commercial, highways, airports, etc.). Like water quality-oriented mitigation banking, developers purchase credits from a local or regional government managing the bank to offset their impacts on the community's stormwater system. These credits are created through the activities of other property owners who voluntarily installed or retrofitted SCMs on their properties (on-site) at relatively low costs or by the governing body that operates the trading program with the intention of selling stormwater credits. The resulting revenue would then be dedicated to implementing, maintaining, and

expanding/enhancing new and existing SCMs. Care should be taken to implement offsetting measures in the same eight-digit hydrologic unit codes (HUCs) where the impacts occurred, mirroring the United States Army Corps of Engineers regulations for water quality-oriented mitigation banking. Limiting the sale and purchase of these credits to eight-digit HUCs ensures that the cumulative impacts of development for which the credits are offsetting, directly mitigate the impacts to stormwater systems. The District of Columbia's (D.C.) Department of Energy and Environment was established in 2013 as one of the first volume-based stormwater credit trading programs in the U.S. A more recent example of a municipal, volume-based credit trading program is the City of Grand Rapids, which established its program in 2023. In partnership with American Rivers, a nonprofit organization, the city established the program in concert with developer-responsible mitigation and an in-lieu fee in response to a revision of the municipal separate storm sewer system (MS4) individual permit that increased requirements for development and redevelopment projects (US EPA 2023).

    - For more information on stormwater credit trading programs, please review *Establishing a Stormwater Volume Credit Trading Program: A Practical Guide for Stormwater Practitioners* (2019), which Stormwater Currency, a group of stormwater project financing experts, prepared. Stormwater Currency's guide can be found through the link below.
    - https://www.americanrivers.org/wp-content/uploads/2019/09/AR_StormwaterVolumeCreditTrading_Final.pdf

- Develop a priority funding mechanism/finance method for a yearly basin or watershed mitigation project for each region across the state. This could be modeled after multiple programs, but the Superfund – Inactive Hazardous Sites program could be used as a guide. Such a program could be developed where previous SCMs no longer function due to lack of maintenance and are assessed and ranked. NCDEQ, or another state agency responsible for managing the program, would receive and allocate the annual funding to address the deficiencies of the SCM and develop a comprehensive maintenance (asset management) plan that includes a responsible party. Initially, the Flood Resiliency Blueprint Tool should be used to rank the action (project), and this primary funding mechanism will be identified when a funding strategy accompanies each action. Over time, modifications to this new program should be considered if actions to rehabilitate SCMs in under-resourced communities consistently receive low rankings and/or actions are not implemented due to a lack of resources (staff).
- Include the development or updating of stormwater inventories as an eligible activity for Blueprint funding, prioritizing regional/multi-county/multi-community data collection and inventory development proposals in support of Recommendation 9: Support the Development of Regional Stormwater Utilities and Partnerships of this report and Recommendation 4.6.3, Implement Multiple Finance and Organizational Approaches to Address Local Stormwater Programs from the Draft North Carolina Flood Resiliency Blueprint.

2.1.3 Recommendation 3: Develop Funding Support

Establish a repeatable, long-term statewide methodology for funding stormwater programs, including small, under-resourced communities. Community policymakers seek organizational structures that make sense to them and are affordable through workable financial arrangements. Provide options to the communities for funding key aspects of their programs, such as planning, design, implementation, and sustainability. Recommended activities include:

- Develop direct contact from the state by basin or region. Establish basin-level or regional contacts, identify funding resources for local communities, and assist with funding proposals.
- Work with participating communities that have received Blueprint funding to develop asset management plans for the planning, design, construction, and/or maintenance of SCMs. Given the best available data, these plans should include a detailed accounting of the estimated operation and maintenance costs over the SCM(s) 's service life. As a component of the long-term costs of SCMs, financial assurances should be made and detailed in the asset management plan to ensure the project maintains the necessary fiscal resources to realize its maximum service life. Financial assurances are often made through bonding or insuring the stormwater assets to ensure the project sponsor can cover the costs associated with long-term maintenance, repairs, and potential liabilities.
- Assume economic responsibility for the assurance of Blueprint-funded SCMs where an accepted project sponsor does not have the financial resources to adequately demonstrate their ability to maintain the SCM to its full-service life. In circumstances where the Blueprint has approved a community's request for funding, but that community meets certain economic and social criteria (to be determined by NCDEQ) that indicate the applicant does not have the financial capacity to assure the proposed SCM(s) over its long-term service life, NCDEQ would assume economic responsibility for bonding or insuring that Blueprint funded SCM. The Blueprint can mitigate some risks associated with assuming this kind of financial responsibility by providing surety bonds. In long-term stormwater operation and maintenance, a surety bond is a financial guarantee ensuring that the stormwater utility or developer maintains and operates the stormwater facilities according to required standards. If the responsible party fails to meet these obligations, the surety company covers the costs, providing financial assurance and risk mitigation for the entity requiring the bond, i.e., NCDEQ. This bond protects public interests and environmental quality by ensuring proper long-term maintenance of stormwater systems.
    - One example similar to Blueprint's proposed financial assurance strategy for stormwater-related actions is the City of Raleigh, NC's Sediment and Erosion Surety process. Raleigh's "Sediment and Erosion (S&E) Surety process applies when a developer requests to receive a permit for land disturbing for a site either through a Mass Grading Permit, Building Permit, or a Site Permit. The purpose of the surety is to protect downstream property owners from erosion in the event work stops on the site, and the applicant is no longer able to maintain Erosion Control measures. The surety will cover permanent stabilization for the disturbed area permitted." (City of Raleigh 2024)
- Provide a contact for assistance with funding administration.

- Develop a simple state audit process for the local stormwater program financials that can be used for federal and state grant funding submittals.
- Assist the community with developing community landscape documentation for funding activities.

2.1.4 Recommendation 4: Provide Grant Opportunities to Establish Stormwater Program(s)

In 2021, the NC General Assembly appropriated $1.69 billion from the state's allocation of the American Rescue Plan Act (ARPA) for drinking water, wastewater, and stormwater investments in Sections 12.13 and 12.14 of the Current Operations Appropriation Act of 2021 (Session Law 2021-180). Approximately $100.5 million was allocated for stormwater projects in the Local Assistance for Stormwater Infrastructure Investments (LASII) fund. NCDEQ's Division of Water Infrastructure (DWI) was charged with administrating these monies, of which approximately $82 million was allocated to fund projects for improving and/or creating infrastructure for controlling stormwater quantity and quality. Grant types available from the LASII fund included construction grants (approximately 70% of allocated funding) and planning grants (approximately 30% of allocated funding). Implementing a stormwater utility was also an eligible use of LASII funding through stormwater construction funds.

Funds were awarded to eligible municipalities through DWI's competitive funding process. In partnership with the State Water Infrastructure Authority (SWIA), DWI established a Priority Rating System for stormwater infrastructure investments based on federal and statutory requirements and stakeholder input. Through the LASII program, DWI awarded approximately $75.7 million in its Fall 2022 funding round and an additional $6.3 million in its Spring 2023 funding round across 95 projects.

It is essential that the Blueprint develop funding support focused on supporting NC communities that would otherwise be unable to implement or effectively maintain a flood-resilient stormwater maintenance program. To this effect, the LASII program has two eligibility requirements, including 1) a documented stormwater quality or quantity issue and 2) demonstrating that the community would experience significant hardship raising the revenue necessary to finance stormwater management activities within its jurisdiction. Under LASII, significant hardship is defined as those communities meet the following standards:

- For applications for Stormwater Construction and Stormwater Planning Grants (except applications to develop and implement a new stormwater utility)
    - City/County has a stormwater enterprise fund and an operating ratio of less than 1.00, **OR**
    - At least two of five Local Government Unit Indicators **Table 2** for a city or county are worse than state benchmarks **OR**
    - Entity does not meet the criteria but has stormwater projects that serve or benefit disadvantaged areas within its jurisdiction
        - 75% or more of project cost must be used to serve or benefit disadvantaged areas
- For applications to develop and implement a new stormwater utility

- If the city or county does not have a stormwater enterprise fund and the application is to develop and implement a new stormwater utility
- Will have met the requirement to demonstrate significant hardship
- Grant amount will be limited based on the number of Local Government Unit Indicators that are worse than state benchmarks

Table 2. The LASII program's Local Government Unit Indicators for Spring 2024 applications

Local Government Unit Indicator		State Benchmarks
Population Change	< =	3.13%
Poverty Rate	> =	13.70%
Median Household Income	< =	$60,516
Unemployment Rate	> =	4.90%
Per Capita Appraised Value of Property	< =	$133,264

Because of these eligibility criteria and the Priority Rating System developed around them, it may be argued that an early success of the LASII program was its prioritization of allocation of available funds towards small, under-resourced, and/or disadvantaged communities and towards addressing stormwater-related water quality and/or quantity issues that directly benefit those communities.

In agreement with one of the Blueprint's main objectives, aligning with and supporting existing programs in the state that work in flood resilience, it is recommended that the Blueprint adopt a similar method to that of LASII to identify stormwater management program funding gaps and allocate resources to fill those gaps in small, under-resourced communities. An extension of the LASII program —or re-envisioning of LASII into a similarly structured funding program specifically framed around the goals of the Flood Resiliency Blueprint—would provide a vehicle for federal and/or state investments to implement some of this report's recommendations on a broader scale that prioritizes under-resourced and underserved municipalities of the state.

2.1.5 Recommendation 5: Technical Advisory Group (TAG) Request to Develop a Centralized State Funding Site

Previous tasks included commentary from TAGs requesting a central funding site for easy access, navigation, and resources. The recommendations include the following:

- Develop a central state funding page.
- Consider accessibility requirements for site login and navigation.
- Use a singular point of reference for all funding sources.
- Connect to federal and state databases.
- Develop a simplified single-page printout with funding data for the community.

2.2 Planning, Data, and Maintenance Recommendations

2.2.1 Recommendation 6: Develop Planning Support

The first step in developing a stormwater maintenance program or considering modifications to an existing program because of significant investments in resilience like the Blueprint is determining what to include, which requires state assistance and funding. Developing state-level, basin-specific stormwater programs to address the local communities' everyday needs would establish a basis for the community as a starting point that can then be used to build an individual stormwater program or a regional group of local stormwater programs that have common interests and a desire to collaborate. The state-level plans should center on basin-wide issues. It is recommended that the state basin-specific plan be developed and funded by the state so that individual communities are not burdened with funding plans that stretch across the basin.

The communities can use the information developed in the plans to determine which state funding and other opportunities to pursue by referencing the basin program requirements and regulations. In addition, it is recommended that:

- Assistance will be provided to local community stakeholders through public input sessions.
- Funding should consider the community members most affected by the conditions and ensure they are willing and able to support the program.
- Include stakeholders such as industry experts for the area as part of the local community stakeholders to ensure community connectivity and insight.
- Assist with details on population, socioeconomic patterns, and other data about urban growth and development combined with community values.
- NCDEQ, in collaboration with its partners, develops a funding guidance document as part of the planning process for large-scale improvements, repairs, or expansions to the stormwater systems.

Multiple stakeholders throughout Phases I and II of the Blueprint identified the planning-related challenge of implementing flood-resilient stormwater management programs due to the need for in-house staff with technical expertise and capacity to plan for, implement, and maintain these actions effectively. To address this challenge, it is recommended that the Blueprint offer to financially support staff members from organizations that have been awarded funds through the Blueprint for a flood-resilient stormwater management activity in completing a stormwater management-related professional certification/training program. Several relevant certification and training options are offered statewide, including, but not limited to, those depicted in **Table 6**.

Under ideal circumstances, the Blueprint would offer to cover the registration costs, in whole or in part, for a pre-approved certification or training course for at least one staff member from each organization awarded funding for stormwater management actions through the Blueprint. However, given the vast array of funding objectives and current financial resources dedicated to the initial round of Blueprint projects, it is recommended that the Blueprint support at least one member of interested regional organizations, such as council of governments, river basin associations, etc., in

completing a novel stormwater management certification or training course and, if applicable in the given timeframe, one staff member from each interested regional organization in achieving a recertification. The knowledge and skills gained through this training can be shared and applied through those organizations' regional activities, which often involve multiple jurisdictions.

2.2.2 Recommendation 7: Develop Data Management Support

Develop a community database for resource management which will allow interdependent organizations of the state, county, and other municipal jurisdictions to coordinate, communicate, and support maintenance activities not only within their community but across boundaries (e.g., regional, basin, municipal, state, etc.) where upstream and downstream conditions are addressed by multiple participants with responsible, systematic, and transparent approaches. Recommended actions include the following:

- Provide a portal access point for both data download and upload.
- Require data updates based on a minimum frequency determined by type of infrastructure, such as stormwater control measures, stormwater drainage networks, and structural reports on dams, walls, and bridges.
- As a grant provision, require supplemental reports and updates after projects are completed with state or federal funding.
- Require supplemental data for community construction activities, including digital as-builts with Finished Floor Elevations, mapped floodplains, stormwater retrofit project data including nature-based solutions, engineered stormwater control devices, and transportation infrastructure changes that occur, such as bridge, channel, or culvert improvements.
- Set a standard format for updating data.
    - "Retrofits of existing SCMs can take the form of either conversions or enhancements. Examples of conversions include converting a dry detention basin to a wet pond or wetland or converting a small pond to a bioretention area or pocket wetland. Examples of enhancements include enlarging the size of an SCM, adding floating wetlands to a wet pond, or directing additional runoff from impervious surfaces to an adequately sized existing SCM."[1]
- Stagger the schedule of updating the basin plans so that significant updates can be staggered to reduce staff burden where reviews are required.

Further, schedule potential funding assistance on the same schedule with database updates to provide the community with the option to either:

1. Request funding support, or
2. Request the state complete the updates (i.e., contract with consultants to complete the data updates on behalf of the communities).

[1] https://www.deq.nc.gov/energy-mineral-and-land-resources/stormwater/bmp-manual/e-3-retrofits/download

2.2.3 Recommendation 8: Develop Maintenance Document Support

Develop or assemble an existing list of policies, inspection requirements, and procedures for use in the individual community operations and maintenance manuals for the stormwater programs (and subsequent ordinance and municipal code modifications) that address SCMs available to the community in reference to system constraints and community values. NCDEQ currently hosts inspection forms and webinars for wet ponds, bioretention cells, infiltration systems, and stormwater wetlands. However, these resources should be expanded to include other management strategies, such as maintaining and enhancing floodplain buyout properties to improve water quality. For all strategies, include items and practices such as:

- Inspection recommendations for drainage systems, structures, and stormwater control measures (reference regulatory manuals).
- Minimum Inspection report data to be provided to the state and how often the inspections should occur (see **Table 12**).
- Recommendations for findings, such as replacement, stabilization potential, resources, etc.
- Monitoring and maintenance (asset management) plan requirements at the 30% design stage to maximize stormwater projects' function, service life, and cost-effectiveness.

Existing NCDEQ-funded SCM monitoring and maintenance reporting requirements should be reviewed alongside a study published in 2017 by the American Society of Civil Engineers (Clary and Piza 2017). The study "Cost of Maintaining Green Infrastructure" presents recommendations for specific reporting requirements that would support establishing a national SCM database. While at the national scale, the study's results still apply to the Blueprint, which will support flood resilient SCM projects statewide. Recommended reporting requirements for best management practice (BMP) facility information, maintenance event records for facilities, and maintenance activity records can be found in **Table 13**, **Table 14**, and **Table 15** of the Appendix.

2.2.4 Recommendation 9: Support the Development of Regional Stormwater Utilities and Partnerships

The Blueprint can support the development of regional stormwater utilities in the state by facilitating conversations between communities during the planning process and allocating funding to support regionalization. Regional stormwater utilities are governmental or quasi-governmental entities responsible for managing stormwater runoff across multiple jurisdictions within a defined region. These utilities are typically tasked with planning, constructing, operating, and maintaining stormwater infrastructure to reduce flooding, improve water quality, and comply with environmental regulations. Regionalization can have multiple benefits for participating communities, including:

- Leadership and policy structure for regulatory compliance
- Shared resources such as equipment and technical skills
- Common public education programs

- Consistent design requirements and post-construction practices specific to the needs of the watershed.

Several regional entities already offer stormwater management-related services in North Carolina. These include river basin associations (RBAs), a collaborative organization encompassing multiple stakeholders, including local governments, non-profit organizations, businesses, and other entities within a specific river basin. These associations are dedicated to the sustainable management and protection of water resources within their respective river basins. RBA activities often include pooling financial, physical, and technical resources, stakeholder and public engagement, regional data collection and planning, and assisting communities with legal and regulatory compliance. Examples of RBAs in North Carolina include, but are not limited to, the Upper Neuse RBA, Lower Neuse RBA, Yadkin-Pee Dee RBA, Roanoke River RBA, Tar-Pamlico RBA, etc. (**Table 3**). Similar partnerships focusing primarily on public awareness and education include the Regional Stormwater Partnership of the Carolinas, the Piedmont Triad Water Quality Partnership and Stormwater SMART program, and the Western North Carolina Stormwater Partnership.

It is recommended that the Blueprint support existing partnerships and regional organizations focused on stormwater management by allocating funding for these entities' regional flood resilient stormwater management activities. Further, it is recommended that the Blueprint devote resources in the future to study the legal, financial, and political structures of these regional entities and the level of services they provide to identify opportunities or areas for improvement as well as garner lessons learned that could be used to develop material promoting the formation of new regional partnerships/organizations throughout the state.

Table 3. Regional organizations/partnerships concerned with stormwater management

Organization	Source
Upper Neuse RBA	https://unrba.org/
Lower Neuse RBA	https://lnba.net/
Yadkin-Pee Dee RBA	https://www.yadkinpeedee.org/about-the-association
Roanoke River RBA	https://www.roanokeriverbasinassociation.org/
Tar-Pamlico RBA	https://tarpam.org/
Regional Stormwater Partnership of the Carolinas	https://regionalstormwater.org/
Piedmont Triad Water Quality Partnership Stormwater SMART program	https://ptwqpartnership.wixsite.com/piedmontwaterquality/ptwqp-partners https://www.ptrc.org/services/regional-planning/stormwater-smart
Western North Carolina Stormwater Partnership	https://www.wncstormwater.org/

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4 Appendix

Table 4. Additional specific maintenance tasks for common NCDEQ-approved SCMs (Hunt, Waickowski, and Lord 2021)

SCM	Description	Maintenance Tasks Specific to SCM
Bioretention cell	Depression filled with sandy media and plants designed to store temporarily and filter runoff	Vegetation pruning and replacement; tree stake/wire removal; flush out underdrain system; mulch replacement; annual soil tests
Wet pond	Depression is designed to capture and slowly release runoff over a 2- to 5-day period.	Algae, cattail, phragmites, and other invasive vegetation removal; remove trees and weeds from floating wetland islands; restoring floating wetland island cables; revegetation
Stormwater wetland	Shallow, vegetation-filled depression designed to capture and slowly release runoff over a 2- to 5-day period, store runoff in shallow pools supporting emergent and riparian vegetation	Algae, cattail, phragmites, and other invasive vegetation removal; revegetation
Permeable pavement	Pavement that captures runoff through voids in the surface and filters runoff through the underlying aggregate base	Vacuum or sweep surface; bag grass clippings or direct away from the surface; weed removal; annual infiltration testing; observation well inspection; surface repair; flush out underdrain system
Sand filter	Surface or subsurface device that percolates runoff through a sand media	Sweep or vacuum adjacent pavement; flush out underdrain system; replace sand media
Rainwater harvesting	Collection device storing rainwater for later use	Inspect and repair all leaks; clean gutters; unclog screens and filters; inspect pump; remove algae; mosquito abatement
Level spreader-filter strip	Exposed buried concrete footer immediately upstream of vegetated area	Unclog and repair flow splitter device; mow and unclog blind swale; repair or replace concrete lip; repair erosion and remove \sediment in filter strip
Disconnected impervious surface	Practice of directing runoff from built-upon areas to properly sized, sloped, and vegetated pervious surfaces	Unclog gutter system; remove sediment and repair erosion in the vegetated area; remove trees or shrubs in the vegetated area; remove obstructions at the interface of impervious and vegetated area
Contech StormFilter® (proprietary underground SCM)	Proprietary device designed to capture runoff and slowly release via an outlet structure	Mosquito abatement; vacuuming; rinse chambers; install fresh cartridge(s)

SCM	Description	Maintenance Tasks Specific to SCM
ADS BayFilter™ (proprietary underground SCM)	Proprietary device designed to capture runoff and slowly release via an outlet structure	Mosquito abatement; vacuuming; rinse chambers; install fresh cartridge(s)

Table 5. Cost, community & environmental issues for SCMs (NCDEQ 2018)

SCM	Construction Cost	Maintenance Level	Safety Concerns	Community Acceptance	Wildlife Habitat
Bioretention	Med-High	Med-High	N	High	High
Stormwater Wetland	Med	Med	Y	Med	High
Wet Pond	Med	Med	Y	Med	Med
Sand Filter	High	High	N	Med	Low
Permeable Pavement	Med-High	High	N	High	N/A
Infiltration Device	Med	Med	N	Med-High	Low
Filter Strip	Low	Low	N	High	Med
Treatment Swale	Low	Low	N	High	Low
Dry Pond	Med	Med	Y	Low	Low
Rooftop Runoff System	Med-High	High	N	High	Med

Table 6. NC-based stormwater management certifications and training

Resource	Organization	Cost (2024)	Description
Surface Water Identification Training & Certification	NC DWR & NC State University	• Regular ($765)	• Time requirements: five days • Required to make a legal determination of stream origins and identify surface waters subject to buffer rules enacted by the NC Environmental Management Commission

Level I-III Erosion & Sediment Control Certification	NC Department of Transportation & NC State University	• Level I-II ($200)
		• NCDOT Employee Level III ($175)
		• Regular Level III ($235)
		• NCDOT Employee Level IIII ($175)
			• Level I – Inspector /Installer
			  ○ Time requirements: online exam (24/7)
			• Level 2 – Site Management
			  ○ Time requirements: online exam (24/7)
			• Level 3 – Control Plans
			  ○ Time requirements: one day

Resource	Organization	Cost (2024)	Description
Stormwater SCM Construction Inspection Certification	NC Department of Energy, Mineral, and Land Resources & NC State University	• Non-Certification Participants ($150) • Certification Participants ($190)	• Time requirements: one day • Topics include phasing of construction, inspection of materials upon delivery, a multitude of proper construction practices, and field testing and verification to ensure green infrastructure and Low Impact Design practices are properly constructed and function as they are designed
Stormwater SCM Inspection & Maintenance Certification	NC Department of Energy, Mineral, and Land Resources & NC State University	• Regular ($410) • Government/Non-profit/Education ($350) • Virtual ($260)	• Time requirements: One full day and one ¾ day • NC communities may either require or recommend the certification of people who maintain and/or inspect stormwater management practices. The NC Dept. of Energy, Mineral and Land Resources endorses this certification but does not require it.
Various Action Specific Workshops & Certifications	Various state agencies & NC State University		• Minimum Design Criteria for Stormwater Designs • Rain Gardens • Swales, Bio-Swales, and Regenerative Stormwater Conveyance • Coastal Region Stormwater Management • Stream Bank Repair, etc.

Table 7. Stormwater wetlands routine maintenance costs and characteristics in North Carolina 2018 (Hunt, Waickowski, and Lord 2021)

Parameter	Mean	Median	Range	
Age (yr.)	14	15	10 to 18	
Typical footprint (acres)	0.4	0.5	0.25 to 0.50	
Maintenance frequency	Monthly	-	-	
Time spent on tasks (hr.)	2	2	1 to 2	
Number of employees maintaining SCM	2	2	1 to 4	**Mean *(Inflation Adjusted - 2023)***
*Routine costs without mowing ($/acre)	8,150	9,200	4,600 to 9,600	**$10,134 per acre**
*Routine costs with mowing ($/acre)	10,950	11,600	5,400 to 15,200	**$13,616 per acre**

Table 8. Bioretention cells routine maintenance costs and characteristics in North Carolina 2018 (Hunt, Waickowski, and Lord 2021)

Parameter	Mean	Median	Range	
Age (yr.)	14	15	10 to 15	
Typical footprint (acres)	0.17	0.13	0.05 to 0.25	
Maintenance frequency	Monthly	-	8 to 21 per yr.	
Time spent on tasks- mulched (hr.)	1	1	0.25 to 3	
Number of employees maintaining SCM-mulched	3	2	1 to 9	**Mean *(Inflation Adjusted - 2023)***
Routine costs without mowing - mulched ($/acre)	11,867	12,000	9,200 to 14,400	**$14,756 per acre**
Routine costs with mowing - mulched ($/acre)	12,400	12,000	12,000 to 14,400	**$15,419 per acre**
Time spent on tasks- grassed (hr.)	1	1	1 to 1.5	
Number of employees maintaining SCM-grassed	3	2	1 to 9	**Mean *(Inflation Adjusted - 2023)***
Routine costs without mowing - grassed ($/acre)	13,467	12,000	9,200 to 19,200	**$16,746 per acre**
Routine costs with mowing - grassed ($/acre)	15,600	12,000	10,800 to 24,000	**$19,398 per acre**

Table 9. Wet ponds routine maintenance costs and characteristics in North Carolina 2018 (Hunt, Waickowski, and Lord 2021)

Parameter	Mean	Median	Range	
Age (yr.)	16	16	10 to 28	
Typical footprint (acres)	0.5	0.5	0.25 to 0.75	
Maintenance frequency	Monthly	-	8 to 21 per yr.	
Time spent on tasks (hr.)	2	1	0.25 to 6	
Number of employees maintaining SCM	3	2	1 to 9	**Mean *(Inflation Adjusted - 2023)***
Routine costs without mowing ($/acre)	6,360	4,600	4,000 to 9,600	**$7,909 per acre**
Routine costs with mowing ($/acre)	9,440	8,800	5,400 to 15,200	**$11,738 per acre**

Table 10. Dry ponds routine maintenance cost characteristics in North Carolina 2018 (Hunt, Waickowski, and Lord 2021)

Parameter	Mean	Median	Range	
Age (yr.)	14	15	10 to 18	
Typical footprint (acres)	0.42	0.5	0.25 to 0.50	
Maintenance frequency	Monthly	-	4 to 21 per yr.	
Time spent on tasks (hr.)	1	1	0.17 to 2	
Number of employees maintaining SCM	3	4	1 to 9	**Mean *(Inflation Adjusted - 2023)***
Routine costs without mowing ($/acre)	6,920	6,000	5,400 to 9,600	**$8,605 per acre**
Routine costs with mowing[b] ($/acre)	11,320	10,400	6,600 to 18,000	**$14,076 per acre**

Table 11. Sand filters routine maintenance costs and characteristics in North Carolina 2018 (Hunt, Waickowski, and Lord 2021)

Parameter	Mean	Median	Range	
Age- above ground (yr.)	10	10	5 to 12	
Typical footprint- above ground (acre)	0.22	0.22	0.02 to 0.33	
Maintenance frequency- above ground	Monthly	-	4 to 21 per yr.	
Time spent on tasks- above ground (hr.)	1	1	0.25 to 1.50	
Number of employees maintaining SCM- above-ground	2	2	1 to 9	**Mean *(Inflation Adjusted – 2023)***
Routine costs without mowing- above ground ($/acre)	13,281	14,262	5,400 to 78,407	**$16,515 per acre**
Routine costs with mowing – above ground ($/acre)	16,875	16,951	9,600 to 24,000	**$20,984 per acre**
Age- underground (yr.)	10	9	8 to 10	
Typical footprint- underground (acre)	0.2	0.2	0.01 to 0.50	
Maintenance frequency- underground	Quarterly	-	4 to 21 per yr.	
Time spent on tasks- underground (hr.)	1	1	0.25 to 1.5	
Number of employees maintaining SCM-underground	4	4	3 to 4	**Mean *(Inflation Adjusted – 2023)***
Routine costs without mowing – underground, residential ($/acre)	73,086	74,407	4,000 to 145,200	**$90,881 per acre**
Routine costs without mowing – underground, commercial ($/acre)	91,207	78,407	4,000 to 223,028	**$113,414 per acre**

Table 12. NC Stormwater Design Manual required inspection frequency for SCMs (NCDEQ 2018)

Frequency	SCM
Monthly and within 24 hours after every water quality storm (greater than 1.5 inches in Coastal Counties and greater than 1.0 inches elsewhere)	• Stormwater Wetlands • Wet Detention Basins • Bioretention Cells
Quarterly and within 24 hours after every water quality storm (greater than 1.5 inches in Coastal Counties and greater than 1.0 inches elsewhere)	• Level Spreaders • Infiltration Devices • Sand Filters • Extended Dry Detention Basins • Permeable Pavement • Rooftop Runoff Management • Filter Strips* • Grassed Swales* • Restored Riparian Buffers*

**Although these devices require quarterly inspection, mowing will usually occur more frequently during the growing season.*

Table 13. Reporting data for stormwater maintenance costs: best management practice (BMP) facility information (facility information is provided in one record and then related to multiple maintenance records in **Table 14**) (Clary and Piza 2017)

Parameter	Description/Picklist
Asset ID	Use the number in the asset management system if applicable.
Facility Type	Individual, cluster, other
Decimal Latitude Decimal Longitude	GPS centroid/geolocated address–enables mapping of
BMP Name	General facility name
BMP Type	Picklist: bioretention, grass swale, grass buffer, tree planter, permeable pavement, composite (treatment train), etc.
City	Enables geographic comparison of records locally and nationally
State	Enables geographic comparison of records nationally
Date Installed	Enables tracking of maintenance cost over time
Tributary Land Area (ac.)	Size of drainage area to facility
Imperviousness (%)	Percent impervious area
Land Use(s)	Picklist
Snow/Ice Management	Picklist
Qualitative Site Loading Intensity	High, moderate, low (i.e., is the site heavily used/dirty, or is it lightly used/clean)
Tributary Land Area Description/Conditions	Include other pertinent characteristics affecting maintenance.
Treatment Volume (cf.)	Provides treatment volume, e.g., Water Quality Capture Volume
Surface Area	Provides information on the footprint of the facility that is maintained
Facility Sizing	Picklist: standard, oversized, undersized (e.g., not to design standards)
Media Type	Picklist: In situ soils, engineered media, not applicable
Vegetation Type	Picklist: highly manicured, moderately manicured, low maintenance, native grasses, turf, wetland vegetation, not applicable
Pretreatment Features	Describe pretreatment features that facilitate ease of maintenance, e.g., sediment forebay.
Inlet Feature	Describe inlet(s), including features affecting maintenance. requirements
Facility Ownership	Picklist: public, private, private-easement, private-HOA, other
Public Visibility	Picklist: high, medium, low
Monitoring Data?	Yes/no/unknown (flag to trigger tie-in to BMP Database)
Comments	Additional description of facility that influences maintenance costs, if needed.

Table 14. Reporting data stormwater maintenance costs: maintenance event records for the facility (multiple event records over time, linked to the facility information in **Table 13**) (Clary and Piza 2017)

Parameter	Description/Picklist
Asset ID	Use the number in the asset management system if applicable.
Maintenance ID	Maintenance Record number (auto-populated)
Event Record Type	Annual summary, individual event, other
Work Order ID	Work order ID used in the asset management system (if applicable)
Work Oder Description	Individual facility visits, multiple facility visits, individual facility-multiple visits, multiple facility-multiple visits, unknown
Mobilization Type	Picklist: multiple facilities, single facility
Facility Stage at Time of Maintenance	Picklist: establishment, mature, post-mature (overgrown)
Facility Performance Status	Normal, failing, unknown.
General Climate Condition	Picklist: normal, wet, dry
Maintenance Type	Picklist: Inspection only, routine, restoration/reactive, rehabilitation, other
Maintenance Entity	Picklist: contractor, municipal, volunteer, combination
Maintenance Date	Enables normalization of cost data over time and documents frequency
Maintenance Narrative	Describe activities conducted or use the additional detailed checklist in **Table 15**
Disposal Type	Solid waste, hazardous waste, storage for bulk disposal, unknown
Irrigation	Irrigation required; no irrigation
Total Cost ($)	Total overall cost
Cost Type	Picklist: flat fee, time & materials
Labor Cost ($)	Total labor cost
Labor Time (min.)	Time required to complete maintenance/site visit
Labor Rate ($/hr.)	Hourly labor rate
Materials Description	Plants, mulch, media, hardscape, chipping materials, etc.
Materials Cost ($)	Cost of materials
Equipment Description	Equipment used, e.g., vacuum sweeper, shovel, backhoe
Equipment Ownership	Own, rent, contractor
Equipment Cost Basis	Describe the basis for allocating the cost of owned equipment.
Equipment Cost ($)	Rental cost or owner cost
Disposal Cost ($)	Cost of sediment/materials disposal, if applicable
Admin./Overhead Cost ($)	The administrative cost of scheduling/tracking maintenance is not reflected in the labor cost.
Other Cost	Additional costs for traffic management or other costs not included above
Comments	Additional comments that identify unusual aspects of maintenance event

Table 15. Reporting data for stormwater maintenance costs: maintenance activity records (activities conducted during maintenance events defined in **Table 13**) (Clary and Piza 2017)

Parameter	Description/Picklist
Asset ID	Use the number in the asset management system if applicable.
Maintenance Record ID	Maintenance Event ID (from Activity Table)
Sediment removal	Y/N
Weeding/thinning/vegetation removal	Y/N
Plant replacement/seeding/sodding	Y/N
Supplemental Irrigation	Y/N
Mowing	Y/N
Fertilization	Y/N
Pruning	Y/N
Trash/debris/leaf removal	Y/N
Erosion repair	Y/N
Mulch replacement	Y/N
Inlet cleaning	Y/N
Outlet cleaning	Y/N
Vacuum/sweep surface	Y/N
Jet-Vac/subsurface vacuum	Y/N
Rechip permeable pavement	Y/N
Replace media	Y/N
Structural repair	Y/N
Clear pipes	Y/N
Mosquito control	Y/N
Algae control	Y/N
Rodent management/address animal damage	Y/N
Other activity/comment	Describe other activities/ provide comments.