

# **Carrboro Flood Resilience Background Report**

**June 30, 2023**

**Prepared by Carrboro Stormwater Staff**

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## Executive Summary

The past decade has seen an uptick in intense rain events and associated runoff and flooding issues in Carrboro and beyond. There are other factors besides changes in rainfall intensity that contribute to the impacts which are in large part a function of the historical use of land and decisions made and actions taken many decades ago. Creating resilience moving forward requires acknowledging these factors. Flooding and flood resilience also involve the complex interaction and consideration of public and private sector constraints, opportunities and challenges, and responsibilities.

The Town has been involved in and incrementally growing flood resilience work since joining the National Flood Insurance Program (NFIP) in 1976. In the past decade and driven by changes in rain intensity, the Town has taken new steps. For example, the Town has commissioned Sungate Design Group to complete studies for multiple locations in Carrboro experiencing flooding. The Town created a Stormwater Utility, Enterprise Fund, and Advisory Commission in 2017 and began receiving dedicated stormwater funding in 2018. The Center for Neighborhood Technology completed a RainReady<sup>SM</sup> study in 2020, and staff has been pursuing supplemental work, including preparation of this report, a companion report on flood mitigation techniques, and other steps to support the community with flood mitigation and resilience and stormwater assistance. Most recently, the Town's Comprehensive Plan has provided flood resilience components; a stormwater infrastructure condition assessment is being pursued; and a residential assessment pilot project has been completed and a potential new residential assistance program is under review. This document is intended to supplement and not contradict any of these prior studies, documents, and actions, but to provide additional background to facilitate new and expanded work going forward.

The following are important contextual flood resilience–related observations explored in this report:

- a. Most of the flooding occurring in Carrboro is urban flooding or localized flooding rather than riverine flooding since Carrboro is geographically located at the headwaters of the Cape Fear River Basin, with smaller creeks rather than larger creeks and rivers, and also topographically, substantially along the ridge line separating the Bolin Creek and Morgan Creek watersheds.
- b. The areas in Town with a greater experience and risk of flooding were mostly developed prior to the more recent and stringent stormwater and floodplain regulations and, in some cases, the adoption of the Land Use Ordinance.
- c. As a function of Carrboro being substantially built out and with most land being privately owned, there are essentially no opportunities for large, public flood mitigation projects. For Carrboro, flood resilience work is best thought of as being distributed, site specific, and requiring collaboration across property lines and neighborhoods.
- d. One flooding consideration is the location of a relatively small number of residential buildings in the regulatory floodplain. These structures predated local, state, and

- federal flood-related regulations, were built using less flood-resilient design and construction and have not been subsequently converted to be more resilient.
- e. Part of a resilience framework is adapting residential landscapes to incorporate solutions to the reality of more intense rains, native soils and geology, and wetter conditions due to climate change.
  - f. There are significant and important legal and financial considerations and constraints regarding the Town’s involvement in flood mitigation and resilience. These include the “public purpose” doctrine and the legal and financial risk to the Town of setting a precedent in service delivery that would need to be extended to all “similarly situated” properties.

Finally, in addition to continuing to pursue strategies and actions already underway, new and synergistic ones that crosswalk with other Town interests can and should be considered to pursue a more flood-resilient future.

## Background and Context

Carrboro and many other communities face water resource management challenges that are significant and complex. We are trying to simultaneously manage the flooding effects of more frequent and intense storms, the challenges of historical and planned land use and development, and the impacts to both residents and local aquatic ecosystems. There is a growing recognition that we cannot meet these challenges by working in silos<sup>1</sup>. **Multifaceted problems require multifaceted solutions.** Communities are now looking for the tools to meet these challenges as efficiently and effectively as possible, with **one overarching goal being increased resilience.**

One important starting point is recognizing that **flooding** (whether it is associated with a regulatory floodplain or more localized or urban flooding) **and stormwater management are distinct disciplines<sup>2,3</sup>; they are not synonymous.** The Town’s stormwater management obligations, and its Municipal Separate Storm Sewer System (MS4), are regulated under an EPA NPDES Phase II stormwater permit, which, along with other regulations, requires action to address the water quality impacts of stormwater runoff. The Town’s floodplain management approach has historically relied upon FEMA’s National Flood Insurance Program, which focuses on flood mitigation needs for insurable structures in federally regulated floodplains. Fundamentally, there is a need to both distinguish between these disciplines and focus on the integrated solutions that will help residents reap the benefits of increased resilience. For the

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<sup>1</sup> <http://uswateralliance.org/about/our-work>

<sup>2</sup> <https://www.fema.gov/floodplain-management#:~:text=Floodplain%20management%20is%20a%20community,in%20a%20more%20resilient%20community.>

<sup>3</sup> [https://swanc.org/index.asp?SEC=75A8192E-23EA-4284-B2C1-ABF0E24D71AC&Type=B\\_BASIC#:~:text=As%20defined%20by%20the%20U.S.,not%20percolate%20into%20the%20ground.](https://swanc.org/index.asp?SEC=75A8192E-23EA-4284-B2C1-ABF0E24D71AC&Type=B_BASIC#:~:text=As%20defined%20by%20the%20U.S.,not%20percolate%20into%20the%20ground.)

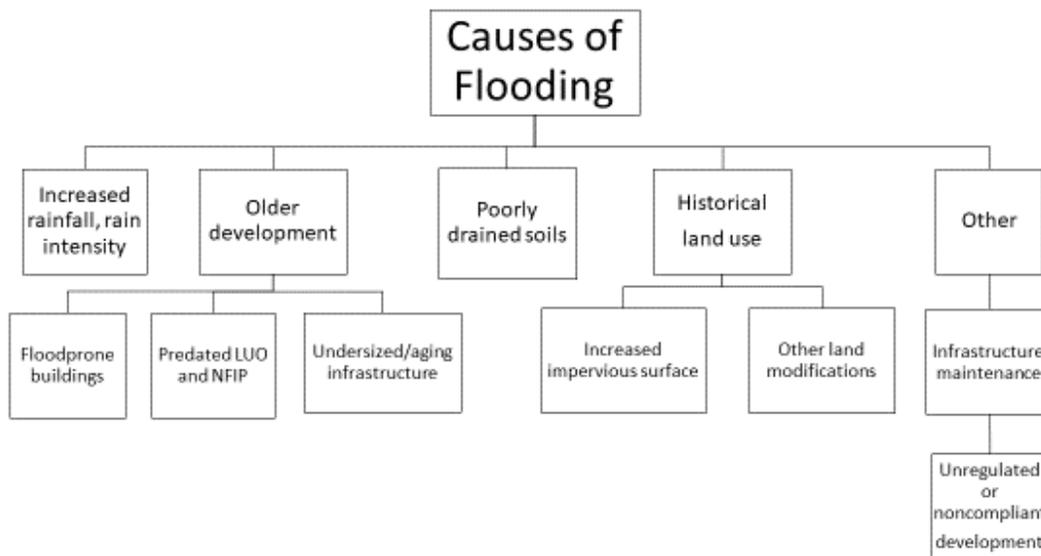
purposes of this report, the intersections of stormwater and floodplain management with other community interests are also relevant.

## Flooding Causes

In Carrboro, the first decade of the 21st century was relatively quiet in terms of heavy rains and tropical storms. In fact, with repeated droughts, water conservation was of more concern than flooding in Carrboro. That has changed in the second and third decades. Late June of 2013 brought the most intense event in recent years, a nontropical summer storm that resulted in flooding throughout town, including in some spots not known for flood problems. Many additional intense rain events, including several tropical storms, have occurred more recently.

Climate change is a primary concern. It is indisputable that the warming atmosphere holds more energy and water vapor, resulting in more high intensity (inches of precipitation per hour), whether tropical or nontropical in origin. This increased intensity results in higher rates of runoff during storms. The reality of a changing climate means the potential for such storms to continue or increase in frequency adds an element of urgency to the need for additional resilience steps.

**Figure 1: Key Causes of Flooding**



While the intensity of individual storm events drives the occurrence of flooding, longer-term (e.g., annual) precipitation is also important. More rain on an annual basis means wetter soils, a higher groundwater table, and less capacity to absorb and infiltrate rainfall. Two of the wettest years of record<sup>4</sup> in North Carolina (2018 and 2020) have occurred recently.

A second reason for flooding problems is the occurrence of some **older and less resilient development**. While it is true that both the downtown area and most of the older parts of town

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<sup>4</sup> <https://spectrumlocalnews.com/nc/charlotte/weather/2021/01/12/2020-was-very-wet-and-warm-for-north-carolina>

sit on a ridge between Bolin and Morgan Creeks, on higher and drier terrain, some older buildings have been built in more flood-prone areas that would not be permissible now, or even within a decade of their construction, due to floodplain and other regulations. Also, some of these buildings were designed and built in a less resilient way, such as below grade (finished or unfinished basements) or at grade (without a crawlspace and above grade floor). Less resilient buildings also may not include wet or dry flood proofing, elevation of equipment and ductwork, or other helpful measures such as dry wells or dry stream beds. Some of the **older stormwater infrastructure** (both public and private) in Carrboro **predated more recent local, state, and federal requirements and standards**. Much of the downtown commercial district and adjacent neighborhoods—including many along and between South and North Greensboro Street, West Main Street, and Hillsborough Road as well as several older neighborhoods in northern Carrboro—fall in this category. Any development approved before the late 1970s predated the Town’s participation in the National Flood Insurance Program and the adoption of the Land Use Ordinance. Since then, floodplain management and stormwater regulations have continuously progressed.

### **What has the Town done?**

The Town has taken action over time, as presented below and summarized in Table 1 and the appendices. It is clear that a more complete and comprehensive framework and strategy that also balances and integrates public and private responsibilities and abilities needs to be articulated and pursued. The motivation for this report is to take a step in the direction of expanding and accelerating flood-resilience efforts in Carrboro.

### **Regulating Development**

**As mentioned above, the Town joined the National Flood Insurance Program in 1976, and in 1980, the Land Use Ordinance (LUO) was adopted.** The 1980s and 90s were periods of both continued population growth and new flood impacts. Subsequent Land Use Ordinance updates to multiple sections<sup>5</sup>, driven by both local input as well as emerging state and federal regulations, have resulted in newer development having a higher degree of flood resilience in general than older development. Carrboro’s regulations in many areas exceed state and federal requirements.

At the same time, it is recognized that the shifting precipitation regime in particular is creating new challenges. In addition, innovative technologies and practices and new approaches to regulation are continuously evolving and emerging. This all indicates that continuing review and updating of regulations is necessary.

### **Stormwater Utility and Enterprise Fund**

Motivated by both flood resilience and aquatic ecosystem concerns, [Town Code amendments](#) were adopted in 2017 to form the Stormwater Utility, Stormwater Enterprise Fund, and Stormwater Advisory Commission. The first tasks for the new utility were 1) creating a rate

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<sup>5</sup> Especially Article XVI: Floodplains, Floodways, Drainage and Erosion, Article XIII Recreational Facilities and Open Space, Appendix I Storm Drainage Design Manual

structure to provide revenue for the new fund, and 2) helping form the new Commission. Both occurred in the first half of 2018. The fall of 2018 also brought 2 tropical storms (Hurricane Florence and Tropical Storm Michael), with 2018 being designated as the wettest year on record. The exceptionally wet period continued through the spring of 2019 with 2020 also rating as one of the wettest years on record. The creation of dedicated staff, funding, and a Commission has enabled the Town to make new strides that were not previously possible.

The Stormwater Utility has been developing and expanding its program, capacity, and services in general. Staffing increased in 2020 to three full-time dedicated employees. Coordination with Public Works operation staff has been improved by the new CityWorks software deployment, and staff have initiated work to improve the stormwater infrastructure GIS database. These are foundational for service delivery. A comprehensive [Homeowners Stormwater and Watershed Manual](#) has been developed and is a highly recommended resource for all Carrboro residents seeking more information about all things stormwater related.<sup>6</sup> In addition, Stormwater staff have been expanding direct outreach<sup>7</sup> and response to inquiries from citizens<sup>8</sup>. The Stormwater web pages continue to be improved, a hotline phone number and email address have been created, and social media and other communication approaches and outreach events and opportunities have been expanding. Dedicated Stormwater staff have been able to pursue and obtain federal/state grant funding for stormwater and stream restoration projects. Staff have been able to undertake a new infrastructure condition assessment and offer consultations and technical assistance to residents regarding their personal properties. The potential for a new cost share program is being reviewed.

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<sup>6</sup> <https://townofcarrboro.org/2324/Stormwater-Homeowners-Manual>

<sup>7</sup> <http://www.townofcarrboro.org/2316/Stormwater-Community-Outreach>

<sup>8</sup> <http://www.townofcarrboro.org/FormCenter/Public-Works-Department-23/Stormwater-Service-Request-134>

**Table 1. Past and Current Town Efforts Related to Flood Resilience**

Activity Type	Activity	Timeframe	Notes
Floodplain Management	Participation in National Flood Insurance Program	1976–present	Examples: updating and enforcing LUO provisions; keeping flood mapping and FIRM panels current; Flood Mitigation Techniques report
	Pursuit of flood mitigation grants	2014–2022	For 4 properties in upper Toms Creek watershed
	FEMA Public Assistance participation	2019–2022	Hurricane Florence; federal support received for emergency preparedness, damage recovery, administration, mitigation
Stormwater Management	Public Works Operations	1970s–present	Public right of way, MS4 and facility maintenance; NPDES compliance support. Street sweeping for past 15 years.
	Land Use Ordinance provisions	1983–present	Floodplain and stormwater provisions regularly updated both for federal/state compliance and to address local conditions. Non-floodplain/stormwater specific provisions also relevant (e.g., buffers, other natural constraints, open space)
	NPDES Phase II permit (MS4)	2005–present	Relevant efforts include Stormwater Control Measure maintenance and inspections and outreach, education, and public participation
	Jordan Lake Rules and listed impaired waters (Bolin Creek) compliance	2007–present	Requirements have some synergistic flood resilience benefits.
	Stormwater Utility, Enterprise Fund, Advisory Commission	2018–present	Provides dedicated stormwater staff, revenue, and oversight for and citizen participation in stormwater program
	Expanded capacity for infrastructure inspections, maintenance, improvements	2018–present	Public and private SCM maintenance; new capacity, contractual services and equipment for camera inspections, cleaning (Jet Vac) and condition assessment work.
	Stormwater Capital Improvement Program	2018–present	Using Stormwater Enterprise Fund to pursue capital improvements, restoration projects, and plan for future retrofits. This is for both “grey” and “green” infrastructure
	Public Works workflow system/capability	2020–present	Implementing new CityWorks platform including field and office work. Integration across Divisions including Stormwater
Resilience/ Assistance	RainReady Pilot Study and follow-up	2020 – present	Homeowners Manual prepared. Expanded staff Technical Assistance. Website improvements. Coordination with Stormwater Advisory Commission. Contractor Directory compiled and released. This document prepared. Residential Assessment Pilot Project pursued in FY23. Program design under review; implementation will require new revenue and staff
	Comprehensive Plan and Town Strategic Priorities	2022–present	Provide incentive for businesses and households Create New “Stormwater Toolbox” focusing on nature-based stormwater solutions.

Another recent project to help connect residents with professionals who can potentially be of assistance is the creation of a [directory of local contractors](#)<sup>9</sup>. Staff have created a web page with links to contractors who perform residential stormwater improvements, from small-scale solutions like the installation of rain gardens to larger-scale projects like elevation of buildings and floodproofing. The directory is intended to connect those in need of services to those who can provide them, recognizing that staff are not able to recommend a specific company or solution.

### RainReady<sup>SM</sup> Study

The Town contracted with the Center for Neighborhood Technology (CNT) to complete a RainReady study. This work was pursued and completed in early 2020. The [CNT RainReady report](#) was presented to and accepted by the Council in May of 2020<sup>2</sup> and has helped provide staff with direction for recent and current work (more below). The study recommended that the Town initiate community education and engagement efforts, develop enhanced communication materials, and design and pilot a residential assistance program, with an emphasis on [green infrastructure](#) (see Figure 2) at both individual lot and neighborhood scales. A compilation of the study recommendations and status of pursuing them is provided in Table 2.

**Figure 2: Examples of residential green infrastructure projects recommended by CNT**

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO <sub>2</sub>	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Practice																		
Green Roofs	●	●	●	●	○	○	○	●	●	●	●	●	○	●	○	○	●	●
Tree Planting	●	●	●	●	○	○	○	●	●	●	●	●	●	●	●	○	●	●
Bioretention & Infiltration	●	●	●	●	○	○	○	●	●	●	●	●	○	○	○	○	○	●
Permeable Pavement	●	●	●	●	○	○	○	○	●	●	●	○	○	○	○	○	○	○
Water Harvesting	●	●	●	●	●	○	○	○	○	○	○	○	○	○	○	○	○	○

Yes
  Maybe
  No

<sup>9</sup> <http://www.ci.carrboro.nc.us/2614/Stormwater-Services-Contractor-Directory>

## Residential Assessment/Assistance

In the spring of 2023, a [Residential Assessment Pilot Project](#) was completed with contractual support. The project provided individualized, professional assessments of residents' properties and identified opportunities for green stormwater infrastructure improvements, flood mitigation techniques, or other ways to increase the resilience of the property. In the fall of 2023, recommendations for a potential new residential assistance program have been drafted and are expected to be reviewed and potentially adopted in early 2024.

## Comprehensive Stormwater Infrastructure Condition Assessment

The Stormwater Division initiated work on a Town-owned stormwater infrastructure condition assessment in 2022. This work involves maintaining an inventory database and planning for and then completing inspections and assessments of the approximately 50 miles of Town-owned stormwater infrastructure. This is being pursued by both Town staff and contractors/consultants using federal and state assessment protocol for three categories of infrastructure: road culverts conveying streams; pipes; and open channels. The results are supporting the Town in planning for and pursuing repairs, rehabilitation, replacement, and retrofit projects. This work will also be a key component that supports the creation of a life cycle/long term stormwater infrastructure asset management plan. It will inform potential grant application efforts. In general, it is a foundational component of both operational and capital aspects of the Town's Stormwater Program. More information is available at <https://www.carrboronc.gov/2963/Stormwater-Infrastructure-Condition-Asse>

## Watershed Restoration Efforts

Carrboro staff worked with Chapel Hill and other local, state and federal agency staff in 2006 to create the [Bolin Creek Watershed Restoration Team](#) (BCWRT) because Bolin Creek has been on the list of state and federal impaired waterbodies. The BCWRT's long term goal is to improve the health of Bolin Creek and its tributaries and remove it from the impaired waters list. This is an ambitious goal that will require a robust commitment for many years to come. Considerable work has been completed since 2006. This work has been and can continue to be synergistic with flood resilience work. For example, [recent grant work](#) has actively supported community collaboration and the piloting of regenerative stormwater conveyance practices.

**Table 2: RainReady and Residential Assessment/Assistance Recommendations and Status**

<b>Recommendation</b>	<b>Status</b>
<b>Short-term (1 year)</b>	
<ul style="list-style-type: none"> <li>• Implement activities identified in the Carrboro Comprehensive Plan..</li> <li>• Identify key community public, private, and nonprofit partners, formalize partnerships, and initiate community education and engagement efforts.</li> <li>• Develop enhanced communication materials.</li> <li>• Budget for, design and pilot small-scale residential green infrastructure program. Determine best approach (e.g., by whom, using what available resources, for whom, and with what desired outcomes) for pilot scale program delivery.</li> <li>• For buildings located in known severe flooding areas, such as natural floodplains, continue to support property owners seeking assistance from federal programs.</li> </ul>	<p>Active</p> <p>Active</p> <p>Active</p> <p>Active</p> <p>Active</p>
<b>Mid-term (2 – 4 year)</b>	
<ul style="list-style-type: none"> <li>• Continue enhanced community education and engagement materials.</li> <li>• Collaborate with other organizations; investigate financing and funding options.</li> <li>• Presuming approval, use lessons learned to tune Town-wide residential green infrastructure assistance program.</li> <li>• Continue larger stormwater program development and integrate other efforts with the residential program.</li> <li>• Coordinate stormwater management projects that address federal and state water quality regulatory requirements associated with the Town’s NPDES Phase II permit.</li> <li>• For buildings located in known severe flooding areas, such as natural floodplains, continue to support property owners seeking assistance from federal programs.</li> </ul>	<p>Active</p> <p>Active</p> <p>Planning</p> <p>Active</p> <p>Active</p> <p>Active</p>
<b>Long-term (5+ year)</b>	
<ul style="list-style-type: none"> <li>• Evaluate program success, including financing and funding and program sustainability</li> </ul>	<p>Pending</p>

## Discussion

The previous sections are intended to provide a foundation for understanding the complex nature of flooding concerns in Carrboro and the efforts that the Stormwater Division has taken since its inception. The purpose of this section is to offer several conceptual cornerstones and shifts in how this complex issue is considered.

### Necessary Paradigm Shifts

There are two necessary paradigmatic and community-scale shifts for increased flood resilience.

The first is a change in what we deem an acceptable fate for stormwater. The old paradigm, present when older sections of Carrboro were built out, was to “send rainfall and the associated runoff away; out of sight, out of mind.” This begs the question: where is “away”? In reality, “away” means downslope and downstream, where neighbors and ecosystems are at risk of being impacted. The problem is compounded when more water is coming down more quickly. Through many interactions with community members, staff are aware that this paradigm is still prevalent.

The new paradigm for managing stormwater runoff, which has been evolving for the past several decades, is to, as articulated by the Center for Neighborhood Technology, “avoid it, sink it, hold it, and send it”. Other ways that this concept is expressed are through the terms: nature-based stormwater strategies/solutions, stormwater volume control, runoff reduction, Low Impact Development (LID), hydrograph matching (meaning an identical rate and amount of runoff before and after development), green stormwater infrastructure, and detention and conveyance as secondary considerations and solutions that only are pursued when the aforementioned ones are not enough.

This requires, in many ways, an acknowledgement of runoff and surface waters as an integral and ever-changing environmental feature. The less that water is seen as a nuisance, hazard, or barrier to prosperity and the more it is seen as a feature of the land, a resource, and a connection to nature, the more creative ways will be found to manage the water while better balancing human and ecosystem needs. Future solutions also need to be grounded in the fact that flooding is a climatic and watershed phenomenon. Precipitation intensity is a primary driver. Water flows by gravity based on the landform. Infrastructure, property lines, and buildings have been historically laid out in a manner that is not completely congruent with this fundamental physical reality. A stronger watershed-based awareness with an understanding of where runoff originates, flows, and ends up, and the insight to work with rather than against nature needs to be fostered. There are many practical and helpful tools to consider at a site and residential scale that do this. Some examples include: rain gardens, backyard wetlands, dry stream beds, regenerative stormwater conveyances, restored/repaired streams/riparian buffers, permeable pavement, dispersion of concentrated flow, swales and bioswales, disconnected impervious surface, lawn conversions, and other soil and landscape enhancements.

Another necessary shift is a transition from the “someone else’s problem to fix” to a more collaborative, shared, and community-oriented approach. In particular, the reliance and

expectation that government, be it local, state, and/or federal, can solely create a more resilient community does not recognize historical or current private property rights and responsibilities, the degree to which private property contributes to increased rates of runoff, nor the reality of government capacity (both workforce and financial).

If both above paradigms were successfully shifted in Carrboro, a different and more frequently shared sentiment would be “Let’s work together to make our properties, the community, and this watershed more resilient to the changes in rainfall, runoff, and flooding that we’re experiencing.”

One of the goals of this framework is to name the need to foster a culture of collaboration and partnership for long term implementation. Doing so will require an acknowledgement of the previous differences in understanding and expectations and a focus on positive and affirming relationships among and between residents, the Town, and all stakeholders while also recognizing the legal and financial realities involved.

### **Public Purpose Doctrine**

As part of building resilience, and in regard to the potential to extend services from the Town to residents and their private property, it is important to mention that the Town Attorney provided a memo in 2019 on the legal and financial reasons for the Town to proceed cautiously in considering taking on this responsibility. To summarize, these reasons include: 1) the constraints of the “public purpose” doctrine; 2) the level of stormwater service that the Town must provide to all “similarly situated” property owners; and 3) the liability the Town could assume.

In North Carolina, the Public Purpose Doctrine (PPD)<sup>10</sup> “requires that all public funds, no matter what their source, be expended for the benefit of the citizens of a unit [of government] generally, and not solely for the benefit of particular persons or interest.” The State has set forth two guiding principles to support decision-making: government revenue supported activity must be related to the work carried out by the specific unit of government, and must benefit the public at large, and not individuals or special interests.

The Town Attorney’s memo specifically stated:

“As for the “public purpose” doctrine, Town funds expended to improve or maintain stormwater infrastructure on private property would be justified only if such action were reasonably necessary to enhance the Town’s stormwater infrastructure on the Town’s own property for the benefit of others in a “public” sense; and the application of this doctrinal limitation would depend on the specific facts of the situation.”

Additionally, assuming the public purpose doctrine was satisfied, “the Town must provide the same level of service or benefit to other similarly situated private property owners,” and “the Town will be liable for the maintenance of and actionable injuries from stormwater infrastructure

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<sup>10</sup> [https://canons.sog.unc.edu/a-look-at-north-carolina%E2%80%99s-constitutional-public-purpose-requirement/#:~:text=Section%202\(1\)%20of%20Article,source%2C%20be%20expended%20for%20the](https://canons.sog.unc.edu/a-look-at-north-carolina%E2%80%99s-constitutional-public-purpose-requirement/#:~:text=Section%202(1)%20of%20Article,source%2C%20be%20expended%20for%20the)

on private property when the Town has adopted or expressly assumed ... control or management over such private infrastructure.”

In application to flood resilience related work, the PPD guides the Town to steer activities toward those benefiting the public at large. The main discernment required will be figuring out if and how to fund or otherwise provide resources for projects that occur on private property and the criteria for determining a net public benefit through better stormwater management or other green infrastructure benefits.

## Past and Future Development

The Stormwater Advisory Commission relayed the following as part of [their review](#) of the RainReady study and community input in 2020, some of which referred to a recently approved development project:

*“It is a misconception that the Town “allowed” development. Property owners have a right to develop their property in accordance with existing zoning and applicable development codes. The residential development in question was required by code to manage stormwater runoff so as not to increase peak flow for the 1-year, 2-year, 5-year, 10-year, and 25-year design storm events. The commercial property at Lloyd Farm had a right to develop that property to meet this same set of standards; however, because the developer wanted to rezone part of the property, the Town was able to negotiate the inclusion of a requirement to also manage peak flow from the 100-year storm. Given the alternative of developing to a lower standard under existing zoning, the SWAC supported the rezoning with the condition of managing the peak flow for the 100-year design storm.”*

Additional thoughts on infill and redevelopment are also warranted. There are various Town regulations, policies and practices that encourage infill development. At the same time, historical development has been and is being pursued in a way that may not be as in tune with the creation of a more flood resilient community. “Greener” land is converted to “greyer” land as part of development and below the threshold for any level of stormwater treatment. In addition, the State has adopted statutes in recent years that limit local authority to exceed State requirements. There may be value in looking at this through amendments to the stormwater provisions in the Land Use Ordinance, but there may be additional and/or better levers through, for example, an overlay district/map amendment, minor subdivision, accessory structure, and impervious surface regulations/allowances or other limitations on or flood risk reduction approaches for development on residential lots.

## Other Town Interests

The Town has recently been emphasizing affordable housing, climate action, and racial equity. It is beyond the scope of this document to thoroughly explore the potential integration of these interests with flood resilience; however, some discussion is offered. This resilience framework will need to be fundamentally in sync with and help advance various elements of the Ecosystem Protection and Enhancement components of the [Community Climate Action Plan](#), and participation in [Governments Advancing Racial Equity \(GARE\)](#). It is worth mentioning that the

CNT RainReady study as well as the Comprehensive Plan include some analysis and thoughts about how the Town may wish to consider these topics. It is possible that synergies can be identified between the more environmentally and socially oriented elements. For example:

- 1) It is possible that new stormwater treatment opportunities can be identified in coordination with traffic calming.
- 2) There may be some synergy with coordinating efforts with the CCAP Green Neighborhoods Initiative<sup>11</sup>.
- 3) While limited in scope, coordinating interest in home elevations and buyouts with new affordable housing opportunities may also be worth exploring.
- 4) For race and equity, staff have already begun using the Government Alliance on Race and Equity<sup>12</sup> lens as a tool for integrating flood resilience and equity interests.

## **Funding and Finance**

While it is beyond the scope of this report to more fully explore how to best fund and finance flood resilience, a few preliminary thoughts are offered. As with many fiscal and financial deliberations, some of the core questions include: How much will this cost? Where will the money come from? What, if any, additional grant sources or funding/financing mechanisms may be available?<sup>13</sup> How competitive are they, what administrative burden comes with pursuing them? Who will pay, and when? Who needs to approve expenditures?

The predominant current funding and financial “structures” available to the Town are the operating and capital improvements budgets, with stormwater related revenue and expenses passing through the Stormwater Enterprise Fund. As discussed above, “stormwater” and “flooding” are not synonymous, and it important to emphasize that Stormwater operating and capital improvements budgeting with the current rate structure and existing and future revenue can address some of the needs discussed in this framework but is certainly insufficient to address all of the needs.

- a) In addition, no programming of the Enterprise Fund for residential flood mitigation projects has been planned or pursued to date. Specifically, the most recent stormwater rate structure adjustment (January 2020) was not sufficient or intended to fully fund the implementation of a longer term and community scale flood resilience strategy;
- b) A recent and relevant emphasis for the Stormwater Division has been bringing forth recommendations for a new Watershed Restoration Residential Assessment Program that includes new revenue from an increase in Stormwater fees.

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<sup>11</sup> <http://www.townofcarrboro.org/2305/Green-Neighborhoods-Initiative>

<sup>12</sup> <http://www.townofcarrboro.org/2535/Race-and-Equity>

<sup>13</sup> There may be new federal funding opportunities; tracking these and deciding on the opportunities worth pursuing could be a time intensive undertaking.

- c) A Local Assistance for Stormwater Infrastructure Improvements grant application has also been submitted to the North Carolina Division of Water Infrastructure;
- d) There are statutory limitations on the use of Stormwater Enterprise Funds that would need to be carefully reviewed before committing Enterprise funds to potentially non-stormwater related uses.

## Going Forward

The above section provides some context for the flooding problems that exist in Carrboro and what has been and is being done. The following recommendations are provided for potential new steps for the Town to pursue going forward. Implementing these steps will need to be tailored to different audiences and partners and will also depend on the resources and capacity that the Town can offer both within and beyond those from Stormwater staff and the Stormwater Enterprise Fund. Ultimately, greater flood/climate change resilience will require community scale efforts and collaborations. All efforts towards more assertively pursuing “nature-based stormwater solutions” will be investments in resilience. The Town should also complete a thorough review of Land Use Ordinance requirements for new development and redevelopment, including infill to ensure that new development does not add to the flooding challenges being experienced. Redevelopment in particular presents an opportunity to improve conditions at the time that new investments are being made.

## References

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## Appendix A: Terminology: Flooding, Stormwater, and More

It is important to develop a common ground for understanding and communicating about the flooding problems in Carrboro and their potential solutions. Terms such as *flooding*, *stormwater*, *drainage*, and *runoff* can be used fairly interchangeably, which can potentially confuse rather than clarify stakeholder understanding. While it is beyond the scope of this document to go into depth on all the relevant terminology, it is important to be clear on the use of a few words.

### Flooding and Stormwater

In this document, the terms *flood*, *flooding*, and *flood mitigation* are specifically defined to refer to the regulated floodplain along the main stem of Carrboro's larger creeks. In contrast, *stormwater* and *stormwater management* are specifically defined to refer to the runoff from developed areas, its impacts, and management outside of a floodplain context. This distinction is important for local, state, and federal regulatory purposes to distinguish between the approaches that can be used for solving problems, and to differentiate the watershed position being referred to. *Stormwater [runoff?]*, as used here, occurs in the areas at higher elevations (ridges and slopes) in the watershed, and flooding occurs at the lower elevations (bottomlands). This is somewhat distinct from common use of these terms, such as "my yard/basement/road flooded," which may or may not have occurred in the regulated floodplain. Additionally, stormwater is distinct from flooding because it refers to runoff in developed areas, including its conveyance and management.

As discussed in the report, the type of flooding has important distinctions. In Carrboro, we experience *riverine* or *overbank* flooding when water overloads a creek channel and rises out into the floodplain. Note that this is a very natural phenomenon—it is what creeks are designed by nature to do. The main source of conflict with humans and development is when we have not adequately accounted for this by placing structures in harm's way. We also experience localized, or urban flooding, which occurs when "the inflow of storm water exceeds the capacity of a drainage system to infiltrate water into the soil or to carry it away."<sup>14</sup> These types of flooding have implications for the types of funding available to remediate damages and the strategies used to address them.

Another distinction that is worthy of clarification is that of a *natural floodplain* versus the *FEMA-regulated floodplain*. A natural floodplain refers to the land adjacent to a stream or river that is inundated by the natural phenomenon of water overbanking. Its extent is a function of the natural topography along creek bottoms. A floodplain has numerous beneficial qualities including natural temporary detention; for this reason, and to reduce risk, development within the floodplain is regulated. A FEMA-regulated floodplain, regulatory floodplain, or 100-year floodplain all refer to the area that is modeled to be inundated by floodwaters during the 1% annual chance of flooding. This is what makes up the Special Flood Hazard Area (SFHA). These

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<sup>14</sup> National Academies of Sciences, Engineering, and Medicine 2019. Framing the Challenge of Urban Flooding in the United States. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25381>.

terms refer to the area immediately outside of the channel that is predicted to be inundated during the “Base Flood Event”. In Carrboro, the regulatory floodplain exists along the major named creeks and up a few tributary arms for a limited distance only.<sup>15</sup>

## Structures, Buildings, and Accessory Structures

The federal definition of a “**structure**”, for floodplain management purposes, is “a walled and roofed building, including a gas or liquid storage tank, that is principally above ground, as well as a manufactured home.”<sup>16</sup> For federal purposes, this term does not include open pavilions, carports, or other structures that do not have at least two rigid walls and a roof.

The term “structure” is *usually* used interchangeable with the term “**building**,” although some differences exist for insurance purposes. For NFIP purposes, a building is “a walled and roofed structure, including a manufactured home that is principally above ground and affixed to a permanent site.”

In the Town Land Use Ordinance Section 15-251.1 Definitions, an “**Accessory Structure** (Appurtenant Structure)” is defined as “A structure located on the same parcel of property as the principal structure and the use of which is incidental to the use of the principal structure. Garages, carports and storage sheds are common urban accessory structures.”

In the NFIP, policies include **building coverage**, for the structure of the building and the things that usually stay with the building when it changes ownership such as utility equipment, built-in appliances, and paneling. It is important to note that detached garages and other appurtenant structures must be insured under a separate policy. Additionally, **contents coverage** exists for removable items inside an insurable building, though there are limitations, especially when applied to items in basements.

Based on the above definitions and for purposes of this document, the following definitions apply:

**Building:** a walled and roofed structure or manufactured home that is principally above ground, which are typically insurable under NFIP. Examples include a single-family home, manufactured home, office, or apartment complex.

**Accessory structure:** a structure located on the same parcel of property as the principal structure, and the use of which is incidental to the use of the principal structure, which may or may not be insurable. Examples include a shed, detached garage, or carport.

**Living areas:** parts of a building which are typically occupied as part of the primary use of the building. Examples include a living room, kitchen, studio, or bedroom.

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<sup>15</sup> <https://tocgis.ci.carrboro.nc.us/Carrboro/Floodplain/>

<sup>16</sup> This language is presented almost verbatim in the Town Land Use Ordinance Section 15-251.1 Definitions section

**Unoccupied areas:** parts of a building which are typically unoccupied as part of the primary use of the building but are physically attached to the structure. Examples include a basement or crawlspace.

## Green Infrastructure

Green infrastructure (GI) is presented as an alternative to grey infrastructure—the systems of stormwater conveyance structures made up of curb and gutter, inlets and catch basins, and pipes and culverts. GI was defined by Congress in the Water Infrastructure Improvement Act of 2019 as “the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspire stormwater and reduce flows to sewer systems or to surface waters.”<sup>17</sup> Examples of GI include green roofs, tree planting, bioretention and infiltration devices, permeable pavement, and water harvesting. These practices result in an array of co-benefits, above and beyond the flood resilience related benefits. Ultimately, they point to a larger percentage of rainfall being infiltrated into the ground, intercepted by vegetation, evapotranspired, harvested for use, and, if necessary, temporarily stored and slowly released.

These concepts are easiest to implement as part of the planning and design of new development. The process of making modifications to existing development is called “retrofitting”. Examples of the GI retrofits include: removal of existing impervious paving or conversion to permeable pavement; conversion of higher runoff areas to lower runoff areas through landscaping and improvements in soil quality; disconnection of impervious surfaces such as roof drains to allow runoff to soak into the soil and pass through vegetated buffers; rain gardens, also known as bioretention, and similar bioswales that increase infiltration and can also be landscape amenities; cisterns and rain barrels; and green roofs. At a neighborhood scale, GI could include open space or stormwater wetlands.

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<sup>17</sup> <https://www.congress.gov/115/plaws/publ436/PLAW-115publ436.pdf>

## Appendix B: Resources for More Information

### **Toms Creek page on Carrboro website:**

<http://www.townofcarrboro.org/1227/Toms-Creek>

*Includes links to reports, presentations, and other resources. Updated as new information becomes available.*

### **Relevant Carrboro Board of Aldermen and Town Council Agendas**

*Note that in addition to the below agenda items, monthly stormwater reports have been provided on the 3<sup>rd</sup> Tuesday of each month in 2020, 2021 and 2022.*

10/15/2013: <https://bit.ly/3mdZOPo>

*Purpose: approve FEMA grant opportunity for flood mitigation assistance for three residential properties.*

11/12/2013: <https://bit.ly/3gbUc4l>

*Purpose: recognize dozens of Town employees for June 20, 2013 storm event response.*

2/11/2014: <https://bit.ly/3xWfV1z>

*Purpose: discuss possible future changes to storm water design standards in light of recent flooding issues and concerns about climate change.*

5/20/2014: <https://bit.ly/3snanAT>

*Purpose: update on various flooding issues. Fiscal impact of technical analyses: \$4,000 to \$5,000*

9/16/2014: <https://bit.ly/3yWHxto>

*Purpose: update on various flooding issues*

5/19/2015: <https://bit.ly/3ga3JJJa>

*Purpose: update on various flooding issues*

1/7/2016: <https://bit.ly/3k5G9yF>

*Purpose: update on various flooding issue, including: overview of rainfall and stream gage data; resources and assistance available to people affected by storms; reports of flooding-12/2015; preliminary engineering/CIP estimates; flood mitigation grant status; funding options/assessment authority*

8/31/2016: <https://bit.ly/3yV9v90>

*Purpose: accept FEMA HMGP grant funds for acquiring two properties and elevating two properties.*

3/5/2017: <https://bit.ly/2VUddSb>

*Purpose: Board retreat dedicated to receiving information on and discussing the current responsibilities, requirements, and programs/services related to stormwater management in Town.*

6/6/2017: <https://bit.ly/3k4NYnU>

*Purpose: establish a new Stormwater Utility to administer Carrboro's stormwater management program.*

9/5/2017: <https://bit.ly/3CVj8qz>

*Purpose: create a new Stormwater Advisory Commission to provide oversight for Carrboro's stormwater management program*

9/26/2017: <https://bit.ly/3xOFTc9>

*Purpose: public hearing on Land Use Ordinance text amendments related to flood damage prevention provisions*

3/13/2018: <https://bit.ly/3k13TDT>

*Purpose: update on establishment of Stormwater Utility and pursuit of rate study.*

5/15/2018: <https://bit.ly/3g7ZLkc>

*Purpose: public hearing on proposed Stormwater Utility rate structure*

6/5/2018: <https://bit.ly/3m9RfoF>

*Purpose: adopt a rate structure and interlocal billing agreement to collect stormwater fees*

4/23/2019: <https://bit.ly/3AOSH45>

*Purpose: provide a report related to flooding concerns associated with several properties*

6/25/2019: <https://bit.ly/3iTS43a>

*Purpose: accept additional FEMA HMGP funds for the elevation of two properties on Lorraine Street*

9/10/2019: <https://bit.ly/37Rp1XG>

*Purpose: provide a report on stormwater activities and service delivery; request approval of a pilot outreach project in the upper Toms Creek watershed; and request direction to report back on the new revenue needed for increases in service delivery.*

1/21/2020: <https://bit.ly/3ARXtO2>

*Purpose: amend the stormwater utility rate structure to raise additional revenue.*

5/5/2020: <https://bit.ly/37S362k>

*Purpose: receive a report from the Center for Neighborhood Technology regarding their RainReady study*

6/15/2021: <https://bit.ly/2W3a3ew>

*Purpose: approve public stormwater infrastructure improvements along High and West Main Streets.*