

MID-CAROLINA
REGIONAL
PORTFOLIO OF
**RESILIENCE
PROJECTS**



**MID-CAROLINA
REGIONAL COUNCIL**

 **NCORR**

NORTH CAROLINA OFFICE OF RECOVERY AND RESILIENCY



EQUAL HOUSING
OPPORTUNITY

RISE

Regions Innovating for Strong
Economies and Environment



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A Letter from the COG



December 12, 2022

Dear Mid-Carolina Residents,

The Mid-Carolina region, encompassing Cumberland, Harnett, and Sampson Counties, is dynamic and evolving to meet the needs of its residents, employees, and visitors. However, natural hazards continue to challenge and impact the region's social, environmental, and economic systems and infrastructure. The region has been working diligently through collective action and proactive planning efforts to reduce the impacts of future natural hazard occurrence.

The Mid-Carolina region has developed a Regional Resilience Project Portfolio in response to climate exacerbated natural hazards. The actions proposed in the portfolio address the major concerns identified in the Mid-Carolina's Vulnerability Assessment. The Resilience Project Portfolio provides an in-depth project overview and implementation pathway for each proposed project. The projects identified in the portfolio represent needs identified through numerous meetings and input from residents, elected officials, and local leaders with assistance from the North Carolina Office of Resiliency, the North Carolina Rural Center, ESP Associates, and Mid-Carolina Regional Council of Government.

As you read through the Mid-Carolina's Portfolio of Projects, think about how, if implemented, these projects will improve the quality of life in our communities and better prepare us for the immediate and long-term future.

Sincerely,



Justin B. Hembree
Executive Director

6205 Raeford Road
Fayetteville, North Carolina 28304
910-323-4191



INTRODUCTION 01

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022



INTRODUCTION

North Carolina's residents, businesses, nonprofits, and governmental organizations are increasingly concerned by the growing frequency and intensity of heat waves, storms, changing precipitation patterns and their impacts. These weather events frequently impact areas beyond individual jurisdictional boundaries. The North Carolina Office of Recovery and Resiliency (NCORR), with staff support from the North Carolina Rural Center (NC Rural Center), created the Regions Innovating for Strong Economies and Environment (RISE) program to encourage and assist communities in a regional scale coordination to identify vulnerabilities and solutions. The Regional Resilience Portfolio of Projects was developed for the Mid-Carolina Region which includes Cumberland, Harnett and Sampson Counties and the municipalities within those counties.

About Rise

NCORR's RISE program supports resilience in North Carolina by:

- Facilitating the Regional Resilience Portfolio Program, which provides coaching and technical assistance for regional partners in the eastern half of North Carolina to build multi-county vulnerability assessments, identify priority actions that reduce risk and enhance resilience in the region and develop paths to implementation.
- Developing the North Carolina Resilient Communities Guide, a statewide resource that will provide tools, guidance and opportunities for building community resilience.
- Hosting the Homegrown Leaders program, an NC Rural Center leadership training workshop that operates in eastern North Carolina to emphasize resilience as a tool for community economic development.

RISE is funded by the U.S. Economic Development Administration, U.S. Department of Housing and Urban Development's CDBG-MIT program and in-kind support from NCORR and NC Rural Center. In addition, the Duke Energy Foundation committed \$600,000 in grant funding to support the Regional Resilience Portfolio Program.

The RISE Regional Resilience Portfolio Program covers nine areas that align with the North Carolina Council of Government regions seen in **Figure 1**.

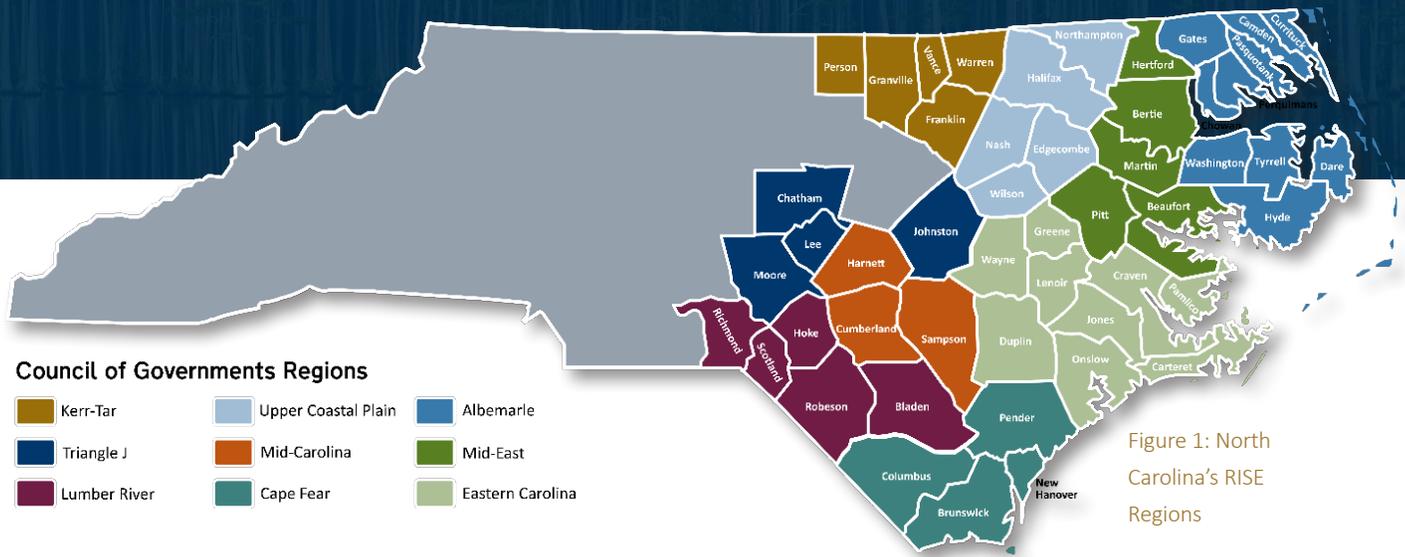


Figure 1: North Carolina's RISE Regions

This Portfolio of Projects is a compilation of six projects identified through community input and stakeholder engagement. The portfolio document outlines funding opportunities and potential project partners to enable a clear path toward implementation for each project.

Land Acknowledgment

We wish to acknowledge and honor the Indigenous communities native to this region and recognize that the Mid-Carolina Resilience Portfolio covers communities and structures that are built on Indigenous homelands and resources. We recognize the Catawba, Cohaire, Lumbee, Skarureh/Tuscarora people and the Cumberland County Association of Indian People as past, present and future caretakers of this land. We also recognize the unnamed tribes that once oversaw these lands and have since relocated or been displaced.

Objectives

The goal of the Portfolio of Projects is to identify priority actions that reduce risk and enhance resilience in the region with clearly identified steps, or pathways, to implementation. This final product includes a set of priority actions that have been selected based on their high impact toward achieving resilience across the region. Additionally, these actions were selected based on the feasibility of implementing in the near- to medium-term. The goal is to produce shovel-ready actions that include detailed implementation pathways to leverage state and federal funding opportunities while establishing partnerships and increasing collaboration.



Development Process

The actions included within this Portfolio of Projects were developed using existing planning documents, Stakeholder Partnership¹ suggestions, input from the public and professional expertise of the planning team. There is some overlap between the proposed actions and existing plans. However, many of the actions included within the portfolio were identified during the stakeholder outreach component of the planning process.

The development of the Climate Hazard Vulnerability Assessment (Vulnerability Assessment) for the Mid-Carolina Region served as a strong basis for action building and brainstorming. The Vulnerability Assessment was used to identify the challenges to resilience caused by natural hazards and climate change. Projects were initially developed at the county-level through county-specific breakout groups during Stakeholder Partnership meetings. Additionally, projects were identified through existing multi-county hazard mitigation plans and the Resilient Redevelopment Plans completed following Hurricane Matthew for Cumberland, Harnett, and Sampson Counties. Based on shared concerns, common themes began to arise for the region. These common themes helped develop a foundation for the region-wide actions contained in this portfolio.

The projects went through a series of analysis, discussion and scoring to further refine and prioritize actions most likely to increase resilience throughout the Mid-Carolina Region. Several Stakeholder Partnership meetings were designated for the discussion and revision of proposed actions. During these meetings, stakeholders were given the opportunity to incorporate specific details, such as location, to portray the full potential of the action. They also had the opportunity to object, modify, or propose new actions more appropriate to address the common issues caused by natural hazards in the region.

The initial list of proposed actions was comprised of seventeen regional strategies. To further refine this list, stakeholders were asked to rank the action's priority using the following scoring matrix: "high priority", "low priority", or "unsure." Six actions were identified as "high priority" by stakeholders. These actions were then built out through stakeholder discussion, professional expertise, and research to ensure feasibility

¹The Mid-Carolina Stakeholder Partnership (membership and frequency of meetings) is discussed in more detail in the Climate Hazard Vulnerability Assessment for the Mid-Carolina Region.

After the list of projects was solidified, follow-up discussions were scheduled with potential lead implementers and individuals with relevant expertise. This information was used to help formulate implementation pathways or strategies that will lead to successful implementation of the actions. The Resilience Portfolio provides “package-ready” projects that are feasible and ready for funding from various sources specific to each of the proposed projects.



Figure 2: Mid-Carolina Regional Resilience Portfolio, Public Meeting #2 in Dunn, NC

Selection of Priority Projects

The figure below displays the six priority projects developed to strengthen the resilience of the Mid-Carolina Region. These six multi-faceted projects were selected to reduce impacts of extreme heat and flooding, prioritize equity and sustainability, and combat the impacts of climate change. They are described in greater detail in the Projects section later in this document.



Project 1

Implement one GI pilot project in each of the three counties to address issues with flooding and improve infiltration



Project 2

Implement a heatwave early warning system to forecast heatwave events and trigger a heatwave action plan



Project 3

Install additional stream gauges/sensors to improve flood forecasting and warning across the region



Project 4

Conduct a feasibility assessment for backup power installation in marginalized communities



Project 5

Complete stream debris/vegetation removal throughout the region



Project 6

Develop a Climate Equity Index tool to document neighborhood-level vulnerability to climate impact

Figure 3: Snapshot of Priority Projects (Note: “GI” under project 1 is an acronym commonly used for green infrastructure)



VULNERABILITY ASSESSMENT SUMMARY

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022

CLIMATE VULNERABILITY ANALYSIS

The full Climate Change and Natural Hazards Vulnerability Assessment was used to identify the challenges to resilience that the region faces as a result of natural hazards and climate change. The Vulnerability Assessment in its entirety is located on the project website at: [Mid-Carolina Vulnerability Assessment](#). The following narrative provides a summary overview of the Climate Hazard Vulnerability Assessment for the Mid-Carolina Region.

Overall Takeaways

Flooding and Heavy Precipitation Events

Localized flooding remains the largest concern for communities located in the Mid-Carolina Region. With several notable streams and rivers, flash flooding and riverine flooding due to heavy precipitation events were a common concern for all three counties. More specifically, the following waterways were identified as hot spots² for flooding: Black River, South River, Little River, Great Coharie Creek, Rockfish Creek, Mingo Swamp, and Hanna's Pond. As the climate warms, heavy precipitation events are anticipated to increase in magnitude and frequency, thereby heightening the chance of flash flooding and riverine flooding throughout the region.

Hurricane and Storms

The magnitude and impact of hurricane and tropical storm events have made them a focal point in local emergency planning and preparedness efforts in the region. Many jurisdictions have taken appropriate action to mitigate against the extreme effects of hurricane and storm events through regularly updated hazard mitigation plans and resilient redevelopment plans post



² Hotspots are areas at relatively high risk of loss from one or more natural hazards. Dilley, M. et al., 2013. *Natural Disaster Hot Spots: A Global Risk Analysis*. <https://doi.org/10.1596/0-8213-5930-4>

Hurricane Matthew. Much of the severe flooding experienced in the Mid-Carolina Region has been a bi-product of a hurricane related rainfall flooding. Recent hurricanes Hurricane Matthew (2016) and Hurricane Florence (2018) resulted in damage ranging from minor to destruction of homes, businesses, critical infrastructure, and agricultural crops. These events have resulted in vigilant and ongoing planning efforts, which heighten the region's overall resilience.

Extreme Temperatures, Including High Heat Index

Extreme heat continues to plague the Mid-Carolina Region and is only expected to intensify. Interestingly, the geographic location of the region as part of the Sandhills magnifies heat vulnerability because of the soil composition. Additionally, although technically considered part of the Coastal Plain, the Mid-Carolina Region does not benefit from the coastal breeze or cooler temperatures associated with many coastal communities. Urban heat island effect is an issue of concern particularly in the City of Fayetteville. However, it was noted that rural communities are at even greater risk. This is partly due to larger distances between critical infrastructure and resources as well as the large agricultural sector in these remote communities. Overall, preparation and response to extreme heat events in the Mid-Carolina Region is minimal.

Wildfire and Drought

Wildfire and drought are anticipated to increase in magnitude and frequency in the region like most of North Carolina. The projected increases in wildfire largely depend on future development into the wildland urban interface (WUI). In accordance with development trends and growth, Fayetteville appears most at risk in Cumberland County when compared to other municipalities. Risk in Harnett County is moderate with clustered areas at greater risk than others. These clusters form around municipalities including Lillington, Erwin, Coats, and the southwest portion of the county. As a result of its rural landscape, Sampson County is at relatively low risk to wildfires when compared to Cumberland and Harnett County.

Hazard Impacts

The Vulnerability Assessment analyzed natural hazards on the five following sectors: housing, critical infrastructure, economic development assets, public health, and cultural and historical resources. NCORR selected these five sectors provide a representative overview of the natural and built environment, regional character, top industries, and housing stock. In sum, flooding from hurricane and heavy precipitation events can result in severe property and structural damage and extreme heat is the most detrimental to public health. All identified hazards impact daily life for on the community. Other non-climate factors that challenge resilience noted in the Vulnerability Assessment include: increased development, aging and undersized infrastructure, access to resources and funding opportunities, collaboration between local governments, complex recovery programs, limited outreach and awareness programs, and outdated flood insurance maps.

Table 1 is intended to give a broad overview of potential impacts caused by natural hazards on the five identified sectors. The summary of potential impacts is intended to provide context to the reader since the projects were developed in response to the region's major vulnerabilities. An in-depth analysis of these findings can be found in the precursory Vulnerability Assessment.

SUMMARY OF NATURAL HAZARD IMPACTS

<p>1. Impacts on Housing</p> <p>Property damage ranging from minor to destruction from flooding. Hurricanes Matthew and Florence were mentioned because of the great impact on homes, business, and roadways.</p> <p>Mobile homes are at a greater risk to flooding because they are typically located in hot spots and house vulnerable populations.</p> <p>Extreme heat results in increased energy costs heightening the burden for economically disadvantaged populations.</p> <p>Homes located or being developed in the wildland urban interface (WUI) are at a great risk of wildfire.</p>
<p>2. Impacts on Critical Infrastructure</p> <p>Natural hazards pose the risk of disrupting or seizing operation of critical facilities during a disaster.</p> <p>Fire stations, schools, and law enforcement facilities are located in the floodplain heightening the risk to flood exposure and ability to function as a critical facility if impacted impeding local government response.</p> <p>Highway flooding (particularly I-95) is a major concern throughout the region because it cuts off main transportation corridors for evacuation or emergency personnel. Efforts are underway to elevate portions of I-95.</p> <p>Critical facilities may experience brownouts or blackouts due to impacts on critical power and transmission lines during a natural hazard occurrence.</p> <p>Damage to critical facilities such as wastewater treatment plants or electrical facilities can interrupt power and water services.</p>
<p>3. Impacts on Economic Development Assets</p> <p>Road closures due to flooding can limit access between existing business and residential areas negatively impacting sales and operation.</p> <p>Several of the top employers within the region are found in the 500-year floodplain including: Cumberland County, Veterans Administration, and Food Lion putting them at increased risk of flooding and potential disruption post event.</p> <p>Hazard occurrence may result in decreased tourism and lower property values.</p> <p>Businesses may face personal hardship including temporary and permanent closures due to impacts from natural hazards.</p>
<p>4. Impacts on Public Health</p> <p>Natural hazards can cause injury, loss of life, displacement of residents, and longstanding mental health issues.</p> <p>Extreme heat is the leading cause of weather-related deaths globally and state-wide.</p> <p>Heat, drought, and wildfire diminish air quality within the region.</p> <p>Smoke and air pollution pose a high risk to vulnerable populations with underlying conditions.</p> <p>Waterborne illness can be pervasive in impacted flood areas.</p>
<p>5. Cultural and Historic Resources</p> <p>Historic properties are vulnerable to the impacts of natural hazards due to aging infrastructure and poor conditions.</p> <p>The region has a total of 139 historic properties.</p> <p>There are 36 historic properties located in the 500-year floodplain, 28 of which are in Cumberland County.</p> <p>Damage or destruction of these resources reduces quality of life, community character, tourism, and economic opportunity in the region.</p>

Table 1: Summary of Key Findings from the Vulnerability Assessment

Regional Themes

Social Vulnerability

Stakeholders across the region unanimously voted in favor of projects and policies that analyze and address social vulnerability. In addition to existing census data, a collaborative effort with local leaders and staff helped identify vulnerable populations throughout the region based on a variety of factors (age, language, income, etc.). Cumberland and Sampson County identified several populations and communities while Harnett County expressed interest in gaining a better understanding of the county's socially vulnerable populations. The goal being to ensure the Portfolio has a positive impact on all communities with an emphasis on populations that have been traditionally overlooked.

North Carolina Social Vulnerability- 2018 CDC SVI Index Overall Scoring

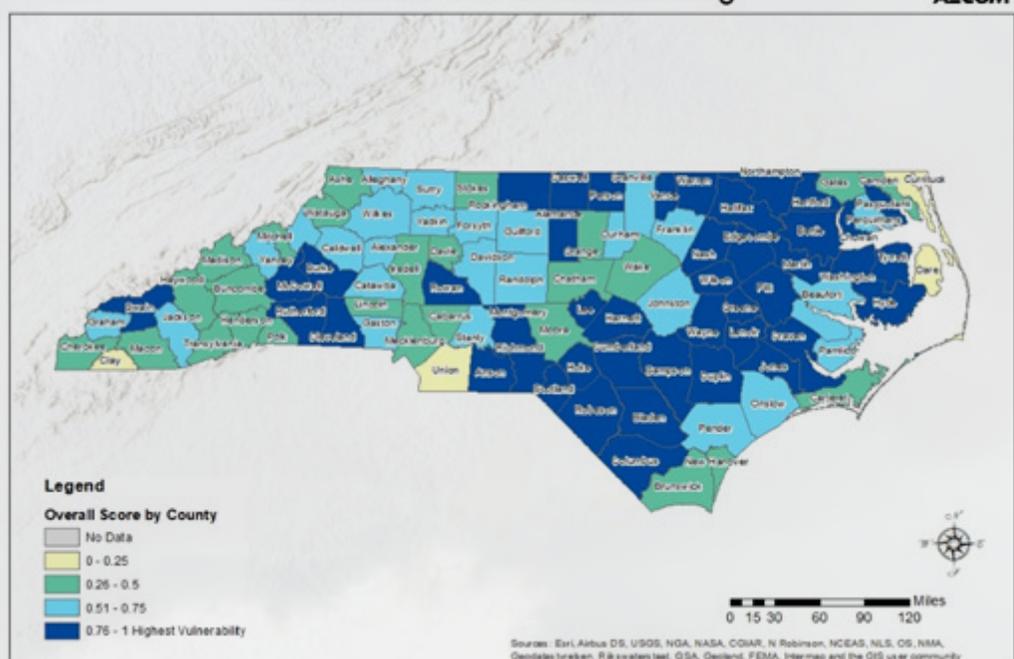


Figure 4: CDC SVI Scores by County in North Carolina

Based on the Centers for Disease Control's (CDC) Social Vulnerability Index (SVI), the Mid-Carolina Region has a *Medium High Level (4)* of vulnerability based on the scorecard definitions. For more information on the CDC's Social Vulnerability Index visit: [CDC/ATSDR SVI Fact Sheet](https://www.cdc.gov/atsdr/svi/fact-sheet/). Within the region, Sampson County has the highest level of vulnerability. It was noted during several stakeholder partnership meetings that Sampson County has an extremely large Spanish-speaking population. According to Census data, more than 9,000 residents in the county speak English less than well. Sampson County

expressed interest in establishing a liaison for the community to enhance consistent communication. The CDC SVI scores for the Mid-Carolina Region are (See **Figure 1**):

- Cumberland County: High Level of Vulnerability (0.864)
- Harnett County: High Level of Vulnerability (0.789)
- Sampson: High Level of Vulnerability (0.9723)

Sustainability

Sustainability was another reoccurring theme found within the Vulnerability Assessment. The ability to recover and adapt strongly relies on sustainability and sustainable development. Sustainability looks at how current generations can meet their needs without compromising that ability for future generations³. In the face of climate change, stakeholders were overwhelmingly supportive of implementing sustainable measures to spark a much-needed change, brainstorm innovative solutions, and strengthen the region's resilience. Sustainability is often interpreted as solely an environmental term. However, this concept encompasses human, social, economic, and environmental sustainability all of which coincide with the sectors previously examined: Housing, critical infrastructure, economic assets, public health, and cultural and historical resources.

Quality of Life

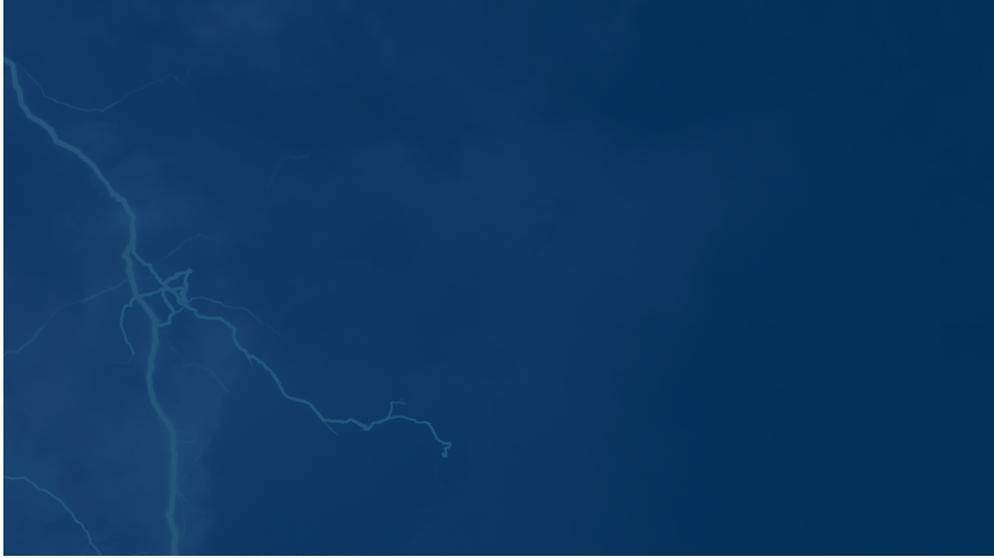
The World Health Organization defines quality of life as "an individual's perception of their position in life in the context of the culture, standards, and concerns." The Portfolio is geared toward regional resilience. However, individual resilience is an underlying factor. When a natural hazard occurs, an individual's perception of the natural hazard is based on their personal experience ranging from no loss to complete devastation. For example, although flooding may have occurred region-wide, individuals were impacted at different levels of severity. That degree of severity has health, social, and economic implications, which can ultimately dictate overall quality of life. Increasing resilience region-wide, with priority given to those most vulnerable, is intended to improve the quality of life for those who live, work, or visit the Mid-Carolina Region.



Figure 5: Image Depicting the Interconnectivity Between the Many Factors that Play into Sustainability, Resilience, Inclusion, and Quality of Life. Source: Quality of Life Hub (statcan.gc.ca)

³ Carnow, Adam. (2022). *Esri. Resilience and Sustainability, the definitions, differences, and applicability of GIS. Resilience and Sustainability, the Definitions, Difference, and Applicability of GIS (esri.com)*

⁴ World Health Organization. *WHOQOL: Measuring Quality of Life. WHOQOL - Measuring Quality of Life | The World Health Organization*



Resilience Assets

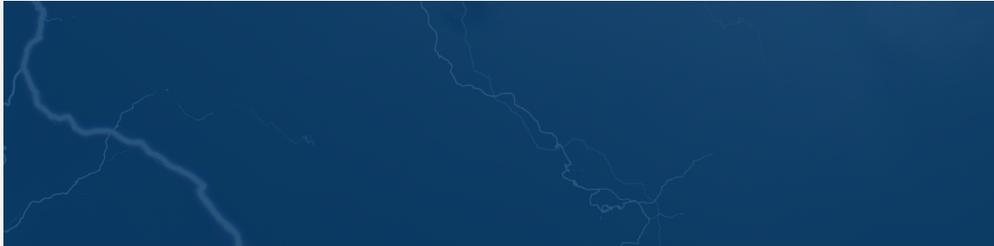
Previous Planning Efforts

Programs and policies have been put into place at federal, state, and local levels to foster local planning efforts aimed at confronting the most prevalent hazards. As a result, the region and the state are better equipped to address weather events that turn disastrous. Existing resources serve as a strong foundation to support future projects and plans.

Table 2 provides a listing of the plans that were reviewed to inform the Vulnerability Assessment.

Existing Plans for Integration/Consideration
Local Hazard Mitigation Plans – Each county has an active hazard mitigation plan. Vulnerabilities and mitigation strategies were reviewed.
Hurricane Matthew Resilient Redevelopment Plans – Following Hurricane Matthew, Cumberland, Harnett, and Sampson County (along with other counties) created hurricane/flood specific resilience plans.
Cumberland County Climate Resiliency Plan – Drafted by Sustainable Sandhills, this plan outlines the priority climate impacts faced in Cumberland County and lays out a Strategic Action Plan.
Community Health Assessment – Updated every three years by each county, this plan identifies major health trends, needed resources, and opportunities related to improving the health of Cumberland, Harnett, and Sampson Counties.
Capital Improvement Plans- By informing capital improvement planning through techniques that incorporate information from extreme weather and climate hazards there is potential to increase resilience.

Table 2: Existing Plans Used in Drafting the Vulnerability Assessment Based on their Relevance to Resilience



High-Capacity Local Emergency Management Programs

The Emergency Management Departments in the region play a crucial role in resilience building. One of the goals of these departments is to prevent and protect the community from natural hazards. Emergency Management is a coordinated effort involving local, state, and federal government agencies as well as volunteer organizations; and within an integrated emergency management framework, these entities assist residents and their communities to prepare for, respond to, recover from, and eliminate or reduce the impacts of natural disasters. Important responsibilities that are carried out by Emergency Management that increase regional resilience include alerting residents via public notification systems, calling out cooling stations throughout the region, maintaining Emergency Operations Plans, and performing routine maintenance.

Year	Disaster Number	Description	Cumberland County	Harnett County	Sampson County
1968	234	Severe Ice Storm		X	
1984	699	Severe Storms and Tornadoes	X		X
1984	724	Hurricane Diana			X
1996	1087	Blizzard of 96		X	
1996	1134	Hurricane Fran	X	X	X
1998	1240	Hurricane Bonnie			
1999	1292	Hurricane Floyd	X	X	X
2000	1312	Severe Winter Storm		X	
2003	1448	Severe Ice Storm		X	
2003	1490	Hurricane Isabel	X	X	X
2004	1546	Tropical Storm Frances	X		
2011	1969	Severe Storms, Tornadoes and Flooding	X	X	X
2011	4019	Hurricane Irene			X
2016	4285	Hurricane Matthew	X	X	X
2018	4393	Hurricane Florence	X	X	X
2019	4465	Hurricane Dorian			X
TOTALS		Mid-Carolina Region Total: 16	8	10	10

Table 3: Presidential Disasters in the Mid-Carolina Region

Source: Data were obtained from FEMA.

Efforts Underway

The towns, cities, and counties that comprise the Mid-Carolina Region are continuously applying for grant funding to enhance resilience both locally and regionally. Throughout the Stakeholder Partnership discussions, it was noted that several communities applied for state and federal assistance to fund local resilience initiatives. Although some were unsuccessful, others were awarded for their efforts and received or anticipate funding in upcoming years. Funding will be used to add additional stream gauges, conduct stream debris removal, create wastewater master plans, and the creation of a cost-benefit analysis for green infrastructure. These efforts will be referenced and discussed in greater detail within each project description based on its relevance and applicability to the action being proposed.

Previous Disaster Experience

Disaster declarations provide initial insight into the hazards that will likely continue to impact the Mid-Carolina Region. Since 1968, sixteen presidential disaster declarations have been reported in the Mid-Carolina Region, as seen in the table below. This number includes 10 declarations related to hurricanes and tropical storms and four declarations related to winter storms. The others were related to severe storms, tornadoes, and flooding.

Drought events do not typically reach the level of presidential declaration, but there has been one Emergency Declaration for drought in the Mid-Carolina Region (in 1977 for Harnett County). Emergency Declarations provide federal assistance for responding to the event, but do not provide long-term recovery assistance that comes with a presidential declaration. In 2007, the State of North Carolina was plagued by warm temperatures and drought. Based on the statistical drought measures, the 2007 drought rivaled or exceeded the drought of 1925, which had long been viewed as the worst drought in North Carolina. August 2007 finished as the second warmest and second driest on record. By the beginning of September, more than 60% of the state was classified in Extreme Drought conditions. Conditions worsened into early October where 37% of North Carolina was classified in Exceptional Drought.





PROJECTS

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022

The following pages provide summaries and proposed implementation pathways for the six high priority resilience projects identified for the region.



PROJECT 1

GREEN INFRASTRUCTURE COUNTY PILOT PROJECTS

Mid-Carolina Regional Portfolio of Resilience Projects
Draft December 2022

PROJECT 1: GREEN INFRASTRUCTURE COUNTY PILOT PROJECTS



I. PROJECT OVERVIEW

Project Scope

The scope of this project will be to implement one (1) green infrastructure project in each of the three (3) counties in the Mid-Carolina Region (Cumberland, Harnett, and Sampson) to address issues of local vulnerability and bolster resilience against natural hazards. All three project sites were identified as problem areas in the Vulnerability Assessment for the Mid-Carolina Region. The pilot projects will exhibit the co-benefits offered by green infrastructure to

neighboring communities. Each county's pilot project will incorporate different mechanisms of implementation, providing ample information for neighboring areas and municipalities to learn from and replicate.

Implementation will occur and will be prioritized in identified problem areas using floodplain mapping, and social vulnerability data. Additionally, ground-truthing data obtained from Stakeholder Partnership meetings, the public survey, the interactive mapping tool, public meetings, and the virtual meeting room was used to support equitable and sustainable outcomes.

A general summary of each of the three green infrastructure projects is provided below

Cumberland County

Partners will work to implement a "green street" stormwater management project located in the Town of Spring Lake. This project will incorporate vegetation (perennials, shrubs, trees), soil, and innovative stormwater systems to slow, filter, and clean stormwater runoff from impervious surface. Prior to the implementation process, an assessment will be conducted using secured FEMA funds to assess existing wastewater and stormwater infrastructure, including stream tributaries, in Spring Lake. This assessment will be used to identify the feasibility and exact location of potential stormwater management solutions needed to address flooding. The Town would like to approach this project with an emphasis on green infrastructure and low impact development solutions. The assessment will be the Phase I of the project and the proposed green street project installation will be Phase II. Additional funding is needed to implement this second phase of the project.

The Town of Spring Lake was decimated by flooding from Hurricanes Matthew (2016) and Florence (2018). The Town experienced heavy rainfall and record-breaking flooding. Stream gauges measured the floodwaters at almost 31 feet during Matthew, breaking a record set in 1945. In the wake of the storm, property owners found their properties destroyed and extensive infrastructural damage. The Town is still finding long term issues due to flooding including sinkholes on roadways, and erosion and debris in the river and creeks.

Spring Lake is home to Fort Bragg Military Base and Pope Army Airfield. Additionally, the Town's wastewater treatment facility, located approximately 400 feet from Little River, was flooding for the first time. According to

the National Oceanic and Atmospheric Administration’s Storm Events Database, this area has been impacted by flooding five times in the last ten years. The green street project would increase infiltration, reduce stormwater runoff, and limit flooding to protect critical infrastructure, residential properties, and ensure economic vitality.

Harnett County

Incorporate green infrastructure at Hanna’s Pond, near Dunn, North Carolina, and the floodplain immediately south of the dam. The goal of this project is to modernize the dam, located at Hanna’s Pond, and restore the existing floodplain. Work by Carolina Wetlands Association is currently underway within the Stony Run Corridor to support a healthy watershed, help manage stormwater runoff from upstream land use, and provide community benefits. Hanna’s Pond and the floodplain located south of the dam are part of a larger scope project within the corridor/watershed.

Carolina Wetlands Association has secured funding from the North Carolina Land and Water Fund for Phase I that will incorporate planning and engineering, data collection, and community engagement efforts focusing on a section of Stony Run between US 301 and I-95. The rehabilitation project of the 28-acre, Hanna’s Pond will seek to modernize this over 100-year-old dam to ensure dam safety and combine the improvements with nature-based techniques to both reduce flood risk and increase resilience. This dam has suffered in recent years due to the increased pressures of nearby development and climate-change intensified storms.

Hanna’s Pond has a drainage area of 3,860 acres. The original floodplain and meandering stream downstream of the dam have been altered, which has reduced the capacity of the floodplain to function properly. Phase II, proposed in this portfolio, will include extensive repairs that feature nature-based solutions including the repair of the earthen embankment, the installation of a modern water control structure, dredging of legacy sediment deposits, floodplain restoration, and wetland plantings throughout the lake and floodplain.

Sampson County

Sampson County is interested in integrating green infrastructure in two communities to address flooding concerns.

Ivanhoe Community

The first is located in Ivanhoe, a small farming community. The County would like to conduct a study to identify the causes and potential solutions of flooding. This area has experienced repetitive flooding in recent years due to Hurricanes Matthew and Florence with access being cut off to the community and some residents having to be airlifted out of the area. Incorporation of green infrastructure as potential solutions to the flooding issues in the community is welcomed.

Newton Grove Community

The second area under consideration for a green infrastructure pilot project is the town of Newton Grove. The County is open to further investigation and study of this problem area and potential integration of green infrastructure in this area. In 2018, the United States Army Corps of Engineers (USACE) completed a study that identifies known flooding problems and suggests potential solutions to alleviate the flooding. According to the study, Newton Grove has experienced flooding from recent hurricanes largely due to inadequate drainage.

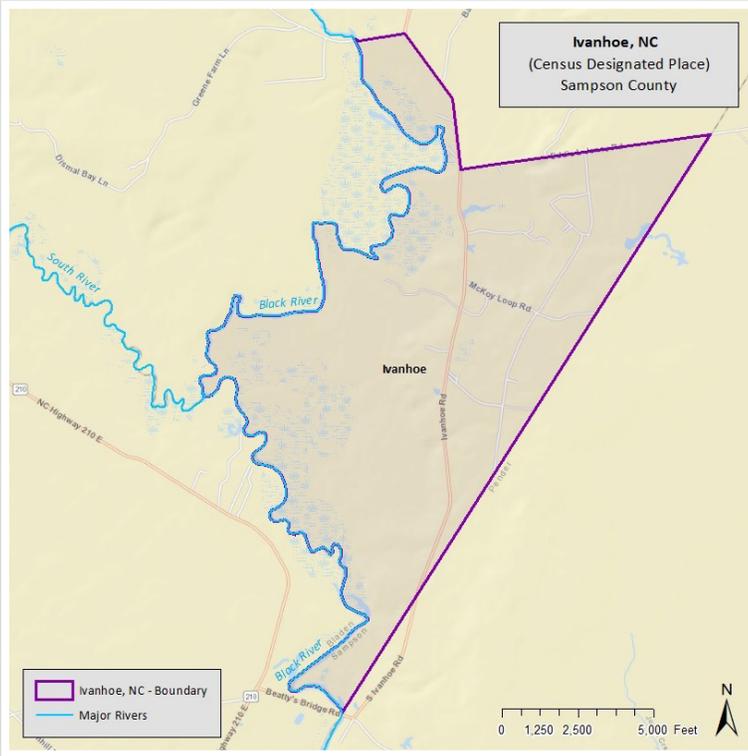


Figure 7: Project Site Location for Sampson County Green Infrastructure Project – Ivanhoe

Sampson County

The two locations under consideration for Sampson County are described in greater depth below.

Ivanhoe Community

Ivanhoe is a census-designated place (CDP) located in southern Sampson County with a population of 229 as of 2020. The town is situated on low-lying topography and is near two large waterways. The Black River and South River merge in the eastern portion of this community heightening its susceptibility to flooding.

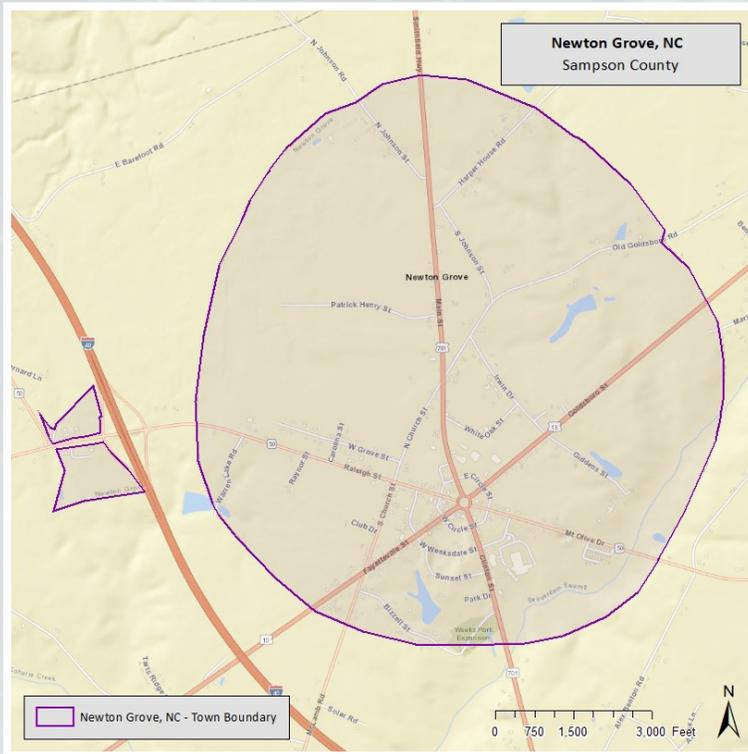


Figure 8: Project Site Location for Sampson County Green Infrastructure Project – Newton Grove

Newton Grove Community

Newton Grove is a small town located in Sampson County near the northern boundary. The Town has a total population of 565 as of the 2021 Census. Three major highways intersect the Town Center including US 701-Highway, US-13 Highway, and NC Route 50. The Town Center acts as a roundabout for the three major roadways.

Vulnerabilities Addressed

This project addresses flooding vulnerability throughout the region, which was the primary hazard of concern found in the Vulnerability Assessment for the Mid-Carolina Region.

Table 4 provides an overview of information gathered from Stakeholder Partnership (SP) and Public Meeting discussions that directly corresponds with the proposed pilot projects.

Input Gathered	Source	County
There is a need to assist smaller communities due to limited capacity and the need for additional assistance with all phases of the disaster cycle.	SP Meeting #1	All Counties
Stormwater is a large issue. Overall drainage is insufficient.	Public Meeting #1	Cumberland
The last major storm resulted in flooding of/nearby Lower Little River	SP Meeting #3	Cumberland
County EM explained a project in Spring Lake would be beneficial for Spring Lake, Fayetteville, Harnett & Cumberland Counties, and Fort Bragg	SP Meeting #5	Cumberland
Carolina Wetlands Association is completing a project in Harnett County that should promote county and regional resilience	SP Meeting #1	Harnett
A planning grant has been awarded for mitigation on Stony Run on the eastern side of Dunn (roughly two miles above I-95)	SP Meeting #3	Harnett
A tree planting requirement for new development was proposed to address urban heat island effect	SP Meeting #3	Harnett
The southern boundary of Harnett County near Lower Little River is a problem area as it is low-lying	SP Meeting #3	Harnett
Ivanhoe experiences repetitive flooding because the Black River runs through this community	SP Meeting #3	Sampson
Route 701 in Newton Grove on near the south end of town has flooded in the past	SP Meeting #3	Sampson

Table 4: Information About Key Vulnerabilities Gathered During Stakeholder Partnership and Public Meetings

Green infrastructure practices utilize natural solutions, like native grasses and trees, along with design that works with the natural environment, to absorb rainfall into soil, working to address water quantity and quality. Green infrastructure, open space and floodplain management can complement existing gray infrastructure in areas that are impacted by flooding in the region. These practices reduce the volume and quality of stormwater that flows into water bodies, protecting the natural function of floodplains while reducing the damage to infrastructure and property.

Green infrastructure also can reduce surface temperatures, which would help address heat vulnerability in the region. According to the United States Environmental Protection Agency (EPA), trees and vegetation lower surface and air temperature by providing shade and through evapotranspiration⁵. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2-9°F (1-5°C)⁶. By incorporating trees and vegetation in the design, municipalities can experience the co-benefits of green infiltration-based practices to increase roadside cooling and shading.

Cumberland County

The installation of a green street in the Town of Spring Lake is intended to mitigate flooding in the area. Local stakeholders noted that the Town experiences repetitive flooding due to its close proximity to Little River and Tank Creek. More specifically, the Town of Spring Lake has experienced severe damage to wastewater and stormwater infrastructure with the wastewater treatment plant in proximity (400 feet) to Little River. Additionally, the low-lying topography of this area increases susceptibility to flooding. By absorbing and slowing the flow of water, green streets can help manage both localized and riverine flooding. This in turn, reduces the burden placed on the stormwater system and mitigates localized flooding.

Location	Date	Type	Property Damage	Crop Damage
Manchester	09/28/2016	Flash Flood	\$100.00K	\$0.00K
Manchester	09/29/2016	Flash Flood	\$1.000M	\$0.00K
(FBG) Fort Bragg	10/08/2016	Flash Flood	\$0.00K	\$0.00K
(FBG) Fort Bragg	10/09/2016	Flood	\$62.100M	\$20.000M
(FBG) Fort Bragg	09/17/2018	Flood	\$35.310M	\$30.000M

Table 5: NOAA Storm Events Database information pertaining to recorded events and associated property and crop damage in Cumberland County

⁵ Evapotranspiration is the sum of all processes by which water moves from the land surface to the atmosphere via evaporation and transpiration. Evapotranspiration includes water evaporation into the atmosphere from the soil surface, evaporation from the capillary fringe of the groundwater table, and evaporation from water bodies on land. Evapotranspiration also includes transpiration, which is the water movement from the soil to the atmosphere via plants.

⁶ Kurn, D., S. Bretz, B. Huang, and H. Akbari. 1994. *The Potential for Reducing Urban Air Temperatures and Energy Consumption through Vegetative Cooling (PDF)*

Harnett County

The installation of green infrastructure south of Hanna’s Pond is intended to mitigate flooding and reduce risk. Hanna’s Pond was breached during Hurricane Florence (2018) and the potential of dam overflow remains a concern. The recent breach has been repaired, but the spillway remains in disrepair. The water release rate cannot be regulated and known issues with the embankment make this high hazard rated dam a major concern. A dam failure would cause dangerous flooding downstream impacting residential areas and major roadway corridors. Ideally, green infrastructure design features would be used for stream flow improvements and floodplain restoration downstream of the dam.

Location	Date	Type	Property Damage	Crop Damage
Dunn	06/07/2013	Flash Flood	\$0.00K	\$0.00K
Dunn	06/19/2020	Flash Flood	\$0.00K	\$0.00K
Dunn	08/15/2020	Flash Flood	\$0.00K	\$0.00K
Dunn	07/27/2021	Flash Flood	\$0.00K	\$0.00K

Table 6: NOAA Storm Events Database information pertaining to recorded events and associated property and crop damage in Harnett County near Hanna’s Pond and Stony Run

Sampson County

The installation of green infrastructure in Ivanhoe and Newton Grove would help mitigate repetitive flooding that impacts the ability of first responders to access the community during storm events and reduce risk to infrastructure and loss of life. Both communities experienced flooding from Hurricanes Matthew and Florence and are identified as areas of high social vulnerability.

Location	Date	Type	Property Damage	Crop Damage
Newton Grove	10/09/2016	Flood	\$4.100M	\$25.000M
Ivanhoe	09/17/2018	Flood	\$8.180M	\$30.000M
Newton Grove	06/19/2020	Flash Flood	\$15.00K	\$0.00K

Table 7: : NOAA Storm Events Database information pertaining to recorded events and associated property and crop damage in Sampson County

Regional Impact

The implementation of green infrastructure is intended to reduce the impacts of natural hazards faced by the region. These projects address several hazards that impact the region primarily dealing with flood and extreme heat. Project locations were selected based on their high level of visibility to exhibit the commitment to and benefits from green infrastructure. Implementing different kinds of green infrastructure to address specific needs embodies the versatile features of green infrastructure. They provide an opportunity to educate the community about the green infrastructure used while garnering support for future projects.

Local Impact

Areas near the proposed pilot projects will reap the benefits of green infrastructure. The goal of each pilot project is to display how appropriate green infrastructure measures can be taken to address each site's vulnerabilities and unique circumstances to increase resilience.

Cumberland County

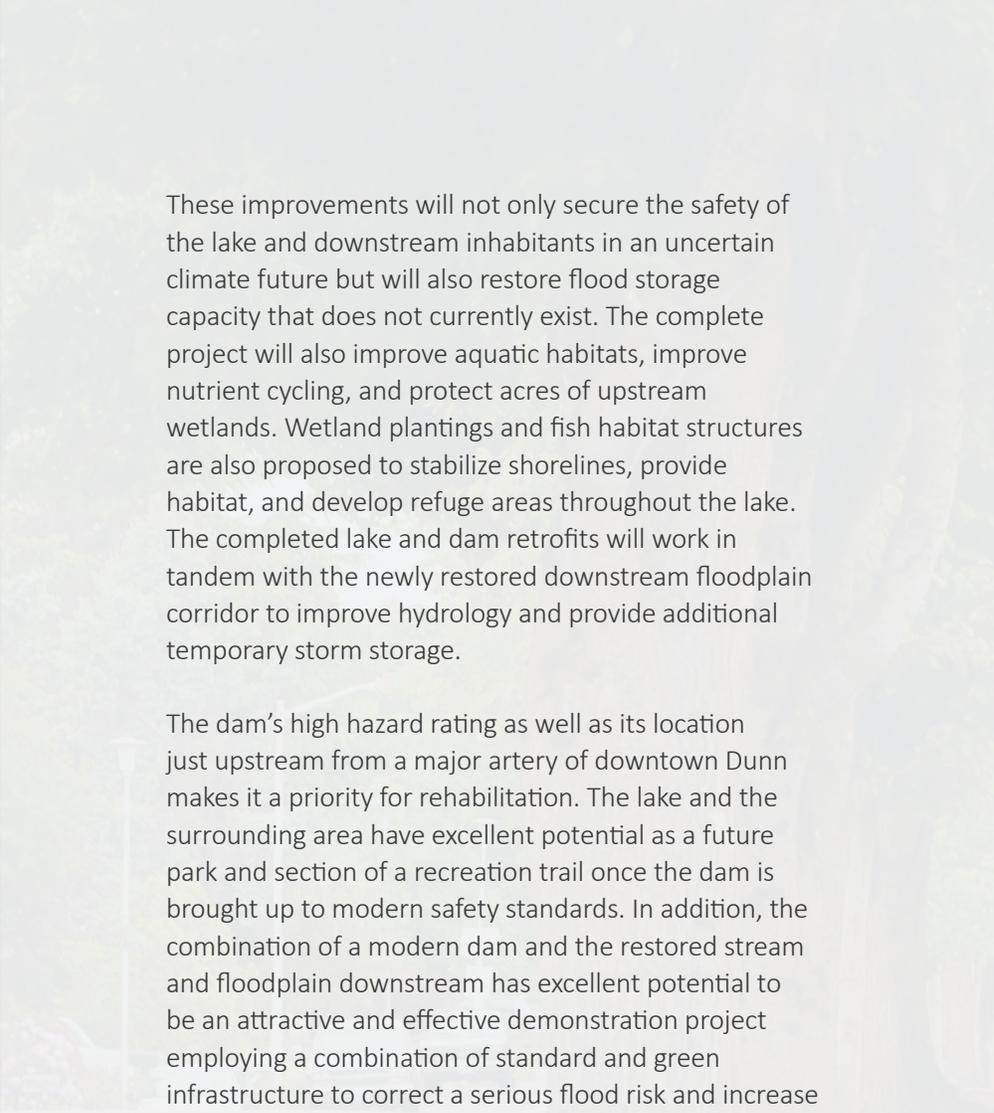
While an exact location has not yet been determined, the green street pilot project for the Town of Spring Lake may help reduce future flooding from increased precipitation (resulting from climate change) and increased development (resulting from population growth). Similarly, the project would benefit critical infrastructure. More specifically, the Town of Spring Lake's wastewater treatment plant would be less vulnerable to flooding.

Military installation, Fort Bragg, plays an important role in the local economy. The Town is immediately adjacent to Fort Bragg and Pope Army Airfield. Road closures due to flooding limit access to Fort Bragg, disrupt continuity of operations and ultimately impact the local economy and ability to carry out their mission as it relates to national security.

Harnett County

Phase I and Phase II work downstream of Hanna's Pond dam will restore the stream from a narrow, cement-walled chute to a more natural braided stream with a restored floodplain to slow and disperse water below the dam where water can be captured and temporarily held during high flow periods. In addition, with a modern control structure, the level in the lake can be lowered in advance of a large storm to increase its capacity of the lake to hold storm waters thereby reducing the risk of flooding.

...Road closures due to flooding limit access to Fort Bragg, disrupt continuity of operations and ultimately impact the local economy and ability to carry out their mission as it relates to national security.



These improvements will not only secure the safety of the lake and downstream inhabitants in an uncertain climate future but will also restore flood storage capacity that does not currently exist. The complete project will also improve aquatic habitats, improve nutrient cycling, and protect acres of upstream wetlands. Wetland plantings and fish habitat structures are also proposed to stabilize shorelines, provide habitat, and develop refuge areas throughout the lake. The completed lake and dam retrofits will work in tandem with the newly restored downstream floodplain corridor to improve hydrology and provide additional temporary storm storage.

The dam's high hazard rating as well as its location just upstream from a major artery of downtown Dunn makes it a priority for rehabilitation. The lake and the surrounding area have excellent potential as a future park and section of a recreation trail once the dam is brought up to modern safety standards. In addition, the combination of a modern dam and the restored stream and floodplain downstream has excellent potential to be an attractive and effective demonstration project employing a combination of standard and green infrastructure to correct a serious flood risk and increase resiliency

Sampson County

The green infrastructure pilot projects for Sampson County will benefit local areas that have experienced repetitive flooding and that are also designated areas of high social vulnerability.

Populations Served

Green infrastructure can help reduce vulnerability to climate change and health risks in underserved communities. Green infrastructure can help make marginalized neighborhoods less vulnerable to climate change and health risks by lowering local temperatures, improving air and water quality, mitigating flooding, and improving community character and quality of life. Additionally, traditionally underserved communities are afforded improved access to leisure activities and open spaces, safe and livable streets, and reduced building energy costs associated with cooling.

Cumberland County

According to the North Carolina Department of Environmental Quality (NCDEQ) Community Mapping System, the project is in NC DEQ's Potentially Underserved Blocks Groups 2019. There are a total of four block groups that may be affected by project implementation. These groups are located along the intersection of Manchester Road and Highway 24. When combined, these block groups have a total population of 5,899.

The Community Mapping System looks at several variables for a deeper dive into socio-economic data. To summarize the project area and populations within this area, averages were calculated for the four census block groups. Based on these calculations, it was found that 68.94% of the population is a minority, 59.69% is classified as low income, and 16.62% is Hispanic.

Harnett County

Although the project site is not directly located in NC DEQ's Potentially Underserved Block Groups (2019), the concern for flooding is to the south of Hanna's Pond Dam. To the south of the dam, DEQ does highlight Potentially Underserved Block Groups (2019) just west of Stony Run. The one block group that is most vulnerable has a population of 1,009 with 93.46% of the population being a minority and 78.68% being classified as low-income. The group is wedged between North Clinton Avenue, State Road 1836, and East Cumberland Street. There are two adjacent block groups to the northwest and southwest that are also identified as Potentially Underserved. These groups are not at risk to flooding due to their location and proximity to Hanna's Pond.

Sampson County

Ivanhoe is in a Potentially Underserved Block Group. The block group has a total population of 1,184 with approximately 68.75% of the population being a minority, 36.82% classified as low-income, and 12.68% is Hispanic. Similarly, Newton Grove is identified as a Potentially Underserved Block Group by North Carolina Department of Environmental Quality (NCDEQ). The block group has a total population of 1,376. Approximately 17.66% of the population is a minority and 32.05% is classified as low-income.



Environmental Considerations

Green infrastructure will also improve water quality and air quality. Stormwater runoff not only contributes to localized flooding but is also one of the largest sources of water pollution and presents many environmental, social, and economic challenges. In fact, the North Carolina Division of Water Quality found that polluted stormwater runoff, also referred to as nonpoint source pollution, is the number one cause of water pollution in North Carolina⁷. The reason being that rainwater that runs off impervious surfaces, such as roadways, rooftops, and parking lots, collects pollutants like oil and grease, animal waste, metals, trash, and sediment.

Green infrastructure can reduce not only the volume of stormwater runoff but reduce water pollution through improved infiltration. In Cumberland County's 2019 Community Health Assessment, participants expressed concerns with the exposure to byproducts from local industry. In particular, health effects from exposure to chemicals from spraying on crops and run off into the water supply⁸. For additional information on the County's Community Health Assessments, visit: [Harnett County Community Health Assessment \(2020\)](#), [Cumberland County Community Health Needs Assessment \(2019\)](#), and [Sampson County Health Needs Assessment \(2021-2022\)](#).

The United States Environmental Protection Agency (EPA) explains that trees, parks, and other green infrastructure features can reduce particulate pollution⁹ by absorbing and filtering particulate matter¹⁰. Breathing smog and particulate pollution can result in respiratory ailments. Green infrastructure assists improving air quality and bolstering public health throughout the region. More information on the long-term benefits of green infrastructure can be found here: [Benefits of Green Infrastructure](#)

Similar Efforts

Person Street Greenstreet in the City of Fayetteville, North Carolina

In 2016, the City of Fayetteville began construction of its first green street located along Person Street. The \$1.2 million project runs along two blocks of Person Street between Cool Springs Street and Person Street Bridge and occupies a major corridor to downtown Fayetteville. Blounts Creek flows directly through town and empties into the Cape Fear River. The creek had become biologically impaired due to polluted runoff from the surrounding areas. The intention of the City's new green street was to improve water quality within the creek by filtering 85% of rainwater through low impact development (LID) features. Increased percolation into the surrounding soil will contribute to flood reduction. The trees and vegetation along the street help improve air quality and reduce heat island effect within the city.

The million-dollar project involved reduction of existing road width decreasing traffic lanes resulting in a 30% reduction in impervious surface area. Reduction of road width allowed for the installation of permeable pavers, and bio-infiltration bump-outs. This project is one of the first comprehensive green streets in North Carolina and can serve as a basis for surrounding areas within the region and a model within the plan. More information on this project can be found here: [Person Street Innovative Stormwater Greenscape](#).

⁷Sea Grant North Carolina. *Water Quality: Estuaries & Polluted Runoff*. [ss_water_quality_estuaries.pdf \(ncsu.edu\)](#)

⁸Cumberland County Community Health Needs Assessment. 2019. [community_health_assessment-2019.pdf \(cumberlandcountync.gov\)](#)

⁹Particulate pollution – The tiny bits of dust, chemicals, and metal suspended in the air we breathe are called particulate matter. It can enter our lungs and cause serious health effects. <https://www.epa.gov/green-infrastructure/benefits-green-infrastructure>

¹⁰EPA. 2022. *Benefits of Green Infrastructure*. [Benefits of Green Infrastructure | US EPA](#)



The City's recent Watershed Master Plan program (currently being conducted) proposes the Russel Street/Person Street bridge replacement with stream modifications. This project includes a nature-based element with about 4000 feet of stream restoration. This project is a natural tie-in to the existing Person Street Greenstreet at Blounts Creek. The City has received approval from Council to pursue funding and intends to submit for Building Resilient Infrastructure and Communities (BRIC) funding

Relationship to Adopted Plans

The green infrastructure pilot projects align with existing planning documents for the region ranging from municipal land use plans to multi-county hazard mitigation plans heightening the project's need and legitimacy. Due to its flexibility and versatile nature, green infrastructure aligns with stormwater improvements, air and water quality standards, sustainability measures, mitigation, and resilience efforts as well as overall quality of life. In terms of applicability, the proposed project largely aligns with existing mitigation and resilience plans for the Mid-Carolina Region.

Cumberland County

Cumberland County Resilient Redevelopment Plan proposes the following actions (1) Stormwater system upgrades are needed at particularly vulnerable locations identified in project locations. Immediate remedies include concrete stabilization of channels, upsizing culverts, and separating storm and sewer systems and (2) Protect critical stretches of roadway from flooding using elevation, enlarged stormwater drainage under the roadways or add swales to channel water away from the low sections of the roadway such as North Bragg Boulevard.

Harnett County

Harnett County Resilient Redevelopment Plan proposes the following actions (1) Improve systems to more appropriately accommodate adequate flow through updating county and municipal stormwater management plans to accommodate growth and prevent future flooding and replacing critical underperforming culverts in Dunn and (2) Improve drainage in East Erwin through a variety of stormwater system improvements in the area, including culvert upsizing and ditch stabilization.

Sampson County

Sampson County Resilient Redevelopment Plan proposes the following actions (1) Develop a Demolish and Redevelopment Program to return properties to sustainable conditions. For properties acquired in other projects, secure funds to demolish blighted structures, and return sites to sustainable spaces such as parks, green space, or other public open space and (2) Develop a county-wide Parks, Open Space and Rural Lands Plan to directly address the need for open space parks and conservation areas thereby removing those areas from developable land inventories. (3) Create plan to elevate (or buyout) homes between Great Coharie Creek and Beaverdam Swamp (specifically mentions Newton Grove and Ivanhoe).

II. IMPLEMENTATION PATHWAY

Recommended Lead Implementers

Lead implementers have been selected based on their relationship to the county, area of expertise, and capacity to implement the proposed pilot project.

Name	Position	Contact	Related Project
Deanna Rosario	Spring Lake Stormwater Administrator, Spring Lake	(910) 985-1804 drosario@townofspringlake.com	Spring Lake, Cumberland
Garry Crumpler	Cumberland County Emergency Management	(910) 438-4069 gcrumpler@cumberlandcountync.gov	
Rick Savage	Executive Director, Carolina Wetlands Association	(919) 412-9754 rick.savage@carolinawetlands.org	Stony Run, Harnett
Rick Sauer	Director of Emergency Services, Sampson County	(910) 592-8996 rsauer@sampsonnc.com	Newton Grove, Sampson
Lethia Lee	County Commissioner, Sampson County	llee@sampsonnc.com	Ivanhoe, Sampson

Table 8: Lead Implementers for County Green Infrastructure Projects

Partnerships

In addition to lead implementers, partnerships are crucial for successful implementation. Combined efforts increase capacity, foster a collaborative setting for brainstorming, and leverage resources to reduce costs. The following experts are recommended to be included: economists with experience in infrastructure return on investment, GIS analysts for mapping needs, engineers to conduct an assessment to determine appropriate measures and estimated cost, and political strategy, marketing, and communication experts. Harnett County noted the capacity of a hydraulic modeler to demonstrate the water quality benefits of the recommended green infrastructure projects.

Potential Partners	Related Project
NC Cooperative Extension	Spring Lake, Stony Run, Sampson County
Soil and Water Conservation	Spring Lake, Stony Run, Sampson County
County Emergency Management & Engineering Departments	Spring Lake, Stony Run, Sampson County
County/Municipal Administration	Spring Lake, Stony Run, Sampson County
County/Municipal Floodplain Administrators	Spring Lake, Stony Run, Sampson County
NC Department of Biological and Agricultural Engineering	Spring Lake, Stony Run, Sampson County
Mid-Carolina Regional Council of Government	Spring Lake, Stony Run, Sampson County

Table 9: Potential Partners for County Green Infrastructure Projects

Implementation Phases

Green infrastructure offers the opportunity to leverage creativity with technicality to address stormwater volume and water quality. Beginning with the ideation and planning phase and ending with ongoing maintenance, each phase must be thoughtfully carried out.

Cumberland County

Cumberland County Emergency Management has secured FEMA funding to perform an assessment for the Town of Spring Lake. The assessment will include a survey, modeling, planning, recommendations to address flooding, and a cost-benefit analysis. Information gathered from the assessment will inform Phase II of this project, green street installation. The design and estimated cost are contingent upon the completion of the assessment. Using the data and cost-benefit analysis provided (an estimate one-year timeline), the County will apply for future grants to implement green infrastructure to reduce flood risk. The scope of the initial phase project is in the Appendix of this document.

The following is a pathway that can be used to implement the green street project in the Town of Spring Lake.

- 1. Assemble a project steering committee comprised of project partners.** Once a specific project site is selected from the assessment, the Town of Spring Lake and Cumberland County Emergency Management should convene a meeting of municipal and County staff as well as other partners to discuss the recommendations in the Phase I assessment and form a project steering committee. Determine when and how the project scope should be shared with appointed and elected boards as well as the public.
- 2. Review and assess existing plans, programs, and projects.** Review and assess existing plans, programs, and projects that interrelate or support the proposed green street project. Information gained from these sources may help further inform the project to ensure a holistic project approach. Consider meeting with Finance Department and Town Administration to understand the project budget and any financial considerations. Determine if this project is in the annual budget and Capital Improvement Plan (CIP) and any budgetary concerns.
- 3. Develop a project scope.** The project steering committee should identify a project scope using the assessment and other relevant documents, such as the Cumberland Hoke Regional Hazard Mitigation Plan, as a foundation.
- 4. Seek assistance for project design.** Once a scope is developed, the project team can develop a Request for Qualifications (RFQ) or Request for Proposals (RFP) to seek design assistance for the green street project. Touch base with the Finance Department to ensure that all local and state procurement procedures are adhered to.

5. **Develop project design.** Work with the selected design professionals to develop the design for the green street project. During the design phase, explore and consider what local or grant funding sources might be used to fund the project. Some grants may have criteria that could impact design. Verify any potential sources of funding early. Consider sharing the project design with appointed and elected boards as well as the community to inform and educate about the project. Some grants may require that final project design be acknowledged or approved by the appointed body. Verify early in the process. Also consider having the designer recommend short- and long-term maintenance and associated costs for any plantings and/or green/grey infrastructure.
6. **Seek project funding.** Meet with the Finance Department and Town Administration to review the project scope and budget. Apply for funding as appropriate.
7. **Bid for construction.** Meet with the Finance Department and Town Administration to determine necessary steps for bidding the project for construction. Local governments in North Carolina are subject to specific legal requirements that govern contracting for construction and repair projects. The UNC School of Government has published a guide titled, [*Basic Legal Requirements for Construction Contracting with North Carolina Local Governments*](#), that can serve as a starting point.
8. **Construct project.** Once the project has been bid, work with the chosen contractor to construct the project according to the design plan.
9. **Maintain the project.** Conduct maintenance on the green street project as recommended by the designer or qualified professional. If additional assistance is needed for maintenance of plantings, the County Cooperative Extension Service may be of technical assistance.

Harnett County

Carolina Wetlands has secured funding from the North Carolina Land and Water Fund for Phase I that will incorporate planning and engineering, data collection, and community engagement efforts focusing on a section of Stony Run between US 301 and I-95. Phase II, proposed in this portfolio, will include extensive repairs that feature nature-based solutions including the repair of the earthen embankment, the installation of a modern water control structure, dredging of legacy sediment deposits, floodplain restoration, and wetland plantings throughout the lake and floodplain.

The following is a pathway that can be used to implement Phase II Improvement to the Hanna's Pond and Dam project.

1. **Assemble a working group comprised of project partners.** Convene a meeting of municipal and County staff, Carolina Wetlands, property owners, and other partners to form a working group. Discuss previous project work conducted by Carolina Wetlands and the status of the project.
2. **Review and assess existing plans, programs, and projects.** Review and assess existing plans, programs, and projects that interrelate or support the proposed Hanna's Pond and Dam Project. Information gained from these sources may help further inform the project to ensure a holistic project approach.
3. **Develop a project scope.** The working group should identify a project scope using information gained through the planning grant, conducted by Carolina Wetlands, and other relevant documents, such as the Cape Fear Regional Hazard Mitigation Plan, as a foundation.

4. **Develop project design.** Work with partners and design professionals to develop the design for the project.
5. **Seek project funding.** Explore appropriate funding sources for project implementation.
6. **Construct project.** Construct the project according to the design plan.
7. **Maintain the project.** Conduct maintenance on the project as recommended by the designer or qualified professional.

Sampson County

The two pilot projects for Sampson County are very preliminary. Previous and relevant efforts in Newton Grove exist and the proposed project aims to build from these efforts.

Newton Grove

The United States Army Corps of Engineers (USACE) completed a hydrologic and hydraulic (H&H) analysis in October of 2019 to investigate potential stormwater drainage improvements within Newton Grove. The goal of the analysis is to address fundamental drainage issues that will become worse in the future. Additional detailed design, permitting, and right-of-way access are required prior to the implementation of a green infrastructure pilot project in this area.

Ivanhoe

The pilot project for this community is in the ideation and planning phase. During this phase, key stakeholders should be selected and engaged. Community engagement, including education and outreach, should be prioritized. Following the ideation phase, an assessment should be conducted to determine design and associated costs. Proceeding the assessment, the community would likely need to apply for and secure funding for implementation.

In both projects, the following implementation pathways could be considered.

1. **Assemble a project steering committee comprised of project partners.** Convene a meeting of municipal and County staff and other partners and form a project steering committee. Determine when and how the project should be shared with appointed and elected boards as well as the public. Also determine stakeholders and how they should be engaged.
2. **Identify next steps and assess existing plans and programs.** Identify what is known specific to each project and what is needed to move each project forward. Review and assess existing plans, programs, and projects that interrelate or support the proposed projects. Information gained from these sources may help further inform the project to ensure a holistic project approach.
3. **Develop a project scope.** The project steering committee for each project should identify a project scope. This could include a project budget range.
4. **Identify potential funding sources.** Identify potential fundings sources that fit the project scope.

Maintenance and Operation Needs

Maintenance of green infrastructure should be included within the design component of each project including parties responsible for upkeep. Education and training are an essential part of operation and maintenance. Many green infrastructure projects are often implemented by local governments, private landowners, and nonprofit organizations, and may rely on private residents or volunteers to conduct project maintenance. Successful projects not only have an operation and maintenance plan in place, but have also conducted public education efforts, outreach campaigns, and training programs.

Effective operation and maintenance training should be provided in an easy-to-understand format, occur at regular intervals, and target the activities employees, residents, or volunteers expected to perform. Education and training can also provide information on the water quality and environmental benefits that green infrastructure can yield when properly maintained. Ongoing engagement with key partners is often critical to success at this stage. Successful projects then become models for future integrated green infrastructure features, which is the long-term goal of this proposed project. For more information on maintenance and operation visit: [Operations and Maintenance Considerations for Green Infrastructure](#).

Challenges/Barriers to Implementation

The concept of using green infrastructure and natural systems to heighten resilience is both innovative and advanced, which can create challenges.

Conflicting Codes and Ordinances

Existing comprehensive plans, zoning codes, and building standards may be silent on, ambiguous towards, or even conflict with green infrastructure principles. More specifically, requirements that can limit opportunities for green infrastructure include zoning density standards, storm sewer connection requirements, and minimum parking and road widths.

Before beginning the green infrastructure project, each community should check for barriers in local codes and ordinances. Tools to support a code barrier audit are: [EPA's Water Quality Scorecard or Updating Local Codes to Cultivate Green Infrastructure and Foster Sustainable Stormwater Management](#). Once barriers are identified we recommend integrating green infrastructure principles into stated goals of codes,

ordinances, and existing planning documents (i.e. land use plans, capital improvement plans, parks and recreation plans) and adding language that provides flexibility concerning design guidelines.

Perception of Higher Cost

Green infrastructure is often considered to be a cost-effective approach over a duration of time but requires high initial investment. The initial cost can pose a barrier for those looking to implement green infrastructure within their communities, particularly small jurisdictions with limited fiscal and technical capacity. Education and outreach are necessary to provide accurate information that depicts the ancillary community benefits of green infrastructure such as reduced energy needs, improved air quality, and heightened climate resilience. For more information on cost-analysis visit: [Community-Enabled Lifecycle Analysis of Stormwater Infrastructure Costs \(CLASIC\) Tool](#) or [Green Values Stormwater Management Calculator](#).

Competing with Gray Infrastructure

Overall, there is a general hesitance to opt for green infrastructure over gray infrastructure. Traditional gray infrastructure refers to man-made structures such as dams, roads, gutters, pipes, or retention basins. The implementation of green infrastructure is intended to supplement gray infrastructure by reducing stress placed on the existing system promoting longevity and reducing long-term maintenance costs.

Opportunities for Integration

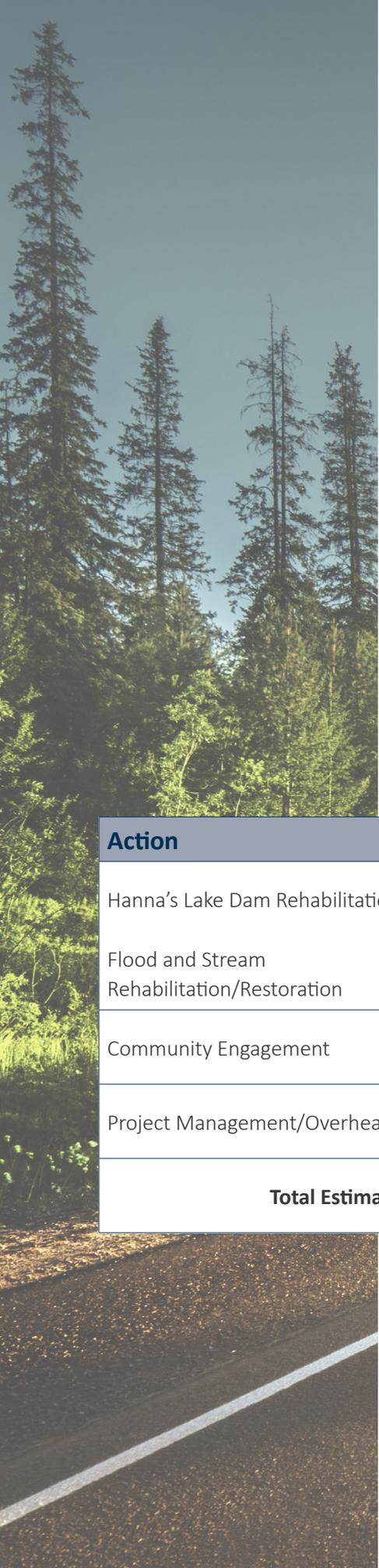
Green infrastructure can be incorporated into processes, projects, and plans governing public land, such as street design standards governing road construction, mitigation planning reducing hazard impacts, capital planning projects, and facilities management governing construction of public buildings and on public land outside of the streetscape such as parks or recreational areas. By investing in green infrastructure, local governments can achieve multiple goals simultaneously, from managing stormwater to reducing temperatures and improving water quality.

Multi-County Hazard Mitigation Plans

The existing multi-county hazard mitigation plans include concepts of green infrastructure as action strategies. Actions from the Cumberland-Hoke Hazard Mitigation Plan include (1) Use natural systems, more open space, and green surfaces to manage stormwater in a more resilient fashion, (2) Develop a tree cutting ordinance to address clear cutting, provide more pervious area for natural drainage, and reduce vulnerability to localized flooding and extreme heat, and (3) Develop a greenway program as a means to protect natural areas along rivers, streams, creeks and drain ways.

Hurricane Matthew Resilient Redevelopment Plans (2017)

Following Hurricane Matthew, each county within the region developed a Resilient Redevelopment Plan. There are several proposed strategies within these plans that strongly align with the proposed pilot projects in Cumberland, Harnett, and Sampson Counties. It should be noted that post-Hurricane Matthew flooding was the primary hazard of concern in North Carolina. The proposed strategies reflect major flooding concerns within the Mid-Carolina Region.



Potential Cost Range

The cost of green infrastructure projects can vary widely based on the size of the project, the location, and the types of features installed. For more information on green infrastructure up front and ongoing maintenance costs visit: [Green Infrastructure Costs by Headwaters Economics](#).

Cumberland County

The cost of green infrastructure along Person Street in Fayetteville, North Carolina was used to develop a rough estimate for the Spring Lake pilot project in Cumberland County. Since the length for of the proposed project is unknown, the cost estimate assumes the same length as Persons Street. The project along Person Street in Fayetteville was 0.3 miles or 0.6 lane-miles and cost \$1.2 million in 2016. Based on information available, the proposed project is estimated to cost between \$2-3 million. To reiterate, this price range is a rough estimate. The scale and potential cost of the project is contingent upon the pending assessment.

Harnett County

The team at Carolina Wetlands Association, designated lead for the Stony Run project, created a rough cost estimate for Phase II improvements to Hanna’s Pond and the downstream floodplain. The projected costs for this project are based on preliminary estimates of potential project scope and recent costs of similar projects. Substantial additional investigation and design will be required before detailed cost estimates can be produced.

Sampson County

The proposed pilot projects in Ivanhoe and Newton Grove are too preliminary to provide a cost estimate. Further conceptual planning is needed to determine an approximate cost range.

Action	Estimated Cost
Hanna’s Lake Dam Rehabilitation	\$3,000,000
Flood and Stream Rehabilitation/Restoration	\$860,000
Community Engagement	\$15,000
Project Management/Overhead	\$125,000
Total Estimate	\$4,000,000

Table 10: Cost Estimate
 Provided by Carolina
 Wetlands Association

Known and Potential Resources

Efforts underway in Cumberland and Harnett County have secured funding for the initial planning phases to guide future design and implementation. There are several potential sources of project funding including State and Federal funding sources. One advantage that green infrastructure projects offer is that they generate so many benefits that they can compete for a variety of diverse funding sources. This diversity heightens the likelihood of funds being awarded, which in turn decreases the limitations placed on the initial cost burden.

Cumberland County

Cumberland County, in collaboration with the Town of Spring Lake, Fort Bragg, and community members, secured funding (\$80,000) from the Flood Mitigation Grant 2022, which is a Disaster Relief and Mitigation Grant. The funding will be used to conduct an assessment of the project area. Additionally, the Cumberland County Board of Commissioners committed \$16,993.75 to this project.

Activity	Scope	Cost
Survey	Collection of data to include current conditions on infrastructure and historical data.	\$10,000
Modeling	Engineered solutions utilizing GIS, past and future models, and current standards.	\$30,000
Planning	Comprehensive report of findings and most effective mitigation options.	\$15,000
FEMA Grant Assistance and Cost-Benefit Analysis	Provide cost-benefit analysis in accordance with FEMA toolkit	\$10,000
Additional Grant Assistance	Assistance preparing applications for state and federal grant programs.	\$10,000
	Total Estimate	\$80,000

Table 11: This table was provided directly from the Flood Mitigation Grant 2022 Application for Spring Lake. For the full application, see Appendix.

Harnett County

Carolina Wetlands Association, in collaboration with the City of Dunn and Harnett County, has secured \$70,000 in grant funding from the North Carolina Land and Water Fund for Phase I of the project and will be complete in July of 2023. Funding for Phase II improvements is needed.

Sampson County

The proposed pilot projects in Ivanhoe and Newton Grove are preliminary and have not received any funding.

The following funding options were selected for the green infrastructure pilot projects as they are compatible with project scope, goals, and cost. Both the Clean Water State Revolving Fund (CWSRF) and the Building Resilient Infrastructure in Communities (BRIC) grant fund have funded individual projects equivalent to or exceeding the estimated cost range. The innovative stormwater solutions and water quality improvements make the project a strong candidate for the Clean Water State Revolving Fund (CWSRF) while the resilience and proactive planning component of green infrastructure makes the project a strong applicant for Building Resilient Infrastructure in Communities (BRIC) funding. Additionally, the social vulnerability aspect of this project has the potential to reduce the local match from 25% to 10% for BRIC funding.

Funding Opportunity	Administered by	Funding Type(s)	Matching & Eligible Amounts	Term/Typical Deadline
Clean Water State Revolving Fund	NCDEQ	Low-interest loans, limited principal forgiveness loans, 0% interest loans	States provide 20% matching funds	March and September of each year
Building Resilient Infrastructure and Communities	NCEM and FEMA	Grant	State/local provide 25% matching funds (10% impoverished communities)	Opens September and closes January of each year

Table 12: Suggested Funding Opportunities for County Green Infrastructure Projects







PROJECT 2

HEATWAVE EARLY WARNING SYSTEMS (HEWS) AND ACTION PLANS

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022

PROJECT 2: HEATWAVE EARLY WARNING SYSTEMS (HEWS) AND ACTION PLANS



I. PROJECT OVERVIEW

Project Scope

The objective of this project is to implement a heatwave early warning system to forecast heatwave events to increase public awareness. Early warning systems involve forecasting the heatwave event, predicting possible health outcomes, triggering effective and timely response plans targeting vulnerable populations, notification of heatwave events, communication of prevention responses and evaluation and revision of systems¹¹.

An action plan triggered by the heatwave early response system will outline appropriate actions that can be taken to reduce the likelihood and severity of health impacts caused by extreme heat. Action plans generated from the proposed project will layout heat response procedures for the Mid-Carolina Region, but county- or city-specific responses may be incorporated as well. For example, additional considerations may be necessary for the City of Fayetteville due to higher percentages of impermeable pavement or Sampson County due to its larger migrant population.

Project Location and Service Area

Region-wide action

Vulnerabilities Addressed

The proposed project is intended to address high heat indexes. Excessive heat is a dangerous and deadly occurrence in North Carolina. According to the National Weather Service, extreme heat is the leading cause of weather-related deaths. The elderly and very young are susceptible to the most detrimental impacts, but heat stroke and exhaustion can plague anyone. Risks from exposure to extreme heat include heat cramps, heat exhaustion, heat stroke and death.

The warning system will help predict possible health outcomes and encourage effective and timely response plans targeting the region's most vulnerable populations. The early warning would allow ample time to notify the public of anticipated heatwave events, which in turn would allow them to better prepare for, and respond to, the event appropriately. Additionally, an action plan would be carried out after the defined threshold is surpassed to collectively take action in response to heatwave occurrence.

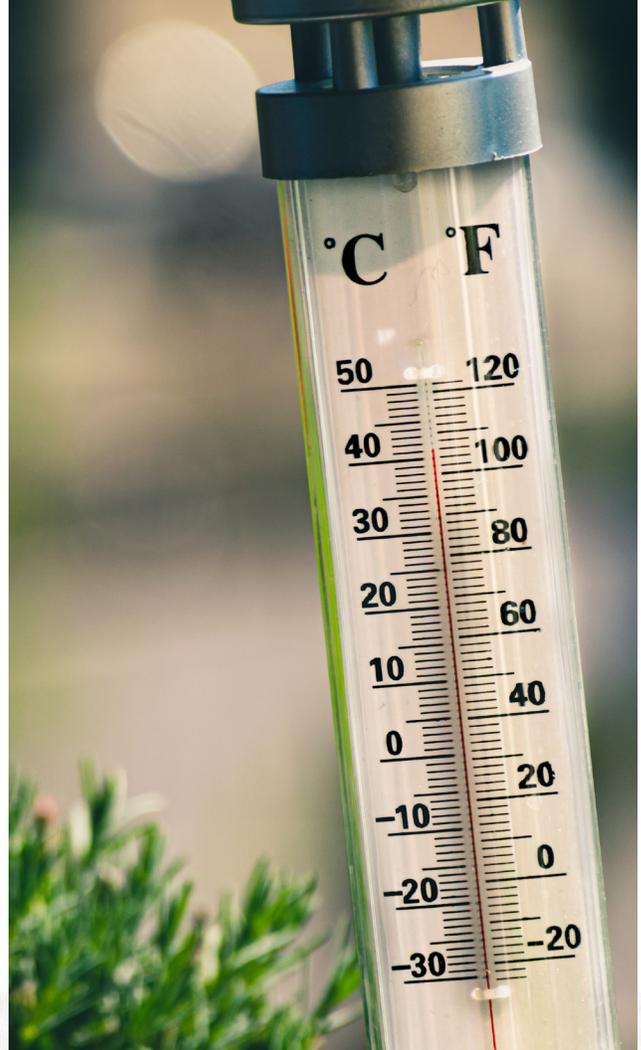
Regional Impact

There is currently no heat protocol in place, so the proposed project is expected to have a large impact on the Mid-Carolina Region supporting new and innovative strategies. The early warning system will allow the region to better prepare for heat events as the climate continues to warm. The action plan will streamline the response process and enable the region to respond to heat crisis in a uniform way. Actions outlined in the action plan will reduce heat sensitivity and the risk of heat-related health impacts.

¹¹ Lowe et al. (2011) Heatwave Early Warning Systems and Adaptation Advice to Reduce Human Health Consequences of Heatwaves. *International Journal of Environmental Research and Public Health*, 8(12): 4623-4648. [10.3390/ijerph8124623](https://doi.org/10.3390/ijerph8124623)

Local Impact

Migrant populations that work in the farming and agricultural industry can be found throughout the entire Mid-Carolina Region. This is especially true in Sampson County where there is a larger concentration of migrant workers because of the large presence of farm and agriculture-based work. Many of these workers are at increased risk of heat-related illness and death because they are exposed to extreme temperatures while working long hours outdoors. This is problematic because many farm workers' salaries are contingent on productivity incentivizing workers to continue in dangerous conditions¹². Additionally, none of Sampson County's estimated ten shelters are outfitted to provide adequate heating or cooling to serve as relief centers. Residents of Cumberland County indicated that they have some infrastructure in place for heating and cooling centers, such as the Salvation Army, transit center and Dream Center. However, those locations are not adequately distributed throughout the county and are only open during operating business hours.



Populations Served

Marginalized communities¹³ are at greater risk of extreme heat impacts due to pre-existing health conditions. Exposure to extreme heat exacerbates poor health conditions that are more common in vulnerable communities jeopardizing their health and wellbeing. The heatwave early warning system is intended to reduce the avoidable health consequences associated with high heat that regularly impact the elderly, young children, unhoused persons, outdoor workers, and emergency responders. Additionally, student athletes have emerged as an at-risk population in North Carolina¹⁴.

There is a higher proportion of people who experience heat-related illness in rural communities. It was determined that many smaller communities lack the resources to combat the effects of heatwaves¹⁵. Specific considerations for rural communities will be incorporated into the warning system and action plan to ensure the barriers posed by remoteness are adequately addressed.

¹² U.S. Climate Resilience Toolkit. *Developing an Early Warning System. Developing an Early Warning System to Prevent Heat Illness | U.S. Climate Resilience Toolkit*

¹³ According to National Collaborating Centre for Determinants of Health, marginalized populations are "groups and communities that experience discrimination and exclusion (social, political, and economic) because of unequal power relationships across economic, political, social and cultural dimensions." *Marginalized populations | National Collaborating Centre for Determinants of Health (nccdh.ca)*

¹⁴ Brainerd, Lucy & Ward, Ashley. (2021). *Developing an Early Warning System to Prevent Heat Illness. U.S. Climate Resilience Toolkit. Developing an Early Warning System to Prevent Heat Illness | U.S. Climate Resilience Toolkit*

¹⁵ U.S. Climate Resilience Toolkit. *Developing an Early Warning System. Developing an Early Warning System to Prevent Heat Illness | U.S. Climate Resilience Toolkit*

Environmental Considerations

As the climate continues to warm, the State of North Carolina can anticipate rising temperatures. The state has warmed by about one degree Fahrenheit over the past 120 years, and warming has accelerated in recent decades¹⁶. Scientists predict the changes in climate felt within this century will be larger than anything experienced in North Carolina’s historical past¹⁷. According to research completed by Carolina’s Integrated Sciences and Assessments program (CISA), the geographic features of the Sandhills region make hot days feel even hotter. The “sandy soil of the region has trouble holding water near the surface, so incoming sunlight energy ends up heating the land rather than evaporating moisture.”¹⁸

Similar Efforts

Recently, the Carolinas Integrated Sciences and Assessments program (CISA) in collaboration with the National Integrated Heat Health Information System (NIHHIS) assessed problems to determine solutions to combat extreme heat in North Carolina’s most vulnerable counties. More specifically, the investigation focuses on the Sandhills region where Sampson County is located. North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT), an epidemiological surveillance system, was used to compile records of every visit to emergency departments throughout the state including zip code and payment method. These records provided socioeconomic and demographic data. This information combined with climate data provided by Southeastern Regional Climate Center (SERCC) was used to develop a pilot instrument that could associate maximum daily temperature with heat-related illness incidents.

The pilot instrument is known as the Heat Health Vulnerability Tool (HHVT) and was released in 2015 on the Convergence of Climate-Health Vulnerabilities website. The tool uses National Weather Service heat index forecasts to predict numbers of emergency department visits. Local leaders and decisions makers can use the tool’s predictions to be made aware of dangerous conditions that may require further action to ensure the public’s health and safety. For more information on the tool visit: [Heat Health Vulnerability Tool \(HHVT\)](#).

Relationship to Adopted Plans

The Cumberland-Hoke Regional Hazard Mitigation Plan and the Cape Fear Regional Hazard Mitigation Plan recognize the potential health risks caused by extreme heat events. They state, “Extreme heat, unlike drought, poses little risk to property. However, extreme heat can have devastating effects on health.” The existing mitigation plans acknowledge the potential health risks associated with extreme heat, but do not propose mitigation strategies to address extreme heat. On the other hand, the Sampson-Duplin Regional Hazard Mitigation Plan does not identify extreme heat as a significant hazard to be included within the plan. The plan states, “This hazard may be possible, but the likelihood and magnitude are so minimal that the MAC decided not to provide a detailed description or risk assessment.”

¹⁶ Dello, Kathie. (2020) North Carolina Climate Science Report Plain Language Summary. [North Carolina Climate Science Report Plain Language Summary - North Carolina State Climate Office \(ncsu.edu\)](#)

¹⁷ Dello, Kathie. (2020). North Carolina Climate Science Report Plain Language Summary. [North Carolina Climate Science Report Plain Language Summary - North Carolina State Climate Office \(ncsu.edu\)](#)

¹⁸ Developing an Early Warning System to Prevent Heat Illness. U.S. Climate Resilience Toolkit. [Developing an Early Warning System to Prevent Heat Illness | U.S. Climate Resilience Toolkit](#)



II. IMPLEMENTATION PATHWAY

Recommended Lead Implementers

Table 13 below provides the names of lead implementers that were identified to implement this project. There is one lead per county to enhance coordination between counties for a consistent regional heat warning system and response protocol.

Name	Position	Contact	Related Project
Greg Frank	County Emergency Management, Harnett County	(910) 893-0712 gfrank@harnett.org	Harnett County
Gary Crumpler	Emergency Management Coordinator, Cumberland County	(910) 438-4069 gcrumpler@cumberlandcountync.gov	Cumberland County
Rick Sauer	Director of Emergency Services, Sampson County	(910) 592-8996 rsauer@sampsonnc.com	Sampson County

Table 13: Lead Implementers for Heatwave Early Warning Systems and Action Plans Project Implementation

Partnerships

In addition to lead implementers, partnerships are crucial for successful implementation. In particular, the heatwave early warning system is intended to act as a regional system requiring collaboration between county, regional, and potentially state staff. Heat is the leading cause of weather-related illnesses and deaths in North Carolina, and combating increasing temperatures requires health resources. North Carolina Department of Health and Human Services is familiar with heat response protocol through creation of the [North Carolina Climate and Health Implementation and Monitoring Strategy \(IMS\) for Heat-Related Illness](#) as well as the [Sandhills Community Readiness Assessment](#). Combined efforts increase capacity, foster a collaborative setting for brainstorming, and leverage resources to reduce costs. The following experts are recommended to be included or consulted for this project:

Potential Partners
North Carolina Department of Health and Human Services
North Carolina Emergency Management
NC Office of Recovery and Resiliency (NCORR)
Sustainable Sandhills
County Health Departments
Mid-Carolina Council of Governments
County/Municipal Administration and Planners
American Red Cross
Researchers from Academic Institutions

Table 14: Potential Partners for Heatwave Early Warning Systems and Action Plans



Implementation Phases

The regional heatwave early warning system is conceptual and further planning efforts are needed to determine specifics. The following steps are suggested to implement the heatwave early warning system:

- 1. Organization and Scope of Work.** Develop a project team with relevant expertise pertaining to increasing temperatures caused by climate change, heat mitigation practices, and associated health risks. In addition to the lead implementers, important project partners could include municipal and county health departments, municipal and county planning departments, and the American Red Cross. Work as a group to develop a scope of work, timeline and phases, anticipated level of effort from working group members, and other relevant components to clarify expectations and roles of working group members
- 2. Seek Funding.** Apply for and secure funding for initial planning efforts for the development of the heatwave early warning system. The timeline for planning efforts is approximately one year.
- 3. Existing Conditions Assessment and Research.** Hold working group meetings focused on existing heat response activities in each county or jurisdiction representing on the working group.
 - a.** Consider the following guiding questions to understand the current state of heat wave response.
 - i.** What existing processes are in place for heat wave response in my county and/or jurisdictions within it? What works well and what could be improved?
 - ii.** Who is included in heat wave response coordination in my county and/or jurisdictions within it? Who is missing?
 - iii.** How does my county ensure that households most vulnerable to heat are prioritized in heat wave response?
 - iv.** When do heat response activities typically go into effect in my county and/or jurisdictions within it? Or what is the threshold for activation that triggers heat response activities? (E.g., maximum temperatures are forecasted to be above the 95th percentile).
 - v.** Are there other partners that should be included as an early warning system and action plan is developed?
 - b.** Assess and identify any existing plans, programs, and policies that support or are a barrier to development of an early warning system and action plan.
 - c.** Identify other communities within and outside of North Carolina doing similar work well.

target audiences. The warning system will be organized into phases concerning forecasting, monitoring, warning, and alert.

- 5. Implement.** Implement the heatwave early warning system. Unlike the Heat Alert System in the Sandhills Region, the proposed warning system will be uniform in the mechanisms used for communication as well as protocol to follow. The aim of uniformity is to ensure efficacy and continuity.

The early warning system is the first step in the process, while the action plan is the second step. The action plan will only be initiated in the severest of scenarios. Assess and develop a plan for moving forward. Assess what has been learned through the existing conditions assessment and research in Phase I above. Identify any gaps in knowledge needed to take next steps for development of an action plan. The following steps are necessary for the development of a heatwave action plan that will describe appropriate actions that can be taken to reduce the likelihood and severity of health impacts caused by extreme heat:

- 1. Develop a Scope of Work.** Develop a scope of work and budget for development of the action plan. Additional funding may be necessary. Consider what types of outreach will be needed as this may impact the budget.
- 2. Develop a Threshold for Activation.** Determine an approach to identify a threshold for activation for heat response activities. The working group may consult the CDC guide [Heat Response Plans: Summary of Evidence and Strategies for Collaboration and Implementation](#), which dedicates a section to Activation Phases.
 - a.** Consider the following guiding questions.
 - i.** Will the threshold to activation be phased or binary? Meaning, will more interventions and processes be triggered as the heat wave risk grows? Or will all activities be triggered as heatwave risk grows?
 - ii.** Will the protocol template have a consistent threshold for activation for all counties and jurisdictions that use and populate the template? Or will local concern and local context (e.g., demographics, energy infrastructure, housing quality, etc.) inform the threshold of activation?
 - iii.** What dataset will the threshold for activation be linked to? Consider federal heat data sources displayed on [Heat.gov](#), a project of the National Integrated Heat Health Information System.
 - b.** Review existing heat action plans in nearby regions or within the state. The North Carolina Emergency Operations Plan (NCEOP) includes a Heat Emergency Response Plan. The Heat Emergency Response Plan outlines the coordinating actions taken by the State Emergency Response Team (SERT) following a heat related emergency that impacts North Carolina. For more information, visit [Heat Emergency Response Plan](#).
 - c.** Consider and address the unique circumstances of any given community based on findings from the research in Phase I above. Continue to engage with traditionally underserved communities and municipal personnel.

- 3. Methodology.** Develop a methodology to identify households most vulnerable to extreme heat to prioritize in the heat wave response protocol template. Consider the following guiding questions.
 - a. What is the appropriate threshold for CDC SVI score that the protocol template should outline as most vulnerable?
 - b. Are there other local datasets with best available data that should be considered?
 - c. Will the protocol template have a consistent methodology and data threshold to identify those most vulnerable to heat-related risk? Or will local context and local knowledge inform the identification of vulnerable individuals?
- 4. Draft the Action Plan.** Ensure that those most vulnerable to heat-related risk are prioritized. Draft potential interventions and activities to include in the action plan. A list of activities will provide users with options that can be adapted as needed to best fit the jurisdiction using the template. The project team may also consult the CDC guide Heat Response Plans: Summary of Evidence and Strategies for Collaboration and Implementation, which dedicates a section to potential interventions.

Maintenance and Operation Needs

An evaluation plan is proposed to ensure system effectiveness. This plan should be completed before the implementation of the early warning system and action plan to lay out clear objectives and expectations. An evaluation plan outlines the evaluation approach, evaluation design, evaluation research questions, data collection methods, evaluation activities, stakeholders that should be engaged, timeline, performance measures, key milestones, and costs²⁰.

Challenges/Barriers to Implementation

Communication with Vulnerable Populations

Among the more common concerns in Sampson County was the notion of migrant populations working outdoors during warmer months. If the aim of this project is to heighten resilience for those most vulnerable to extreme heat, it is essential this information is readily available on several platforms in several languages. If this information is not accessible to non-English speaking populations or those who do not have access to technology (i.e., a computer or smart phone), its use diminishes. The dissemination of heat advice to vulnerable populations should involve websites, pamphlet distribution or media campaigns.

Vulnerable populations of lower socio-economic status tend to not be persuaded by media to change behavior²¹. Therefore, presenting verbal information may be more effective than simply providing written brochures or fact sheets. These individuals may be reached through more effective communication modes and community-based strategies such as establishing a trusted liaison within the Spanish-speaking community. As part of this effort, there should be discussion of potential candidates.

²⁰ Rural Health Information Hub. 2022. Evaluation Planning. [Evaluation Planning \(ruralhealthinfo.org\)](https://www.ruralhealthinfo.org/evaluation-planning)

²¹ Semenza J.C., Ploubidis G.B., George L.A. Climate change and climate variability: Personal motivation for adaptation and mitigation. *Environ. Health.* 2011;10

Electrical and Energy Usage

Increasing householder air-conditioning use as a response to heat is problematic when the source of the electricity contributes to greenhouse gas emissions. Air-conditioning use also increases peak electricity demand and blackouts during heatwaves, which leaves at risk individuals more vulnerable to the effects of heat. Many vulnerable populations may not be able to afford to purchase or use air-conditioning. Public spaces could act as refuge during a heatwave event for those who do not have access to air-conditioning at home. Refuge should be places where air-conditioning use cannot be avoided, such as hospitals, department stores and public institutions.

Information Fatigue

There is concern for information fatigue. Although technology has made information more readily available and accessible, it has also resulted in saturation or over-bombardment of information. In turn, this results in decreased value, meaning, or full comprehension of information over time. If heat alerts are sent out on a regular basis, readers are less likely to understand the severity of the event or follow protocol to stay safe. As the region develops the early warning system, the planning team should be mindful of this concern and determine an appropriate threshold that is indicative of dangerous and life-threatening temperatures.

Opportunities for Integration

Extreme heat was included in the Cumberland-Hoke Regional Hazard Mitigation Plan and the Cape Fear Regional Hazard Mitigation Plan (Harnett County). The Cape Fear Hazard Mitigation Plan does not incorporate any mitigation strategies that aim to directly address extreme heat. Extreme heat was not identified as a significant hazard to be included in the Sampson-Duplin Regional Hazard Mitigation Plan. However, the plan notes “This hazard may be possible, but the likelihood and magnitude are so minimal that the MAC decided not to provide a detailed description or risk assessment.”

The Cumberland-Hoke Regional Hazard Mitigation Plan proposes the following actions to address extreme heat: (1) Include climate predictions from the Cumberland County Climate Resiliency Plan in the Regional Hazard Mitigation Plan, (2) Provide financial assistance for low-income residents to help with power bills and support services during extended periods of high temperature and other extreme weather, (3) Analyze and update local development ordinances to make buildings safer from wind and flooding, more energy and water efficient, more tolerant of heatwaves and healthier to live in, and (4) Develop a tree ordinance to address clear cutting.

When comparing existing plans for the three counties, Cumberland is the only county that has proposed strategies to address extreme heat. Cumberland County is also the only county in the Mid-Carolina Region to have implemented a resilience plan in the past. This resilience plan highlighted climate change and increasing temperatures. In turn, the resilience plan was called out, referenced, and received consideration in the regional mitigation plan update. Therefore, this Portfolio can be integrated into hazard mitigation plans moving forward. Other communities in the region could explore the possibility of integrating and planning for extreme heat in an existing or stand-alone planning document.

Potential Cost Range

The proposed project is estimated to cost between \$50,000-\$100,000. The cost was estimated based on existing resources, personnel expertise, anticipated planning efforts, and similar efforts completed. This cost does not reflect the ongoing operation and maintenance of the warning system nor continual updates to the action plan based on regular evaluations.

Known and Potential Resources

The following funding options were selected for the regional heatwave early warning system and action plan as they are compatible with project scope, goals, and cost. Both the Emergency Management Performance Grant (EMPG) and the Building Resilient Infrastructure and Communities (BRIC) grant fund have the financial capacity to fund the proposed project if the project is found to be eligible. The warning system is intended to monitor increasing temperatures and better prepare both local officials and residents for an extreme heat event making the project a strong candidate for the Emergency Management Performance Grant (EMPG) while the resilience and proactive planning component of the triggered action plan makes the project a strong applicant for Building Resilient Infrastructure in Communities (BRIC) funding.

The Climate Change Adaptation in the Sandhills Region funding opportunity is intended to build local capacity and expertise of climate change within the Sandhills region. The aim is to help implement adaptation and evaluation plans to address the compound climate hazards of impaired air quality, extreme heat, and flooding. Although Sampson County is the only county within the Mid-Carolina Region that is also located in the Sandhills region, funding is available to areas that serve the Sandhills region leaving opportunity for Cumberland and Harnett County as well.

Funding Opportunity	Administered by	Funding Type(s)	Matching & Eligible Amounts	Term/Typical Deadline
Emergency Management Performance Grant	DHS and FEMA	Grant	States provide 20% matching funds	March and September of each year
Building Resilient Infrastructure and Communities	NCEM and FEMA	Grant	50% federal and 50% state cost-share cash or in-kind match requirement	Opens April and closes June of each year
Climate Change Adaptation in the Sandhills Region	DPH/OEE and CDC	Grant	-	Opens September and closes October

Table 15: Suggested Funding Opportunities for Heatwave Early Warning System





PROJECT 3

INSTALL ADDITIONAL STREAM GAUGES

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022

PROJECT 3: INSTALL ADDITIONAL STREAM GAUGES



Figure 9: Stream Gauge, Source: NCEM

Project Scope

The installation of additional stream gauges and sensors at multiple locations throughout the region has been identified as a need that will help improve flood warning and forecasting in areas that repetitively flood. The additional gauges will provide information to map and communicate real-time water levels and flood risk.

The proposed project is intended to improve and expand the existing system of stream gauges in the region to make the network more comprehensive, help better understand stream flows, and improve communication of flood risk. The gauges will be also used to expand the capacity of the State of North Carolina’s Flood Inundation and Mapping Alert Network (FIMAN) which has proven to be an effective tool for emergency response and mitigation planning efforts.

Project Location and Service Area

The following locations were suggested during the planning process:

Location	County
Rockfish Creek toward Hoke County	Cumberland County
Little River in Linden near NC Highway 217	Cumberland County
Little River near Highway 210 north of Spring Lake	Cumberland County
Little River at Spring Lake Wastewater Treatment Plant	Cumberland County
Cliffdale Road in Fayetteville	Cumberland County
Black River from Angrier to Dunn (proposed network)	Harnett County
Mingo Swamp on Harnett County Line	Harnett County
Upper Little River at Highway 401 South	Harnett County
Lower Little River at Highway 401 South	Harnett County
NC Highway 217 Bridge in Erwin	Harnett County
Black River at Dr. Kerr Road	Sampson County
South River at W. Williams Street	Sampson County
Great Coharie Creek at Garland Highway/US 701	Sampson County
South River at Elizabethtown Highway/NC Highway 242	Sampson County
Great Coharie Creek at Boykin Bridge Road	Sampson County
South River on the border of Sampson and Cumberland County	Sampson/Cumberland County

Table 16: Selected Locations for Additional Stream Gauges Throughout the Mid-Carolina Region



County emergency management staff compiled a list of recommended locations for additional stream gauges. Information gathered during Stakeholder Partnership Meetings, Public Meetings, and the planning team’s Interactive Mapping tool was then used to support the identified locations to confirm areas of repetitive flooding or concern. By doing so, the list for gauges was narrowed down to five per county for feasibility purposes. However, all locations identified throughout public and stakeholder participation can be found in the appendix for future funding consideration.

Vulnerabilities Addressed

Additional stream gauges are intended to improve monitoring of heavy precipitation, stream/river levels and flow, and better communicate flood risk and potential downstream impacts throughout the region. Flash flooding and riverine flooding were identified as two major concerns by both the public and stakeholders. Knowing the extent of flooding helps each community identify at-risk areas and place resources at these locations. Therefore, the gauges will closely monitor stream levels in real time to better map the stream network, prepare for potential flood events, and understand upstream and downstream conditions. .

Regional Impact

According to the United States Geographic Survey (USGS), “Information on the flow of rivers is a vital national asset that safeguards lives, protects property, and ensures adequate water supplies for the future.”²² More specifically, stream gauges are essential for storm resilience as ample gauge data can lessen flood impacts. Additional stream gauges will enhance the region’s ability to provide advanced prediction of possible stream flooding conditions. In turn, this will increase lead time for public notification, evacuations, and roads closures to minimize damages and risk to human health.

River discharge records are crucial for estimating and predicting flood frequency and magnitude: how often discharge events of a certain size can and will occur. In addition to improved notification, stream gauges help communities better understand how to build culverts and bridges that can withstand the highest flows that are anticipated to occur on a semi-regular basis. Further, the Federal Emergency Management Agency (FEMA) uses river studies to develop more accurate Special Flood Hazard Area Maps (SFHA). Those river studies rely on data provided by stream gauges.²³

²² USGS. *How do we benefit from USGS streamgages? How do we benefit from USGS streamgages? | U.S. Geological Survey*

²³ Miami Conservancy District. *Stream Gages: Commitment Yields Benefits. Stream Gages: Commitment yields benefits – Blog of the Miami Conservancy District (mcdwater.blog)*

Populations Served

The installation of additional stream gauges will benefit region with a direct impact on critical infrastructure, residential structures, and property adjacent to the following waterways: Black River, South River, Great Coharie Creek, Little River, and Mingo Swamp. The gauges will reduce the loss of life and property and bolster public safety through effective warning times, especially in marginalized communities.

Environmental Considerations

The North Carolina Climate Science Report explains that although there is no trend in annual precipitation, extreme rainfall has increased in the recent past including a new statewide record for precipitation. North Carolina's wettest year on record occurred 2018 as the 2015-2018 period saw an increase in the number of days with heavy rain (defined as 3 inches or more in 24 hours)²². Annual precipitation is also expected to increase as heavy rains from hurricanes and other weather systems will become more frequent and intense. These projections strongly support the need for additional gauges to closely monitor water levels throughout the region.

Similar Efforts

The City of Charlotte, North Carolina has a model stream gauge program. The United States Geological Survey Cooperative Water Program and Charlotte-Mecklenburg Stormwater Services worked together to expand and enhance the data collection network. Currently, the network consists of 72 rain gauges and 52 stream gauges and has evolved into a true real-time notification system using line-of-site radios and satellite telemetry²³. During extreme conditions when thresholds are exceeded at a gauge, data is immediately reported as part of the Flood Information and Notification System (FINS).

In 2018, the Charlotte entered a partnership with the United States Department of Homeland Security Science and Technology Directorate (DHS S&T) to design technology to reduce fatalities from flood events, reduce property losses from future flood events, support community flood resiliency, and provide predictive analytic tools for FEMA. Within this effort, Storm Water Services integrated low-cost flood sensors into the Flood Information Notification System (FINS) based on the deployment plan. Using more than 130 USGS stream gauges and low-cost sensors, Charlotte-Mecklenburg Stormwater Services gathers data for a large portion of the FEMA Regulated Streams throughout Mecklenburg County.²⁴

Relationship to Adopted Plans

The county hazard mitigation plans and resilient redevelopment plans following Hurricane Matthew call for additional stream gauges to mitigate flood impacts. These strategies call out specific locations within each county to better monitor water levels. The overall goal of the proposed project is to improve the region's network as a whole with an emphasis on areas experiencing repetitive flooding. The shift from a county to a regional network provides a larger scale perspective, which depicts a more accurate representation of the stream and river networks throughout the region as well as the relationship between upstream and downstream communities.

²² Dello, Kathie. (2020). *North Carolina Climate Science Report Plain Language Summary*. [North Carolina Climate Science Report Plain Language Summary - North Carolina State Climate Office \(ncsu.edu\)](#)

²³ USGS. *Charlotte-Mecklenburg Hydrologic Network*. [Charlotte-Mecklenburg Hydrologic Network \(usgs.gov\)](#)

²⁴ City of Charlotte. *Flood Management Risk Tools and Flood Sensors*. [Flooding > Flood Sensors Technical Resources \(charlottenc.gov\)](#)

II. IMPLEMENTATION PATHWAY

Recommended Lead Implementers

Emergency management personnel provided information pertaining to hotspots and flood vulnerability. Due to continual work with flood risk and response, it was determined county-level emergency management is well suited to guide this project. The lead implementer is assigned by associated county. Coordination between county leads is crucial particularly when dealing with unincorporated areas of the region.

Name	Position	Contact	Related Project
Greg Frank	County Emergency Management, Harnett County	(910) 893-0712 gfrank@harnett.org	Harnett County
Gary Crumpler	Emergency Management Coordinator, Cumberland County	(910) 438-4069 gcrumpler@cumberlandcountync.gov	Cumberland County
Rick Sauer	Director of Emergency Services, Sampson County	(910) 592-8996 rsauer@sampsonnc.com	Sampson County

Table 17: Lead Implementers for Stream Gauges Project Implementation

Partnerships

Partnerships are recommended to streamline the implementation process. The following partners and entities are suggested based on their experience with similar projects and access to resources for continual operation and maintenance. Stream gauges currently exist and function within the region. The main objective of additional gauges is to enhance the existing networks for improved monitoring and accuracy. Therefore, entities involved in the management and operation of the existing networks must be actively engaged. The following experts are recommended to be included or consulted for this project:

Potential Partners
County Soil and Water Conservation Offices
North Carolina Emergency Management Hazard Mitigation Section (for coordination with FIMAN integration)
North Carolina Department of Transportation (for coordination with FIMAN-T)
Stream Gauges Installation Contractors - Intellisense, Evigia, and Progeny
United States Geological Survey (USGS)
United States Department of Homeland Security Science & Technology Directorate (DHS S&T)
Friends of the River

Table 18: Potential Partners for Stream Gauges Project Implementation

Implementation Phases

A total of sixteen locations are being proposed for additional stream gauges. This number reinforces the need to better monitor flood-prone waterways, understand streamflow, and enhance existing systems used to forecast flood events. The following steps are recommended for successful implementation.

- 1. Develop a Project Team.** Made up of potential partners and other key stakeholders as identified to guide the initial planning process for additional stream gauges throughout the Mid-Carolina region. The potential project partners could include state, local and county staff, business owners, and non-profit river supporters.
- 2. Conduct a Brief Existing Conditions Analysis.** To help locate all existing gauge locations, condition of existing gauges (i.e. the need for any repair or replacement), and identify any major gaps in the network.
- 3. Share Findings.** Share findings of existing conditions analysis and any gaps with NCEM and NCDOT. Determine if any of the identified gauges can be integrated into existing state efforts.
- 4. Property Specific Flood Risk Assessment.** To better understand flood risk, a property-specific flood risk assessment on the sixteen proposed locations is recommended, but not necessary. If the project teams opt out of a flood risk assessment, at minimum they should analyze the following key factors:
 - a.** Historical flood occurrence (the number of times an area has flooded within a given window of time)
 - b.** Assets nearby at-risk (any critical infrastructure or facilities such as government buildings, emergency operation centers, major roads, wastewater treatment plants, etc.)
 - c.** Populations at risk with an emphasis on socially vulnerable communities (elderly, low-income, non-English speaking, etc.)
- 5. Create an Implementation and Deployment Plan.** For deploying the gauges within the existing networks. This plan should explicitly state the number of phases determined, the gauge locations per phase, the type of sensor proposed for each individual location, suggested funding sources, and the specific entities responsible for implementation, maintenance, and performance monitoring. Visit Charlotte-Mecklenburg Flood Sensor Deployment Plan for more information on content.
- 6. Apply for Funding.** Using the findings from the existing conditions analysis that establishes need, apply for funding to conduct a property-specific flood

risk assessment and the creation of an implementation and deployment plan to guide future installations and maintenance. It is suggested to place high-cost, in-depth sensors, such as USGS gauges, in high priority areas. Ideally, outside funding would be used to secure high-cost sensors and local operating budgets would be used to purchase low-cost sensors. Once funding is received, coordinate with entities identified within the deployment plan for implementation and ongoing maintenance.

Maintenance and Operation Needs

If a community purchases the appropriate gauges, the North Carolina Emergency Management (NCEM) team can still assist with ongoing operation and maintenance to ensure proper function. In fact, NCEM has the capacity to provide technical assistance with procurement, installation training, technical assistance with maintenance, and providing the data to North Carolina Flood Inundation Mapping Alter Network (FIMAN). USGS gauges are primarily operated and maintained by USGS, but most are funded in partnership with one or more federal, state, local, and tribal agencies, and organizations²⁵.

Most gauges are relatively low maintenance where maintenance is only required typically following a hazard event. Routine maintenance involves inspecting equipment, equipment calibration (when/if necessary), and taking discharge measurements²⁶. Beyond the maintenance of the gauge itself, there is substantial effort required to maintain databases, provide online access, and analyze data. Fortunately, integration into FIMAN would streamline these maintenance processes for the Mid-Carolina region.

Challenges/Barriers to Implementation

Implementation and maintenance of stream gauges is a relatively simple process. There is a strong history of stream gauge installation for improved forecasting throughout the region. Therefore, the region has the technical capacity to successfully plan for and install new gauges. Additionally, the potential partners selected for this project were selected to increase overall capacity through access to resources such as equipment, contractors, and processes. Coordination with partners will be imperative (NCEM, NCDOT, etc.).

Applying for and securing adequate funding is the only anticipated challenge. Another variable to consider is the projects proposed phases. This would likely extend the overall project timeline, which may not be favorable when considering increased flood risk and potential impacts as the climate continues to warm. If possible, low-cost gauges may be accounted for within the local operating budgets to alleviate time-sensitivity.

²⁵ Dello, Kathie. (2020). *North Carolina Climate Science Report Plain Language Summary*. North Carolina Climate Science Report Plain Language Summary - North Carolina State Climate Office (ncsu.edu)

²⁶ USGS. *Charlotte-Mecklenburg Hydrologic Network*. *Charlotte-Mecklenburg Hydrologic Network* (usgs.gov)

Opportunities for Integration

Today, most gauges are compatible with FIMAN and will be incorporated into existing FIMAN and FIMAN-T programs. Integration into the existing system benefits the network as a whole and contributes to regional resilience. The additional gauges will allow for real-time flooding extents and impacts in the Mid-Carolina region, which will lead to improved response and recovery.

In addition to the 16 identified locations for new stream gauges, other locations were proposed. These locations can be found in the Appendix of this document. It is suggested to incorporate the remaining stream gauge locations into the regional hazard mitigation plans since these plans already propose additional stream gauges as a mitigation strategy. These plans should also make note of project status to provide an up-to-date overview of completed efforts and to reduce redundancy.

Potential Cost Range

There are varying technologies used to measure water surface elevations, which are what stream gauges measure, but there are essentially two cost options with stream gauges:

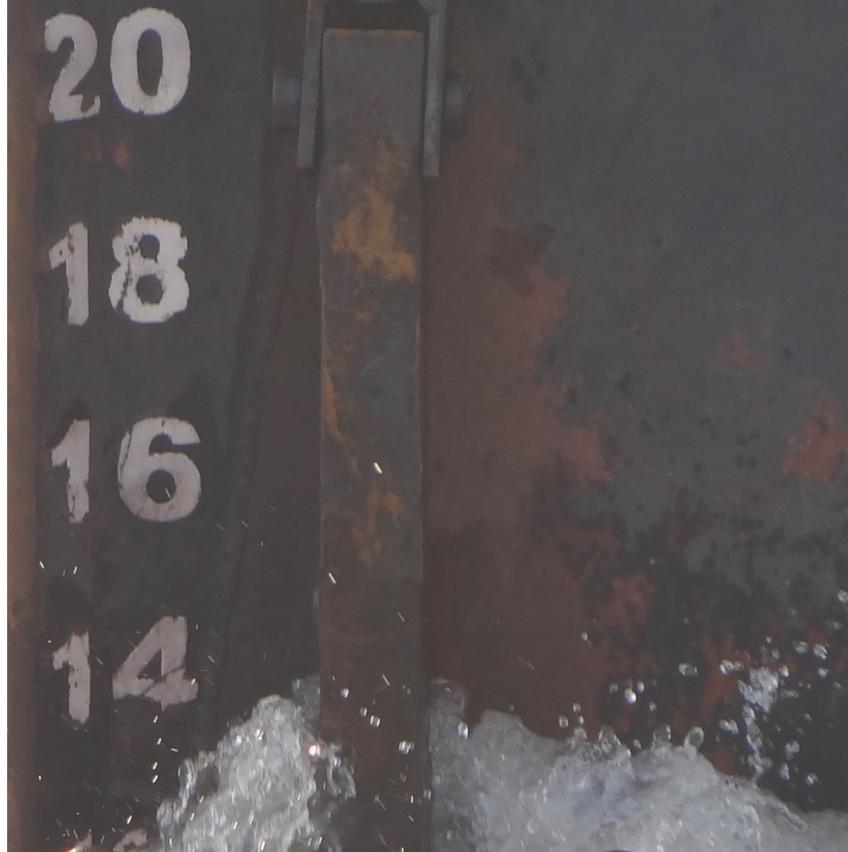
- Low-Cost Sensors: Cost \$5,000- \$6,000 /per gauge for hardware and installation
- Higher-Cost Sensors: \$25,000 /per gauge

Based on these costs, the estimated project cost ranges from \$100,000-400,000 depending on the type of gauge selected. There are pros and cons of each: Lower cost sensors enable more equipment to be installed at a reduced cost. However, these may provide lower-tech readings, require increased maintenance, or need frequent equipment replacement when compared to than higher-cost options.

Known and Potential Resources

State funding has been used to purchase and install gauges, but the programs used are not recurring. Federal funding has been sought from programs such as the Hazard Mitigation Grants Program with limited success. The City of Fayetteville, on the other hand, has been successful in securing Building Resilient Infrastructure and Communities (BRIC) funding for gauge installation.

Most gauge additions have come from local funding sources including local operating budgets.



Funding Opportunity	Administered by	Funding Type(s)	Matching & Eligible Amounts	Term/Typical Deadline
Flood Mitigation Assistance (FMA)	NCEM and FEMA	Grant	75% federal and 25% state/local match (up to 90% match for LMI communities)	Opens September and close January
Building Resilient Infrastructure and Communities	NCEM and FEMA	Grant	50% federal and 50% state cost-share cash or in-kind match requirement	Opens April and closes June of each year
USGS Cooperative Matching Funds (CMF) Program	U.S. Geological Survey	Grant	Up to 50% federal match	-

Table 19: Funding Opportunities for Additional Stream Gauges in the Mid-Carolina Region





PROJECT 4

FEASIBILITY ASSESSMENT FOR ENERGY BACKUP INSTALLATION IN MARGINALIZED COMMUNITIES & CRITICAL FACILITIES

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022



PROJECT 4: FEASIBILITY ASSESSMENT FOR ENERGY BACKUP INSTALLATION IN MARGINALIZED COMMUNITIES & CRITICAL FACILITIES

I. PROJECT OVERVIEW

Project Scope

Conduct an assessment to determine the best suited solutions for energy backup across the region that would benefit marginalized communities²⁷ and simultaneously provide redundant systems for critical facilities. Power failure is a common result of hurricanes, severe thunderstorms, severe winter weather and, in some cases extreme heat when power blackouts may be imposed to reduce strains on power grids caused by increased usage.

The assessment aims to identify optimal locations for energy backup to serve two crucial functions. The first function is to provide backup power generation to selected critical facilities to ensure continuity of operations and time sensitive response during a disaster (flood, extreme heat, hurricane, drought, or wildfire). Additionally, backup power supply should be strong enough to provide adequate support for heating, ventilation, and air conditioning (HVAC) so these buildings could potentially serve as cooling centers and/or shelters to provide relief from the heat during warmer months.

The second function is to provide marginalized communities with reliable power. Stakeholders acknowledged the direct relationship between marginalized communities and poor health conditions. Hazard events can exacerbate existing health conditions leaving vulnerable populations at even greater risk. Heat is particularly important in this effort as it is the leading cause of hazard-related illness and death and has been overlooked by county efforts in the past. In addition to supplying reliable power during extreme heat events, this project aims to lower the energy cost burden on low-income households during warmer months and during storm events.

The State Energy Office is exploring recommendations and potential locations for microgrids throughout the state. This project should coordinate with and build upon any recommendations from the State Energy Office.

Project Location and Service Area

Locations contingent upon assessment results.

Vulnerabilities Addressed

The locations identified for redundant power, in alignment with work being conducted by the State Energy Office, is intended to serve those that currently are powered by an unreliable source. This project aims to build off existing state efforts to enhance and stabilize power in areas that experience significant outages compared to the region as a whole or where major gaps exist with providers. Unstable power is typically concentrated in rural portions of the region,

²⁷ When referring to marginalized communities, this portfolio uses the following definition: Groups or communities that experience discrimination and exclusion (social, political, economic) because of unequal power relationships across economic, political, social and cultural dimensions. Source: *Marginalized populations | National Collaborating Centre for Determinants of Health (nccdh.ca)*

marginalized communities, or both. This project will improve power stability and reliability in traditionally underserved communities with the potential to lower energy cost burdens, improve health outcomes, and increase resilience against natural hazards.

Regional Impact

The anticipated regional impact will improve power stability and reliability in the region and especially in traditionally underserved communities with the potential to lower energy cost burdens, improve health outcomes, and increase resilience against natural hazards.

Populations Served

Populations served contingent upon assessment results.

Environmental Considerations

It is not anticipated that this project will have negative impacts on the environment. If “clean energy” solutions are part of the identified strategy, the environmental considerations for this project would be positive.

Similar Efforts

The State Energy Office is currently assessing areas of the state that would most benefit from having energy backup solutions identified and implemented. This project should be closely coordinated with them to ensure consistency with statewide efforts. Currently, it is unsure how statewide priorities overlap with the communities in the Mid-Carolina Region.

Relationship to Adopted Plans

The Cape Fear Regional Hazard Mitigation Plan identifies the following related mitigation action for Harnett County:

Action PP-4: Provide backup power for critical facilities

The Cumberland Hoke Regional Hazard Mitigation Plan identifies the following related mitigation action for Cumberland County:

Action C-7: Provide financial assistance for low-income residents to help with power bills and support services during extended periods of high temperature and other extreme weather.

Action C-15: Seek grant funding to install backup generators or quick connect hook ups for mobile generators on any county critical facilities.

The Sampson Duplin Regional Hazard Mitigation Plan identifies the following related mitigation action for Sampson County:

Action S26: Provide backup power to critical facilities.

II. IMPLEMENTATION PATHWAY

Recommended Lead Implementers

Table 20 below provides the names of lead implementers that were identified to implement this project.

Position/Agency	Related Project
Cumberland, Harnett, and Sampson County Administration	Region-wide
Municipal Administration, City of Fayetteville Administration	Region-wide
Cumberland, Harnett, and Sampson County Emergency Management	Region-wide
Mid-Carolina Regional Council of Governments	Region-wide

Table 20: Lead Implementers / “Champions” for Feasibility Assessment for Energy Backup Installation Project Implementation

Partnerships

In addition to lead implementers, partnerships are crucial for successful implementation. Combined efforts increase capacity, foster a collaborative setting for brainstorming, and leverage resources to reduce costs. The following experts are recommended to be included or consulted for this project:

Potential Partners
North Carolina State Energy Office
Power Companies (Duke Energy, Local Power Co-ops including South River EMC, Tri-County EMC, Four County EMC, Central Electric Membership Corp., South River)
Researchers from Academic Institutions (NC State, ECU, UNC)
The National Renewable Energy Laboratory (NREL)
U.S. Department of Energy’s (DOE) Energy Transitions Initiative and Partnership Project (ETIPP)

Table 21: Potential Partners for Feasibility Assessment for Energy Backup Installation Project Implementation

Implementation Phases

Full implementation of this project will be a long-term/multi-year timeframe. The project could be implemented in three phases:

Phase I: Feasibility Assessment

Phase II: Identification of potential solutions (should be an outcome of Phase 1)

Phase III: Implementation of energy backup solutions. Potential energy backup solutions should be identified in Phase II.

The following implementation pathway could be employed to accomplish this project:

- 1. Assemble a working group comprised of project partners.** Convene a meeting of municipal and County staff, the Mid-Carolina Council of Government, state partners, power companies and other partners to form a working group.
- 2. Review and assess existing plans, programs, and projects.** Review and assess existing plans, programs, and projects that interrelate or support project. Work completed related to micro grids by the State Energy Office should be included in this assessment. Information gained from these sources may help further inform the project to ensure a holistic project approach.
- 3. Develop a project scope.** The working group should identify a project scope. Determine the overall project approach, general budget considerations, and timeline for completion.
- 4. Assess existing infrastructure.** Inventory and map, if possible, existing power infrastructure in the communities as well as critical facilities or other key infrastructure that will be part of the assessment. Much of this information should be available in the Hazard Mitigation Plan.
- 5. Seek project funding.** Explore appropriate funding sources for completion of Phases I, Feasibility Assessment.
- 6. Conduct the feasibility assessment.** The Phase I Feasibility Assessment should outline potential solutions and this information can be used to identify potential funding sources for project implementation.
- 7. Seek funding for implementation of energy backup solutions identified in the Feasibility Assessment.**
- 8. Install energy backup solutions at identified sites.**

Maintenance and Operation Needs

It is not anticipated that any maintenance or operation costs would be needed to implement the first phase of this project. Future phases would likely require maintenance and operation costs depending on the proposed (and implemented) solutions.

Challenges/Barriers to Implementation

Like green infrastructure, some energy backup solutions, such as microgrids require a high initial investment that reduces costs long-term. However, there are more affordable options when considering power redundancy include backup generators. Additionally, the State of North Carolina has taken a proactive approach in planning efforts for energy efficiency and funding for upfront costs. Technical assistance may also be available for smaller communities with limited grant capacity.

Many localities struggle to identify which groups are marginalized. It may be obvious, with common examples of the homeless, impoverished, or new immigrants. However, it can be more difficult in other cases, particularly with those who lack technological access, civic literacy, and mobility. Inclusive planning initiatives are crucial to ensure that traditionally underserved and rural communities are actively engaged for adequate representation.

Opportunities for Integration

This project can be coordinated with Statewide Energy Resiliency efforts of the State Energy Office.

Potential Cost Range

It is estimated that the first phase of this project (Feasibility Assessment) would cost between \$50,000 and \$100,000. Future phases would be dependent on the size and complexity of the proposed solutions.

Known and Potential Resources

There are currently several potential funding sources that could be considered for funding this project. Project eligibility will need to be determined, but potential federal grant programs to consider include:

- Building Resilient Infrastructure and Communities (BRIC) Program
- Infrastructure Investment and Jobs Act Funding
- Inflation Reduction Act Funding
- Renewables Advancing Community Energy Resilience (RACER) Funding Program





PROJECT 5

STREAM DEBRIS REMOVAL

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022



PROJECT 5: STREAM DEBRIS REMOVAL

I. PROJECT OVERVIEW

Project Scope

Stream debris removal, on identified streams, throughout the region was identified as a high priority resilience action for the Mid-Carolina Region. Based on input gathered through the public and Stakeholder Partnership meetings, locations were selected based on need and their potential impact on the region. Stream debris removal is a best management practice for the removal of vegetation (clearing) and/or selective removal of snags, drifts, or other obstructions from natural or improvement channels and streams. This includes downed trees, broken tops and vegetative debris that have fallen into the stream beds, which typically results in restricted water flow. Additionally, man-made debris such as tires, appliances, and other garbage will be removed.

Project Location and Service Area

Table 22 displays the selected locations for stream debris removal with Cumberland, Harnett, and Sampson Counties. Emergency Management staff from each county helped develop this cohesive list of locations in need of debris removal. These locations correspond with problem areas identified on the NCORR Action Map²⁸ as well as during stakeholder and public engagement.

Location	County
Little River in Spring Lake	Cumberland County
Gate Line around Fort Bragg	Cumberland County
Black River in Dunn	Harnett County
Cape Fear and Upper Little River Merge south of Erwin	Harnett County
Great Coharie Creek from US 421 North of Clinton to Boykin Bridge Road	Sampson County
Southern end of Black River near Ivanhoe Community	Sampson County

Table 22: Stream Debris Removal Project Locations Selected by County Emergency Management Staff and Municipal Staff

²⁸ The NCORR Action Map was created and used to increase ground-truthing data collection through visual engagement. The map enabled individuals to demarcate areas of vulnerability across the region using a point, line, or polygon. Once an area was selected, the user was asked the hazard of concern, any specific occurrences/events, issues caused by the hazard, and the name of the submitter.

Vulnerabilities Addressed

Debris buildup in water can result in diverted flows, which contribute to flooding or erosion, damage to roads, bridges, and other development. This project is intended to (1) Reduce risks to agricultural resources by removing obstructions that hinder channel flow or sediment transport, (2) Reduce excessive bank erosion by eddies or redirection of flow caused by obstructions, (3) Reduce risk of flooding, and (4) Minimize blockages by debris. Streams are dynamic systems that adjust to changes. Disturbance to one section of a stream corridor (including channel, banks, floodplain, riparian, and upland areas) may have damaging results to other sections, both upstream and downstream.

Regional Impact

The region recognizes stream debris removal as economically and environmentally defensible and technically sound. Removing excess debris will help restore hydraulic flow capacity and direction, provide protection from flooding or soil erosion, and reduce threats to life and property. Although specific locations have been identified for cleanout, this effort is considered a regional action due to the intricate relationship between waterways and adjacent communities. The scope of the project spans far beyond the project location because action taken will impact upstream and downstream communities. Additionally, this project may encourage communities to develop comprehensive debris management and resilience plans for future guidance and use.

Local Impact

Stream debris removal will have the largest impact on property and structures adjacent to the identified waterways. Although debris removal is beneficial in many regards, unnecessary removal of woody debris can disrupt and damage the natural ecosystem in place.

Populations Served

All locations identified in the project scope, excluding Fort Bragg Military Installation, have high levels of social vulnerability based on CDC's Social Vulnerability Index (SVI) scoring. This project will mitigate future flooding that impacts personal property and causes loss of life, especially in vulnerable and underserved populations.

Ivanhoe, located in southern Sampson County, was identified as a problem area due to its low elevation and proximity to two major rivers in the region.

The South River and the Black River converge on the eastern side of this small community. When flooding occurs, water can take upwards of five to seven days

to recede. Out of the four themes used to determine social vulnerability scores, the “minority status and language” largely contributed to Ivanhoe’s overall high vulnerability. Debris removal conducted in the Black River could potentially alleviate flood vulnerability in this community, or at minimum, speed recovery including water recession after a flood event.

Environmental Considerations

Prior to implementation, debris that pose risk to the surrounding areas should be evaluated. If this distinction is not established prior to implementation, removal of some debris may result in unintended consequences. Not all debris are problematic or unwanted. Woody debris, such as trees, branches, or stumps, play an integral role in natural and healthy stream systems. In the upper reaches of streams, such debris increases channel roughness, dissipates energy, slows floodwaters, and reduces flood damage downstream. This material also forms a basis for the entire aquatic ecosystem food chain by providing nutrients and improving in-stream habitat. Woody debris that pose little risk to existing infrastructure are best if left in place, and thereby saving time and resources for more critical work at other locations.

Similar Efforts

Harnett Soil and Water Conservation recently completed a stream debris removal project to reduce lowland flooding during large rain events by removing blockages allowing water to flow more freely. The project totaled 71 miles of river and creek channels in Harnett County. Debris removal has been completed in the Upper Little River from the Lee County line to the Cape Fear River (accounting for 43.41 miles), Anderson Creek from Highway 210 to the Lower Little River (accounting for 9.13 miles), and Lower Little River from McCormick Rod to Cape Fear River (accounting for 18.81 miles).

These river segments were selected in partnership with the local Emergency Management staff following Hurricane Florence (2018). Based on their knowledge and expertise in Harnett County, problem areas were identified with consideration to structure flooding or rescues conducted. Funding received to complete this project includes the United States Department of Agriculture’s (USDA) Emergency Watershed Protection (EWP) Program as well as the North Carolina Department of Agriculture and Consumer Services (NCDA)’s Division of Soil and Water Conservation stream debris removal funding.

The County has secured funding from the new North Carolina Department of Agriculture’s (NCDA) Streamflow Rehabilitation Assistance Program (StRAP) for an amount of \$379,528 to begin another project to clean out vegetative debris from Neills Creek. Neills Creek is susceptible to flooding from a typical summer thunderstorm in North Carolina.

Relationship to Adopted Plans

Stream debris removal is a rather common practice in hazard mitigation that can be cited in county planning documents including the county mitigation plans as well as the resilient redevelopment plans. The goal of this project is to streamline the removal process, and establish partnerships between landowners, municipalities, and county staff to better maintain the waterways periodically. Stream debris removal typically occurs pre and post disaster (as county mitigation plans call for), but from a resilience standpoint, problem areas should be evaluated routinely for clean up or removal. This ongoing effort will alleviate the push for removal in short notice, reduce flood vulnerability, and allow staff to shift their efforts toward other urgent matters before, during, and following a hurricane or flood event.

II. IMPLEMENTATION PATHWAY

Recommended Lead Implementers

Table 23 below provides the names of lead implementers that were identified to implement this project. Again, these entities were selected based on their area of expertise and familiarity with the project. The suggested leads have extensive knowledge and background on efforts completed, underway, or needed pertaining to stream debris removal and reduced flood vulnerability.

Name	Position	Contact	Related Project
Lynn Lambert	Natural Resources Director, Harnett County Soil & Water	llambert@harnett.org	Black River
Greg Frank	County Emergency Management, Harnett County	(910) 893-0712 gfrank@harnett.org	Harnett County
Gary Crumpler	Emergency Management Coordinator, Cumberland County	(910) 438-4069 gcrumpler@cumberlandcountync.gov	Cumberland County
Rick Sauer	Director of Emergency Services, Sampson County	(910) 592-8996 rsauer@sampsonnc.com	Sampson County

Table 23: Lead Implementers for County Stream Debris Removal

Partnerships

In addition to lead implementers, partnerships are crucial for successful implementation. The County Soil and Water Conservation Offices have experience with stream debris removal and access to necessary resources for implementation. The Soil and Water Conservation Districts have an ongoing partnership with the Natural Resources Conservation Service (NRCS) to provide technical assistance and inform the public.

The Soil and Water Conservation District Offices work routinely with NC State Forest Service, NC Cooperative Extension Service, the Farm Service Agency, and the Wildlife Agencies. Combined efforts increase capacity, foster a collaborative setting for brainstorming, and leverage resources to reduce costs. The following experts are recommended as potential partners for this project:

Potential Partners
County Soil and Water Conservation Offices
NC Division of Water Resources
U.S. Army Corps of Engineers
Friends of the River
Coharie Indian Tribe

Table 24: Potential Partners for Stream Debris Removal Projects

Implementation Phases

Like the stream gauges project, the magnitude of this project will likely involve several implementation phases. The following steps are proposed for stream debris removal throughout the Mid-Carolina region:

- 1. Develop a Project Team.** Made up of potential partners and other key stakeholders as identified to guide the initial planning process for stream debris removal throughout the Mid-Carolina region.
- 2. Develop a Project Scope.** Determine the number of a phases needs to complete all six proposed locations. Since there are two locations per county for this project, two implementation phases are suggested: 1 project per county (3 total per phase).
- 3. Complete an Existing Conditions Analysis.** To evaluate the extent of debris removal needed at each suggested location. Areas with higher flood risk should receive priority when considering phases. Flood risk should consider historical flood occurrence, evacuations conducted, assets in close proximity, populations at risk, and population density.
- 4. Apply for Appropriate Funding.** The project team will need to consider if a grant application should be submitted at the regional level (for all phase one projects) or at the county level. Submitting a grant application at the regional level is more time efficient and leverages available resources.
- 5. Request Quotes from Experienced Vendors.** That specialize in stream debris removal work including the scope of work, additional details, and all requirements. Visit [Request for Proposals: Harnett Soil and Water Conservation District](#) for a local and in-depth example of a RFP. Items to be included within the Request for

Proposals (RFP) include:

- a. Purpose
- b. Contract Period
- c. General Provisions
- d. Special Provisions
- e. Scope of Work
 - i. Method
 - ii. Delivery of Inspection Services
 - iii. Permits and Licensing
 - iv. Management Agent/Employees
 - v. Property Description
6. **Select Best Qualified Vendor(s).** To complete stream debris removal within the designated contract period. The planning team will need to consider how many vendors will be selected (if more than one), and how they will vote/determine the best candidate(s).
7. **Establish Next Steps Routine Maintenance.** To continue this effort and complete steps 4-6 for the following implementation phase. The project team may consider other sites as well for future action.

Maintenance and Operation Needs

The maintenance of waterways in the Mid-Carolina region is an ongoing effort. It was noted by local Emergency Management staff that stream debris removal does not eliminate the need for continual monitoring and maintenance of debris in waterways. Rather, removal is temporary and debris will continue to fall in and around major creeks and streams disrupting flow and capacity. Opportunities for Integration

Opportunities for Integration

There may be opportunities for the Counties to work collaboratively to maximize funding and technical capacity. This would shift the work from a county perspective to a regional perspective. Counties would work together to address debris removal within any given waterway, ignoring municipal boundaries, to maintain the designated stream or creek. This action is particularly important when looking at unincorporated portions of the region.

The Sampson-Duplin Regional Hazard Mitigation Plan is the only mitigation plan that proposes an action pertaining to stream debris removal. The plan states “Expand beaver management program to mitigate stream debris and

temporary staging sites, permanent storage or disposal of debris, work in bodies of water, and debris that may have historic significance²⁹. Stream debris removal should be thoughtfully planned to have the smallest impact possible on the natural system. For more information on guidelines for removal visit: [NCDEQ Guidelines for Cleanup/Restoration in NC Streams and Wetlands After a Natural Disaster/Catastrophic Event](#).

Potential Cost Range

The recent stream debris removal completed in Harnett County was used to create a rough cost estimate. The County received approximately \$380,000 for stream debris removal in one waterway (Neills Creek). Since two implementation phases are being proposed, three projects per phase, that number was multiplied by three to calculate the cost range for each phase. Therefore, the cost range is estimated between \$1-1.5 million per phase (\$2-3 million total). The cost will be contingent upon the total length of debris removal needed, which is dependent upon the existing conditions analysis and findings.

Known and Potential Resources

The funding opportunities proposed for stream debris removal are primarily based on recently awarded funds for similar efforts within Harnett County. As described previously, Harnett County has completed several large-scale stream debris removal efforts. This reveals the county’s ability to secure adequate funding, carry out successful removal, and overall commitment to reduce flood vulnerability and increase resilience. The Emergency Watershed Program should be pursued as a first option because of its large federal match requirement and opportunity for limited resource areas.

Funding Opportunity	Administered by	Funding Type(s)	Matching & Eligible Amounts	Term/Typical Deadline
Emergency Watershed Program (EWP)	USDA	Grant	75% federal and 25% local (up to 90% match for "limited resource area")	-
Streamflow Rehabilitation Assistance Program (StRAP)	NCDA	Grant	50% federal and 50% state cost-share cash or in-kind match requirement	Opens April and closes June of each year

Table 25: Funding Opportunities Proposed for Stream Debris Removal in the Mid-Carolina Region





PROJECT 6

CLIMATE EQUITY INDEX TOOL

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022



PROJECT 6: CLIMATE EQUITY INDEX TOOL

I. PROJECT OVERVIEW

Project Scope

Using GIS technology, the Mid-Carolina Regional Council will lead the development of an interactive mapping tool that overlays available hazard data with socially vulnerable populations data to display increased risk for marginalized communities to better understand existing disparities that challenge resilience within these communities.

The tool will display different layers including climate impacts, social vulnerability, natural resources, and built assets. Each layer will have relevant information to further refine the search. **Table 26** below displays some of the layers of information that can potentially be used to depict a comprehensive overview of existing conditions per census tract (or at a finer level if possible) to better understand how to increase resilience in the face of climate change.

Layer 1: Climate Impacts	Layer 2: Social Vulnerability Factors
<ol style="list-style-type: none"> 1. Hurricanes and Storms 2. Flooding and Heavy precipitation 3. Wildfire and drought 4. Extreme Temperatures (High Heat Indexes) 	<ol style="list-style-type: none"> 1. Overall Social Vulnerability 2. Population 3. Social Health and Safety 4. Household 5. Income and Education 6. Housing and Transportation
Layer 3: Natural Resources	Layer 4: Built Assets
<ol style="list-style-type: none"> 1. Street Trees 2. Trees (Other) 3. Lakes 4. Protection Areas 5. Wetland Conservation Prioritization 6. Terrestrial Habitat 7. Water Bodies 	<ol style="list-style-type: none"> 1. Critical Facilities 2. Communications 3. Buildings and Housing 4. Community Facilities 5. Energy Facilities and Infrastructure 6. Food Access 7. Government and Planning Facilities 8. Medical Facilities 9. Transportation Infrastructure 10. Water and Waste Infrastructure

Table 26: Potential Layer Information for the Climate Equity Tool

The tool can also be used to measure the level of access to opportunities (i.e., public transportation, pedestrian amenities, lower energy cost burden, etc.) residents have within a census tract³⁰, and assess the degree of potential impact from climate change to these areas. It should be distinguished that these populations are not only confronted with a decreased level of access to opportunity, but rather, face barriers that limit their social and economic opportunity.

The map would be implemented regionally and available for public use. In addition to guiding climate policy, the tool can be used to increase public awareness, educate, and inform emergency managers. Educational and financial resources pertaining to the region's specific vulnerabilities will be available within the tool. The goal is not only to call out the data, but to provide information that results in action; action that reduces vulnerability before a hazard event occurs.

Project Location and Service Area

Region-wide action.

Vulnerabilities Addressed

In essence, the map would help address all hazards impacting the Mid-Carolina Region including hurricanes and storms, flooding and heavy precipitation, extreme temperatures including high heat indexes, and drought and wildfires. Although the map itself does not directly address these hazards, it sheds light on a key vulnerability in the region that has been traditionally overlooked in the planning process: social vulnerability. Understanding the correlation between social vulnerability and natural hazard impacts will enable community leaders to make informed decisions to better protect those most at risk.

Regional Impact

This project is intended to address social vulnerability and support equitable decision-making for future resilience planning efforts against natural hazards impacting the Mid-Carolina Region. The tool would allow users to better prioritize and allocate local, state, and federal resources to address inequity and to protect people, property, and infrastructure. Resources would be used to provide public facilities and services to communities in need while increasing mobility and accessibility.

Populations Served

This project is intended to bolster resilience in marginalized communities throughout the Mid-Carolina Region. The mapping tool would be used by local officials and organizations

³⁰ Census tract level will allow for in-depth analysis with existing information that is consistent with other ongoing efforts such as Qualified Census Tracts or LMI communities. Incorporating this data into the map will contribute to a comprehensive overview of each tract.

to develop equitable climate resilience plans and policies to better inform, prepare, and respond in the event of a natural disaster. It was noted by the Sampson County's Emergency Management staff that designated shelters currently lack back-up generation or are ill-equipped to support a heating, ventilation, and air conditioning (HVAC) system. It would be useful to identify these shelters and recommended improvements in the Climate Equity Index tool for future funding purposes. Additionally, the tool would provide valuable information for the general public pertaining to existing resources, such as evacuation routes.

Social Vulnerability

The overall goal of the Mid-Carolina Regional Resilience Portfolio is to heighten equitable resilience. Equitable resilience is a "form of resilience which is increasingly likely when resilience practices take into account issues of social vulnerability and differential access to power, knowledge, and resources; it requires starting from people's own perception of their position within their human-environmental system, and it accounts for their realities and for their need for change of circumstance to avoid imbalances in power into the future."³¹ This project is intended to acknowledge, support, and address inequities that impact the region's overall resilience through the development of systems and practices that are contextually-rooted, responsive to change and socially just.

Case Study

The proposed project will replicate the tool created by the City of Richmond Virginia known as the RVAgreen 2050 Climate Equity Index. This innovative tool was used as a case study in the U.S. Resilience Toolkit. Overall, there was strong support to develop and launch a similar tool. Stakeholders across Cumberland, Harnett, and Sampson County recognized the importance of social vulnerability in resilience building. Interestingly, stakeholders indicated a need to better understand and grasp this issue to take appropriate action. For more information on the Richmond's mapping tool visit: [RVAgreen 2050 Climate Equity Index](#).

Similar Efforts

The City of Fayetteville recently added the Flood Awareness Map, a public-facing map, to the City's website. The map allows viewers to explore flood vulnerability within each neighborhood. The goal of this map is to increase vigilance among residents and heighten awareness of flood risk. Variables found within the map include single access neighborhoods (only one point of entry and exit), disconnected areas (low-lying areas that are disconnected during a flooding event), low water crossings (a culvert that could potentially overtop), and historical flood reports (areas where flooding has been reported and validated by city staff). This map is one part of the City's multi-media Flood Awareness Campaign to inform as many people as possible. Some components are still under development. For more information visit: [City of Fayetteville's Flood Awareness Map](#).

³⁰ Nulifar Matin et al. 2018. *What is Equitable Resilience?* *World Development*, 109(2018), 197-205. <https://doi.org/10.1016/j.worlddev.2018.04.020>.

Relationship to Adopted Plans

The existing hazard mitigation plans and resilient redevelopment plans for Cumberland, Harnett and Sampson County make mention of similar efforts that strongly align with the proposed Climate Equity Index tool for the Mid-Carolina Region. Distinct from the existing county plan actions, the proposed mapping tool would provide a regional perspective in addition to county-specific items. A broader perspective will allow for collective action and collaboration between parties. The tool will incorporate elements from each hazard mitigation plan to support continuity, building upon previous planning initiatives.

II. IMPLEMENTATION PATHWAY

Recommended Lead Implementers/Champions

The lead implementer for this project is the Mid-Carolina Regional Council Government. The COG has recently received funding from NCORR and will add the proposed project to its workbook.

Name	Position	Contact	Related Project
Samantha Wullenwaber	Director, Local Government Services, Mid Carolina Regional Council	swullenwaber@mccog.com	Climate Equity Index Tool

Table 27: Lead Implementers for the Climate Equity Index Tool Implementation

Partnerships

In addition to lead implementers, partnerships are recommended to increase technical capacity. It was noted that the Mid-Carolina Regional Council of Government currently does not have GIS capacity. Therefore, the COG would be responsible for selecting an experienced contractor to carry out GIS-related tasks. County and municipal emergency managers and planning staff have local knowledge of existing issues pertaining to vulnerability, inequity, and hotspots. The following partners should be included in this project:

Potential Partners
North Carolina Department of Environmental Quality, Environmental Justice Office (Pending approval)
Climate Equity Index Tool Contractors
County and Municipal Emergency Manager and Planners
NC Geographic Information Coordinating Council (GICC) (NC One Map)

Table 28: Potential Partners for Climate Equity Index Tool Project

Implementation Phases

Generally, it would be anticipated that this project would be able to be completed within the period of approximately one year. Similar to a hazard mitigation plan, the region will aim to refresh data within the Mid-Carolina's Climate Equity Index every five years or more frequently if funding is made available. The necessary steps for successful implementation include:

- 1. Develop a Project Team.** With the technical capacity needed to deliver an innovative mapping tool that is user-friendly.
- 2. Apply For and Secure Appropriate Funding.** Conduct Significant Community Outreach. Including key stakeholders, businesses, and marginalized communities with an emphasis on ground-truthing.
- 3. Data Collection.** Collect and analyze existing information, such as American Community Survey data, parcels data, building footprint data, and other data identified in Table 26: Potential Layer Information for the Climate Equity Tool above. Create the Online Platform. To display information collected with a cohesive and user-friendly interface.
- 4. Maintain Layer and Online Mapping Tool.** Maintain layers contained in the tool and add other data as appropriate. Update the tool regularly, at a minimum of every five years.

Maintenance and Operation Needs

During the beginning stages of the planning process, the project team should determine who is responsible for the continual maintenance of the online mapping tool. Once the Climate Equity Index tool is live and available for public use, the designated staff should seek additional input from the public. Residents can view their neighborhood in the mapping tool, along with all corresponding layers and variables, and provide feedback on the tool's accuracy including any necessary adjustments. This feedback will indicate if residents feel like the map accurately depicts their community. In addition to public feedback, staff should ensure the map is updated regularly to reflect all relevant available data. Climate projections anticipate increased frequency and intensity of natural hazards in coming years. Therefore, the map should correspond with such projections and present the information accordingly.

Challenges/Barriers to Implementation

There are several limitations that involve data availability that either restrict the potential for regular updates once implemented or prevent the inclusion of certain indicators into the Climate Equity Index (CEI) tool. These limitations challenge the tool's capacity to capture the full extent of social vulnerability within the region. Regular updates are crucial for a dynamic, representative, and accurate tool. The project team must determine a qualified individual(s) to maintain the site with skills necessary to conduct research and analysis. Maintenance of the tool will alleviate the issue of data limitations and relativity, which is discussed in greater depth in the following section.

Opportunities for Integration

In the future, update and maintenance of this tool should be identified as an action in the Hazard Mitigation Plan or other similar planning documents. The existing regional hazard mitigation plans mention GIS training and social vulnerability actions related to the proposed Climate Equity Index Tool. These actions should be reviewed and assessed to determine if they can be integrated into the tool and its ongoing maintenance. The following actions are found in the existing hazard mitigation plans.

Cumberland County

The Cumberland-Hoke Regional Hazard Mitigation Plan proposes (1) Maintain an all hazards public education program to educate and prepare residents for all the hazards that impact Cumberland County, (2) Conduct social vulnerability analysis to identify priority needs and opportunities that will address the specific problems vulnerable populations face from all hazards, including barriers to evacuation, event-specific vulnerabilities, and impediments to recovery, and (3) Identify and map structures that are vulnerable to high winds.

Harnett County

The Cape Fear Regional Hazard Mitigation Plan proposes (1) The County will create a data layer of all known properties that are located within the floodplain to be used for future development planning purposes and (2) The County will provide a GIS training tool that will be aimed at educating surveyors and builders about responsible growth in regard to hazard mitigation.

Sampson County

The Sampson-Duplin Regional Hazard Mitigation Plan proposed (1) Maintain and regularly update the County’s GIS system. These will include utilizing GIS to catalog protected areas (wildlife, land conservancy, wetlands) that should be protected from development, working toward completion of computer modeling of public infrastructure/utilities and assess hazards, identifying transportation systems to review and/or designate systematic evacuation routes. This map will be available online once complete and (2) Develop and implement a hazard awareness program including availability/dissemination of education materials on all natural disasters and hazards.

The Sampson County Resilient Redevelopment Plan proposes an Environmental Justice Health Vulnerability Assessment to assess the cumulative effects of flooding and disaster on the community’s health, particularly on low-to-moderate income (LMI) households and vulnerable populations.

Potential Cost Range

It is estimated that the costs associated with building the Mid-Carolina Climate Equity Index tool would be approximately \$100 – 500,000. Maintenance and potential staffing costs would also be needed to keep the data updated. Including updates to the tool as a mitigation action within the regional hazard mitigation plans would support future funding.

Known and Potential Resources

Funding opportunities for the Climate Equity Index Tool are included in **Table 26**.

Funding Opportunity	Administered by	Funding Type(s)	Matching & Eligible Amounts	Term/Typical Deadline
Building Resilient Infrastructure and Communities	NCEM and FEMA	Grant	50% federal and 50% state cost-share cash or in-kind match requirement	Opens April and closes June of each year

Table 29: Funding Opportunities Proposed for Climate Equity Index Tool



APPENDIX

04

Mid-Carolina Regional Portfolio of Resilience Projects
December 2022



SPRING LAKE APPLICATION – SCOPE

Woodson "Gene" Booth
Director



Emergency Services Department

Flood Mitigation Grant 2022 Disaster Relief and Mitigation Grant

I. Applicant Information

Applicant Name: County of Cumberland

Address: 131 Dick St. Fayetteville, NC 28301

Applicant Point of Contact: Garry Crumpler, Emergency Management Coordinator

Email: gcrumpler@co.cumberland.nc.us

Phone: (910) 489-6107

Secondary Point of Contact: Gene Booth, Emergency Services Director

Email: wbooth@co.cumberland.nc.us

Phone: (910) 678-7641

II. General Description of Project

Background

Spring Lake, small community of over 12,000 in Cumberland County, sits astride the Little River, a tributary to the Cape Fear River. It is immediately adjacent to Fort Bragg and Pope Army Airfield. Accordingly, Spring Lake's economic and physical stability is essential to the continued functioning of a major military installation. The town has experienced severe damage to wastewater and stormwater infrastructure in recent years due to repeated flooding from hurricanes Matthew and Florence, severe thunderstorms, and flash flood events. In February and January of 2021, the town's wet well, a component of the wastewater system, flooded due to a severe storm.

Law Enforcement Center, 131 Dick Street, Room 114 | P.O. Box 1829 | Fayetteville, North Carolina 28301
Phone: 910-678-7688 | Fax: 910-677-5552

co.cumberland.nc.us

Woodson “Gene” Booth
Director



Emergency Services Department

Project Description

In coordination with the Town of Spring Lake, Ft. Bragg, and community members, Cumberland County will hire a survey and engineering firm to conduct the first comprehensive assessment of Spring Lake’s stormwater and wastewater infrastructure, as well as tributaries that run throughout the community. The evaluation will include the identification of shovel-ready projects, as well as short and long-term mitigation solutions, and a cost-benefit analysis.

III. Mitigation

Information gathered from the assessment will inform decisions about siting, designing, and floodproofing of critical infrastructure. The assessment will also provide information on nature-based solutions and resilience measures, such as revised building standards in areas likely to be impacted by flooding. Using the data and cost-benefit analysis provided, the County will apply for future grants such as Building Resilient Infrastructure and Communities (BRIC) to reduce the flood impact on the community and strengthen community lifelines.

IV. Scope of Work (SOW)

Scope and Cost Estimate

*Estimate provided on 3/14/2022 from qualified engineering and assessment firm that has completed previous nature-based mitigation solutions in Cumberland County.

In December 2022, the Cumberland County Board of Commissioners committed \$16,993.75 to this project.

Activity	Scope	Cost*
Survey	Collection of data to include current conditions on infrastructure and historical data.	\$10,000

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Woodson "Gene" Booth
Director



Emergency Services Department

Modeling	Engineered solutions utilizing GIS, past and future models, and current standards.	\$30,000
Planning	Comprehensive report of finding and most effective mitigation options.	\$15,000
FEMA grant assistance and Benefit-Cost Analysis	Provide benefit-cost analysis in accordance with FEMA toolkit.	\$15,000
Additional Grant Assistance	Assistance preparing applications for state and federal grant programs.	\$10,000
Total Estimate		\$80,000

V. Timeline

Time	Activity	Description
Month 1	Project Development Team	Development of the team to include representatives from County Government, the Town of Spring Lake, Ft. Bragg, and community members.
Months 2-4	Request for Quote	The County will request bids from qualified engineering and assessment firms using uniform guidance. <i>Start-Stop Point.</i>
Months 5-11	Assessment	Selected company will conduct the assessment and prepare a comprehensive report highlighting shovel-ready projects and future mitigation projects.
Month 12	Report of Finding	Meeting with the project management team to report findings.

VI. Project Management

In collaboration with the Cumberland County Engineering Department, Cumberland County Emergency Management will be the manager for this project. The Town of Spring Lake, Ft. Bragg, and community members will function as project development team members.

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ADDITIONAL PROJECT LOCATIONS

ADDITIONAL PROJECT LOCATIONS

Project Description	Location	Source	Additional Notes
Entire structure of Juniper Creek running through the center of Dunn could be modified with proper floodplain design with lower slopes and green hardscaping for stormwater introduction into the system	Dunn, Harnett County	Wesley Johnson, Wetland Solutions	Via email correspondence inquiring about any/all proposed project locations
Improved stormwater management in older shopping centers using green infrastructure practices	Dunn, Harnett County	Wesley Johnson, Wetland Solutions	Via email correspondence inquiring about any/all proposed project locations
Debris removal in Black River through Coats	Coats, Harnett County	Zach Shean, Harnett County EM	Via email correspondence inquiring about any/all proposed project locations
Debris removal in Riverside area along Bunnlevel Erwin Road	Bunnlevel, Harnett County	Zach Shean, Harnett County EM	Via email correspondence inquiring about any/all proposed project locations
Update/replace gauge in Black River at Harrells Highway- the existing gauge does not have forecast capabilities	Clear Run, Sampson County	NCORR Action Map	Repetitive flooding identified at this location