Climate Change and Natural Hazards

VULNERABILITY ASSESSMENT

for the

Lumber River Region

December 2022

NC RURAL CENTER

NCORR

KLEINFELDER

RISE
Regions Innovating for Strong Economies and Environment

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ACKNOWLEDGEMENTS

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We wish to acknowledge and honor the Indigenous communities native to this region and recognize that this vulnerability assessment covers communities and structures that are built on Indigenous homelands and resources. We recognize the Cheraw, Lumbee, Skaruhreh/Tuscarora and Waccamaw Siouan 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.

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ACRONYMS

ACS	American Community Survey
AMI	Area Median Income
BRIC	Building Resilient Infrastructure and Communities
CDBG-DR	Community Development Block Grant – Disaster Recovery
CDBG-MIT	Community Development Block Grant – Mitigation
CDC	Centers for Disease Control
COG	Council of Governments
EAL	Expected Annual Loss
EMS	Emergency Management Services
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
HMP	Hazard Mitigation Plan
HUD	Housing and Urban Development
LEAD	Low-Income Energy Affordability Data
LEED	Leadership in Energy and Environmental Design
NCDC	National Climatic Data Center
NC	North Carolina
NCDEQ	North Carolina Department of Environmental Quality
NCDOT	North Carolina Department of Transportation
NCHPO	North Carolina Historical Preservation Office
NCNHP	North Carolina Natural Heritage Program
NCORR	North Carolina Office of Recovery and Resiliency
NHIS	National Health Interview Survey
NRHP	National Register of Historic Places
NRI	National Risk Index
PRI	Priority Risk Index
QCEW	Quarterly Census of Employment and Wages
RAPT	Resilience Analysis and Planning Tool
RCRA	Resource Conservation and Recovery Act
RISE	Regions Innovating for Strong Economies and Environment Program
ROW	Right-of-Way
SNAP	Supplemental Nutrition Assistance Program

SVI	Social Vulnerability Index
TMDL	Total Daily Maximum Load
TRI	Toxic Release Inventory
WRAP	Wildfire Risk Assessment Portal
WUI	Wildland Urban Interface

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LRCOG

Dedicated to Regional Excellence

May 19, 2022

Dear Lumber River Region Residents:

Our region, encompassing Bladen, Hoke, Richmond, Robeson and Scotland counties, is known for its diversity, beautiful natural resources, and hardworking and determined population. Yet, our region has faced ever increasing impacts from natural disasters and is continuing to deal with the recovery needs from hurricanes Matthew and Florence.

In light of these challenges, our goal for the Lumber River region is to take action to strengthen our resilience. This work includes reducing the immediate and long-lasting risks that natural and climate disasters pose for people, property, infrastructure and natural resources. The Lumber River Vulnerability Assessment uses rigorous technical analysis combined with local knowledge to outline the major gaps in our region's preparedness for future natural hazards, climate events and their impacts. The report is the result of numerous meetings with residents, elected officials, local leaders, the North Carolina Office of Recovery and Resiliency, North Carolina Rural Center, Kleinfelder, and Lumber River Council of Governments staff. These findings help us identify and prioritize efforts to become more resilient. In the coming months, we will use this Assessment to develop a suite up to 10 resilience projects for our five-county region. However, the Vulnerability Assessment is made available for any use by the public, including the development of independent resilience efforts and grant applications.

As you read through this review of our region's susceptibility to climate impacts, I hope you will think about ways you can prepare neighborhoods, communities and the region.

Please know that your Lumber River Council of Governments will continue to be here to serve our region and its citizens as we continue to adapted to our ever-changing environment.

Sincerely,

David Richardson, JD/MBA
Executive Director

/dr

Member Governments

BLADEN COUNTY
Bladenboro • Clarkton • Dublin
East Arcadia • Elizabethtown
Tar Heel • White Lake

HOKE COUNTY
Raeford

RICHMOND COUNTY
Dobbins Heights • Ellerbe • Hamlet
Hoffman • Norman
Rockingham

SCOTLAND COUNTY
Gibson • Laurinburg • Wagram

ROBESON COUNTY
Fairmont • Lumber Bridge • Lumberton
Marietta • Maxton • McDonald
Orrum • Parkton • Pembroke
Proctorville • Red Springs • Rennert
Rowland • St. Pauls

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1.0 Executive Summary

Over the next 30 years, the Lumber River region must adapt to changing climate conditions. In the Coastal Plain and Sandhills Region, climate scientists project that heavy rainfall and flooding will increase, severe weather will intensify, the number of very hot days will increase, and drought and wildfire will become more common occurrences. The region will also continue to face other hazards, such as high winds. Proactive measures to build resilience are crucial because inaction may lead to serious consequences that threaten residents' health and livelihoods, along with communities, buildings, the local economy, and environment throughout the Lumber River region.

To address these concerns, the Lumber River region participated in the Regions Innovating for Strong Economies and Environment (RISE) program administered by the North Carolina Office of Recovery and Resiliency (NCORR). The RISE program helps advance resilience efforts in North Carolina by supporting multi-county vulnerability assessments and regional solutions that reduce risks from climate change and natural hazards. NCORR established the program in partnership with North Carolina Rural Center, the Lumber River Council of Governments, and Kleinfelder, Inc.

1.1 Vulnerability Assessment Methodology

This Vulnerability Assessment provides a comprehensive analysis of the potential impacts of climate change and natural hazards in the Lumber River region. It positions the Lumber River region to prioritize its efforts to build resilience, based on the best available technical analysis and stakeholder input. It points to common challenges across local communities, challenges that may benefit from local- and regional-scale solutions. The main components of the vulnerability assessment include an analysis of natural hazards, risk and vulnerabilities, impacts across housing, health, the economy, and other sectors, and a brief identification of opportunities and next steps for increasing resilience in the context of natural hazards and climate change.

Review of Literature and Data

The project team gathered relevant content and data through existing reports and planning documents to identify key information about the region. NCORR provided the project team with a

compilation of reports to review for observed and projected changes related to climate hazards, such as heavy precipitation events, droughts, hurricanes, wind, and extreme temperatures. Additional data sources provided information related to socially vulnerable populations, floodplain extent, and natural environmental systems. A sample of reviewed plans is listed in the box (right) and a full list of sources can be found in **9.0 References.**

Reports Included in the Literature Review

- Cumberland Hoke Regional Hazard Mitigation Plan (2020)
- Bladen Columbus Robeson Regional Hazard Mitigation Plan (2020)
- Pee Dee Lumber Regional Hazard Mitigation Plan (2018)
- Hurricane Matthew Resilient Redevelopment Plans for Bladen, Hoke, Richmond, Robeson, and Scotland Counties (2017)
- North Carolina Climate Science Report (2020)
- North Carolina Climate Risk Assessment and Resilience Plan (2020)
- Relevant County Plans (Comprehensive Economic Development Strategy, Land Use Plans, etc.)

Stakeholder and Public Engagement

Local knowledge and expertise were critical to developing the vulnerability assessment. The project team held monthly Stakeholder Partnership meetings from January through November 2022. The Stakeholder Partnership was comprised of individuals living or working in all five counties (Bladen, Hoke, Richmond, Robeson, and Scotland) of the Lumber River region and was open to anyone that wanted to participate. A local facilitator hired by NC Rural Center, the Lumber River Council of Governments (COG), Kleinfelder, Inc., and the North Carolina Office of Recovery and Resilience (NCORR) jointly led these meetings.

Organizations Represented on the Lumber River Stakeholder Partnership

- Town of Maxton
- Town of Pembroke
- Town of Red Springs
- City of Lumberton
- NC Disaster Survival & Resiliency School
- Robeson County Cooperative for Sustainable Development
- Carolina Wetlands Association
- NC Foundation for Soil and Water Conservation
- NC Emergency Management
- Fort Bragg

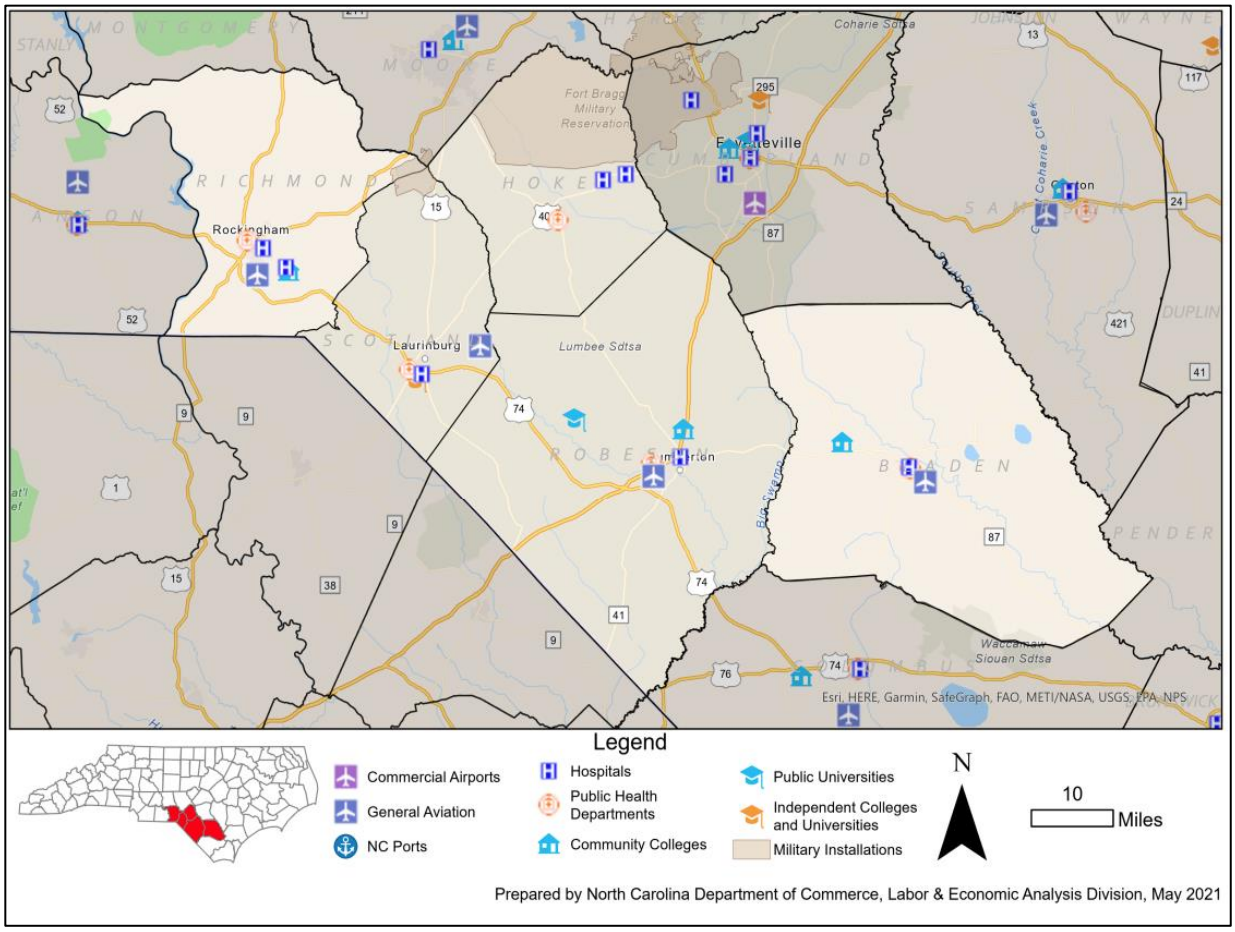
One virtual and one in-person public open house meetings were held in May 2022 to facilitate discussion about known vulnerabilities and personal experience with climate hazards. During Stakeholder Meetings, the project team utilized a variety of engagement strategies, such as live polling, virtual collaboration using

Google Jamboard, asynchronous surveys, and facilitated breakout discussions. Additional information related to project efforts was hosted on the Building Resiliency in the Lumber River Region StoryMap for stakeholders and others interested in the RISE program to interact with. All of the stakeholders who participated in one or more of the monthly meetings contributed valuable insight on the strengths, weaknesses, and opportunities for the region and provided guidance in developing the Vulnerability Assessment. Stakeholders described issues in specific locations (e.g., streets, neighborhoods, creeks, etc.) and offered information related to previous and ongoing efforts to address some of the challenges the region faces from climate hazards.

1.1.1 The Lumber River Region

The Lumber River region, show in **Figure 1**, is situated in southern North Carolina and touches the border of South Carolina. Characterized by wetlands and mostly rural areas, the natural

Figure 1 - Lumber River Five-County Region



Source: North Carolina Department of Commerce, Labor & Economic Analysis Division

resources within the region, like the Lumber River and large tracts of undeveloped forested land, provide opportunities for residents. Five counties make up the Lumber River region – Bladen, Hoke, Richmond, Robeson, and Scotland – and the area is multicultural and diverse. The Lumbee Tribe is a state-recognized Native American tribe, with ancestral lands across Hoke, Robeson, and Scotland counties. Vulnerabilities of the region include aging or inadequate infrastructure, slow growth-related issues (e.g., economic activity and employment), vulnerable populations, and limited resources. These challenges are likely to exacerbate the impacts of climate change. Programs such as RISE position communities to plan for climate change as a unified region with the same goals because climate change and natural hazards do not stop at political boundaries. Participation in RISE aims to create a more resilient region that can withstand the impacts of natural hazards while preserving its character and addressing its challenges.

1.2 Summary of Findings

1.2.1 Regional Strengths and Challenges

The Lumber River has many strengths and challenges that impact its ability to deal with natural hazards that are made worse by climate change. The region's strengths include natural resources and ecosystems that manage flood waters, allow for an agricultural economy, and provide sanctuary for wildlife and drinking water sources, among other benefits. The region also has passionate community organizations that work to help each other prepare for and recover from natural hazards. Furthermore, with six higher education institutions and nearby military operations, residents have access to learning opportunities, technical support, and military support during recovery efforts from catastrophic events.

Many challenges in the Lumber River make it hard for the region to increase its resilience to the impacts of climate change. Recent hurricanes have forced many to emigrate from the area, causing a mismatch in labor and workforce and a loss of tax base. With high unemployment rates and a lack of skilled and available personnel in many sectors, many families have a hard time meeting their basic needs, let alone preparing for disasters. Infrastructure repairs continue to be a need, as Hurricanes Matthew and Florence caused major damage to roads and buildings. Many individuals are still displaced from these major events, which have caused lasting impacts and trauma to residents in the region. The rural natural of the region often makes it difficult for vulnerable residents living in remote areas to receive resources they need.

1.2.2 Natural Hazards

Based on research from scientific reports, regional planning documents, and localized knowledge obtained from the Stakeholder Partnership, the most prominent, high-impact climate hazards in the Lumber River region today are flooding, hurricanes and tropical storms, and severe weather, specifically heavy rainfall, and winds. Extreme heat, heavy rain events, drought, wildfire, and winter storms are projected to occur more frequently by the 2050s and beyond. This vulnerability assessment explores these climate hazards and explains present-day and future risks for the region and impacts to the population, resources, buildings, and environment. Summary points for each hazard of concern are shown in **Figure *2*** below.

Figure 2 - Hazard Impacts to the Lumber River Region

- **Flooding** is the most prominent natural hazard that impacts the region and occurs due to heavy rainfall associated with storms.
- It causes widespread damage to residential and commercial property and infrastructure.
- Flooding is very likely to increase over the next 30-50 years.

- **Severe weather** includes thunderstorms, rain, wind, lightning, and hail.
- These events can cause substantial property damage and create dangerous conditions for residents.
- The frequency and intensity of severe weather and storms are likely to increase over the next 30-50 years.

- **Hurricanes and tropical storms** are the most damaging type of natural hazard.
- Heavy, sustained rainfall and high winds cause property destruction, debris accumulation, and severe, widespread flooding.
- Hurricanes and tropical storms are very likely to increase in frequency and intensity over the next 30-50 years.

- **Extreme heat** and heat waves impact health and can cause heat exhaustion, heat stroke, and death. It also raises energy costs for households.
- High temperatures and warm nights pose threats to vulnerable populations like seniors and those working outdoors.
- The number and severity of heat waves and high nighttime temperatures are likely to increase through the 2050s and beyond.

- **Droughts** can impact agriculture, wildlife, and water supply.
- Extreme heat can exacerbate drought conditions and impact the agriculture in the region.
- The region has previously experienced long periods of drought, and drought conditions are likely to increase in the next 30-50 years.

- **Wildfire** poses a high risk to much of the region, with highest ignition rates in Richmond, Scotland, Robeson, and Hoke Counties, putting these areas at greater risk of wildfire.
- Wildfires can impact water quality and water supply and pose a threat to public health.
- Wildfire is likely to become a more severe threat in the next 30–50 years.

1.2.3 Sector Impacts

As the hazards described above grow in strength and number of occurrences, the region can expect impacts to housing, critical facilities, the regional economy, historical and cultural resources, natural environmental systems, public health, and vulnerable individuals to get worse. The Lumber River region's most significant vulnerabilities are illustrated in the graphics below.

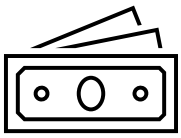
Housing

	• More than 58% of homes in the region were built more than 30 years ago and may have inefficient heating or cooling systems that may put residents more at risk of impact from natural hazards. • Hoke County has the most homes (16%) built within the past decade, and Scotland County has the most homes (69%) built prior to 1989. • Robeson County (36%) and Bladen County (33%) have the greatest proportion of mobile/manufactured homes in the region. Mobile homes may be more prone to structural damages related to high wind events and hurricanes. • Bladen County has the highest percentage of vacant housing units (26%). • Approximately 843 residential buildings (valued at approximately $73.1 million) have a first-floor elevation below the current 100-year floodplain. Approximately 2,804 residential buildings (valued at $324 million) have a first-floor elevation below the current 500-year floodplain.

Critical Facilities

	• Critical facilities are susceptible to severe weather and flooding that cause business, school and road closures; downed trees and powerlines; and structural damage. • There are 1,811 critical facilities in the region, the majority of which are classified as social hubs. • Seventy-five critical facilities are within the 100-year floodplain (58 in Robeson County) and 90 critical facilities are within the 500-year floodplain. • There are currently twelve major critical facilities located in the 100-year floodplain – two in Bladen County, nine in Robeson County, and one in Scotland County. • There are 3 major critical facilities located in the 500-year floodplain – all in Robeson County. • 325 critical facilities are at high risk of wildfire.

Regional Economy

	• Flooding from hurricanes and severe weather is the most significant hazard to the regional manufacturing economy. • Disruption to the supply chain, logisitics, and transportation routes caused by hazards like flooding, hurricanes and severe weather can affect the manufacturing industry and regional economy. • Agriculture is prominent in the region, with 611,753 acres in agricultural production. However, only 43% of farmland acres have crop insurance. • Flooding, extreme heat, erosion and drought all pose a significant risk to agriculture. • Eighteen percent of commercial properties are at risk of flooding in the region, with the largest proportion in Robeson County.

Historical and Cultural Resources

	• Flooding poses the most significant climate risk to historical and cultural resources because it is difficult to physically move these resources. • 23 of the 78 sites on the National Register of Historic Places are in the 100-year floodplain. • Archival records stored in government buildings are often impacted by flooding. • Bladen County has the largest number of sites in the 100-year floodplain, and the Robeson County Courthouse is very close to the 100-year floodplain.

Natural Environmental Systems

	• The Lumber River itself is federally designated as a National Wild and Scenic River, a unique designation. • Wetlands, agriculture, and forests are key resources in the region to aid in resilience and should be given protection from development. • Fifteen species listed as endangered, threatened, or of special concern are found in all five counties and may be vulnerable to climate impacts that permanently change their habitat, such as higher temperatures. • Bladen County has 24,254 acres of pocosin wetlands that are unique to the region and important for carbon storage, and many areas high in conservation value that are lacking management and protection.

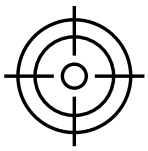
Public Health

	• Physical and mental health can be directly impacted by natural hazards, particularly hurricanes, flooding, and extreme heat. • Robeson, Scotland and Richmond counties have the highest percentage of adults that report fair or poor physical or mental health. • An average of 27% of residents reported poor physical health and 18% reported poor mental health. • Elderly persons and persons with disability are more vulnerable to natural hazards. • Natural hazards can impact drinking water quality and supply, directly affecting public health. • Heat-related illnesses are common during extreme heat events and are the result of the body's decreased ability to cool itself.

Social Vulnerability

	• Social vulnerabilities are the individual characteristics that make it harder for a person to withstand and quickly recover from natural hazards and other stresses. • Bladen, Robeson and Scotland counties have the highest overall social vulnerability and may be affected by natural hazards more than other parts of the region – however, all five counties have an overall high social vulnerability score. • The region is considered highly vulnerable because of household composition and disability, meaning there are high proportions of elderly, youth, single-parent households, and residents living with a disability. • Bladen County has the highest percentage (24%) of elderly persons who are more likely to experience harm from natural hazards. • Robeson County has the highest percentage (44%) of American Indians, followed by Scotland County (14%). • Census Tract 9706, east of Rockingham in Richmond County, has the highest overall social vulnerability score for the state of North Carolina.

Hot Spots

	• Census Tract 9706 east of Rockingham in Richmond County, tract 9603 around Red Springs, tracts 9608.01, 9608.02, 9609, 9610, 9611, 9612, 9613.02 around Lumberton, and tract 102 north of Laurinburg are climate hazard hot spots. These locations are within proximity to the 100-year floodplain, have a greater number of high heat days, have more impervious surface area, and have a greater number of mobile homes and nursing homes compared to other areas in the region.

1.3 Next Steps

Now that this Vulnerability Assessment has provided an analysis of the potential impacts of climate change in the Lumber River region, the region is ready to prioritize efforts to build resilience. Using this document and stakeholder input, the project team will identify five to 10 regional-scale solutions and develop an implementation pathway for each strategy. The pathways will provide clarity of purpose, identify aligned funding opportunities, and outline a direct path for implementation. The Climate Resilience Projects for the Lumber Region can be found here **(link).**

2.0 North Carolina Office of Recovery and Resiliency (NCORR) Overview

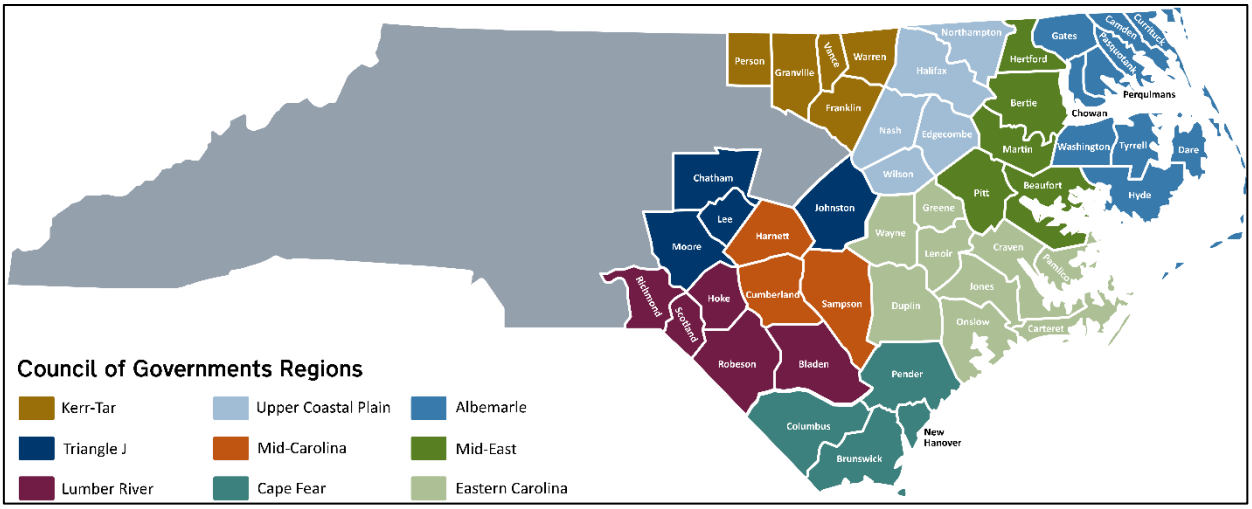
2.1 About NCORR

In the wake of Hurricane Florence in 2018, the State of North Carolina established the Office of Recovery and Resiliency (NCORR) to lead the state's efforts in rebuilding smarter and stronger. At that time, eastern North Carolina communities were still recovering from Hurricane Matthew in 2016. NCORR manages a billion dollars in U.S. Department of Housing and Urban Development (HUD) funding in two grant types, Community Development Block Grant – Disaster Recovery (CDBG-DR) funds and Community Development Block Grant – Mitigation (CDBG-MIT) funds, aimed at making North Carolina communities safer and more resilient to future storms. Additional funding is provided through the State Disaster Recovery Acts of 2017 and 2018, the Storm Recovery Act of 2019, and the Economic Development Administration Disaster Supplemental Funds. NCORR manages programs statewide that include homeowner recovery, infrastructure, affordable housing, resilience, and strategic buyouts. To learn more about NCORR programs, visit the ReBuild.NC.gov website. NCORR is a division of the Department of Public Safety.

2.2 About RISE

Developed in partnership with the North Carolina Rural Center, NCORR's Regions Innovating for Strong Economies and Environment (RISE) program supports resilience in North Carolina. **Figure**

Figure 3 - North Carolina Council of Governments (COG) Regions



3 depicts the nine regions participating in the RISE program, and all are grouped by their designated Council of Government's coverage area.

The RISE program aims to support resilience primarily in the storm-impacted regions of North Carolina by:

- Facilitating the Regional Resilience Portfolio Program, which provides coaching and technical assistance to regional partners in the eastern half of the state to build multi-county vulnerability assessments
- Identifying priority actions to reduce risk and enhance resilience in their region
- Developing paths to project 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, a NC Rural Center leadership training workshop, which operates in the eastern half of the state and emphasizes resilience as a tool for community economic development.

RISE is funded by the U.S. Economic Development Administration and the U.S. Department of Housing and Urban Development's Community Development Block Grant – Mitigation funds, with in-kind support from NCORR and the North Carolina Rural Center. In addition, the Duke Energy Foundation committed $600,000 in grant funding to support the Regional Resilience Portfolio Program.

2.3 Regional Resilience Portfolio Program

The Regional Resilience Portfolio Program for the Lumber River region is a collaboration between NCORR, the North Carolina Rural Center, the Council of Government, Kleinfelder, Inc., and the five participating counties. The project team, consisting of the previously identified organizations, established a Stakeholder Partnership made up of representatives who live and/or work in the Lumber River region. The stakeholders are local county and municipal government officials, economic development planners, emergency managers, and community organizers and activists. The project team conducted monthly stakeholder meetings beginning January 2022 that continued through November 2022. One virtual and one in-person open house session occurred in May 2022 that were open to both stakeholders and the public. Initial meetings focused on

regional resiliency and natural and non-natural hazards. There are two main deliverables for each region participating in the RISE Regional Resilience Portfolio Program:

- A vulnerability assessment that can be a standalone document but is also appropriate for integration into regional and local plans, grant applications, public presentations, educational opportunities, and other planning tools; and,
- A project portfolio of 5-10 projects identified through community input and expert consultation. This is a separate document that outlines funding opportunities and paths to project implementation.

The following Lumber River region vulnerability assessment, which covers Bladen, Hoke, Richmond, Robeson, and Scotland counties, is the first of two main deliverables. The contents of this vulnerability assessment incorporate stakeholder (and members of the public) feedback as well as information gathered from existing literature such as regional hazard mitigation plans, the *North Carolina Climate Risk Assessment and Resilience Plan*, the *North Carolina Climate Science report,* and numerous other sources. The vulnerability assessment (this document) identifies and evaluates vulnerabilities that will inform the second deliverable, the Project Portfolio (a forthcoming, separate document).

3.0 Introduction

Natural hazards are a natural occurrence and unavoidable. Storms, floods, drought, wildfire, and hurricanes are all types of events that have the potential to impact or cause harm to humans and things we care about. A changing climate will likely mean that these events will become stronger and more frequent. The unfortunate reality is that natural hazards do not impact all communities equally. Some people may be at a higher risk of being impacted by hazards based on where they live and other factors such as physical health or income level.

The primary intention of this vulnerability assessment is to identify how climate hazards impact specific community sectors and which locations in the Lumber River region are most vulnerable to their potential devastating effects. The assessment focuses on people, infrastructure, and assets. In addition to natural hazards that are made worse by climate change, this report includes discussions about non-climate related hazards and how they contribute to regional vulnerability.

3.1 Vulnerability Assessment Organization

The main components of this vulnerability assessment include an analysis of natural hazards, risk and vulnerabilities, sector impacts, and identification of opportunities and next steps for increasing resilience in the context of natural hazards and climate change.

Section one provides an executive summary of the findings from the Vulnerability Assessment.

Section two provides a brief introduction of the NCORR RISE Program and explains how the program positions communities to plan for climate change as a unified region with the same goals.

Section three provides an overview of the Lumber River region, including demographic information such as population, income, and race. This chapter also discusses regional strengths and challenges related to climate change and regional vulnerability.

Section four identifies natural hazards that affect the region and discusses how they are expected to increase in the future due to climate change. Hazards include hurricanes and tropical storms, flooding, severe weather, extreme heat, drought, and wildfire. Flooding is the most prominent, high-impact hazard in the Lumber River. Other high-risk hazards include severe weather, extreme heat, and drought as communities will increasingly experience compounding effects of these hazards due to climate change. Each of these hazards and vulnerabilities are explored in depth with a discussion on present-day and future risks for the region.

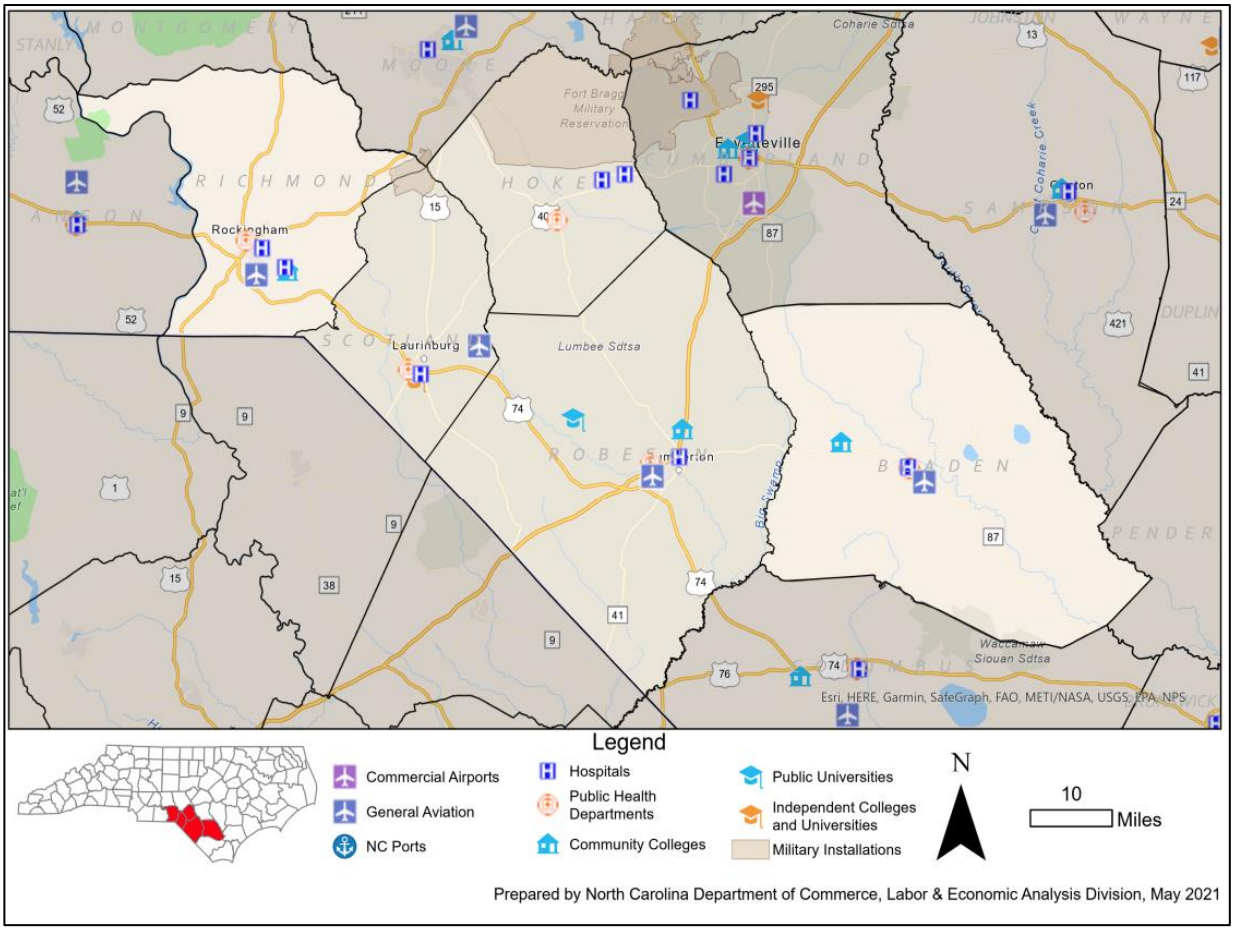
Section five discusses the impact of natural hazards on the following key sectors: housing, critical facilities, regional economy, historical and cultural resources, natural environmental systems, public health, and social vulnerabilities.

Sections six and seven identify climate vulnerability hot spots and outline next steps. Sections eight and nine include appendices, a glossary, summaries of stakeholder/open house meetings, data tables, and references.

3.2 Overview of the Lumber River Region

The Lumber River region is comprised of five counties: Bladen, Hoke, Richmond, Robeson, and Scotland Counties. The region is situated in southern North Carolina (NC) and touches the border of South Carolina. The five-county region is part of the Coastal Plain and comprised of soft, sandy soil. To the north lies the Raleigh-Durham metropolitan area. **Figure 4** below illustrates the Lumber River region and its location within North Carolina.

Figure 4 - Lumber River Five-County Region



Source: North Carolina Department of Commerce, Labor & Economic Analysis Division

3.3.1 Demographics

The Lumber River region is a mostly rural area. Major cities and towns in the region include Elizabethtown, Raeford, Lumberton, Laurinburg and Rockingham. Population estimates by county for 2021 range from 29,525 (Bladen County) to 116,328 (Robeson County) (U.S. Census Bureau, 2022). **Table 1** shows population statistics by county for the region. Table 1 provides population data from 2010, population estimates as of July 1, 2021, and population change between 2010-2021. Population growth rates are lower than the state average of 18.5%, with Bladen County seeing the largest change in population between 2010 and 2021 at -16.1% (U.S. Census Bureau, 2022). Bladen County also has the lowest population of all five counties. Hoke County is growing significantly, in part due to close proximity to the city of Fayetteville. Robeson is the largest county by land area. Overall, the region has seen a decline in population which presents challenges to the tax base, economy, and housing industry.

Table 1 - Population Statistics for the Lumber River Region

County Name	County Seat	Land Area (sq. mi), 2020	Population, 2010	Population estimates, 2021	Population change (2010-2021)	River Basin
Bladen	Elizabethtown	875	35,190	29,525	-16.1%	Lumber, Cape Fear
Hoke	Raeford	390	46,952	53,114	13.1%	Lumber, Cape Fear
Richmond	Rockingham	473	46,639	42,724	-8.4%	Yadkin-PeeDee
Robeson	Lumberton	947	134,168	116,328	-13.3%	Lumber
Scotland	Laurinburg	319	36,157	34,227	-5.3%	Lumber
All Counties	n/a	3,004	299,106	275,918	n/a	Yadkin-PeeDee, Lumber, Cape Fear

Source: U.S. Census Bureau QuickFacts: United States (2021)

The Lumber River region is a culturally diverse area of North Carolina, as shown in **Table 2**. Bladen, Hoke, Richmond, and Scotland counties are greater than 30% Black or African American. Robeson County has about 44% of their population that identify as Native American. The Lumbee Tribe is a State-recognized tribe whose ancestral homelands span all of eastern North Carolina into southern Virginia and northeastern South Carolina, including all of Robeson County.

Table 2 - Race and Hispanic Origin in the Lumber River Region

Race and Hispanic Origin	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
White alone	60.4%	48%	60.5%	29.3%	43.2%
Black or African American alone	33.4%	35.9%	32.2%	23.2%	39%
American Indian and Alaska Native alone	3.6%	9.2%	3.4%	43.6%	13.8%
Asian alone	0.5%	1.6%	1.1%	0.6%	1.0%
Hispanic or Latino	8.2%	15%	7.3%	9.3%	3.7%

Source: U.S. Census Bureau QuickFacts: United States (2021)

Table 3 below provides demographic data related to housing, language, broadband, education, disability, labor force, income, and poverty. This information helps provide an overview of the region for planning purposes.

Table 3 – Demographic Information for the Lumber River Region

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Population (April 2020 Census)	29,606	52,082	42,946	116,530	34,174
Population per square mile (April 2020 Census)	33.8	133.5	90.7	123	107.1
Housing units (July 2021)	15,250	20,491	19,933	48,791	14,390
Median value of owner-occupied housing units	$106,000	$154,400	$92,200	$77,900	$89,600
Language other than English spoken at home	7.3%	10.9%	6.8%	8.2%	4.1%
Households with a broadband Internet subscription	79.7%	85.4%	77%	66.5%	74.3%
High school graduate or higher	85%	87.7%	82.7%	77.9%	81.3%
With a disability, under age 65 years	10.5%	15.1%	11.6%	11.5%	10.6%
In civilian labor force (total, age 16 years+)	49.3%	52.5%	57%	50.8%	52.4%

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Median household income (in 2021 dollars), 2017-2021	$39,259	$53,456	$38,926	$36,736	$39,866
Persons in poverty, percent	21.6%	15%	21.5%	26.6%	29.7%
Total employer establishments, 2020	519	483	795	1,785	591

Source: U.S. Census Bureau QuickFacts: United States (2021)

Hoke County has the largest proportion of Hispanic or Latino population for the region at 15% and the highest percentage of the population that speaks a language other than English at home. With a larger presence of people that speak a different language, it is important that any information related to hazards, emergency preparedness, and resilience is also translated into additional languages to meet the needs of those residents. Hoke County also has highest percentage of adults under the age of 65 living with a disability (15.1%). Less than 66% of households in Robeson County have a broadband Internet subscription, which hinders communication and often the ability to receive important information or attend online meetings. Robeson County also has the lowest median household income ($36,736). Scotland County has the highest percentage of persons in poverty (29.7%). Lower income populations, people with disabilities, and people living in poverty are disproportionately more vulnerable to hazards and may not have the same ability and resources to prepare or respond to a disaster. Comparatively, the North Carolina state average median household income in 2020 is $56,642 and the average percent of persons in poverty is 12.9% (U.S. Census Bureau, 2022).

Housing tenure (ownership) and housing occupancy are additional components of demographic makeup and can provide useful information when analyzing the vulnerability of a region and capacity for resilience. Refer to **Table 4** below for the comparison of owner-occupied and renter-occupied housing within each county based on 2021 American Community Survey 5-Year estimates.

Table 4 - Housing Tenure

Housing Tenure					
	Bladen	Hoke	Richmond	Robeson	Scotland
Owner-occupied	70%	69%	66%	66%	59%
Renter-occupied	30%	31%	34%	34%	41%

Source: 2021 American Community Survey (ACS) 5-Year Estimates Data Profiles

Bladen County has the highest percentage of owner-occupied houses. Housing occupancy status (renting vs. homeowner) can influence the maintenance of a structure. Renting tenants are often more transient than homeowners and are less likely to provide regular maintenance to the home. Likewise, landlords may be less likely to provide updates or fix issues with a rental unit. Over time, deferred maintenance can increase the vulnerability of a building and lead to structural integrity and safety issues.

Similarly, occupied housing is more likely to receive regular maintenance and improvements than vacant homes. Units left vacant can also pose problems to local communities and require attention. Refer to **Table 5** below for the composition of occupied and vacant homes within each county based on 2021 American Community Survey 5-Year estimates.

Table 5 - Housing Occupancy

Housing Occupancy					
	Bladen	Hoke	Richmond	Robeson	Scotland
Total Housing Units	15,459	20,114	19,767	48,916	14,445
Occupied housing units	11,492	17,705	16,292	42,241	12,214
Vacant housing units	3,967	2,409	3,475	6,675	2,231
Percent vacant	26%	12%	18%	14%	15%

Source: 2021 American Community Survey (ACS) 5-Year Estimates Data Profiles

Bladen County has the highest percent of vacant housing at 26%. Vacant houses are more likely to be dilapidated and can take away from usable housing stock in the county. Hazards may also cause further damage to these buildings and make them unsafe to surrounding residents.

3.2.2 Regional Strengths

The Lumber River Region has many strengths and advantages to combat climate hazards. During stakeholder meetings and open houses held between January and June, stakeholders provided their local knowledge about the region.

3.3.2.1 Resilient Communities

The strong-willed character of people living in the Lumber River region is a strength when challenges are abounded. Hurricanes Matthew and Florence significantly impacted communities, with major flooding leaving lasting and often traumatic experiences on residents. This firsthand experience dealing with flooding has set the tone for many in the community recognizing the criticality of preparing for these hazards. Community-based organizations have reached out to help neighbors address needs in the six years following these storms, and the people of the Lumber River region continue to adapt and plan for the challenges ahead. They represent the steadfast and determined mentality of past generations that first rendered this low-lying region inhabitable to secure it for future generations.

3.3.2.2 Natural Environment

Dominated by wetlands, sandy soils, and mostly flat elevation, the Lumber River region is home to many unique natural resources. Characterized by an abundance of aquatic ecosystems and large tracts of undeveloped, forested land, the natural resources within the region provide a multitude of ecosystem services that are distinctly advantageous to the Lumber River region. Three major river systems, the Little PeeDee, Lumber, and Cape Fear, cut through the region and provide sanctuary for wildlife and drinking water sources. River floodplains and a mosaic of unique wetland types provide natural flood control, reduce overall storm damage, and improve water quality (U. S. Environmental Protection Agency, 2022). In addition to creating recreational opportunities such as swimming, fishing, hunting, and hiking, these aquatic ecosystems also provide the communities of the Lumber River region with an opportunity to seek refuge from increasingly hot summer temperatures. The undeveloped, forested lands within the Lumber River region add to the overall resiliency of the region by acting as carbon sinks, reducing outdoor air pollution, and providing economic and recreational opportunities (Southern Group of State Foresters).

3.3.2.3 Military Support

An advantage for the Lumber River region is its proximity to Fort Bragg, one of the largest military installations in the world. The presence of the United States Army, under the Department of Defense, within the region translates to a unique opportunity of military support during recovery efforts from catastrophic natural hazard events. Beyond recovery, the military enhances efforts to improve resiliency by various means such technical services like mapping data and analysis, to construction and maintenance of land resource features (Defense Media Network, 2019).

3.3.2.4 Educational Access

Access to educational institutions is an advantage in the region where there are six locations of higher learning:

- University of North Carolina – Pembroke (Pembroke)
- Robeson Community College (Lumberton)
- Richmond Community College (Hamlet)
- St. Andrews University (Laurinburg)

- Bladen Community College (Dublin)
- Lumbee River Christian College (Shannon)
- Sandhills Community College (Raeford)

These institutions help residents advance their education and improve their employment opportunities and career growth.

3.3.3 Regional Challenges

Non-climate related issues impede the region's ability to create, enhance, and sustain its climate resilience-building efforts. Stakeholders provided feedback about challenges they see in the region and this information provides a more personalized, local viewpoint. To corroborate stakeholder input, the project team reviewed planning documents, regional data, and maps to gain a holistic understanding of the challenges.

3.3.3.1 Labor and Workforce

There is a lack of skilled and available personnel within local governments to manage daily operations. Many public sector employees "wear several hats," which makes it difficult to implement climate resiliency measures. Competing priorities can also limit efforts to advance resilience, particularly when there are more immediate issues to address like sewer, water, and public safety. Additional staffing and continuing education are needed to support efforts related to comprehensive planning, grant writing and funding strategies, and emergency planning.

Following the impact of recent hurricanes, many residents have decided to leave the region for opportunities elsewhere, causing the tax base to shrink. Less tax revenue for counties and municipalities adds to the strain of funding basic services and having the ability to expend funds for forward-thinking resilience and adaptation efforts. Similarly, unemployment is high throughout the region, with rates well above the state average. Richmond, Robeson, and Scotland Counties are among the highest unemployment rates for North Carolina (**Table 6**). Unemployment often negatively affects the disposable income that families have, meaning people purchase less goods and services, which can lead to unemployment for other workers in a cascading effect on the economy of a region. These cumulative economic strains affect resiliency planning efforts

because families must first meet their basic needs before shifting focus to extraneous issues like climate hazards.

Table 6 - Unemployment, Income, and Poverty

County	Unemployment Rate (2022)	Medium Household Income (2017-2021)	Persons in Poverty (2021)
Bladen	4.3%	$39,259	21.6%
Hoke	4.7%	$53,456	15%
Richmond	5.6%	$38,926	26.2%
Robeson	5.8%	$36,736	27.9%
Scotland	7.3%	$39,866	24.4%
Regional Average	**5.5%**	**$41,648**	**23%**
State Average	**4.1%**	**$60,516**	**13.4%**

Source: U.S. Census Bureau QuickFacts: United States (2021), Neighborhood Information | Homefacts

3.3.3.2 Vulnerable Demographics

The Lumber River region is challenged with higher proportions of vulnerable populations, particularly those with a disability, without access to a vehicle, and those without health insurance. There are no public transportation services provided in any of the counties or municipalities within the region. Lack of individual mobility and public transportation increases the risk of negative impacts during natural hazards. Residents may be unable to evacuate in a timely manner or may require emergency response. Older adults in the region may also have unmet needs that make them more vulnerable. Often hazards impact homes and cause damage that needs to be fixed, and older adults may not be able to complete this without assistance. They may also rely on medical devices that need electricity, and when the power is out and the home lacks backup power, this puts them at greater risk for health and safety. **Table 7** below outlines persons aged

65 and older, those under age 65 with a disability or without health insurance, and households without a vehicle.

Table 7 - Vulnerable Demographics

County	Over Age 65 (2021)	Under Age 65 with Disability (2017-2021)	Under Age 65 with no Health Insurance (2021)	No Vehicle Households (2016)
Bladen	23.5%	10.5%	15.5%	8.4%
Hoke	11.0%	15.1%	15.4%	5.9%
Richmond	18.2%	11.6%	14.9%	10.2%
Robeson	16.0%	11.5%	19.7%	8.4%
Scotland	18.6%	10.6%	14.3%	11.3%
Regional Average	**17.5%**	**11.9%**	**16%**	**8.8%**
State Average	**17.0%**	**9.2%**	**12.4%**	**5.8%**

Source: U.S. Census Bureau QuickFacts: United States (2021), Neighborhood Information | Homefacts

3.3.3.3 Interagency Communication

Communication amongst local and county government, and across community organizations is an area in need of improvement. Often, policies and practices to address natural hazards are not consistent or uniform. For example, if one jurisdiction undertakes a project to remove debris within its waterways, the cumulative effect is diminished if downstream jurisdictions have not completed the same activity. Similarly, there are many community-based organizations working within the region, however it is often unclear what work is being done, by whom, and for whom. Clearer channels of communication amongst organizations are imperative to enhance resiliency across the region.

3.3.3.4 Infrastructure Repair

Following Hurricanes Matthew and Florence, infrastructure across the region sustained major damage, as noted in Hurricane Matthew Resilient Redevelopment Plans for each county. Where significant flooding accrued, businesses were forced to close because of structural damage. Many of these buildings are still in need of repair to be fully functional again. Bridges and roads throughout the region were washed out and natural debris buildup caused blockages and detours. Stakeholders have repeated the need to repair high priority infrastructure.

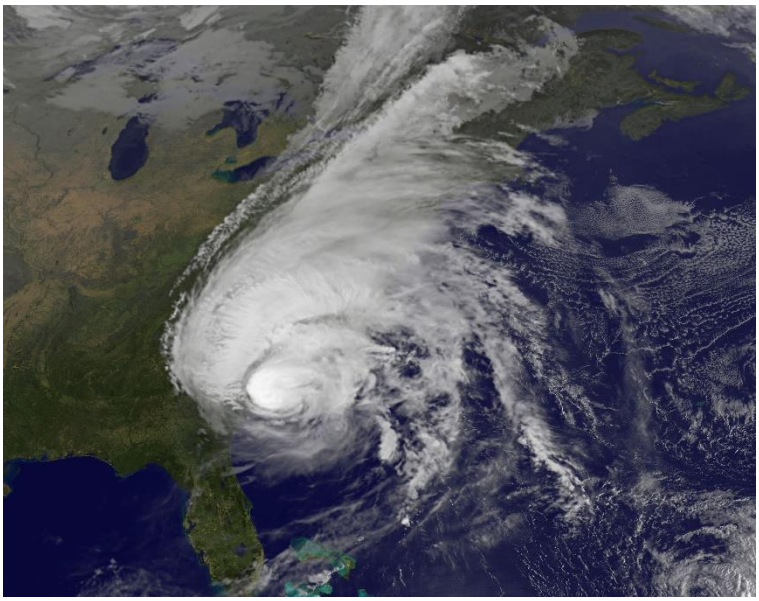
3.3.3.5 Stormwater Management

Flood improvements and better stormwater management practices have been identified through stakeholder meetings and regional planning documents as areas of improvement for the region. Efforts are continuously ongoing by some local governments within the region, but the focus should be at the watershed scale and not only at a municipal jurisdictional boundary. Stakeholders have acknowledged that there are areas within the region that lack mapped stormwater infrastructure, which hinders progress on stormwater management improvements.

3.3.4 Resiliency-Related Work – Needed and Underway

Hurricanes Matthew (2016) and Florence (2018) devastated the Lumber River region. As much as 17.5 inches of heavy rainfall from Hurricane Matthew inundated portions of Bladen and Robeson counties, with all five counties in the region receiving more than 6 inches of rainfall within a 48-hour period (RebuildNC, 2017). Though it has been a few years since these significant storm events, the residents of the region continue to face daunting challenges from these storms as well as from other climate hazards, such as frequent flooding. It is likely that climate change will

Figure 5 - Hurricane Matthew (October 8, 2016)



Source: NASA/NOAA GOES Project

increase the frequency, intensity, and duration of hurricanes in the future, potentially resulting in higher wind speeds and heavier rainfall events.

Lumber River communities have learned from past storm events in ways that will increase resilience. While efforts to build a more resilient region are underway, there is more work to be done to protect communities from both climate and non-climate hazards. The strong-willed character of the people living in this region, coupled with firsthand experience in dealing with severe flooding, have set the tone for many in the community to prepare for these hazards. Stakeholders provided insight about current and future resiliency-related efforts during stakeholder meetings and the open house.

3.3.4.1 Current Efforts

The five-county region continues to work in areas of community response, infrastructure repair, and stormwater management to advance resilience efforts.

- Buy outs for flood prone properties in Robeson and Bladen Counties.
- Interstate 95 construction improvements including bridge improvements at the Lumber River and other flood prone locations.
- Development of dam rehabilitation/replacement projects in Hoke and Bladen counties.
- Completion of a comprehensive stormwater study by The Town of Pembroke, in conjunction with the University of North Carolina. Maintenance and capital improvement projects are being implemented as a result of this study.
- Flood gate project in The City of Lumberton to mitigate 100-year flood events from flowing from the west side of the I-95 overpass.
- The City of Lumberton's Lumberton Levee Trail and the Lumberton Loop which consist of a trail network that would connect and preserve hundreds of acres of land that currently lies within the 100-year floodplain.

3.3.4.2 Stated Needs

Though the region has implemented many projects and improvements, there are topics that need further attention according to stakeholder input.

- Based on a review of HMPs, counties and municipalities in the region are addressing the development of floodplain zoning and permit programs to limit construction in areas at risk of flooding.
- Existing stream maintenance and dam removal programs need improvements to be sustainable. These programs also need planning on a regional scale instead of limited to municipal or county boundaries.
- Alternative energy sources like solar can be used for backup power generation.
- The region also needs continued broadband service enhancement.
- Existing emergency shelters need enhancements and identification of locations for additional shelters will address current constraints.
- Improved communication efforts across emergency management agencies (Department of Social Services, Red Cross, Federal Emergency Management Agency, and Emergency Management Service) will make it easier for residents to prepare and respond during an event.

4.0 Natural Hazards

Based on regional hazard mitigation plans (AECOM, 2020), (Counties, 2016), (AECOM, 2018) and stakeholder feedback, the major high-risk natural hazards in the Lumber River region are flooding, severe weather, specifically heavy rainfall and winds, and hurricanes and tropical storms. Other high-risk natural hazards include extreme heat, drought, and wildfire. Additional analysis by the project team using publicly available Geographic Information System (GIS) data confirms these as the top regional natural hazards. All high-risk natural hazards have widespread potential impacts and damages and can be highly threatening to people and the built environment.

This section discusses how natural hazards influenced by climate change are likely to change and affect the Lumber River region over the next 30 – 50 years. The team that developed the vulnerability assessment analyzed data and conclusions from the North Carolina Climate Science Report (2020) and other climate science research reports (Kunkel, et al., 2020) to provide a discussion about climate hazards pertaining to the Lumber River region. The North Carolina Climate Science Report discusses the three regions of North Carolina:

- The Coastal Plain region, whose climate is dominated by oceanic influences and is typically more humid and experiences smaller day-to-night temperature changes than other parts of North Carolina, due to its proximity to the ocean.
- The western Mountains region, whose climate is most influenced by the elevation and topography of the Appalachian Mountains. This region is cooler due to its higher elevation.
- The Piedmont region, which lies between the Coastal Plain and Mountains, and lacks the influence of high elevation and steep topography or proximity to the ocean.

The Lumber River region is located primarily in the Coastal Plain region, with only Richmond County considered part of the Piedmont region. Many of the climate observations and projects stated in this report are based on the findings for North Carolina's Coastal Plain and Piedmont regions.

4.1 Flooding

Flooding is a major high-risk natural hazard for the Lumber River region, as the region is still rebuilding and recovering after Hurricanes Matthew caused extreme widespread damaging flooding. Inland flooding is the most common and frequent natural hazard in North Carolina, most often resulting from tropical storms. In the last 20 years, eastern North Carolina has experienced three extreme flood-producing hurricanes – Floyd (1999), Matthew (2016), Florence (2018) (Kunkel, et al., 2020).

It is a natural event for lands adjacent to rivers, streams, and shorelines to flood occasionally. In the Lumber River region, flooding is generally the result of heavy rainfall rather than wind-driven surge or tidal influence like along the coast. Damaging floods in the region are caused by rainfall resulting from hurricanes and tropical storms, short-duration heavy rainfall from intense convection like thunderstorms, and winter coastal storms. Flooding may occur near rivers as high volumes of sustained rainfall exceed the capacity of the streams. Changes in climate conditions such as rainfall amount, in water management practices, or in land use and land cover can determine how flooding will impact communities.

Recent climate science and trend analyses indicate:

- severe thunderstorms will increase in frequency,
- winter storms will very likely produce heavier precipitation and,

- hurricane intensity and associated heavy precipitation in North Carolina will very likely increase.

4.2 Severe Weather

Severe weather in the Lumber River includes several hazards such as thunderstorms, winds, lightning and hail. Although typical severe weather systems affect small geographic areas, they can cause substantial property damage and be very dangerous.

4.2.1 Thunderstorms

Thunderstorms are a major source of heavy rain in the Lumber River region, and can include flooding, high winds, hail, lightning, and sometimes tornadoes. While individual thunderstorms are unlikely to cause flooding on the scale of a hurricane or tropical storm, thunderstorms can cause short-duration heavy rainfall which leads to flash flooding and power outages in some parts of the Lumber River region. Stormwater regulations of 10-year storm data is now insufficient to address flash flooding. Lightning associated with thunderstorms may ignite wildfires; both lightning and heavy winds result in property damage, disruption to transportation networks, and potentially loss of life.

Severe thunderstorms are likely to occur more frequently in the Lumber River region by over the next 30-50 years (Kunkel, et al., 2020). Thunderstorms are typically isolated, intense events, and thus cannot be explicitly simulated in large-scale climate models. However, large-scale climate models can simulate changes over time in the frequency and intensity of conditions conducive to thunderstorm formation - for example, the measures of temperature, humidity, and differences in wind speed at various heights in the atmosphere. It is also possible to study fine-scale events like thunderstorms using more detailed, localized models. While no consensus on future thunderstorm characteristics in North Carolina has been reached through such methods, studies across the US have found that conditions conducive to thunderstorm formation are likely to become more common by 2050 (Genio, Yao, & Jonas, 2007).

4.2.2 Wind

Strong winds in the Lumber River region are associated with a range of weather patterns including thunderstorms, hurricanes and tropical cyclones, and tornadoes. When high winds occur, they can:

- damage property and vital infrastructure like powerlines,
- interrupt transportation by blocking roads,
- create dangerous driving conditions, and
- increase the potential spread of wildfire during dry weather.

At present, climate science studies do not contain sufficient evidence or consensus to make a confident conclusion on future changes in high winds or in storms caused by cyclones, which are associated with strong wind in the region. However, it is likely that convective storms will occur more frequently, and that hurricanes and other tropical cyclones will affect the region with greater intensity in the next 30 – 50 years (Kunkel, et al., 2020). For example, 60 – 80 mile per hour wind gusts affected Robeson County after Hurricane Matthew passed inland (Horne, 2021).

Studies of tornado formation across the US have found that, while the number of days per year on which tornadoes occur has decreased since the 1970s, tornadoes are more likely to occur in clusters (multiple tornadoes in one region and day) and that the length of the season over which tornadoes occur is increasing (Elsner, Elsner, & Jagger, 2014) (Tippett, 2014) (Kunkel, et al., 2020). While these conclusions are not specific to the Lumber River region or even North Carolina, regional emergency managers should consider the implication that tornado destructiveness may increase in the region over the next 30 – 50 years and that tornadoes may become a plausible threat earlier in the year and continue to occur later into the year.

4.2.3 Lightning

Lightning is a dangerous severe weather hazard in the United States and is responsible for deaths, injuries, and property damage to buildings, power lines, and electrical systems each year. Lightning strikes the U.S. about 25 million times each year (NOAA, 2014). Lightning can also cause forest and brush fires.

Lightning can occur anywhere there is a thunderstorm, and it is one of the most underrated severe weather hazards – lightning strikes in the U.S. cause an average of 50 deaths per year (NOAA, 2014). While evidence of how lightning activity in the Lumber River region will change over the next 30 – 50 years is inconclusive, scientific evidence suggests it is likely that severe thunderstorms will become more frequent in the same period.

4.2.4 Hail

Hail is an important hazard in the Lumber River region because hailstorms can be damaging to crops. Hail can fall during thunderstorms and is formed when updrafts carry water droplets into freezing areas of the atmosphere causing the water to turn into ice (National Weather Service, n.d.). Hail then falls back to the earth when it becomes heavy enough to overcome the force of the updraft. Hailstorms can occur in spring, summer, or fall but are more common in late spring and early summer, when many crops are at or near harvest. Crop damage causes economic loss for farmers. Hail can also cause property damage to vehicles either in use or left outdoors.

Specific scientific evidence of the future frequency of hailstorms is inconclusive in the Lumber River region. However, general scientific conclusions suggest it is likely that thunderstorms, a leading cause of hail, will become more frequent in the Lumber River region in the next 30-50 years (Kunkel, et al., 2020).

4.2.5 Heavy Rainfall

Heavy rainfall in the Lumber River region can have severe consequences to residents, agriculture, and businesses, and heavy rainfall is expected to become more frequent and severe in the future. There has been an upward trend in the number of heavy rainfall events (three inches or more in a day), with the greatest number of events since 1990 occurring between 2015-2018. It is likely that precipitation will increase for North Carolina over the next 30-50 years. Scientists project that is very likely that heavy rainfall will increase, both in frequency and intensity, due to increases in atmospheric water vapor content (Kunkel, et al., 2020).

Heavy rainfall, where more than three inches of rain occur in a 24-hour period, occurs rarely, making it difficult to characterize recent trends based on observational data. In the Lumber River region, heavy rainfall events have historically occurred about one day per year. It is also difficult to make statements on likely future trends in heavy rainfall based on climate modelling studies.

The heaviest rainfall events tend to be spatially isolated unless caused by a very large storm system, so weather station records of heavy rainfall amounts can be very different from station to station during the same storm. Because of this issue, the techniques used to estimate the frequency of such extreme events across stations tend to underrepresent the frequency of extreme precipitation in areas far away from stations. For example, one station may estimate 0.4 days with more than three inches of rain and a different station may estimate 0.8 days with more than three inches of rain in the Lumber River region (Kunkel, et al., 2020).

Hurricanes Matthew (2016) and Florence (2018) delivered as much as seventeen inches over four days and twenty-two inches over six days in the Lumber River region, respectively. Recent climate science and analysis of recent trends indicate it is likely that severe thunderstorms will increase in frequency, that winter storms will produce heavier precipitation, and that the intensity of strong hurricanes and the heavy precipitation from hurricanes over North Carolina is very likely to increase in the next 30-50 years. Additionally, stormwater regulations of 10-year storm data are now insufficient to address flash flooding.

4.3 Hurricanes and Tropical Storms

Hurricanes and tropical storms are some of the most damaging natural hazards influenced by climate change in the Lumber River region and are among residents' top concerns. Heavy, sustained rainfall and high winds combine to cause property destruction, debris accumulation, and severe and widespread flooding. In some hurricanes, tornadoes may develop. Approximately 80 hurricanes and tropical storms have been tracked through the Lumber River region since 1930 (Hurricane Information, 2022). Even tropical systems that have not directly tracked through the region have left their impacts in the form of heavy rainfall, high winds, and flooding.

Recent hurricanes Matthew (2016) and Florence (2018) caused widespread damage across the region. Major emergencies caused by these two storms included the need for water rescues from homes threatened by water, fatalities when people attempted to navigate flooded roads, and vegetation and debris that blocked the flood flow (Neeley, 2016).

Flooding during Hurricane Matthew was particularly impactful because the heavy rains occurred shortly after more moderate soaking rainfall from Tropical Storms Colin, Julia, and Hurricane Hermine. Because rain was so heavy on already-soaked ground, residents reported unexpected

flooding in areas where they never experienced flooding before. Hurricane Florence devastated the area two years later with heavy rains and bands of tornadoes, in many cases undoing recovery efforts in areas which had been hit hard by Hurricane Matthew (Armstrong, 2022).

Hurricanes and tropical storms form over the ocean and make landfall at the coast, but they can affect inland areas such as the Lumber River region. The Atlantic hurricane season runs from June to November, with the peak season from mid-August to late October. On a global scale, the intensity of the strongest hurricanes is likely to increase with warming. In addition, heavy precipitation associated with hurricanes and tropical storms will very likely increase for North Carolina over the next 30-50 years, which increases the risk of flooding (North Carolina Department of Environmental Quality, 2020).

4.4 Extreme Heat

Extreme heat can have significant effects on health, property, and infrastructure. Residents of mobile homes and low-income households, and individuals working outside, are especially vulnerable to extreme heat. “Heat waves” are defined as any event lasting at least three days where temperatures reach ninety degrees Fahrenheit or higher. Humidity can exacerbate the physiological response to heat waves. The National Oceanic and Atmospheric Administration (NOAA) identifies heat as the number one weather-related cause of death from a natural hazard, followed by frigid winter temperatures. The National Weather Service devised the Heat Index, often called the “feels like” temperature, to better inform the public of heat dangers. The Heat Index, shown in **Figure 6,** uses air temperature and humidity to determine the heat index or apparent temperature.

Figure 6 - Heat Index

		Relative Humidity (in percent)																				
		0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
Air Temp (in F)	140	125																				
	135	120	128																			
	130	117	122	131																		
	125	111	116	123	131	141																
	120	107	111	116	123	130	139	148														
	115	103	107	111	115	120	127	135	143	151												
	110	99	102	105	108	112	117	123	130	137	143	150										
	105	95	97	100	102	105	109	113	118	123	129	135	142	149								
	100	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144						
	95	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136				
	90	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122		
	85	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
	80	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86	87	88	89	91
	75	69	69	70	71	72	72	73	74	74	74	75	75	76	76	77	77	78	78	79	79	80
	70	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

In the chart, heat indices:

- highlighted in red indicate extremely dangerous conditions in which heat stroke and/or sunstroke are highly likely for people continuously exposed
- highlighted in orange are dangerous; heat exhaustion, heat cramps, sunstroke, and/or heatstroke are for those exposed to the conditions for prolonged periods or engaged in physical activity
- highlighted in yellow indicate extreme caution should be taken by all exposed for prolonged periods or engaging in physical activity
- highlighted in pale tan indicate caution should be taken with prolonged exposure and/or physical activity

Table 8 - Heat Index Health Risks

Heat Index Temperature (in F)	Description of Risks
80°-90°	Fatigue possible with prolonged exposure and/or physical activity
90°-105°	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105°-130°	Sunstroke, heat cramps, and heat exhaustion likely, and heatstroke possible with prolonged exposure and/or physical activity
130° or higher	Heatstroke or sunstroke is highly likely with continued exposure.

Table 8 provides a detailed explanation of consequences of exposure to each heat index category.

While Lumber River region residents consider extreme heat to be a lower-priority concern relative to other natural hazards in the region at present, climate science studies indicate extreme heat may become a dangerous threat in the region's future (Kunkel, et al., 2020). The average annual temperature in North Carolina has increased by about 1.0°F since 1895. The most recent years (2009-2018), however, represent the warmest 10-year period on record in North Carolina, averaging about 0.6°F warmer than the warmest decade in the 20th century. The most recent data indicates that 2019 was the warmest year on record for North Carolina (Kunkel, et al., 2020).

Observed and projected increases in average temperature, hot days, and warm nights suggest an increase in the frequency of dangerous heat index values and cooling demand which are a serious concern in a region already challenged by poor housing quality and where summer electric bills can cost more than rent. Current trends suggest that average temperatures will continue increasing.

Scientists project the number of very hot days will increase from the historical average of 13 days per year to 17-60 days each year by the 2050s. Similarly, the number of very warm nights may increase from an average of 6 per year to 23-55 per year by the 2050s. While the region is primarily rural, the number of warm nights may be even higher in urbanized centers that have higher impervious land cover. Dark impervious surfaces like roads trap heat during the day and release it during the night. Areas that have less vegetative cover likes trees and green areas are not able to help cool the area down. It is very likely that the number of warm and very warm nights will continue to increase through the 2050s and beyond (Kunkel, et al., 2020).

Scientists project the average annual temperature in North Carolina will increase by 1.5°F to 3.5°F during the 2021-2050 period compared to the long-term average from 1971-2000 (Kunkel, et al., 2020). It is likely that the number of days annually where high temperatures exceed 95°F in North Carolina will increase by at least 15-20 days over the next 30-50 years (Kunkel, et al., 2020). Further, it is very likely that the summer heat index will increase in North Carolina with the number of hot and very hot days (Kunkel, et al., 2020).

4.5 Drought

The Lumber River region is particularly vulnerable to drought given the regional importance of agriculture and the prevalence of homes which rely on private wells for drinking water. Droughts are a normal occurrence in nearly all climatic regions, including areas with high and low average rainfall, are a normal part of the climate in the Lumber River. Drought is the consequence of a natural reduction in the amount of rainfall anticipated over an extended period of time, usually a season or more in length. High temperatures, winds, and low humidity can exacerbate drought conditions. Droughts can also be exacerbated by water management regimes which extract water more rapidly than it can be replenished. Drought is a serious hazard to the Lumber River region, which faced drought recently in 2007 – 2009 along with much of the southeast US (Kunkel, et al., 2020). The drought followed the fourth-wettest fall (2006) on record in North Carolina at the time, but a below-average rainfall spring, dry summer, and hot late summer weather placed much the Lumber River region in “Exceptional Drought,” the most severe category, by October 2007. Private domestic wells are often the first to feel the impacts of falling groundwater levels during drought; this is a significant concern in the Lumber River region where many residents rely on private wells for drinking water. The drought of 2007 – 2009 affected not only domestic wells, but also centralized surface water and groundwater supply systems. Under the dry conditions, wildfire

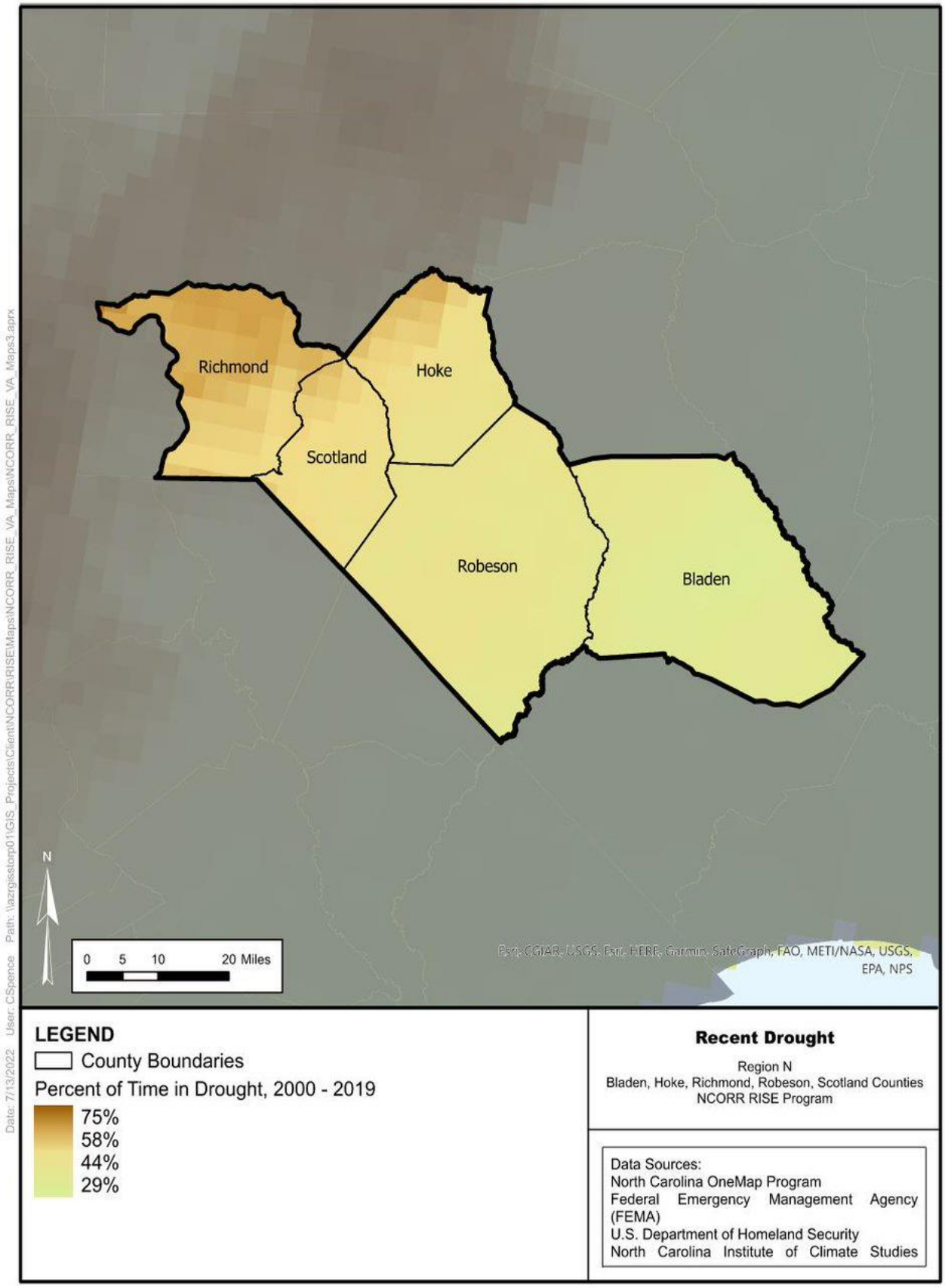
activity in the region heightened. North Carolina's agriculture industry suffered an estimated $573 million loss due to the combined effects of the drought and an extreme cold spell in April 2007 (Davis, 2015).

The state and region responded to the severe impacts of the drought with a range of interventions:

- bottled water was distributed to residents whose wells had dried up,
- water conservation restrictions on public water supplies slowed the drawdown,
- and the governor of North Carolina requested federal disaster aid and waved road weight restrictions for trucks carrying hay to conserve soil moisture on drought-stricken farms (2007 Drought Timeline, 2007).

The onset of droughts is typically slow, but over time droughts can have damaging affects to agriculture, municipal and recreational water supply and use, and wildlife. In the future, droughts are projected to occur during warmer conditions, which will cause more rapid water loss due to evaporation and transpiration through plants in the sustained absence of precipitation (Kunkel, et al., 2020). While climate model projections and recent trends provide some limited and inconclusive evidence that annual total precipitation may increase in the Lumber River region by mid-century, additional evidence suggests that more rainfall will arrive as high-intensity, short-duration events where a greater volume of water will run off rather than replenish groundwater stores (Kunkel, et al., 2020). Therefore, droughts in the future will likely cause more issues than droughts in the past. **Figure 7** below depicts the percent of time the region was in drought from the years 2000-2019. Drought conditions are likely to increase in the future, and the Lumber River region should consider revisiting lessons learned from past droughts to prepare.

Figure 7 - Regional Drought in the Lumber River Region



4.6 Wildfire

The risk of wildfire is higher in the Lumber River region than other parts of North Carolina, and future climatic conditions may increase the frequency of conditions that are conducive to wildfire. Wildfire is any outdoor fire that is not under control, supervised, or prescribed, meaning planned and executed under controlled circumstances for a specific purpose. Fires occur naturally in forest and grassland ecosystems, but fires may also be caused by humans. Nationally, negligent human behavior such as smoking in wooded areas and improperly extinguishing campfires has surpassed natural causes such as lightning as the most common start of wildfires. In North Carolina, most fires are caused by debris burning. Fires are particularly dangerous in dry conditions, in conditions where fuel has built up to higher than usual levels, and when fires occur near human settlement.

Drought conditions increase the probability of wildfires by producing fuel in both urban and rural settings. During a drought, dead and dying vegetation provides a ready fuel source which can sustain and propagate burning when a fire ignites. More accumulated fuel after a long period without burning can increase the duration and destructive potential of wildfire. Wildfires are more likely to spread widely during high wind conditions, which can blow burning debris to ignite fire in new areas. As discussed above, severe droughts are likely to increase across North Carolina due to higher future temperatures, which accelerate the depletion of moisture in soil and vegetation in times without precipitation. As a result, it is likely that the frequency of climate conditions conducive to wildfires will increase in the next 30-50 years (Kunkel, et al., 2020).In the Lumber River region, wildfires pose risks to farmers and to homes, industries, and businesses located in sparsely settled rural areas where evacuation routes may not be clear and water supplies used to fight fires are more likely to come from small wells which may not reliably supply water during drought conditions. Since 2017, Robeson County has had more than 90 wildfires including 18 which occurred in one day. The risk of wildfire within Bladen County is 86% higher than the average county in North Carolina (AECOM, 2020).

Local weather conditions influence the risk of wildfires, but human behavior and natural resource management strategies can mitigate the risk. Public cooperation with fire prevention measures lowers the risk of wildfire even during high-risk weather conditions. Fire ignition is more likely where people camp, burn debris, and where construction is taking place. Fires are more destructive when fuel has accumulated over long periods without burns. Many forested areas

within the Lumber River region's five counties are historically fire dependent ecosystems such as long leaf pine habitat that would naturally burn at frequent intervals. However, modern development in the areas have led to fire suppression activities that cause these forested areas to accumulate dense undergrowth, fueling more massive wildfires than would naturally occur without fire suppression regimes. The region can prepare for more conditions conducive to burning in the future through public education on responsible camping and smoking practices, fire-smart land management in agricultural areas, and developing a prescribed burning program to reduce fuel accumulation.

4.7 Winter Storms

The future prevalence and impacts of winter storms, snow, and ice in the Lumber River region are presently uncertain. Winter storms in the region are typically rainfall events, but when winter storms coincide with very low temperatures, the precipitation may fall as snow, sleet, freezing rain, or a wintry mix. These storm events can create dangerous conditions over a large area. Winter storms can have a substantial impact on communities, utilities, transportation systems, agriculture, and can result in the loss of life due to hypothermia and accidents. Residents are less concerned about this hazard and its impacts to the region, so it hasn't been a topic of focus during stakeholder meetings.

While climate science studies show it is very likely that winter storms will produce heavier precipitation in the future than they do now, the season-average winter temperatures in the Lumber River region have been consistently higher than the long-term average since the 1990s. Projections show that winter temperatures are very likely to continue increasing through the remainder of the century, resulting in warmer winter seasons and less snowfall than today (Kunkel, et al., 2020).

Scientists hypothesize that it is likely that total snowfall will decrease along with the number of heavy snowstorms (Kunkel, et al., 2020). Very cold days may not become more common but can still happen. Given the impacts of extreme cold and winter weather in the Lumber River region, it is important to not discount preparation for these events as part of climate resilience planning.

5.0 Lumber River Region Sector Impacts

This chapter describes how natural hazards impact the following sectors:

- Housing
- Critical facilities
- Regional economy
- Historical and cultural resources
- Natural environmental systems
- Public health
- Social vulnerability

5.1 Housing

Figure 8 - Housing Sector Overview

	• 58% of homes in the region were built more than 30 years ago -- may have inefficient heating or cooling systems that will be detrimental to residents during periods of cold spells and extreme heat • Hoke County has the most homes (16%) built within the past decade, and Scotland County has the most homes (69%) built prior to 1989 • Robeson (36%) and Bladen (33%) have the greatest proportion of mobile/manufactured homes in the region. Mobile homes may be more prone to structural damages related to high wind events and hurricanes. • Bladen County has the highest percentage of vacant housing units (26%). • Approximately 843 residential buildings (valued at approximately $73.1 million) have a first-floor elevation below the current 100-year floodplain. Approximately 2,804 residential buildings (valued at $324 million) have a first-floor elevation below the current 500-year floodplain.

Homes provide shelter and comfort during weather related events and are a key social determinant of health. Social determinants of health are the conditions in the environment where

people live, work, etc. that affect a wide range of health, functioning, and quality-of-life outcomes and risks (US Department of Health and Human Services, n.d.). Other examples include polluted air and water, education and job opportunities, transportation, and neighborhoods. A lack of housing, poor-quality housing, or housing instability can negatively affect an individual's physical and mental health status. For example, dampness, mold, inadequate heating and cooling, or overcrowding directly affect the wellbeing of individuals and their families. Approximately 58% of homes in the region were built more than 30 years ago and about 8% were built after 2010 (U.S. Census Bureau, 2022). Hoke County has the most homes (16%) built between 2010 and 2019 and Scotland County has the greatest percentage (69%) of homes built more than 30 years ago (built prior to 1989). Homes 30 years and older typically are more prone to experience dampness and mold issues and inadequate heating and cooling. Additionally, an analysis by the project team found that at least 3,600 residential buildings are located in the 500-year floodplain and are at a greater risk of flooding. Using a variety of data sources, this section includes maps that identify which homes are most vulnerable to each hazard. To explore the impacts of natural hazards on housing further, the project team looked at present day conditions and 30-year projections of natural hazards using best available methods.

5.1.1. Housing Characteristics that Affect Vulnerability

Individual homes may be more vulnerable to the impacts of natural hazard events if they have certain characteristics. The age of a structure, housing type, housing tenure (ownership), and occupancy status may make it more susceptible to hazard impacts. Older homes or manufactured/mobile homes, for example, may be more prone to structural damages related to high wind events and hurricanes. The project team collected data from the 2020 American Community Survey 5-Year Estimates to discuss the housing vulnerability metrics presented below.

5.1.1.1 Structural Condition

The age of residential buildings can directly impact ability to withstand climate hazards. In **Table 9** below, the American Community Survey data shows that the following percentages of homes in each county are at least 30 years old, which can put them at higher risk of costly maintenance and repair:

Table 9 - Percent Homes Greater than 30-Years Old

County	Homes Greater than 30-Years Old (percent)
Bladen	58%
Hoke	33%
Richmond	71%
Robeson	60%
Scotland	69%
Regional Average	**58%**

Source: 2021 American Community Survey (ACS) 5-Year Estimates Data Profiles

Scotland County has the greatest percentage (69%) of homes built more than 30 years ago (built prior to 1989). Comparatively, Hoke County has the least number of homes built more than 30 years ago (33%). The majority of homes built between 1990-1999 were in Hoke County and Robeson County.

Table 10 further illustrates the construction dates of homes within each county of the Lumber River region based on 2021 American Community Survey 5-Year estimates. About 8% of homes across the region are newer than 2010. Stakeholders have discussed issues related to dilapidated housing stock and overall lack of housing availability and new construction in some areas throughout the region during meetings.

Table 10 - Home Construction Dates

Structure Build Date					
	Bladen	Hoke	Richmond	Robeson	Scotland
Built 2020 or later	0.1%	0.5%	0%	0.2%	0.0%
Built 2010 to 2019	6%	16%	5%	7%	4%
Built 2000 to 2009	13%	28%	10%	10%	9%
Built 1990 to 1999	23%	23%	15%	22%	19%
Built 1980 to 1989	13%	11%	14%	18%	18%
Built 1970 to 1979	19%	10%	18%	18%	18%
Built 1960 to 1969	8%	6%	16%	8%	13%
Built 1950 to 1959	9%	4%	9%	8%	9%
Built 1940 to 1949	5%	2%	6%	4%	5%
Built 1939 or earlier	4%	2%	8%	5%	6%

Source: 2021 American Community Survey (ACS) 5-Year Estimates Data Profiles

The build type of a structure may also influence its ability to withstand natural hazards. Site-built homes with permanent, concrete foundations are generally expected to withstand strong storms, including tornadoes and high winds. Manufactured homes are constructed in a controlled setting and delivered to a property where the house is then attached to the ground using anchors and reinforced with steel straps to ensure stability during storms (Gritton, 2019). The term "mobile home" is often used historically to refer to "trailers," which are typically smaller homes on wheels that can be moved from site to site fairly easy. Manufactured homes today are also often referred to as mobile homes because they are built off-site and transported (mobile) with wheels that are removed when the house is permanently attached to the ground (Gritton, 2019). However, standards for manufactured homes are regulated by the US Department of Housing and Urban Development with standards for high wind and such, whereas site-built homes often have multiple contractors and sub-contractors working to construct the house and may not have the same regulatory oversight for standards. Two important components of considering risk of damage during severe storms is the location of the structure and who lives there. Land within and near

floodplains is often less expensive and may be appealing to someone looking for property to place a manufactured home. Lower income people and older adults may also live in smaller structures like manufactured homes due to income constraints or mobility. Risk of negative impacts therefore depends on the standards the home was built to, whether it meets those standards, and where it is located. Manufactured/mobile homes represent approximately 20% of the different housing types in the region. Refer to **Table 11** below for housing type composition for each county within the region based on 2021 American Community Survey 5-Year estimates. Counties with larger proportions of manufactured and mobile homes, such as Bladen (33%) and Robeson (36%) Counties, should consider ways to ensure safety and structural integrity during storms.

Table 11 - Housing Types

Housing Type					
	Bladen	**Hoke**	**Richmond**	**Robeson**	**Scotland**
Single Unit	63%	72%	68%	54%	60%
Multiple Units	4%	7%	11%	9%	14%
Mobile Home	33%	21%	21%	36%	27%

Source: 2021 American Community Survey (ACS) 5-Year Estimates Data Profiles

5.1.2 Impacts by Hazard

5.1.2.1 Flooding

Flooding can have a major impact on housing. Homes that experience flooding must deal with expensive cleanup and repairs, including long term effects such as mildew and mold. Often, flooding can result in a complete loss of the structure and/or abandonment for families that cannot afford the cost of repairs. Floodwaters are especially problematic as they carry large loads of sediments that are deposited and left behind in the interior of homes when floodwaters recede. This results not only in damages to the housing structure itself but also to the personal items inside.

The project team used available GIS data to compare residential building first floor elevations to the 100-year and 500-year floodplain to analyze how many residential buildings are at risk of flooding. Approximately 843 residential buildings (valued at approximate $73.1 million) are estimated to have a first-floor elevation below the current 100-year water surface elevation. Approximately 2,804 residential buildings (valued at $324 million) are estimated to have a first-floor elevation below the current 500-year water surface elevation (North Carolina Department of Information Technology, 2019). Since current 500-year floodplain data are only available for Richmond, Robeson, Scotland, and portions of Bladen and Hoke Counties, *the number and value of homes inundated by the 500-year flood is likely underestimated.*

Table 12 presents the number of homes located within the 100-year and 500-year floodplain for each county and the total number in the Lumber River region.

Table 12 – Number of Homes in Floodplain

County	Homes in 100-Year Floodplain	Homes in 500-Year Floodplain
Bladen	296	90
Hoke	8	8
Richmond	25	2
Robeson	481	2,546
Scotland	32	158
Total	**843**	**2,804**

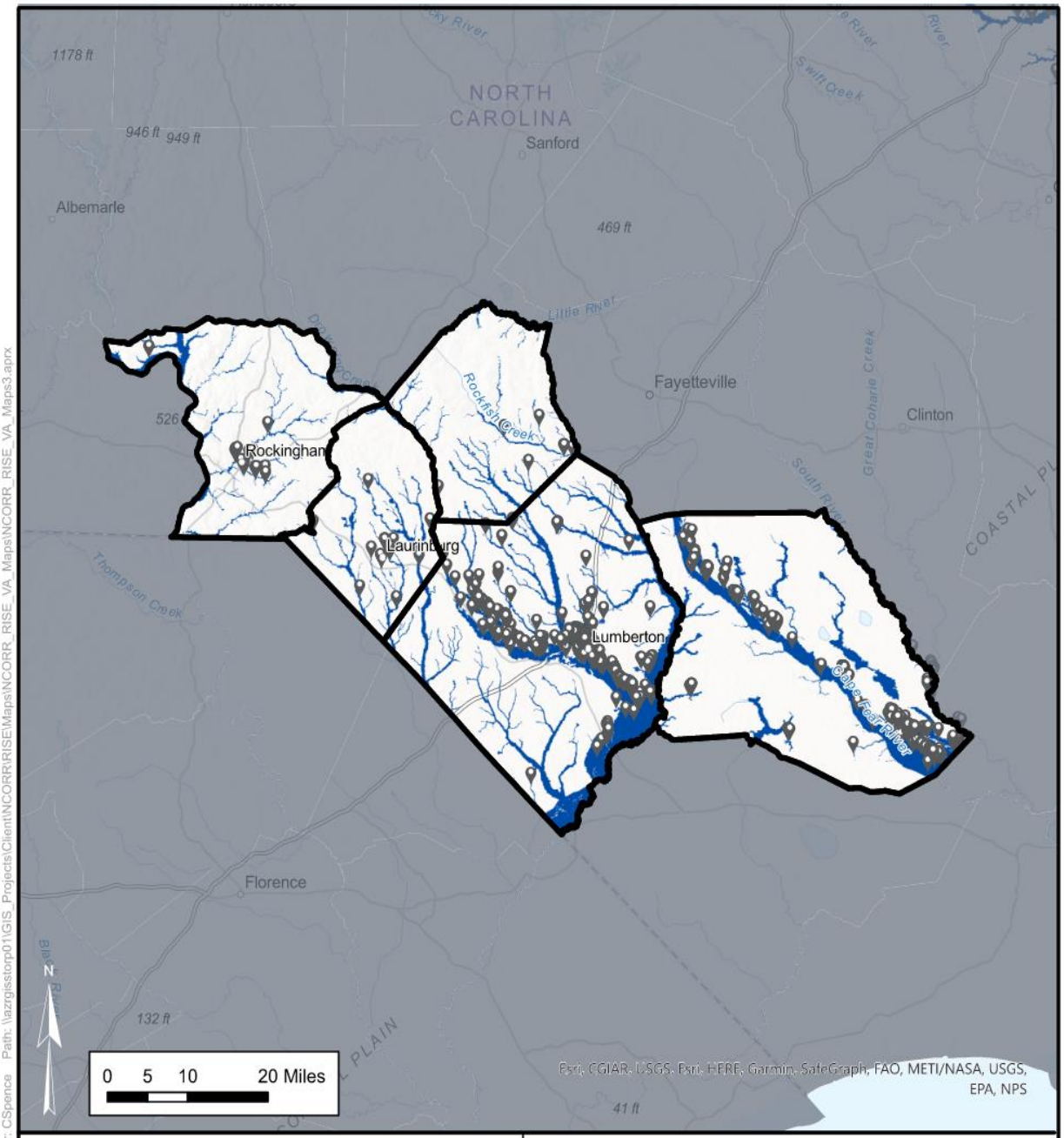
Source: NC OneMap

Manufactured/mobile homes may have higher exposure to flooding because they are often located on land in floodplains.

Figure 9 and **Figure 10** identify homes located in both the 100- and 500-year floodplain. As a proxy for the 30-year projections, the 500-year flood event map was used for this analysis. Note that one pinpoint represents one residential building. It is possible that the building may have multiple units. Robeson County has the greatest number of homes in the 100-year and 500-year floodplains.

Residential buildings located in the 100-year floodplain are at greater risk from flooding and are required to have flood insurance. The State of North Carolina regulates the floodplain to protect property and people and to reduce future flood losses (also called repetitive loss properties). It is important to note which residential buildings are in the floodplain to ensure residents are aware of their increased risk and take proper precautions to mitigate damages from flooding. Residential buildings that are not in the floodplain may still experience flooding – any location that receives rainfall has the potential to flood. However, homes located closer to a body of water inherently begin with more risk than homes that are not near a body of water.

Figure 9 - Homes Exposed to the 100-Year Flood Event



LEGEND

- County Boundaries
- Homes Flooded by the 100-Year Event
- 100-Year Floodplain

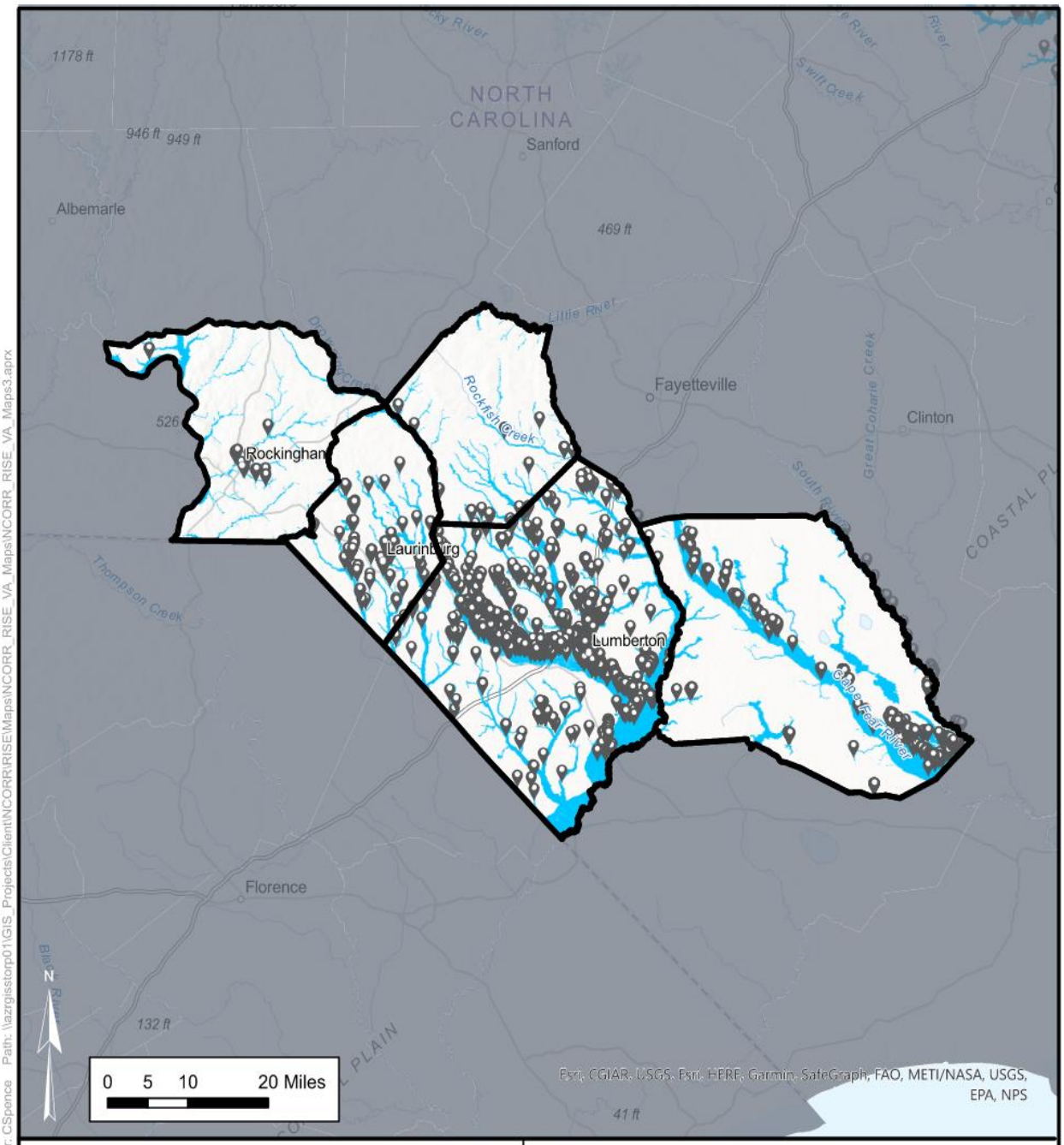
Homes Exposed to 100-Year Flood

Region N
Bladen, Hoke, Richmond, Robeson, Scotland Counties
NCORR RISE Program

Data Sources:
North Carolina OneMap Program
Federal Emergency Management Administration (FEMA)

Date: 8/10/2022 User: CSpence Path: \\azrgisstorp01\GIS_Projects\Client\NCORR\RISE\Maps\NCORR_RISE_VA_Maps\NCORR_RISE_VA_Maps3.aprx

Figure 10 - Homes Exposed to the 500-Year Flood Event



LEGEND

- County Boundaries
- Homes Flooded by the 500-Year Event
- 500-Year Floodplain

Homes Exposed to 500-Year Flood

Region N
Bladen, Hoke, Richmond, Robeson, Scotland Counties
NCORR RISE Program

Data Sources:
North Carolina OneMap Program
Federal Emergency Management Administration (FEMA)

Date: 8/10/2022 User: CSpence Path: \\azrgisstorp01\GIS_Projects\Client\NCORR\RISE\Maps\NCORR_RISE_VA_Maps\NCORR_RISE_VA_Maps3.aprx

5.1.2.2 Severe Weather

Severe weather impacts to housing are similar to the impacts from flooding and hurricanes. Thunderstorm wind conditions, lightning and hail cause damage to housing and property. The National Center for Environmental Information records indicate that the region has endured approximately $4 million in property damages from thunderstorm wind since 1950 (AECOM, 2018) (AECOM, 2020), (AECOM, Cumberland Hoke Regional Hazard Mitigation Plan, 2020). Across all five counties, more than 105,000 residential buildings are at risk of 100-year thunderstorm winds (AECOM, 2018) (AECOM, 2020), (AECOM, Cumberland Hoke Regional Hazard Mitigation Plan, 2020).

In future scenarios, the 2020 *North Carolina Climate Science Report* notes that "global climate models consistently project an increase in the frequency of severe thunderstorm environments in the United States in the mid- to late 21st century" (Kunkel, et al., 2020). Therefore, it is likely that the impact to housing due to wind, hail, and lightening damage will increase in the next 30-50 years.

5.1.2.3 Hurricanes and Tropical Storms

Hurricanes and tropical storms can have devastating impacts to homes and entire communities. Heavy rainfall from these storms can cause localized flooding and high winds can damage the exterior of homes, tear off shingles and damage roofs, cause trees to fall onto homes, break windows, and damage personal property. NOAA's Office for Coastal Management keeps records of all historical hurricane tracks, and between August 1851 and July 2021, there were 30-40 hurricanes and tropical storms that passed within 50 miles of the Lumber River Region (NOAA Office of Coastal Management, 2022). Many of the homes in the Lumber River region are at risk from hurricane and tropical storm winds.

5.1.2.4 Extreme Heat

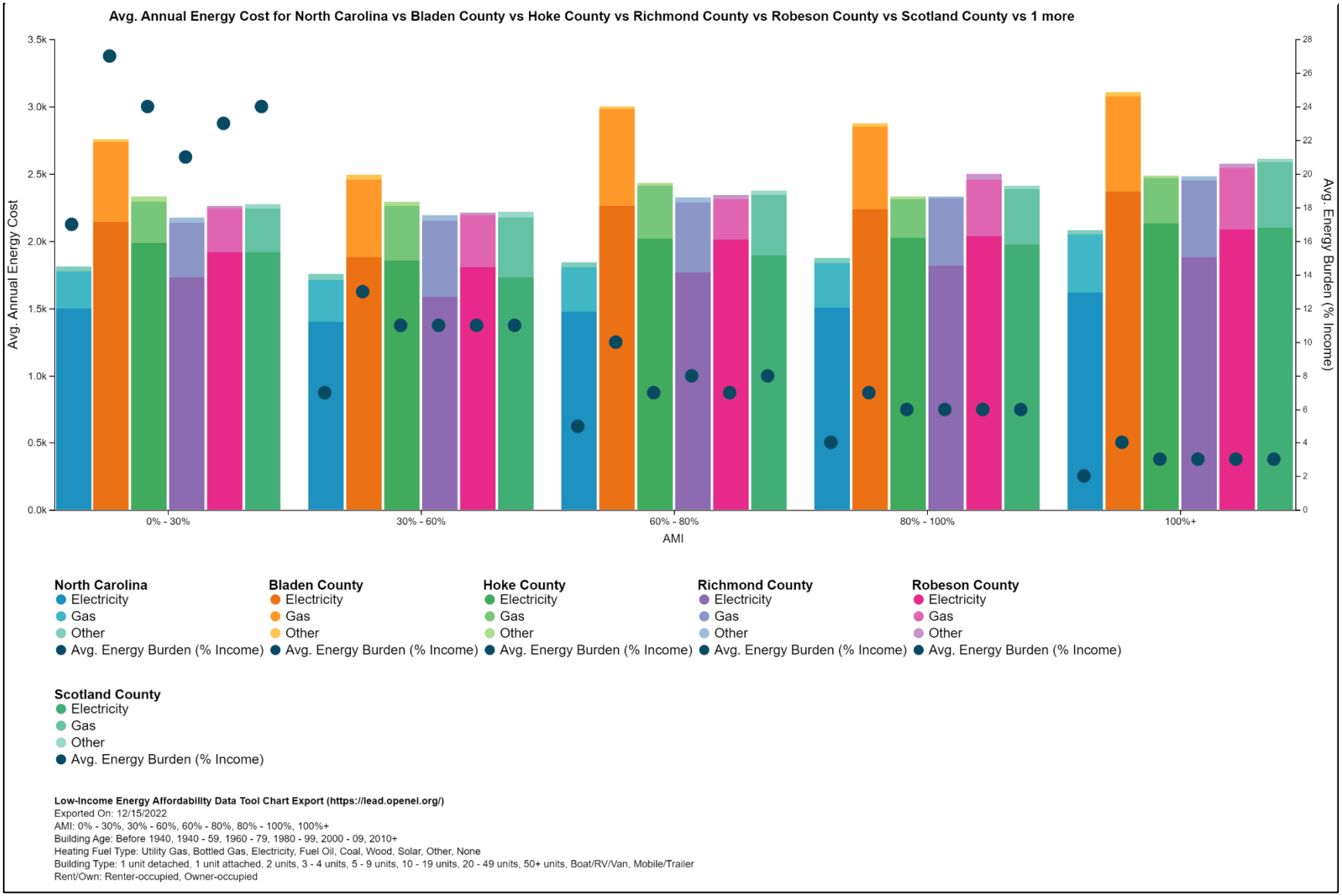
Comparatively, excessively hot temperatures can strain aging building materials in homes and residential structures. Some homes may lack central cooling units, leaving residents to rely only on fans and open windows. Where cooling units are installed, higher energy use can overburden power lines and be very cost prohibitive. Where cooling units are installed, the increased energy

use can put a tax on the utility infrastructure. Manufactured/mobile homes may utilize different heating and cooling systems and may be less energy efficient than site-built homes.

Across the U.S., low-income households tend to spend a larger portion of their income on home energy costs (e.g., electricity, natural gas, and other home heating fuels) than other households (U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2018). This measure is often called “energy cost burden” and can mean households may have to choose between paying energy bills and buying food or other essentials (U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2018). **Figure 11** below illustrates the energy cost burden in the Lumber River region (US Department of Energy, 2022). Area median income is the household income for the median/’middle’ household in the region and is used as a benchmark to determine categories of income level. Specifically, extremely low, very low, and low-income households are critical to highlight as these are likely to experience energy cost burden. Households with an income of 80% or less than the area median income are categorized as low income; households with an income of 50% or less than the area median income are categorized as very low income; and households with an income of 30% or less than the area median income are categorized as extremely low income. In the figure, each county is compared to one another within each category of area median income – 0% - 30%, 30% - 60%, 60% - 80%, 80% - 100%, and 100% +. The dots represent the average energy burden or cost of energy that households in that county pay per year. For example, extremely low-income households in Bladen County spend 27% of their income on energy costs. In comparison, households in the 100%+ category for Northampton County spend just 4% of their income on energy costs.

Bladen County tends to have a higher energy cost burden than the other four counties in the region at each level of area median income. The average amount that extremely low-income residents in Richmond County pay per year for energy is 21% of their total income. In Hoke and Scotland County, that number is 24%. Overall, energy cost burden impacts housing resiliency when residents are forced to choose what they can spend limited money on.

Figure 11 - Low-Income Energy Affordability Data



Source: [Low-Income Energy Affordability Data (LEAD) Tool]

5.1.2.4 Wildfire

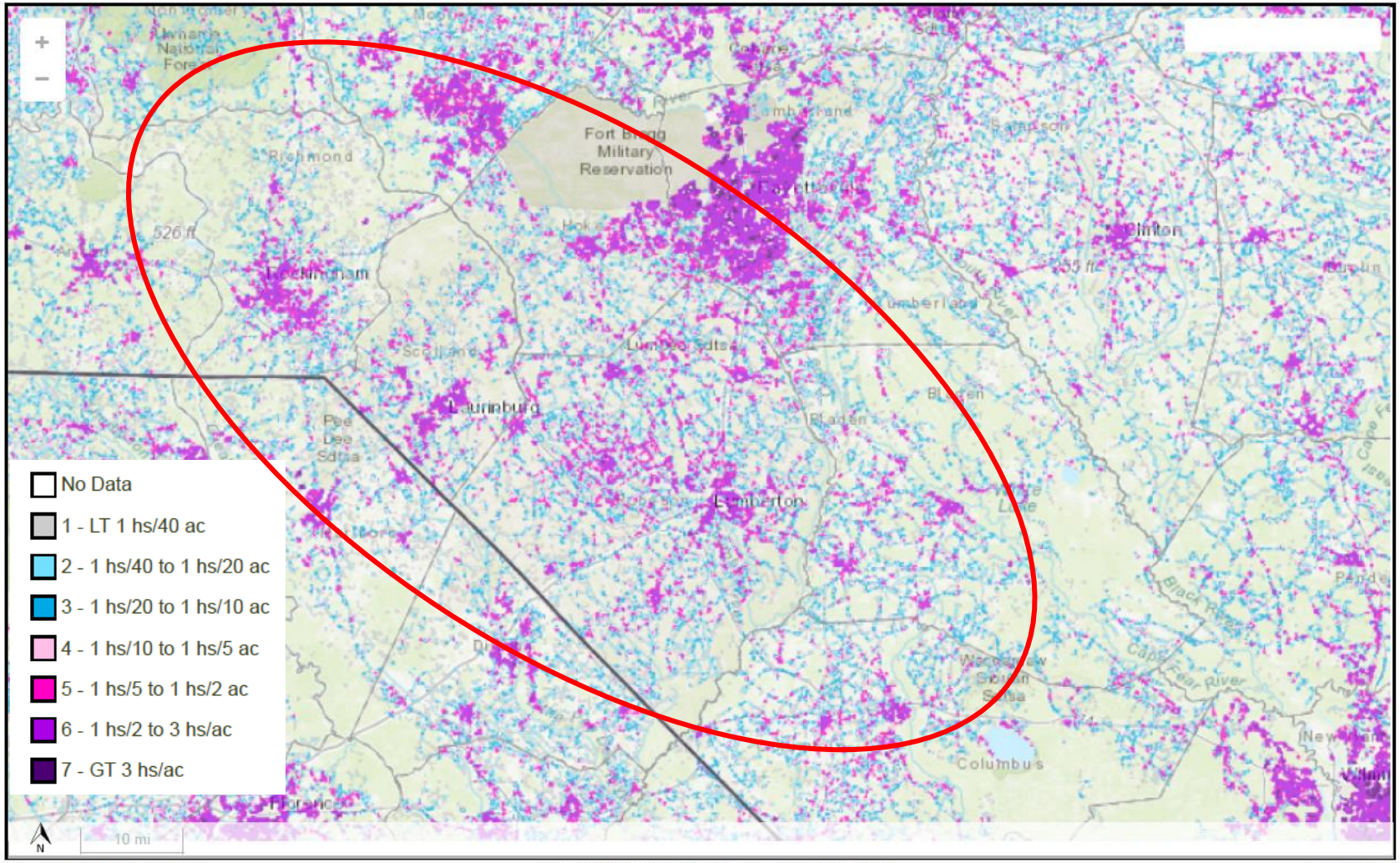
Fire is a critical component of most natural environmental systems, particularly in the Coastal Plain. Fire suppression across the region and much of the state has caused forested areas to accumulate dense undergrowth, which can fuel massive wildfires.

The most severe fires typically occur between February and May when dry and windy days provide the best conditions for ignition. When uncontrolled, wildfires threaten houses as embers and small flames land on roofs and grasses and ignite the house quickly.

The Southern Group of State Foresters Wildfire Risk Assessment Portal (WRAP) provides accurate and up-to-date wildfire risk information across the South. The map viewer includes data about the Wildland Urban Interface, Wildland Urban Interface Risk Index, Community Protection Zones, and Wildfire Ignition Density.

The Wildland Urban Interface (WUI) is the land that transitions between developed areas and natural wilderness. This area is important to focus on, because as more populated areas move closer towards more wild or natural areas, fire risk may increase, and homes may be more susceptible to wildfire. The Portal's Wildland Urban Interface data reflects housing density, depicting where humans and their structures meet wildland fuels. As seen in **Figure 12**, areas highlighted in pink and purple indicate higher numbers of houses per acre.

Figure 12 - Lumber River Wildland Urban Interface (WUI)



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SGSF Wildfire Risk Assessment Portal
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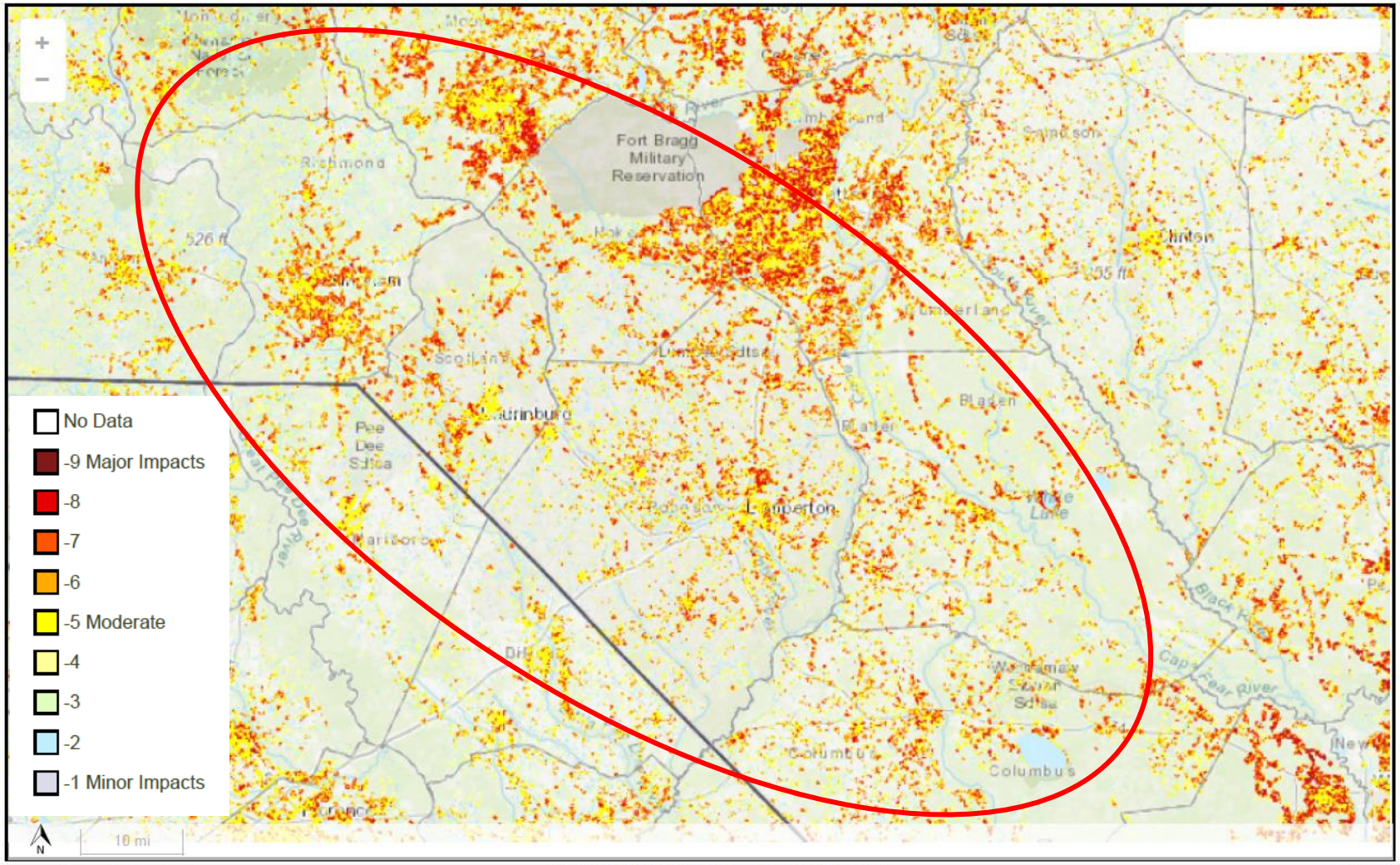
The Portal's Wildland Urban Interface Risk Index layer is a rating of the potential impact of a wildfire on people and their homes. Data in **Figure 13** displays a gradient of major impacts in dark red to minor impacts in gray. Most of the Lumber River region would experience minor to moderate impacts from wildfire. Those areas with moderate impacts are clustered around more urban centers where wildfire poses risk to more infrastructure.

Figure 13 - Lumber River Wildland Urban Interface Risk Index



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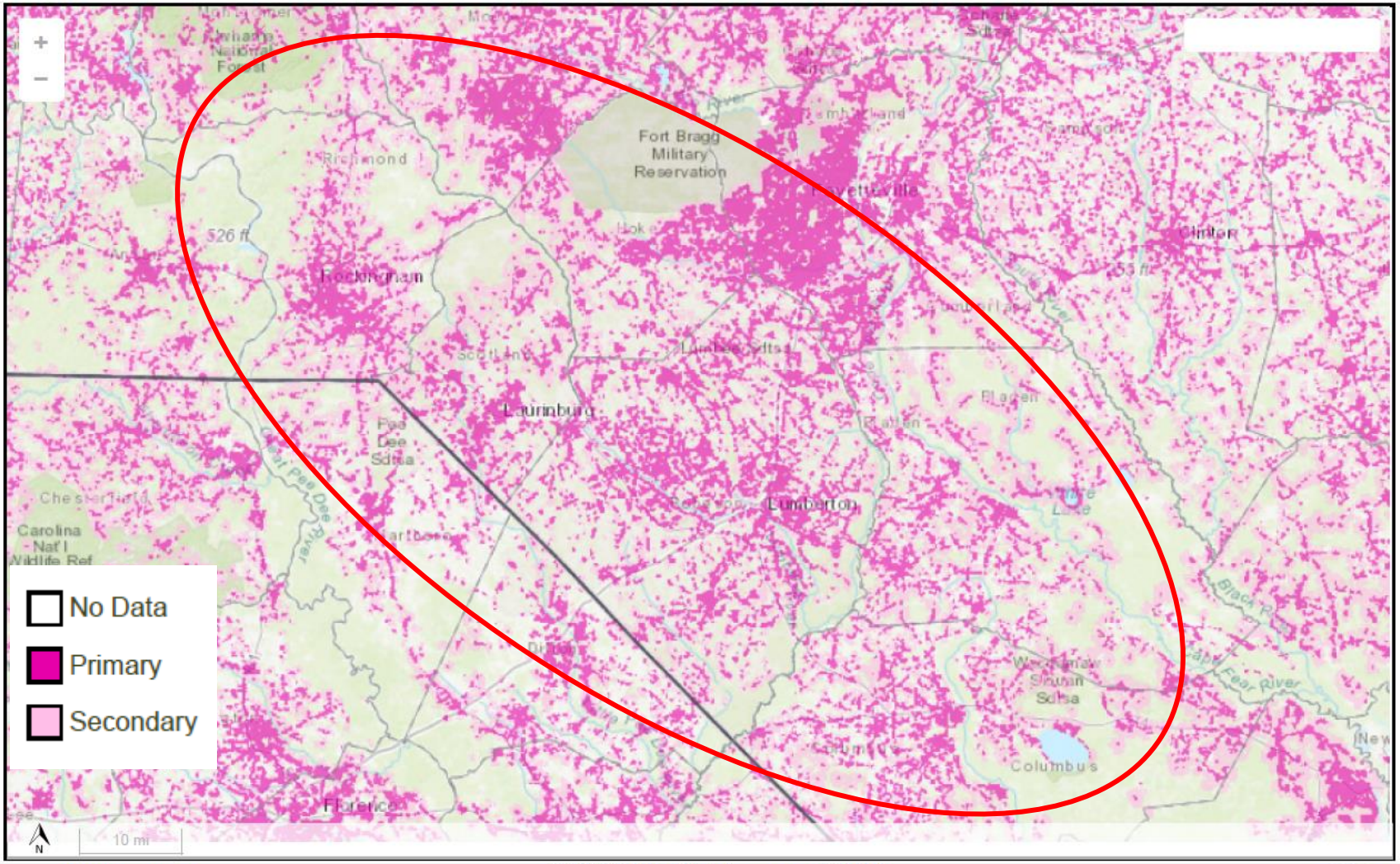
Community Protection Zones represent areas considered highest priority for mitigation planning activities. Wildfires that begin in this area contribute more to potential loss of community assets than other management zones (U.S. Forest Service, Pacific Southwest Region, 2016). Under most conditions, direct action to mitigate wildfires is needed in this area to prevent direct threats to life or property. In **Figure 14**, dark pink indicates primary community protection zones to focus actions to mitigate wildfire risk.

Figure 14 - Lumber River Community Protection Zones



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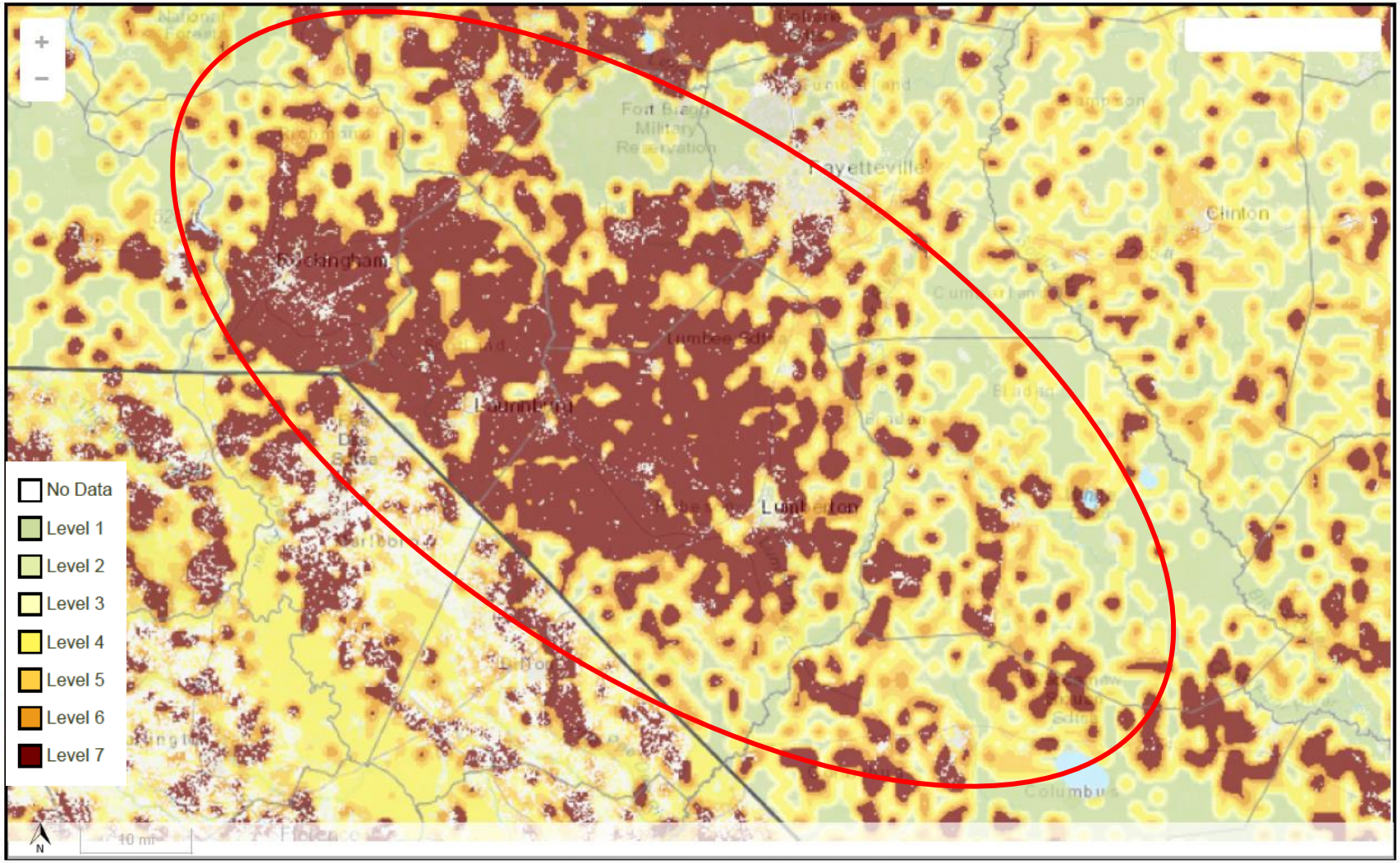
Wildfire ignition density is the likelihood of a wildfire igniting in an area, based on historic records. Since it is currently not possible to accurately model 30-year projections of wildfires in the region, climate scientists use wildfire ignition density as the best measurement substitute. Data in **Figure 15** on average ignition rates displays as Very Low (Level 1) in light green to Very High (Level 7) in dark red.

Figure 15 - Lumber River Wildfire Ignition Density



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Much of Richmond, Scotland, Robeson, and Hoke Counties have the highest ignition rates possible, putting these areas at greater risk of wildfire. Actions should be taken now to properly manage wildfire risk, such as prescribed burning and educational awareness, as it is likely that wildfires may present hazard to the housing sector.

5.2 Critical Facilities

Figure 16 - Critical Facilities Overview

	• Critical facilities are susceptible to severe weather and flooding that cause business, school and road closures; downed trees and powerlines; and structural damage. • There are 1,811 critical facilities in the region, the majority of which are classified as social hubs. • Seventy-five critical facilities are within the 100-year floodplain (58 in Robeson County) and 90 critical facilities are within the 500-year floodplain. • There are currently twelve major critical facilities located in the 100-year floodplain – two in Bladen County, nine in Robeson County, and one in Scotland County. • There are 3 major critical facilities located in the 500-year floodplain – all in Robeson County. • 325 critical facilities are at high risk of wildfire.

Critical facilities consist of assets, systems, and networks, both physical and virtual, that impact security, economic security, and public health and safety. The project team collected data on critical facilities in the Lumber River region that included critical health resources such as emergency medical services, dialysis centers, pharmacies, urgent care centers, and hospitals; critical social hubs and resources such as SNAP-authorized retailers, schools, and houses of worship; emergency response such as emergency operations centers, police and fire stations, emergency shelters, and cellular towers; group quarters and vulnerable housing such as colleges and universities, correctional institutions, nursing homes, and mobile home parks; and hazardous contamination potential such as hazardous waste sites, landfills, and power plants. TABLE below shows the total number of critical facilities within each category for the Lumber River region.

Table 13 - Critical Facilities in the Lumber River Five-County Region

Critical Health Resources	Social Hubs & Resources	Emergency Response	Group Quarters & Vulnerable Housing	Hazardous Contamination Potential
276	**829**	**275**	**218**	**213**

Source: NC OneMap

There are 1,811 critical facilities in the region with the majority categorized as social hubs and resources. Examples of these include houses of worship, gas stations, Dollar General, convenience, and grocery stores. Social hubs and resources are critical to the integrity of the region and should be addressed in resiliency efforts.

5.2.1 Impacts by Hazard

Natural hazard occurrences in the region can damage critical infrastructure and assets causing many indirect and direct impacts, the most severe being injury and loss of life. Buildings, utilities, and roadways are especially at risk of extensive damage. Property damage may be widespread. Power outages happen because of the increased use of air conditioning during heat waves and because of downed trees and powerlines, especially during hurricanes, high wind, and winter storm events. Loss of power can range from a mild inconvenience to a life-threatening event for those reliant on powered medical equipment and air conditioning units. During hurricanes and severe weather, transformers can explode, and exterior building features like windows can shatter. Blocked roadways and bridges can prevent access to life-saving care and delay first responders. Agricultural fields can also be significantly impacted or destroyed.

Damages to infrastructure within the Lumber River region have secondary impacts that can be just as detrimental as the direct ones. These include mental trauma, displacement, financial losses for businesses and individuals, job losses, prolonged cleanup, and food and water supply concerns. Socially vulnerable populations such as youth, the elderly, disabled persons, low-income persons, and mobile home occupants, among others, are at greater risk of harm from hazardous events. As such, critical facilities like senior centers, assisted care communities, healthcare facilities, mobile home parks, schools, and other facilities serving socially vulnerable populations should be prioritized in resiliency efforts.

5.2.1.1 Flooding

Flooding is one of the most frequently mentioned natural hazards in the Lumber River region, particularly inland flooding. During stakeholder meetings and the May 2022 open house, participants regularly mentioned flooding as a main concern. All types of structures in a floodplain are at-risk of damage to varying degrees. Factors that affect the degree of damage include physical location, building methods, structure age, elevation levels, and more. The project team used available GIS data to compare the location of critical facilities to the 100-year and 500-year floodplain to analyze how many critical facilities are at risk of flooding.

The Lumber River region is connected to surrounding areas via its transportation network. The ability to carry goods, services, and persons across land in an efficient manner is essential to sustaining the region's economy, vitality, and livelihood. Interstate 95 (I-95), the largest highway system, traverses through the region north to south, and US Highway 74 travels east to west. Additional major roadways include Interstate 73 and US Routes 701, 15, and 40. Railways consist of CSX Transportation and Amtrak. Regional airports are in Bladenboro (Bladen County), Lumberton (Robeson County), Rockingham (Richmond County), and Laurinburg/Maxton (Scotland County). Should any of them be impacted by natural hazards, the effects would be costly and widespread. This was the case in the aftermath of Hurricanes Matthew and Florence when approximately 60 miles of Interstate 95 flooded in multiple sections and left the interstate impassable for seven days. **Table 14** below shows the number of road miles at risk of flooding and becoming impassable because of 100-year flooding.

Table 14 - Road Miles Subject to Flooding

County	Number of miles of roads at risk of becoming impassable
Bladen	792
Hoke	296
Richmond	283
Robeson	1,511
Scotland	325
All counties	3,207

Source: Flood Factor

"Major" critical facilities were separated from the five main categories and analyzed for risk. Major critical facilities have been defined to include emergency medical services, fire stations, police and law enforcement, emergency shelters, power plants, and wastewater treatment plants. There are currently twelve major critical facilities located in the 100-year floodplain – two in Bladen County, nine in Robeson County, and one in Scotland County. Additionally, there are 3 major critical facilities located in the 500-year floodplain – all in Robeson County. Portions of Gilbert Carroll Middle School fall into both the 100-year and 500-year floodplains. **Table 15** shows the major critical facilities, including facility name and address, within the 100-year and 500-year floodplain.

Table 15 - Major Critical Facilities in the 100-Year and 500-Year Floodplain

100-Year Floodplain			
Name	**Address**	**Facility Type**	**County**
Kelly Volunteer Fire Station	18628 NC 53, Kelly, NC 28448	Fire Station/Emergency Medical Services	Bladen
Town of Bladenboro Wastewater Treatment Plant	417 W Bladen Street, Bladenboro, NC 28320	Wastewater Treatment Plant	Bladen
West Lumberton Police Department	2401 W. 5th St., Lumberton, NC 28358	Police & Law Enforcement	Robeson
Green Grove Elementary*	1850 School Road, Fairmont, NC 28340	Emergency Shelter/School	Robeson
West Lumberton Elementary School	451 School Street, Lumberton, NC 28358	Emergency Shelter/School	Robeson
W.H. Knuckles Elementary School	1520 Martin Luther King Jr Drive, Lumberton, NC 28358	Emergency Shelter/School	Robeson
Gilbert Carroll Middle School	300 Bailey Road, Lumberton, NC 28358	Emergency Shelter/School	Robeson
Lumberton Fire Department Station 3	801 Dunn Road, Lumberton, NC 28358	Fire Station/Emergency Medical Services	Robeson
Pine Terrace Volunteer Fire Department	1292 Alamac Road, Lumberton, NC 28358	Fire Station	Robeson
Lumberton Power Plant	1866 Hestertown Rd, Lumberton, NC 28358	Power Plant/ Wastewater Treatment Plant	Robeson
Robeson Community College*	5160 Fayetteville Road, Lumberton, NC 28360	Colleges/Universities	Robeson

Laurinburg City Fire Department Station 1/Scotland County Rescue Squad	501 North Main Street, Laurinburg, NC 28352	Emergency Medical Services	Scotland
500-Year Floodplain			
Name	**Address**	**Facility Type**	**County**
North Carolina State Highway Patrol Troop B, District VII	4650 Kahn Drive, Lumberton, NC 28358	Law Enforcement	Robeson
Lumberton Junior High School	82 Marion Road, Lumberton, NC28358	Emergency Shelter/School	Robeson
Gilbert Carroll Middle School	300 Bailey Road, Lumberton, NC 28358	School	Robeson
Riverside Christian Academy	3644 US-74-ALT, Lumberton, NC 28360	Non-Public Schools	Robeson

Source: NC OneMap, FEMA National Flood Hazard Layer Viewer

**Northwest edge of campus is in floodplain – buildings are not.*

The location of these important facilities in an area with a 1% and/or 0.2% chance of flooding in any year puts them at risk of failing to operate or being damaged when a storm does occur. Many of these facilities provide emergency response and in the event of an emergency, lives and property are even more at risk if flooding impacts these locations.

Figure 17 below depicts all critical facilities – approximately 75 – that are identified within the 100-year floodplain. **Figure 18** depicts an additional 90 critical facilities are located in the 500-year floodplain. For future risk levels, 500-year is used as proxy for the 30-year projection. Like residential buildings located in the floodplain, it is important to identify critical facilities that have a disproportionate risk to flooding. For example, SNAP-authorized retailers are important retailers of food for low-income populations. If these facilities are impacted by flooding, or community residents can't access these places during hazard events, vulnerable populations may struggle to purchase necessities. There are 23 SNAP-authorized retailers located in the 100-year floodplain.

Figure 17 - Critical Facilities Exposed to a 100-year Flood Event

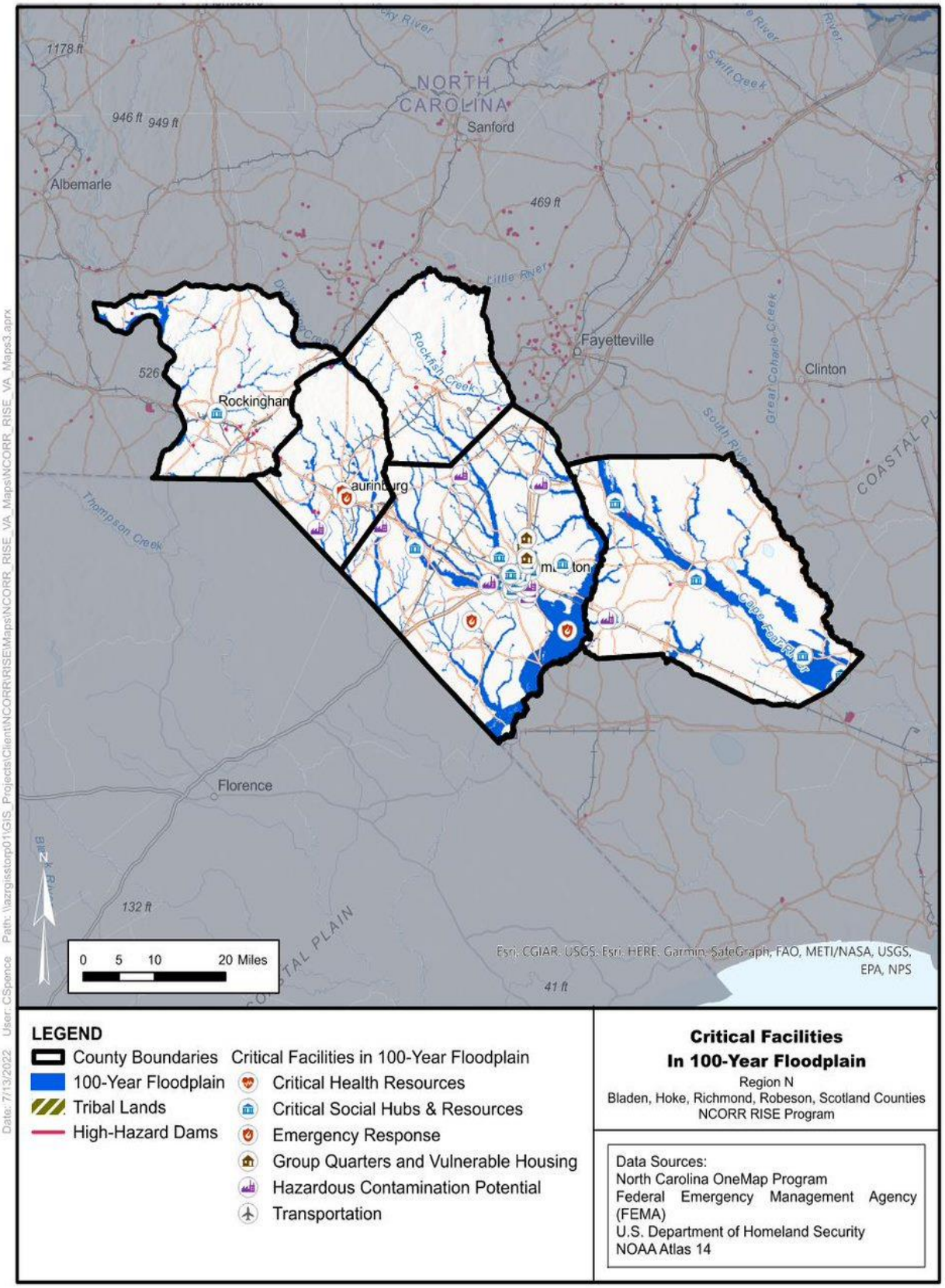
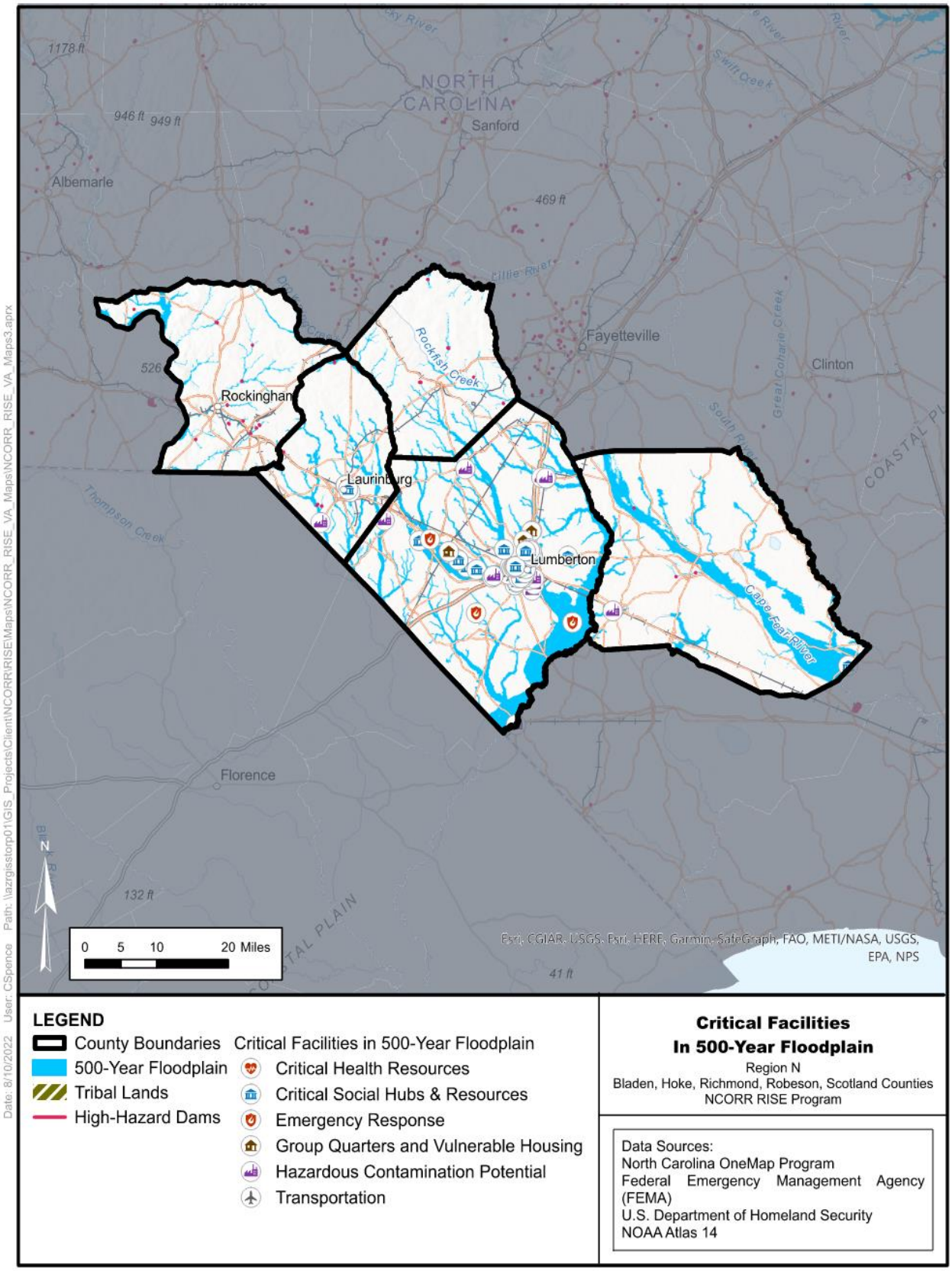


Figure 18 - Critical Facilities Exposed to a 500-year Flood Event



5.2.1.2 Severe Weather

Severe weather includes thunderstorms that can be accompanied by wind, lightning hail, and heavy rainfall. As mentioned in Section 5.1, severe weather impacts critical facilities similarly to houses. Stakeholders are knowledgeable of locations throughout their communities that flood with any rainfall event. Location of heavy rainfall also influences communities downstream, as water flows over land into streams and rivers and sometimes has a greater impact after the initial storm event.

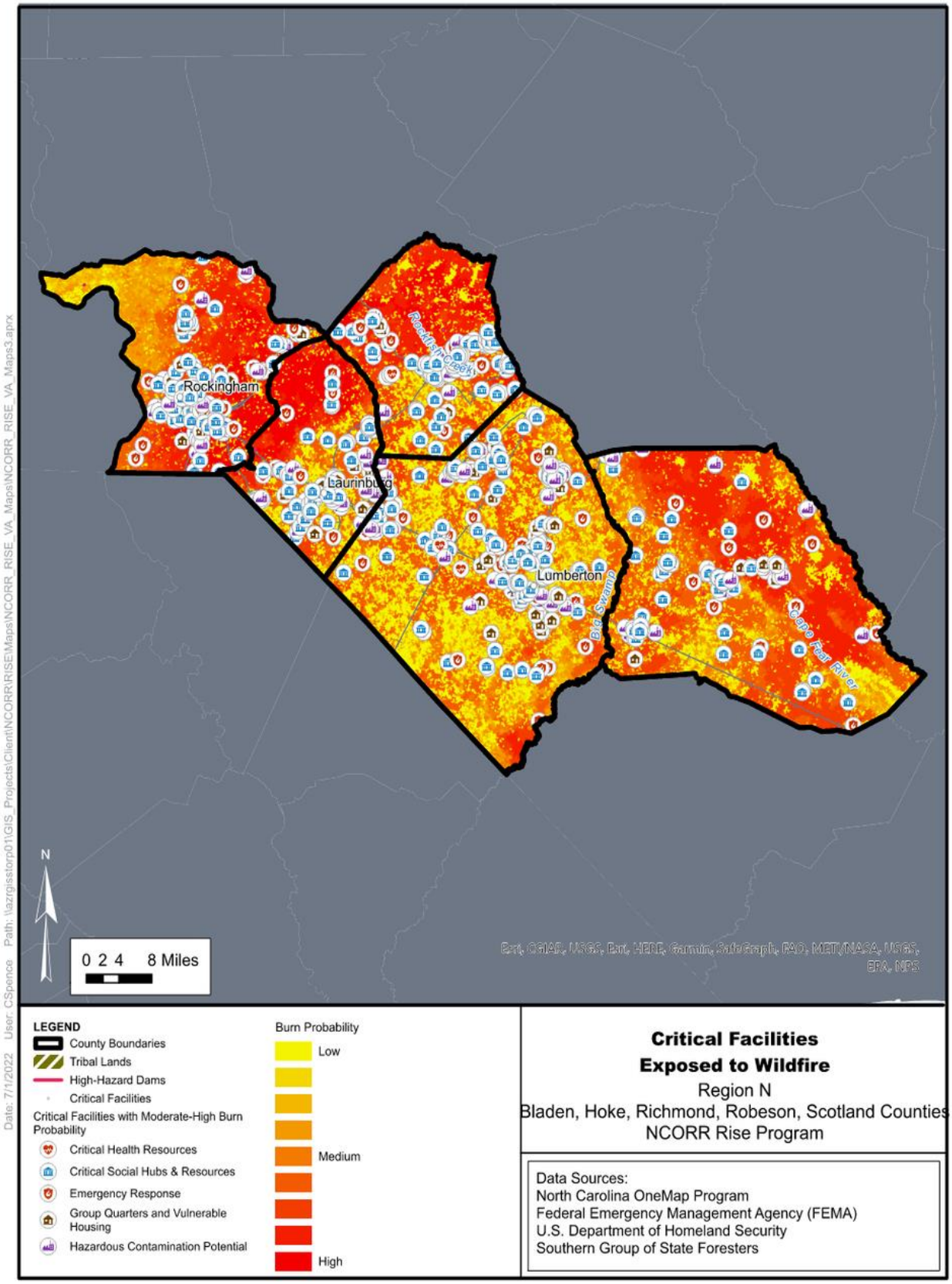
5.2.1.3 Extreme Heat

Extreme heat can cause significant damage to infrastructure. In extreme cases, in which several factors must align such as prolonged periods of very high temperatures, road surfaces can be damaged as asphalt softens and train rails can buckle due to heat-induced expansion. Powerlines may also sag. When there is a high demand on the electrical grid for cooling purposes, it can increase power line temperatures that can result in fire. One important cascading impact of extreme heat is that increased use of air conditioning systems can strain the power grid, triggering power outages which can lead to adverse health impacts. More commonly, the consequences of extreme heat lead to heat-related illnesses and agricultural losses.

5.2.1.4 Wildfire

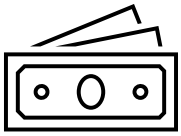
Wildfire risk is high across most of the Lumber River region. Wildfire is a naturally occurring event, but it can be attributed to negligent human actions and can very quickly spread and destroy critical facilities. Extreme temperatures and drought can also increase wildfire risk. The project team analyzed the location of critical facilities in relation to the risk of wildfire and found that a total of 325 critical facilities have a high burn probability risk in the region. **Figure 19** below spatially depicts the total number of critical facilities that are located within high burn probability areas.

Figure 19 - Critical Facilities Exposed to Wildfire Risk



5.3 Regional Economy

Figure 20 - Regional Economy Overview

	• Flooding from hurricanes and severe weather is the most significant hazard to the regional manufacturing economy. • Disruption to the supply chain, logisitics, and transportation routes caused by hazards like flooding, hurricanes and severe weather can affect the manufacturing industry and regional economy. • Agriculture is prominent in the region, with 611,753 acres in agricultural production. However, only 43% of farmland acres have crop insurance. • Flooding, extreme heat, erosion and drought all pose a significant risk to agriculture. • Eighteen percent of commercial properties are at risk of flooding in the region, with the largest proportion in Robeson County.

Climate change is likely to pose impacts to industries in the region. Heavy rainfall during hurricanes and thunderstorms will likely cause flooding on roads, preventing employees and customers from accessing a business. Droughts will make water more expensive, which will affect the cost of raw materials and production (Cho, 2019). Supply chain and logistics can be affected by severe weather, hurricanes, and other hazards happening in different locations. The result is delays and increased timelines. Water damage to building infrastructure can also cause businesses to close for a period, affecting profit and job stability for employees. Heavy rain, flooding, and extreme temperatures will likely cause school closures, disrupting teaching and learning. Each industry in the Lumber River region has felt the impacts of climate change in some way already and will need to prepare and become resilient starting now. The following section outlines the top industries and largest employers in the region and vulnerabilities that affect the regional economy.

Historically, the Lumber River region's economy was agriculture-based, dependent on cotton and tobacco production. The Lumber River itself also played a significant role in the region's economic growth. As the region changes through the years, so do industries and employment opportunities. The economy and workforce today have shifted towards manufacturing. Although the

manufacturing industry experienced a dramatic decline in the 1990s, it remains the top industry for the region. **Table 31** in

8.4 Tables displays the number of establishments and average employment for industries across all five counties (Bladen, Hoke, Richmond, Robeson, and Scotland) for 2021.

Across the Lumber River region, the agricultural industry is vulnerable to natural hazards that can cause crop and livestock losses. During stakeholder meetings and the Open Houses in May 2022, flooding and drought to local farms was discussed. A suggested project was to address agricultural needs with an irrigation system. Some points were mentioned about the change in weather patterns and the unpredictability of rain and drought. **Figure 21** presents data about farm operations across the region and what percent of acreage has crop insurance if weather hazards impact production.

The top crops in the region are grains, oilseeds, dry beans, and dry peas followed by tobacco. Robeson County has the greatest number of farms (722) and acreage of farms (263,740) in the region. Regionally, there are approximately 611,753 acres of farmland – however, only 43% of the total acreage has crop insurance, putting farmers at risk of negative economic impact if a hazard causes crops to be unharvested.

Figure 21 - Agricultural Sector

County	Number of Farms	Acreage in Farms	Proportion of Total County Land Acres in Farms	Total Acreage with Crop Insurance
Bladen	512	180,340	32.2%	53,775 (30%)
Hoke	189	53,647	21.5%	21,239 (40%)
Richmond	237	59,173	19.5%	10,996 (19%)
Robeson	722	263,740	43.5%	154,690 (59%)
Scotland	108	54,853	26.9%	22,824 (42%)
Region	**1,768**	**611,753**	**-**	**263,524 (43%)**

Source: USDA - 2017 Census of Agriculture

5.3.1 Impacts by Hazard

5.3.1.1 Flooding

Flooding poses a significant risk to the regional economy of the Lumber River region and can cause serious financial losses. The First Street Foundation Flood Model is a tool created by the First Street Foundation and displays data about specific properties' current and future risk of flooding, flood history, and how flood risk is changing over time. A property's Flood Factor is a comprehensive risk assessment including thirty-year risk of flooding from heavy rainfall, overflowing rivers and streams, high tides, and storm surge (Flood Factor FAQ, n.d.). Using the Flood Factor tool to quantify flood risks for the commercial sector, the project team determined that approximately 18% of commercial properties are at risk of flooding in the region. The majority of properties at risk are in Robeson County. Currently, Flood Factor does not provide mapping, so these commercial property locations are unknown. **Table 16** below shows the total number of businesses at risk of flooding over the next 30 years.

Table 16 - Flood Risk to Commercial Properties

County	Number of Commercial Properties at Risk of Flooding	Total Number of Commercial Properties
Bladen	181	922
Hoke	39	391
Richmond	116	1,531
Robeson	632	2,654
Scotland	148	843
Regional Total	**1,116**	**6,341**
Total Percent at Risk	**18%**	

Source: Flood Factor - County

5.3.1.2 Extreme Heat, Wildfire, and Drought

Severe weather within the Lumber River region can impact the regional economy to varying degrees. Property damage may be widespread. Power outages from downed trees and powerlines can occur during hurricanes, high wind, and storms. Both property damage and power outages can harm businesses and individuals, leading to financial losses and unemployment. For example, power outages can cause a loss of refrigeration at homes and grocery stores, resulting

in food spoiling. There may be prolonged periods of rebuilding communities and the economy, further putting a strain on this sector. During extreme heat events, the increased use of air conditioning can strain the power grid and result in outages. Customers may opt to stay indoors in cooler temperatures instead of supporting local businesses. Outdoor workers may suffer heat-related illnesses and business operations may slow down, as people opt to heed extreme heat warnings. Droughts and wildfire impact the economy by reducing tourism and recreational opportunities.

When these hazards damage economic assets, the secondary impacts can be just as detrimental as the direct ones. Mental trauma, long term psychological impact, displacement, prolonged cleanup, financial losses, and food and water supply concerns can stress people as well as the local economy. For example, if a business is destroyed from a flood or hurricane event, the business owner may experience financial losses and their employees may lose their jobs.

The Lumber River region has already felt some of these direct economic impacts following Hurricanes Matthew and Florence, in addition to periods of drought and seasonally heavy storms. Secondary impacts such as the COVID-19 pandemic and domestic crises also strain economic development, and when compounded with natural hazards, can significantly impact the region.

5.4 Historical and Cultural Resources

Figure 22 - Historical and Cultural Resources Overview

- Flooding poses the most significant climate risk to historical and cultural resources because it is difficult to physically move these resources.
- 23 of the 78 sites on the National Register of Historic Places are in the 100-year floodplain.
- Archival records stored in government buildings are often impacted by flooding.
- Bladen County has the largest number of sites in the 100-year floodplain, and the Robeson County Courthouse is very close to the 100-year floodplain.

The identity of the Lumber River region can be defined by its historical and cultural heritage. The region is rich in cultural resources such as historic and archeological sites, historic districts, and archival records, including those of the Lumbee Native American tribe. These types of resources are unique and irreplaceable assets that are equally vulnerable to natural hazards. Awareness of the need to preserve and protect these resources is ever increasing.

In the Lumber River region, there are 78 sites in the National Register of Historic Places (NRHP). Established by the 1966 National Historic Preservation Act, the NRHP is the nation's official list of historic places worthy of preservation for their significance in American history, architecture, archaeology, and culture (Resources, 2022). The list includes districts, sites, buildings, structures, and objects of historical significance.

Additionally, in the Lumber River region, there are 2,246 sites on the "Study List" evaluated by the North Carolina Historic Preservation Office (NCHPO) for inclusion in the NRHP. The Study List screens out properties that are not eligible for the National Register, but nonetheless, identifies properties and districts that have potential significance and could be eligible for the National Register in the future. The Study List is also intended to help stimulate preservation at the local level.

5.4.1 Impacts by Hazard

5.4.1.1 Flooding

The phrase "water-where-it-doesn't-belong" collectively represents the biggest threat to cultural and historical resources (North Carolina Department of Environmental Quality, 2020). Floods caused by hurricanes and tropical storms, heavy rainfall, and other weather events pose the greatest risk to the sector. Cultural resources in fixed locations are inherently sensitive to flooding and it is difficult to reduce the exposure of a site to flooding. Increased or more frequent flooding may inundate and potentially destroy more cultural resources.

The project team used available GIS data to compare Study List and National Register sites to the 100-year floodplain to analyze how many cultural resources are at risk of flooding. The results are summarized in **Table 17** below. Sites are identified as in or within 500 feet of the 100-year FEMA floodplains.

Table 17 - Historical and Cultural Sites within the 100-Year Floodplain

County	National Register Sites within the 100-Year Floodplain	Study List Sites within the 100-Year Floodplain	Study List Sites within 500 ft Proximity to the 100-Year Floodplain
Bladen	8	26	3
Hoke	7	17	3
Richmond	3	8	0
Robeson	3	8	0
Scotland	2	9	0
Regional Totals	**23**	**62**	**6**

Source: National Register of Historic Places

Of the 78 sites on the National Register in the Lumber River region, 23 are in the 100-year FEMA floodway and/or floodplains – approximately 29%. Note that Bladen County has the highest

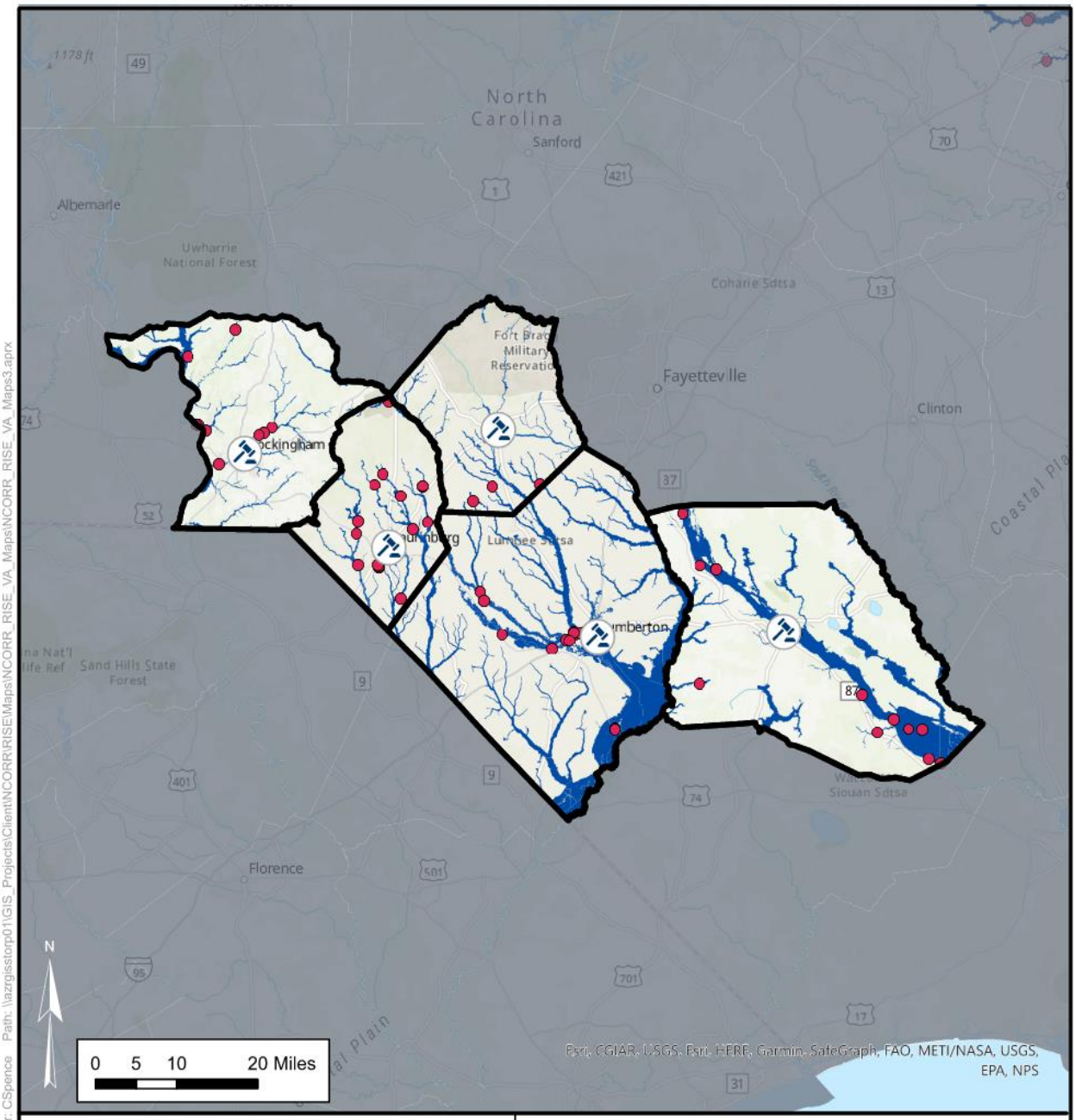
percentage of its National Register sites in the 100-year floodplain. An inventory of all National Register sites in the Lumber River region can be found in **Table 33** in

8.4 Tables.

In Bladen County, notable National Register Sites located within the 100-year floodplain include Louisburg Historic District and Speed Farm. In Hoke County, the Oxford Historic District and Eldon B. Tunstall Farm are both within the floodplain. In Richmond County, North Roxboro and Reamstown Residential Historic Districts are within the floodplain. In Robeson County, the Robeson County Courthouse, Belvidere, and LaGrange houses are within the floodplain. And in Scotland County, Lake O'Woods and Buxton Place are within the 100-year floodplain. These locations are important to the heritage and cultural identity of communities throughout the region, and damage from flooding may cause irreparable losses.

Figure 23 below shows the locations of museums, county courthouses, and locations of Study List and National Register sites within the 100-year floodplain. There are approximately 91 historical and cultural resources within or near the 100- and 500-year floodplains.

Figure 23 - Cultural and Historic Resources in the 100-Year Floodplain



LEGEND

- Museums
- Courthouses
- Historic Resources in 100-Year Floodplain
- 100-Year Floodplain

Cultural and Historic Resources: 100-year Flood
Region N
Bladen, Hoke, Richmond, Robeson, Scotland Counties
NCORR RISE Program

Data Sources:
North Carolina OneMap Program
Federal Emergency Management Agency (FEMA)
U.S. Department of Homeland Security

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5.5 Natural Environmental Systems

Figure 24 - Natural Environmental Systems Overview

	• The Lumber River itself is federally designated as a National Wild and Scenic River, a unique designation. • Wetlands, agriculture, and forests are key resources in the region to aid in resilience and should be given protection from development. • Fifteen species listed as endangered, threatened, or of special concern are found in all five counties and may be vulnerable to climate impacts that permanently change their habitat, such as higher temperatures. • Bladen County has 24,254 acres of pocosin wetlands that are unique to the region and important for carbon storage, and many areas high in conservation value that are lacking management and protection.

Natural environmental systems are also at risk of severe and long-term impacts from climate change. Natural environmental systems, or ecosystems, are defined as a community of organisms living in a particular environment and the physical elements in which they interact. An ecosystem can be as small as a field or as large as the ocean. Ecosystems create habitat that allow plants and animals to flourish. These plants, animals, and their ecosystem rely on a particular set of climatic conditions. With natural hazards and climate change, those climatic conditions are changing, and the rate of change is too fast for many species to adapt. Ecosystems sustain human societies by providing agricultural, environmental, cultural, recreational, and aesthetic resources. Ecosystem services, defined as the direct and indirect contributions of ecosystems to human wellbeing and survival, include crops, livestock, fish, wood, clean water, energy, oxygen, and wildlife. Without natural environmental systems, human life could not exist.

5.5.1 Lumber River Ecosystems and Ecosystem Services

The Lumber River region is home to unique ecosystems that include rivers, streams, wetlands, managed forests, and working lands. One such unique ecosystem is the Lumber River, which is the only black-water river to earn federal designation as a National Wild and Scenic River in North Carolina. Ecosystem services are the economic, social, and environmental benefits that

WHAT ARE 'NATURAL AND WORKING LANDS'?

Natural and working lands are made up of forests, farmland, and wetlands and are managed for natural purposes, to support food and fiber production, and for human communities. Examples include public and private forests, cropland, pastureland, grassland, wetlands, salt marsh, recreational areas, and 'development lands,' which refer to natural and managed lands within urban and rural communities (NC Department of Environmental Quality, 2020). North Carolina consists of 31.1 million acres of land area and forests make up about 14 million acres and agriculture makes up another 6.9 million acres (NC Department of Environmental Quality, 2020).

ecosystems provide to human society. Wetlands and other aquatic habitats buffer hurricane and severe weather impacts by providing water storage and flood control. Wetlands also improve water quality by filtering pollutants and nutrients from water supplies, provide fish and wildlife habitat, and hold water during droughts. Managed forests supply lumber, reduce inland flooding, and provide recreational opportunities. Working lands or agricultural lands are the farms that produce food, feed communities, and drive regional economies. Each ecosystem benefits and contributes to climate resilience. Decisions made in planning and development occasionally fail to consider connections throughout the surrounding environment and can impact the provision of ecosystem services. It is important to recognize the value of each ecosystem and preserve and conserve these lands for future generations.

5.5.2 Importance of Natural and Working Lands

Natural and working lands reduce disaster-related impacts to communities. Forests and wetlands slow water flow, reduce downstream flooding, contain contaminated floodwaters, and filter pollutants. Having these natural areas intact within the floodplain, rather

than developed land and populated areas, reduces the risk to people and property. Additionally, these natural and working lands accumulate and store carbon, preventing it from escaping from tree biomass and soils, which mitigates greenhouse gas emissions. Once these lands are disturbed or developed, this stored carbon is released into the atmosphere where it contributes to harmful impacts of climate change. 27.4 million acres of North Carolina are natural and working lands, which covers 88% of the total land area in the state. These areas are slowly declining as forests and farms are converted to developed land (Katie Warnell, n.d.). Most natural and working lands are privately owned and are important to the state's economy, collectively producing more than 20% of the total economy (Warnell, Jaffe, & Olander, n.d.).

In the Lumber River region, wetlands, agriculture, and forests are key resources that can aid in resilience to climate hazards. The collaboration amongst agencies to produce the *North Carolina Natural and Working Lands Action Plan* is important for stakeholders in the region to use when considering ways to address resilience. The Plan provides recommendations for the best opportunities to pursue actions.

DEFINITIONS

Endangered – any native or once-native species of wild animal whose continued existence as a viable component of the State's fauna is determined by the Wildlife Resources Commission to be in jeopardy, or any species of animal determined to be endangered pursuant to the Endangered Species Act.

Threatened – any native or once-native species of wild animal likely to become endangered within the foreseeable future throughout all or a significant portion of its range, or one that is designated as a threatened species pursuant to the Endangered Species Act.

Special Concern – any species of wild animal native or once native to North Carolina which is determined by the Wildlife Resources Commission to require monitoring

Source: (North Carolina Natural Heritage Program, 2018).

5.5.3 At-risk Species

The North Carolina Natural Heritage Program gathers and shares information about rare species and natural communities across the state. This information can help the region identify plants,

animals, and ecosystems that are unique to the Lumber River region and may be impacted by natural hazards and climate change. The Natural Heritage Program found that, in the Lumber River region, there are fifteen species that are endangered, threatened, or of special concern. Each species, shown in **Table 18** is found in all five counties. The majority found across all five counties are considered Special Concern for North Carolina, meaning that the Wildlife Resources Commission will monitor the population.

Table 18 - Species of Interest

Common Name	Taxonomic Group	NC Status
Red-cockaded Woodpecker	Bird	Endangered
Twisted-Leaf Goldenrod	Vascular Plant	Endangered
Pine Barrens Treefrog	Amphibian	Threatened
Southern Hognose Snake	Reptile	Threatened
Bachman's Sparrow	Bird	Special Concern
Broadtail Madtom	Freshwater Fish	Special Concern
Pinewoods Darter	Freshwater Fish	Special Concern
Thinlip Chub	Freshwater Fish	Special Concern
Dwarf Salamander	Amphibian	Special Concern
Southern Chorus Frog	Amphibian	Special Concern
Eastern Chicken Turtle	Amphibian	Special Concern
Eastern Coachwhip	Reptile	Special Concern
Timber Rattlesnake	Reptile	Special Concern
Eastern Big-eared Bat	Mammal	Special Concern
Star-nosed Mole (Coastal Plain population)	Mammal	Special Concern

Source: NC Natural Heritage Program Online Data Search

Climate change and natural hazards threaten the vulnerability of species by altering habitats to the extent that breeding patterns change, habitat becomes no longer suitable, competition from other species pushes natives out, and ecosystems overall are altered. For example, drought can lower water levels in streams and rivers where freshwater bivalves live, and extreme heat can increase water temperatures to a point that kills crustaceans and bivalves. Severe weather and hurricanes that hit the Lumber River region can knock down trees that provide habitat for birds. It is important to consider vulnerabilities of wildlife and natural ecosystems for the roles they play, often in the background of our daily lives.

Biodiversity in the Lumber River Region

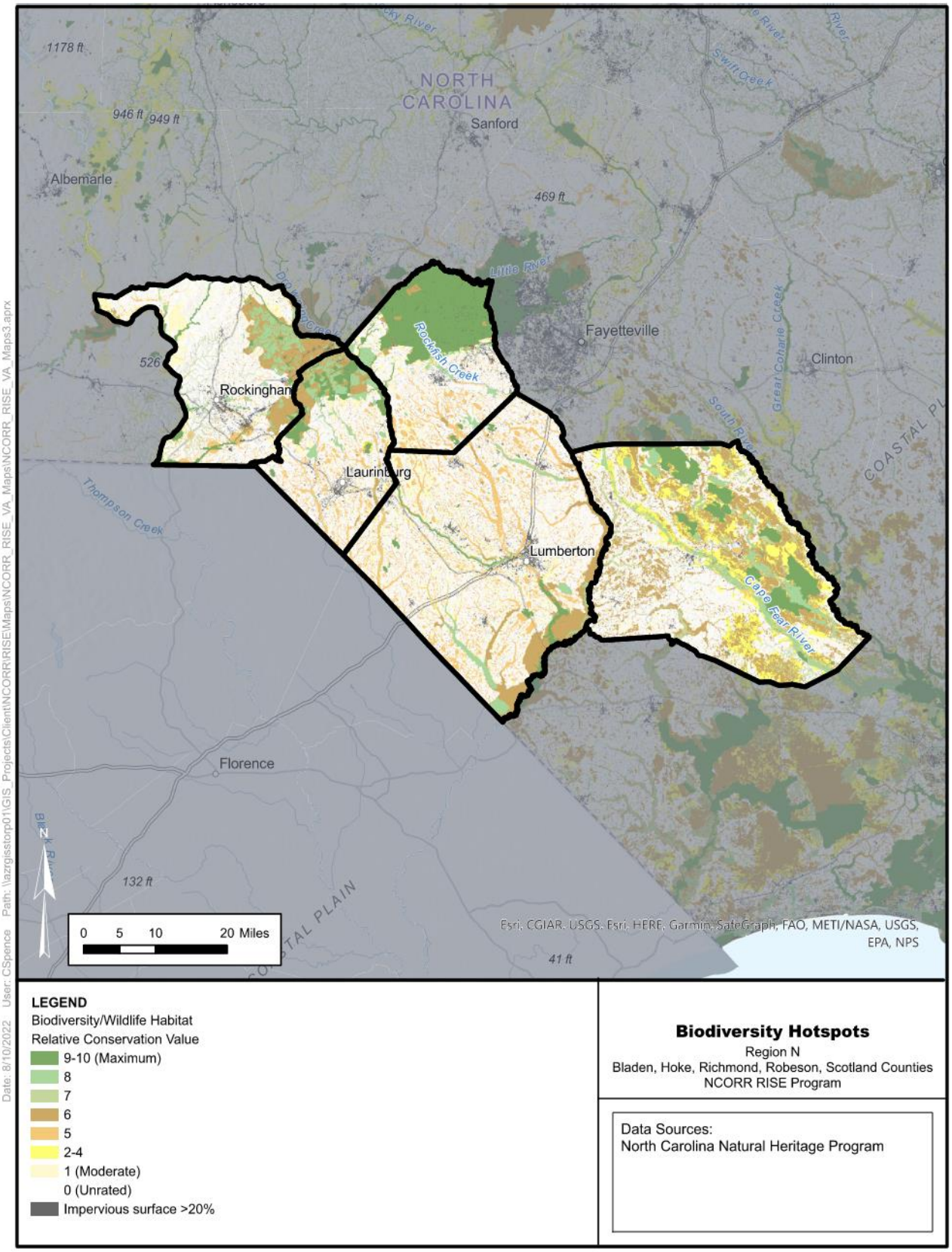
A variety of flora and fauna are located throughout the Lumber River region. The North Carolina Natural Heritage Program created the Biodiversity and Wildlife Habitat Assessment to identify, evaluate, and prioritize areas that are important for maintaining healthy and sustainable ecosystems (North Carolina Natural Heritage Program, 2021). This analysis helps visualize important areas that can provide ecosystem services and resilience to natural hazards but may also be vulnerable to impacts of climate change and land development. **Figure 25** below depicts the ranking of areas pertaining to conservation values that focus on 1) the biodiversity of aquatic and terrestrial species and communities, 2) large-scale landscapes, including core wildlife habitats and habitat connectors, and 3) lands important to ecosystem processes like riparian buffers and wetlands. Biodiversity hotspots were identified in the northeast corner of Richmond County around Hoffman, the northwest corner of Scotland County, around the Lumber River, and in the eastern half of Bladen County, particularly the pocosin wetlands, described in detail below.

These data identify areas and conservation values of significant natural resources throughout the state and have been applied by a variety of stakeholders (such as local governments, state agencies, regional councils of governments, private sector, etc.) to support planning and decision-making for land use, conservation, mitigation, and transportation projects (North Carolina Natural Heritage Program, 2021).

Data inputs for this assessment include natural heritage natural areas, rare species occurrences, core wildlife habitats and their connections, important aquatic resources, wetlands, and watershed

priorities. Combined, areas receive a rating from 1 to 10, where areas rated 5-10 have significant importance to conservation efforts.

Figure 25 – Priority Biodiversity Locations in the Lumber River Region



In the Lumber River region, areas with a relative conservation value between 8-10 are most often located adjacent to bodies of water – particularly around notable rivers like the Lumber and Cape Fear Rivers, Big Marsh Swamp near St. Paul's, and around Carolina bays in Bladen County. Greener areas have a greater conservation value compared to areas with impervious surfaces – such as towns, buildings, and roads.

Natural and Managed Areas in the Lumber River Region

Many of the natural and managed areas in the region, as depicted in **Figure 26** below, are on private land and are not open to the public. Natural and managed areas are important to identify because they provide ecosystem services and protection for flora and fauna that depend on that habitat. Additionally, natural and managed areas play a role in climate resilience through supporting wildlife, retaining floodwaters, providing habitat, and contributing to biodiversity all around.

Knowing where there are areas that are home to important species will help prioritize voluntary conservation activities for landowners, land managers, local planners, and funding agencies (Wojcik, 2018). Conservation easements are tools that land managers and conservationists can encourage as they prohibit the development, farming, timbering, and mining on the land – but still allow for passive and low-impact recreation activities like hunting, fishing, and educational uses (North Carolina Department of Environmental Quality, Stewardship Program, n.d.) In the Lumber River region, areas within or adjacent to military installations tend to have high conservation priority ratings.

NATURAL AREAS

Natural areas are land or water important for conservation of the natural biodiversity of North Carolina. They contain known locations of rare animal or plant species, rare or high-quality occurrences of natural communities, and/or are sites for important animal assemblages (groups).

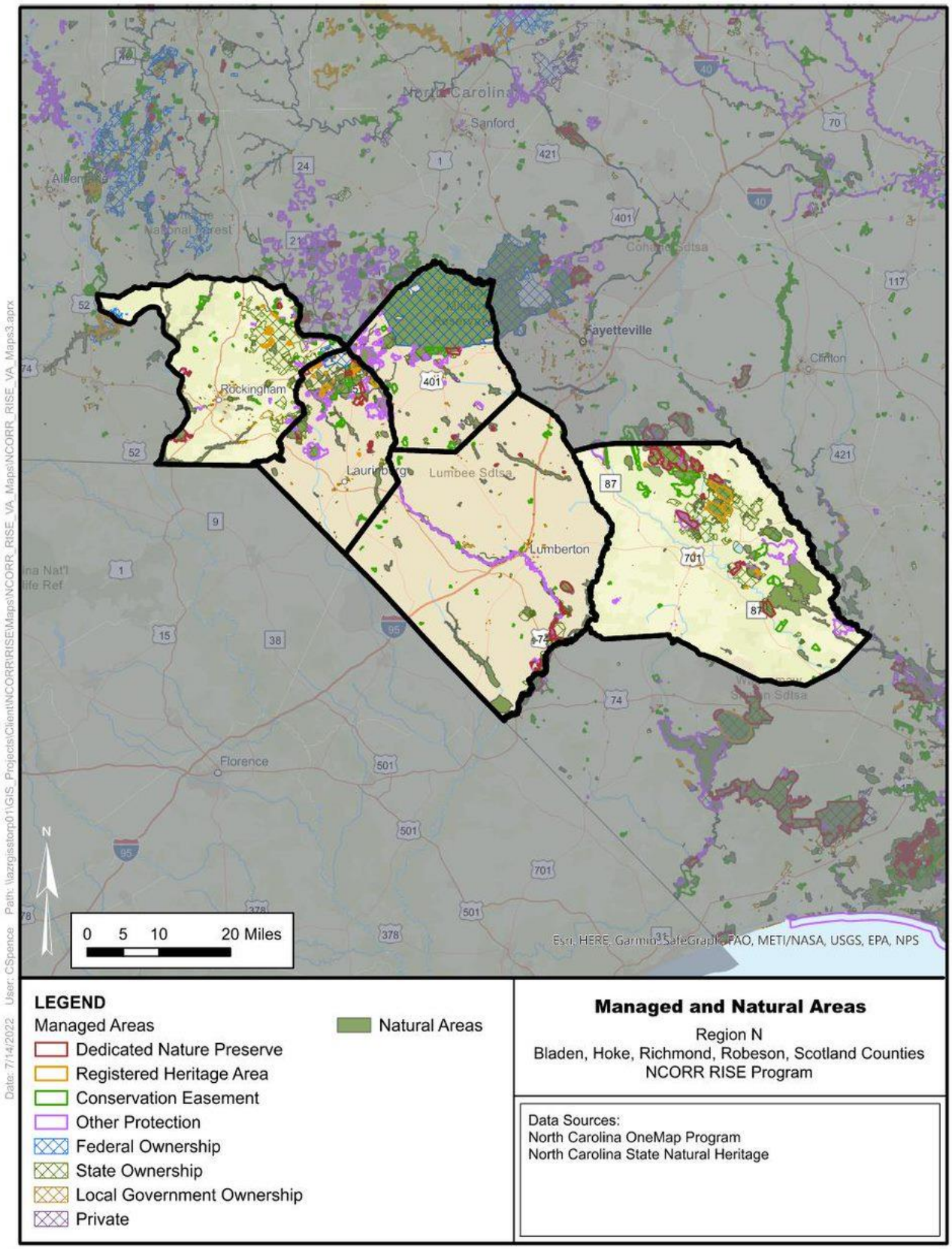
Source: (Wojcik, 2018)

MANAGED AREAS

Managed areas are a collection of properties and easements where natural resource conservation is one of the primary management goals or are of conservation interest.

Source: (North Carolina Department of Environmental Quality, Stewardship Program, n.d.)

Figure 26 - Managed and Natural Areas



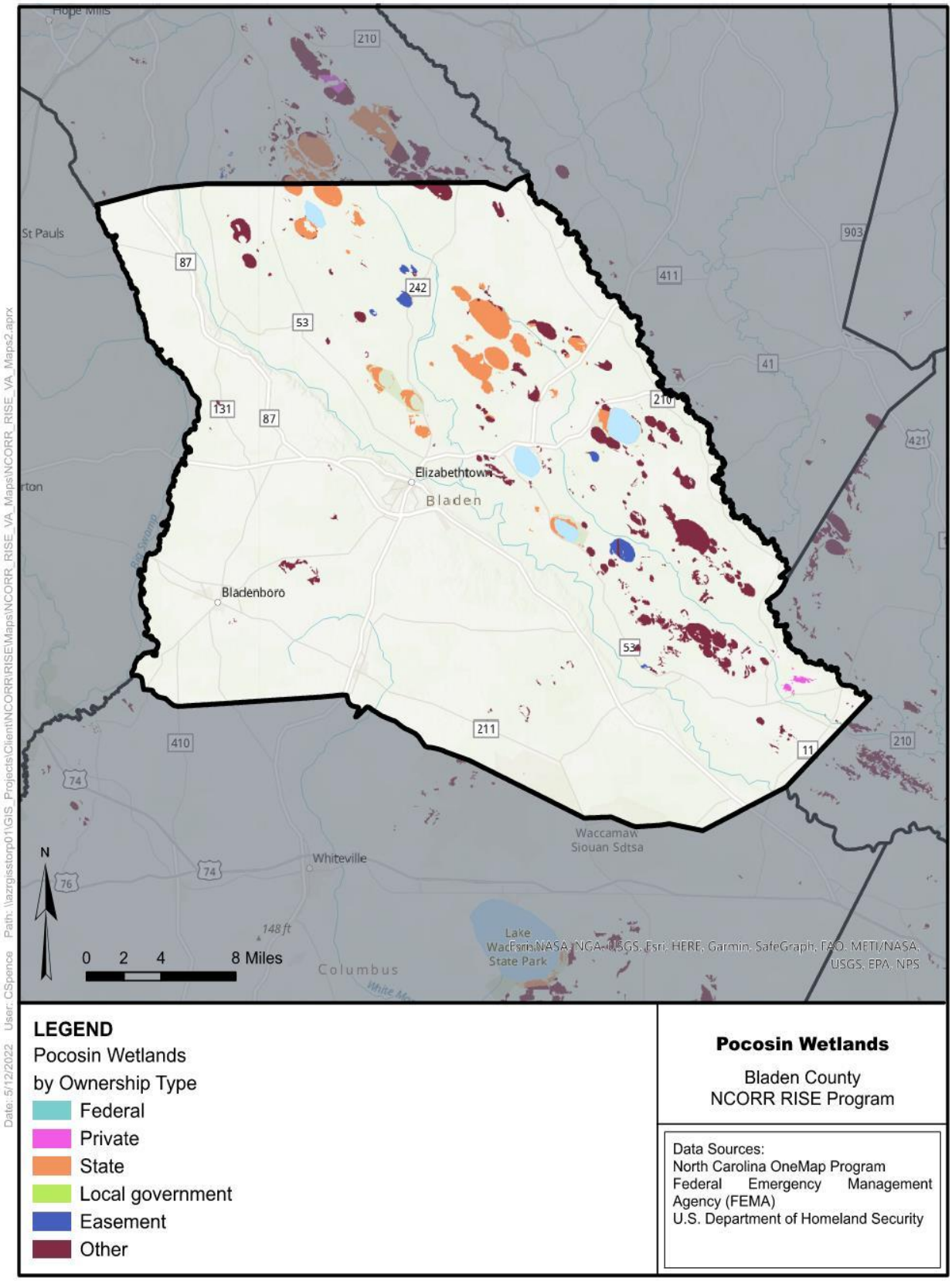
Pocosin Wetlands

Pocosins are a naturally occurring freshwater evergreen shrub wetland found in the coastal plain of North Carolina and are characterized by deep, acidic, sandy, peat soils (NCDEQ, 2019). While referred to as wetlands, they are not completely covered in water and support a wide range of wildlife (NCDEQ, 2019). Pocosins form over thousands of years and are an accumulation of built-up organic matter resulting in large amounts of carbon storage. They are extremely vulnerable to climate change and man-made alteration and can be impacted by drainage, land use changes, and plantation forestry. Impacted pocosins, particularly those that have been drained, are highly susceptible to wildfire and will release carbon into the atmosphere.

Similar to other wetlands, pocosins are highly valued for their ability to store large quantities of carbon, aiding in tackling greenhouse gas emissions and climate change. Another ecosystem found in the Lumber River region are Carolina Bays, which contain unique ecosystems due to wetland isolation, and are largely fed by rain and shallow groundwater (NCDEQ, 2019). Carolina Bays have a unique oval shape, however the cause of this is not entirely clear (SCDNR Geological Survey, n.d.).

Pocosin wetlands were identified in Bladen County, where approximately 24,254 acres or 0.04% of the total estimated 570,00 acres within the county are pocosin wetlands. Some of the pocosin wetland acres are already state-owned and managed lands, but most of them are in private ownership. Consideration should be given to acquiring the private land containing pocosin wetlands so that they can be preserved and remain undeveloped. **Figure 27** below depicts the pocosin wetlands within Bladen County.

Figure 27 - Pocosin Wetlands in Bladen County



5.5.4 Impacts by Hazard

5.5.4.1 Severe Weather

Heavy rainfall can damage river systems by causing excessive flooding, increasing water volumes and velocities, resulting in increased erosion, and scouring. The number one pollutant in North Carolina's waterways is sedimentation, which is usually caused by heavy precipitation events.

High winds damage trees and forested areas. Wind intensity and frequency are key factors that affect forest dynamics and diversity. Wind damage can create gaps in forest canopy, allowing the newly opened space to be invaded by exotic species or the recruitment of shade-intolerant plants, thereby altering the native ecosystem.

5.5.4.2 Extreme Heat

Extreme heat impacts water resources and terrestrial species. Extreme heat increases water temperatures, which decreases dissolved oxygen, which directly impacts aquatic species. Low dissolved oxygen levels cause stress to aquatic species that can interfere with feeding and reproduction. When dissolved oxygen levels drop too low, fish and other aquatic species can die. Similarly, algal blooms can occur which can harm aquatic species and contaminate drinking water. Terrestrial species can also be affected by increasing temperatures. Studies have concluded that warmer daytime and nighttime temperatures affect animal breeding behavior, gender, parasites, and food availability.

Similarly, warmer winters are expected to benefit the expansion of invasive exotic species that change native landscapes. Cogon grass (*Imperata cylindrica*), Chinese tallowtree (*Triadica sebifera*), and fire ants (*Solenopsis invicta*) are just a few examples of invasive exotic species that are anticipated to spread across North Carolina due to warmer winter weather. Similarly, studies have shown that climate change has contributed to the expanded range and prevalence of ticks. Warming temperatures in the next 30-50 years could extend the period that ticks are active during the year and increase the time people could be exposed to disease (EPA, 2021).

5.5.4.3 Drought and Wildfire

Droughts can cause water shortages and create an increased risk of wildfire. The hazard can reduce the availability of suitable habitat for wetland and aquatic species and can cause mortality for species that are unable to migrate to areas with water sources. Drought intolerant flora are also affected during periods without rain.

Fire is important to many natural ecosystems in the coastal plain, as it constitutes change and allows for regeneration. However, it can threaten conservation and working lands if it is not managed. Climate change is projected to increase fire severity and frequency, and a change to frequency could negatively impact how certain ecosystems function.

5.5.4.4 Impacts of Non-Climate Stressors

Land use change, typically driven by population increases and development, directly affects all natural ecosystems in the Lumber River region. Hydrological changes resulting from changes to flood control, groundwater depletion and water withdrawal, damming of rivers and streams, and water pollution are the greatest threats to the water resources through the state. Impacts to riparian zones, vegetated areas next to water bodies, damage the health of riverine systems and create issues for bank stabilization and the filtration of pollutants and nutrients. Invasive exotic species alter species and community composition, outcompete native species, affect biodiversity, and disrupt ecological interactions and processes.

Natural environmental systems provide many benefits for us, from necessities like food and drinking water, to aesthetics and inspiration. It is important to examine the natural processes that environmental systems inherently do that will contribute to climate resilience, and to conserve, restore, and protect these systems into the future.

5.6 Public Health

Figure 28 - Public Health Overview

	• Physical and mental health can be directly impacted by natural hazards, particularly hurricanes, flooding, and extreme heat. • Robeson, Scotland and Richmond counties have the highest percentage of adults that report fair or poor physical or mental health. • An average of 27% of residents reported poor physical health and 18% reported poor mental health. • Elderly persons and persons with disability are more vulnerable to natural hazards. • Natural hazards can impact drinking water quality and supply, directly affecting public health. • Heat-related illnesses are common during extreme heat events and are the result of the body's decreased ability to cool itself.

Climate and public health are directly related. The risks to health include heat related illness, respiratory illness, water borne diseases, injury and mortality from extreme weather events, vector borne diseases, malnutrition and food borne diseases, and mental health issues (Climate Change and Health, 2021). As climatic conditions change, their impacts on public health will become more pronounced. There are ways in which to monitor health and the potential negative impacts from climate change. This includes evaluating and tracking primary metrics such as physical health, mental health, and heat-related issues. Secondary metrics include evaluating and monitoring impaired waters, brownfields, and hazardous waste sites.

Knowledge of health statistics for the regional population, for example, may help county officials and other advocates plan for future changes. Locations of hazardous waste sites can be included in emergency operations and response plans to prevent potential leakage and spreading contamination.

Furthermore, any irregularities to metrics of public health can be a sign of worsening climate conditions. For example, as the number of very hot days increases, there will be an uptick in the

number of heat-related illnesses, and, during drought events, communities may experience water supply shortages and increasing poor water quality.

The following section discusses health related vulnerabilities in the Lumber River region and current conditions in relation to each of the health metrics listed above. These can then be tracked for change over time and help to inform resiliency efforts.

5.6.1 Physical Health Conditions

Physical health is important for quality of life and individuals that have poor physical health are more vulnerable to the negative effects of climate change. The project team collected data from the Centers for Disease Control and Prevention (CDC) National Environmental Public Health Tracking Network to provide a high-level summary of public physical health by county based on data from the CDC Behavioral Risk Factor Surveillance System, the Census 2010 population, and American Community Survey estimates. **Table 19** below shows that an average of 27% of adults in the Lumber River region self-reported to have poor or fair health – much higher than the North Carolina average of 18% (University of Wisconsin Population Health Institute, 2022). A changing climate can make poor health conditions worse. For example, approximately 10.9% of the population in the Lumber River region reports currently suffering from asthma (Centers for Disease Control, 2021). Increasing temperatures cause early and prolonged pollen seasons that directly affect current asthma sufferers.

Table 19 – Poor or Fair Health

County	Percent of Adults with Poor or Fair Health (2019)
Bladen	26%
Hoke	24%
Richmond	27%
Robeson	32%
Scotland	28%
Regional Average	**27%**
North Carolina Average	**18%**

Source: County Health Rankings & Roadmaps – Poor or Fair Health

About one third of residents in Robeson County report having poor or fair health (32%), followed by Scotland and Richmond Counties. Physical health is important for quality of life. Since individuals that have poor physical health are more vulnerable to the negative effects from climate change, it is important to focus on current physical health to bolster the population's ability to withstand additional environmental stress. Investments in public health can include improving accessibility to medical facilities, introduce/improve disease prevention information campaigns, eliminate food deserts through increased access to affordable nutritious food, and encourage exercise through improvements to public parks and trails.

5.6.2 Mental Health Conditions

Mental health, which is also important for quality of life, can be exacerbated by extreme weather events that lead to traumatic experiences. In addition, individuals struggling with poor mental health are more vulnerable to risk behaviors, such as binge drinking, smoking, little physical activity, and sleeping less than seven hours (Health Risk Behaviors Measure Definitions, 2021). Extended periods of risk behavior can lead to increased vulnerability. According to County Health Rankings & Roadmaps data, the regional average number of days per year that adults in the Lumber River self-reported that their physical health was not good is 5.0 days – a little more than

1 full day more than the North Carolina average of 3.7 days (University of Wisconsin Population Health Institute, 2022). Comparatively, the regional average number of days per year that adults self-reported that their mental health was not good is 5.2 days – again, higher than the North Carolina average of 4.4 days per year (University of Wisconsin Population Health Institute, 2022). **Table 20** below shows the average number of physically and mentally unhealthy days per year in each region. Halifax County has the highest number days adults indicate that they experience physically and mentally unhealthy days.

Table 20 - Average Number of Physically and Mentally Unhealthy Days

County	Average # of Physically Unhealthy Days	Average # of Mentally Unhealthy Days
Bladen	4.8	5.1
Hoke	4.4	4.8
Richmond	4.9	5.2
Robeson	5.7	5.7
Scotland	5.1	5.3
Regional Average	**5.0**	**5.2**
North Carolina Average	**3.7**	**4.4**

Source: County Health Rankings & Roadmaps – Physically and Mentally Unhealthy Days

Any region-scale mental health initiatives targeted at alleviating climate-driven impacts should therefore begin in Robeson, Scotland, and Richmond counties, as these have the highest percentage of adults with less than good mental health.

5.6.3 Heat-Related Illness

Extreme heat is a major cause of death and is often known as the ‘silent killer’ because it doesn’t cause environmental damage like other weather hazards and lacks sufficient data and monitoring (Jacks, 2014). Heat-related illnesses are common during extreme heat events and are the result of the body’s decreased ability to cool itself. Symptoms of heat-related illness include heavy sweating, cool skin, weakness, possible throbbing headaches, muscle cramps, and more (Jacks, 2014). North Carolinians and those living in the Lumber River region are familiar with hot and humid months, particularly in the summer. However, prolonged periods of extreme heat and high nighttime temperatures pose hazard to health and particularly vulnerable populations. Extreme heat events occur when the air temperature and/or heat index is greater than 95F. Heat waves and high nighttime temperatures are likely to increase over the next 30 years.

Rising temperatures also contribute to air quality. Hotter temperatures and poor air quality have disproportionate impacts on maternal and infant mortality, young children, and older adults. Individuals living below the poverty line often lack access to adequate home cooling. Older adults are at risk of social isolation and typically live on fixed/limited incomes, which limits their ability to afford rising energy costs associated with home cooling. Laborers working outside are also vulnerable to heat related-illness due to exposure. Individuals with respiratory illnesses such as asthma or chronic obstructive pulmonary disease are particularly vulnerable to extreme heat due to worsening air quality conditions. Athletes and laborers working outside are also highly susceptible to heat related illness. Impaired air quality from wildfire smoke, pollen, and ozone may also contribute to increased emergency department visits for individuals with asthma, cardiovascular disease, and diabetes within the Lumber River region. Approximately 3,099 emergency department visits for heat-related illness were observed for North Carolina in 2020. About 14% of the total emergency department visits across North Carolina were seen in the hospitals in the Sandhills sub-region, which includes Bladen, Hoke, Richmond, Robeson, and Scotland counties (North Carolina Department of Health and Human Services, 2020).

While the National Oceanic and Atmospheric Administration and National Weather Service provide forecasts for prolonged periods of high temperatures, most of the Lumber River region lacks unified heat warnings for residents. Additional efforts could be made across local health departments, emergency management, and local governments to coordinate responses before and during a heat wave to ensure vulnerable populations are aware of available resources and actions to take to protect their health.

5.6.4 Impaired Waters

Access to clean water is an essential component of public health that can be impacted by climate change. In 1970, the United States Congress passed the Clean Water Act with the goals of protecting waters from pollution, improving water quality, and maintaining clean, healthy waters. Section 303(d) of the Clean Water Act established the impaired waters list which is a requirement for all states to evaluate and identify impaired and threatened waterways (e.g., stream/river segments, lakes) based on certain water quality indicators.

Knowing the location of impaired waters and the cause of impairment is important in building regional resiliency because these water bodies may affect public and environmental health if they are flooded over a larger area. A waterway's water quality is evaluated based on its designated use, such as drinking water supply, recreation, or shell-fish propagation. There are two kinds of pollution that contaminate and degrade water quality, causing "impairment." Point source pollution has a specific location, such as discharges from industrial and municipal facilities, while non-point source pollution is discharged across a wide area, such as sedimentation from construction sites, leaking septic tanks, street runoff, and agricultural runoff.

Current (2022) GIS data for impaired waters are not publicly available for download (the latest GIS data for impaired waters was published in 2014). However, the North Carolina Department of Environmental Quality (NCDEQ) maintains an online mapping system that depicts current impaired waters. Please follow this link to view the latest maps from 2020 IR 2020 Dashboard (arcgis.com).

Based on the online mapping system, some segments of Marks Creek, Mill Branch, Little Raft Swamp, Long Branch, Jones Lake, Nells Branch, Naked Creek, and the Pee Dee River are listed as Category 5 for impairment, many of which exceed the maximum standard for dissolved oxygen, benthic organisms, chlorophyll-a, and zinc. Most of the streams exceed the maximum standard for pH and benthic organisms (Long Branch also exceeds in mercury). Impaired streams designated as Category 5 require participation in a Total Maximum Daily Load program, which establishes the maximum amount of a pollutant (i.e., bacteria, nutrients, metals) the waterbody can receive daily and still meet water quality standards.

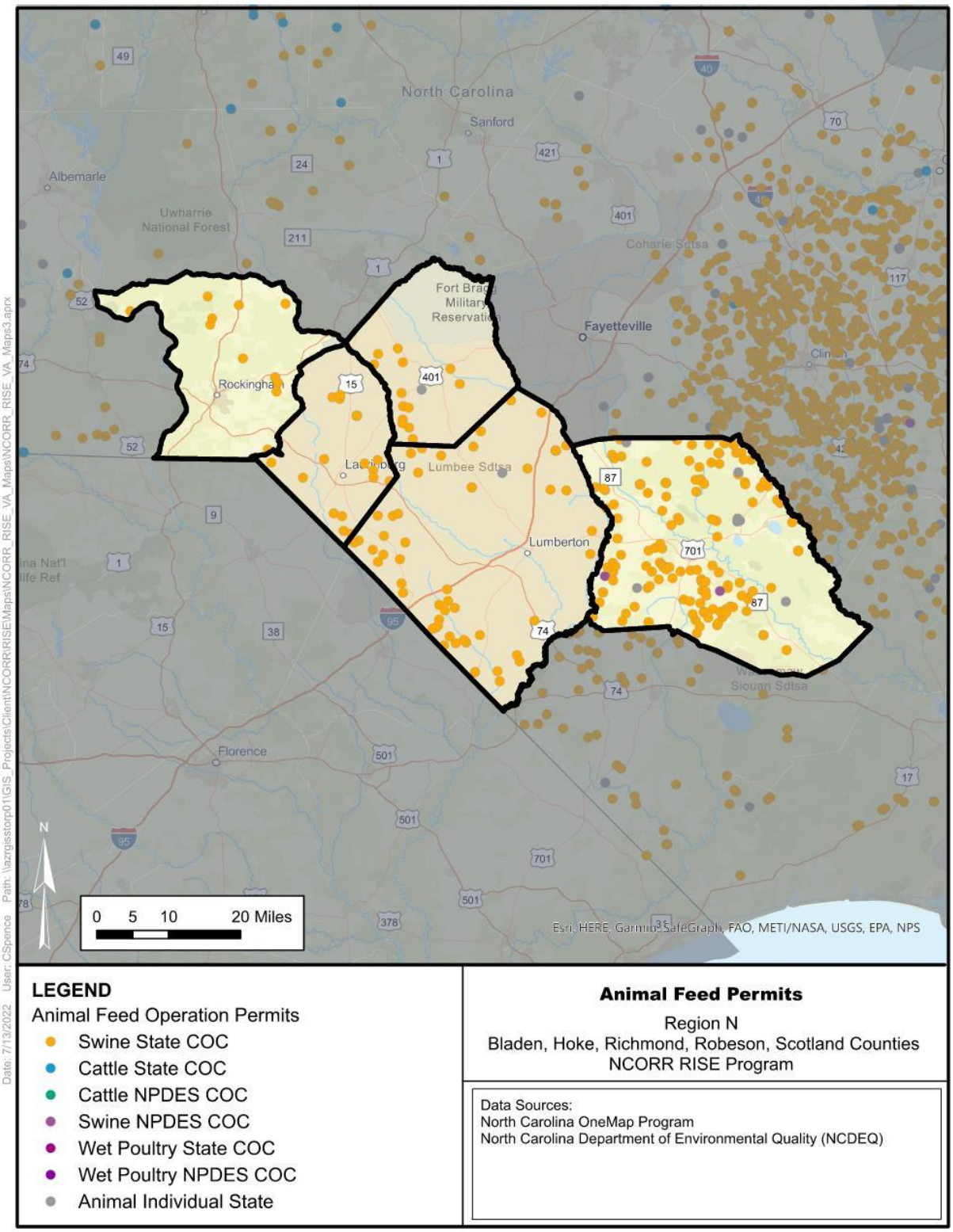
Statewide, the number of impaired waters is growing, having increased by a third between 2017 and 2019 (Sorg, 2019). Increases in air and water temperature have a direct effect on the chemistry and biology of water resources. As regional temperatures continue to rise, so too will the number of impaired waters, thus directly affecting the health, safety, and wellbeing of its users, whether it is for drinking, recreation, fisheries or shellfish.

5.6.5 Animal Feed Operation Sites

Animal feed operations and agriculture throughout the region can contribute to poor water quality when rain carries fertilizer and animal waste to waterways. Hurricanes and heavy rains create more surface water runoff and flooding, moving pollutants from fertilizer and animal waste to waterways faster and in higher quantities. As climate change makes these hurricanes and heavy rains stronger, polluted waterways will continue to grow in toxicity. Analyzing the vulnerability of agricultural sites is important in building regional resilience because flooding may cause public health problems and environmental contamination. Animal feed operation sites are regulated through the NC Department of Environmental Quality and include swine farms, wet poultry, and cattle. In the Lumber River region there are approximately 246 animal feed operation sites, and the majority are swine. **Figure 29** below depicts the locations of animal feed operations in the Lumber River region.

Flooding from hurricanes and heavy rainfall directly threaten hog farms and poultry operations in the Lumber River region and across eastern North Carolina. The North Carolina Department of Agriculture reported that across the state, an estimated 2,800 hogs died during Hurricane Matthew in 2016 and roughly 5,500 hogs and 3.4 million chickens died during Hurricane Florence (Oglesby, 2021). Hog lagoons are contained areas where waste is collected, and most often sprayed back onto fields as a fertilizer. When these lagoons are flooded, the animal waste mixes with floodwaters and poses a serious threat to water quality and public health. Additionally, rising floodwaters can trap livestock and cause death, also contributing to a public health risk as the animals decompose. Adding to the public health risk, farmers experience an economic loss when the livestock is impacted. Animal feed operations located in the 100-year and 500-year floodplains are particularly vulnerable to flooding and following major damage from Hurricane Floyd in 1999, the North Carolina Floodplain Buyout Program has incorporated purchasing swine productions located in the 100-year floodplain (Oglesby, 2021).

Figure 29 - Animal Feed Operation Permits



5.6.6 Contaminated Waste Sites

As climate change increases the frequency and intensity of heavy rain and storm events, waste sites located throughout the Lumber River region may contaminate nearby resources, particularly drinking water. Similarly, wildfires can damage site remedies and lead to the release of contaminants. Waste sites are a component of many landscapes and are necessary to deal with human consumption.

The contamination of brownfields often makes it difficult to redevelop the land due to regulations about safety. Brownfields are common across North Carolina and can be remediated for certain future uses. However, those sites located in proximity to waterways can have negative impacts on water quality when contaminants from the site enter the water through surface runoff or underground leaching.

BROWNFIELDS
Brownfields are lands previously developed for commercial or industrial purposes that have been compromised by something harmful, typically pollutants or chemicals (Hazardous Waste Experts, 2014).

There are approximately 10 sites within the region that have started the process of enrolling in the NCDEQ Brownfields Program, which helps property owners to come to an agreement with NCDEQ on the activities needed to make the site suitable for reuse, in addition to cleaning up the site to meet regulatory standards. Each county in the region has at least one recorded brownfield site. Tarboro is currently funded by a $300,000 EPA Brownfields grant Within Robeson County there are two brownfield sites, located just south of Lumberton, within the 100-year floodplain.. Due to its proximity to the floodplain, it is at higher risk of contaminant release during storm events.

There are no brownfield sites within Hoke County. As noted previously, wildfire risk is relatively high throughout the Lumber River region. With respect to wildfire, there is one brownfield site in Richmond County, two sites in Scotland County, two sites within Robeson County, and one site in Bladen County located within or near an area with high probability of wildfire.

HAZARDOUS WASTE
A hazardous waste is waste that has properties that make it dangerous or capable of having a harmful effect on human health or the environment, such as motor oil, car batteries, industrial chemicals, explosives, etc. (EPA Hazardous Waste, 2021)

Weather hazards like flooding and hurricanes may also cause hazardous waste sites to contaminate surrounding resources. The Resource Conservation and Recovery Act, commonly known as RCRA, is the federal law that regulates the management of such wastes. NCDEQ manages hazardous waste at the state level and maps the locations of sites.

There are approximately 60 sites within the region regulated by the Resource Conservation and Recovery Act. All counties have at least one hazardous waste site and Robeson County has the most sites. There are multiple RCRA sites throughout the region located within the 100-year floodplain. There is one site in Cordova (Richmond County) and approximately 6 sites in central Robeson County located in the 100-year floodplain. Due to their proximity to the floodplain, they are at higher risk of contaminant release during storm events. There are approximately seven sites in southeastern Richmond County located within areas at high risk of wildfire, as well as one site in northeastern Hoke County.

COAL ASH
Coal ash is the byproduct of burning coal in coal-fired power plants, and without proper management, can pollute waterways, groundwater, drinking water, and the air (EPA, 2022).

Other toxic waste dump sites are managed by the EPA through the Comprehensive Environmental Response, Compensation and Liability Act, informally known as Superfund. There is one Superfund site south of Cordova in Richmond County. The site is not located within the 100-year floodplain or an area of high wildfire risk.

Storage sites containing coal ash and other industrial process byproducts are at risk for flooding from heavy rains and hurricanes, causing spills that contaminate waterways and nearby communities. There are no permitted industrial waste landfills in the Lumber River region.

Contaminated waste sites and other drivers of pollution can be environmental justice concerns as the sites have historically been more commonly located in communities of color. Studies have shown that in the United States, 79% of municipal solid waste incinerators are in environmental justice communities, and the majority of landfills and burn facilities are located near these communities as well (Yang, 2021). Environmental justice communities are those where there is

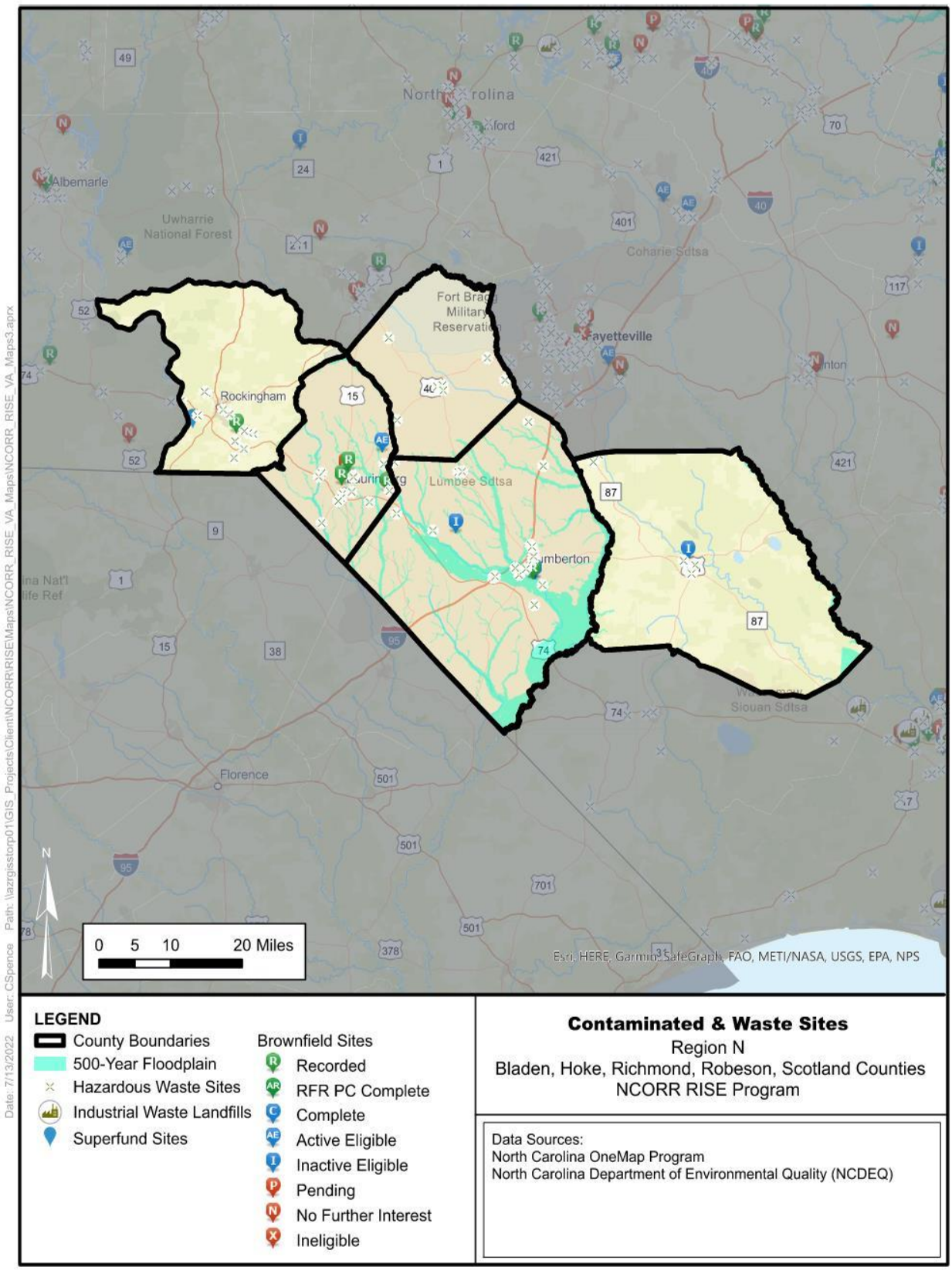
1) disproportionate exposure to environmental hazards and 2) increased vulnerability to those hazards (Foresight Design Initiative, 2017). Communities of color bear a disproportionate risk when flooding impacts waste sites, including hog lagoons. In eastern North Carolina following Hurricanes Matthew and Florence, major flooding caused widespread issues as lagoons meant to hold hog waste mixed with floodwater and traveled across the land.

When preparing for climate change, it will be important for the region to account for impacts from weather hazards to contaminated waste sites. There are currently six waste facilities located within the 100-year floodplain – 5 in Robeson County and 1 in Scotland County. These sites are considered waste sites due to the chemicals used and stored on site. **Table 21** displays the name and address of these facilities. **Figure 30** below shows contaminated waste sites including hazardous waste, industrial waste landfills, Superfund sites, and brownfield sites throughout the Lumber River region.

Table 21 - Waste Sites in the 100-Year Floodplain

100-Year Floodplain			
Name	**Address**	**Facility Type**	**County**
Con-Way Freight – NLB	West 5th St., Lumberton, NC 28358	Freight	Robeson
Robeson County School Bus Garage	Kenric Rd., Lumberton, NC 28358	Auto	Robeson
Lumberton Chevrolet Buick GMC Cadillac	500 Linkhaw Rd., Lumberton, NC 28358	Auto	Robeson
Lumberton Nissan	1949 N. Roberts Ave, Lumberton, NC 28358	Auto	Robeson
CVS Pharmacy #7641	3001 Fayetteville Rd., Lumberton, NC, 28358	Pharmacy	Robeson
Poole's Auto Body	9600 McColl Rd., Laurinburg, NC 28352	Auto	Scotland

Figure 30 – Contaminated Waste Sites in Relation to the 500-Year Floodplain



5.6.7 Well Water

Private wells are a main source of drinking water for many homes across the Lumber River region, particularly in rural communities that are not connected to municipal water. However, these wells are vulnerable to climate change, particularly droughts and flooding. Wells collect groundwater for drinking and other purposes and can vary in depth. Flooding from heavy storms and hurricanes can result in increased pollution and surface runoff, which can inundate wells and cause contamination. Often this contamination is a result of bacteria and nitrates that can cause short-term illnesses and be dangerous to vulnerable populations like children, pregnant women, elderly, or immunocompromised individuals. Common contaminants detected in private well water in North Carolina include arsenic, cadmium, lead, and manganese (UNC Superfund Research Program, n.d.).

Conversely, droughts result in less water entering the ground because rainfall is not replenishing underground aquifers. During this time, aquifers can become depleted when more water is pumped out for consumption than can be replenished by rain or other water sources (Uhlman, n.d.). Depleting groundwater can affect agriculture and strain other water sources.

The University of North Carolina Superfund Research Program Community Engagement Core is working in counties across the state to provide well water tests to private well owners. The team is focusing efforts first in areas where high concentrations of arsenic have been found in private wells and with Black and Indigenous People of Color and/or low-income populations (Gillings School of Global Public Health, n.d.). Robeson County residents have been engaged with the Community Engagement Core and the Lumber Riverkeeper, following impacts from Hurricane Florence involving coal ash. About one out of three North Carolinians drink water from private wells and well owners are solely responsible for their water quality – the Environmental Protection Agency does not regulate private wells (Kummerer, 2019). In 2019, about 70 Robeson County residents had their well water tested – many tested outside the recommended pH level and almost 30% of the wells tested had coliform bacteria (but not E. coli) (Kummerer, 2019). Continued testing and community outreach will be important to ensure residents are aware of water quality and health impacts following climate hazards.

5.7 Social Vulnerability

Figure 31 - Social Vulnerability Overview

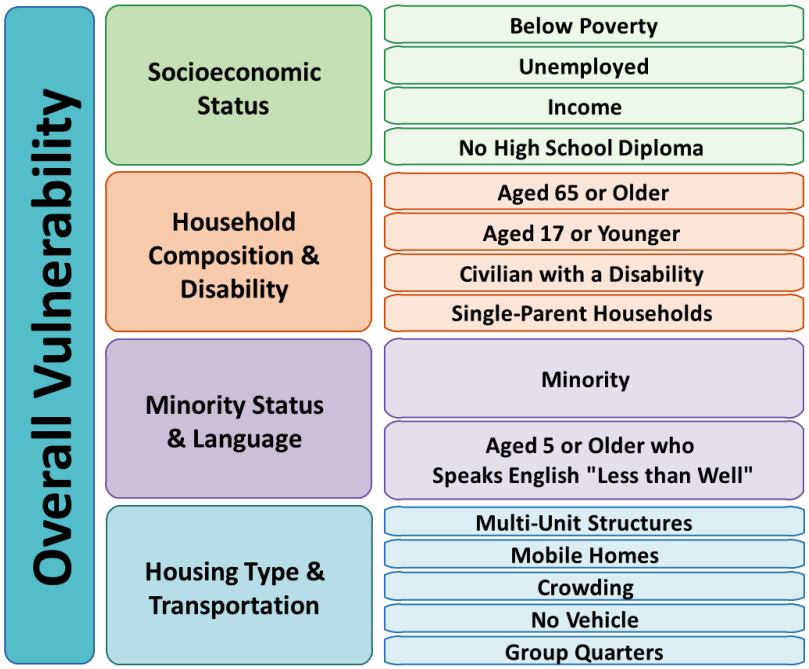
- Social vulnerabilities are the individual characteristics that make it harder for a person to withstand and quickly recover from natural hazards and other stresses.
- Bladen, Robeson and Scotland counties have the highest overall social vulnerability and may be affected by natural hazards more than other parts of the region – however, all five counties have an overall high social vulnerability score.
- The region is considered highly vulnerable because of household composition and disability, meaning there are high proportions of elderly, youth, single-parent households, and residents living with a disability.
- Bladen County has the highest percentage (24%) of elderly persons who are more likely to experience harm from natural hazards.
- Robeson County has the highest percentage (44%) of American Indians, followed by Scotland County (14%).
- Census Tract 9706, east of Rockingham in Richmond County, has the highest overall social vulnerability score for the state of North Carolina.

Social vulnerability is directly linked to regional resilience. Socially vulnerable populations such as youth, elderly, disabled individuals, low-income households, and mobile home occupants, among others, are at greater risk of harm from hazardous events than individuals who do not fall into those groups. For example, individuals without personal transportation may have difficulty evacuating before a hurricane arrives. Similarly, those with a limited income or who are unemployed may have difficulty rebuilding or repairing homes and businesses after a natural disaster. It is therefore imperative to understand the vulnerabilities of the region to develop targeted action plans and emergency preparedness that help those most in need. High social vulnerability can indicate challenges in a community's ability to respond to hazardous events.

SOCIAL VULNERABILITY
Social vulnerability refers to the potential negative effects to communities caused by external stresses on human health.

Social vulnerability refers to the potential negative effects to communities caused by external stresses on human health. Communities can use social vulnerability information to prioritize preparedness actions, allocate emergency resources, and plan for recovery.

Figure 32 - CDC Social Vulnerability Index



Source: CDC SVI Documentation 2018

Social vulnerability is described at the census tract level because this smaller scale provides a better understanding of communities that may be vulnerable, rather than across a county. The more social factors – like percentage below poverty, percentage aged 65 or older, percentage minority, and percentage mobile homes, for example – that are present within a certain area, the higher vulnerability that area is likely to be due to the compounding factors.

The Lumber River region exhibits high levels of social vulnerability, with Bladen, Robeson and Scotland counties reporting the highest levels of social vulnerability amongst census tracts.

5.7.1 Background

The Center for Disease Control and Prevention Social Vulnerability Index (CDC SVI or simply SVI, hereafter) was created to help public health officials and emergency response planners identify and map the communities that will most likely need support before, during, and after a hazardous event (Centers for Disease Control / Agency for Toxic Substances and Disease Registry, 2022). The SVI ranks each census tract on 15 social factors, and groups them into four themes listed below. **Figure 32** details the structure of the SVI.

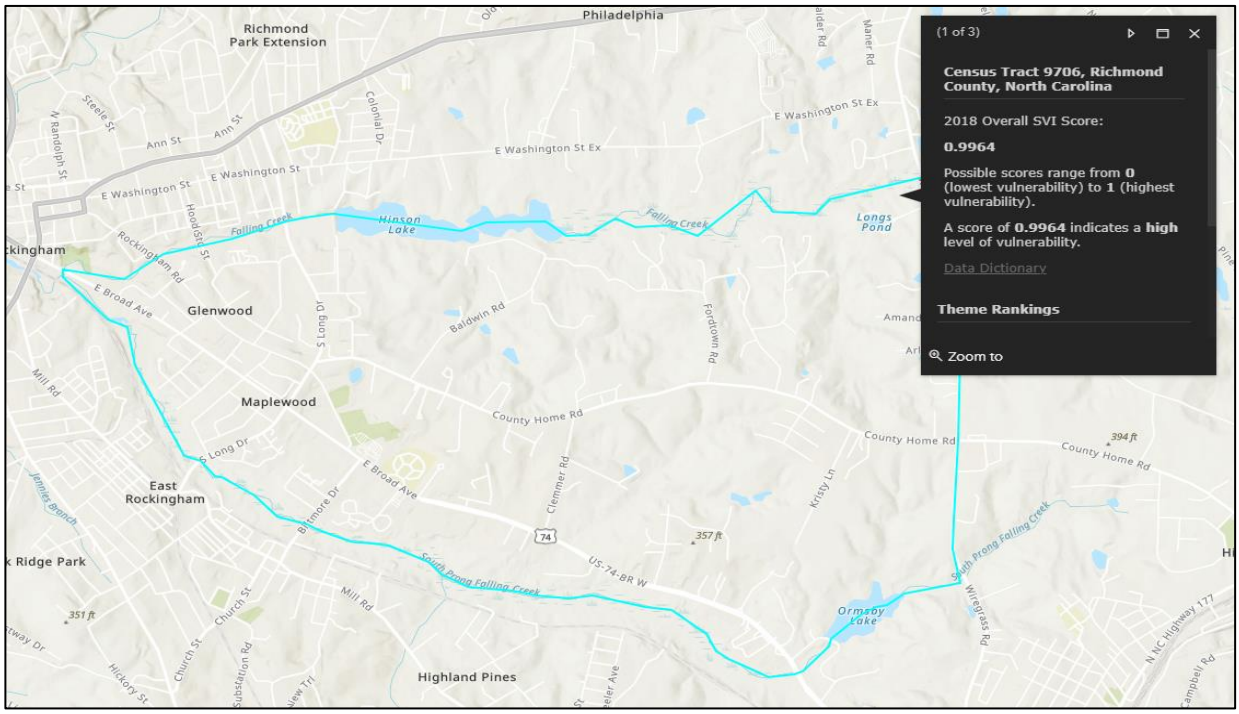
1) Socioeconomic Status
2) Household Composition and Disability

3) Minority Status and Language
4) Housing Type and Transportation

The CDC uses the US Census and the American Community Survey 5-year data to assign each census tract a ranking for each of the four themes as well as an overall ranking. These percentile rankings (or scores) are between zero and 100, with zero being lowest vulnerability and 100 being highest vulnerability. The social vulnerability indicators for a specific census tract are compared against other census tracts in North Carolina (as opposed to the entire country) to produce the final rankings.

A percentile score of 0 – 25 is considered a low vulnerability score, 26 – 50 is considered low to moderate, 51 – 75 is considered moderate to high, and 76 – 100 is considered a high vulnerability score. **Figure 41 - Census Tract 9706, Richmond County** encompasses an area east of Rockingham in Richmond County. This tract has a socioeconomic status ranking of 99.97, which means that it is more vulnerable than 99.97% of all other census tracts in North Carolina because of the percentage of its population below poverty, unemployed, low-income, and with no high school diploma. It is the highest overall vulnerability tract for the State of North Carolina. The

Figure 33 - Census Tract 9706, Richmond County



Source: [CDC Social Vulnerability Index Interactive Map]

analysis below discusses which of these variables is driving the result so that the region can understand how best to prepare its residents for the impacts of disasters.

5.7.2 Overall Social Vulnerability

In addition to the four vulnerability themes discussed above, the CDC SVI also provides an overall vulnerability score for each census tract. The overall score is a composite of all the vulnerability themes. The average overall vulnerability score for all five counties in the Lumber River region is within the high range. **Table 22** shows these results.

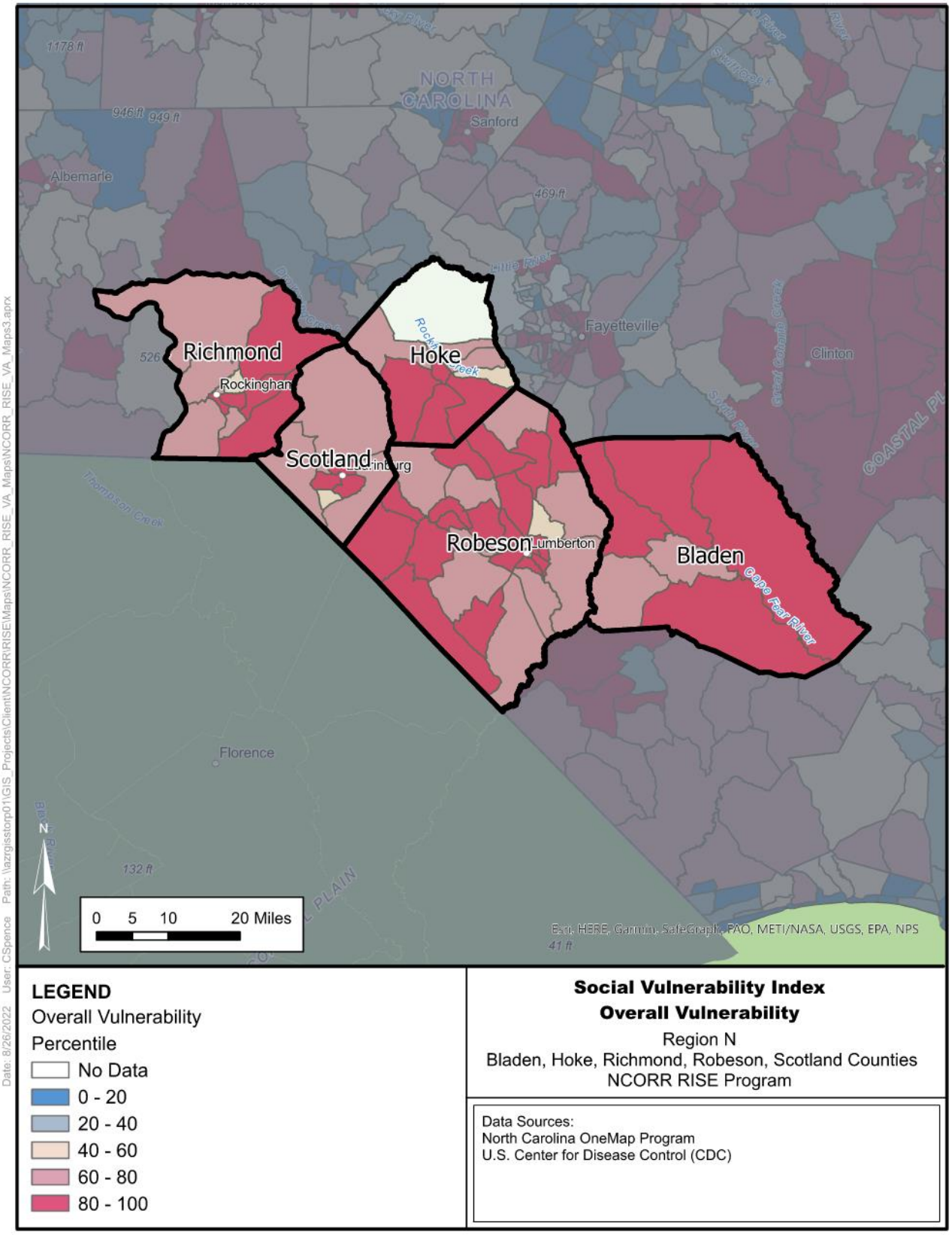
Table 22 - Overall Vulnerability

Overall Vulnerability		
County	**Percentile Score**	**Vulnerability Description**
Bladen	83rd percentile	High
Hoke	76th percentile	High
Richmond	76th percentile	High
Robeson	83rd percentile	High
Scotland	83rd percentile	High
Region Overall	80th percentile	High

Source: The Social Vulnerability Index (SVI)

Bladen and Scotland counties have consistently high vulnerability scores, with the exception of minority status and language, in which they are in the moderate to high vulnerability range. While the most vulnerable census tracts are not located in Bladen County for the measured variables, Bladen has high vulnerability scores across many variables. **Figure 34** below shows the overall vulnerability scores for the census tracts within the region represented by color. The overall vulnerability scores within the Lumber River region range from the 40th to 100th percentile.

Figure 34 - Overall Social Vulnerability for the Lumber River Region



5.7.3 Socioeconomic Status

The overall socioeconomic vulnerability score for the Lumber River region is high. The average socioeconomic score for Robeson and Scotland counties is the highest percentile (83rd) of the five counties. The socioeconomic theme combines data on persons below poverty, unemployed (individuals aged 16 years or older), per capita income, and no high school diploma (persons aged 25 years or older). **Table 23** depicts these results.

Table 23 – Socioeconomic Status

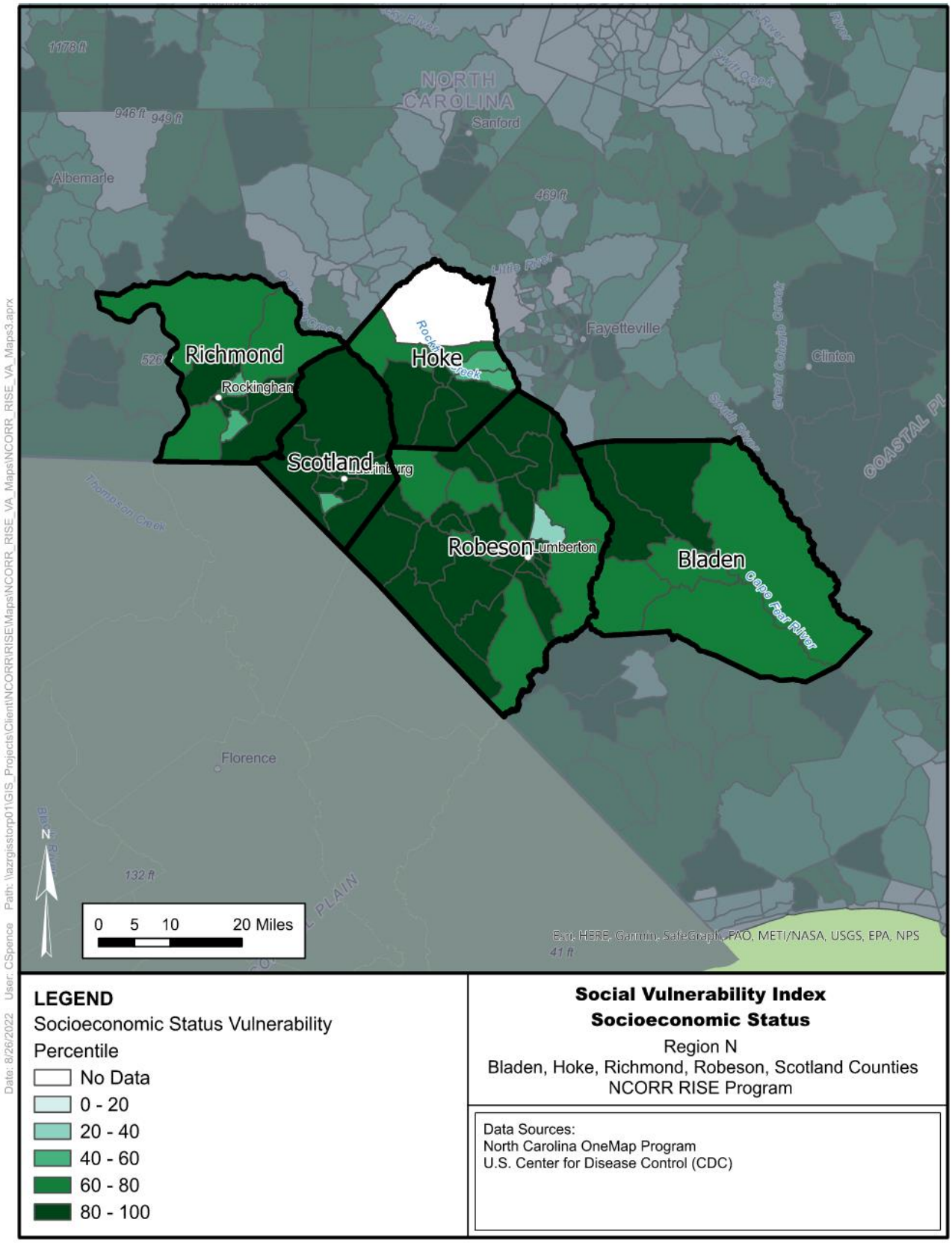
Socioeconomic Status		
County	**Percentile Score**	**Vulnerability Description**
Bladen	80th percentile	High
Hoke	76th percentile	High
Richmond	78th percentile	High
Robeson	83rd percentile	High
Scotland	83rd percentile	High
Region Overall	80th percentile	High

Source: The Social Vulnerability Index (SVI)

The three census tracts with the highest socioeconomic vulnerability are in Robeson and Hoke counties. **Figure 43 - Census Tract 9608.01, Robeson County,** located just west of Lumberton, has the highest socioeconomic vulnerability score. Additionally, it ranks within the 90th percentile for poverty, unemployment, low income, and lack of high school diploma. **Census tracts 9704.01 and 9704.02,** making up most of southeastern Hoke County, rank second and third highest for socioeconomic vulnerability in the Lumber River region. Both tracts are within the 90th percentile for unemployment, low income, and lack of high school diploma with tract 9704.02 also being in the 90th percentile for poverty.

Across the Lumber River region, 73% of census tracts have high socioeconomic vulnerability. Twenty-eight percent of census tracts in the region are in the 90th percentile for poverty, 25% are in the 90th percentile for unemployment, 28% are in the 90th percentile for low income, and 31% of census tracts are in the 90th percentile for populations without high school diploma. **Figure 35** below show the socioeconomic vulnerability scores for census tracts within the region represented by color. The darker color indicates higher vulnerability. Relative socioeconomic vulnerability among all tracts ranges from the 19th to 99th percentile.

Figure 35 - Social Vulnerability Index - Socioeconomic Status for the Lumber River Region



5.7.4 Household Composition and Disability

The overall household composition and disability score for the Lumber River region is moderate to high. The average household composition and disability vulnerability score for Bladen, Richmond, and Scotland counties are within the high range, while Hoke and Robeson are within the moderate to high range. The household composition and disability theme reviews persons aged 65 and older, persons aged 17 or younger, persons with disability, and single parent households with children under 18 years old. **Table 24** depicts the results.

Table 24 – Household Composition and Disability

Household Composition and Disability		
County	**Percentile Score**	**Vulnerability Description**
Bladen	81st percentile	High
Hoke	70th percentile	Moderate to High
Richmond	83rd percentile	High
Robeson	75th percentile	Moderate to High
Scotland	81st percentile	High
Region Overall	78th percentile	High

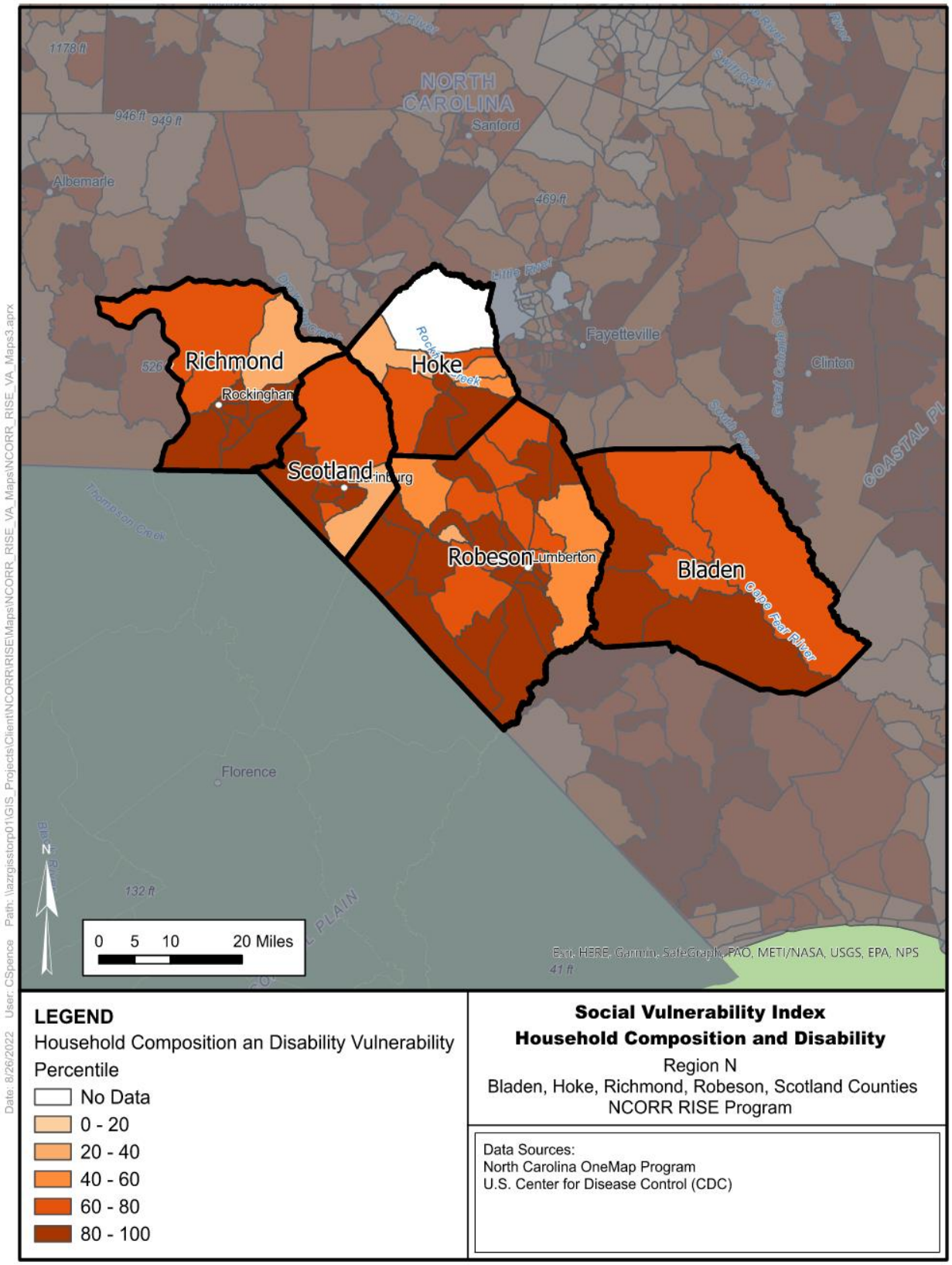
Source: The Social Vulnerability Index (SVI)

The three census tracts with the highest household composition and disability vulnerability scores are in Scotland and Richmond counties. **Figure 50 - Census Tract 102, Scotland County** has the highest vulnerability and is within the 90th percentile for percent of the population age 17-years or under, those with disabilities, or single parent households. Two additional highly vulnerable census tracts are located near Laurinburg in Scotland County and southeastern Richmond County, with single parent households and persons with disabilities in the 90th percentile, respectively. All census tracts in Bladen County are within the high vulnerability range, with

multiple tracts scoring in the 90th percentile for persons with disabilities and single parent households.

Figure 36 below shows the household composition and disability vulnerability scores for census tracts within the region represented by color. The darker color indicates higher vulnerability. The household composition and disability vulnerability scores for the region range from the 26th to 99th percentile.

Figure 36 - Social Vulnerability Index - Household Composition and Disability for the Lumber River Region



5.7.5 Minority Status and Language

The overall minority status and language score for the Lumber River region is moderate to high. The minority status and language theme of the social vulnerability index captures the share of minorities (all persons except white, non-Hispanic) and people 5 years or older who speak English "less than well." **Table 25** shows these results.

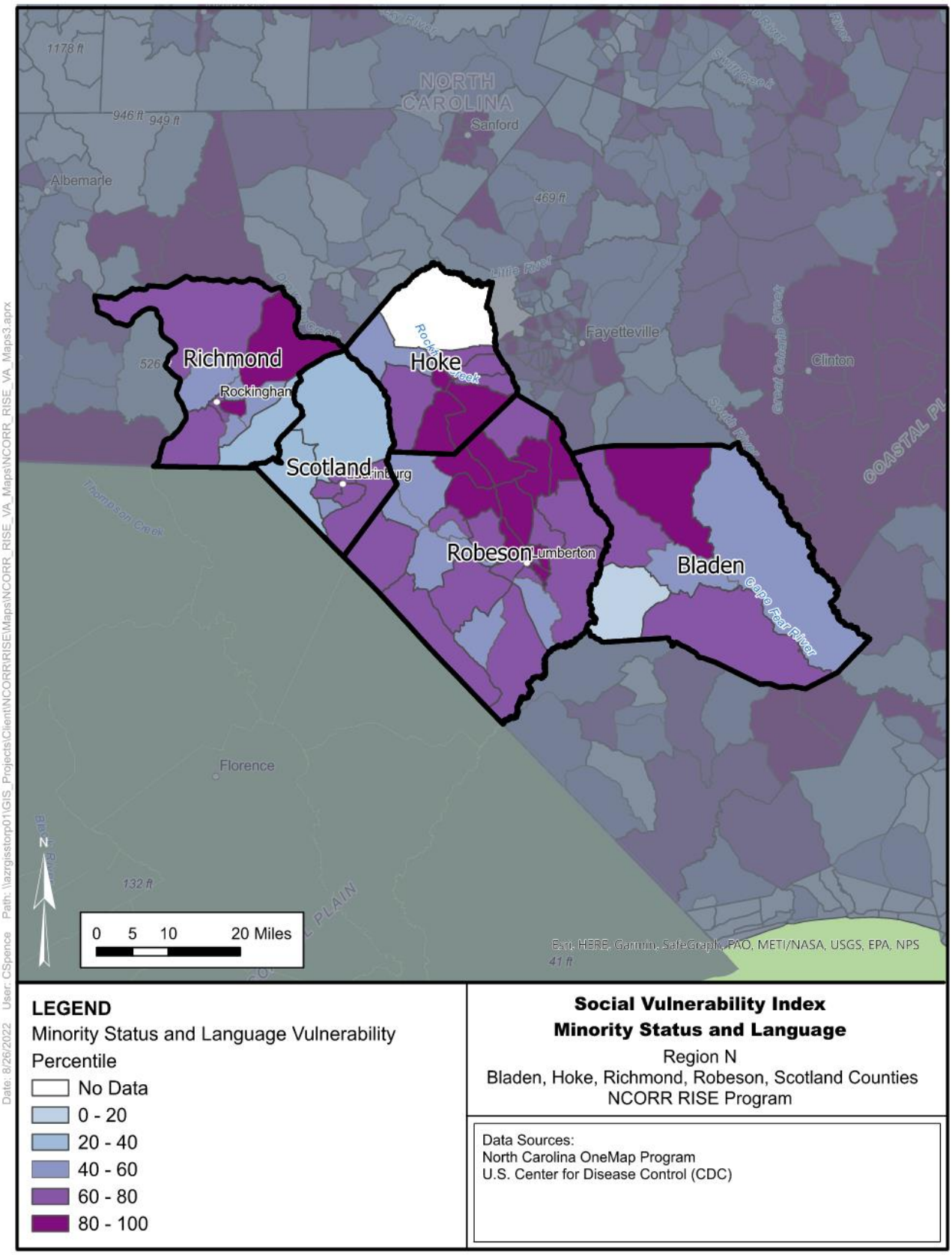
Table 25 – Minority Status and Language Vulnerability

Minority Status and Language		
County	**Percentile Score**	**Vulnerability Description**
Bladen	59th percentile	Moderate to High
Hoke	81st percentile	High
Richmond	60th percentile	Moderate to High
Robeson	73rd percentile	Moderate to High
Scotland	55th percentile	Moderate to High
Region Overall	66th percentile	Moderate to High

Source: The Social Vulnerability Index (SVI)

The average minority status and language vulnerability score for Hoke County is within the high range while Bladen, Richmond, Robeson, and Scotland scores are in the moderate to high range. The three census tracts with the highest minority status and language scores are in southern Hoke County and northern Robeson County. All three tracts rank within the 90th percentile for both minority populations and those who speak English less than well, with an average 88% of the population having a minority status and 7% speaking limited English. **Figure 37** below shows the minority status and language vulnerability scores for census tracts within the region represented by color. The minority status and language vulnerability scores within the region range from the 8th to 93rd percentile.

Figure 37 - Social Vulnerability Index - Minority Status and Language for the Lumber River Region



5.7.6 Housing Type and Transportation

The overall housing type and transportation score for the Lumber River region is moderate to high. The housing type and transportation theme of the social vulnerability index examines the prevalence of multi-unit housing (housing in structures with ten or more units), mobile homes, crowded housing (more people than rooms at the household level), households without a vehicle, and persons living in institutionalized group quarters. **Table 26** contains these results.

Table 26 – Housing Type and Transportation Vulnerability

Housing Type and Transportation		
County	**Percentile Score**	**Vulnerability Description**
Bladen	82nd percentile	High
Hoke	57th percentile	Moderate to High
Richmond	60th percentile	Moderate to High
Robeson	72nd percentile	Moderate to High
Scotland	78th percentile	High
Region Overall	70th percentile	Moderate to High

Source: The Social Vulnerability Index (SVI)

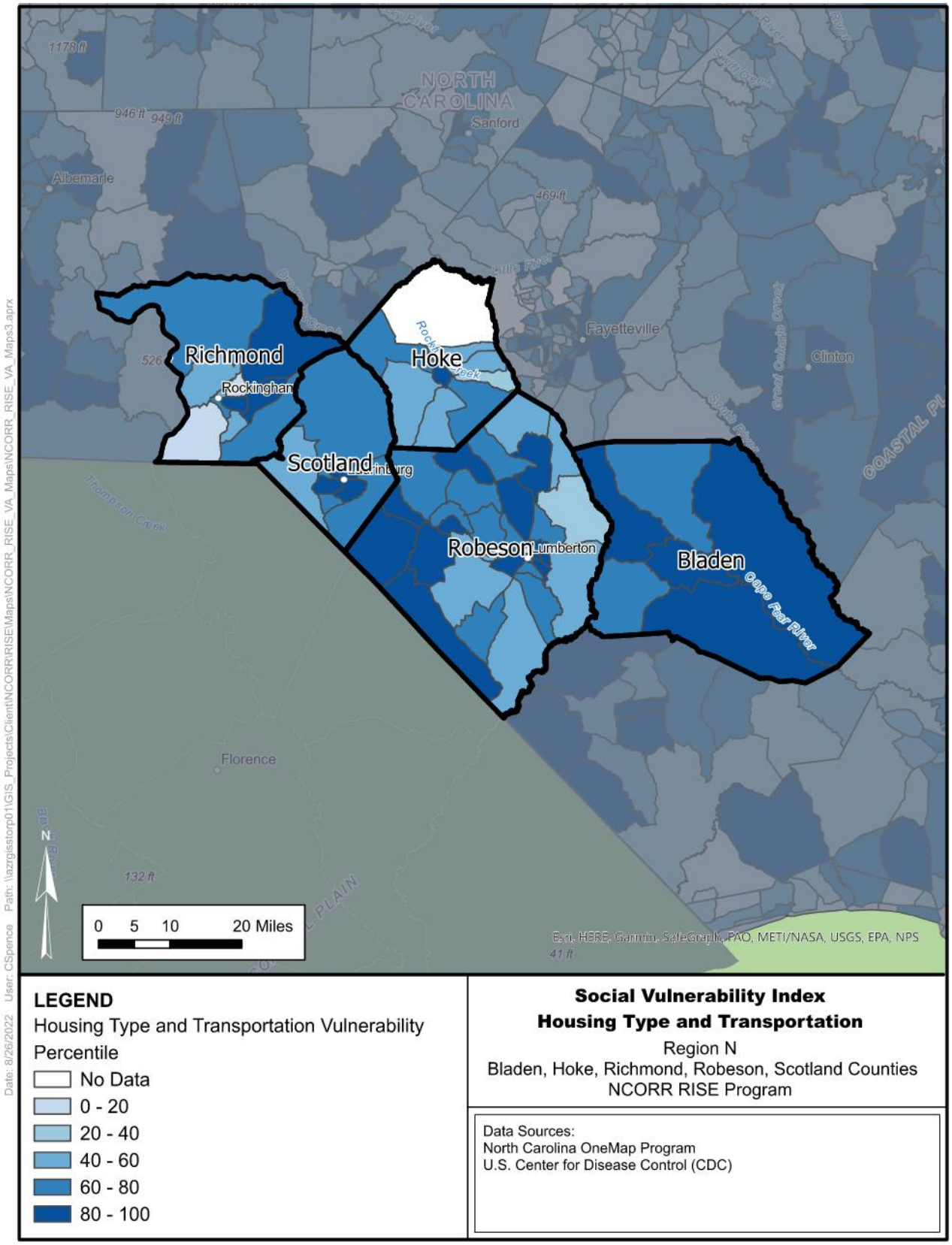
The average housing type and transportation vulnerability score for Bladen and Scotland counties is within the high range, while the Hoke, Richmond, and Robeson counties vulnerability scores are within the moderate to high range. **Figure 41 - Census Tract 9706, Richmond County** is the most vulnerable census tract with respect to housing type and transportation in North Carolina. This tract is in the 90th percentile for households without access to a vehicle and 20% of the population lacks personal transportation.

A tract in central Robeson County and a tract in south-central Scotland County are both within the 90th percentile for crowded households and populations living in institutionalized group quarters. Another tract in Scotland County is also in the 90th percentile for households without

access to a vehicle. More than two-thirds of the census tracts in Bladen County are within the high range for housing and transportation vulnerability, with three tracts in the 90th percentile for mobile homes.

Figure 38 below shows the housing type and transportation vulnerability scores for census tracts within the region represented by color. The housing type and transportation vulnerability scores within the Lumber River region range from the 8th to 100th percentile.

Figure 38 - Social Vulnerability Index - Housing Type and Transportation for the Lumber River Region



6.0 Regional Climate Vulnerability Hot Spots

The project team identified locations where multiple natural hazards intersect with communities of high vulnerability. These locations are within proximity to the 100-year floodplain, have a greater number of high heat days, have more impervious surface area, and have a greater number of mobile homes and nursing homes. Areas with a large amount of impervious surface—e.g., concrete and asphalt—correspond to areas with increased surface heat, otherwise known as heat islands. Mobile home parks and nursing homes are noted as additional locations of vulnerable communities. As seen in **Figure 39** and **Figure 40**, the following census tracts are highly exposed to flooding and heat with higher numbers of mobile homes and nursing homes compared to other areas:

- **Census Tract 9706**, east of Rockingham in Richmond County
- **Census Tract 9603**, Red Springs in Robeson County
- **Census Tract 9608.01**, west of Lumberton to I-95, south to US-74, east to Martin Luther King Dr. in Robeson County
- **Census Tract 9608.02**, in Lumberton from Martin Luther King Dr, north to W. 2nd St., along the Lumber River east to Lumber River State Park, to Kite Rd and Carolina Plantation Golf Club in Robeson County
- **Census Tract 9609** from I-95 north to N. Roberts Ave, east to N. Barker St., south to Riverside Blvd in Robeson County
- **Census Tract 9610**, in Lumberton from the river along W 15th St, north to N. Roberts Ave, to E. 6th St., south to the river by S. Chestnut St. in Robeson County
- **Census Tract 9611**, in East Lumberton from S. Chippewa St north to E. 5th St, east to Plant Cooling Lake in Robeson County
- **Census Tract 9612**, in Lumberton from S. Chippewa St north to N. Roberts Ave, south to E 5th St. in Robeson County
- **Census Tract 9613.02**, in Lumberton from N. Roberts Ave north to Meadow Rd., east to Snake Rd, south to E 5th St in Robeson County
- **Census Tract 102**, north of Laurinburg from E. Church St. west to Laurel Hill Church Rd, north to McFarland Rd., south to Old Lumberton Rd in Scotland County

Table 27 further details the analysis.

Table 27 – Hot Spot Analysis Results

Location	Census Tract	County	Social Vulnerability Score	# of Nursing Homes	# of Mobile Home Parks	# of Days over 90°F
East Rockingham	9706	Richmond	0.9977	2	2	81-83
Red Springs	9603	Robeson	0.9935	2	4	71-80
West Lumberton	9608.01	Robeson	0.9861	0	4	71-80
South Lumberton	9608.02	Robeson	0.9093	0	1	61-70
NW Lumberton	9609	Robeson	0.5039	0	0	71-80
Central Lumberton	9610	Robeson	0.7885	0	0	71-80
East Lumberton	9611	Robeson	0.9338	0	7	61-70
Central East Lumberton	9612	Robeson	0.9075	1	2	71-80
NE Lumberton	9613.02	Robeson	0.9519	1	16	71-80
North Laurinburg	102	Scotland	0.9921	0	2	71-80

Source: Kleinfelder

See **8.3 Highly Vulnerable Census Tracts** for maps of these and other highly vulnerable locations.

Figure 39 - Climate Vulnerability Hot Spots

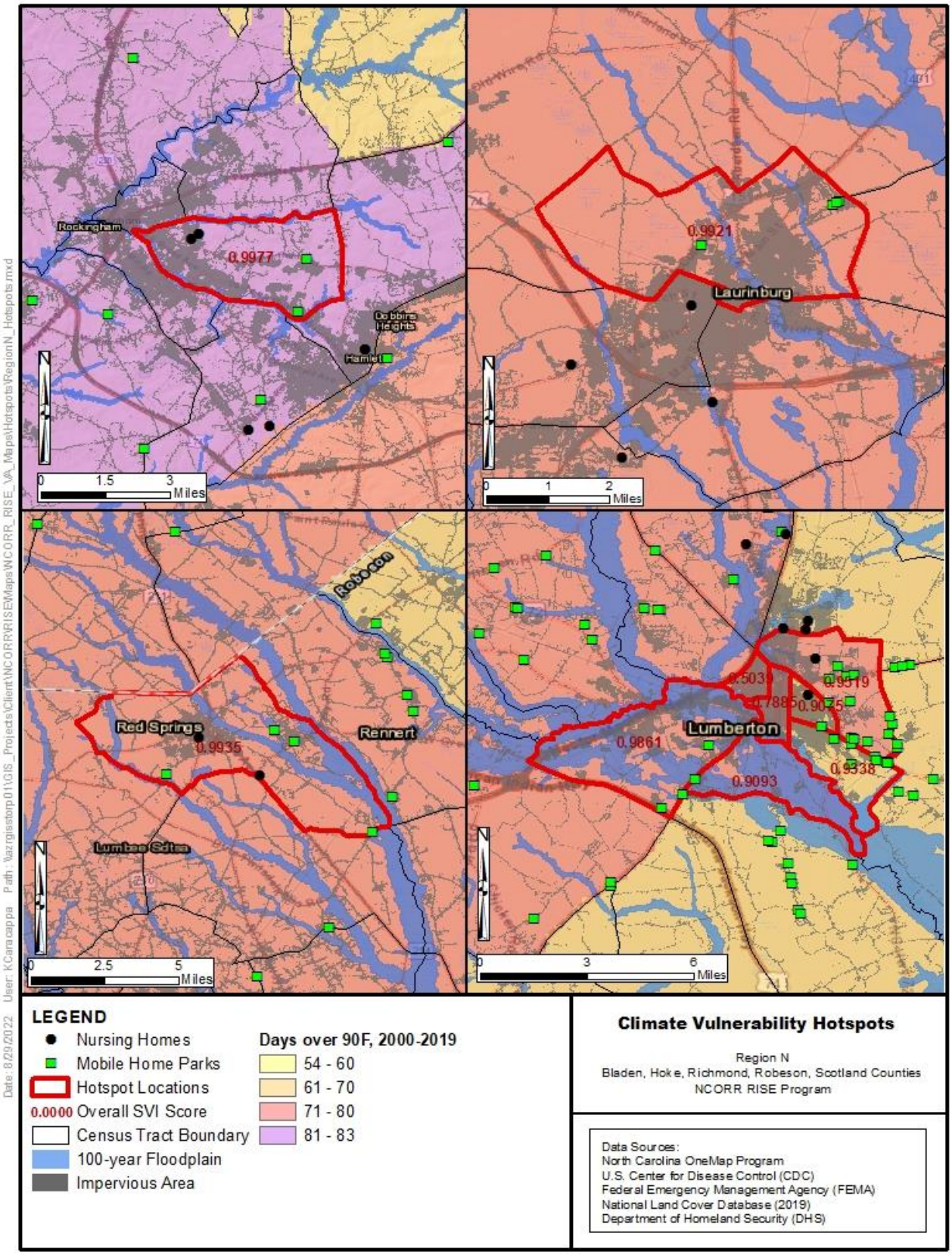
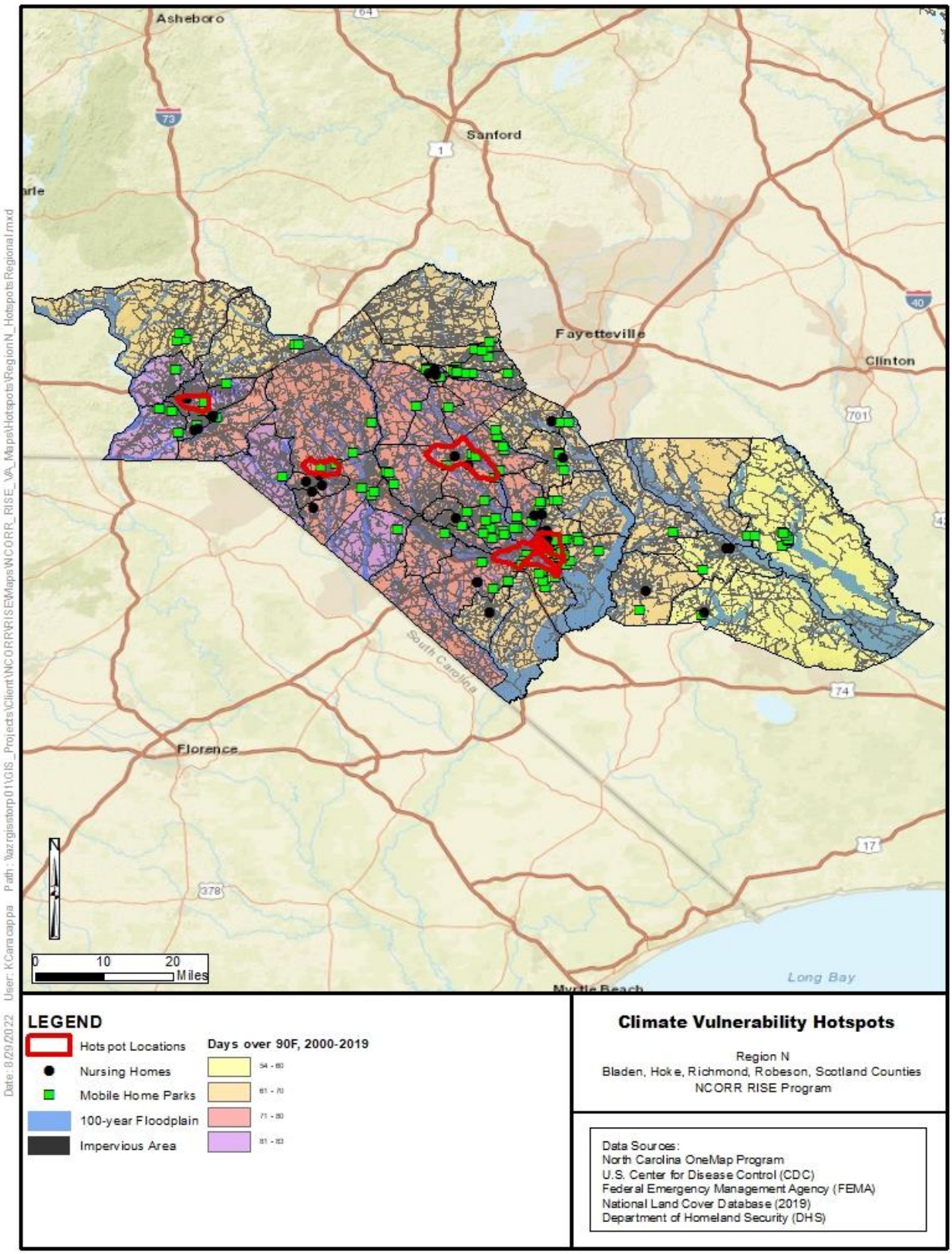


Figure 40 - Climate Vulnerability Hot Spots in the Lumber River Region



Additionally, **Table 28** details specific census tracts across the region with overall vulnerability scores greater than 0.9, indicating very high social vulnerability. Robeson County has the greatest number of tracts with high vulnerability and all of these locations should receive focus when planning for hazard resilience.

Table 28 - Census Tracts with Overall Vulnerability Greater Than 0.9

County	Census Tract	Overall Vulnerability Score
Bladen	Census Tract 9503	0.9602
Hoke	Census Tract 9703	0.95
Hoke	Census Tract 9704.01	0.9482
Hoke	Census Tract 9704.02	0.9588
Richmond	Census Tract 9706	0.9977
Richmond	Census Tract 9707	0.9315
Richmond	Census Tract 9711	0.9204
Robeson	Census Tract 9601.02	0.9361
Robeson	Census Tract 9602.02	0.9158
Robeson	Census Tract 9603	0.9935
Robeson	Census Tract 9607.01	0.9394
Robeson	Census Tract 9608.01	0.9861
Robeson	Census Tract 9608.02	0.9093
Robeson	Census Tract 9611	0.9338
Robeson	Census Tract 9612	0.9075
Robeson	Census Tract 9613.02	0.9519
Robeson	Census Tract 9618.01	0.9403
Robeson	Census Tract 9619	0.9287
Robeson	Census Tract 9620.01	0.9547
Robeson	Census Tract 9620.02	0.9412
Scotland	Census Tract 101.02	0.9667

County	Census Tract	Overall Vulnerability Score
Scotland	Census Tract 102	0.9921
Scotland	Census Tract 103	0.9815

Source: CDC/ATSDR SVIA Data (2018)

7.0 Conclusion

The Lumber River region faces a variety of vulnerabilities to natural hazards and climate change. The most significant vulnerabilities in this region are tied to flooding, hurricanes and tropical storms and high heat, although other risks like drought are still significant. These hazards are all likely to increase in frequency and intensity over the next 30-50 years.

This Vulnerability Assessment revealed that the region contains a high number of aging homes at risk of weather-related impacts, and that there are concerning numbers of homes, critical facilities and historic sites at risk of flooding. Much of the housing stock in the region was impacted by Hurricanes Matthew and Florence. The persistence of economic hardship makes housing repair and recovery difficult. Additionally, there are over 2,647 homes currently located within the 100-year and 500-year floodplains that are at risk of damage from hurricanes and other heavy precipitation events. Similarly, there are over 1,811 critical facilities in the region, such as nursing homes, SNAP-authorized retailers, police and fire departments, and convenience stores. There are currently twelve major critical facilities located in the 100-year floodplain – two in Bladen County, nine in Robeson County, and one in Scotland County – and 3 major critical facilities in Robeson County located in the 500-year floodplain are at greater risk of flooding during a storm. There are also 23 historical and cultural sites listed on the National Register of Historic Places that are in the 500-year floodplain. As flooding is already a concern for the Lumber River region, and increased frequency and intensity of flooding is likely in the next 30-50 years, regional adaptation efforts should focus on protecting public infrastructure from flooding and on development standards that will improve housing resilience.

Flooding and extreme heat pose risk to the regional economy. The manufacturing industry heavily relies on transportation and with 3,207 miles of road at risk of becoming impassible due to 100-year flooding, that can disrupt supply chain and logistics. Additionally, the agriculture industry is highly susceptible to flooding, drought, and extreme heat. Currently, only 43% of agricultural lands have crop insurance. Drought conditions are likely to increase in the future and instability of seasonal weather patterns will make it difficult for farmland to be productive.

In addition to structures and economies, climate impacts will also affect individuals and families in North Carolina's Lumber River region. Social vulnerabilities are the individual characteristics that make it harder for a person to withstand and quickly recover from natural hazards and other

stresses. Bladen, Robeson and Scotland counties have the highest overall social vulnerability due in part to the number of people living in poverty, those living with a disability, and lack of reliable broadband internet. Bladen County has a high percentage (24%) of elderly persons who are more at risk from natural hazards. It may be harder for these populations to prepare ahead of natural hazard events, evacuate when needed, and recover after events. Physical and mental health can also be directly impacted by natural hazards, particularly flooding, hurricanes, and extreme heat. These hazards can impact drinking water quality and supply as well, potentially posing a threat to public health.

Many residents live below the poverty line and communities throughout the region have seen people move away due to displacement after disasters and job loss. This impacts the tax base that local governments rely on to address infrastructure and other challenges in their communities. Programs designed to increase flood resilience should focus on helping residents who have been displaced by flooding find affordable homes in communities of their choice. Residents are interested in collaborative regionalized approaches to building flood resilience and in upgrading and modernizing stormwater infrastructure in general, which will reduce the incidence of flooding because of moderate-intensity storms.

In all, there are climate hazard hot spots throughout the region that are disproportionately more vulnerable. Census Tract 9706 east of Rockingham in Richmond County, tract 9603 around Red Springs, tracts 9608.01, 9608.02, 9609, 9610, 9611, 9612, 9613.02 around Lumberton, and tract 102 north of Laurinburg are climate hazard hot spots. These locations are within proximity to the 100-year floodplain, have a greater number of high heat days, have more impervious surface area, and have a greater number of mobile homes and nursing homes. The combination of hazards and high social vulnerability make these important communities in which to focus resilience efforts.

Despite these challenges, the Lumber River region has unique assets that support efforts to build resilience. Many residents have longstanding ties to the region, which ensures that local solutions are grounded in local realities and local leadership. The unique cultural landscape of the region reflects a multicultural heritage that has been handed down across many generations. Through the difficulties of surviving and recovering from two major hurricanes, the region’s residents and local leaders may have more first-hand understanding of resilience than in any other place in the state. The lush rural landscape will continue to provide essential natural buffers against hazards,

while supporting a diversity of plants and animals. Each of these characteristics will support the region's efforts to cope with and adapt to natural hazards and climate change.

7.1 Next Steps

By participating in the RISE program, the Lumber River region demonstrates its commitment to increasing resilience against natural hazard events. This vulnerability assessment incorporates research gathered from planning documents and evidence-based reports and localized knowledge obtained from a series of stakeholder meetings and open houses. It is the foundation for the next phase of the RISE program: the project portfolio. The Lumber River region's project portfolio is intended to be a collection of five to 10 regional resiliency projects designed to address the vulnerabilities identified in this document. Project selection will be based on public input collected through stakeholder meetings and open houses, as well as a standardized method that assesses and prioritizes projects for inclusion in the Resilience Project Portfolio. Each project will be published with an implementation pathway that provides clarity of purpose, identifies aligned funding opportunities, and outlines a direct path for implementation.

Below is a list of potential projects that have been discussed for inclusion in the project portfolio.

Table 29 - Resilience Projects Under Consideration

Projects Under Consideration	Description
Stormwater system assessment	Conduct a comprehensive assessment of stormwater systems in all five counties and develop an immediate implementation plan for correcting deficiencies in existing networks.
Water infrastructure assessment	Assess the need for increased water infrastructure capacity and identify actions to increase or maintain that capacity as needed.
Hydrology and hydraulic modeling for stormwater drainage	Perform H&H study in all five counties to determine capacity needed for effective stormwater drainage design.
Housing strategy for older adults	• Prepare the housing sector to meet the needs of an aging population through identifying and implementing housing and community changes

Projects Under Consideration	Description
	that would improve the quality of life for older residents in the region. • Conduct a county-wide or regional needs assessment to understand what existing housing stock can remain and serve this purpose, which structures need improvements, and which structures should be demolished and returned to open space or less critical uses.
Energy burden and home weatherization analysis	Analyze existing programs related to weatherization and energy costs for low-income households and their reach in the Lumber River region and recommend strategies to increase uptake.
Community-based resilience programs	Identify needs and provide support for local capacity-building programs.
Stream gage installation	Install new stream gages at pre-identified sites across the five-county region to assist with more accurate predictions of water levels and early flood warning.
Stream restoration	• Develop a methodology for identifying stream restoration projects that have a high probability of mitigating local flooding. Analyze the network of local and state partners that may want to participate.
Open space conservation	• Stream restoration along a tributary where an outcome would include flood reduction downstream. • Wetland conservation or buyout project, based on properties that could hold flood water. Publicly owned land highly preferred • Develop a methodology for identifying parcels (public or private ownership) that have a strong possibility, if conserved, returned to wetlands, or allowed to flood (water farming), of holding floodwater and reducing downstream flooding. • Build on existing outreach efforts to make private landowners aware of opportunities to do flood mitigation-relevant conservation on their land

Projects Under Consideration	Description
Flood risk mapping and analysis	Update flood profiles and mapping in areas of frequent and nuisance flooding across the five-county region to better understand overall risk of future events.
Community emergency preparedness plan	With many channels of information related to ways to prepare yourself and home for natural hazard events, this project can create a plan to: • Identify relevant and trusted channels of communication • Explore utilizing early flooding notification tools • Explore ways to encourage residents to enroll in local emergency warning systems • Create preparedness programs targeted towards vulnerable populations (including LEP, Latine, seniors, low-income, disabled, mobile home communities) • Conduct public education about wildfire risk in the Lumber River region, including mitigation strategies homeowners and property owners can take to avoid damage
Zoning gap analysis	Conduct a gap analysis of current zoning policies and update zoning codes to reflect best practices.
Parking lot assessment and resurfacing	Perform an assessment of county parking lots and prioritize resurfacing with pervious materials to restore functionality of infrastructure and create positive environmental outcomes.
Public infrastructure inventory	Maintain a county-wide infrastructure vulnerability assessment program to identify priority needs infrastructure and structures.
Microgrid power systems	Building upon efforts by the State Energy Office and Smart Electric Power Alliance, pilot a project to build a microgrid system in a pre-identified location based on findings from the State Energy Office feasibility study.

7.2 Considerations for Developing the Resilience Portfolio

The Resilience Project Portfolio will be published in late 2022 and consist of five to 10 projects identified through stakeholder collaboration and planning document review. Based on this vulnerability assessment, the project team recommends the following considerations when identifying projects for the portfolio:

- Recognize and support the efforts of communities that are building capacity and resiliency. These efforts are important and display the determination of residents in the Lumber River region.
- Identify all critical facilities and county infrastructure that may be impacted by natural hazards and plan for updates.
- Consider reviewing local and county planning documents and update ordinances according to the most current climate science projections for flooding and other natural hazards.
- Examine stormwater conveyance measures and evaluate capacity.
- Evaluate sheltering needs and coordinate across organizations.
- Develop programs and outreach efforts related to flooding, including early warning systems.

8.0 Appendices

8.1 Glossary

Key definitions provided by FEMA (unless otherwise stated) used throughout the vulnerability assessment include:

Assets are determined by the community and include but are not limited to people; structures; systems; natural, historic, and cultural resources; and/or activities that have value to the community.

Disaster is an occurrence of a natural catastrophe, technological accident, or human-caused event that has resulted in severe property damage, deaths, and/o multiple injuries. It is important to note that the term 'natural disaster' is not entirely accurate because it ignores the role that humans have in the disaster – a hazard only becomes a disaster once it affects society or a community.

Exposure is the people, property, systems, or functions that could be lost to a hazard. Exposure includes what lies in the area the hazard could affect.

Natural hazards are a source of harm or difficulty created by a meteorological, environmental, or geological event. Natural hazards, such as flooding and earthquakes, impact the built environment, including dams and levees. [Note that natural hazards and climate hazards may be used interchangeably in the vulnerability assessment.]

Resilience is the capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption (United States Global Change Research Program, 2021).

Risk for the purpose of hazard mitigation planning is the potential for damage or loss created by the interaction of natural hazards with assets, such as buildings, infrastructure, or natural and cultural resources.

Social vulnerability is understood as the potential for loss within an individual or social group, recognizing that some characteristics influence an individual's or group's ability to prepare, respond, cope, or recover from an event. These characteristics can overlap within populations to create heightened vulnerability, which may be compounded by infrastructure deficiencies within communities and historic or existing discriminatory government policies.

Vulnerability is a description of which assets, including structures, systems, populations, and other assets as defined by the community, within locations identified to be hazard-prone, are at risk from the effects of the identified hazard(s).

8.2 Open House Summary

Summary of Lumber River Region Open Houses – May 2nd and 3rd, 2022

Attendance at the evening session on May 2nd totaled approximately 4 participants in addition to the six Core planning team members. The morning session on May 3rd totaled approximately 9 participants in addition to the six planning team members. At both sessions, the first question discussed was, "What is a weather hazard that impacts you, your family, and/or community? Identify locations in your community where you've seen issues." The second question discussed was, "Your community has been impacted significantly in the past. What types of recovery/resiliency efforts have been implemented? What works best for you, your family, and/or community?" The following document summarizes key themes and important points of information gained from both Open House sessions.

Impacts of hurricanes

Hurricanes caused people to move away and they haven't come back, partly due to inadequate housing and slum lords who bought trailer parks and rent single-wide trailers for $800/month. Population decrease has also led to school closures like South Robeson High and RB Dean Elementary and Townsend Middle school. The City of Lumberton has 40% of houses vacant; some houses have also been condemned since Hurricane Matthew. Some students from A&T are doing research on the housing situation. Red Springs and Maxton also have an issue with vacant housing. Businesses in South Lumberton by 5th Street have closed and left, leaving the whole area depressed. There is mold in churches near Maxton. There were lots of public housing units after the hurricanes. Robeson County had a waiting list of 500 people. Many didn't have insurance or got tired after the second hurricane.

Water Quality + Infrastructure

Sewer and water lines were laid in the 1920s and 1930s and is extremely out of date. Red Springs has clay pipes in the older parts of town and people experience damaged pipes, occasionally due to ice, leading to loss of potable water. Buildings also lose water pressure when this happens. The Town is working to replace the pipes and also build a new water treatment plant that will stabilize the flow of water into the pipes. The region is very much a groundwater system instead of surface water, with two aquifers and private wells that range from 9-30 feet deep. Following Hurricane Florence, the region has collaborated with UNC Chapel Hill Superfund Research Program to study and evaluate private well water. Chromium 6 was detected in some samples in

the region, which is a carcinogenic chemical. There may also be industrial runoff into water near the airport.

Elected officials are aware of water infrastructure issues and the Council of Governments studies water systems every 4-5 years. County plans for water would likely require radical change. There have also been some private efforts to make drinking water safer, and there has been funding through the NC Division of Clean Water, but no public programmatic approach yet.

Roads and culverts were designed in the 1950s and 1960s for less capacity than they receive today. Residential development and impervious surfaces overwhelm the systems as well. There is a need for NCDOT to evaluate culverts.

Streamways are blocked from down trees and are backing up water. There are several drainage districts in the county where farmers are assessed a fee to help maintain the systems, however the fees are too low to maintain drainage and become and remain blocked. After the hurricanes we got the right equipment to clean out ditches and evacuate the water. For example, we cleaned out a retention pond in Red Springs. Farmers also clean out canals, but more water will then flood the next canal that isn't cleaned out (such as in Maxton along Hwy 71).

Development

Maxton used to have a strong milling industry that is no longer there. As communities lose residents, they also lose tax base. There are few developments planned in the region – Deercroft in Scotland County; Hoke County has some military development, making it the only county growing in population. The Lumber River Council of Governments (COG) is currently working with 14-15 local governments to update their Comprehensive Plans as part of the Chapter 160D requirements set by the state. There is some willingness at the local level to change zoning codes to allow for new/different development. With a large amount of vacant housing, we should find out who owns these homes and figure out where they are in the recovery process – the last thing we need is abandoned homes because that equates to erasure.

Deforestation is a major issue and NC has a lot of destruction. There are four wood pellet facilities and along with pipelines, over 600 acres of forest has been cleared which is likely causing flooding in Bryan Circle.

Buyouts

Following major flooding, the topic of property buyouts has surrounded the region. Buyouts are a disservice to people when the amount offered isn't enough to support those who have to find somewhere else to live. It causes displacement, tears up the fabric of the community, and there is a lack of information and engagement with communities about the buyout process. In some places where buyouts are the only solution, there has been no explanation to communities as to why buyouts might be necessary. Marginalized communities, who are most affected, find buyouts distasteful and the topic is not well received in Lumberton. It's like dangling money in front of people but in the end, that money won't actually get you very far. There are issues with buyouts in Bladen and Robeson counties, where most of the land is backswamp and not suitable for people to move and build on.

Coordination

There is disjointedness across entities in the region. Lumberton gets to go full speed ahead and do whatever they want. There are 17 different plans all lacking coordination and when we flood again, nobody knows what's going on. Very few organizations from outside of the region actually go out INTO the community to engage with folks and there needs to be true engagement from all levels of government early on. There is little communication across jurisdictional lines as well. A county manager told me about things that the county is doing, but they haven't told the community what they are doing. If you deal with a problem in one municipality but not the other, what's the use when that problem isn't confined to a single municipality?

United Way in Robeson County fills an important role in sharing information. They experienced some downsizing, and they need more support to grow, but if we can build them back they will be a valuable resource. Creating an interagency council through United Way might be a good way to share information. Robeson is starting an interagency council to coordinate recovery and resiliency efforts for the community.

The Lumber River United Way – Bladen, Hoke, and Robeson; Scotland United Way; and Richmond United Way. We need to work to bring the three together to share across county lines. Initially after hurricanes, there were lots of organizations and churches that did very specific things like rehab houses. Everyone was working separately and not collaborating on the big picture. Slowly we are making headway in collaboration and getting people together again. We're developing relationships with nonprofits and developing a more shared relationship.

Community

There are 60 identifiable communities in Robeson County. It will be critical to find stakeholders and lifelines in each community – individuals that folks can turn to for information and direction. Some folks are stepping up to be a community liaison. But there are some people that still don't know what is going on in their own communities. We need to put things aside and say "Let me help you" so we can work together and get things rolling. A critical piece is sharing resources – everything is siloed everywhere and there is the fear of "if you get it, I won't get it." But it's important to realize that "if it happens to one, it happens to all of us" – we need to get the regional spirit through governments and to the community.

There was a huge change from Hurricane Matthew to Hurricane Florence – nobody was prepared for Matthew but after it happened, we started developing plans to respond and put action plans in place. But if we don't get another big hurricane within the next 4-5 years, there's a change some people forget the impact of these disasters.

Vulnerable populations + Health

Seniors and vulnerable populations are affected by weather hazards and meal delivery can be disrupted. But "they will get meals in Red Springs because someone will be at the community center with food no matter what." Robeson and Cumberland County started a MoldBusters program where they partnered with FEMA, the Health Department, and others. The program helped people understand how to remove and prevent mold in their houses. But it only lasted 2-3 years after Hurricane Florence. Mold is a big issue and happens in some of the town buildings. The region is very humid, and most homes don't have dehumidifiers. Homeowners reach out to report mold and there have been trainings for volunteers. Maybe climate change has exacerbated the mold problem. The Disaster Survival School is putting together videos that include mold trainings for the community.

Work is being done at a hospital with social determinants – there are a lot of partner organizations, lots of ideas, and lots of money through ARPA, but we don't know if everything is in place is solving issues. Social determinants of health started as the bottom line for hospitals. People need transportation to doctor appointments, and if they don't have it, they skip appointments and can have more severe health issues. There's a coalition called Health Robeson that's been around for a few years but had different names. No one knew what we did but some people have been

going out and meeting individually with churches and pastors to find out what they're already doing and bring them into the health network. There are still several things for social determinants that need to be addressed because it's very broad right now.

Broadband

There are areas where you can't get internet unless you have a wifi hotspot. This causes people to miss notifications about important meetings and other events. Municipal governments don't always think about scheduling out communications far enough in advance of meetings so that we have time to find out about things.

Ice + Heat

Ice and freeze events cause power outages and difficult driving situations, especially for school buses. There are homes and schools without adequate heating, which is also a problem for seniors.

Drought is a major problem impacting farmers. Heat stress impacts elderly and agricultural workers and outdoor construction workers. NCDHHS has statistics on hospital visits and heat strokes. Drought is also a problem for folks that want to grow local produce. There needs to be an irrigation system as a potential project for this project. Heat stress is also a big issue across the southeastern part of the state. Robeson, Bladen, and Scotland have the highest heat stress levels in the state. We need to have NCDHHS and CDC sponsor a program on heat stress because this would be a critical project area to collaborate on a prevention program, throughout the Cape Fear and Lumber River basins.

Resiliency Actions

The Disaster Survival and Resiliency School just kicked off in Robeson County. It's focusing first on Lumberton and Red Springs, which were hit the hardest by hurricanes, and then it will open up to the rest of the county. The Recovery and Resiliency School is key, and we need to build upon further training for future generations and long-term investment. Knowledge is power and this will help folks understand their story and find resiliency themselves. FEMA helped with some of the recovery process, but this local effort will hopefully be more sustainable. There are long term recovery groups, faith-based and community-based organizations, and a county-based one through NCVOAD that was created after Hurricane Florence. It's important to empower the community members themselves and to ask people what they've gone through and what's worked

and what hasn't. The question becomes, "are we going to be prepared enough to rebuild? What's going to be left of homes if it happens again?"

Needs

A community resource shelter that also acts as an emergency shelter would be great to have in Maxton. There was one that used to exist that was funded through the State previously. Maxton lacks cooling facilities during heat events – the facilities only open if there is a hurricane. There is also a need for county-based integrated case management systems. Mobile community resource hubs would be important tools to make the public aware of what's available because there is a lot people don't know about. Affordable housing is also a big issue for the region and there are desires to raise house foundations. Smaller towns also receive fewer resources and have lower capacity to address issues.

Local, fresh, affordable food is a real need in the region. There is a regional food system down east but UNC Pembroke and community college have ongoing projects around this topic.

There haven't been improvements on electrical upgrades or back up power, which are outstanding needs.

Locations + Flooding

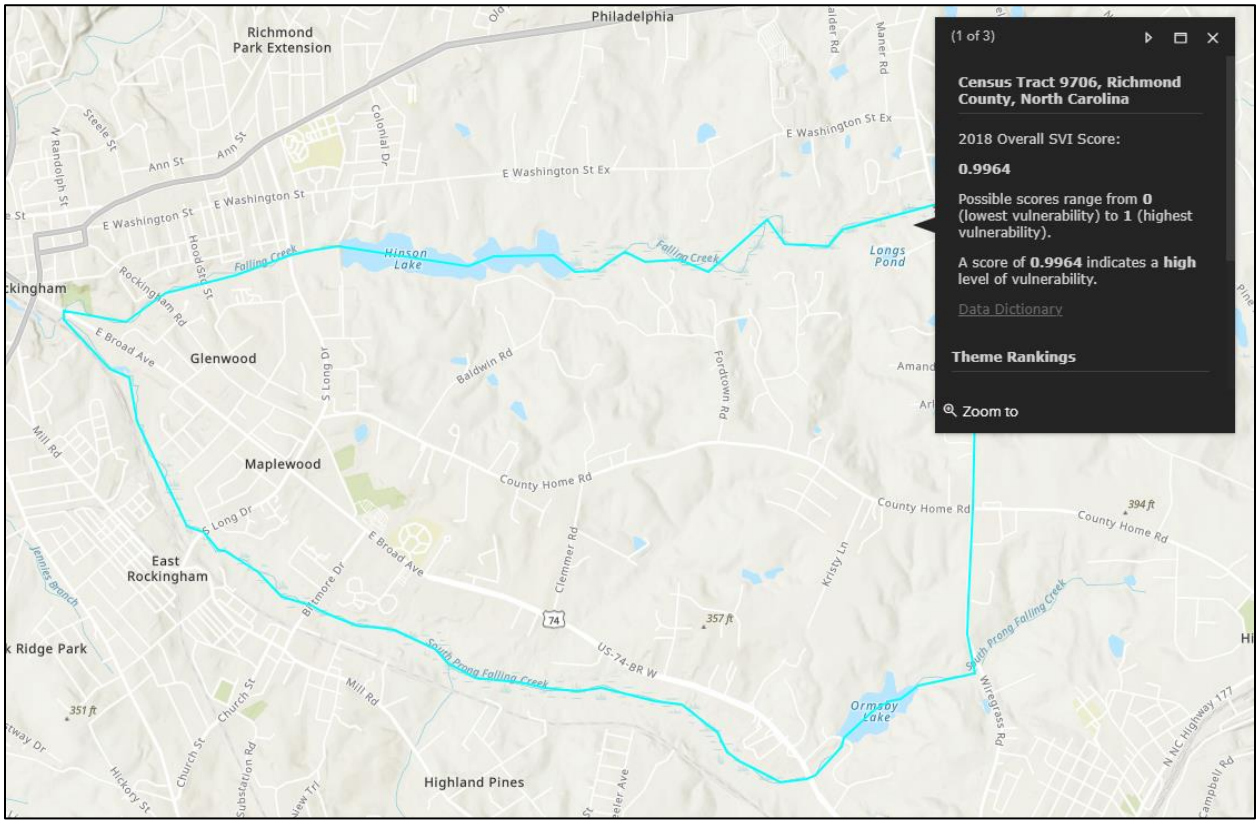
Flooding has caused a lot of damage to roads and infrastructure. In Shannon on the Hoke County side, both bridges closed due to flooding and roads being washed out. Two bridges on Battleford Rd and the road to Raeford. All of the rural areas outside of Maxton flood, along with Robeson County; Bryans Circle near Maxton; Harpers Ferry along the river; Alma – have all flooded. Entire streets flood when it rains and driving in a couple inches of rainfall is pretty dangerous. There are three main streets in a neighborhood in west and south Lumberton with 2-3 houses on each street that don't have walls or floors. West Lumberton near the railroad tracks has major flooding. On Hwy 71 in Maxton near the Campbell's Plant, there used to be water up past the sign. Road improvements did help fix the flooding.

Where I live, I'm not required to have flood insurance. I spoke with one lady in the Highland Park neighborhood, which is considered affluent, and she has flood insurance with a $5,000 deductible. That is kind of cost prohibitive.

8.3 Highly Vulnerable Census Tracts

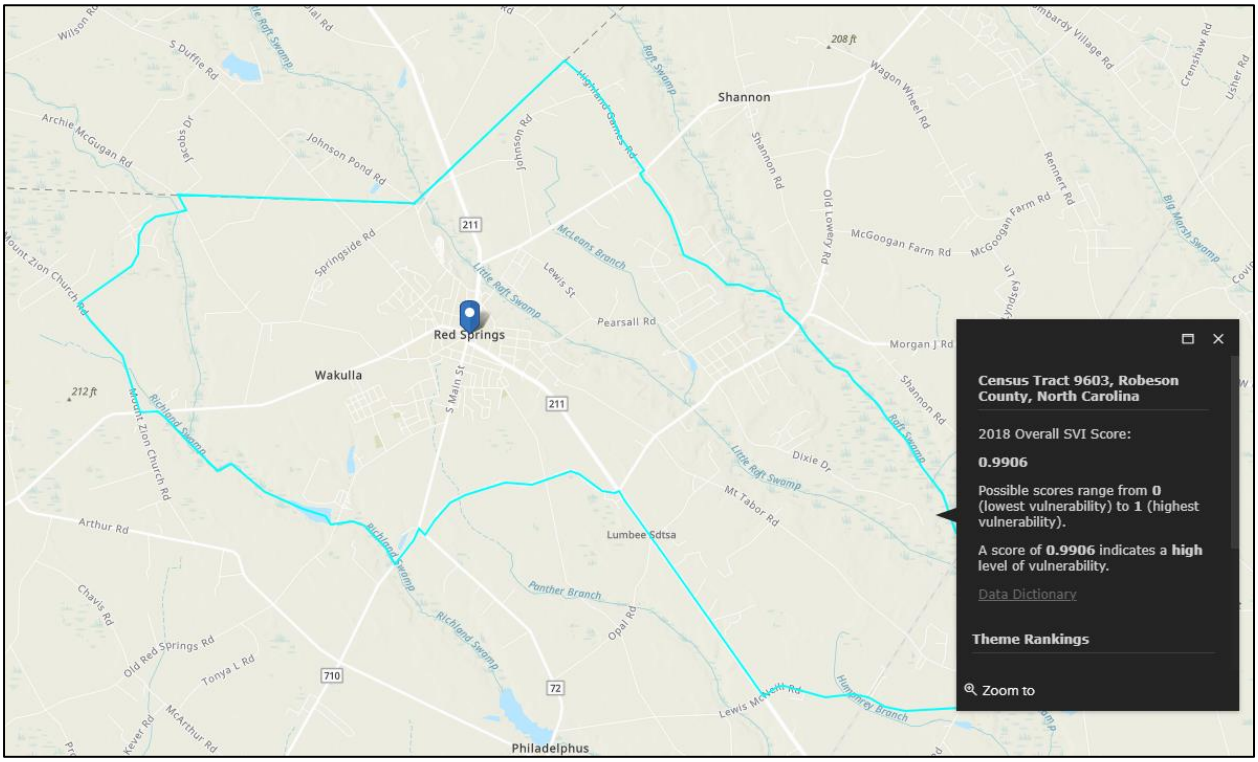
The following figures are census tract locations according to the CDC SVI mapping tool.

Figure 41 - Census Tract 9706, Richmond County



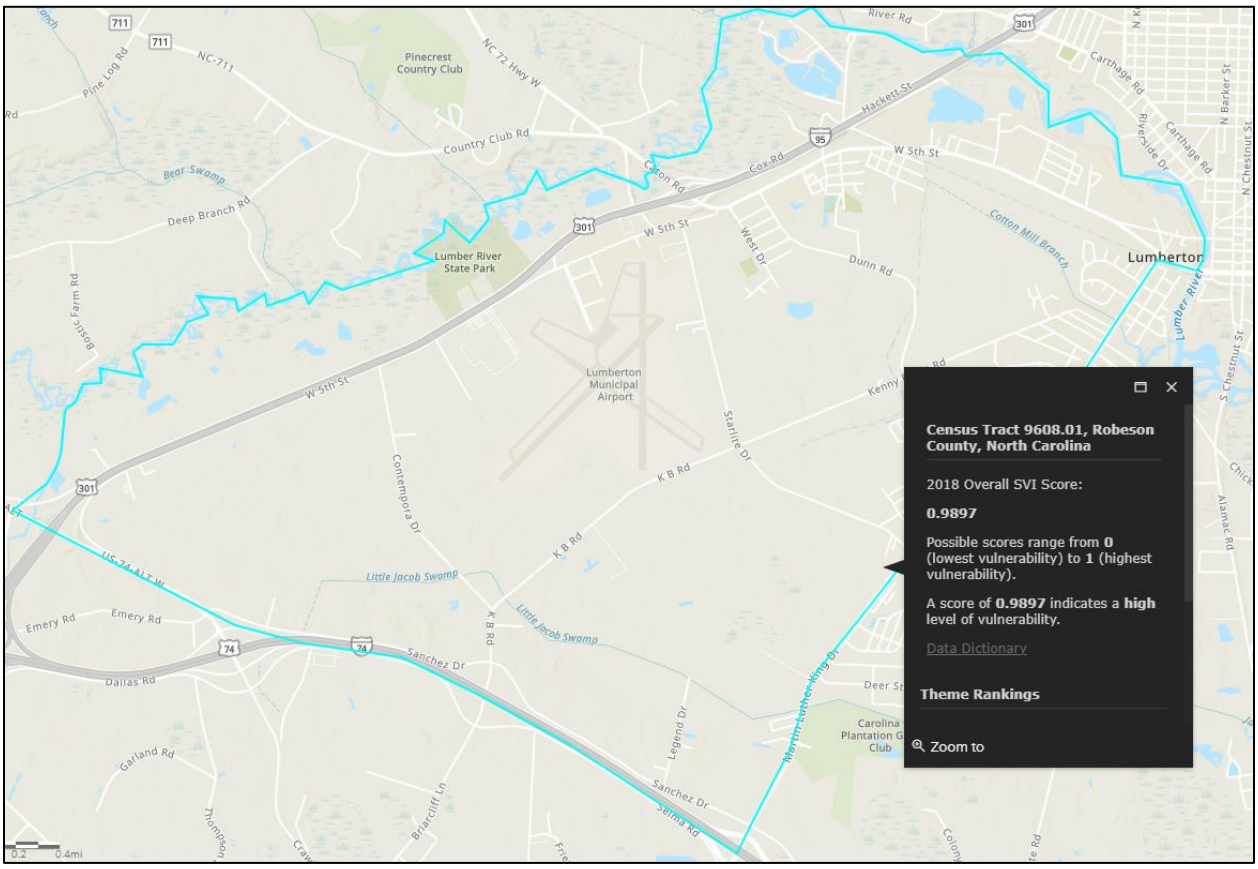
Source: [CDC Social Vulnerability Index Interactive Map]

Figure 42 - Census Tract 9603, Robeson County



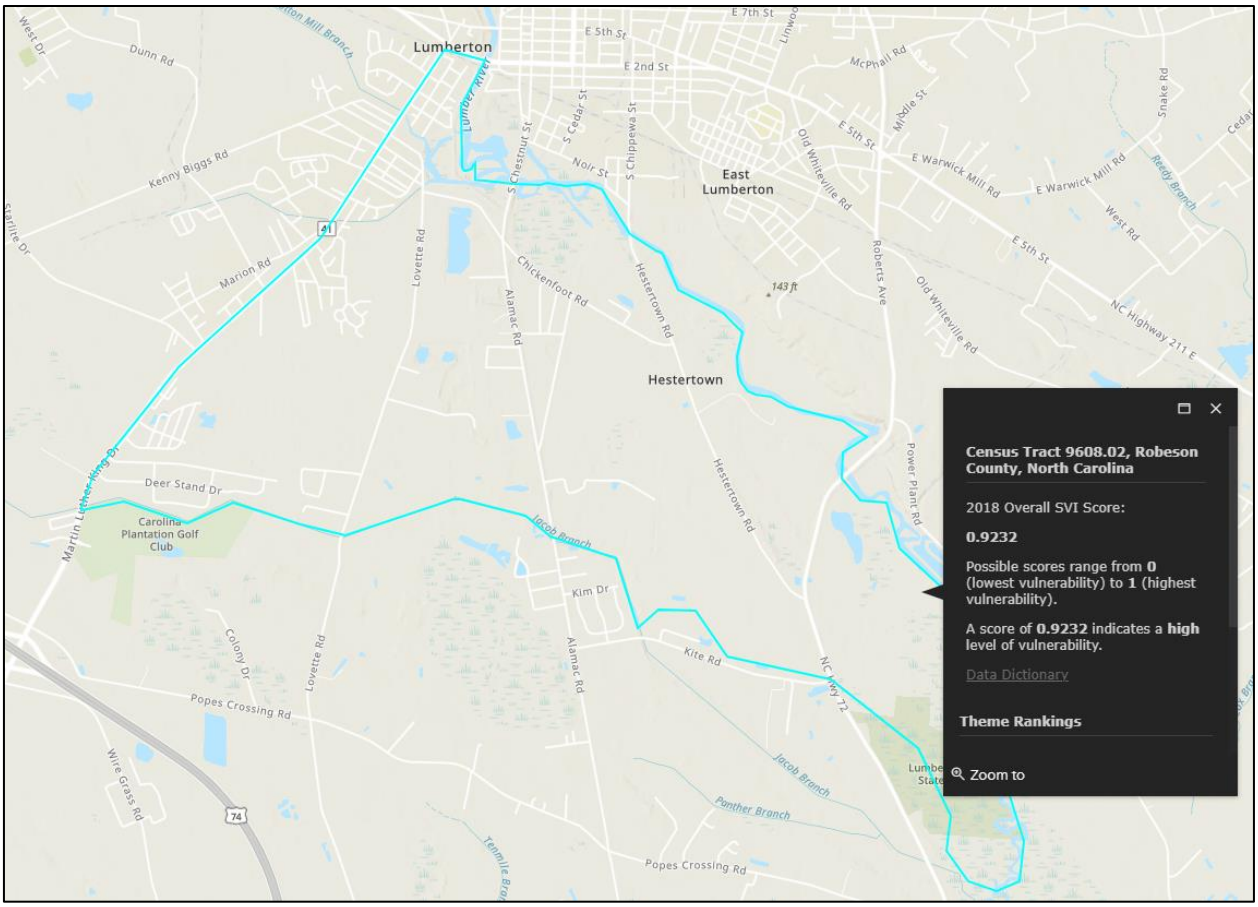
Source: [CDC Social Vulnerability Index Interactive Map]

Figure 43 - Census Tract 9608.01, Robeson County



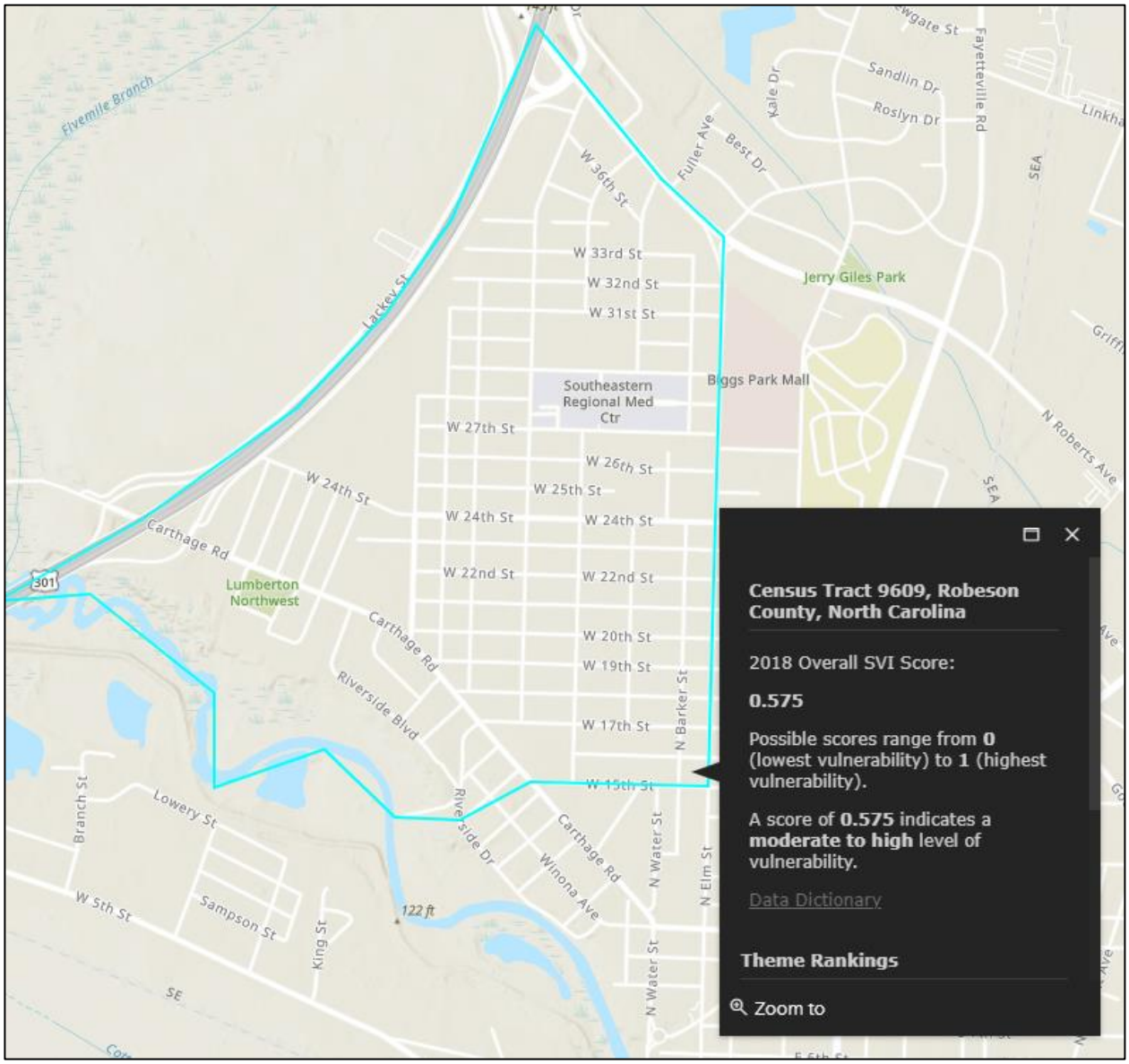
Source: [CDC Social Vulnerability Index Interactive Map]

Figure 44 - Census Tract 9608.02, Robeson County



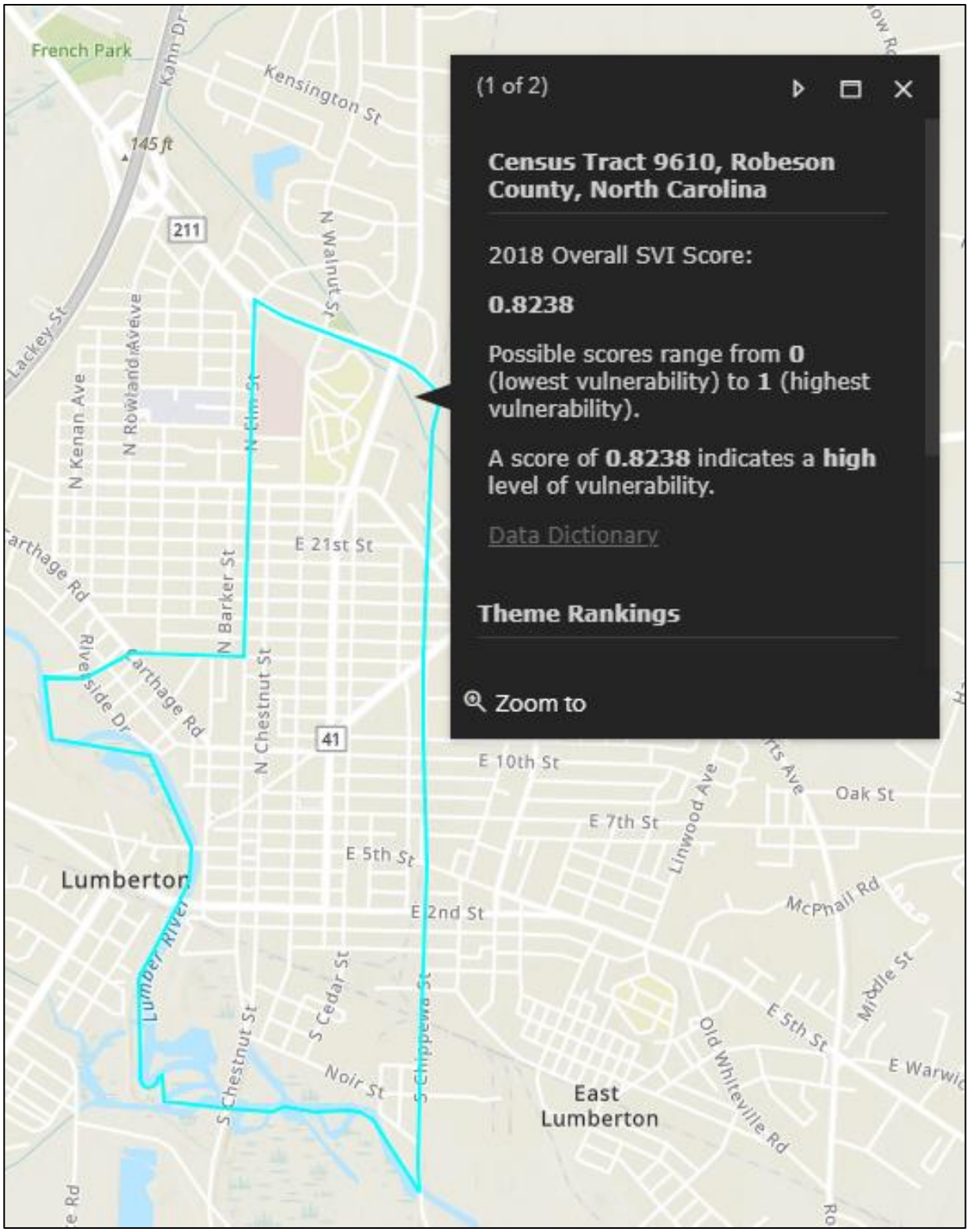
Source: [CDC Social Vulnerability Index Interactive Map]

Figure 45 - Census Tract 9609, Robeson County



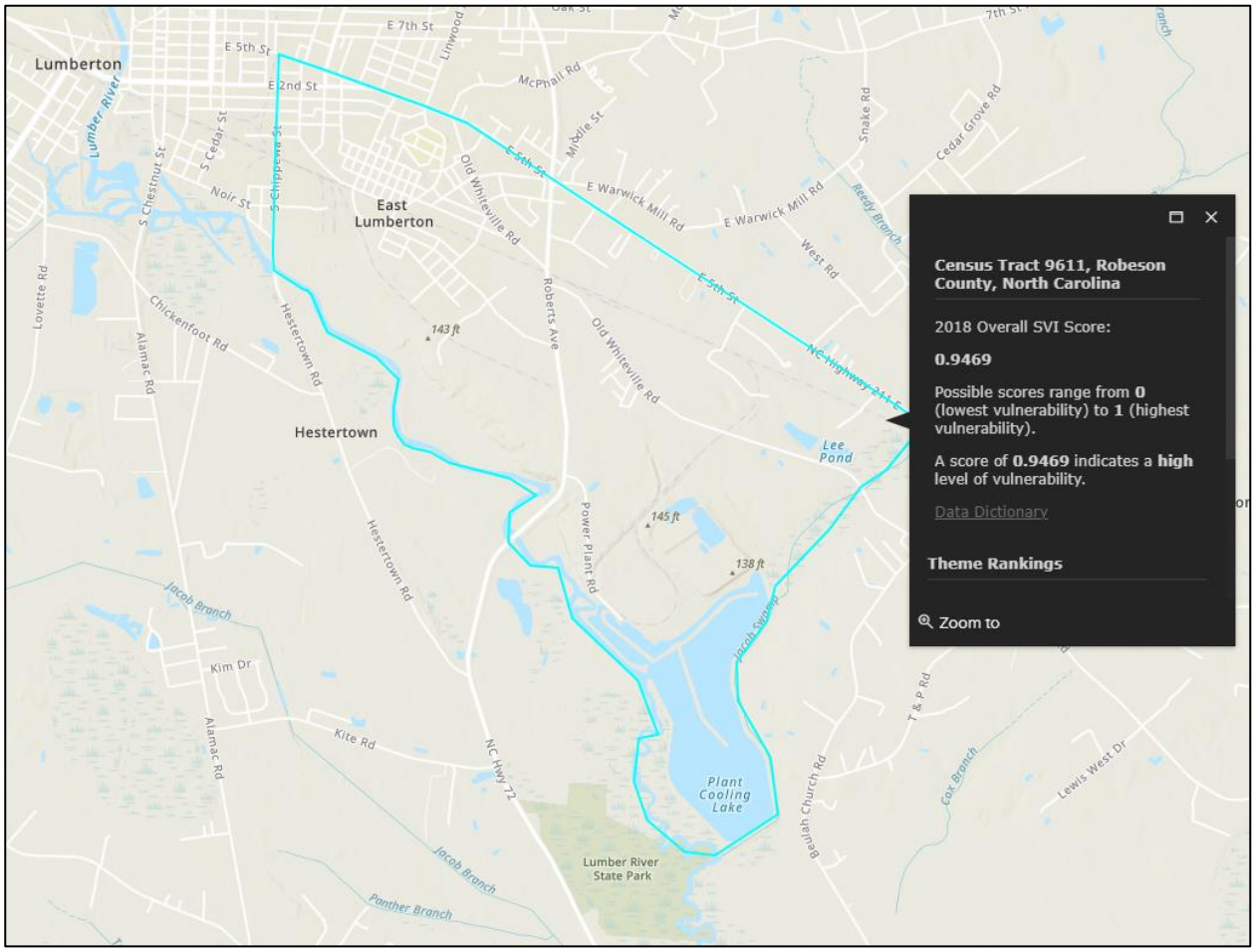
Source: [CDC Social Vulnerability Index Interactive Map]

Figure 46 - Census Tract 9610, Robeson County



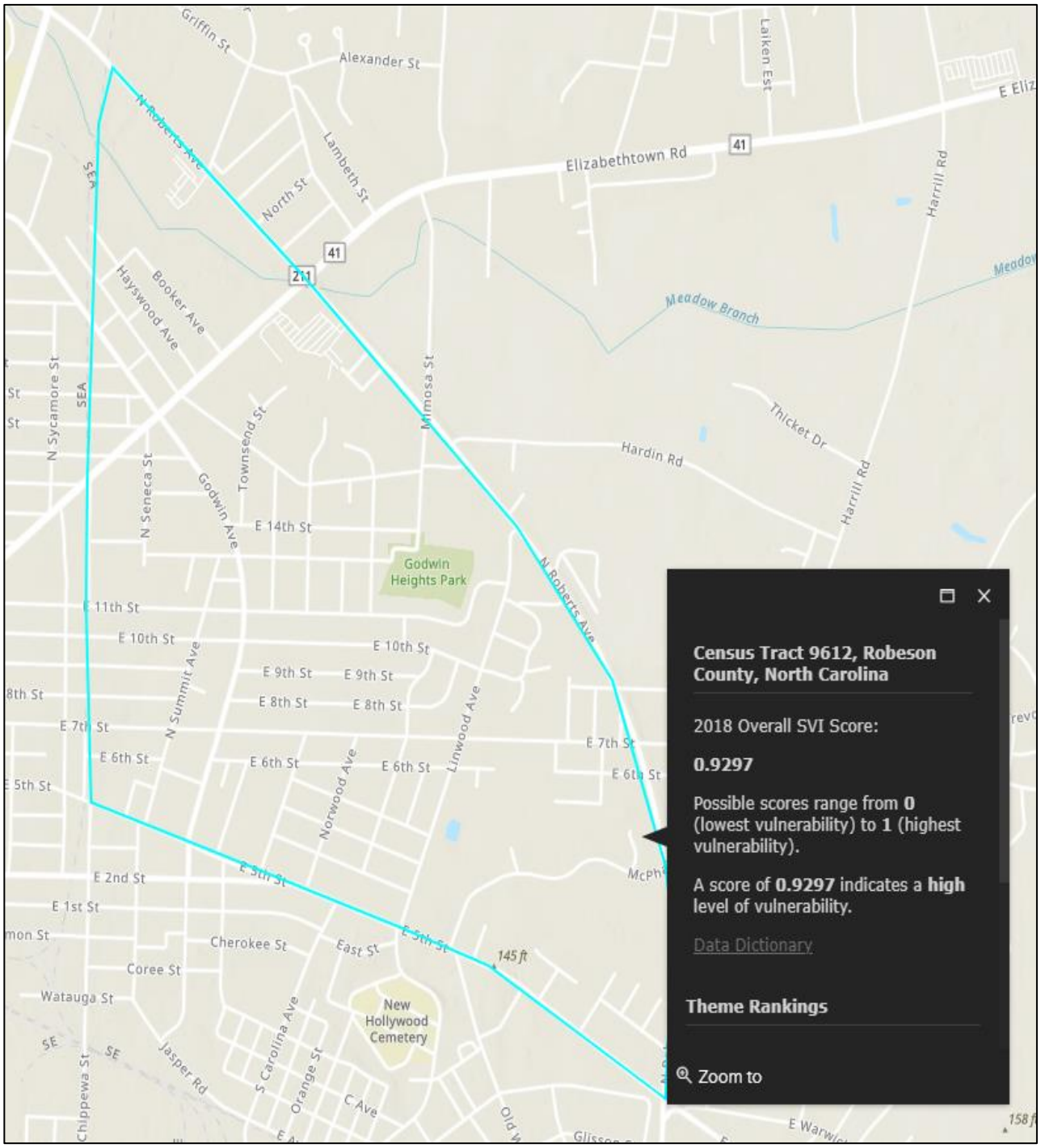
Source: [CDC Social Vulnerability Index Interactive Map]

Figure 47 - Census Tract 9611, Robeson County



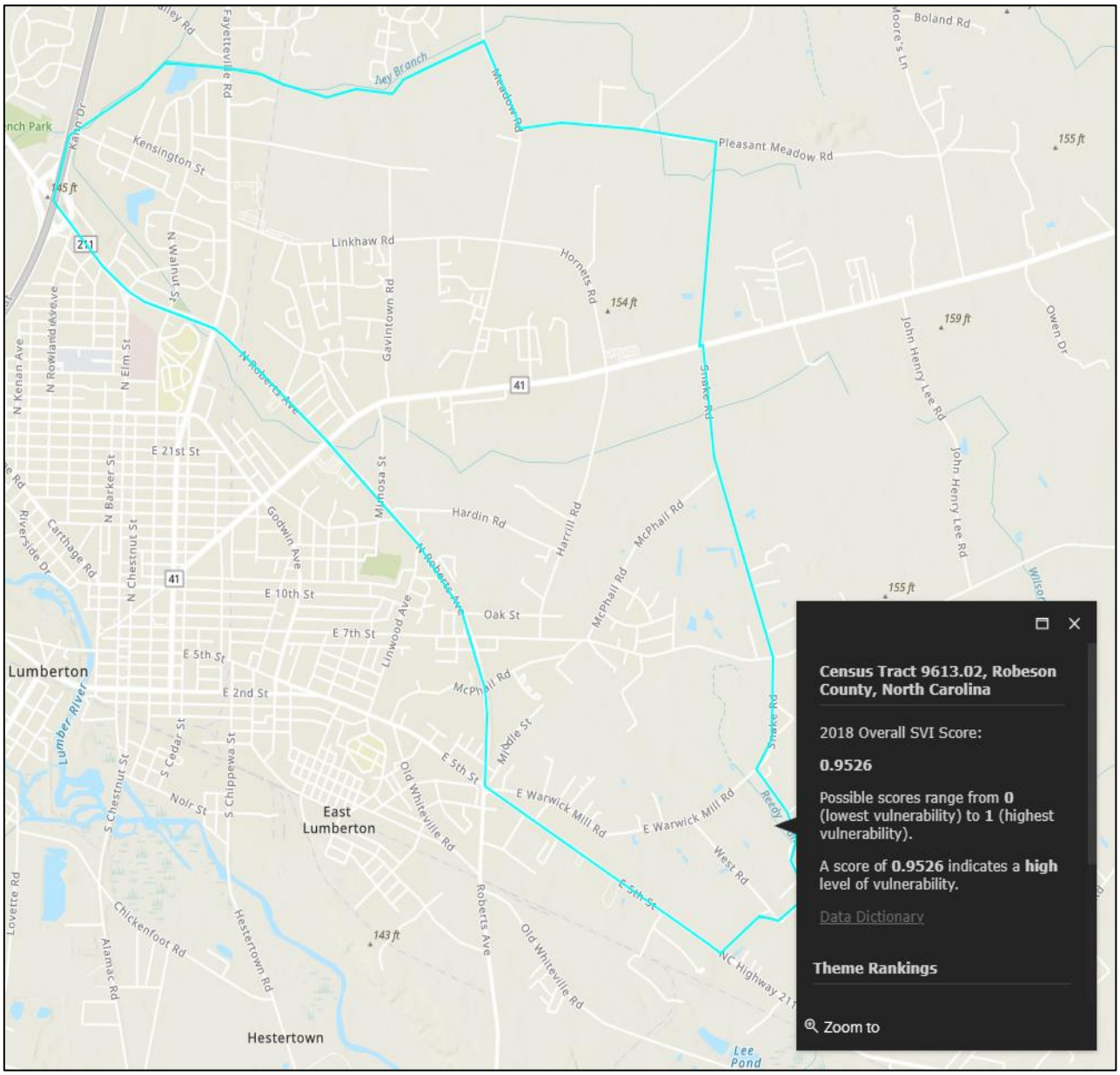
Source: [CDC Social Vulnerability Index Interactive Map]

Figure 48 - Census Tract 9612, Robeson County



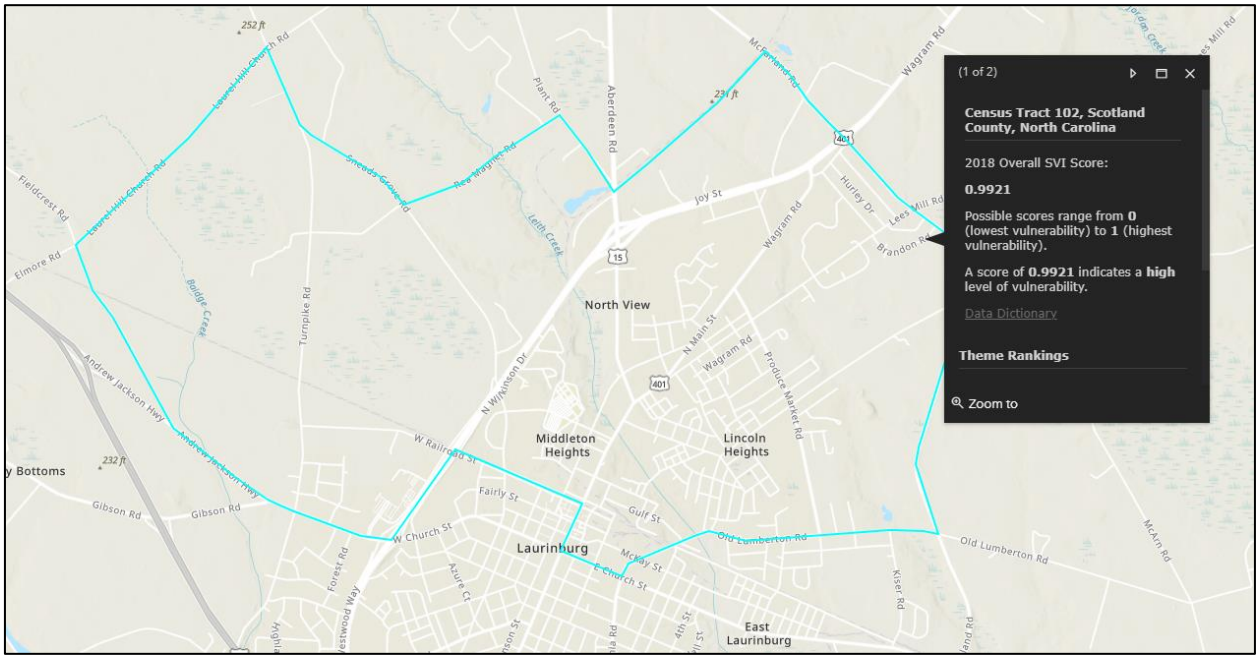
Source: CDC Social Vulnerability Index Interactive Map

Figure 49 - Census Tract 9613.02, Robeson County



Source: [CDC Social Vulnerability Index Interactive Map]

Figure 50 - Census Tract 102, Scotland County



Source: CDC Social Vulnerability Index Interactive Map

8.4 Tables

Table 30 provides data on demographics for each county in the region.

Table 30 - Regional Demographics

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Population					
Population Estimates, July 1, 2021, (V2021)	29,525	53,114	42,724	116,328	34,227
Population estimates base, April 1, 2020, (V2021)	29,606	52,082	42,946	116,530	34,174
Population, percent change - April 1, 2020 (estimates base) to July 1, 2021, (V2021)	-0.3%	2.0%	-0.5%	-0.2%	0.2%
Population, Census, April 1, 2020	29,606	52,082	42,946	116,530	34,174
Population, Census, April 1, 2010	35,190	46,952	46,639	134,168	36,157
Age and Sex					
Persons under 5 years, percent	5.3%	7.8%	6.2%	6.6%	6.3%

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Persons under 18 years, percent	20.4%	27%	23.7%	25.2%	23.7%
Persons 65 years and over, percent	23.5%	11%	18.2%	16%	18.6%
Female persons, percent	52.5%	50.5%	51.1%	51.9%	49.9%
Race and Hispanic Origin					
White alone, percent	60.4%	48%	60.5%	29.3%	43.2%
Black or African American alone, percent	33.4%	35.9%	32.2%	23.2%	39%
American Indian and Alaska Native alone, percent	3.6%	9.2%	3.4%	43.6%	13.8%
Asian alone, percent	0.5%	1.6%	1.1%	0.6%	1%
Native Hawaiian and Other Pacific Islander alone, percent	0.1%	0.4%	0.2%	0.2%	0.1%
Two or More Races, percent	2%	4.9%	2.6%	3%	2.9%
Hispanic or Latino, percent	8.2%	15%	7.3%	9.3%	3.7%
White alone, not Hispanic or Latino, percent	54.6%	37.3%	55.2%	23.3%	41.2%
Veterans and Foreign Born					

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Veterans, 2017-2021	2,220	5,821	2,181	6,190	1,918
Foreign born persons, percent, 2017-2021	3.4%	6%	3.4%	4.4%	2.7%
Housing					
Housing units, July 1, 2021, (V2021)	15,250	20,491	19,933	48,791	14,390
Owner-occupied housing unit rate, 2017-2021	69.7%	69.3%	65.6%	65.5%	59.4%
Median value of owner-occupied housing units, 2017-2021	$106,000	$154,400	$92,200	$77,900	$89,600
Median selected monthly owner costs - with a mortgage, 2017-2021	$1,096	$1,268	$1,016	$1,051	$1,073
Median selected monthly owner costs - without a mortgage, 2017-2021	$424	$399	$373	$367	$402
Median gross rent, 2017-2021	$687	$923	$686	$679	$692
Building permits by county, 2021	30	423	30	210	52
Families & Living Arrangements					

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Households, 2017-2021	11,492	17,705	16,292	42,241	12,214
Persons per household, 2017-2021	2.58	2.88	2.58	2.73	2.65
Living in same house 1 year ago, percent of persons age 1 year+, 2017-2021	93.4%	87.2%	87.5%	92.7%	87.3%
Language other than English spoken at home, percent of persons age 5 years+, 2017-2021	7.3%	10.9%	6.8%	8.2%	4.1%
Computer & Internet Use					
Households with a computer, percent, 2017-2021	85.8%	88.3%	85.6%	84.9%	83.4%
Households with a broadband Internet subscription, percent, 2017-2021	79.7%	85.4%	77%	66.5%	74.3%
Education					
High school graduate or higher, percent of persons age 25 years+, 2017-2021	85%	87.7%	82.7%	77.9%	81.3%
Bachelor's degree or higher, percent of persons age 25 years+, 2017-2021	17.7%	19.8%	17.5%	14.2%	15.3%
Health					

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
With a disability, under age 65 years, percent, 2017-2021	10.5%	15.1%	11.6%	11.5%	10.6%
Persons without health insurance, under age 65 years, percent	15.5%	15.4%	14.9%	19.7%	14.3%
Economy					
In civilian labor force, total, percent of population age 16 years+, 2017-2021	49.3%	52.5%	57%	50.8%	52.4%
In civilian labor force, female, percent of population age 16 years+, 2017-2021	43.7%	54.6%	54.8%	48.8%	51%
Total accommodation and food services sales, 2017 ($1,000)	31,876	24,235	49,538	190,471	55,362
Total health care and social assistance receipts/revenue, 2017 ($1,000)	47,731	117,641	187,816	588,184	252,175
Total transportation and warehousing receipts/revenue, 2017 ($1,000)	28,747	19,483	24,919	102,167	-
Total retail sales, 2017 ($1,000)	210,335	188,848	481,862	1,414,354	337,091
Total retail sales per capita, 2017	$6,289	$3,484	$10,759	$10,666	$9,582
Transportation					

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Mean travel time to work (minutes), workers age 16 years+, 2017-2021	25.8	29.8	24.5	24.4	23.3
Income & Poverty					
Median household income (in 2020 dollars), 2017-2021	$39,259	$53,456	$38,926	$36,736	$39,866
Per capita income in past 12 months (in 2020 dollars), 2017-2021	$25,975	$24,398	$22,088	$20,294	$23,230
Persons in poverty, percent	21.6%	15.5%	26.2%	27.9%	24.4%
Businesses					
Total employer establishments, 2020	519	483	795	1,785	591
Total employment, 2020	10,581	5,810	12,041	32,979	9,442
Total annual payroll, 2020 ($1,000)	350,328	187,970	421,477	1,152,001	332,343
Total employment, percent change, 2019-2020	-2.6%	0.6%	4.7%	-1.4%	-1.4%
Total non-employer establishments, 2019	1,852	2,918	2,118	7,843	1,888
All employer firms, Reference year 2017	333	287	666	1,490	409

Fact	Bladen County	Hoke County	Richmond County	Robeson County	Scotland County
Men-owned employer firms, Reference year 2017	166	S	353	838	224
Women-owned employer firms, Reference year 2017	S	32	S	243	42
Minority-owned employer firms, Reference year 2017	S	54	101	484	S
Nonminority-owned employer firms, Reference year 2017	230	S	432	818	241
Veteran-owned employer firms, Reference year 2017	28	S	S	155	S
Nonveteran-owned employer firms, Reference year 2017	227	S	526	1,140	290
Geography					
Population per square mile, 2020	33.8	133.5	90.7	123	107.1
Population per square mile, 2010	40.2	120.2	98.4	141.3	113.4
Land area in square miles, 2020	875.03	390.15	473.69	947.3	319.14
Land area in square miles, 2010	874.33	390.74	473.82	949.22	318.85

Source: U.S. Census Bureau QuickFacts: United States (2021)

The North Carolina Department of Commerce, Labor & Economic Analysis Division (LEAD) provides data and statistical information for the state. For the Lumber River region, **Table 31** displays the number of establishments and average employment for industries across all five counties for 2021 (Bladen, Hoke, Richmond, Robeson, and Scotland). An industry is a group of establishments that produce similar products or provide similar services and are grouped according to the North American Industry Classification System (NAICS).

Table 31 - Employment distribution by industry

Rank	Industry	# of Establishments	Average Employment
1	Manufacturing	192	19,994
2	Health Care and Social Assistance (Private)	685	12,393
3	Retail Trade	881	9,868
4	Accommodation and Food Services	395	6,505
5	Educational Services (Local Gov't)	86	6,163
6	Public Administration (Local Gov't)	43	4,386
7	Administrative and Support and Waste Management and Remediation Services	257	4,265
8	Construction	395	2,719
9	Public Administration (State Gov't)	46	2,078
10	Educational Services (State Gov't)	4	1,958
11	Wholesale Trade	146	1,940
12	Transportation and Warehousing	186	1,823
13	Finance and Insurance	198	1,345
14	Professional, Scientific, and Technical Services	302	1,233
15	Other Services (except Public Administration)	387	1,114

Source: Quarterly Census of Employment and Wages (QCEW), Annual 2021 Sector

Table 32 displays a ranked list of top employers for each county in the region, providing further description of which companies have the most employees and what industry the companies are grouped into. The North Carolina Department of Commerce LEAD provides data and the following tables present annual statistics from 2021.

Table 32 - Largest Employers by County (2021)

Rank	Company Name	Industry	Employment Range
Bladen County			
1	Smithfield Foods Inc	Manufacturing	1000+
2	Gildan Yarns LLC	Manufacturing	1000+
3	Bladen County Schools	Educational Services	500-999
4	The County of Bladen	Public Administration	250-499
5	First Source Staffing Services LLC	Administrative and Support and Waste Management and Remediation Services	250-499
6	C R England Inc	Transportation and Warehousing	250-499
7	Specialty Product Technologies	Manufacturing	250-499
8	Cape Fear Valley Health Systems	Health Care and Social Assistance	100-249
9	Bladen Community College	Educational Services	100-249
10	Packers Sanitation Services Inc	Administrative and Support and Waste Management and Remediation Services	100-249
Hoke County			
1	Hoke County Board of Education	Educational Services	1000+
2	Butterball LLC	Manufacturing	500-999
3	Office of County Auditor	Public Administration	250-499
4	Burlington Industries	Manufacturing	250-499
5	Cape Fear Valley Health Systems	Health Care and Social Assistance	250-499

Rank	Company Name	Industry	Employment Range
6	Conopco Inc	Manufacturing	250-499
7	Firsthealth of The Carolinas Inc	Health Care and Social Assistance	250-499
8	Wal-Mart Associates Inc.	Retail Trade	100-249
9	Fedex Ground Package System Inc	Transportation and Warehousing	100-249
10	Food Lion	Retail Trade	100-249
Richmond County			
1	Richmond County Schools	Educational Services	1000+
2	Perdue Farms Incorporated	Manufacturing	500-999
3	Firsthealth of The Carolinas Inc	Health Care and Social Assistance	500-999
4	Richmond County Government	Public Administration	250-499
5	Richmond Community College	Educational Services	250-499
6	Plastek Industries Inc	Manufacturing	250-499
7	Wal-Mart Associates Inc.	Retail Trade	250-499
8	Cascades Moulded Pulp	Manufacturing	250-499
9	Burlington Industries	Manufacturing	250-499
10	Dept of Public Safety	Public Administration	250-499
Robeson County			
1	Mountaire Farms of NC Inc	Manufacturing	1000+
2	Public Schools of Robeson County	Educational Services	1000+
3	Southeastern Regional Medical Ctr	Health Care and Social Assistance	1000+
4	Wal-Mart Associates Inc.	Retail Trade	1000+
5	Robeson County Finance Dept	Public Administration	1000+
6	UNC Pembroke	Educational Services	1000+

Rank	Company Name	Industry	Employment Range
7	Campbell Soup Supply Company LLC	Manufacturing	1000+
8	Food Lion	Retail Trade	250-499
9	Two Hawk Employment Services LLC	Administrative and Support and Waste Management and Remediation Services	250-499
10	McDonalds	Accommodation and Food Services	250-499
Scotland County			
1	Scotland Memorial Hospital (A Corp)	Health Care and Social Assistance	500-999
2	Scotland County Schools	Educational Services	500-999
3	Dept of Public Safety	Public Administration	500-999
4	Scotland County	Public Administration	250-499
5	Meritor Heavy Vehicle Systems LLC	Manufacturing	250-499
6	Pilkington North America Inc	Manufacturing	250-499
7	Wal-Mart Associates Inc.	Retail Trade	250-499
8	FCC (North Carolina) LLC	Manufacturing	250-499
9	Hanesbrands, Inc	Manufacturing	250-499
10	Edwards Wood Products Inc	Manufacturing	100-249

Table 33 identifies historic and cultural sites that are in or adjacent to floodplains and floodways. "In FEMA Floodplain" refers to the 100-year FEMA floodplain. Properties in bold are on the National Register of Historic Places.

Table 33 - National Register of Historic Places at Risk of Flooding

SITE ID	SITE NAME	DESCRIPTION	PROXIMITY TO FLOODPLAIN
Bladen County			
FK0526	A.T. Neal Brick Building (Gone)		In FEMA Floodplain
FK0299	Alford-Whitaker Mill Ruin (Gone)		In FEMA Floodplain
FK0026	Baker Farm	3-phase 19th c. 2-story frame farmhouse	In FEMA Floodplain
FK0602	Bridge	1954 bridge	In FEMA Floodplain
FK0609	Bridge	1946 bridge	In FEMA Floodplain
FK0289	Bridge #64 (Cedar Creek Bridge)	1962 concrete bridge	In FEMA Floodplain
FK0567	Bridge No. 42 (Replaced)	steel frame bridge	In FEMA Floodplain
FK0568	Bridge No. 55 (Replaced)		In FEMA Floodplain
FK0569	Bridge No. 68 (Replaced)		In FEMA Floodplain
FK0570	Bridge No. 99 (Replaced)	Low steel truss bridge w/ two spans & angle iron type railings	In FEMA Floodplain
FK0001	Cascine	18th-19th c. plantation complex; Georgian, Greek Revival	In FEMA Floodplain
FK0318	Cascine Mill	c. 1825 4-story frame mill	In FEMA Floodplain
FK0024	Clifton House (Relocated) and Mill Site	Mid-19th c. 2-story frame Greek Revival house, 15-foot-high stone dam & ruins of mill	In FEMA Floodplain
FK0554	Franklin County Training School - Riverside Union School	1951-1968 African American school complex	~200' from FEMA Floodplain

SITE ID	SITE NAME	DESCRIPTION	PROXIMITY TO FLOODPLAIN
FK0802	Gupton Millpond Dam	c. 1900 dam	In FEMA Floodplain
FK0465	Ira Weldon's Mill	Dam, mill, and store	In FEMA Floodplain
FK0387	Jackson Mill Pond	1 1/2-story front gable frame mill	In FEMA Floodplain
FK0011	Laurel Mill	Mid-19th C. frame grist mill	In FEMA Floodplain
FK0282	Louisburg Historic District	19th-early 20th c. courthouse town	~100' from FEMA Floodplain
FK0015	Massenburg Plantation	Early 19th c. & 1838 Federal 2-story frame house, outbuilding	In FEMA Floodplain
FK0868	Mitchiners Fishing Club	c. 1930	In FEMA Floodplain
FK0414	Moore's Mill Pond	Dam, mill ruins, wheel	In FEMA Floodplain
FK0019	Person-McGhee Farm	c. 1890 Queen Anne 2-story frame house and farm	In FEMA Floodplain
FK0572	Raleigh & Gaston Railroad Cedar Creek Bridge Piers	1830s tapered stone bridge piers for original rail bridge over creek	In FEMA Floodplain
FK0689	Seaboard Coast Line Tar River Bridge		In FEMA Floodplain
FK0285	Speed Farm	1847 2-story frame house and farm	In FEMA Floodplain
FK1270	Water pump station and water tower (Gone)	c. 1925 concrete reservoir w/ wood frame & sheet metal roof	In FEMA Floodplain
Hoke County			
GV0003	Abrams Plains	1770s-1830 Federal/Greek Revival 2-story frame house	In FEMA Floodplain
GV0689	Bridge No. 141		In FEMA Floodplain
GV0666	Currin-Bowling Farm		In FEMA Floodplain
GV0010	Eldon B. Tunstall Farm	1907 I-house and farm	In FEMA Floodplain
GV0106	James Blackwell House	1820s and later Federal house	In FEMA Floodplain
GV0018	Lewis Wimbish Plantation (Gone?)	1850s Greek Revival 2-story frame house	In FEMA Floodplain

SITE ID	SITE NAME	DESCRIPTION	PROXIMITY TO FLOODPLAIN
GV0972	Oxford Historic District	c. 1845-c.1965 district eligible under Crit A and Crit C	In FEMA Floodplain
GV0667	Oxford Water Works		~50' from FEMA Floodplain
GV0175	Rose Hill	1834 Greek Revival 2-story brick house	In FEMA Floodplain
GV0059	Rufus Amis House and Mill Boundary Amendment	1850s house and grist mill	In FEMA Floodplain
GV----	Watkins Farm Rural Historic District		In FEMA Floodplain
Richmond County			
PR0011	Burleigh	Mid-19th c. Greek Revival 2-story frame house; outbuildings	In FEMA Floodplain
PR0022	Davis Mill (Approximate site)		In FEMA Floodplain
PR0033	Harris Mill		In FEMA Floodplain
PR0089	Hurdle Mill		In FEMA Floodplain
PR0102	Moore's Mill (ruin)		In FEMA Floodplain
PR0326	North Roxboro Residential Historic District	c. 1842-present	In FEMA Floodplain
PR0328	Reamstown Residential Historic District	c. 1890-present	In FEMA Floodplain
PR0290	Truss Bridge #35	c. 1900 pin-connected Pratt half-hip pony truss (DOT 720035)	In FEMA Floodplain
Robeson County			
VN0015	Belvidere	1850 Greek Revival/Italianate 2-story frame house	In FEMA Floodplain
VN0082	Hibernia (Hargrove Place) (Gone)	c. 1800 2-story side gable frame house w/ 3 exterior chimneys	In FEMA Floodplain
VN0014	LaGrange	Mid-19th c. Greek Revival 2-story frame house	In FEMA Floodplain

SITE ID	SITE NAME	DESCRIPTION	PROXIMITY TO FLOODPLAIN
VN0113	Mabry's Mill (Gone)	19th C. frame grist mill	In FEMA Floodplain
VN0341	Raleigh and Gaston Railroad Bridge Piers	c. 1840 tapered, granite pylon; remains of original bridge	In FEMA Floodplain
VN0341	Raleigh and Gaston Railroad Bridge Piers		In FEMA Floodplain
VN0386	Thomas A. Morgan Farm	Thomas A. Morgan Farm - complex includes 12 properties	In FEMA Floodplain
VN0035	Weldon's Mill	Late 19th c. 2-story side gable frame grist mill w/ outbuildings	In FEMA Floodplain
Scotland County			
WR0316	Bridge No. 4	1934 timber stringer/multi-beam (DOT 920004)	In FEMA Floodplain
WR----	Bridge No. 74 on SR 1641		In FEMA Floodplain
WR0390	Bridge No. 9	1920 reinforced concrete slab (DOT 920009)	In FEMA Floodplain
WR0251	Buxton Place	1857 Greek Revival/Italianate 2-story frame house	In FEMA Floodplain
WR0107	Davis Mill		In FEMA Floodplain
WR0197	Dr. Pitchford House	Mid-19th c. Greek Revival 2-story frame house	In FEMA Floodplain
WR0132	Hamme's Mill	c. 1800, 1937 2-story front gable frame mill w/ weatherboard	In FEMA Floodplain
WR0008	Lake O'Woods	1852 Greek Revival 2-story frame house	In FEMA Floodplain
FK0690	Shocco Creek Bridge (Bridge No. 66)	1920 reinforced concrete tee beam (DOT 340066)	In FEMA Floodplain

Source: National Register of Historic Places

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