

Johnston County

Natural Resource Initiative

Green Infrastructure Assessment Report



An assessment of Johnston County's network of natural areas, working lands, and open spaces.

February 2012



"The North Carolina Forest Service is an equal opportunity employer. Its programs, activities and employment practices are available to all people regardless of race, color, religion, sex, age, national origin, disabilities, or political affiliation."

ncforestservice.gov



"The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, DC 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer."

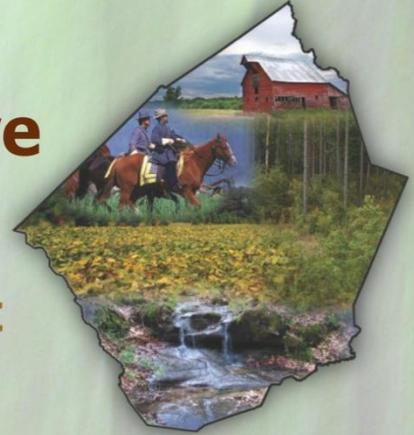
www.fs.fed.us

"This document was produced in part with funding from the USDA Forest Service."

An Ecofont was used throughout much of this report. This font type uses approximately 50 percent less toner than traditional fonts.

Johnston County Natural Resource Initiative

Green Infrastructure Assessment Report



Prepared for the
Johnston County Natural Resource Initiative (JCNRI)



By
N.C. Department of Agriculture & Consumer Services

N.C. Forest Service
1616 Mail Service Center
Raleigh, NC 27699-1616
ncforestservice.gov

And
JCNRI Project Participants
jcnri.wikispaces.com

FEBRUARY 2012

Funding

The Johnston County Natural Resource Initiative Green Infrastructure Assessment Report was made possible through funding from the U.S. Department of Agriculture Forest Service (USFS), Southern Region. The competitive funds were awarded to the N.C. Forest Service through a grant under the State and Private Forestry program of the USFS.

Acknowledgements

The Johnston County Natural Resource Initiative (JCNRI) has been made possible by many individuals, organizations, and county and state government agencies, including the towns of Benson, Clayton, Selma, Smithfield, and Wilson's Mills; Johnston County Planning and GIS Departments; Johnston County Soil and Water Conservation District; N.C. Cooperative Extension; N.C. Forest Service, N.C. Wildlife Resources Commission, N.C. Natural Heritage Program; Triangle Land Conservancy; Triangle J Council of Governments; and N.C. State University. More information about the project and partners can be found on the JCNRI Wikispace: jcnri.wikispaces.com.

Assessment Report Authors and Content Contributors

The following individuals were instrumental in drafting content for this report or served as technical editors. This report could not have been completed without the contributions of these individuals.

Johnston County Cooperative Extension: Bryant Spivey

Johnston County Heritage Center: T. Wingate Lassiter

Johnston County Planning Department: Berry Gray

Johnston Soil and Water Conservation District: Susan Woodard

N.C. Forest Service: Alan Moore (Project Coordinator),

David Jones (Primary Assessment Report Author / Editor),

Doug White, Tom Gerow, and Bill Swartley

N.C. Natural Heritage Program: Allison Weakley, Harry LeGrand, Judith Ratcliffe, Kim Douglass

N.C. Wildlife Resources Commission: Jacquelyn Wallace and Jeff Marcus

Triangle Land Conservancy: Jon Scott and Leigh Ann Hammerbacher

U.S. Fish and Wildlife Service: Sarah McRae (formerly N.C. Natural Heritage Program)

N.C. Urban Forestry Council: Leslie Moorman (formerly N.C. Forest Service)

Johnston County Natural Resource Initiative Contacts

JCNRI Project Coordinator

Alan Moore

Eastern Region Urban Forestry Specialist

N.C. Forest Service

1616 Mail Service Center

Raleigh, NC 27699-1616

Email: alan.moore@ncagr.gov

Office Phone: 919-857-4841

Johnston County Representative

Berry Gray

Director, Johnston County Planning and

Zoning Department

309 E. Market Street

Smithfield, NC 27577

Email: berry.gray@johnstonnc.com

Office Phone: 919-989-5150

EXECUTIVE SUMMARY

What is the Johnston County Natural Resource Initiative?

The Johnston County Natural Resource Initiative (JCNRI) is a collaborative effort among county and municipal governments, natural resource professionals, and non-profit organizations to develop and promote strategies in the County for the conservation of natural resources through a network of farms, forests, and open space. Participants include Johnston County Soil and Water, Johnston County Cooperative Extension, Johnston County Planning Department, North Carolina Natural Heritage Program, North Carolina Forest Service, North Carolina Wildlife Resources Commission, North Carolina State University, Triangle Land Conservancy, Triangle J Council of Governments, and staff from the towns of Benson, Clayton, Selma, Smithfield, and Wilson’s Mills. Funding for this project was provided through a grant from the U.S. Department of Agriculture Forest Service, Southern Region.

The North Carolina Forest Service led the assessment process and worked in conjunction with the Johnston County Planning Department to meet their need for a reference document concerning the natural resources of the County. All other agencies and organizations involved provided expertise and guidance related to their particular field of natural resource management.

Johnston County residents and landowners were invited to participate in three different workshops. Those workshops were held on March 31, 2009, November 12, 2009, and September 23, 2010. The workshops introduced the project to residents and landowners, provided information about green infrastructure, and allowed for public input and comment on the project. Stakeholder feedback from those public meetings was incorporated into the assessment.

A workshop for planners and elected officials from the County as well as all the cities and towns in the County was held on September 23, 2010. A speaker from the Green Infrastructure Center presented on how to use green infrastructure planning and how this document could be used by attendees.

What is Green Infrastructure?

Green infrastructure (GI) is a connected network of green spaces (natural lands, working lands, and open space) that is planned and managed for its natural resource value and for the associated benefits and services provided to people and communities. Those benefits and services are collectively referred to as “ecosystem services.”

Ecosystem services are generally viewed as free benefits to society, such as wildlife habitat, watershed services, carbon storage, and scenic landscapes. Lacking a formal market, these natural assets are often overlooked in public, corporate, and individual decision-making processes. Recognizing forest ecosystems as natural assets with economic and social value can help promote conservation and more responsible decision-making. Green infrastructure plays a critical role in providing the natural resources (water, land, air, forest, wetlands, etc.) that support our communities, cities, and societies. Without these resources, our basic needs for food, shelter, and raw materials will not be met.

Normally, when we think of infrastructure, we think of grey infrastructure such as buildings, roadways, and sewer systems. We understand that there has to be connectivity between our roads and highways, utility lines, or water systems for this infrastructure to function successfully.

Green infrastructure is applying these same concepts of connectivity to trees and the natural system. It is a strategic approach to land conservation, addressing the economic and social impacts of sprawl, fragmented open spaces, and forestland.

The green infrastructure network is formed by connecting significant sites (community parks and arboretums) and natural hubs (working lands, state forests, and wildlife refuges) with linkages such as trails and river corridors. It is designed to be flexible and adjustable to meet the needs of current development. Just as grey infrastructure is managed to meet the needs of society, so must the components of green infrastructure.

What is the Purpose of this Green Infrastructure Assessment?

This assessment was prepared in order to highlight the existing natural resources of the County and to provide direction in linking these resources together to form a green infrastructure network. The information is intended as a tool to aid decision makers in strategic planning and taking proactive steps to conserve the natural resources of the County. The green infrastructure assessment provides the foundation needed to integrate conservation planning with land development and grey infrastructure. As Johnston County continues to grow in population, more roads, homes, and businesses will be developed and built to accommodate the growth. The County's natural resources currently provide clean water, desirable farmland, workable forestland, livable wildlife habitats, and enticing recreational areas for its residents. Breaking the links between these elements can increase the risks of flooding; lead to more sedimentation in creeks and rivers; increase costs for providing goods, utilities, and services; and degrade the desirability and appeal of recreational areas.

What are the Key Findings of this Assessment Report?

- ✿ Johnston County has a rich cultural history rooted in agriculture dating back to pre-colonial times. Much of the County's history can be linked back to the Neuse River, which historically served as an important shipping corridor. Throughout the County's history, the Neuse River has also been the primary source of clean surface water supplies for agriculture and other uses (e.g., human consumption, recreation, etc.).
- ✿ Present-day Johnston County is the tenth largest county by land area in the state and is comprised of a diverse landscape dominated by agricultural land, forestland, and expanding urban centers. Despite population growth and expanding urban areas, the County remains predominately rural, with approximately 91 percent of the County classified as agricultural land, forestland, water, or wetland. As of 2006, urban land uses represented approximately 9 percent of the County with a majority located within municipal boundaries and along the I-40 and I-95 corridors and interchanges.
- ✿ The County is situated on the transition of two major physiographic regions of the state – the Piedmont and Coastal Plain. This transition area is termed the “Fall Line” and provides for unique geologic features that support diverse natural communities and wildlife habitats. The geology of the County also produces fertile soils suitable for agriculture and forestry. Approximately 41 percent of the County's soils are designated as prime farmland soils by

the Natural Resource Conservation Service (NRCS). Another 15 percent of the County is designated as prime farmland when the soils are sufficiently drained and 21 percent are considered farmland soils of statewide importance.

- ✿ The County's wealth has long been linked to the natural resources managed on working lands, such as farm and forestland. While these resources are vital to the economic health of the County, they also provide many critical ecosystem services, including providing clean water, clean air, wildlife habitat, and recreation areas. Urban forests and urban tree canopy are also critical components of Johnston County's green infrastructure.
- ✿ Population growth and land use change are the most significant threats to conserving the natural resources (green infrastructure) of the County, including the economic and intrinsic values of these resources. Other threats include insects, diseases, and non-native invasive plants; fire exclusion and wildfire hazards; and mining and mineral exploration.
- ✿ The County's population has grown 174 percent in the last four decades from 61,737 in 1970 to 168,878 in 2010. While the highest decadal growth occurred between 1990 and 2000 at 50 percent, population growth continued to be high between 2000 and 2010, increasing 38 percent during this period.
- ✿ Population growth has contributed to land use conversion from farmlands, forestlands, and natural communities to urban land in some areas of the County. Farmland area has decreased 17 percent from 1987 to 2007 and forestland area has decreased 33 percent from 1992 to 2006. Upland forest natural communities, including hardwood dominated, pine dominated, and mixed forests, represent the largest declining category of natural communities, with a 42 percent decline from 1992 to 2006. However, upland forests still represent approximately 26 percent of the County.
- ✿ Population growth and land use change – both within and upstream of the County – has contributed to declining water quality. Since 1992, the number of watershed catchments with at least 70 percent forest or other natural vegetation – an important threshold indicator of when water quality conditions commonly begin to deteriorate in a watershed – has declined approximately 39 percent. Watershed impervious cover has also increased from 2001 to 2006, contributing to declining water quality. In 2010, there were eight surface water segments listed as impaired on the Clean Water Act 303(d) list by the N.C. Division of Water Quality for not meeting their intended uses. Impairments included: low dissolved oxygen, low pH, copper, zinc, turbidity, and poor ecological / biological integrity.
- ✿ Approximately 98 percent of the County's source water assessment areas are considered highly susceptible to contamination according to the N.C. Division of Water Resources Public Water Supply Section (approximately 53 percent of the County). While water supply has historically not been an issue for Johnston County residents, multiple information sources suggest that the demand for clean water could surpass supply as early as 2020.
- ✿ Urban tree canopy can improve air quality by absorbing and filtering out harmful pollutants. The indirect costs associated with poor air quality can be significant, including higher health care costs and lower tourism revenues. The Urban Tree Canopy (UTC) study conducted as a part of this project estimated that an 8 percent increase in urban tree canopy in Smithfield (approximately 600 acres) could equate to a 23 percent reduction in indirect costs associated with poor air quality. Other towns in the County could realize similar air quality improvements by expanding urban tree canopy.
- ✿ Johnston County has adopted a 2030 Comprehensive Plan and an Agricultural Development Plan that include recommendations for several important conservation strategies. However, implementation of these and other important measures will be needed to conserve the County's natural resources (green infrastructure). These conservation strategies will be necessary to sustain the economic and ecologic benefits derived from the County's farmlands, forestlands, natural communities, streams, rivers, and wetlands.

What are some of the Intended Uses of this Report?

This report is intended for use by the Johnston County Planning Department and the various municipal planning departments to assist in shaping the future of land use in the County. It may also be used by the public, land developers, and resource professionals to help make informed decisions related to natural resources, planning, and development. This report can help the County realize some of the goals outlined in the *Johnston County 2030 Comprehensive Plan* and complement some of the recommendations in the *Agricultural Development Plan for Johnston County*. As Johnston County grows, integration of land development with green infrastructure will be needed to conserve the economic and ecologic benefits of the County's natural resources for residents, landowners, and visitors. Natural resources identified in this report, including the linkages between those resources, can be used to help prioritize conservation efforts in the County.

What are the Next Steps?

The asset maps, resource descriptions, GIS analyses, and overall findings of this assessment can be used to help achieve the goals, objectives, and recommendations found in the *Johnston County 2030 Comprehensive Plan* and the *Agricultural Development Plan for Johnston County*. Specifically, this green infrastructure assessment can be incorporated into Action Recommendations 24, 26, and 35 in the *Johnston County 2030 Comprehensive Plan*. All data gathered and mapped for this assessment using geographic information systems (GIS) have been given to the Johnston County Planning Department. Thus, the County and all its municipalities can use the data to prioritize high-value asset areas for conservation, enhancement, and / or restoration; update zoning maps to help guide new development; and develop a list of voluntary options that encourage conservation of land areas with high-value green infrastructure assets.

Additionally, Johnston County could develop a green infrastructure or comprehensive conservation plan. The development of this plan could be achieved with the assistance of a group comprised of Johnston County residents, landowners, planning professionals, resource professionals, and elected officials. This group could help:

- ✿ Define the visions and goals for green infrastructure as a part of the *Johnston County 2030 Comprehensive Plan*, the *Agricultural Development Plan for Johnston County*, and other land use plans;
- ✿ Identify ways to fund green infrastructure planning and implementation without creating a new department or additional taxes;
- ✿ Set priorities for the County's green infrastructure (natural resources) identified in this assessment;
- ✿ Educate residents and visitors about the importance of maintaining the natural features that Johnston County residents cherish and that visitors are drawn to; and
- ✿ Develop a written green infrastructure or comprehensive conservation plan that is regularly monitored and updated in conjunction with the *Johnston County 2030 Comprehensive Plan*.

Conclusion

Johnston County is at a crossroads. The land use, economic, and ecologic alternatives are numerous and complex. County residents, land planners, and elected officials are faced with decisions on how to blend the County's rich history of rural land management (farm and forestland) and diverse natural landscapes, with the growing pressures of population growth, urban development, and economic expansion.

During the last two decades (1990-2010), the County has experienced rapid population growth and urban development. While this growth can be a welcome stimulus for the County's economy, without proper planning it can also have detrimental effects on the County's natural resources (green infrastructure). However, with the adoption of the *Johnston County 2030 Comprehensive Plan* and the *Agriculture Development Plan for Johnston County*, the County has taken two positive steps towards balancing growth and natural resource conservation. Each of these planning documents includes objectives, strategies, and recommendations that can be implemented to help conserve the green infrastructure of the County while expanding the economy. However, an opportunity still exists to more clearly define, plan, and implement the County's natural resource conservation goals, priorities, strategies with the development of a comprehensive natural resource or green infrastructure plan.

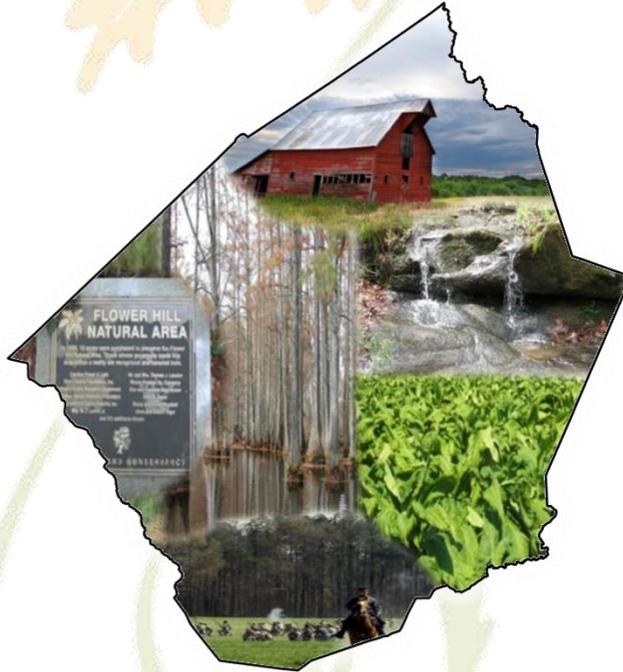


TABLE OF CONTENTS

EXECUTIVE SUMMARY	V
<i>What is the Johnston County Natural Resource Initiative?</i>	<i>v</i>
<i>What is Green Infrastructure?</i>	<i>v</i>
<i>What is the Purpose of this Green Infrastructure Assessment?.....</i>	<i>vi</i>
<i>What are the Key Findings of this Assessment Report?</i>	<i>vi</i>
<i>What are some of the Intended Uses of this Report?.....</i>	<i>viii</i>
<i>What are the Next Steps?</i>	<i>viii</i>
<i>Conclusion</i>	<i>ix</i>
CHAPTER 1 - JOHNSTON COUNTY NATURAL RESOURCE INITIATIVE	1
<i>1.1 Project Description</i>	<i>1</i>
<i>1.2 Project Participants</i>	<i>1</i>
<i>1.3 Overview of Green Infrastructure.....</i>	<i>1</i>
<i>1.4 Purpose of the Green Infrastructure Assessment</i>	<i>3</i>
<i>1.5 Summary of Related Projects</i>	<i>3</i>
CHAPTER 2 - AN OVERVIEW OF JOHNSTON COUNTY	9
<i>2.1 Brief County History</i>	<i>9</i>
<i>2.2 Johnston County Today.....</i>	<i>9</i>
<i>2.2.1 Population</i>	<i>11</i>
<i>2.2.2 Land Use</i>	<i>11</i>
<i>2.2.3 Business, Industry, and Transportation</i>	<i>13</i>
CHAPTER 3 - JOHNSTON COUNTY NATURAL RESOURCES	14
<i>3.1 General County Description</i>	<i>14</i>
<i>3.1.1 Physical Geography and Topography.....</i>	<i>14</i>
<i>3.1.2 Geology.....</i>	<i>15</i>
<i>3.1.3 Soils</i>	<i>17</i>
<i>3.2 Biodiversity and Wildlife Habitat</i>	<i>19</i>
<i>3.2.1 Natural Plant Communities and Wildlife Habitats</i>	<i>19</i>
<i>3.2.2 Significant Natural Heritage Areas</i>	<i>34</i>
<i>3.2.3 Rare Plant and Animal Species</i>	<i>38</i>
<i>3.3 Water Resources</i>	<i>42</i>
<i>3.3.1 Watersheds.....</i>	<i>43</i>
<i>3.3.2 Streams and Waterbodies</i>	<i>46</i>
<i>3.3.3 Drinking Water Sources and Water Use</i>	<i>47</i>
<i>3.4 Working Lands</i>	<i>52</i>
<i>3.4.1 Present Use Value (PUV) Program</i>	<i>52</i>
<i>3.4.2 Farmlands.....</i>	<i>54</i>
<i>3.4.3 Forestlands.....</i>	<i>61</i>
<i>3.5 Urban Forests and Tree Canopy.....</i>	<i>68</i>

3.6 *Open Space – Trails and Recreational Resources*..... 71

3.7 *Cultural and Historic Resources*..... 74

CHAPTER 4 - GREEN INFRASTRUCTURE ASSESSMENT 77

4.1 *Threats to Natural Resources*..... 77

4.1.1 Population Growth and Land Use Change 78

4.1.2 Insects, Diseases, and Non-native Invasive Plants..... 81

4.1.3 Fire Exclusion and Wildfire Hazard 85

4.1.4 Mining and Mineral Prospects..... 88

4.2 *Natural Resource Conditions and Trends*..... 88

4.2.1 Natural Communities and Wildlife Habitats 88

4.2.2 Water Resources..... 93

4.2.3 Working Lands..... 99

4.2.4 Urban Canopy and Air Quality..... 101

CHAPTER 5 - GREEN INFRASTRUCTURE PLANNING..... 102

5.1 *Why Plan for Green Infrastructure?* 102

5.2 *How Do You Plan for Green Infrastructure?* 102

5.2.1 A Framework for Green Infrastructure Planning in Johnston County 102

5.3 *What Tools are Available for Implementing Green Infrastructure Planning?*..... 106

5.4 *What can Johnston County Residents do to Promote Green Infrastructure in the County?*..... 107

List of Acronyms..... 108

List of References 110

Terms and Definitions 115

LIST OF FIGURES

Figure 1.	Green Infrastructure Diagram.....	2
Figure 2.	Townships, Towns, Unincorporated Communities, and Major Roads in Johnston County	10
Figure 3.	2006 Generalized Land Use / Land Cover in Johnston County	12
Figure 4.	Physiography and Ecoregions in Johnston County.....	14
Figure 5.	Geologic Belts and Rock Types in Johnston County	15
Figure 6.	Geologic Formations, Faults, and Dikes in Johnston County	16
Figure 7.	Soil Systems in Johnston County	17
Figure 8.	General Soil Map of Johnston County	18
Figure 9.	Landscape Habitat Indicator Guilds in Johnston County.....	33
Figure 10.	Significant Natural Heritage Areas in Johnston County	37
Figure 11.	CPT Biodiversity and Wildlife Habitat Assessment for Johnston County	41
Figure 12.	River Basins in Johnston County	43
Figure 13.	Subwatersheds, Watershed Planning Areas, Surface Waters, and Surface Water Intakes in Johnston County	49
Figure 14.	CPT Water Services Assessment for Johnston County.....	51
Figure 15.	Farmland and Forestland Enrolled in the PUV Program as of August 2011 in Johnston County.....	53
Figure 16.	Prime Farmland Soils in Johnston County	57
Figure 17.	CPT Farmland Viability Assessment for Johnston County	60
Figure 18.	Statewide Assessment of Forest Resources Priority Landscapes, Priority Maps, and Input Data Layers.....	63
Figure 19.	SAFR Rural Forest Priority Landscapes in Johnston County.....	64
Figure 20.	SAFR Urban Forest Priority Landscapes in Johnston County	65
Figure 21.	SAFR Priorities for Conserving Working Forestlands in Johnston County	66
Figure 22.	SAFR Priorities for Maintaining Viable Urban Forests in Johnston County	67
Figure 23.	Urban Tree Canopy and Land Cover in the Town of Clayton, Johnston County	69
Figure 24.	Urban Tree Canopy and Land Cover in the Towns of Selma and Smithfield, Johnston County.....	70
Figure 25.	Conserved Open Space, Trails, and Recreational Resources in Johnston County	73
Figure 26.	Historic Sites in Johnston County Listed in the National Register of Historic Places ...	76
Figure 27.	SAFR Priorities for Forest Health in Johnston County	84
Figure 28.	SAFR Priorities for Protecting Forests and Communities from Wildfire Risk in Johnston County.....	87
Figure 29.	Trends in Forest / Natural Cover and Impervious Cover from 1992, 2001, and 2006 Summarized by NHD Plus Catchments and 2010 303(d) Listed Streams in Johnston County.....	95
Figure 30.	Source Water Assessment Program Susceptibility to Contamination in Johnston County.....	98

LIST OF TABLES

Table 1.	Incorporated Towns and Date of Incorporation	9
Table 2.	2010 Estimated Population by City in Johnston County	11
Table 3.	2006 Land Use / Land Cover in Johnston County.....	11
Table 4.	Major Soil Types (Series) in Johnston County	17
Table 5.	Biological Themes, Natural Plant Communities, and Associated NCWAP Habitat Types in Johnston County	21
Table 6.	NCWAP Habitat Types – Significance for Wildlife by Ecoregion.....	22
Table 7.	Significant Natural Heritage Areas in Johnston County	35
Table 8.	Definitions for Significant Natural Heritage Area Significance Ranks	36
Table 9.	Rare Species with Current Known Occurrences in Johnston County	38
Table 10.	Input Layers for the CPT Biodiversity and Wildlife Habitat Assessment.....	40
Table 11.	River Basins, Subbasins, Watersheds, and Subwatersheds in Johnston County	43
Table 12.	Primary Surface Water Classifications used in Johnston County and Surrounding Counties	46
Table 13.	Local Water Supply Plans in Johnston County	47
Table 14.	Water Systems, Water Sources, Source Types, Usage, Supply, and Population Served in Johnston County	48
Table 15.	Input Layers for the CPT Water Services Assessment.....	50
Table 16.	Soils Designated Prime Farmland and of Statewide Importance in Johnston County .	55
Table 17.	Businesses Supporting the Agriculture Industry in Johnston County	59
Table 18.	Businesses Supporting the Forest Industry in Johnston County	62
Table 19.	Urban Tree Canopy Categories and Land Cover for Clayton, Selma, and Smithfield .	68
Table 20.	Trails and Recreational Resources in Johnston County	71
Table 21.	Cultural and Historic Resources in Johnston County Listed in the National Register of Historic Places.....	74
Table 22.	Population Growth by City in the Last Two Decades in Johnston County.....	78
Table 23.	Population Growth in the Last Four Decades in Johnston County	79
Table 24.	Significant Insects, Diseases, and Non-native Invasive Plant Threats to Johnston County.....	81
Table 25.	NCWAP Habitats – Status and General Conditions by Ecoregion	89
Table 26.	NCNHP Natural Communities, NCWAP Habitats, and NLCD Generalized Land Cover Types – Acreage and Percent Change from 1992, 2001, and 2006	91
Table 27.	Impaired 303(d) Listed Waters in Johnston County	94
Table 28.	Trends in Farmlands from the Last 25 Years in Johnston County.....	99
Table 29.	Trends in Timberland Values from the Last 10 Years in Johnston County	100
Table 30.	Effect of Urban Canopy on Air Quality in Town of Smithfield, Johnston County	101

CHAPTER 1 - JOHNSTON COUNTY NATURAL RESOURCE INITIATIVE

1.1 Project Description

The Johnston County Natural Resource Initiative (JCNRI) is a collaborative effort among County and municipal governments, natural resource professionals, and non-profit organizations to develop and promote strategies in the County for the conservation of natural resources through a network of farms, forests, and open space.

1.2 Project Participants

Project partners include Johnston County Soil and Water, Johnston County Cooperative Extension, Johnston County Planning Department, North Carolina Natural Heritage Program, North Carolina Forest Service, North Carolina Wildlife Resources Commission, North Carolina State University, Triangle Land Conservancy, Triangle J Council of Governments, and staff from the towns of Benson, Clayton, Selma, Smithfield, and Wilson's Mills. Funding for this project was provided through a grant from the USDA Forest Service, Southern Region.

The North Carolina Forest Service led the assessment process and worked in conjunction with the Johnston County Planning Department to meet their need for a reference document concerning the natural resources of the County. All other agencies and organizations involved provided expertise and guidance related to their particular field of natural resource management.

Johnston County residents and landowners were invited to participate in three different workshops. The first workshop, held on March 31, 2009, introduced the project to residents and landowners, educated them about green infrastructure, and allowed for public input and comment on the project. A second workshop was held on November 12, 2009. This workshop gave residents the opportunity to learn about the progress of the JCNRI. All attendees had an opportunity to identify natural resource areas that are important to them by highlighting on provided maps. The final workshop aimed at the public was held on September 23, 2010 and was conducted to solicit comments on the final draft of the assessment report. Feedback from those public meetings was incorporated into the assessment.

A workshop for planners and elected officials from the County as well as all the cities and towns in the County was held on September 23, 2010. A speaker from the Green Infrastructure Center presented on how to use green infrastructure planning and how this document could be used by city planners and elected officials.

1.3 Overview of Green Infrastructure

Green infrastructure (GI) is a connected network of green spaces (natural lands, working lands, and open space) that is planned and managed for its natural resource value and for the associated benefits and services provided to people and communities. Those benefits and services are collectively referred to as "ecosystem services."

Ecosystem services are generally viewed as free benefits to society, such as wildlife habitat, watershed services, carbon storage, and scenic landscapes. Many lacking formal markets, these natural assets are often overlooked in public, corporate, and individual decision-making processes.

Recognizing ecosystems as natural assets with economic and social value can help promote conservation and more responsible decision-making. Green infrastructure plays a critical role in providing the natural resources (water, land, air, forest, wetlands, etc.) that support our communities, cities, and societies. Without these resources, our basic needs for food, shelter, and raw materials will not be met.

Normally, when we think of infrastructure, we think of grey infrastructure such as buildings, roadways, sewer systems, etc. The highways need to be connected to side streets in order for us to get from our homes to places of business and utilities need to be connected to these same places to provide electricity and water. We understand that there has to be connectivity between our roads and highways, utility lines, and water systems for this infrastructure to function successfully. We depend on this system to sustain and improve society.

Green infrastructure is applying these same concepts of connectivity to forests and the natural system. It is a strategic approach to land conservation, addressing the economic and social impacts of sprawl and fragmented land on natural communities, forestlands, and farmlands.

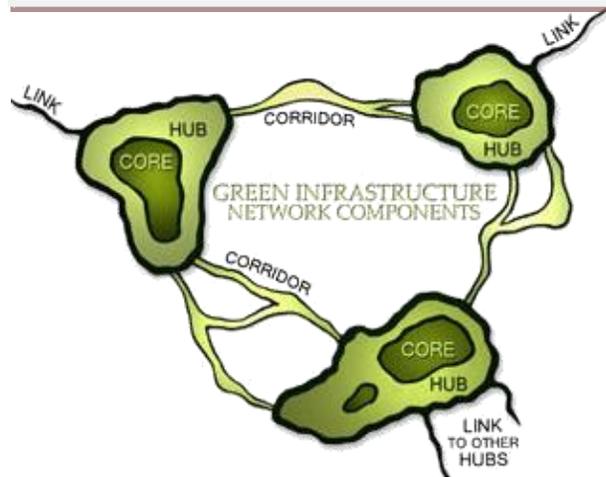
The green infrastructure network is formed by connecting significant sites (community parks and arboreta) and natural hubs (working lands, state forests, significant natural areas, and wildlife refuges) through linkages such as trails and river corridors.

Green infrastructure can be managed at a number of different scales for a multitude of objectives; it is designed to be flexible and adjustable to the needs of current development. For green infrastructure to function properly the whole network must be actively managed. As development and other land use changes occur, it is important to keep the system of cores, hubs, corridors, and links connected in such a way that benefits are still realized and ecosystem services are still delivered. Just as grey infrastructure is managed to meet the needs of society, so must the components of green infrastructure.

Green infrastructure systems can be:

- ✿ Protected watersheds that provide safe and dependable drinking water supply for communities;
- ✿ Forested landscapes that help protect water quality, provide wildlife habitat, and increase ecosystem biodiversity;
- ✿ Agricultural landscapes that provide crops and pollination services;
- ✿ Planted swales or detention ponds that retain, absorb, and filter storm water run-off;
- ✿ Managed greenways that provide year-round recreational opportunities for citizens; and / or
- ✿ Significant cultural, historic, and natural heritage sites.

Figure 1. Green Infrastructure Diagram



** Green Infrastructure Diagram created by
The Conservation Fund*

1.4 Purpose of the Green Infrastructure Assessment

Infrastructure is the underlying foundation upon which the continuance and growth of any community depends. As Johnston County grows in population, more roads, homes, and businesses will be developed and built to accommodate the growth. The green infrastructure of the County needs to be assessed in order to plan for the best way to conserve, protect, and use the natural resources of the County in concert with land development and grey infrastructure. Johnston County's natural resources currently provide clean water, productive farmland and forestland, livable wildlife habitats, and enticing recreational areas. Breaking the links between these elements can increase the risk of flooding; increase sedimentation in creeks and rivers; increase costs for providing goods, utilities, and services; and degrade the desirability and appeal of recreational areas.

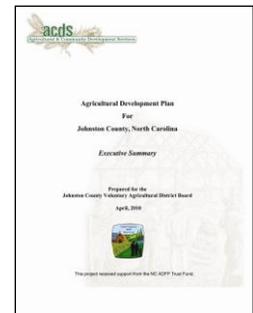
An assessment of the County's existing green infrastructure helps prioritize conservation opportunities and can direct development in ways that optimize land uses to meet the needs of people while conserving natural resources.

1.5 Summary of Related Projects

The *Johnston County Green Infrastructure Assessment* was conducted with the assistance of several existing projects. A brief description of each of these projects is provided below, listed in alphabetical order. Portions of this Report have been copied directly from these projects / products in an effort to prevent misrepresenting the information provided by each.

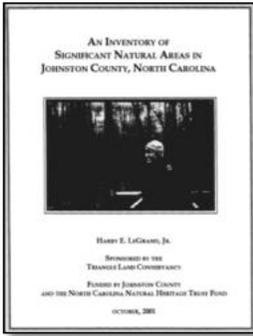
Agricultural Development Plan for Johnston County

The continued success of agriculture and agribusiness in Johnston County is dependent upon adequate land and other natural resources. In 2006, the Johnston County Board of Commissioners adopted the Voluntary Agricultural District Ordinance creating the Johnston County Voluntary Agricultural District program. N.C. Cooperative Extension, working with the Johnston Soil and Water Conservation District and the Johnston County Voluntary Agricultural District Board, acquired a grant from the North Carolina Agriculture Development and Farmland Preservation Trust Fund in 2008 to create a farmland protection plan for Johnston County.



The Voluntary Agricultural District Board provided the oversight for the development of the agricultural plan and contracted with J. Philip Gottwals, Agricultural & Community Development Services to assist with data collection and writing the plan. The plan is named the *Agricultural Development Plan for Johnston County* (Ag Plan) and was adopted by the Johnston County Board of Commissioners as a policy guidance document on April 5, 2010.

The adopted Ag Plan consists of three segments including an Executive Summary, the Johnston County Agricultural Land Use Findings and Recommendations, and the Johnston County Agricultural Economic Development Findings and Recommendations. The Ag Plan provides a framework for the continued success and further expansion of the agricultural industry in Johnston County. The Ag Plan can be accessed online at www.johnstonnc.com/planning.



An Inventory of Significant Natural Areas in Johnston County

Beginning in 1999 and concluding in 2001, the N.C. Natural Heritage Program (NCNHP) conducted an inventory of the natural areas of Johnston County. The primary objective of the Johnston County natural area inventory was to identify the most significant natural areas in the County, describe their features, and document all of the natural communities and rare species of plants and animals associated with them. In addition, recommendations for the management and protection of each of these sites are described.

A total of 39 significant natural heritage areas (sites) are described. Of these, two (the Little River and Swift Creek) are considered to be Nationally significant. A number of other rivers and creeks are significant at the State and Regional level. The most significant terrestrial area is the Neuse River floodplain below Interstate (I-) 95, a State significant region of extensive bottomlands and other alluvial features. The County also contains several significant remnant pine flatwoods and a handful of significant sandhills communities. Several bluffs, slopes, and floodplain knolls are also significant. For more details on these sites, or to order the report, visit:

www.ncnhp.org/Pages/publications.html.

The inventory report provides a framework for conservation of the biological diversity found in the County. The County contains very little land managed for conservation by public agencies or private organizations. Thus, it is hoped that the identification of the County's most significant natural resources documented in this report will lead to voluntary conservation of many of the significant biological features in Johnston County.



Johnston County 2030 Comprehensive Plan

After two decades of rapid growth, Johnston County experienced numerous growth pressures including clogged roadways, overburdened utilities, crowded schools, suburban sprawl and conflicting land uses. Although various planning documents had been prepared in the past, Johnston County leaders realized there was a limit to how the County could

handle the growth pressures without some sort of coordinated framework for decision making in place, such as a comprehensive land use plan. Johnston County was one of the few counties in North Carolina without such a plan. Therefore, the Johnston County Board of Commissioners authorized the creation of a Comprehensive Land Use Plan. This plan was to identify the current and anticipated growth issues and provide a road map to help the County identify where it wanted to be and what it wanted to look like in the year 2030.

Objective 9B of the 2030 Comprehensive Plan: Work to Provide Connected Open Areas

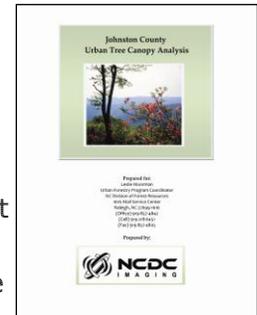
Action Recommendation 24: *Pursue preparation of a new Open Space / Recreation plan that identifies priorities for use of open space funds, with particular reference to ongoing initiatives such as the Green Infrastructure Project and the Mountains-to-the-Sea trail project.*

Action Recommendation 26 & 35: *Include the findings and recommendations of the ongoing Green Infrastructure initiative, when completed, into this Comprehensive Plan.*

After a year of preparation through the assistance of Clarion Associates and numerous public hearings and workshops, the Board of County Commissioners adopted the *Johnston County 2030 Comprehensive Plan* in 2009. The plan identifies goals and objectives with recommended strategies on how to deal with key growth related issues. The themes of these issues include managing growth / infrastructure, expanding economic activities, providing housing / protecting neighborhoods, preserving farmland / rural character, protecting environment / cultural resources, enhancing mobility, and intergovernmental coordination. The comprehensive plan refers to the use of this green infrastructure assessment report in Objective 9B and also in Action Recommendations 24, 26, and 35. A copy of the final plan can be found at: www.johnstonnc.com/planning.

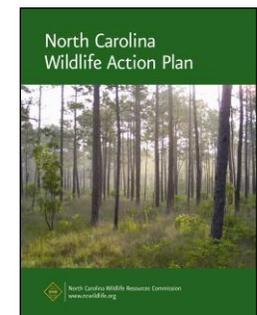
Johnston County Urban Tree Canopy Analysis

As a component of this assessment, the N.C. Forest Service contracted NCDC Imaging to conduct an analysis and summary of existing and possible urban tree canopy (UTC) throughout the cities of Clayton, Selma, and Smithfield. NCDC Imaging produced a comprehensive land cover classification and multiple summary statistics. The resulting data can be used to visualize present land use zones and land cover throughout the three cities. The UTC analysis includes Possible UTC, wherein Possible UTC is defined by the question, “Where is it biophysically feasible to plant trees?” and is the initial step in an assessment process. It includes any land theoretically available for the establishment of tree canopy but does not consider costs, logistics, or future land use. Possible UTC areas can therefore be any lands not currently covered by water, roads, or buildings. This analysis was used by the JCNRI to evaluate the existing UTC in the cities of Clayton, Selma, and Smithfield as a component in the green infrastructure. The analysis could be a tool to aid in the continued promotion of tree planting efforts.



N.C. Wildlife Action Plan

In 2001 the U.S. Congress set up the State Wildlife Grants Program after recognizing that much of our nation’s wildlife is at risk of population decline. This initiative mandated that each state develop a proactive strategy, or a wildlife action plan, to conserve, protect, and restore fish and wildlife populations into the future. The N.C. Wildlife Resources Commission, in partnership with numerous conservation partners, completed North Carolina’s Wildlife Action Plan in 2005.



The N.C. Wildlife Action Plan (NCWAP) identifies fish and wildlife species and habitats most in need of conservation action, and outlines conservation strategies to address these needs. The NCWAP identifies 371 priority species of birds, mammals, reptiles, amphibians, fish, mollusks, and crustaceans in need of protection. The NCWAP promotes a proactive, cost-effective approach to the conservation of wildlife habitats.

The NCWAP can be used to identify which “priority habitats and species” (i.e., animals and habitats most in need of conservation action) can be found in the Mountains, Piedmont, and Coastal Plain. Identification of priority habitats and species at the county level requires technical resource professional review. These priority habitats can be included in private or public development and planning processes. Conservation strategies outlined in the NCWAP can also help guide

development. Additional information about the North Carolina Wildlife Action Plan can be found at: www.ncwildlife.org/plan/index.htm.



One NC Naturally – Conservation Planning Tool (CPT)

The N.C. Department of Environment and Natural Resources (NCDENR) recognizes the need to coordinate statewide conservation efforts as population pressures threaten our state’s finite natural resources. Developed in response to this need, the *One NC Naturally Conservation Planning Tool* provides a framework for decisions about future growth, while also ensuring that significant benefits provided by our state’s natural resources will be preserved for future generations.

The *One NC Naturally Conservation Planning Tool* was envisioned to streamline the process of identifying and prioritizing the areas in North Carolina’s landscape that are essential for conservation. Specifically, the focus of the CPT is on identifying, evaluating, and prioritizing the conservation of an interconnected network of ecosystem resources and functions, upon which citizens of the state depend. The selected planning approach draws upon the expertise of the Natural Heritage Program and is based on “Green Infrastructure” principles, which emphasize the importance of maintaining an interconnected network of green space that conserves valuable natural ecosystem functions, while also providing associated benefits to human populations. This analysis pinpoints areas that are already protected, as well as those areas in the landscape that represent protection “gaps” in a functional ecosystem network.

Recognizing the dual role that ecosystem functions play for wildlife and humans, separate assessments were developed to more accurately rank the functions of each. The assessment series, which is composed of geospatial data layers, does not value one kind of benefit over another, but separates them into six classifications. The values used to assess necessary ecosystem functions are different enough that no meaningful combination into a single scale can be made. For example, it would not be reasonable to compare the significance of drinking water to the value of a rare species.

The *One NC Naturally Conservation Planning Tool* includes six natural resource assessment maps:

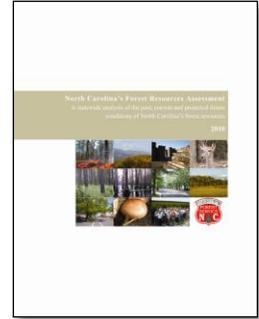
- ✿ Biodiversity and Wildlife Habitat,
- ✿ Open Space and Conservation Lands,
- ✿ Water Services,
- ✿ Agriculture Lands, and
- ✿ Forestry Lands.

This comprehensive planning tool can be used by individual organizations, state, and local agencies to inform decisions about conservation and other land use planning efforts in North Carolina. The assessment maps can be used independently or in combination. By coordinating assessment data, various programs can quickly identify lands that provide multiple benefits for compatible uses. The ranking system helps prioritize conservation funding decisions, resulting in cost-effective investment of tax dollars towards our most precious and vulnerable remaining lands.

For more information visit: www.onencnaturally.org.

Statewide Assessment of Forest Resources (SAFR)

With the passing of the 2008 Farm Bill, amendments to the Cooperative Forestry Assistance Act required state forestry organizations to conduct state-wide assessments of forest resources and develop strategies for forest resource conservation and management. The overarching goal of this new initiative is to identify priority forest landscape areas and highlight work needed to address national, regional, and state forest management priorities. The N.C. Forest Service (NCFS), in collaboration with many agencies and organizations, began work on the *State-wide Assessment of Forest Resources* followed by the *State-wide Forest Resource Strategy* in early 2009 and completed the project in mid-2010.

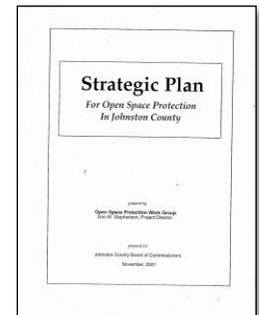


The assessment was designed to provide a comprehensive analysis of the forest-related conditions, trends, threats, and opportunities within the state. The strategy is intended to provide a long-term, comprehensive, coordinated strategy for investing state, federal, and leveraged partner resources to address the management and landscape priorities identified in the assessment. The Strategy also incorporates existing statewide forest and resource management plans and provides the basis for future program, agency, and partner coordination.

While the NCFS is overseeing the development of the assessment and strategy, collaboration, expertise, and feedback of many other agencies, organizations, and individuals was critical for the successful completion of the project. This project was used by the JCNRI to evaluate the forest resources that are part of the green infrastructure in Johnston County. The assessment and strategy were both published in *North Carolina's Forest Resources Assessment* and can be found at: www.ncforestassessment.com/index.htm.

Strategic Plan for Open Space Protection in Johnston County

In July 2000, a strategic plan to protect natural areas, historic and cultural resources, farmland, and recreational resources within the County was prepared. A broad-based stakeholder group was formed and meetings were held to develop a strategic plan that could guide the County's efforts in meeting stakeholder needs for open space protection. The *Strategic Plan for Open Space Protection in Johnston County* was presented to the Johnston County Board of Commissioners in November 2001.



The *Strategic Plan for Open Space Protection in Johnston County* can be summarized into these four different recommendations: 1) how to develop a needed infrastructure within the County government to administer an effective open space protection program; 2) identify and obtain funds for acquisition of open space lands; 3) raise public awareness; 4) identify and develop specific protective strategies for the various types of open space.

This open space plan was used by the JCNRI to confirm components of green infrastructure that have already been identified. The JCNRI also used the open space plan as a building block to assess which recommendations have and have not been successful in keeping open spaces as viable and important features of Johnston County.

Water 2030 Initiative

In March 2004, the N.C. Rural Economic Development Center (NCREDC) began the Water 2030 Initiative to provide “citizens and leaders with information critical to making sound decisions about North Carolina’s water future.” The Water 2030 Initiative is a statewide water resources initiative working to ensure that North Carolinians in every part of the state have access to ample supplies of clean water. The initiative produced information on the state's public infrastructure and long-term water supply and is engaging leaders and citizens in discussions about the future of North Carolina's water resources.

In an effort to identify the areas of greatest need for additional water supply planning in the state, NCREDC forecasted estimates of water demand growth from 2005 to 2030. These estimates, which are currently being updated, were used to supplement County public utility data in an effort to identify the County’s greatest water supply challenges (i.e., shortages). Additional information about the Water 2030 Initiative can be found at the following website: www.ncruralcenter.org/rural-policy/246-water-2030-initiative.html.

CHAPTER 2 - AN OVERVIEW OF JOHNSTON COUNTY



2.1 Brief County History

The first known inhabitants of what is now Johnston County were the Tuscarora Native Americans. The Tuscarora people settled in the fertile Neuse River valley to farm, fish, and hunt. The tribe built many trails and villages, which were largely abandoned in the late 1600’s when they moved north to assist the Iroquois in resisting the English expansion (Powell, 2006).

These trails were eventually discovered and connected to an English trading route known as Green’s Path, which roughly followed present day I-95. One of the earliest (circa 1730’s) recorded land grants in this wilderness frontier was given to Joseph Boone. This tract of land came to be known as Boone Hill, which is present-day Princeton. Shortly thereafter John Smith Sr. was also granted land along the banks of the Neuse River. A portion of this land became Smith’s Ferry and eventually the Town of Smithfield. Smith’s Ferry was a strategic stop and trading post that provided travelers overnight lodging along the river en route to the port at New Bern, which was the State Capitol at the time. During this period, English and Scottish settlers came up the river and down Green’s Path to claim fertile land and start small family farms. In time, Smithfield became an important agricultural distribution center for shipping cotton and tobacco down to New Bern. The County was also known to produce corn, wheat, oats, and some wool.

As the population grew, it became increasingly more difficult for the Craven County government, also centered in New Bern, to govern from such a great distance. In 1746, the Colonial Assembly divided the land that was Craven County, creating Johnston County and naming it after the Royal Governor Gabriel Johnston (Lassiter, 2004). A riverside courthouse was built in Smithfield in 1771 and served as the seat of County government until 1786 when a new one was constructed at the intersection of Second and Market streets.

From early in its history, agriculture has been an economic asset of the County. The Smithfield Tobacco Market operated for over 100 years, and Johnston County continues to be a strong agricultural county in North Carolina (JCVB, 2009).

2.2 Johnston County Today

Located in east-central North Carolina, Johnston County is the tenth largest county in land area in the state, covering approximately 795 square miles. The County is comprised of a diverse landscape dominated by agricultural land, forestland, and expanding urban areas.

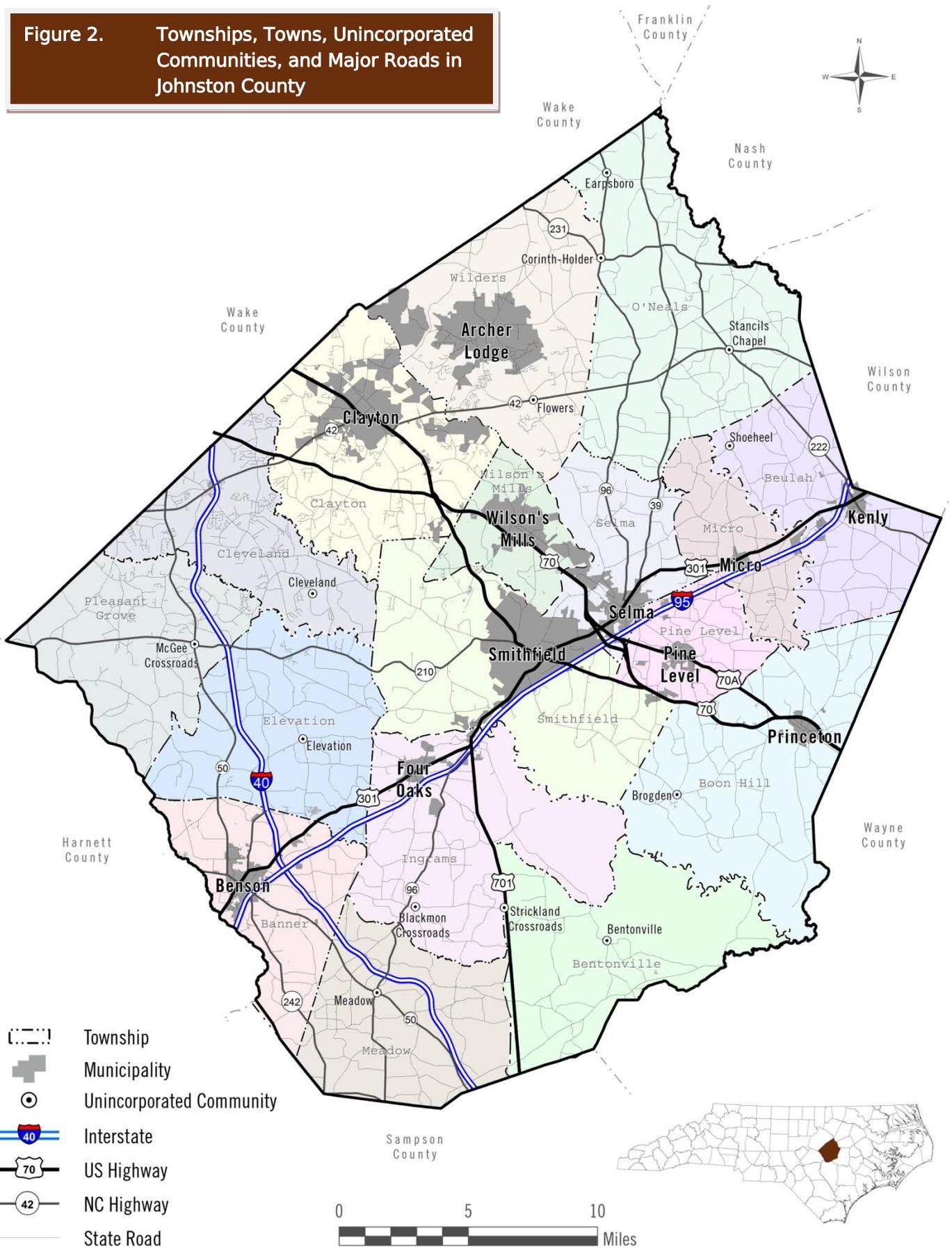
There are 17 townships, 11 incorporated towns (Table 1), and many unincorporated communities in the county (Figure 2, next page).

Table 1. Incorporated Towns and Date of Incorporation

Town	Date Incorporated
Archer Lodge	2009
Benson	1887
Clayton	1869
Four Oaks	1889
Kenly	1887
Micro	1899
Pine Level	1874
Princeton	1861
Selma	1873
Smithfield	1777
Wilson’s Mills*	1927 / 1995

*Wilson’s Mills was first chartered in 1927, surrendered its charter in 1971 as an inactive municipality, and was re-chartered in 1995.

Figure 2. Townships, Towns, Unincorporated Communities, and Major Roads in Johnston County



2.2.1 Population

As of 2010, the estimated population was 168,878, approximately 212 people per square mile (Table 2). The top three population centers in descending order are: Clayton, Smithfield, and Selma (USCB, 2010). The County continues to grow with many new residents moving in from neighboring Wake County. As noted in the *Johnston County 2030 Comprehensive Plan*, areas experiencing the most growth are along the Johnston-Wake County border, in and around Clayton, and the I-40 / N.C. Highway 42 interchange. Relative close proximity to the Raleigh-Durham-Research Triangle Park – combined with easy access to transportation corridors – is concentrating growth in the northern and western parts of the County.

Table 2. 2010 Estimated Population by City in Johnston County

City	Estimated Population in 2010
Archer Lodge	4,292
Benson	3,311
Clayton	16,116
Four Oaks	1,921
Kenly	1,176
Micro	441
Pine Level	1,700
Princeton	1,194
Selma	6,073
Smithfield	10,966
Wilson's Mills	2,277
Non-Municipal	119,411
TOTAL	168,878

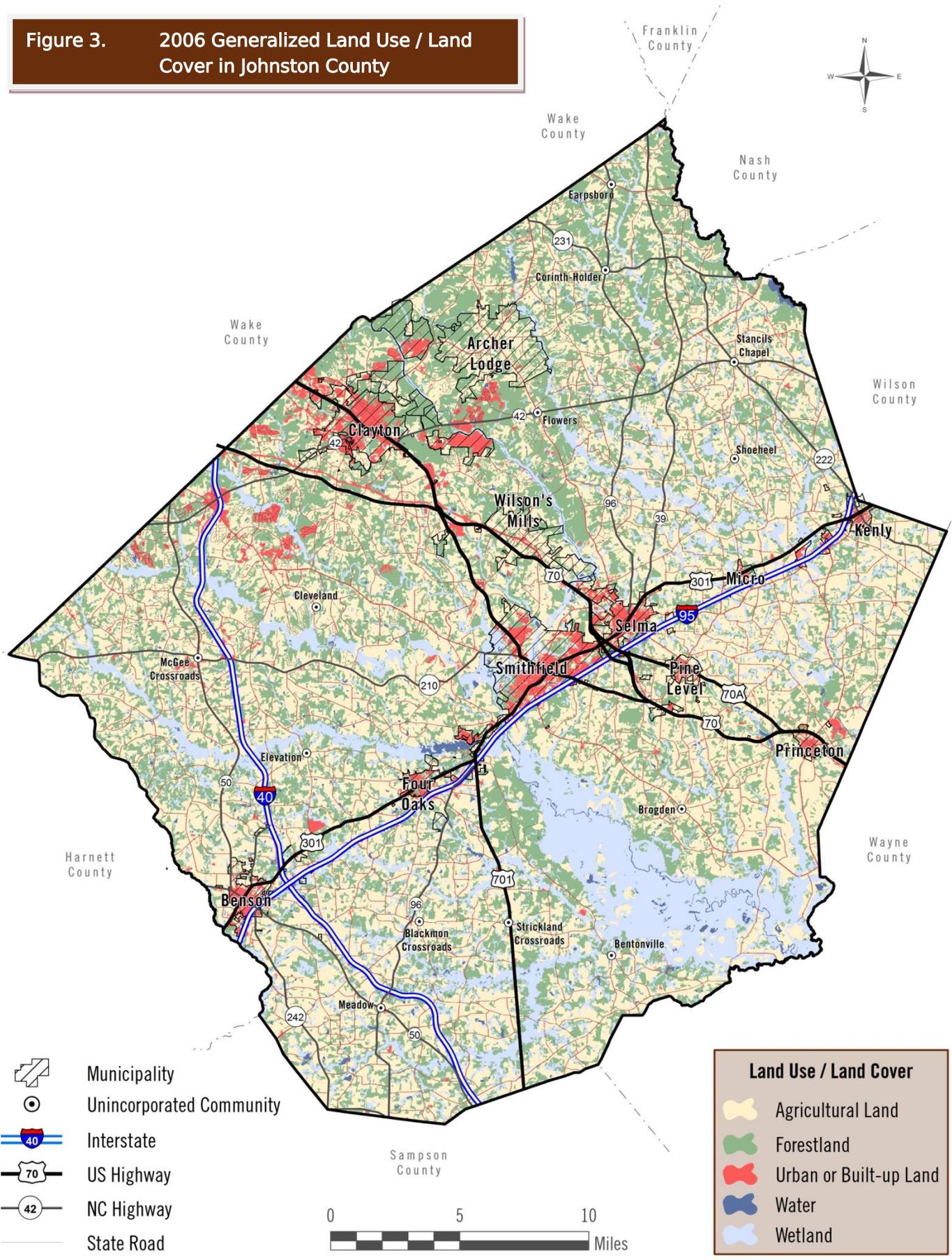
2.2.2 Land Use

According to the 2006 National Land Cover Database (NLCD), Johnston County is comprised of approximately 509,123 acres of agricultural land, forestland, urban land, water, and wetland. Despite population growth and expanding urban centers, the County remains predominately rural, with approximately 465,330 acres or 91 percent classified as agricultural land, forestland, water, or wetland (Fry et al., 2011). Urban land uses represent approximately nine percent of the County with a majority located within municipal boundaries and along the I-40 and I-95 corridors and interchanges. Generalized NLCD land use / land cover (LULC) data for the County is summarized in Table 3 and Figure 3 on the next page.

Table 3. 2006 Land Use / Land Cover in Johnston County

Land Use / Land Cover	Acres	Percentage of County
Agricultural Land	226,620	44 %
Forestland	152,034	30 %
Urban or Built-up Land	43,793	9 %
Water	5,340	1 %
Wetland	81,336	16 %
TOTAL	509,123	100 %

Figure 3. 2006 Generalized Land Use / Land Cover in Johnston County



2.2.3 Business, Industry, and Transportation

Agriculture has long been an economic driver for the County. However, in recent years, the leading industries for employment in Johnston County have been educational services, health care, social assistance, construction, and retail trade. According to 2010 employment records, manufacturing, retail trade, health care / social assistance, and food service industries represented approximately 56 percent of the County's employment (JCEDO, 2011). The diversity of business ranges from small family-owned companies to globally-positioned corporate manufacturers and distributors. Johnston County is attractive to business and industry because of easy access to transportation routes, including railroads, major state roads, and two interstates, as well as its proximity to Research Triangle Park. The quality of life afforded to residents, and thus potential employees, helps attract businesses to the County.

Housing construction contributed to a rapid population and development growth period over the past two decades. While this sector of the economy is still recovering, housing, office, and retail construction could rebound more quickly in the County given its proximity to major transportation corridors and the Research Triangle Park. Tourism, and its relationship to a strong retail industry, is a meaningful component of the County's economy, which could be further developed through green infrastructure planning.

Agriculture and the associated agribusinesses represent a critical segment of the local economy in Johnston County, contributing over \$3 billion value-added annually. In addition, agriculture and agribusiness represent 9,500 jobs or 15.2 percent of the County's workforce. According to the 2007 U.S. Census of Agriculture, Johnston County farms represented 194,090 acres or 38 percent of the total land area in the County. The 2009 agricultural statistics for North Carolina placed Johnston County 3rd in the state for cash receipts from crop production, ranking 2nd for tobacco, vegetables, fruits, and nuts and 8th for soybeans (NASS, 2010).

Forestry is also an important contributor to the County's economy. Average annual total stumpage value (price paid to landowner for standing timber) between 2007-2010 was more than \$3.8 million, with the delivered value (price paid to timber buyer upon delivery of timber to the mill) nearly twice that amount. There are four sawmills located in the County that collectively produce approximately 73 million board feet of lumber annually.

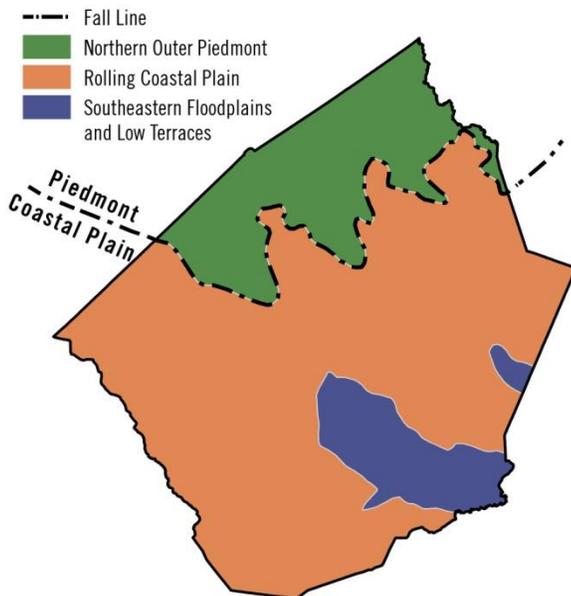
Local market availability is vital to sustain production of agricultural and forestry-based commodities, which represent a core component of Johnston County's economy and green infrastructure.

CHAPTER 3 - JOHNSTON COUNTY NATURAL RESOURCES

Natural resources are the materials supplied by Earth and its processes, including but not limited to nutrients, minerals, water, plants, and animals. These resources are the foundation of the ecological and economic health of the County.

This chapter is intended to provide a descriptive summary of the natural resources found in Johnston County. Additional information about the County's natural resources can be found in the documents discussed in Section 1.5 of this report and within the referenced publications.

Figure 4. Physiography and Ecoregions in Johnston County



3.1 General County Description

3.1.1 Physical Geography and Topography

Johnston County is located in portions of two physiographic provinces – the Piedmont and Coastal Plain. The transition between these physiographic regions is commonly termed the “Fall Line,” and yields a relatively diverse landscape (Figure 4). While the name implies a steep drop-off, the Fall Line is more of a gradual transition from the rolling land of the Piedmont to the flatter land of the Coastal Plain. These physiographic regions can further be divided into ecoregions, including the Northern Outer Piedmont, Rolling Coastal Plain, and Southeastern Floodplains and Low Terraces (Griffith et al., 2002).

The transition of these three ecoregions creates many diverse landscape features (e.g., Flower Hill Preserve) that range from having steep to flat topography. The County's landscape elevation averages approximately

217 feet above mean sea level (AMSL), with the lowest (60 feet AMSL) natural elevation occurring as the Neuse River flows out of the southeastern portion of the County. The highest elevation (370 feet AMSL) occurs near the intersection of Shotwell Road and Covered Bridge Road just northwest of Clayton (NCDEM, 2002).

The most distinguished topographic feature within the County is the Neuse River; in particular, the Neuse River floodplain. As the Neuse River flows out of the Piedmont and into the Coastal Plain east of I-95, the floodplain widens to as much as four miles (LeGrand, 2001).

Physical geography (physiography), topography, geology, and soils heavily influence the terrestrial and aquatic communities found in the County, which in turn play a key role in supporting ecological diversity.

These geographic features also influence the businesses and industries of the County, and are the underlying factors that led to human settlement in the area.

3.1.2 Geology

Johnston County is comprised of primarily three geologic belts (terranes) – the Raleigh Belt, Eastern Slate Belt, and Coastal Plain Belt (Figure 5). The Piedmont portion of the County is largely underlain by old metamorphic and intrusive (igneous) rocks, while the Coastal Plain portion is underlain by much younger sedimentary rocks. The younger sedimentary rocks originate from deposits made on the Atlantic Ocean floor, when the ocean covered this portion of the County as recently as three million years ago (NCGS, 1988).

More detailed geologic information can be found in various publications authored by the N.C. Geological Survey (Wilson, 1981; NCGS, 1988; Carpenter, 1990; Carpenter et al., 1995; Carpenter et al., 1996a, 1996b; Carpenter et al., 1998a, 1998b, 1998c; Clark et al., 2004). A map of the detailed geology for Johnston County based on the 1985 Geologic Map of North Carolina can be found on the next page (Figure 6).

Figure 5. Geologic Belts and Rock Types in Johnston County

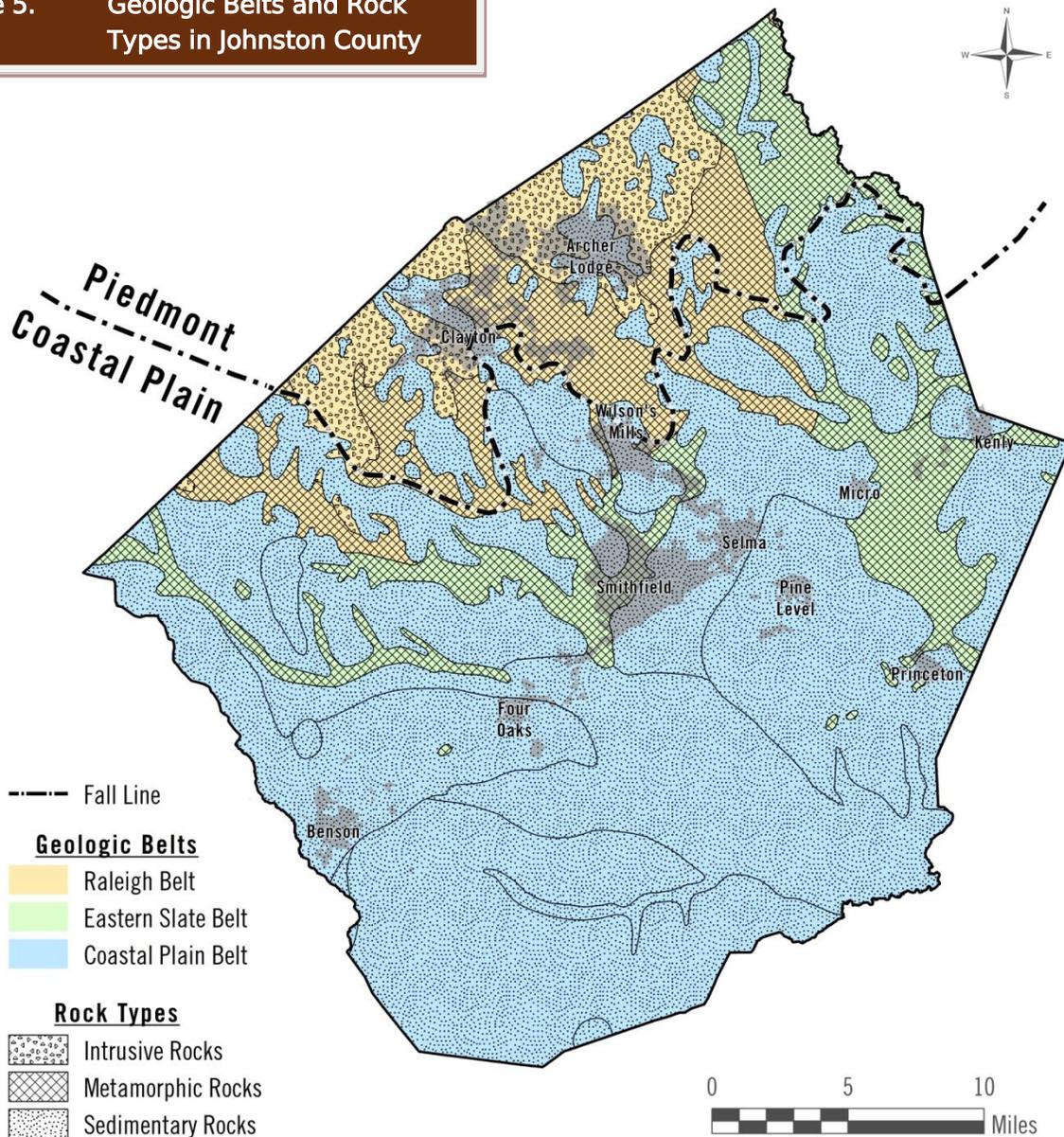
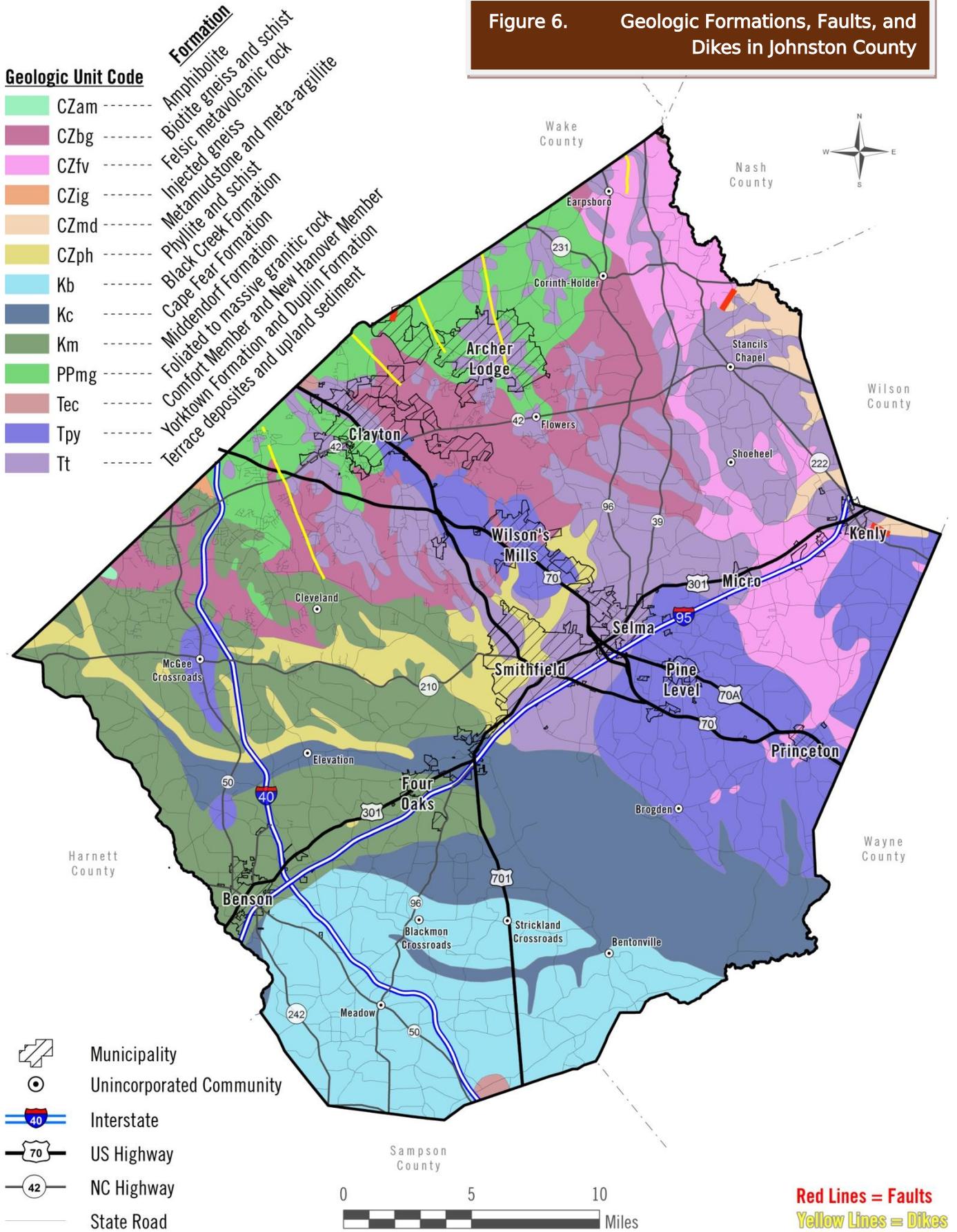


Figure 6. Geologic Formations, Faults, and Dikes in Johnston County



3.1.3 Soils

Geologic features that occur in Johnston County have weathered over time to create four predominant soil systems – the felsic crystalline system, upper coastal plain and piedmont system, middle coastal plain system, and large river valley and floodplain system (Daniels et al., 1999; Figure 7). Individual soils found in these soil systems vary based on the underlying geology, topography, and landscape position in which they occur. The General Soil Map of Johnston County (USDA, 1992) identified 10 general groups of soils that are found in similar landscape positions and have similar drainage characteristics (Figure 8, next page).

According to the Soil Survey of Johnston County (Bliley, 1994), these general soil groups are made of 40 individual major soil types (soil series) (Table 4).

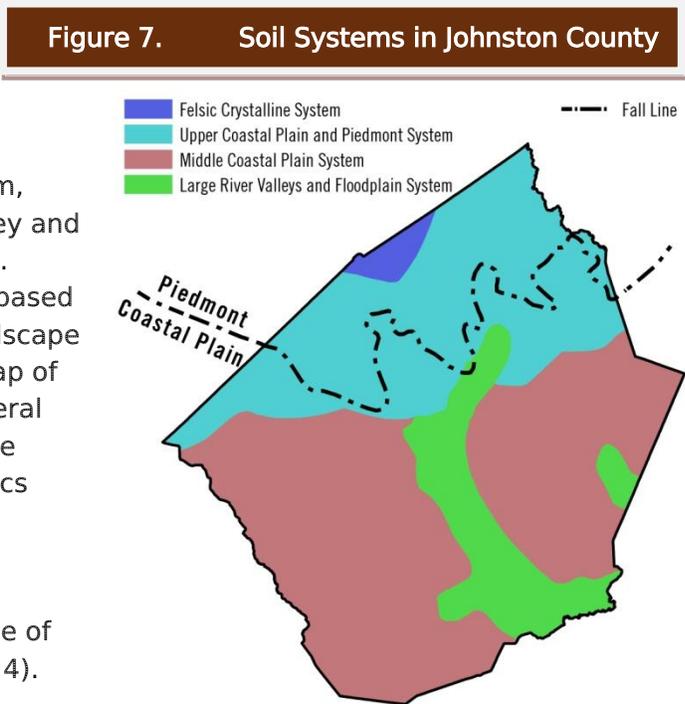


Table 4. Major Soil Types (Series) in Johnston County

Altavista	Cowarts	Marlboro	State
Appling	Dorian	Nahunta	Tarboro
Augusta	Faceville	Nankin	Toisnot
Autryville	Fuquay	Nason	Tomotley
Bibb	Gilead	Norfolk	Uchee
Blanton	Goldsboro	Pacolet	Vance
Bonneau	Grantham	Pantego	Varina
Cecil	Lakeland	Rains	Wagram
Chastain	Leaf	Rion	Wedowee
Chewacla	Lynchburg	Roanoke	Wehadkee

Additional information regarding soils well suited for agricultural crops can be found in Section 3.4.2.

Figure 8. General Soil Map of Johnston County

DOMINANTLY NEARLY LEVEL AND GENTLY SLOPING, WELL DRAINED TO POORLY DRAINED SOILS; ON UPLANDS OF THE COASTAL PLAIN

- 1 Norfolk-Goldsboro-Rains
- 2 Wagram-Blanton-Bonneau
- 3 Rains-Goldsboro-Lynchburg

DOMINANTLY GENTLY SLOPING TO MODERATELY STEEP, WELL DRAINED, MODERATELY WELL DRAINED, AND POORLY DRAINED SOILS; ON UPLANDS OF THE PIEDMONT AND THE COASTAL PLAIN

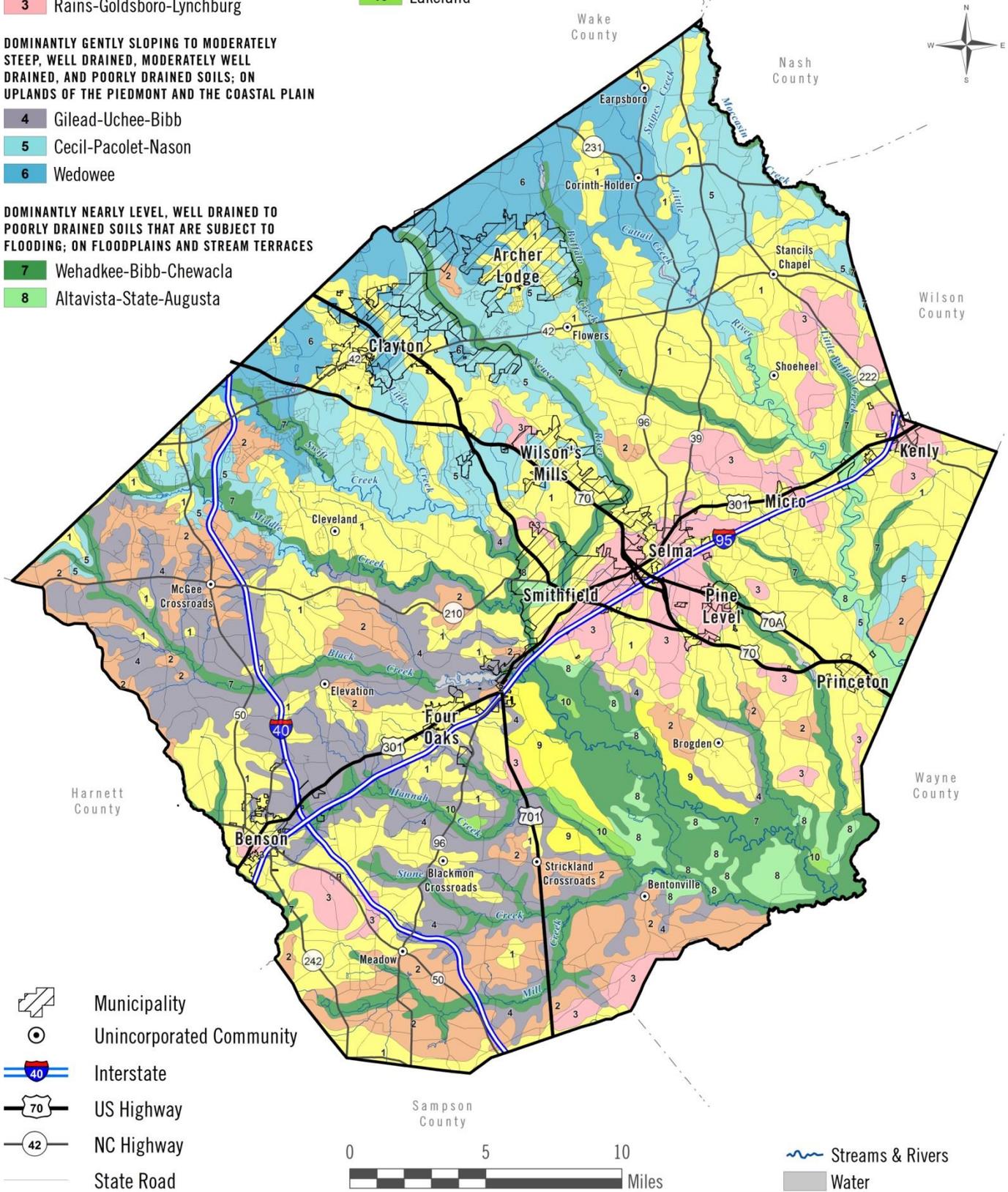
- 4 Gilead-Uchee-Bibb
- 5 Cecil-Pacolet-Nason
- 6 Wedowee

DOMINANTLY NEARLY LEVEL, WELL DRAINED TO POORLY DRAINED SOILS THAT ARE SUBJECT TO FLOODING; ON FLOODPLAINS AND STREAM TERRACES

- 7 Wehadkee-Bibb-Chewacla
- 8 Altavista-State-Augusta

DOMINANTLY NEARLY LEVEL AND GENTLY SLOPING, EXCESSIVELY DRAINED, MODERATELY WELL DRAINED, AND POORLY DRAINED SOILS; ON STREAM TERRACES

- 9 Leaf-Dogue
- 10 Lakeland



- Municipality
- Unincorporated Community
- Interstate
- US Highway
- NC Highway
- State Road

- Streams & Rivers
- Water

3.2 Biodiversity and Wildlife Habitat

Biodiversity is the degree in variation of plants and animals in an ecosystem and can serve as a measure of the overall health of an ecosystem. Biodiversity also contributes to ecosystem health by filtering water (mussels), pollinating plants and crops (many insects and birds), and keeping many pest populations from reaching unhealthy levels. Wildlife habitats contribute to our economy and quality of life in many other ways, such as absorbing rainfall; minimizing flooding; slowing storm runoff; buffering and filtering pollutants from water; cleaning the air; and providing for birdwatching, hunting, fishing, and other wildlife-related recreational opportunities for residents and tourists. Wildlife-related recreation is a \$2.5 billion/year industry in North Carolina (USFS and USDOC, 2008) and an important component of many local economies.

The description, status, and importance of biodiversity and wildlife habitats in Johnston County and throughout the state has been a focus of several projects mentioned in Section 1.5 of this report, including *An Inventory of Significant Natural Areas in Johnston County*, the *North Carolina Wildlife Action Plan*, the *Statewide Assessment of Forest Resources*, and the *One NC Naturally Conservation Planning Tool*. This section provides an overview of the natural communities and wildlife habitats as documented in the above mentioned projects, as well as the unique natural areas (Significant Natural Heritage Areas [SNHAs]) and rare plant and animal species that occur in Johnston County.

3.2.1 Natural Plant Communities and Wildlife Habitats

A natural community is a distinct and reoccurring assemblage of plants, animals, bacteria, and fungi naturally associated with each other and their physical environment (Schafale and Weakley 1990). Natural communities represent a diversity of organisms, and not only have intrinsic value as natural systems, but have economic and aesthetic value to humans.

Nearly 30 different communities were identified in *An Inventory of Significant Natural Areas in Johnston County, North Carolina* (LeGrand 2001), which can be grouped into two main landscape categories: 1) upland and 2) wetland and riparian. The N.C. Natural Heritage Program (NCNHP) currently recognizes 27 natural plant communities in Johnston County (Table 5), of which 24 communities have documented high-quality occurrences. Detailed overall descriptions of these natural plant communities / vegetation types can be found in the *Classification of the Natural Communities of North Carolina: Third Approximation* (Schafale and Weakley 1990). Specific descriptions of these communities as they have been observed in Johnston County are provided in this section of the Assessment Report and can be found in *An Inventory of Significant Natural Areas in Johnston County, North Carolina* (LeGrand 2001). In addition, the NCNHP has grouped natural community types into biological themes based on similarities in community composition and range. This grouping allows for more easy discussion of conservation needs, issues, and goals. There are 11 biological themes known to exist in Johnston County. Detailed descriptions of the biological themes can be found in the *Descriptions of the Biological Themes of North Carolina* (NCNHP 2001).

The N.C. Wildlife Resources Commission (NCWRC) Wildlife Action Plan (NCWAP) identified and characterized 23 primary habitat types across the state and listed priority wildlife species for each of the habitat types by ecoregion (i.e., Mountains, Piedmont, and Coastal Plain). Of the 23 primary habitat types, 13 are known to occur in Johnston County. Of these habitat types, 11 are land-based (terrestrial) and two are aquatic habitats. These habitats often include more than one associated natural plant community, but refer to groupings of natural communities that are similar with

respect to the habitat provided to wildlife. The one exception to this is the *early successional* habitat type. This habitat does not correspond directly to a natural community, but refers to a variety of communities that have been disturbed in some way and are in the early stages of re-establishing historic vegetation assemblages. Early successional habitat may also include pasture / hay fields and row crops, which do not correspond to a natural community type. The NCWAP primary habitat types often correspond with a NCNHP biological theme. More detailed descriptions of these habitat types and prioritized wildlife species can be found in the NCWAP (NCWRC, 2005).

Table 5 on the next page lists the 11 biological themes, the 27 natural plant communities, and the associated NCWAP habitat type(s) by landscape category that occur in Johnston County.

Table 5. Biological Themes, Natural Plant Communities, and Associated NCWAP Habitat Types in Johnston County

Landscape Category	Biological Theme (NCNHP 2001)	Natural Plant Communities (Schafale and Weakley 1990)	Associated NCWAP Habitat Type(s) (NCWRC 2005)
Upland Communities	Dry Longleaf Pine Communities	Mesic Pine Flatwoods	<ul style="list-style-type: none"> • Mesic Forest • Dry Coniferous Woodlands
		Pine/Scrub Oak Sandhill	<ul style="list-style-type: none"> • Dry Coniferous Woodlands • Dry Longleaf Pine Forest
		Xeric Sandhill Scrub	<ul style="list-style-type: none"> • Dry Longleaf Pine Forest • Dry Coniferous Woodlands
	Low Elevation Cliff / Rock Outcrops	Piedmont / Coastal Plain Heath Bluff	<ul style="list-style-type: none"> • Low Elevation Cliff / Rock Outcrops
	Piedmont and Coastal Plain Mesic Forests	Mesic Mixed Hardwood Forest (Coastal Plain subtype)	<ul style="list-style-type: none"> • Mesic Forest
		Mesic Mixed Hardwood Forest (Piedmont subtype)	<ul style="list-style-type: none"> • Mesic Forest
	Piedmont and Coastal Plain Oak Forests	Dry-Mesic Oak-Hickory Forest	<ul style="list-style-type: none"> • Oak Forest
		Dry Oak-Hickory Forest	<ul style="list-style-type: none"> • Oak Forest
Wetland and Riparian Communities	Blackwater Coastal Plain Floodplains	Coastal Plain Semipermanent Impoundment	<ul style="list-style-type: none"> • Floodplain Forest • Small Wetland Communities
		Coastal Plain Small Stream Swamp (Blackwater subtype)	<ul style="list-style-type: none"> • Floodplain Forest
		Cypress-Gum Swamp (Blackwater subtype)	<ul style="list-style-type: none"> • Floodplain Forest
		Oxbow Lake	<ul style="list-style-type: none"> • Floodplain Forest • Small Wetland Communities • Riverine Aquatic Communities • Lakes and Reservoirs
	Brownwater Coastal Plain Floodplains	Coastal Plain Bottomland Hardwoods (Brownwater subtype)	<ul style="list-style-type: none"> • Floodplain Forest
		Coastal Plain Levee Forest (Brownwater subtype)	<ul style="list-style-type: none"> • Floodplain Forest
		Cypress-Gum Swamp (Brownwater subtype)	<ul style="list-style-type: none"> • Floodplain Forest
		Sand and Mud Bar	<ul style="list-style-type: none"> • Small Wetland Communities • Riverine Aquatic Communities
	Peatland Pocosins	Pond Pine Woodland	<ul style="list-style-type: none"> • Nonalluvial Mineral Wetlands • Wet Pine Savanna

Landscape Category	Biological Theme (NCNHP 2001)	Natural Plant Communities (Schafale and Weakley 1990)	Associated NCWAP Habitat Type(s) (NCWRC 2005)
Wetland and Riparian Communities	Piedmont and Mountain Floodplains	Floodplain Pool	• Small Wetland Communities
		Piedmont / Low Mountain Alluvial Forest	• Floodplain Forest
		Piedmont / Mountain Bottomland Hardwoods	• Floodplain Forest
		Piedmont / Mountain Levee Forest	• Floodplain Forest
		Piedmont / Mountain Semipermanent Impoundment	• Floodplain Forest • Small Wetland Communities
	Streamhead Pocosins	Streamhead Atlantic White Cedar Forest	• Nonalluvial Mineral Wetlands • Pocosin
		Streamhead Pocosin	• Pocosin • Nonalluvial Mineral Wetlands
	Upland Seepages and Spray Cliffs	Low Elevation Seep	• Low Elevation Cliff / Rock Outcrops • Small Wetland Communities
	Wet Pine Savannas	Pine Savanna	• Wet Pine Savanna
		Wet Pine Flatwoods	• Wet Pine Savanna • Nonalluvial Mineral Wetlands • Pocosin

Table 6 below lists each of the 13 NCWAP habitat types found in Johnston County, the ecoregions (Piedmont or Coastal Plain) that they occur within, descriptive text regarding the status of these habitats within a given ecoregion, and descriptive information regarding the significance of these habitats for wildlife by ecoregion.

Table 6. NCWAP Habitat Types – Significance for Wildlife by Ecoregion

NCWAP Habitat Type (NCWRC 2005)	Ecoregion	Significance for Wildlife
Dry Coniferous Woodlands	Coastal Plain	Habitat for early successional wildlife and pine specialist species. Mature stands are particularly important for some rare species. Active management (e.g., thinning and burning) required to maximize habitat value.
Dry Coniferous Woodlands	Piedmont	Same as Coastal Plain Dry Coniferous Woodlands habitat. Often includes high variation in plant composition.

NCWAP Habitat Type (NCWRC 2005)	Ecoregion	Significance for Wildlife
Dry Longleaf Pine Forest	Coastal Plain	Small mammals and birds rely on the grass-dominant understory and open pine ecosystem. Mature stands are particularly important for some rare species.
Early Successional (grasslands, old fields, regenerating forests, etc.)	Coastal Plain	Important for bobwhite quail, turkey, deer, prairie warbler, field sparrow and several other songbirds.
	Piedmont	Similar to Coastal Plain Early Successional habitat.
Floodplain Forest	Coastal Plain	Intermittent flooding supports aquatic animals and plants. Habitat for furbearers, breeding amphibians, and overwintering and migrant birds. A habitat of high animal diversity and high productivity.
	Piedmont	Movement corridors for wildlife. Pools offer breeding sites for frogs and salamanders. Remnants of canebrake provide habitat for migratory birds. Intact habitat reduces flooding and filters run-off.
Lakes and Reservoirs	Coastal Plain	Lakes and reservoirs are particularly beneficial to bald eagles, osprey, herons and egrets, wood ducks, wintering waterfowl, and many game fish.
	Piedmont	Similar to Coastal Plain habitat.
Low Elevation Cliff / Rock Outcrops	Piedmont	Includes many distinct natural communities that support plants and animals found only in rocky habitat.
Mesic Forest	Coastal Plain	Habitat for a variety of birds, small mammals, and reptiles.
	Piedmont	Larger patches provide habitat for forest interior birds.
Nonalluvial Mineral Wetlands	Coastal Plain	Wetland hydrology supports diverse aquatic plants and animals. Particularly important for birds such as Swainson's warbler, Kentucky warbler, and yellow-crowned night heron.
	Piedmont	Same as Coastal Plain Nonalluvial Mineral Wetlands habitat, though fewer species supported due to the limited extent in the Piedmont.
Oak Forest	Coastal Plain	Habitat for birds and amphibians.
	Piedmont	Provides habitat particularly for upland birds and reptiles. Large patches important for area-sensitive species.

NCWAP Habitat Type (NCWRC 2005)	Ecoregion	Significance for Wildlife
Pocosin	Coastal Plain	The suite of species present is highly dependent on size and condition of pocosin (i.e., open water, cane dominated, evergreen shrub dominated, etc.). Pocosin habitats can be important for several mammals, including black bear.
Riverine Aquatic Communities	Coastal Plain	Critical for several game and non-game fish and freshwater mussels, and very important for herons, egrets, several species of turtle, water snakes, and alligators. Several rare aquatic species in Johnston County.
	Piedmont	Critical for several game and non-game fish and freshwater mussels, and very important for great blue heron, several species of turtle and water snakes. Several rare aquatic species in Johnston County.
Small Wetland Communities	Coastal Plain	Habitat for many priority birds, amphibians, reptiles, crayfish, and semi-aquatic species. Many turtles, salamanders, and frogs spend part of life in wetland areas and part in the surrounding upland. Therefore, conservation of adjacent uplands is also important.
	Piedmont	Same as Coastal Plain Small Wetland Community habitat, though fewer species supported.
Wet Pine Savanna	Coastal Plain	Very diverse herbaceous plant communities where fire occurs that support reptiles, amphibians, and woodpeckers.

Brief descriptions of the 27 natural communities known to occur in Johnston County are provided below, along with the biological theme that they belong to and the associated NCWAP habitats. These descriptions come directly from *An Inventory of Significant Natural Areas in Johnston County, North Carolina* (LeGrand, 2001), with few changes. Additional information about these natural communities can be found in the *Classification of the Natural Communities of North Carolina: Third Approximation* (Schafale and Weakley, 1990).

Upland Communities

Mesic Pine Flatwoods

Biological Theme:

Dry Longleaf Pine Communities

Associated NCWAP Habitat Type(s):

Mesic Forest, Dry Coniferous Woodlands

This community is found in the southern two-thirds of the county, extending north to the Selma and Stancils Chapel areas. Mesic Pine Flatwoods are present on flat topography where the soil is somewhat sandy. Longleaf pine (*Pinus palustris*) is usually mixed with loblolly pine (*P. taeda*), but pond pine (*P. serotina*) is normally absent. Most sites in the county are severely fire-suppressed and as a result, dense zones of shrubs such as sweet pepperbush (*Clethra alnifolia*) and dangleberry (*Gaylussacia frondosa*) often occur in the understory. Some plants typical of upland soils, such as sourwood (*Oxydendrum arboretum*) and various legumes are usually present, which are often good indicators of this community.

Pine / Scrub Oak Sandhill

Biological Theme:

Dry Longleaf Pine Communities

Associated NCWAP Habitat Type(s):

Dry Coniferous Woodlands, Dry Longleaf Pine Forest

As with the Xeric Sandhill Scrub, this community is common to the southwest in the Sandhills region of the state's Coastal Plain ecoregion. There are many more examples of this community in Johnston County than there are Xeric Sandhill Scrub communities. Pine / Scrub Oak Sandhill is fairly common in the southern part of the county, but most sites have been severely fire-suppressed and have a poor herbaceous layer. The community features a mix of scrub oaks such as turkey oak (*Quercus laevis*), scrub post oak (*Q. margarettae*), bluejack oak (*Q. incana*), and blackjack oak (*Q. marilandica*), beneath a canopy of longleaf pines. The shrub and herbaceous layers are usually more diverse than in the Xeric Sandhill Scrub community, as the sites occur on soils slightly more loamy or clayey, with slightly higher moisture content.

Xeric Sandhill Scrub

Biological Theme:

Dry Longleaf Pine Communities

Associated NCWAP Habitat Type(s):

Dry Longleaf Pine Forest, Dry Coniferous Woodlands

Though a very common natural community in the Sandhills region of the state's Coastal Plain, this community is infrequent in Johnston County and is found sparingly on the driest and sandiest soils in the southern part of the county. The community is dominated by turkey oaks beneath a canopy of longleaf pines. Species diversity tends to be quite low, in comparison with other sandhills communities such as the Pine / Scrub Oak Sandhill community.

Piedmont / Coastal Plain Heath Bluff

Biological Theme:

Low elevation cliff / rock outcrops

Associated NCWAP Habitat Type(s):

Low Elevation Cliff / Rock Outcrops

This natural community is found primarily on steep, north-facing slopes and bluffs. Surprisingly, Johnston County has a moderate number (a dozen or more) of these communities, scattered mainly in the northern half of the county. A handful of examples are located along the Piedmont portion of the Neuse River, though the most significant heath bluff in the county is Flower Hill, located on Moccasin Creek at the northern edge of the county. Most heath bluffs contain dense stands of either Catawba rhododendron (*Rhododendron catawbiense*) or mountain laurel (*Kalmia latifolia*). Galax (*Galax aphylla*) is another good indicator plant for this community.



Galax located at Flower Hill Preserve

Mesic Mixed Hardwood Forest (Coastal Plain Subtype)

Biological Theme:

Piedmont and Coastal Plain Mesic Forests

Associated NCWAP Habitat Type(s):

Mesic Forest

There are several variants of this natural community subtype in the state, but only the Floodplain variant has been identified in Johnston County. This variant is found on slightly raised terraces in the Neuse River floodplain southeast of I-95, where upland trees such as white oak (*Q. alba*) and American beech (*Fagus grandifolia*) are found, mixed with wetland trees such as swamp chestnut oak (*Q. michauxii*) and cherrybark oak (*Q. pagoda*).

Mesic Mixed Hardwood Forest (Piedmont Subtype)

Biological Theme:

Piedmont and Coastal Plain Mesic Forests

Associated NCWAP Habitat Type(s):

Mesic Forest

In the Piedmont, this is a common and often well preserved natural community, as it occurs on the lower and middle slopes where development, agricultural, and silvicultural activities are less frequent. However, in Johnston County the community is not common. There are some good, small examples of this community present, especially on north-facing slopes along Swift and Middle creeks. These communities often contain good displays of spring-blooming wildflowers and a great diversity of plant species.

Dry-Mesic Oak-Hickory Forest

Biological Theme:

Piedmont and Coastal Plain Oak Forests

Associated NCWAP Habitat Type(s):

Oak Forest

This is one of the most common natural communities in the state’s Piedmont ecoregion, and a moderate number of examples are present in the county, mainly west of I-95. However, sizable stands (over 50 acres) are rare. The community occurs on upper slopes and ridges, generally below the Dry Oak-Hickory Forest but upslope of the Mesic Mixed Hardwood Forest community. White oak dominates the canopy, but there are few ericaceous shrubs (heath family), their place being taken by saplings of tree species or by shrubs more typical of mesic habitats.

Dry Oak-Hickory Forest

Biological Theme:

Piedmont and Coastal Plain Oak Forests

Associated NCWAP Habitat Type(s):

Oak Forest

There are two variants of this community type in the county, the Piedmont Upland variant and the Coastal Plain Sand variant. The former is rare in the county, at least in terms of high-quality examples. White oak is the dominant tree of this community, and ericaceous shrubs such as blueberries (*Vaccinium* spp.) are very common. However, many examples of the latter variant are present in the southern portion of the county, where the community blends with the Pine / Scrub Oak Sandhill community. The Sand variant features “non-scrub” oaks such as southern red oak (*Q. falcata*), post oak (*Q. stellata*), black oak (*Q. velutina*), among others, mixed with various hickory species (*Carya* spp.). The presence of a few longleaf pine and / or a few shortleaf pine (*P. echinata*) are also indicative of this community.

Wetland and Riparian Natural Communities

Coastal Plain Semipermanent Impoundment

Biological Theme:

Blackwater Coastal Plain Floodplains

Associated NCWAP Habitat Type(s):

Floodplain Forest, Small Wetland Communities

This community is often created when beavers (*Castor canadensis*) dam a stream; the increased duration of standing water slowly transitioning other alluvial wetland and riparian communities of the Coastal Plain to semipermanent impoundments. These communities also occur in association with old man-made ponds, such as Holt’s Lake and Holt’s Pond. Coastal Plain Semipermanent Impoundments may also occur where natural vegetation is re-establishing on abandoned sand mining sites within the Neuse River floodplain. These communities commonly include tree species that are adapted to standing water, such as bald-cypress (*Taxodium distichum*) and / or swamp tupelo (*Nyssa biflora*). Semipermanent impoundments in the Coastal Plain may also contain marsh vegetation, but generally have less marsh and shrub growth, with fewer dead trees than Piedmont impoundments. This community is fairly common in the county, with one example (Wendell Lake) occurring in the Piedmont physiographic province.

Coastal Plain Small Stream Swamp (Blackwater subtype)

Biological Theme:

Blackwater Coastal Plain Floodplains

Associated NCWAP Habitat Type(s):

Floodplain Forest

This community roughly corresponds to the Piedmont / Low Mountain Alluvial Forest in the Piedmont portion of the county. These small stream swamps are found in a majority of the narrow floodplains along streams in the Coastal Plain portion of county. Wetland plant species are commonly mixed with upland plant species, often including at a single site, bald-cypress, red maple (*Acer rubrum*), sweetgum (*Liquidambar styraciflua*), white oak, and tuliptree (*Liriodendron tulipifera*). Features such as natural levees and swamps are not present in this community and the floodplain is generally inundated for only brief periods, which allows herbaceous and shrub layers to establish. Giant cane (*Arundinaria gigantea*) is a common species in the shrub zone.

Cypress-Gum Swamp (Blackwater subtype)

Biological Theme: <i>Blackwater Coastal Plain Floodplains</i>	Associated NCWAP Habitat Type(s): <i>Floodplain Forest</i>
------------------------------------------------------------------	---------------------------------------------------------------

This subtype is found along some of the larger creeks in the Coastal Plain portion of Johnston County where the floodplain is inundated with water for much of the year. Long-duration inundation generally restricts the development of herbaceous and shrub layers. Canopy trees include swamp tupelo, red maple, and bald-cypress. Swamp cottonwood (*Populus heterophylla*) and overcup oak (*Q. lyrata*) are rare or absent. Coastal Plain streams (blackwater) that do not contain much standing water, and thus combine bottomland and swamp features with some herbaceous and shrub layers, are best characterized as Coastal Plain Small Stream Swamps.

Oxbow Lake

Biological Theme: <i>Blackwater Coastal Plain Floodplains</i>	Associated NCWAP Habitat Type(s): <i>Floodplain Forest, Small Wetland Communities</i>
------------------------------------------------------------------	------------------------------------------------------------------------------------------

This is a rare natural feature / natural community in North Carolina, as few rivers or large streams contain natural oxbows. Oxbows are formed when river channels cut across the base of a large meander (bend) in the channel. Water no longer flows through the meander, and over time sediment along the banks of the new channel blocks the ends of the meander, creating an oxbow lake. A few oxbows are located along the Neuse River southeast of I-95. Bald-cypress and swamp tupelo are characteristic trees growing along the shores / edges of these communities.

Coastal Plain Bottomland Hardwoods (Brownwater subtype)

Biological Theme: <i>Brownwater Coastal Plain Floodplains</i>	Associated NCWAP Habitat Type(s): <i>Floodplain Forest</i>
------------------------------------------------------------------	---------------------------------------------------------------

The extensive three-to-five-mile wide Neuse River floodplain southeast of I-95 contains thousands of acres of this natural community. Portions of the floodplain can be subdivided into “wet bottomland” and “dry bottomland” variants. The wetter portions contain overcup oak, and swamp cottonwood, which are absent in the drier portions. Over most of the community, characteristic trees include swamp chestnut, cherrybark, willow (*Q. phellos*), and laurel (*Q. laurifolia*) oaks; American elm (*Ulmus americana*); and water hickory (*Carya aquatica*), among many others. There is generally a very dense stand of giant cane or other grasses and sedges in this community. Standing water is generally limited to a few days after heavy rains, with the bottomlands staying damp most of the year, but not saturated.

Coastal Plain Levee Forest (Brownwater subtype)

Biological Theme: <i>Brownwater Coastal Plain Floodplains</i>	Associated NCWAP Habitat Type(s): <i>Floodplain Forest</i>
------------------------------------------------------------------	---------------------------------------------------------------

This natural community corresponds to the Piedmont / Mountain Levee Forest, but is located solely in the Coastal Plain portion of the county. A few examples are present along the banks of the Neuse River southeast of I-95, but many of these areas have been disturbed by silvicultural activities. Typical tree species of this community include sugarberry (*Celtis laevigata*), sycamore (*Platanus occidentalis*), and water hickory, though a wide array of oaks and other trees are often present. Common pawpaw (*Asimina triloba*) can often be found on many levees, but painted buckeye (*Aesculus sylvatica*) is scarce on the Coastal Plain levees.

Cypress-Gum Swamp (Brownwater subtype)

Biological Theme: <i>Brownwater Coastal Plain Floodplains</i>	Associated NCWAP Habitat Type(s): <i>Floodplain Forest</i>
------------------------------------------------------------------	---------------------------------------------------------------

Cypress-Gum Swamps are common in the Coastal Plain portion of the county along sloughs within the Neuse River floodplain, which is a brownwater system. The community is dominated by bald-cypress and / or swamp tupelo, with swamp cottonwood often being present. Overcup oak and pumpkin ash (*Fraxinus profunda*) may also be present. While water tupelo (*Nyssa aquatic*) is a common tree in this community across much of the Coastal Plain physiographic province of the state, it is rare in Johnston County. These swamps contain standing water for much or most of the year, which limits the development of a herbaceous layer. Cypress and gum swamps that are located on lakes and ponds are better characterized by Coastal Plain Semipermanent Impoundments.

Sand and Mud Bar

Biological Theme: <i>Brownwater Coastal Plain Floodplains</i>	Associated NCWAP Habitat Type(s): <i>Small Wetland Communities, Riverine Aquatic Communities</i>
------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------

This is one of two wetland communities in the state (the other being Rocky Bar and Shore) that lie within a river or large stream, such that the community can actually be submerged for a portion of the year. Along parts of the Neuse River southeast of I-95, exposed sand bars are present at bends of the river. Early successional woody plants such as willows (*Salix* spp.) and alder (*Alnus serrulata*) can be found on the older portions of the bars. Various herbaceous species, such as seedboxes (*Ludwigia* spp.) may also be present. Perhaps the most common plant on the Neuse River sand bars is halberd-leaved marsh-mallow (*Hibiscus militaris*), which grows in tall dense stands.

Pond Pine Woodland

Biological Theme: Peatland Pocosins	Associated NCWAP Habitat Type(s): <i>Nonalluvial Mineral Wetlands, Wet Pine Savanna</i>
----------------------------------------	--------------------------------------------------------------------------------------------

This natural community is commonly found farther east in the Coastal Plain ecoregion of the state where the frequency of poorly drained wetlands increases due to lower elevations and more gradual topography. It is not certain whether Johnston County originally contained stands of Pond Pine Woodland, which occur over peat soils. While this community is believed to be largely absent in the county, one small area was located north of Kenly. Pond Pine Woodlands contain dense canopies in all strata, with pond pine dominating the overstory and various evergreen species commonly found in Streamhead Pocosins, such as titi (*Cyrilla racemiflora*), dominating the understory and shrub layers.

Floodplain Pool

Biological Theme: <i>Piedmont and Mountain Floodplains</i>	Associated NCWAP Habitat Type(s): <i>Small Wetland Communities</i>
---------------------------------------------------------------	-----------------------------------------------------------------------

This is a rather small natural community in size, often only several yards wide or long. Floodplain Pools are scattered throughout the county located within floodplains; some lie parallel to the base of a slope, whereas others are located just behind a natural levee. Many pools are portions of relic stream or river channels. Hydrology of these communities is associated with floodwater rather than

seepage and as a result, pools may seasonally go dry. Under normal rainfall conditions, Floodplain Pools generally contain water in the winter and early spring, making these communities important breeding sites for amphibians. There is often little to no vegetation growing in the pools, though some may have duckweeds (*Lemna* spp.) or other floating plants.

Piedmont / Low Mountain Alluvial Forest

Biological Theme:

Piedmont and Mountain Floodplains

Associated NCWAP Habitat Type(s):

Floodplain Forest

This is a very common community lying along most of the smaller creeks in the Piedmont portion of Johnston County. However, high-quality examples are not common due to past landuse practices and damage from hurricanes. This forest differs from a bottomland forest community in that fluvial landforms such as natural levees are absent on these smaller streams, and tree species may include a mix of upland species as well as species typical of very wet soil conditions. Trees such as red maple, sweetgum, white oak, willow oak, and tuliptree may be found with various wetland oaks such as swamp chestnut and cherrybark.

Piedmont / Mountain Bottomland Hardwoods

Biological Theme:

Piedmont and Mountain Floodplains

Associated NCWAP Habitat Type(s):

Floodplain Forest

This is a rare community limited to the Neuse River floodplain in the Piedmont portion of the county. Bottomland trees such as swamp chestnut oak, cherrybark oak, and willow oak are common in these communities. Where present, Piedmont / Mountain Bottomland Hardwood communities often have diverse spring wildflowers.

Piedmont / Mountain Levee Forest

Biological Theme:

Piedmont and Mountain Floodplains

Associated NCWAP Habitat Type(s):

Floodplain Forest

There is a small amount of this uncommon natural community along banks of the Neuse River northwest of I-95. It is located adjacent to Piedmont / Mountain Bottomland Hardwoods, but on slightly higher ground and richer soils. Tree species commonly include sugarberry, box-elder (*A. negundo*), and shrubs / small trees such as common pawpaw and painted buckeye.

Piedmont / Mountain Semipermanent Impoundment

Biological Theme:

Piedmont and Mountain Floodplains

Associated NCWAP Habitat Type(s):

Floodplain Forest, Small Wetland Communities

This is a natural community generally created when beavers dam a stream; with the resulting pond or lake eventually killing the overstory vegetation (trees). As a result, these communities typically consist of dead trees, snags, and open water, along with freshwater marsh vegetation and shrubs along the margin. The community is rather common across the county but is more typical of the Piedmont section. Vegetation such as cattails (*Typha latifolia*) and various smartweeds (*Polygonum* spp.) are common. Piedmont / Mountain Semipermanent Impoundments are important habitats for a variety of wildlife species, including waterfowl, herons, frogs, and turtles.

Streamhead Atlantic White Cedar Forest

Biological Theme:

Streamhead Pocosins

Associated NCWAP Habitat Type(s):

Nonalluvial Mineral Wetlands, Pocosin

As with Streamhead Pocosins, this community is commonly linear in configuration on the landscape and is more common in the Sandhills region of the state. Only one site in the county was found that contains a moderate canopy of Atlantic white cedar (*Chamaecyparis thyoides*). While this occurrence could possibly be called a Small Stream Swamp or a Streamhead Pocosin, there is enough cedar (at least 50 trees) to indicate the community could be considered a Streamhead Atlantic White Cedar Forest. Trees such as loblolly pine and tuliptree are also present, as well as a dense stand of pocosin shrubs. Atlantic white cedar forests were historically common throughout the Coastal Plain. However, these ecosystems are presently much less common, which makes conservation of the remaining natural communities important.

Streamhead Pocosin

Biological Theme:

Streamhead Pocosins

Associated NCWAP Habitat Type(s):

Pocosin, Nonalluvial Mineral Wetlands

This natural community is also found primarily in the Sandhills region of the southwestern portion of the state’s Coastal Plain ecoregion. However, a number of small streams in the southern part of Johnston County contain this community, which typically is somewhat linear in configuration on the landscape. In some cases, it lies adjacent to a small floodplain, between the floodplain vegetation (such as a Small Stream Swamp) and the upland vegetation farther upslope. In other cases, the Streamhead Pocosin lies along a very small stream and bisects upland vegetation. Streamhead Pocosins always contain dense stands of shrubs, which are usually evergreen species that are typical of pocosin communities found farther east in the Coastal Plain. Various evergreen hollies (*Ilex* spp.), ericaceous shrubs (e.g., fetterbush – *Lyonia lucida*), “bay” trees (e.g., redbay – *Persea borbonia* and sweetbay – *Magnolia virginiana*), and evergreen vines (e.g., bamboo-vine – *Smilax laurifolia*) are common. One streamhead in the north-central portion of the county contains a powerline clearing that allows savanna species, such as pitcherplants, to be present.

Low Elevation Seep

Biological Theme:

Upland Seepages and Spray Cliffs

Associated NCWAP Habitat Type(s):

Low Elevation Cliff / Rock Outcrops, Small Wetland Communities

This is primarily a community of the Piedmont ecoregion, but it also occurs in the upper Coastal Plain. It is always located at the base of steep slopes, where seepage emerges and provides the characteristic wetland habitat. These small communities are scattered across the county, often only 15 feet in width and 50 to 100 feet in length. Various wetland species such as cinnamon fern (*Osmunda cinnamomea*), royal fern (*O. regalis*), and lizard’s-tail (*Saururus cernuus*) are typically found in Low Elevation Seeps.

Pine Savanna

Biological Theme:

Wet Pine Savannas

Associated NCWAP Habitat Type(s):

Wet Pine Savanna

This natural community was historically present in Johnston County; however fire suppression in recent decades has allowed the community to become more characteristic of pine flatwoods. Remnants of savanna vegetation can still be seen in a few areas, most notably at the Stancils Chapel Pine Flatwoods natural area. A few powerline and telephone line clearings have been mowed or burned frequently enough that they contain flora typical of Pine Savannah communities, which are generally limited to more coastal regions of the state (e.g., Carteret and Columbus Counties). One powerline near Selma contains dozens of herbaceous species that are typically associated with savannas, and some are near the inner edge of their range, such as several species of pitcherplants (*Sarracenia flava* and *S. purpurea*), milkworts (*Polygala* spp.), pinks (*Sabatia* spp.), and milkweeds (*Asclepias* spp.).

Wet Pine Flatwoods

Biological Theme:

Wet Pine Savannas

Associated NCWAP Habitat Type(s):

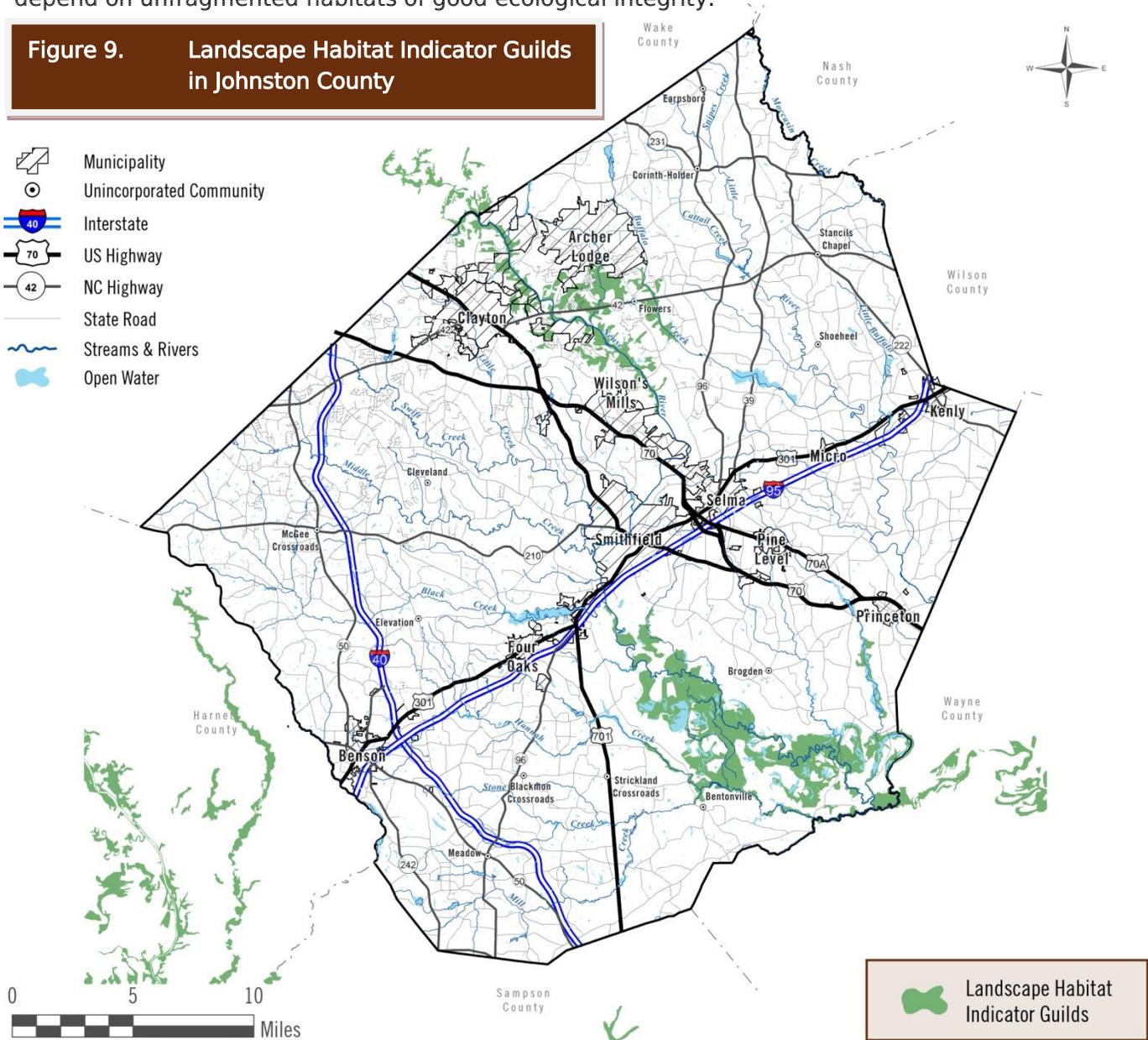
Wet Pine Savanna, Nonalluvial Mineral Wetlands, Pocosin

This community grades with the Mesic Pine Flatwoods and the two communities are often found together in Johnston County, with the Wet Pine Flatwoods occurring on the slightly lower ground. Fewer upland plants are present in this community than in Mesic Pine Flatwoods, and pond pine is often present with a mix of loblolly and longleaf pine. Understory “bay” trees such as redbay and sweetbay are usually present, as well as dense stands of sweet pepperbush (*Clethra alnifolia*). Man-made openings in this community, such as along telephone or gaslines, can contain a great array of herbaceous “savanna” plants, though these are not otherwise normally seen within the forest.

Landscape Habitat Indicator (LHI) Guilds

The NCNHP has conducted a Landscape Habitat Indicator Guild (LHIG) analysis for the Piedmont and Coastal Plain ecoregions (Hall, 2008; Hall, 2009a; Hall, 2009b) that further describes the location and quality of important wildlife habitats in Johnston County. LHIG's are groups of species whose presence is indicative of landscape integrity, such as where large blocks of habitat persist (core areas) or where a number of smaller blocks are sufficiently well-connected (connectors) to support breeding populations of these species. While guild indicator species are habitat specialists, the habitats they occupy represent a combination of different natural communities. These species include both rare and more common species and as a result, can serve as indicators of high quality functional ecosystems (CCP, 2011). LHIG core areas identified in Johnston County primarily include two areas along the Neuse River dominated by various upland, riparian, and wetland natural communities – one near the Neuse River Lowgrounds and the other further upstream as the Neuse flows between Clayton and Archer Lodge (Figure 9). Maintaining these core areas and connections across the landscape in Johnston County is especially important for area-sensitive species that depend on unfragmented habitats of good ecological integrity.

Figure 9. Landscape Habitat Indicator Guilds in Johnston County



 Landscape Habitat Indicator Guilds

3.2.2 Significant Natural Heritage Areas

A Significant Natural Heritage Area (SNHA) is an area of land or water identified by the NCNHP as being important for conservation of the State's biodiversity. Natural areas are important resources that make North Carolina and Johnston County an attractive place to live and visit, providing both recreational, scenic, and economic benefits. Additionally, they are critical areas of biological diversity, providing habitat for a wide variety of species.

An element occurrence is an area of land and / or water where a species or ecological community is or was present and has practical conservation value.

SNHAs, or "sites," are primarily identified by NCNHP biologists during natural heritage inventories, and contain one or more Natural Heritage elements, including high-quality or rare natural communities, rare species, and special animal habitats. SNHA boundaries represent the areas containing the significant rare species and natural communities within them, as well as the habitat that is necessary to maintain the rare species and the quality of the natural community (CCP, 2011).

SNHAs are rated based on the value of the element occurrences they contain. Their significance is rated based on rarity and quality of their occurrence in comparison with other sites for those same elements. SNHAs are designated as National, Regional, State or County significance using parameters developed by the NCNHP, NatureServe, and The Nature Conservancy to measure statewide and global rarity for rare species and communities. Designation as a SNHA does not restrict land use rights or place legal protection on the land. Many of these sites are located on privately owned land and are not protected from threats such as urban development.

As of July 2011, 37 SNHAs have been documented in Johnston County (NCNHP, 2011a). Table 7 on the next page lists the SNHAs, their significance rank, and ownership type. Table 8 on page 35 provides definitions for SNHA significance ranks.

Table 7. Significant Natural Heritage Areas in Johnston County

Site Name	Significance Rank	Ownership
Benson Goldenrod Site	D	Private
Bentonville Battlefield Natural Area	C	Private, NCDCR
Black Creek Sandhill and Bluff	D	Private
Brogden Bottomlands	B	Private
Buckhorn Reservoir	D	Local
Camp Atkinson Hardwood Forest	D	Private
Camp Tuscarora Sandhills	C	NSL
Cowbone Oxbows / Sage Pond Natural Area	B	Private
Eldridge Road Sandhill and Pocosins	D	Private
Flower Hill / Moccasin Creek Bluffs	C	TLC, Private
Hannah Creek Sandhill	C	Private
Hannah Creek Swamp	D	Private
Holts Lake / Black Creek Swamp	D	Private
Howell Woods	B	JCC
Little River Aquatic Habitat	A	Public Waters
Little River Galax Bluffs	D	Private
Long Branch Sandhills	C	Private
Marks Creek Floodplain	C	Local, Private
Middle Creek Aquatic Habitat	B	Public Waters
Middle Creek Amphibolite Slope	D	Private
Middle Creek Floodplain Knolls	C	Private
Mill Creek Aquatic Habitat	C	Public Waters
Mill Creek Cypress Forest	D	Private
Moccasin Creek Aquatic Habitat	B	Public Waters
Moccasin Creek Wetlands	C	Private
Moccasin Swamp	D	Private
Mudham Road Beaver Ponds	D	Private
Neuse River (Clayton) Forests	D	Private, Local
Reedy Branch Floodplain	D	Local
Richardson Bridge Bottomlands	B	Private
Selma Heath Bluffs	C	Private
Selma Pine Flatwoods	C	Private
Smithfield Pine Flatwoods	D	Private
Stancils Chapel Pine Flatwoods	D	Private
Swift Creek Aquatic Habitat	A	Public Waters
Swift Creek Magnolia Slopes	D	Private
Wendell Lake	D	Private

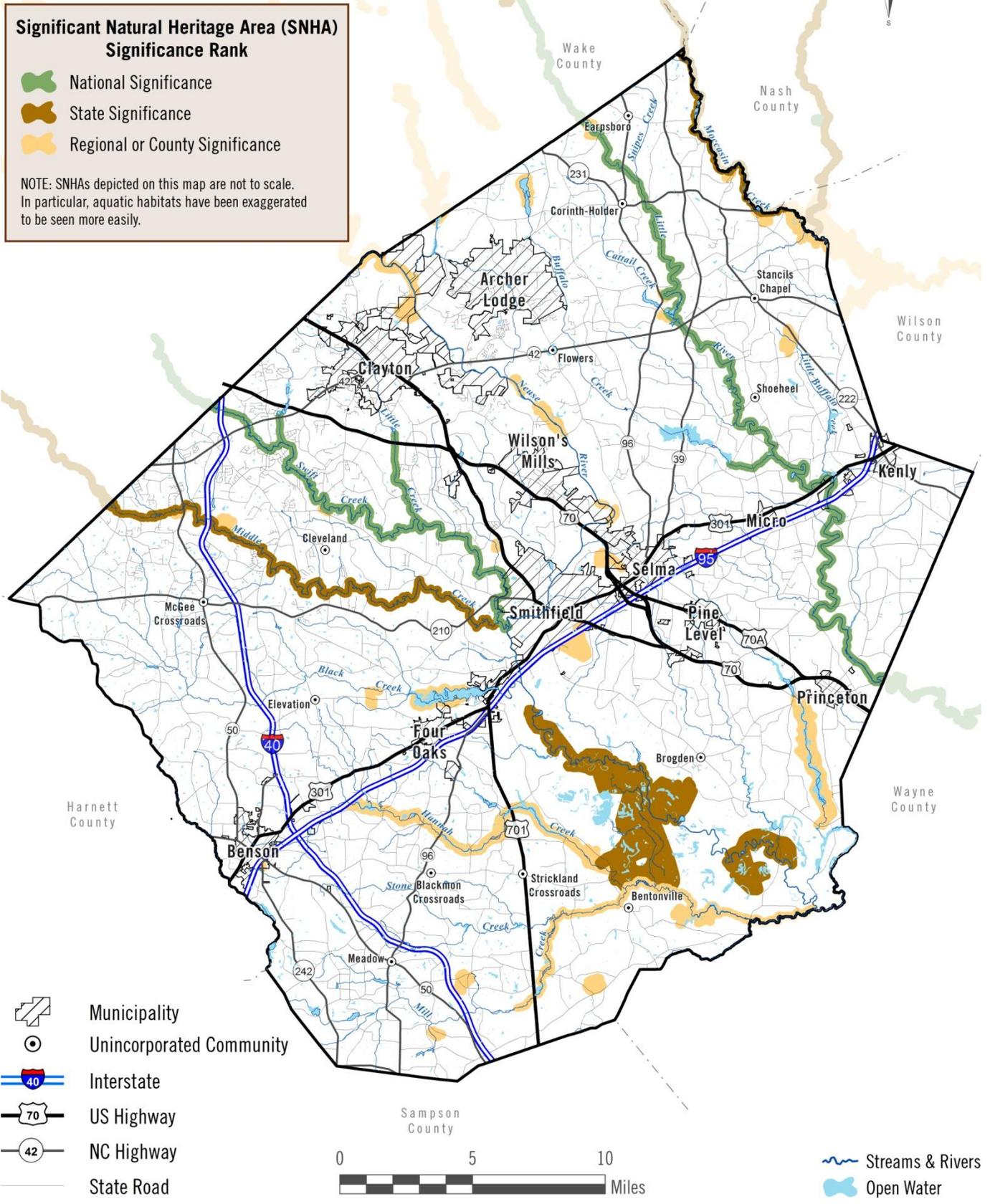
NOTE: List based on NCNHP data available July 2011. This list includes both protected and unprotected areas. Inclusion on this list does not mean that public access exists or is appropriate. Permission of the land owner is needed for all lands not open to the public.

Table 8. Definitions for Significant Natural Heritage Area Significance Ranks

Rank	Significance Rank
A	Nationally significant areas contain examples of natural communities, rare plant or animal populations, or geologic features that are among the highest quality, most viable, or best of their kind in the nation, or clusters of such elements that are among the best in the nation.
B	Statewide significant natural areas contain similar ecological resources that are among the best occurrences in North Carolina. There are examples of higher quality representatives or larger populations on nationally significant sites elsewhere in the nation or possibly within the state.
C	Regionally significant natural areas contain natural elements that may be represented elsewhere in the state by better quality examples, but which are among the outstanding examples in their geographic region of the state. A few better examples may occur in nationally or state significant natural areas. Regions consist of an area the size of approximately five counties.
D	County significant natural areas contain exemplary instances of high quality community types that are either common or at least fairly widespread in this region, or sites that serve as important wildlife habitat. These sites are considered important for local conservation based on size and integrity of the site, maturity and diversity of the community, and lack of disturbance/fragmentation. Sites important for wildlife habitat are also connected by corridors of continuous forest habitat, and are thus part of a network of wildlife habitats extending through the landscape.

Of the SNHAs identified in Johnston County as of July 2011, two are of National significance for their importance for rare species and high quality aquatic habitats: Little River Aquatic Habitat and Swift Creek Aquatic Habitat. Six sites have Statewide significance, including Brogden Bottomlands, Cowbone Oxbows / Sage Pond Natural Area, Howell Woods, Middle Creek Aquatic Habitat, Moccasin Creek Aquatic Habitat, and Richardson Bridge Bottomlands. Eleven sites are Regionally significant and 18 are significant at the County level. Figure 10 on the next page illustrates the location of SNHAs in Johnston County, including their significance ranks.

Figure 10. Significant Natural Heritage Areas in Johnston County



3.2.3 Rare Plant and Animal Species

The NCNHP maintains lists of native plant and animal species in North Carolina that are officially recognized by federal or state agencies as protected or otherwise rare. The NCNHP provides information on those rare species and natural areas to landowners, consulting firms, local, state, and federal agencies, as well as conservation organizations and private citizens. This information is used for conservation planning and to facilitate the design and implementation of ecologically sound development projects (NCNHP, 2011b).

A current list of all rare species tracked by the NCNHP and the counties in which they are known to occur can be accessed at: www.ncnhp.org/Pages/heritagedata.html. These lists are dynamic, with new records continually being added and old records being revised as new information is received. Current definitions for species statuses and ranks can also be found on the NCNHP website at: nhpweb.enr.state.nc.us/search/codes.html.

Rare species with current records (last observed within the past 20-40 years) and those considered rare in Johnston County as of September 2011 are included in Table 9.

Table 9. Rare Species with Current Known Occurrences in Johnston County

Taxa Group	Scientific Name	Common Name
Amphibian	<i>Necturus lewisi</i>	Neuse River waterdog
Bird	<i>Lanius ludovicianus</i>	Loggerhead shrike
	<i>Dendroica cerulea</i>	Cerulean warbler
	<i>Haliaeetus leucocephalus</i>	Bald eagle
Crustacean	<i>Orconectes carolinensis</i>	North Carolina spiny crayfish
Fish	<i>Lampetra aepyptera</i>	Least brook lamprey
	<i>Noturus furiosus</i>	Carolina madtom
Insect	<i>Matrioptila jeanae</i>	A Caddisfly
Mammal	<i>Corynorhinus rafinesquii macrotis</i>	Rafinesque's big-eared bat - Coastal Plain subspecies
	<i>Myotis austroriparius</i>	Southeastern myotis
	<i>Sciurus niger</i>	Eastern fox squirrel
Mussel	<i>Alasmidonta heterodon</i>	Dwarf wedgemussel
	<i>Alasmidonta undulata</i>	Triangle floater
	<i>Elliptio lanceolata</i>	Yellow lance
	<i>Elliptio marsupiobesa</i>	Cape Fear spike
	<i>Elliptio roanokensis</i>	Roanoke slabshell
	<i>Elliptio steinstansana</i>	Tar River spiny mussel
	<i>Euphyes bimacula</i>	Two-spotted skipper
	<i>Fusconaia masoni</i>	Atlantic pigtoe
	<i>Lampsilis cariosa</i>	Yellow lampmussel
	<i>Lampsilis radiata</i>	Eastern lampmussel
	<i>Lasmigona subviridis</i>	Green floater
	<i>Strophitus undulatus</i>	Creeper
	<i>Villosa constricta</i>	Notched rainbow

Taxa Group	Scientific Name	Common Name
Plant	<i>Asclepias purpurascens</i>	Purple milkweed
	<i>Baptisia alba</i>	Thick-pod white wild indigo
	<i>Didiplis diandra</i>	Water purslane
	<i>Hottonia inflata</i>	Featherfoil
	<i>Iris prismatica</i>	Slender blue iris
	<i>Leersia lenticularis</i>	Catchfly cutgrass
	<i>Lindera subcoriacea</i>	Bog spicebush
	<i>Macbridea caroliniana</i>	Carolina bogmint
	<i>Solidago verna</i>	Spring-flowering goldenrod

NOTE: Data is based on NCNHP 2011a.

NOTE: There are 15 additional species tracked by the NCNHP in Johnston County considered historic. Species with historic records may still occur in the County. NCNHP records should not be substituted for field surveys if suitable habitat exists within a proposed project area.

Rare species with current records in Johnston County include three mammals, four birds, one amphibian, two fishes, 12 mussels, one crayfish, two insects, and nine plants (NCNHP 2011a). Of these rare species, three are considered Federally Endangered – Dwarf Wedgemussel, Tar River Spiny mussel, and the Red-cockaded Woodpecker – and 11 are considered Federal Species of Concern. Sixteen species are designated State Threatened or Endangered. The Federally Endangered Michaux's sumac is also tracked for Johnston County; though its occurrence in the County is considered historical, a current record for this species exists in the Marks Creek Floodplain Significant Natural Heritage Area in adjacent Wake County.

The majority of the rare species currently tracked in Johnston County by the NCNHP are freshwater mussels that require healthy aquatic habitats and good water quality, and are found in the Little and Neuse Rivers and their larger tributaries. Other rare species tracked in the County occur in floodplains and bottomland forests; seeps; sandhills; or savannas, flatwoods, and pocosin communities.

Conservation Planning Tool – Biodiversity and Wildlife Habitat Assessment

As discussed in Section 1.5 of this report, the *One NC Naturally Conservation Planning Tool* (CPT) includes a statewide natural resource assessment of *Biodiversity and Wildlife Habitat*. This assessment includes data that represent three major components of ecological resources, including:

- ✿ Biodiversity, both aquatic and terrestrial species and communities;
- ✿ Large scale terrestrial landscapes, including core wildlife habitats and habitat connectors; and
- ✿ Other lands of particular importance to ecosystem processes, such as riparian buffers and wetlands.

Currently, this assessment is comprised of 27 individual input layers, which could be sourced from the same dataset but represent unique attributes. Many of these input layers are information sources for the various biodiversity and wildlife topics discussed throughout Section 3.2 of this report. Each of these input layers was assigned a qualitative rank based on the precision, accuracy, and representation of the data and their relative importance for biodiversity and wildlife habitats,

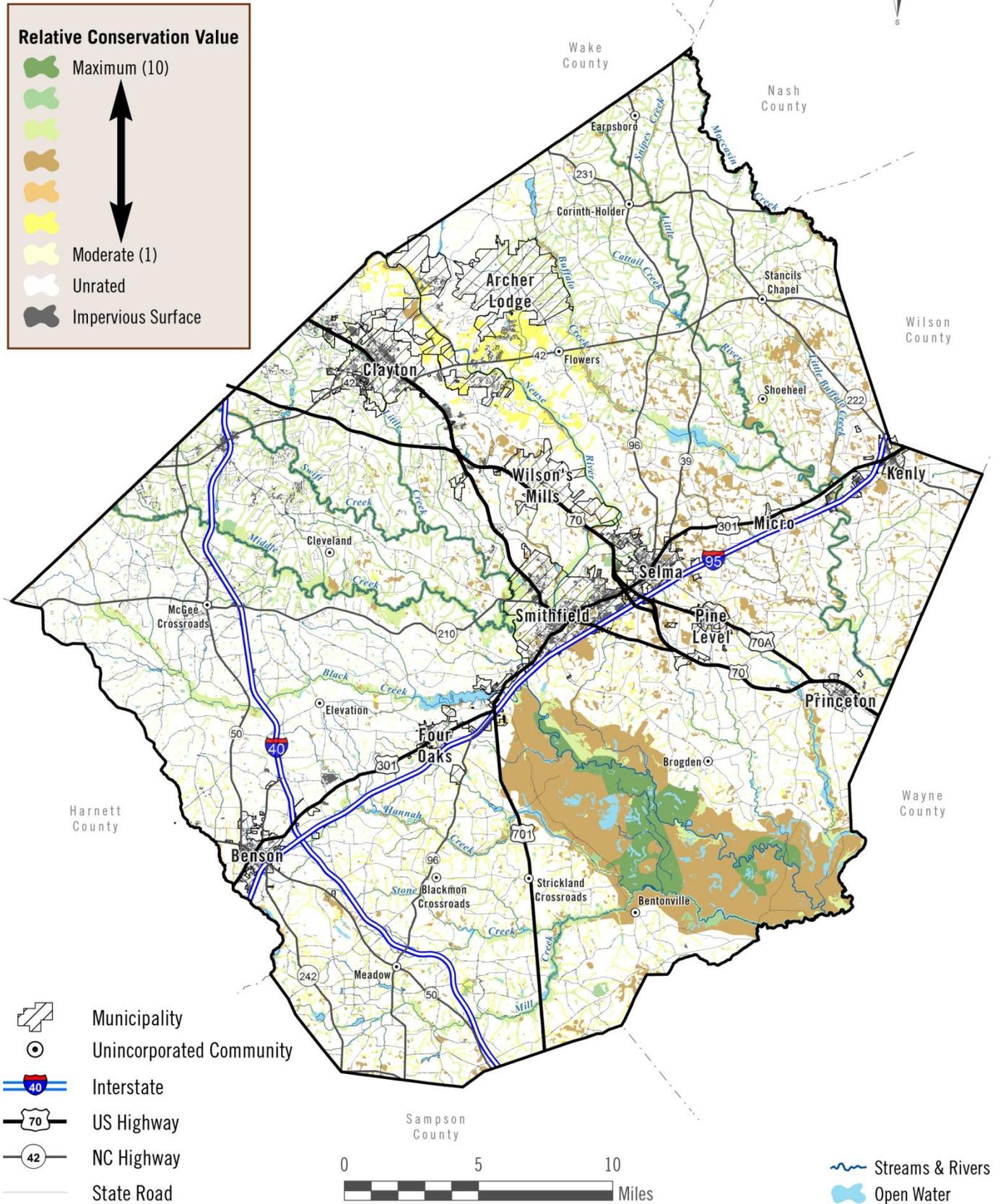
and a geographic analysis was conducted to combine these layers. More detailed information about the methods for generating this CPT product can be found at: www.onencnaturally.org

Table 10 lists the individual input layers and the qualitative conservation value assigned to each for the geographic analysis of biodiversity and wildlife habitat. Figure 11 on the next page depicts the CPT *Biodiversity and Wildlife Habitat* assessment for Johnston County. The areas of the County shaded green in Figure 11 represent areas of highest conservation values based on statewide priorities for biodiversity and wildlife habitat.

Table 10. Input Layers for the CPT Biodiversity and Wildlife Habitat Assessment

Category Name	Individual Input Layers	Source for Input Layers
NHP	Significant Natural Heritage Areas (SNHAs) – National or State Significance	<i>N.C. Natural Heritage Program</i>
	SNHAs – Regional Significance	
	SNHAs Areas – Local Significance	
	Element Occurrences – High Ranking	
	Element Occurrences – Other	
Wetlands	Coastal Region Evaluation of Wetland Systems (CREWS) – Exceptional Ranking	<i>N.C. Division of Coastal Management</i>
	CREWS – Substantial Ranking	
	National Wetlands Inventory	<i>U.S. Fish and Wildlife Service</i>
	CREWS – Beneficial Ranking	<i>N.C. Division of Coastal Management</i>
Guilds	Landscape Habitat Indicator Guilds	<i>N.C. Natural Heritage Program</i>
DWQ	Outstanding Resource Waters	<i>N.C. Division of Water Quality</i>
	BioClass – Excellent	
	High Quality Waters	
	BioClass – Good	
	All other streams	
FishHabitat	Native Brook Trout	<i>N.C. Wildlife Resources Commission</i>
	Anadromous Fish Spawning Areas	<i>N.C. Division of Marine Fisheries</i>
	Fish Nursery Areas	
Watersheds	Stream Buffer Tributaries to Threatened and Endangered Species	<i>N.C. Wildlife Resources Commission</i>
	Priority Watersheds	<i>N.C. Natural Heritage Program, Wildlife Resources Commission, The Nature Conservancy</i>
Marine	Oyster Sanctuaries	<i>N.C. Division of Marine Fisheries</i>
	Submerged Aquatic Vegetation	
Hardbottom	Open Shellfish / Shellbottom	<i>N.C. Division of Marine Fisheries</i>
	Hardbottom	
	Closed Shellfish / Shellbottom	
IBA	Important Bird Area	<i>Audubon</i>
Impervious	Impervious Surface Above 20%	<i>U.S. Environmental Protection Agency</i>

Figure 11. CPT Biodiversity and Wildlife Habitat Assessment for Johnston County



3.3 Water Resources

Water is an essential resource to all life on earth and is a central organizer of ecosystems and human societies (Cosgrove and Rijsberman, 2000; Sedell et al., 2000). Regardless of administrative or political boundaries, water can connect people who are separated geographically by great distances. If not used by humans or animals, transpired by plants, or evaporated, water that enters the Flat River just south of Roxboro in central Person County over 50 miles away from Johnston County will eventually travel through the County (via the Neuse River). Likewise, water that exits the County in the Neuse River flows southeast more than 60 miles before emptying into the Albemarle-Pamlico Estuary and Sound, east of New Bern in Craven County. This hydrologic connection brings more than 1,320,379 people, 18 counties, and more than 70 municipalities together; each depending on the other in some way for the sustainable and wise use of water.

Throughout history, the fate of many human settlements has been inextricably linked to the availability of water. In Johnston County, the Neuse River has been the driving factor for human settlement in the County, providing ample water supplies for drinking, farming, and other uses. While the quality and quantity of water in Johnston County has historically been sufficient to meet human and ecological needs, rapid population growth, land use change, and increasing point- and non-point source pollution – both upstream and within the County – have emphasized the need for additional water resource planning.

This section provides an overview of the watersheds (hydrologic units), streams and waterbodies, drinking water, and water uses that occur in Johnston County.

What's a Watershed?

A watershed is an area of land where all of the water that is under it, or drains off of it, goes into the same place. Watersheds come in all shapes and sizes; crossing municipal, county, state, and national boundaries.

The U.S. Geological Survey (USGS) developed a hierarchical coding system that divides watershed areas based on surface drainage patterns into four levels: Regions, Subregions, Accounting Units (currently referred to as "Basins"), and Cataloging Units (currently referred to as "Subbasins") (Seaber et al., 1987). However, other federal and state agencies required smaller hydrologic divisions ("units") in order to address watershed water resource management needs. As a result, the USDA-NRCS worked with various federal and state agencies to further divide the hydrologic units into Watersheds (5th-level) and Subwatersheds (6th-level). Each of these units is sequentially assigned a hydrologic unit code (HUC), which starts at two digits and increases to 12 digits at the 6th level (Subwatersheds). An example of how a 12-digit HUC is composed from a Subwatershed in Johnston County is provided below.

<u>Hydrologic Unit Level</u>	<u>Code</u>	<u>Hydrologic Unit Name</u>
Region (1 st)	03	South Atlantic-Gulf Region
Subregion (2 nd)	0302	Neuse-Pamlico
Basin (3 rd)	030202	Neuse River
Subbasin (4 th)	03020201	Upper Neuse River
Watershed (5 th)	0302020117	Walnut Creek – Neuse River
Subwatershed (6 th)	030202011702	Buffalo Creek – Neuse River

3.3.1 Watersheds

The majority of Johnston County (98 percent) lies within the Neuse River Basin, but a small portion of the southwestern edge of the County lies within the Cape Fear River Basin (Figure 12).

The County intersects portions of three subbasins – the Contentnea and Upper Neuse subbasins in the Neuse River Basin and the Black subbasin in the Cape Fear River Basin. The basins, subbasins, watersheds, and subwatersheds that intersect Johnston County are listed in Table 11. Some subwatershed areas are contained entirely in Johnston County, while others are partially contained or touch the boundary of the County.

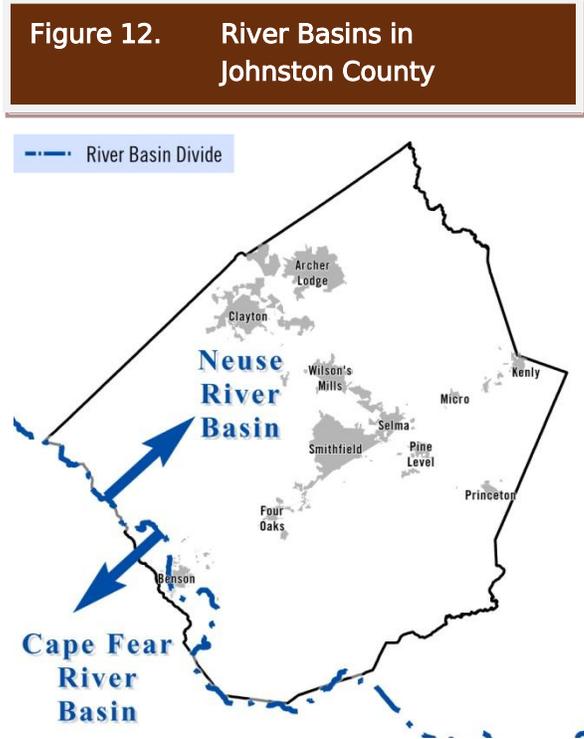


Table 11. River Basins, Subbasins, Watersheds, and Subwatersheds in Johnston County

River Basin Name (6-Digit HUC)	Subbasin Name (8-Digit HUC)	Watershed Name (10-Digit HUC)	Subwatershed Name (12-Digit HUC)	
Neuse River (030202)	Upper Neuse (03020201)	Middle Creek (0302020109)	Middle Middle Creek (030202010902)	
			Lower Middle Creek (030202010903)	
		Swift Creek (0302020110)	Whiteoak Creek (030202011003)	
			Mahlers Creek-Swift Creek (030202011004)	
			Little Creek (030202011005)	
			Piney Grove Cemetery-Swift Creek (030202011006) [†]	
			Reed Branch-Swift Creek (030202011007) [†]	
			Walnut Creek- Neuse River (0302020111)	Marks Creek (030202011102)
		Walnut Creek- Neuse River (0302020111)	Poplar Creek-Neuse River (030202011103)	
			Mill Creek-Neuse River (030202011104) [†]	
			Buffalo Creek-Neuse River (030202011105) [†]	
		Black Creek (0302020112)	Black Creek (0302020112)	Little Black Creek-Black Creek (030202011201)
				Camp Branch-Black Creek (030202011202) [†]
				Holts Lake-Black Creek (030202011203) [†]

[†] Subwatersheds contained entirely in Johnston County.

River Basin Name (6-Digit HUC)	Subbasin Name (8-Digit HUC)	Watershed Name (10-Digit HUC)	Subwatershed Name (12-Digit HUC)
Neuse River (030202)	Upper Neuse (03020201)	Mill Creek (0302020113)	Upper Hannah Creek (030202011301) [†]
			Lower Hannah Creek (030202011302) [†]
			Upper Mill Creek (030202011303)
			Stone Creek (030202011304) [†]
			Middle Mill Creek (030202011305)
			Lower Mill Creek (030202011306)
		Falling Creek (0302020114)	Upper Falling Creek (030202011403)*
		Upper Little River (0302020115)	Upper Buffalo Creek (030202011502)
			Cattail Creek-Little River (030202011503)
			Lower Buffalo Creek (030202011504) [†]
			Long Branch-Little River (030202011505) [†]
		Lower Little River (0302020116)	Little Buffalo Creek (030202011601)
			Little Creek-Little River (030202011602) [†]
			Dennis Branch-Little River (030202011603)
	Moccasin Creek- Neuse River (0302020117)	Bawdy Creek (030202011701) [†]	
		Polecat Branch-Neuse River (030202011702) [†]	
		Moccasin Creek (030202011703)	
		Charles Branch-Beaverdam Creek (030202011704)	
		Quaker Neck Lake-Neuse River (030202011705)	
	Contentnea (03020203)	Buckhorn Reservoir (0302020301)	Upper Moccasin Creek (030202030101)
			Lower Moccasin Creek (030202030102)
			Little Creek-Buckhorn Reservoir (030202030105)
		Black Creek (0302020302)	Great Swamp (030202030201)
Lee Swamp-Black Creek (030202030203)*			
Nahunta Swamp (0302020305)		Headwaters Nahunta Swamp (030202030501)	
Cape Fear River (030300)	Black (03030006)	Upper South River (0303000601)	Upper Black River (030300060101)*
			Upper Mingo Swamp (030300060103)
	Great Coharie Creek (0303000604)	House Pond-Sevenmile Swamp (030300060401)*	
		Headwaters Great Coharie Creek (030300060402)	

[†] Subwatersheds contained entirely in Johnston County.

* Subwatersheds whose border touches the border of Johnston County.

Watershed Planning

Watershed planning efforts are conducted at varying scales across the state by a variety of agencies, organizations, and groups. The N.C. Division of Water Quality (NCDWQ) prepares basinwide water quality plans for all 17 of North Carolina's river basins. These plans serve to identify water quality problems and restore full use to impaired waters, identify and protect high value resource waters, and protect unimpaired waters. The plans also document trends in certain water quality parameters over longer periods of time. This provides a general indicator of where water quality improvements have occurred, where conditions have stayed the same, and where conditions have worsened. The fourth revision of the Neuse River Basinwide Water Quality Plan was completed in 2009 and can be found at the following website:

h2o.enr.state.nc.us/basinwide/Neuse/2008/NeuseRiverBasinPlanDRAFT.htm. The third revision of the Cape Fear River Basinwide Water Quality Plan was completed in 2005 and can be found at the following website: h2o.enr.state.nc.us/basinwide/draftCPFApril2005.htm, with the fourth revision underway. NCDWQ also administers the Use Restoration Watershed Program (URW). The URW Program was established to restore the beneficial uses of impaired waters statewide by prioritizing waters for restoration, promoting and supporting restoration initiatives, and improving documentation and recognition of restoration efforts. Currently there are no watershed areas in Johnston County prioritized by the URW Program. More information about the URW Program can be found at the following website: portal.ncdenr.org/web/wg/ps/bpu/urw.

The N.C. Ecosystem Enhancement Program (NCEEP) also conducts watershed planning to identify priorities for the protection and enhancement of water quality, fisheries, wildlife habitat, recreational opportunities, and flood protection. Priorities are identified as Targeted Local Watersheds (TLWs), which are roughly equivalent to subwatersheds (12-digit HUCs). Targeted Local Watersheds are further prioritized during Local Watershed Planning (LWP) efforts. Local Watershed Planning is conducted in specific priority areas (typically one or more TLWs) where NCEEP and the local community have identified a need to address critical watershed issues. Through this planning process, NCEEP collaborates with local stakeholders and resource professionals to identify projects and management strategies to restore, enhance, and protect local watershed resources. More information about NCEEP's watershed planning efforts can be found at the following website: www.nceep.net/pages/lwplanning.htm. In 2009, the NCEEP – working with Wake and Johnston County governments – identified watersheds in eastern Wake County and western Johnston County where common planning goals exist to restore impaired waters and protect threatened aquatic habitats. This LWP effort became known as the Wake-Johnston Collaborative Local Watershed Plan. More information about Wake-Johnston Collaborative Local Watershed Plan can be found at the following website: www.nceep.net/services/lwps/Wake_Johnson_collaborative.

The U.S. Fish and Wildlife Service, N.C. Natural Heritage Program, and the N.C. Wildlife Resources Commission all conduct watershed planning activities to identify areas important to aquatic species conservation. Many of these priorities are focused on conserving aquatic habitats that are important for rare species, or for species that are at risk. These priorities are often integrated into other watershed planning efforts and are not individually compiled into a single informational resource. Many aquatic priorities were identified in the N.C. Wildlife Action Plan described in Section 1.5 of this report and are also incorporated into the *Conservation Planning Tool – Biodiversity and Wildlife Diversity Assessment*.

In addition to watershed water quality and aquatic species planning efforts, several organizations conduct watershed planning related to drinking water supply. In addition to developing a statewide

water supply plan (www.ncwater.org/Water_Supply_Planning/NC_Water_Supply_Plan), the N.C. Division of Water Resources (NCDWR) oversees the Local Water Supply Plan program. Local Water Supply Plans are assessments of a water system’s current and future water needs and its ability to meet those needs. NCDWR also oversees programs related to Source Water Assessment and Protection in order to determine the condition of areas that supply drinking water and determine the planning efforts needed to protect these critical water sources. More information about these watershed planning efforts can be found on the NCDWR website: www.ncwater.org.

An effort initiated in 2008 by the NCDWQ, with regular meetings starting in 2010, brings together a multitude of state agencies working on watershed-related programs to discuss opportunities for collaboration. The Watershed Restoration Improvement Team (WRIT) works to “strengthen partnerships in order to enhance each agency’s ability to carry out its own water-related goals and activities to improve watershed functions throughout North Carolina.” As a part of this effort, the WRIT has geographically compiled subwatershed (12-digit HUC) priorities for many state agencies to identify subwatersheds with the greatest collective priority. In addition to this collective priority overlay, information about program and project implementation across agencies was compiled to determine the subwatersheds where the most (and least) amount of work was being conducted. These two datasets were combined to determine collective subwatershed priorities with the greatest and the least amount of program / project implementation. Several subwatersheds in Johnston County were identified as collective priorities. Opportunities for collaboration among agencies to increase program / project implementation and address collective priority areas were identified in a few of the subwatersheds in the County. To learn more about the WRIT watershed planning effort, contact NCDWQ basinwide planning staff (URW Program Coordinator) listed at the following website: portal.ncdenr.org/web/wq/ps/bpu/contacts.

3.3.2 Streams and Waterbodies

Streams and waterbodies upstream or within Johnston County drain approximately 2,300 square miles of the Neuse River drainage area (USEPA and USGS, 2005). These waters pass through or originate within the County. There are approximately 800 linear miles of named streams and rivers, 1,300 linear miles of unnamed streams, and 2,700 acres of waterbodies (e.g., ponds, lakes, etc.) within the County.

Surface waters (i.e., streams, creeks, rivers, lakes, ponds, etc.) are classified according to their best intended use (e.g., swimming, aquatic life support, water supply, etc.) and are evaluated on how well they are supporting their designated uses. In North Carolina, the NCDWQ assigns

Table 12. Primary Surface Water Classifications used in Johnston County and Surrounding Counties

Classification Code	Surface Water Classification Description
B*	Primary Recreation, Fresh Water
C*	Aquatic Life, Secondary Recreation
CA*	Critical Area
FWS	Future Water Supply Waters
HQW	High Quality Waters
NSW*	Nutrient Sensitive Waters
ORW	Outstanding Resource Waters
SW*	Swamp Waters
WS-I	Water Supply I – Natural Watershed
WS-II	Water Supply II – Undeveloped Watershed
WS-III	Water Supply III – Moderately Developed Watershed
WS-IV*	Water Supply IV – Highly Developed Watershed
WS-V*	Water Supply V – Upstream, drains to a WS-IVs or located in an industrial Watershed

* Classifications currently used in Johnston County as of February 2011.

these primary classifications to all named streams and waterbodies (and some unnamed). Unclassified waters automatically adopt the classification of the nearest classified water to which they drain (downstream). A list of primary surface water classifications used for waters located in Johnston County and surrounding counties is provided in Table 12 with a brief description for each. Detailed information about surface water classifications can be found at the following website: portal.ncdenr.org/web/wq/ps/csu.

Currently there are 106 individual surface water segments classified in Johnston County, including 86 unique named waters and approximately 806 miles of river, stream, and pond / lake shoreline. A majority of the classified surface waters are designated as Class C waters (68 percent), Class WS-IV (12 percent), or Class WS-V (16 percent). Water supply (WS) waters include areas of land designated as “critical” or “protected.” A critical area is the land adjacent to a water supply intake where risk associated with pollution is high and includes the land within one-half mile upstream and draining to a river intake or within one-half mile and draining to the normal pool elevation of water supply reservoirs. Protected areas are located within WS-IV watersheds and include land within five miles and draining to the normal pool elevation of water supplies / reservoirs or within ten miles upstream and draining to a river intake. A full list of classified surface waters can be found at the following website: h2o.enr.state.nc.us/bims/reports/reportsWB.html.

3.3.3 Drinking Water Sources and Water Use

Water available for drinking and other uses (e.g., agriculture, industry, etc.) in Johnston County comes from both groundwater and surface water sources. Groundwater supplies primarily come from the Surficial and Bedrock Aquifers, with some wells in the southern and eastern portions of the County accessing the deeper Black Creek and Upper Cape Fear Aquifers (Campbell and Coes, 2010; N. Wilson, personal communication, September 2011, NCDWR). A majority of the County’s population is served by surface water sources; approximately 90 percent (NCDWR, 2011; USEPA, 2011). Surface water supplies primarily come from the Neuse River, with some withdrawals and / or purchases of water coming from the Cape Fear River.

The County provides water to a number of municipalities, private utilities, and water districts, as well as providing a bulk supply to the Town of Fuquay-Varina in Wake County. As of 2008, 16 water districts are responsible for managing Johnston County’s water resources. As of 2009, a total of approximately 112,000 retail customers were supplied water (Table 14).

Currently there are 13 Local Water Supply Plans for water systems that are either located in Johnston County or provide water to the County (Table 13). The City of Dunn in neighboring Harnett County sells a relatively small quantity of treated water to the Town of Benson.

Table 13. Local Water Supply Plans in Johnston County

Public Water Supply ID	Water System	Ownership
03-51-025	Benson	Municipality
03-51-020	Clayton	Municipality
03-43-010	Dunn	Municipality
03-51-195	Flowers Plantation	Business
03-51-035	Four Oaks	Municipality
03-51-070	Johnston County	County
03-51-030	Kenly	Municipality
03-51-045	Micro	Municipality
40-51-008	Micro (County Line)	County
03-51-040	Pine Level	Municipality
03-51-050	Princeton	Municipality
03-51-015	Selma	Municipality
03-51-010	Smithfield	Municipality

Primary water systems located in Johnston County, water sources, source types, usage, supply, and population served data are summarized in Table 14.

Table 14. Water Systems, Water Sources, Source Types, Usage, Supply, and Population Served in Johnston County

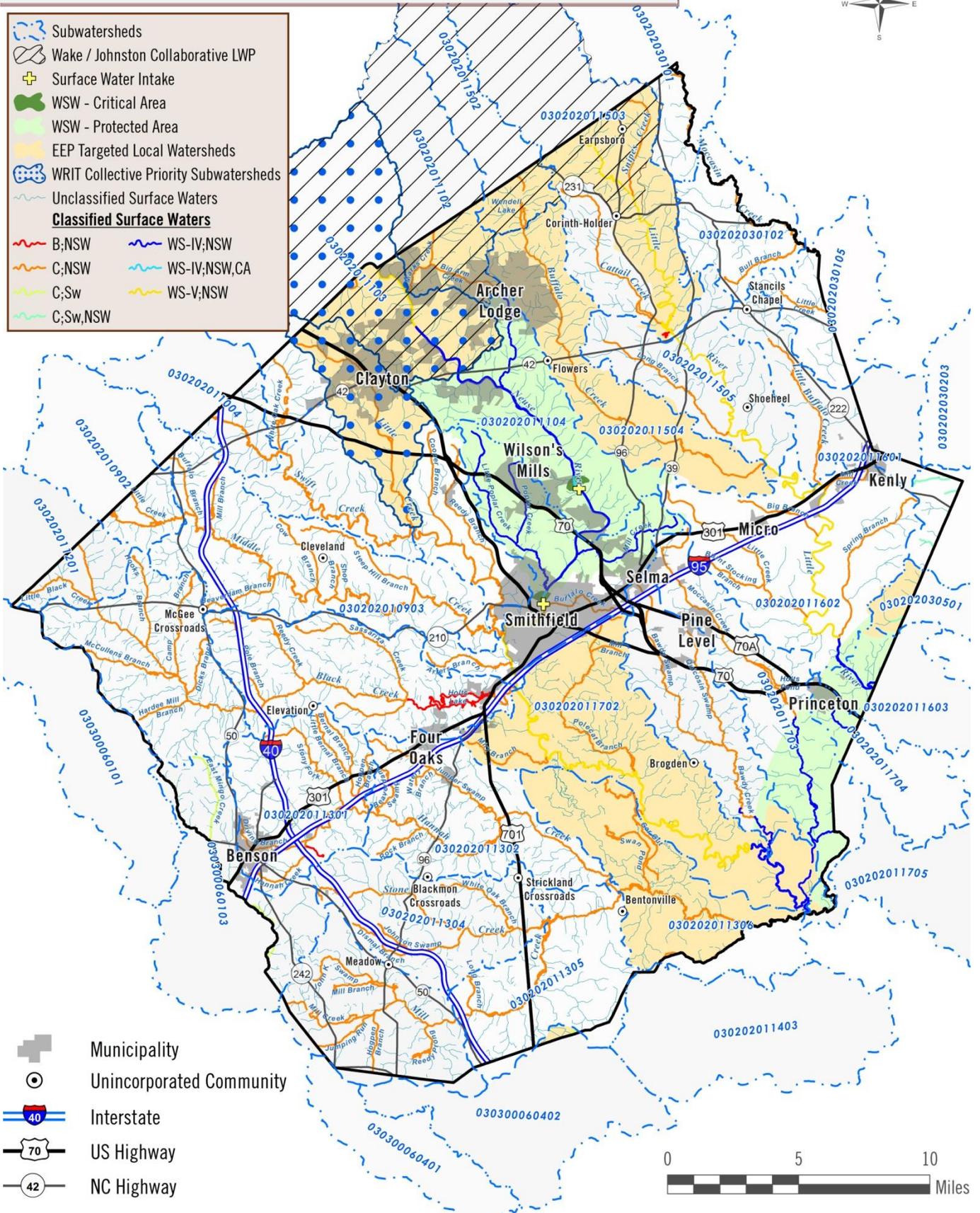
Water System	Water Source	Source Type	Average Usage in MGD*	Available Supply in MGD*	Usage % of Supply	Population Served*
Benson	Dunn, Johnston County	Purchase	0.830	1.600	52%	4,671
Clayton	Johnston County	Purchase	2.251	2.389	94%	16,096
Four Oaks	Johnston County	Purchase	0.202	0.189	107%	2,570
Johnston County	Reservoir, Benson, Smithfield, Wayne County WD	Surface	7.68	12.000	--	65,000
		Purchase	1.471	5.600		
		Sub-Total	9.151	17.6	52%	
Kenly	Johnston County	Purchase	0.247	0.3	82%	1,870
Micro	Wells, Johnston County	Groundwater	0.060	0.175	--	845
		Purchase	0.004	0.005		
		Sub-Total	0.064	0.180	35%	
Pine Level	Wells, Johnston County	Groundwater	0.124	0.125	--	1,920
		Purchase	0.006	0.037		
		Sub-Total	0.130	0.162	80%	
Princeton	Johnston County	Purchase	0.103	0.127	81%	1,376
Selma	Wells, Johnston County	Groundwater	0.679	1.175	58%	7,143
		Purchase	0.151	0.215	--	
		Sub-Total	0.830	1.390	60%	
Smithfield	Neuse River, Johnston County	Surface	2.617	6.2	--	11,476
		Purchase	0.1	0.1		
		Sub-Total	2.717	6.3	43%	
TOTAL			16.525	30.237	--	112,967

* Values are for 2009 in millions of gallons per day (MGD).

NOTE: The N.C. Division of Water Resources (NCDWR) provides the data contained within the Local Water Supply Plans (LWSPs) as a courtesy and service to its customers. NCDWR staff do not field-verify data. Neither NCDWR, nor any other party involved in the preparation of these LWSPs attests that the data is completely free of errors and omissions. Furthermore, data users are cautioned that these LWSPs are PROVISIONAL and have yet to be reviewed by NCDWR staff. Subsequent review may result in significant revision. Questions regarding the accuracy or limitations of usage of this data should be directed to the water system owner and / or NCDWR.

Figure 13 on the next page depicts subwatersheds, watershed planning areas, surface waters, and surface water intake locations in Johnston County.

Figure 13. Subwatersheds, Watershed Planning Areas, Surface Waters, and Surface Water Intakes in Johnston County



Conservation Planning Tool – Water Service Assessment

As discussed in Section 1.5 of this report, the *One NC Naturally Conservation Planning Tool* (CPT) includes a statewide assessment of lands that are most critical to conserve in order to protect the water resources that serve the residents of North Carolina. The three guiding principles for the *Water Services Assessment* are:

- ✿ Water quality,
- ✿ Water quantity, and
- ✿ Water use / human consumption.

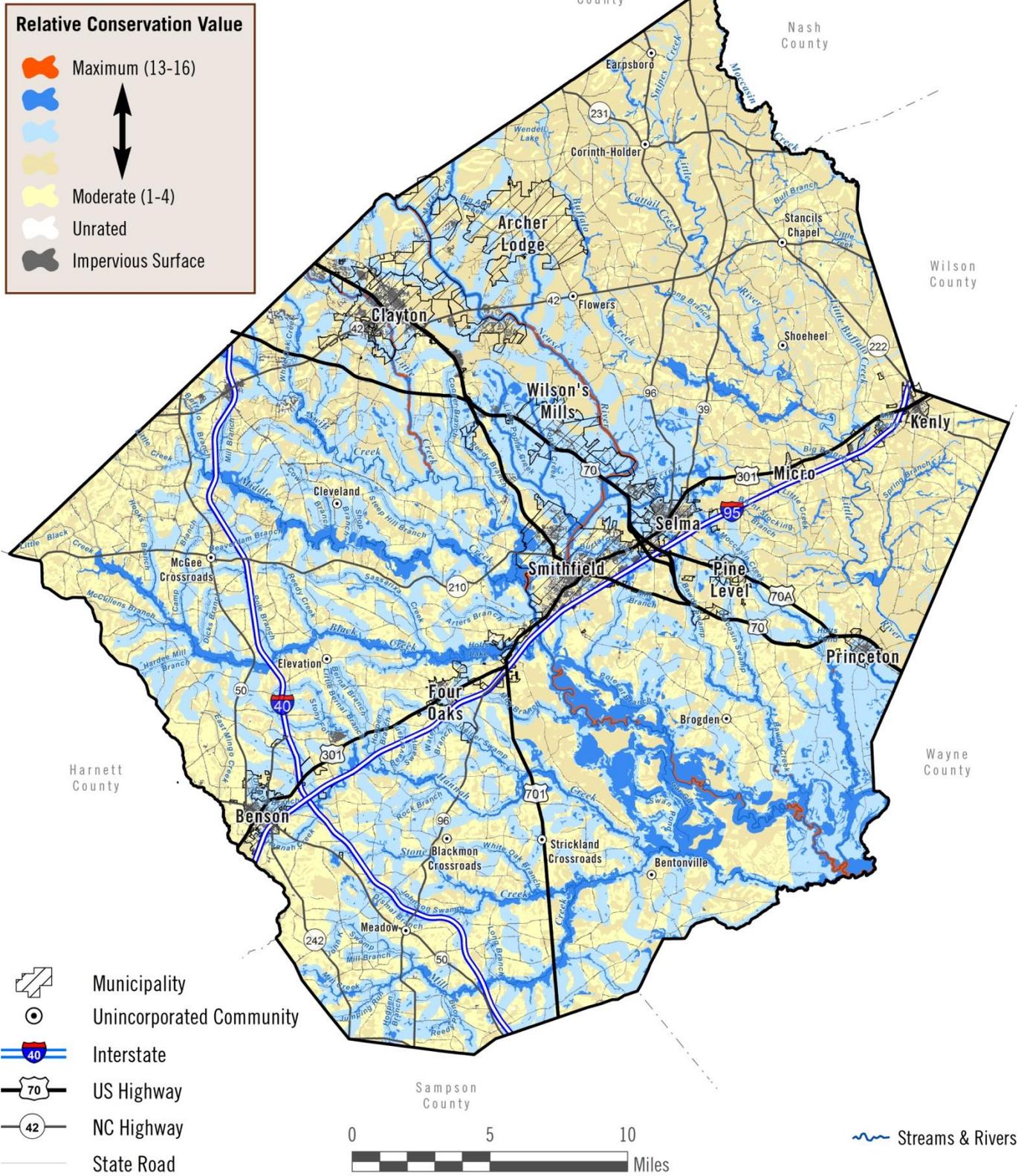
These principles were used to guide the selection of the resource datasets used in the geographic analysis and their subsequent ranking. Based on these principles, 42 different datasets were selected to represent the resources in the landscape that most directly influence water services (i.e., quality, quantity, and use). Table 15 below lists the individual datasets used to create the *Water Services Assessment* layer.

Table 15. Input Layers for the CPT Water Services Assessment

Water Quality	Water Quality	Water Quantity	Water Use / Consumption
All streams	✓	✓	
Floodplains	✓	✓	
Headwaters	✓	✓	
Groundwater (Land Cover)	✓	✓	
Future Water Supply	✓	✓	
Class - SC, SB, C, B	✓		✓
Water Supply WS - I to V	✓		✓
Outstanding Resource Waters	✓		✓
High Quality Waters	✓		✓
SWAP Susceptibility Rate Data	✓		✓
Shellfish Waters data	✓		✓
Recreational Waters	✓		✓
Designated Rivers	✓		✓
Native Trout Waters	✓		✓
CREWS Data	✓		
Unique Wetlands	✓		
National Wetland Inventory	✓		
Fish Community Data	✓		
Benthos Data	✓		
Riparian Zones & 100 yr. Flood Plains	✓		

Figure 14 on the next page depicts the CPT *Water Services Assessment* for Johnston County.

Figure 14. CPT Water Services Assessment for Johnston County



3.4 Working Lands

Access to commercially viable tracts of working land is imperative to maintaining Johnston County's rural beauty as well as its rural industries, such as agriculture and forestry. These working lands help protect the quality of life, scenic and cultural landscapes, farmers' markets, recreational opportunities, ecotourism, local jobs, and community businesses. Farm and forestlands also provide important food and cover for wildlife and help to control flooding, conserve watershed functions, and maintain air quality. Similar to undisturbed natural communities, working lands also retain and absorb rainfall, filter wastewater and urban runoff, and recharge groundwater supplies (CCP, 2011).

Working lands contribute significantly to the fiscal security of local governments. New development often requires additional public services such as schools, roads, water, sewer, and emergency services, whereas privately-owned and managed working lands require few of these services (CCP, 2011). Cost of Community Services (COCS) studies have demonstrated that taxes on residential and urban uses generally fail to cover the cost of public services while the costs of farms, forests, and open lands more than pay for the municipal services they require (FIC, 2010).

This section provides an overview of the working lands in Johnston County. Much of the information summarized herein originates from the *Agricultural Development Plan for Johnston County, North Carolina* (hereafter abbreviated as the "Ag Plan") and the *Statewide Assessment of Forest Resources* (hereafter abbreviated as the "SAFR"). Information presented in this section represents a small component of the detailed information provided in the Ag Plan and the SAFR. As needed, future green infrastructure planning efforts in Johnston County should utilize the Ag Plan and the SAFR for more detailed information on these working land resources. The full Ag Plan can be accessed at the following website:

www.johnstonnc.com/files/soilandwater/Johnston_Agricultural_Development_Plan_January.pdf. The SAFR can be accessed at the following website: www.ncforestassessment.com.

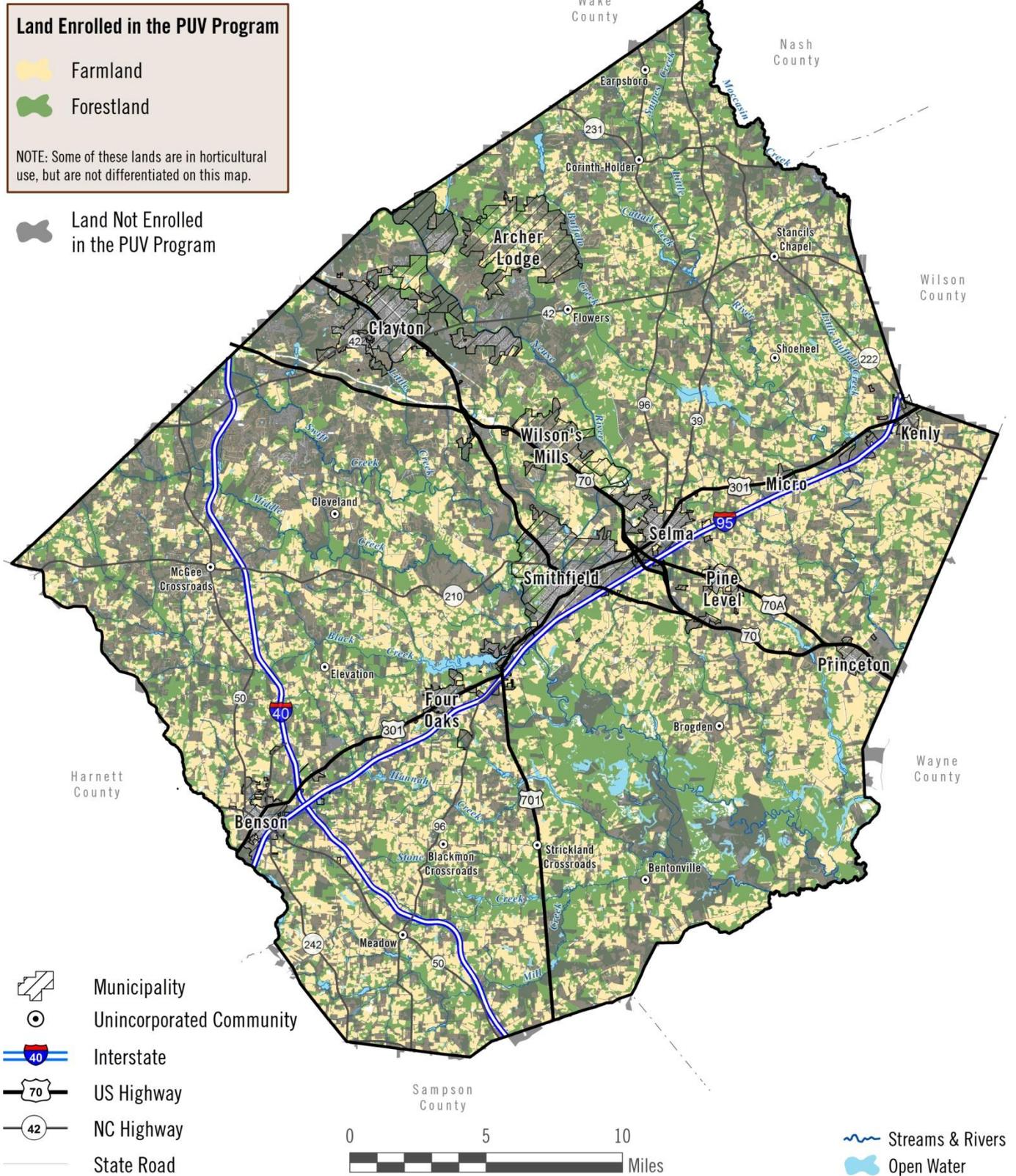
3.4.1 Present Use Value (PUV) Program

North Carolina's use value taxation law ([N.C. GEN. STAT. §§ 105-277.2 to .7 \[2011\]](#)) allows county tax offices to assess agricultural, horticultural, and forestland at its value for these uses rather than its value in another possible future use, such as residential. In general, agriculture and horticultural land must produce a three year rolling average gross income of \$1,000 and be under a sound management program. Forestland must be managed for the production and sale of forest products following a written sound forest management plan. Additionally, agricultural land must include 10 acres, forestland must include 20 acres, and horticultural land must include 5 acres in production. Figure 15 on the next page depicts farmland and forestland currently enrolled in the PUV program in Johnston County.

Importance of Landowner Incentives

Landowner incentives are important tools for farm and forestland owners. In many cases, owners of these working lands would not be able to afford continued ownership under farm and / or forestry use without these incentives. While the PUV program is the most widely used incentive throughout the state, other programs exist, including the Voluntary Agricultural District (VAD) program. As of August 2011, there were over 7,000 parcels enrolled in the PUV program and approximately 370 parcels enrolled in the VAD program in Johnston County.

Figure 15. Farmland and Forestland Enrolled in the PUV Program as of August 2011 in Johnston County



3.4.2 Farmlands

Agriculture is North Carolina's biggest industry and contributes significantly to the economy by providing farm sales, jobs, and farm-related industries. Similarly, as described in the Ag Plan, agriculture is a significant land use in Johnston County, with 38 percent (194,090 acres) of the land actively managed for crop and livestock. Cropland represents the largest share of farms in the County at 66 percent of the total, or approximately 128,227 acres. Much of the land in farms is controlled by farm operators but only 50 percent derive their full income from farming and 30 percent have full ownership of the farm (ACDS, 2010).

Farmlands in the County can generally be divided by the central development corridor along I-95, with significant differences between the northern and southern agricultural regions. The southern region is known to have the highest concentration of prime and productive soils and is generally the area of the County with the highest concentration of field crops and livestock operations. The northern agricultural region has piedmont soils with smaller farm operations. In this region, tobacco and livestock production are important (ACDS, 2010).

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture (USDA). Given that the acreage of high-quality farmland is limited, the USDA Natural Resources Conservation Service (NRCS) in collaboration with other federal, state, and local government organizations has identified soils that are important for the production of the nation's food supply (Bliley, 1994). There are three primary categories of important farmlands recognized in North Carolina – Prime, Unique, and Statewide.

Prime Farmland, as defined by the USDA, includes land with soils that are best suited for producing food, feed, forage, fiber, and oilseed crops. It could be cultivated land, pastureland, forestland, or other land, but it is not urban or built-up land or water areas. The soil quality, growing season, and moisture supply are suitable to sustain production of high yield crops when properly managed, including water management and acceptable farming methods. In general, Prime Farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, and acceptable salt and sodium content. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope mainly ranges from 0 to 8 percent (Bliley, 1994).

Common Agricultural Crops of Johnston County



From top to bottom:
tobacco, soybeans, cotton
Photos by NCFS

Unique Farmland is determined by the presence of soils with special properties for producing high-value crops. In North Carolina, Unique Farmland occurs on soils well-equipped for the production of blueberries. There are currently no areas in Johnston County designated as Unique Farmlands.

In general, soils that do not quite meet the requirements for Prime Farmland fall into the Statewide Importance category. This could be due to steepness of slope, presence of rocks, high erodibility, very slow permeability, low water capacity / availability, or poorly drained soils that are excessively wet.

There are 20 soil map units designated as Prime Farmland soils (National Importance), eight soil map units designated Prime Farmland when drained or not flooded, and 14 soil map units designated as Farmland of Statewide Importance in Johnston County. A list of soil map units considered Prime Farmland and of Statewide Importance is provided below in Table 16. Soils considered Prime Farmland and Farmland of Statewide importance are depicted in Figure 16, page 57.

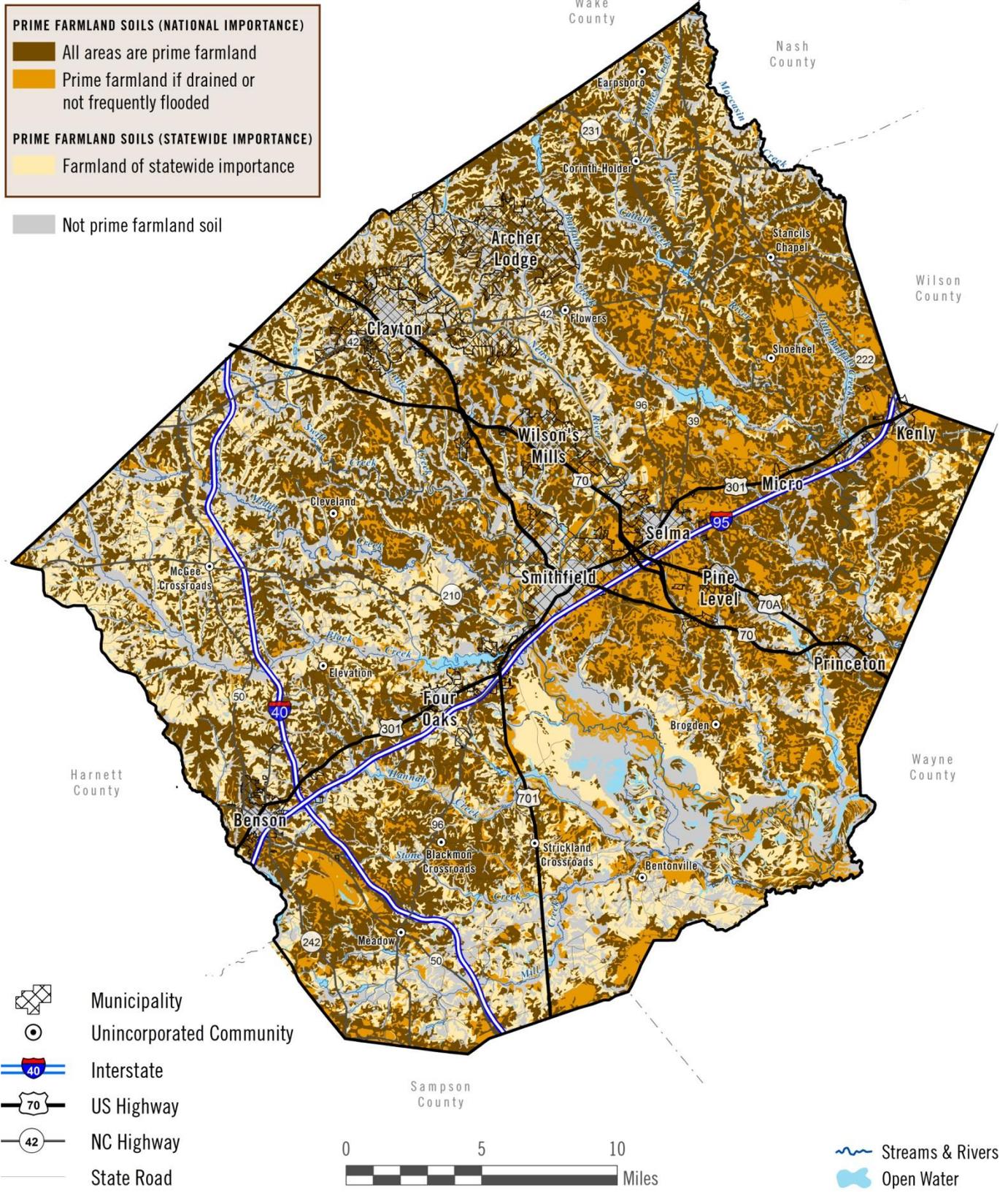
Table 16. Soils Designated Prime Farmland and of Statewide Importance in Johnston County

Soil Series	Soil Map Unit Symbol	Soil Map Unit Description
PRIME FARMLAND SOILS (NATIONAL IMPORTANCE)		
Altavista	AaA	Altavista fine sandy loam, 0 to 2 percent slopes, occasionally flooded
Appling & Marlboro	AmB	Appling-Marlboro complex, 1 to 6 percent slopes
Cecil	CeB	Cecil loam, 2 to 6 percent slopes
Dorian	DoA	Dorian fine sandy loam, 0 to 2 percent slopes, rarely flooded
Faceville	FaA	Faceville sandy loam, 0 to 2 percent slopes
	FaB	Faceville sandy loam, 2 to 6 percent slopes
Gilead	GeB	Gilead sandy loam, 2 to 8 percent slopes
Goldsboro	GoA	Goldsboro sandy loam, 0 to 2 percent slopes
Marlboro	MaA	Marlboro sandy loam, 0 to 2 percent slopes
	MaB	Marlboro sandy loam, 2 to 8 percent slopes
	McB	Marlboro-Cecil complex, 2 to 8 percent slopes
Nankin	NkB	Nankin fine sandy loam, 2 to 6 percent slopes
Nason	NnB	Nason silt loam, 2 to 8 percent slopes
Norfolk	NoA	Norfolk loamy sand, 0 to 2 percent slopes
	NoB	Norfolk loamy sand, 2 to 6 percent slopes
State	StA	State sandy loam, 0 to 3 percent slopes, occasionally flooded
Vance	VaB	Vance coarse sandy loam, 2 to 8 percent slopes
Varina	VrA	Varina loamy sand, 0 to 2 percent slopes
	VrB	Varina loamy sand, 2 to 6 percent slopes
Wedowee	WoB	Wedowee sandy loam, 2 to 8 percent slopes
PRIME FARMLAND IF DRAINED OR NOT FLOODED		
Augusta	AsA	Augusta sandy loam, 0 to 2 percent slopes, occasionally flooded
Grantham	Gr	Grantham silt loam, 0 to 2 percent slopes
Lynchburg	Ly	Lynchburg sandy loam, 0 to 2 percent slopes
Nahunta	Na	Nahunta silt loam, 0 to 2 percent slopes

Soil Series	Soil Map Unit Symbol	Soil Map Unit Description
Pantego	Pn	Pantego loam, 0 to 1 percent slopes, occasionally flooded
Rains	Ra	Rains sandy loam, 0 to 2 percent slopes
Tomotley	To	Tomotley sandy loam, 0 to 2 percent slopes, rarely flooded
Chewacla	Ch	Chewacla loam, 0 to 2 percent slopes, frequently flooded
FARMLAND OF STATEWIDE IMPORTANCE		
Autryville	AuA	Autryville sand, 0 to 2 percent slopes
Bonneau	BoA	Bonneau sand, 0 to 3 percent slopes
Cecil	CeC	Cecil loam, 6 to 10 percent slopes
Fuquay	FuA	Fuquay sand, 0 to 3 percent slopes
Gilead	GeD	Gilead sandy loam, 8 to 15 percent slopes
Leaf	Le	Leaf silt loam, 0 to 2 percent slopes
Nason	NnD	Nason silt loam, 8 to 15 percent slopes
Pacolet	PaD	Pacolet loam, 10 to 15 percent slopes
Roanoke	Ro	Roanoke loam, 0 to 2 percent slopes, occasionally flooded
Uchee	UcB	Uchee loamy coarse sand, 2 to 6 percent slopes
	UcC	Uchee loamy coarse sand, 6 to 12 percent slopes
Wagram	WaB	Wagram loamy sand, 0 to 6 percent slopes
Roanoke	Wh	Warne loam, 0 to 2 percent slopes, occasionally flooded
Wedowee	WoD	Wedowee sandy loam, 8 to 15 percent slopes

NOTE: List of soil map units and designations from Bliley, 1994. Digital data from the [SoilsDataMart](#) 2011.

Figure 16. Prime Farmland Soils in Johnston County



Voluntary Agricultural Districts (VADs)

In 1985, the North Carolina General Assembly, through the Farmland Preservation Enabling Act, set forth the concept of “voluntary agricultural districts” as an effective and politically viable way to protect North Carolina farmland. Voluntary Agricultural Districts (VADs) form partnerships between farmers, county commissioners, and land use planners in order to promote and protect agriculture as an integral part of the County (ACDS, 2010).

Since the creation of the VAD program in 1985, more than two thirds of North Carolina’s 100 counties (including Johnston County) have passed ordinances establishing VADs. In doing so, commissioners appoint a local board to oversee the program. This board determines eligibility and guidelines for enrollment, which are specific to each County. The Johnston County Voluntary Farmland Preservation Program Ordinance states its purpose to provide the following benefits to farmers and County residents:

- ✿ The program preserves and maintains agricultural areas within the County;
- ✿ The program informs non-farming neighbors and potential land purchasers that the participating farm may emit noise, dust, and smells (this feature may help avoid conflicts between neighbors and potential nuisance claims);
- ✿ The program gives the farming community a better voice in Johnston County policy affecting farmland;
- ✿ Farmer participation in the program is voluntary and the farmer may terminate his / her participation at any time;
- ✿ The program requires the Johnston County Commissioners to use farmland “as a last resort” if they are attempting to condemn county lands;
- ✿ The program would provide green space and natural resources as the County’s population and development expands;
- ✿ The program maintains opportunities to produce locally grown food and fiber.

An agricultural district is initiated when interested landowners submit a proposal to the Johnston County Agricultural Advisory Board. The district shall contain a minimum of five acres for horticultural use, 10 acres for agricultural use, and 20 acres for forestry use. This includes leased and / or rented land.

Farmland Communities and Infrastructure

Most towns and unincorporated communities in Johnston County provide some level of support to the agriculture industry. However, the towns of Four Oaks, Kenly, Micro, and Pine Level and the communities of Bentonville, Blackmon Crossroads, Elevation, and Meadow are particularly important hubs for the agriculture industry in Johnston County. There are many locations throughout the County where farmers can purchase supplies and market goods. These hub towns and communities as well as the supporting suppliers, mills, and markets form the base of the agricultural infrastructure in the County. Table 17 on the next page provides a list of known businesses that support the agriculture industry as well as markets where agricultural products are sold locally in the County.

Table 17. Businesses Supporting the Agriculture Industry in Johnston County

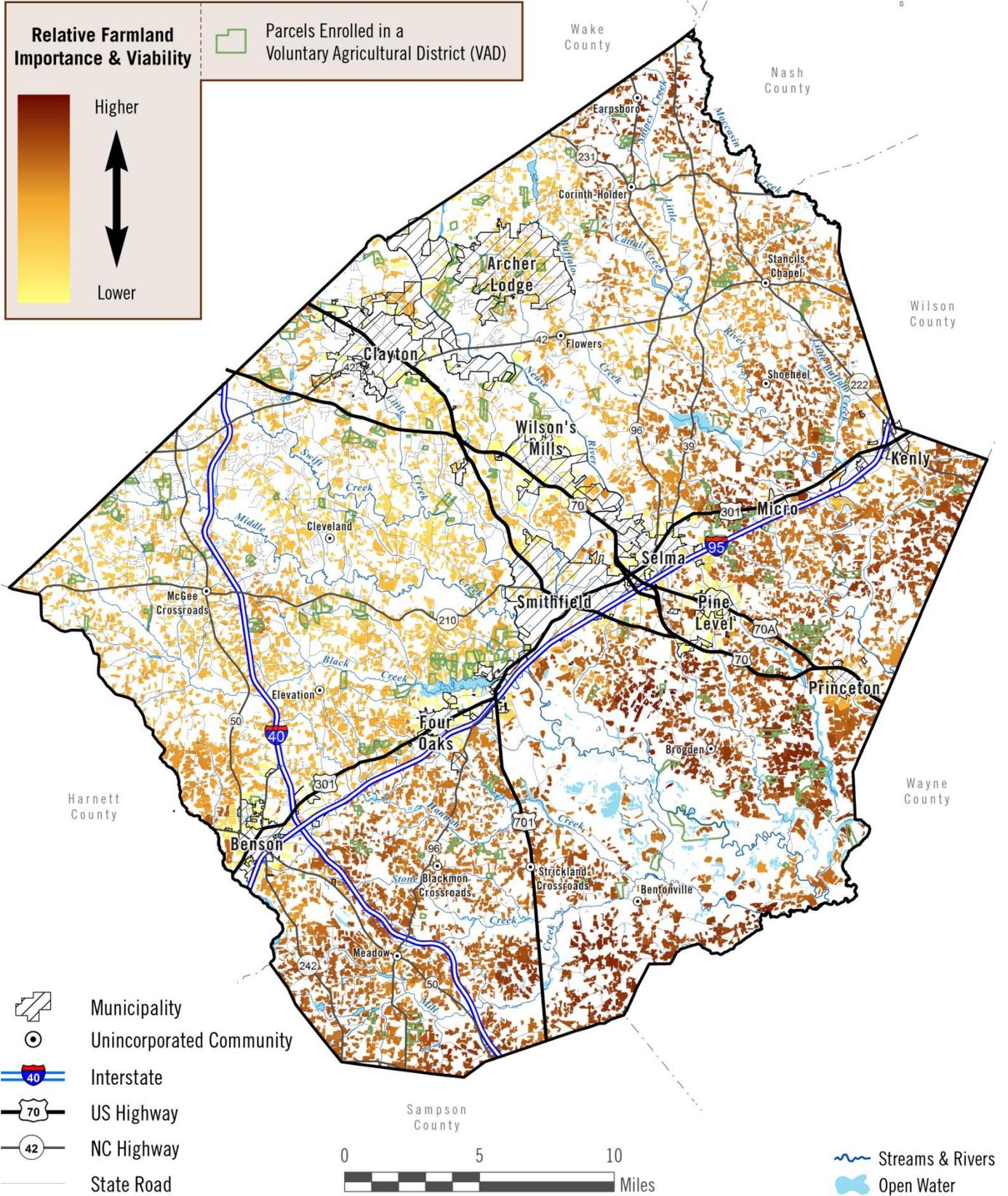
Name of Business	Category
Ace Hardware, Clayton	Supplies
Austin Feed Store	Supplies
Bissette Farm Supply	Supplies
C.W. Flowers Store	Supplies
Carolina Eastern Benson	Supplies
Clayton Farm and Community Market	Farmers Market
Cleveland Emporium	Supplies
Coastal Chemical Corporation	Supplies
Coor Farm Supply Service, Inc.	Supplies
Edgerton Feed Mill	Supplies
Family Home and Garden	Supplies
Home and Tool Connection	Tractor Supplies and Equipment
Hubbard Feeds, Inc.	Feed Mill
Johnston County Farmers Market and Craft Center	Farmers Market
Jones Farm Supply	Supplies
Kenly Farm and Home Supply Company	Supplies
Medlin and Dorman, Inc.	Supplies
Martha's Farm and Garden Supply	Supplies
Micro Oil Company, Inc.	Supplies
Nahunta Feed Supply	Supplies
Old Johnson Feed	Supplies
Royster Clark	Supplies
Smithfield Farmers Market	Farmers Market
Tractor Supply Company	Farm Supplies and Equipment

NOTE: List of businesses may not be comprehensive.

Conservation Planning Tool – Farmland Assessment

The *One NC Naturally Conservation Planning Tool* (CPT) includes a statewide *Farmland Assessment* designed to identify agricultural lands across the state that are important for the agricultural economy and are also supported by the necessary agricultural infrastructure. The CPT *Farmland Assessment* gives priority to lands in proximity to agricultural infrastructure (including agribusiness support and processing facilities), conservation lands (including farmland in conservation), and existing farm operations. Higher priority is given to lands with VADs and good soil productivity as well as counties with high agricultural cash receipts and farmland conservation plans. Input layers were combined using a geographic information system to determine the location of important agricultural lands statewide. However, these input layers are dynamic, and as a result, agricultural lands deemed important and viable today may change based on urban development, or the opening and closing of supporting agricultural businesses. Figure 17 on the next page depicts the most current CPT *Farmland Assessment*. The areas of the County with darker shades of brown in Figure 17 represent farmlands estimated to be important for the agricultural economy that are also supported by essential agricultural infrastructure. Figure 17 also illustrates parcels enrolled in the VAD program, some of which must still be incorporated into the CPT *Farmland Assessment*. More information about the *Farmland Assessment* can be found at: www.onencnaturally.org

Figure 17. CPT Farmland Viability Assessment for Johnston County



3.4.3 Forestlands

The forest products industry currently employs more than 180,000 people and contributes over \$4.1 billion dollars to the State's Gross Product, equaling approximately \$23.1 billion dollars in total economic benefit. In Johnston County alone, the sale of timber accounted for nearly \$77.6 million in income for landowners during the last decade, making forests an important contributor to the economy of the County.

As of 2006, Johnston County had approximately 236,700 acres of upland and wetland forest. Approximately 95 percent of these forestlands are considered timberlands. Timberlands are defined by the U.S. Forest Service as forestlands capable of producing 20 cubic feet of industrial wood per acre per year and not withdrawn from timber utilization (i.e., conserved or preserved lands). As of 2009, there were approximately 226,992 acres of timberland in Johnston County.

While the timber managed and harvested from these lands represents an important component of the County's economy – in both jobs and commodities – the intrinsic values of these forests far exceed the direct monetary values. Healthy forests protect water resources by stabilizing the soil, filtering pollutants, absorbing and slowing stormwater runoff, contributing to groundwater recharge, and minimizing flooding. Forests also provide essential wildlife habitat, improve air quality, and offer recreational opportunities.

Forestlands in the County range from upland dry oak-hickory forest and pine plantations to bottomland and wetland forests. While upland forests represent the majority of the forestland in the County, wetland and riparian forests along the Neuse River represent the largest contiguous blocks. The average size of contiguous forestland area throughout the County is 24 acres, ranging from smaller than one acre to as large as 38,000 acres (Bentonville area and adjacent Neuse River floodplain).

The majority of forestland in the County is privately owned by non-industrial landowners. These tracts are on average less than 50 acres in size. Throughout the state, many of these small, private forest landowners identify reasons other than commercial timber production as their reason for owning forestland. Among the reasons given, the most common are a legacy for their heirs, aesthetics, and stewardship of the land. Statewide, the average size and number of these family forests is expected to decrease due to pressure from development and land use change. The reduction in size and number of family forests is expected to be most prominent in the Piedmont and Upper Coastal Plain ecoregions of the state (NCFS, 2010), particularly within and adjacent to the Triad Area (Raleigh-Greensboro-Charlotte).

\$\$\$ The Value of Forest Ecosystem Services Revealed \$\$\$

A recent study conducted by the Georgia Forestry Foundation and the University of Georgia estimated that the 22.1 million acres of forest in the state of Georgia were worth approximately \$38 billion a year for the intrinsic values of gas and climate regulation; water purification, regulation (flooding), and supply; pollination; wildlife habitat; and aesthetic or recreational use (Moore et al., 2011). The estimated values for these ecosystem services were the highest for wetland and riparian forests located near urban land, with lower (yet still high) values associated with upland forests in rural areas.

Forestry Communities and Infrastructure

While forestland is well distributed throughout the County, several areas and communities represent concentrated areas of active forestland management. Forestlands in the north-central part of the County connected to roads that tie into NC-222, particularly north of NC-42, are important areas for forestry. Also, forestlands between Kenly and Princeton and southeast of I-95 around the communities of Bentonville, Blackmon Crossroads, and Brogden represent important forestlands. These areas are generally located near or connected to Devils Racetrack Road south of the Neuse River and Brogden Road north of the Neuse River.

Currently there are four sawmills and one veneer facility located within the County as well as a number of logging companies, wood dealers or suppliers, and forestry consultants. Table 18 below lists the forest industry facilities and professionals known to work in Johnston County by category.

Table 18. Businesses Supporting the Forest Industry in Johnston County

Name of Business	Category
A & B Logging	Logging Company
B. A. Logging Company	Logging Company
Benson Veneer Company Inc.	Veneer Mill
Black Creek Forestry Services, LLC	Wood Dealer/Supplier
Black Creek Herbicide	Herbicide Application
David C. Raynor Logging Company	Logging Company
Fordham Timber Company	Wood Dealer/Supplier
Frontier Timber Company, Inc.	Wood Dealer/Supplier
Georgia Pacific Corporation	Wood Dealer/Supplier
Grady Atkins and Son Logging	Logging Company
J & B Logging and Timber	Logging Company
J & N Land and Timber	Logging Company
Jerry G. Williams and Sons, Inc.	Sawmill
Joe Bowen Logging	Logging Company
KD Logging	Logging Company
Keener Lumber Company	Sawmill, Pine
Lampe and Malphrus Lumber Company	Sawmill, Pine
Mike Atkins and Son Logging	Logging Company
Mill Creek Timber Company, Inc.	Wood Dealer/Supplier
OLT Logging	Logging Company
Piedmont Woodyards, Inc.	Wood Dealer/Supplier
Renew Pro-Loggin	Logging Company
Smithfield Forest Products, Inc.	Logging Company
Squires Forest Products, Inc.	Wood Dealer/Supplier
Steve Crumpler Logging Company	Logging Company
T.E. Johnson Lumber Company, Inc.	Sawmill
Approximately 98 Registered Foresters and 78 Consulting Forestry Companies Work in Johnston County: www.ncforestservice.gov/contacts/pdf/cf/cfjohnston.pdf	Forestry Consulting Firms and Consulting Foresters

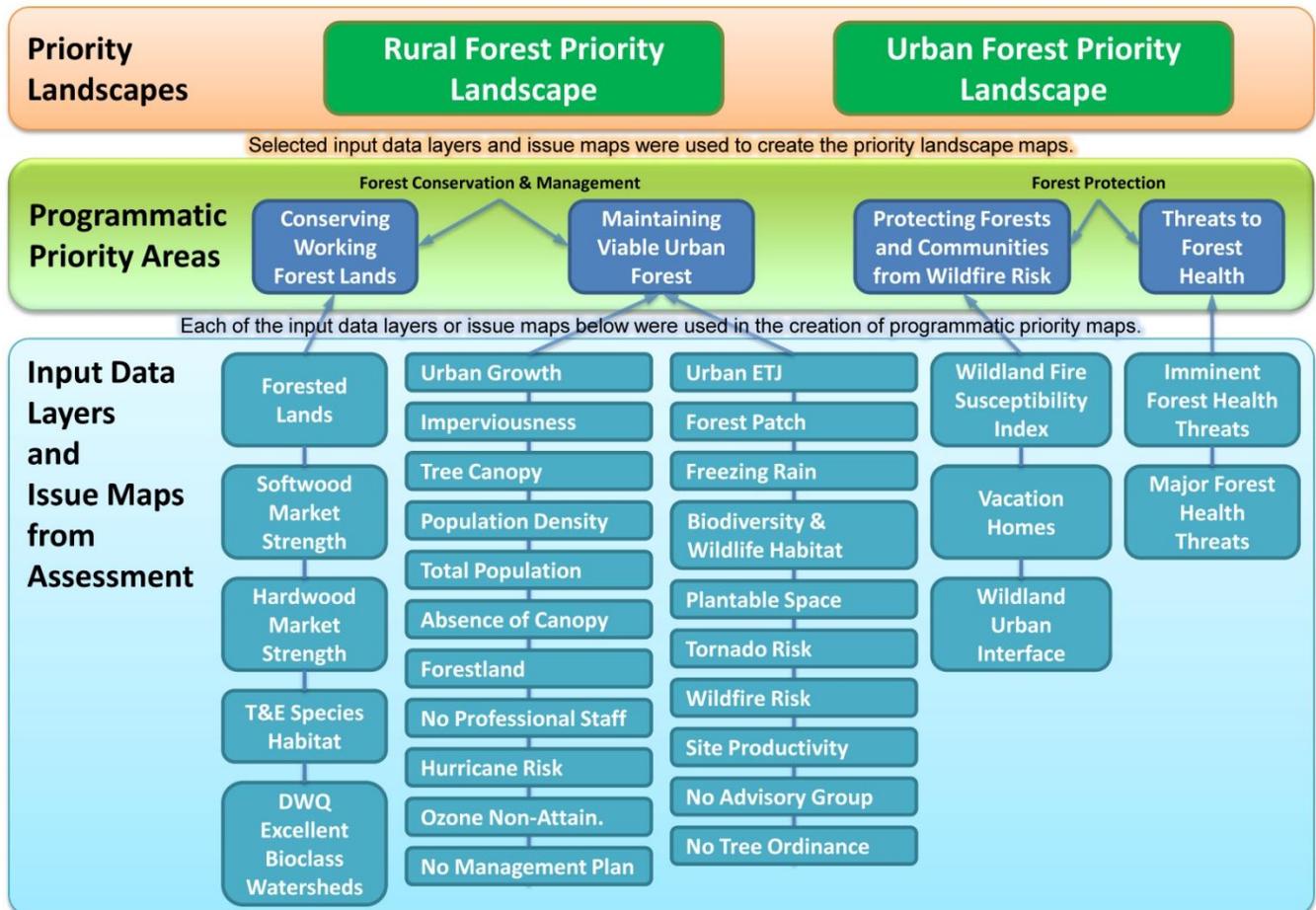
NOTE: List of businesses may not be comprehensive.

Statewide Assessment of Forest Resources (SAFR)

As discussed in Section 1.5 of this report, the N.C. Forest Service (NCFS) completed a *Statewide Assessment of Forest Resources* (SAFR) in 2010. This statewide assessment identifies current forest conditions and depicts priority areas across the state in which to focus efforts to sustain viable forests for the future. Given that North Carolina continues to urbanize, the SAFR provides priority maps for both Rural Forest and Urban Forest Landscapes. Within these landscapes there are four general programmatic areas: (1) Conserving Working Forest Lands, (2) Maintaining Viable Urban Forests, (3) Protecting Forests and Communities from Wildfire Risk, and (4) Threats to Forest Health.

Many data layers were used to generate maps of these priority landscapes and programmatic priority areas. Figure 18 below is a schematic illustrating the relationship between the priority landscapes, programmatic priority areas, and the data layers used to generate these geographic datasets. Figures 19 and 20 illustrate areas which fall within each of the two priority forest landscapes. Figure 21 shows areas of important working forestlands and Figure 22 shows areas of important urban forests. More information about the spatial analyses used to generate these maps can be found in Appendix B of the SAFR, available at: www.ncforestassessment.com.

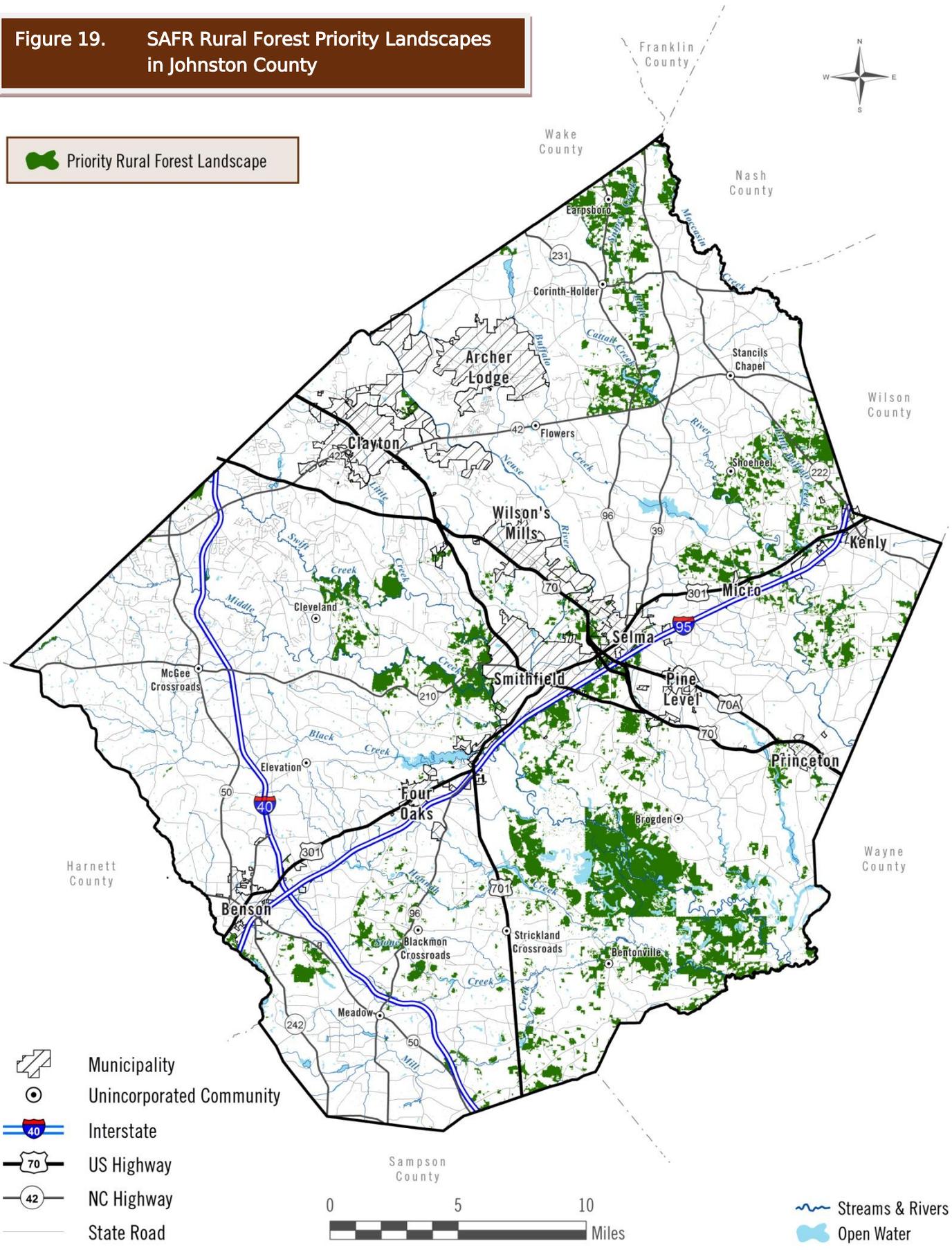
Figure 18. Statewide Assessment of Forest Resources Priority Landscapes, Priority Maps, and Input Data Layers



NOTE: Subject matter modified from original content presented in the 2010 Statewide Assessment of Forest Resources.

Figure 19. SAFR Rural Forest Priority Landscapes in Johnston County

 Priority Rural Forest Landscape

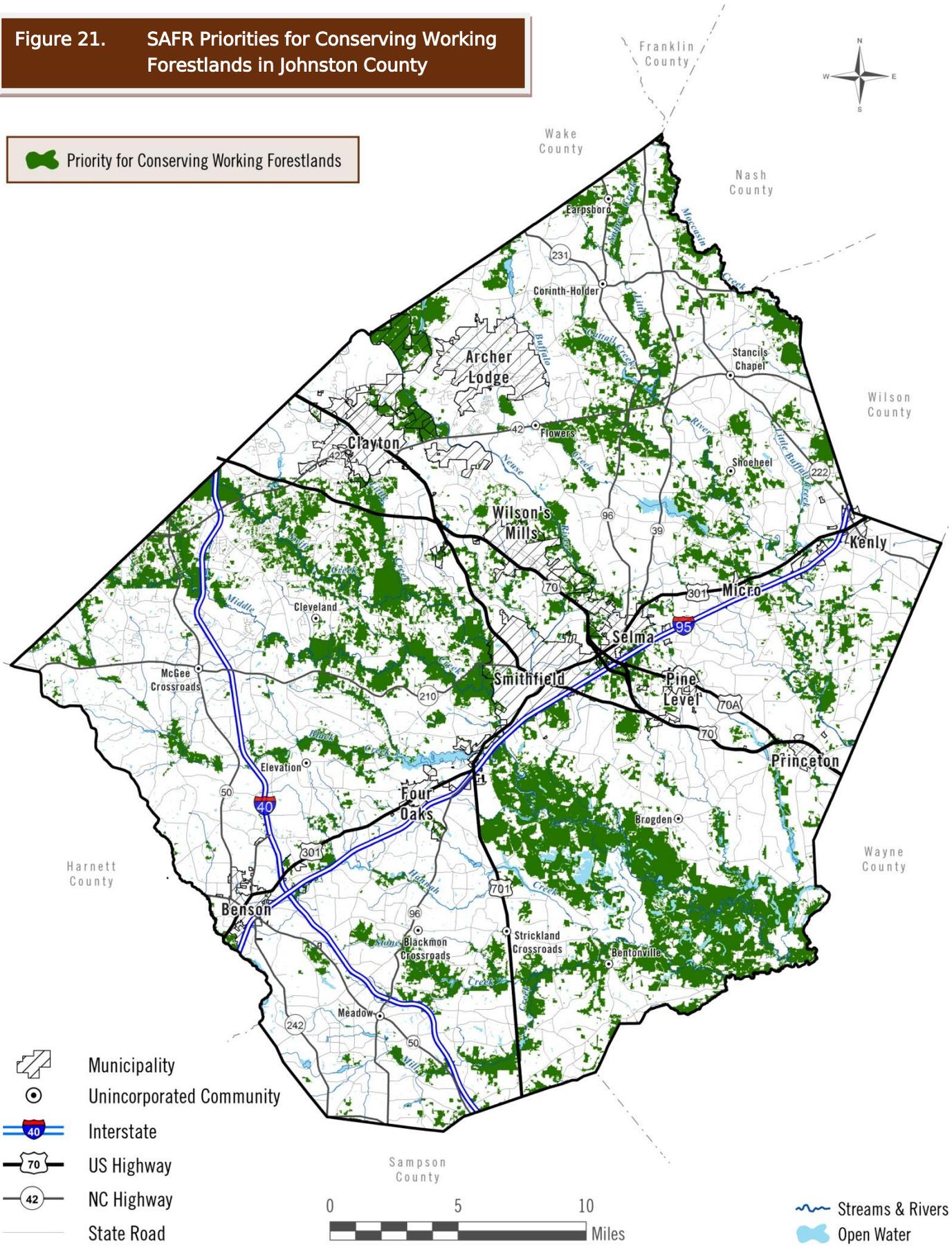


-  Municipality
-  Unincorporated Community
-  Interstate
-  US Highway
-  NC Highway
-  State Road

 Streams & Rivers
 Open Water

Figure 21. SAFR Priorities for Conserving Working Forestlands in Johnston County

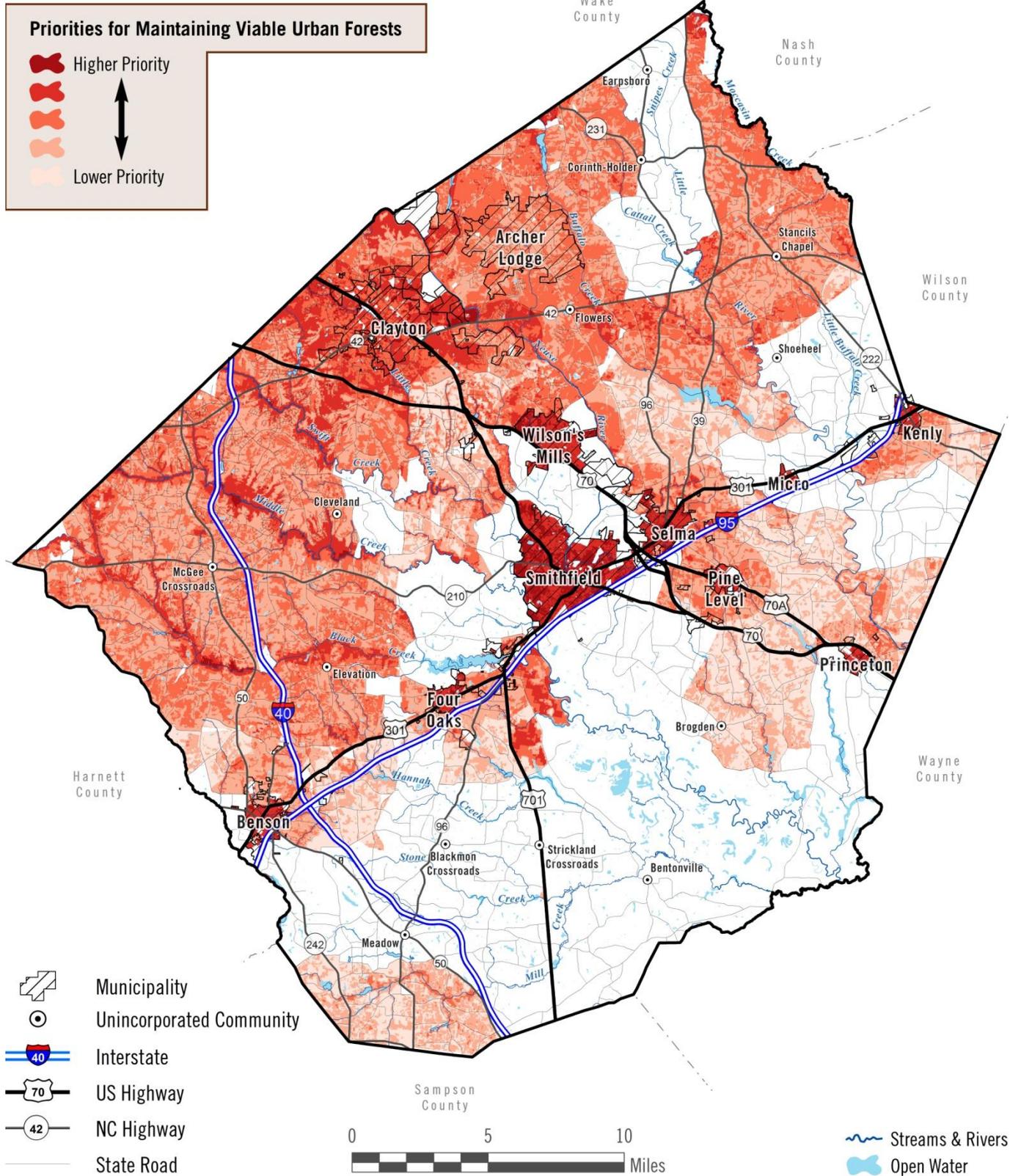
 Priority for Conserving Working Forestlands



-  Municipality
-  Unincorporated Community
-  Interstate
-  US Highway
-  NC Highway
-  State Road

-  Streams & Rivers
-  Open Water

Figure 22. SAFR Priorities for Maintaining Viable Urban Forests in Johnston County



3.5 Urban Forests and Tree Canopy

Urban forests are also a key component of Johnston County’s green infrastructure. By absorbing and filtering out nitrogen dioxide (NO₂), sulfur dioxide (SO₂), ozone (O₃), carbon monoxide (CO), and certain particulate matter in their leaves, urban trees perform a vital air cleaning service that directly affects the well-being of urban citizens. Urban forests are also known to capture and reduce stormwater runoff, decrease soil erosion in urban areas, improve water

A healthy urban forest has been defined as an urban forest with the ability to provide sustained goods and services, such as clean air and water, energy conservation, stormwater mitigation, biodiversity, and a sense of place (McPherson, 1993).

quality, create urban wildlife habitat, increase recreational opportunities, increase property values, reduce noise levels, decrease energy costs, increase community pride, and positively influence consumer behavior. In short, the value of trees in urban areas, both for human health and aesthetics are widely studied and the research indicates that increased urban forest canopy has a positive effect on communities, the people in them, and the environment. (SCUFR&I, 2006).

Measuring urban tree canopy is one method of determining the distribution of urban forests. The term urban tree canopy (UTC) refers to the layer of leaves, branches, and stems of trees that cover the ground when viewed from above. As a component of this project, the N.C. Forest Service acquired the services of NCDC Imaging to conduct an analysis and summary of existing and possible UTC throughout the cities of Clayton, Selma, and Smithfield. The first step in this process included a land cover analysis in each of these cities. Land cover was mapped as one of the following classes: bare soil, grass, impervious surface, marsh, trees, and water. These land cover classes were further grouped into three categories of UTC: existing, possible, and unsuitable. The UTC categories and land cover percentages for Clayton, Selma, and Smithfield are presented in Table 19 below.

Table 19. Urban Tree Canopy Categories and Land Cover for Clayton, Selma, and Smithfield

UTC Category	Land Cover Class	Clayton		Selma		Smithfield	
		Acres	%	Acres	%	Acres	%
Existing	Marsh	371	5	624	8	87	3
	Trees	3,897	48	2,628	35	913	31
Sub-Total		4,268	53	3,252	43	1,000	34
Possible	Bare Soil	254	3	69	1	19	< 1
	Grass	2,501	31	2,745	36	1,353	46
Sub-Total		2,755	34	2,814	37	1,372	46
Unsuitable	Impervious Surface	1,051	13	1,360	18	551	19
	Water	62	< 1	138	2	44	1
Sub-Total		1,113	13	1,498	20	595	20
TOTAL		8,136	100	7,564	100	2,967	100

NOTE: Acres are approximate. Total acreage may not sum to current town acreage.

The town of Clayton currently has the largest percentage of existing UTC (53 percent), followed by Selma (43 percent) and Smithfield (34 percent). The extent of possible UTC – where trees could potentially be planted to expand UTC – is inversely related to the amount of existing tree canopy in these three cities, with Smithfield having the highest possible UTC percentage (46 percent) followed by Selma (37 percent) and Clayton (34 percent). UTC categories and land cover classes are depicted in Figure 23 for Clayton and Figure 24 for Selma and Smithfield.

Figure 23. Urban Tree Canopy and Land Cover in the Town of Clayton, Johnston County

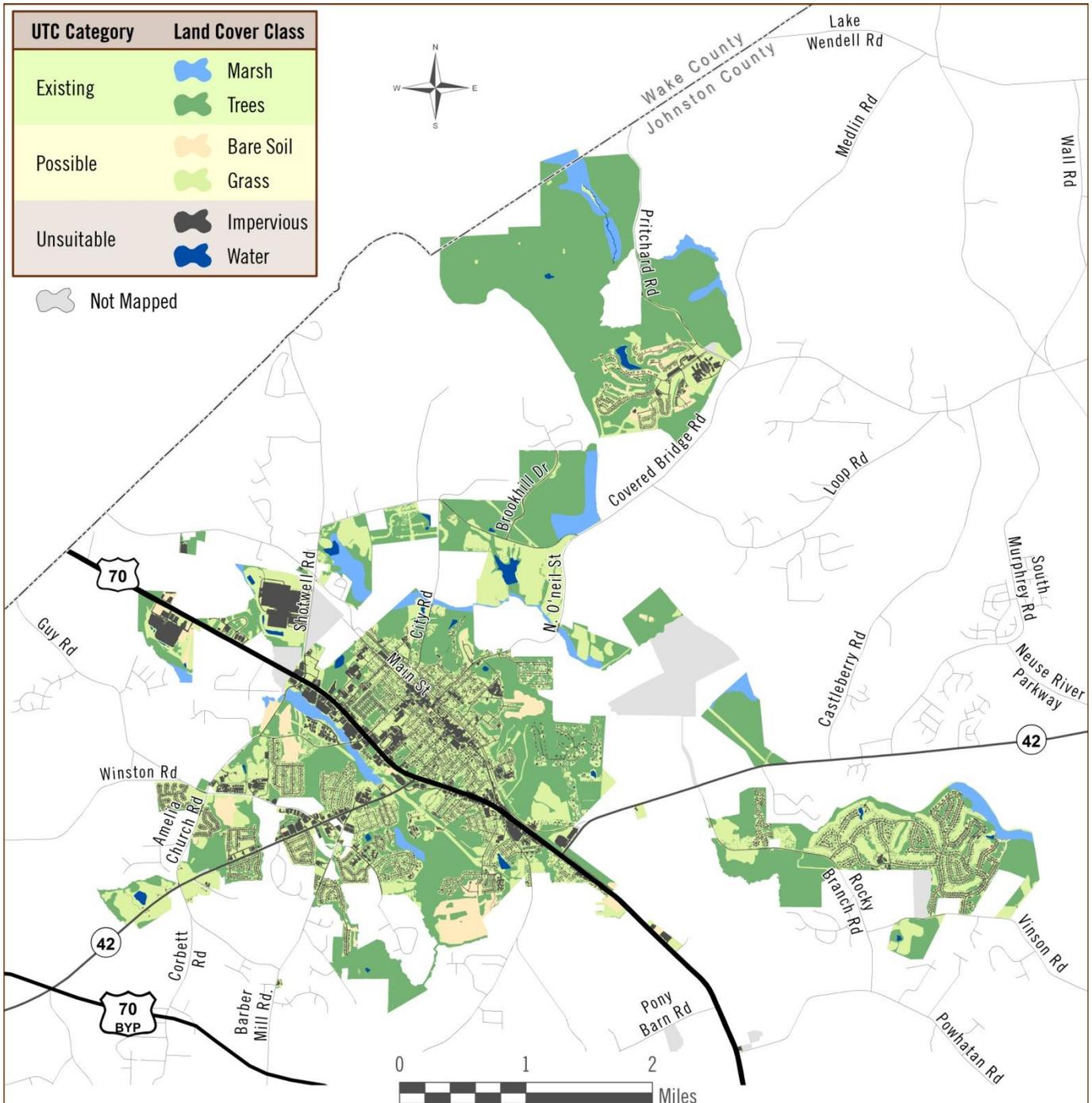
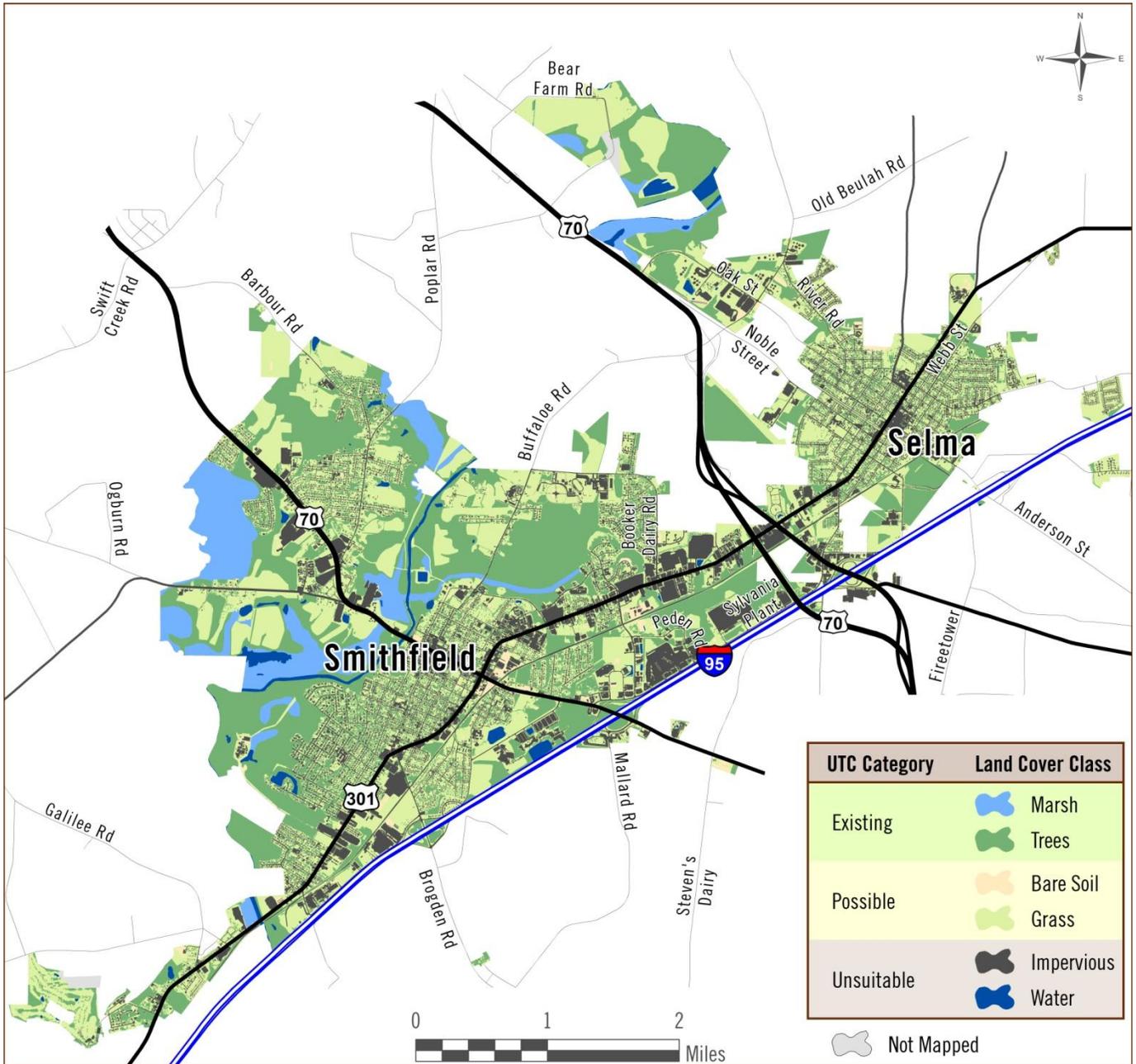


Figure 24. Urban Tree Canopy and Land Cover in the Towns of Selma and Smithfield, Johnston County



3.6 Open Space – Trails and Recreational Resources

Trails, parks, and other recreational areas (open spaces) can have a positive effect on nearby residential property values, and can lead to proportionally higher property tax revenues for local governments; provided the municipalities are not subject to caps on tax levies. The influence of opens spaces on property values is often related to how far the recreational areas are from the residential area, the size of the open space, and the characteristics of the surrounding neighborhood (ALR, 2010). Human physical health has also been linked to the availability of open space, with citizens who live in walkable neighborhoods or near recreational areas having fewer health problems related to the lack of exercise and physical activity (e.g., obesity, diabetes, etc.).

Johnston County has numerous trails and other recreational resources including state, county, and municipal parks. Recreational areas often make up a key component of green infrastructure, given that these areas are already conserved or intended for uses other than development. The County's recreational properties – both large and small – offer opportunities for boating, fishing, swimming, golfing, camping, hunting, wildlife watching, hiking, and other outdoor activities. Table 20 below lists these resources along with their general intended use and location, as well as their approximate size. Figure 24 on page 73 depicts the open space, trails, and recreational resources known to occur in Johnston County.

Table 20. Trails and Recreational Resources in Johnston County

Recreational Resource Name	Use / Location	Size (Acres)
All-Star Park	Park / Clayton	1
Benson Civic Center and Municipal Park	Park / Benson	18
Bingham Park	Park / Smithfield	18
Bob Wallace Jaycee Kiddie Park	Park / Smithfield	7
Burlington Park	Park / Smithfield	<1
Camp Mary Atkinson	Camp - Girl Scout / SE of Archer Lodge	262
Cardinal Country Club	Golf / S of Micro	137
Clayton Community Park	Park / Clayton	43
Clemmons Educational State Forest	Educational Forest / Clayton	825
Country Club of Johnston County	Golf / Smithfield	150
Creech Recreation Complex	Golf / E of Archer Lodge	30
Gertrude B Johnson Park	Park / Smithfield	5
Grady Park	Park / Kenly	1
Howell Woods Environmental Learning Center	Educational Forest / SSE of Four Oaks	2,856
Jerome Park	Park / Micro	1
Kenly Parks and Rec	Park / Kenly	31
Legend Park	Park / Clayton	24
Lincoln Drive Park	Park / Kenly	1
Mitchell Nance Athletic Complex/Picnic Shelter	Park / Benson	3
Mountains-to-Sea Trail	Trail / Roughly follows the Neuse River	53*
Neuse Golf Club	Golf / Clayton	169
Pine Hollow Golf Course	Golf / Clayton	75
Reedy Creek Golf Course	Golf / NNE of Benson	152
Richardson's Bridge	Boating Access / SSW of Princeton	9

Recreational Resource Name	Use / Location	Size (Acres)
Riverwood Golf Club	Golf / Clayton	187
Smith Collins Park	Park / Smithfield	9
Smithfield Community Park	Park / Smithfield	43
Talton Park	Park / Smithfield	3
Town Commons	Park / Smithfield	5
Tuscarora Scout Reserve	Camp - Boy Scout / SE of Four Oaks	1,100
TOTAL ACRES		6,165

*Linear miles

Potential New State Park – Middle Neuse River

The North Carolina Constitution states, “It shall be the proper function of the state to acquire and preserve park, recreational and scenic areas, and in every other appropriate way, to preserve as a part of the common heritage of this State, its open lands and places of beauty.” The N.C. State Parks Act of 1987 (SPA) also declares that the State's unique examples of natural diversity “are part of the heritage of the people of the State to be preserved and managed by those people for their use and for the use of their visitors and descendents.”

The N.C. Division of Parks and Recreation (NCDPR) serves as the primary agency charged with fulfilling the conservation objectives outlined in the State Constitution and the SPA. In this role, the NCDPR started an initiative in 2002 titled “*New Parks for a New Century*.” This initiative targets some of the most treasured and threatened natural resources as potential additions to the State Parks System. The *New Parks for a New Century* initiative has identified an area along the Neuse River in east-central Johnston County as a potential state park. This potential new State Park area is referred to as the “Middle Neuse River,” and has been targeted given the unique nature of the Neuse River floodplain, the natural and aquatic communities found in the area, and the wildlife species that are known to occur and that are dependent on the habitats. This area, often locally known as the “Let-lones,” also harbors state and federally protected rare species, or includes habitat where these species are commonly found. While funding for the acquisition and creation of this proposed state park has not been identified, the site will remain on the list of potential state parks. More information about *New Parks for a New Century* initiative can be found at the following website: www.ncparks.gov/About/plans/new/additions_main.php.

3.7 Cultural and Historic Resources

Cultural and historic resources are often overlooked or discussed in separate contexts in traditional natural resource assessments. Humans have questioned their place in the hierarchy of animals and plants on earth for centuries, but the undeniable fact that we are dependent on these resources for our continued existence supports the position that humans are a part of nature, and not apart from it. Therefore, the markers of our existence on- and as a part of- the landscape, including cultural and historic resources, very much represent important components of green infrastructure.

“The great question, whether man is of nature or above her.”

*- George Perkins Marsh,
Man and Nature*

Johnston County has an old and rich human history, with several markers of this history scattered throughout the County. Cultural and historic resources in the County range from archeological sites to historic battlegrounds and buildings. There are currently 35 historic districts, buildings, and other features listed in the National Register of Historic Places (Table 21). There are approximately 380 know archeology sites in the County, most of which have been assessed and determined ineligible for listing in the National Register. Additionally, there are approximately 125 different properties that are currently on the Study List for inclusion on the National Register of Historic Places. These resources include homes, farms, churches, schools, historic districts and other types of sites. A complete listing of these sites is available from the Johnston County Heritage Center on their website at: johnstonnc.com/mainpage.cfm?category_level_id=653.

Table 21. Cultural and Historic Resources in Johnston County Listed in the National Register of Historic Places

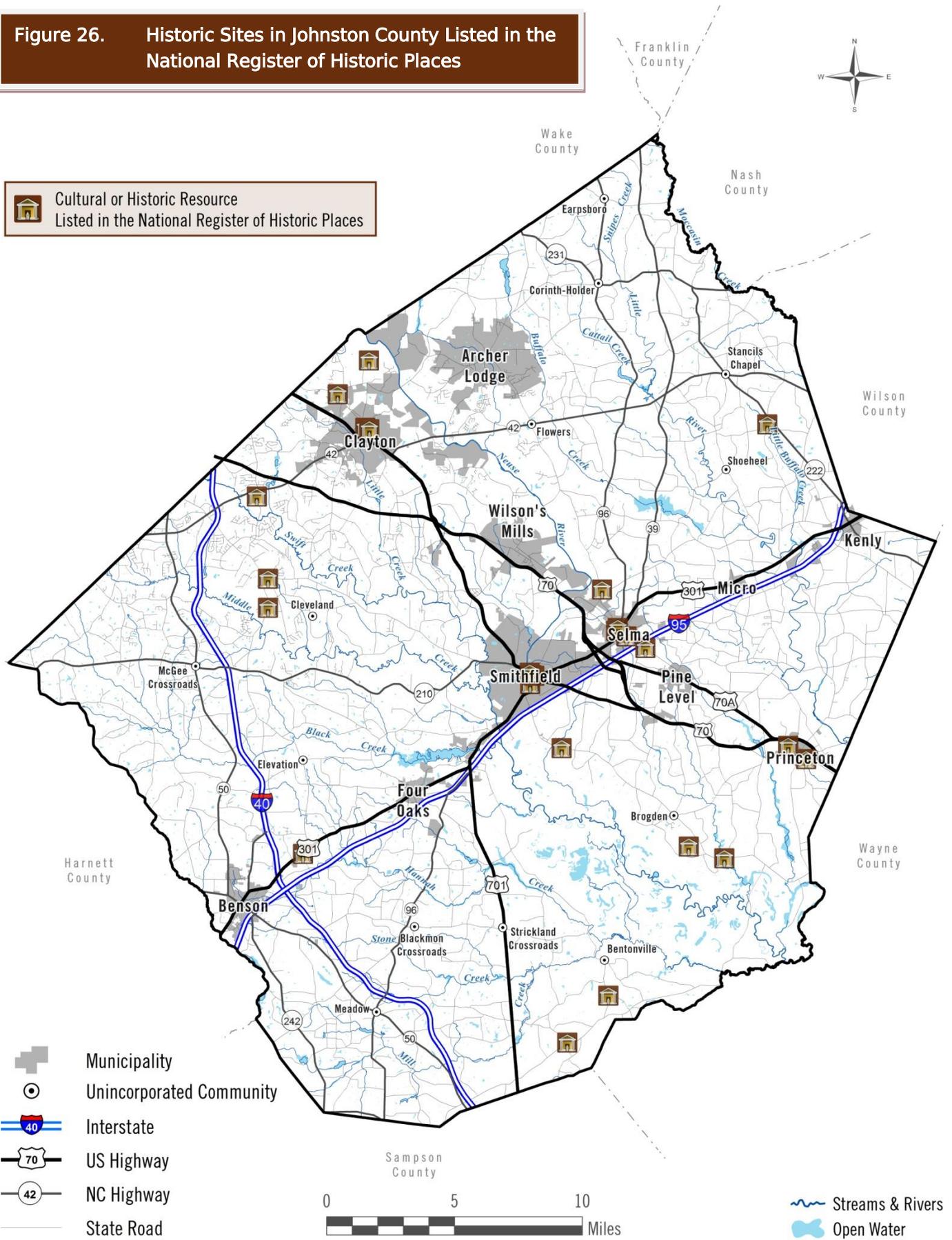
Township	Cultural or Historic Resource	Ownership	Current Use(s)
Banner	Benson Historic District	Private, Local Gov't	Commerce/Trade, Domestic
	Hannah's Creek Primitive Baptist Church	Private	Church, Cemetery
Bentonville	Bentonville Battlefield State Historic Site	State	Park
	Harper House	State	Museum
Beulah	Boyette Slave House	Private	not in use
	Tobacco Farm Life Museum	Non-profit	Working Museum
Boon Hill	Atkinson-Smith House	Private	Domestic
	Hastings-McKinnie House	Private	Domestic
	Princeton Graded School	Non-profit	Work in Progress
	Shiloh Primitive Baptist Church	Private	Work in Progress
Clayton	(former) Clayton Banking Company Building	Private	Commerce/Trade
	(former) Clayton Graded School & Auditorium	Private, Local Gov't	Government, Culture
	Clayton Historic District	Private, Local Gov't	Commerce/Trade, Domestic, Government

Township	Cultural or Historic Resource	Ownership	Current Use(s)
Clayton	Ellington-Ellis Farm	Private	Agriculture, Domestic
	Stallings-Carpenter House	Private	Agriculture, Domestic
Cleveland	Cleveland School	Private, Local Gov't	Domestic
	Sanders-Hairr House, a.k.a. White Oak	Private	Domestic
	Walter R. & Eliza Smith Moore House	Private	Domestic
Ingrams	Four Oaks Commercial Historic District	Private	Commerce/Trade, Transportation
Selma	Downtown Selma Historic District	Private	Commerce/Trade
	Everitt P. Stevens House	Private	Agriculture, Domestic
	Noah Edward Edgerton House	Private	Domestic
	Nowell-Mayerburg-Oliver House	Private	Domestic
	Union Station	Local Gov't	Transportation - Rail
	Waddell-Oliver House	Private	not in use
	William E. Smith House, a.k.a. The French Country Inn	Private	Commerce/Trade, Domestic
Smithfield	Brooklyn Historic District	Private	Commerce/Trade, Domestic, Education, Recreation And Culture
	Downtown Smithfield Historic District	Private	Commerce/Trade, Government, Recreation And Culture
	Hood Brothers Building	Private	Commerce/Trade
	Hood-Strickland House	Private	Domestic
	Johnston County Courthouse	Local Gov't	Government
	North Smithfield Historic District	Private	Commerce/Trade, Domestic, Funerary, Social
	Smithfield Masonic Lodge	Private	Work in Progress
	(former) U. S. Post Office	Private	Commerce/Trade
	Watson-Sanders House	Private	Agriculture, Domestic

Figure 26 on the next page depicts the approximate location of historic sites listed in the National Register of Historic Places. All other known sites are not depicted due to the sensitive nature of some sites, the exact location of which is protected under state law.

Figure 26. Historic Sites in Johnston County Listed in the National Register of Historic Places

 Cultural or Historic Resource Listed in the National Register of Historic Places



-  Municipality
-  Unincorporated Community
-  Interstate
-  US Highway
-  NC Highway
-  State Road

-  Streams & Rivers
-  Open Water

CHAPTER 4 - GREEN INFRASTRUCTURE ASSESSMENT

This chapter is intended to provide a brief overview of some of the threats to natural resources in Johnston County, as well as the conditions and trends of these resources. The assessment was conducted using publicly available datasets, or information gathered during detailed urban tree canopy (UTC) analyses completed in association with this project. While the condition and trends of some resources were not assessed, the documented threats affecting the County's green infrastructure have a relatively uniform impact on all of the individual resources. As a result, trends of documented natural resources could serve as indicators of the condition of resources not discussed in this chapter.

4.1 Threats to Natural Resources

Threats are things that jeopardize the functionality of natural resources. These threats are commonly associated with human activities either directly or indirectly. Each of these threats affects the condition of the County's green infrastructure in some way; the impact of which is often overlapping and / or cumulative. Threats to the County's natural resources could originate from within or come from outside its boundary. Similarly, the scale of a threat could be localized within the County or could extend well beyond its borders.

Examples of potential threats to natural resources include population growth and land use change, including road and other grey infrastructure projects; ecosystem insects, diseases, and non-native invasive (NNI) plants; mining and mineral exploration; wildfire; and climate change. These threats often result in the alteration and degradation of terrestrial and aquatic habitats, water pollution, and air pollution.

Descriptions of Direct, Indirect, and Cumulative Impacts to Natural Resources

***Direct Impacts:** The effects on the environment caused by the action that occur at the same time and place. Examples of direct impacts include sediment runoff, noise pollution, and air pollution occurring from the use of heavy equipment during road construction or land clearing.*

***Indirect (Secondary) Impacts:** The effects on the environment caused by the action that are later in time and farther removed in distance, but are still reasonably foreseeable. Indirect effects may include changes in land use or population density and the related effects on air, water, and other natural resources.*

***Cumulative Impacts:** Impacts to the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. An example of cumulative impacts are the effects of the action added to the collective effects of non-point source pollution from various land uses over time resulting in the degradation of water quality.*

4.1.1 Population Growth and Land Use Change

Land use change to accommodate population growth is inevitable. People need places to live, work, buy food and clothing, and transportation systems to get them where they would like to go (CCP, 2011). However, without proper planning, population growth can lead to significant direct, indirect, and cumulative impacts to the green infrastructure of the County. Farms, forests, wetlands, water supplies, air quality, and wildlife habitat are at risk when development is poorly planned or implemented.

Population growth and land use change are the most significant threats to conserving the green infrastructure of the County, including the economic and intrinsic values of these vital resources. Johnston County’s population has grown 108 percent in the last 20 years (Table 22) and 174 percent in the last 40 years (Table 23). This growth has been the driving factor for land use change in the County. According to the National Land Cover Database (NLCD) urban land increased by 254 percent (approximately 30,500 acres gained) and forestland decreased by 33 percent (approximately 75,000 acres lost) from 1992 to 2006.

Table 22. Population Growth by City in the Last Two Decades in Johnston County

City	Total Population			Percent Change		
	1990	2000	2010	1990-2000	2000-2010	1990-2010
Archer Lodge	*	*	4,292	*	*	*
Benson	3,044	2,993	3,311	-2	11	9
Clayton	4,756	8,126	16,116	71	98	239
Four Oaks	1,308	1,514	1,921	16	27	47
Kenly	1,549	1,569	1,176	1	-25	-24
Micro	417	454	441	9	-3	6
Pine Level	1,217	1,319	1,700	8	29	40
Princeton	1,181	1,090	1,194	-8	10	1
Selma	4,600	5,914	6,073	29	3	32
Smithfield	7,540	10,867	10,966	44	1	45
Wilson’s Mills	**	1,296	2,277	**	76	**
Non-Municipal	55,694	86,758	119,411	56	38	114
TOTAL	81,306	121,900	168,878	50 %	39 %	108 %

*Archer Lodge was incorporated in 2009.

**Wilson’s Mills was re-incorporated in 1995.

As Johnston County grows to accommodate the increasing population, land use conversion from farm and forestland to urban land will likely increase. Residential, commercial, and industrial development, including the expansion of transportation and utility infrastructure to support these land uses, can change the landscape in many ways. These changes can result in the degradation of natural resources, both from an ecological and economic perspective.

Impacts to Working Lands

Urban growth and public works infrastructure projects can lead to the direct conversion of farm and forestlands to other uses and can also indirectly impact farmers and forestland owners. Land values commonly increase when water and sewer services are provided, which increases the tax burden. An increased tax burden makes it more difficult for new or beginning working landowners to acquire land or for existing farm and forestland owners to expand their ownership under management. Population growth can also present new challenges to farm and forestland owners adjacent to expanding urban and suburban communities. Conducting traditional management on these working lands can be more difficult as residents settle in close proximity to operational farms and forests. Population growth and land use change can also result in the conversion of prime farmland soils to non-farm or forestland use, which can restrict working lands to marginal areas where soils are more prone to erosion and drought, are less productive, and are less easily cultivated.

Table 23. Population Growth in the Last Four Decades in Johnston County

Year	County Total Population	Percent Growth	Decadal Percent Growth
1970	61,737	**	1970 - 1980 14 %
1975	66,800	8 %	
1980	70,599	6 %	1980 - 1990 15 %
1985	75,826	7 %	
1990	81,306	7 %	1990 - 2000 50 %
1995	98,259	21 %	
2000	121,998	24 %	2000 - 2010 38 %
2005	143,982	18 %	
2010	168,878	17 %	

Impacts to Natural Communities and Wildlife Habitats

Development as a result of population growth can also lead to the conversion of natural communities to urban lands, reducing the available habitat for plants and animals. This conversion can have adverse direct, indirect, and cumulative impacts on both terrestrial and aquatic habitats. Urban and suburban development commonly results in terrestrial habitat fragmentation, which reduces the area of contiguous habitat and increases the distance between ecosystems. Habitat fragmentation excludes species with large area-requirements and isolates other species, making populations more vulnerable to disturbance, disease, and predation. Many animals move only through habitats that are familiar to them, and are turned back by abrupt changes in habitat.

Impacts to Water Resources

Without proper planning, population growth and land use change can severely impact water resources, including aquatic habitats and species. With the expansion of urban land, impervious surfaces created by the construction of roads, parking lots, rooftops, and driveways can decrease groundwater infiltration of runoff and increase runoff volumes and rates. Drinking water supplies and baseflows can also be adversely affected by reduced recharge of groundwater supplies. Changes in runoff volumes and rates can often increase flooding, erosion, and sedimentation of streams and waterbodies (USEPA, 2005).

Development activities are generally associated with an increase in water pollution, including sediment, nutrients, pathogens, household chemicals, metals, fertilizers, pesticides, oils, and grease. Increased pollutants in surface and groundwater supplies can limit human and ecological uses of these valuable water sources. New construction projects associated with population growth and land development generally disturb soil and can lead to erosion and sedimentation. In the U.S., sediment has been identified as the leading cause of streams and waterbodies not meeting their intended uses (i.e., impaired) (USEPA, 2005).

Water pollution is generally placed into one of two categories: (1) nonpoint source pollution and (2) point source pollution. The term “nonpoint source pollution” (NPS) refers to pollution that comes from many diffuse sources and not from a single source at a single location. Unlike pollution from direct discharges (point source), NPS pollution comes from many sources and locations and is caused by precipitation (e.g., rain, snow and snowmelt, sleet, etc.) moving over and through the ground. As this runoff flows over impervious surfaces, yards, construction sites, farms, and forests, it can pick up and carry pollutants to streams and waterbodies, including percolating into groundwater supplies (CCP, 2011).

Examples of nonpoint source pollution include:

- ✿ Fertilizers, herbicides, and pesticides from agricultural lands and residential areas;
- ✿ Oil, grease, and toxic chemicals from urban runoff and energy production;
- ✿ Sediment from construction sites, farm and forest lands, and eroding streambanks;
- ✿ Bacteria, viruses, and nutrients from livestock, pet wastes, faulty septic systems, and biosolid land application sites; and
- ✿ Atmospheric deposition.

Point source pollution is defined by Section 502(14) of the Clean Water Act (CWA), as: *any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.*

In some cases, point source effluent is treated before being discharged. However, in other cases, untreated effluent can be discharged into streams and waterbodies. To reduce the effects of point source pollution on water resources, the CWA established the National Pollutant Discharge Elimination System (NPDES). Under the NPDES program, dischargers of point source pollution, such as factories, wastewater treatment plants, and concentrated animal feeding operations, must obtain a permit before discharging waste or effluent into streams or waterbodies. While the NPDES program provides some water quality protection from point source pollution, these discharges still have direct, indirect, and cumulative impacts on water resources. More information about the NPDES program in North Carolina can be accessed at the following website:

portal.ncdenr.org/web/wq/swp/ps/npdes.

4.1.2 Insects, Diseases, and Non-native Invasive Plants

Insects, diseases, and non-native invasive (NNI) plants can cause significant ecological and economic damage to Johnston County’s natural resources. In the forests, losses from native forest insects and diseases are typically cyclical as native forest tree and pest species have coexisted for many years. The intensity and duration of cyclical outbreaks can be aggravated by land use changes due to human activities or poor land management practices. Non-native insects and diseases can be particularly threatening to native forest health given that these forests have not evolved with these pests. As a result, many native forests have not produced adequate natural defenses. In addition, major NNI plants crowd out native species; their impacts minimize diversity, simplify natural systems, limit production of native wildlife food, and foster monocultures. Many non-native species continue to spread and have not reached their full biological impact. As a result, the full economic and ecologic cost has not yet been realized.

Specific insects, diseases, and non-native invasive plants that are currently threatening the natural resources of Johnston County are being monitored by various natural resource agencies such as the N.C. Department of Agriculture, N.C. Forest Service, N.C. Wildlife Resource Commission, N.C. Cooperative Extension, and the Natural Resource Conservation Service. The insects, diseases, and non-native invasive plants that present the greatest immediate threat to forest and farmlands in Johnston County are listed in Table 24.

Table 24. Significant Insects, Diseases, and Non-native Invasive Plant Threats to Johnston County

Type	Common Name	Scientific Name	Threatened Resource	County Extent
Insect	Asian longhorned beetle	<i>Anoplophora glabripennis</i>	Forests	None yet
	Bagworm	<i>Thyridoteryx ephemeraeformis</i>	Forests	In county
	Black turpentine beetle	<i>Dendroctonus terebrans</i>	Forests	In county
	Brown garden snail	<i>Helix aspersum</i>	Farmlands; vegetables	None yet
	Brown marmorated stink bug	<i>Halyomorpha halys</i>	Farmlands; sweet potatoes	None yet
	Emerald ash borer	<i>Agilus planipennis</i>	Forests	None yet
	Flea beetles	Multiple families and species	Farmlands; crops	In county
	Gypsy moth	<i>Lymantria dispar</i>	Forests	None yet
	<i>Ips</i> engraver beetles	<i>Ips avulsus, I. grandicollis, I. calligraphus</i>	Forests	In county
	Kudzu bug	<i>Megacopta cribraria</i>	Farmlands; soybean crops	In county
	Nantucket pine tip moth	<i>Rhyacionia frustrana</i>	Forests	In county
	Red imported fire ant	<i>Solenopsis invicta</i>	Wildlife; working lands	In county
	Redbay ambrosia beetle (Laurel wilt)	<i>Xyleborus glabratus</i>	Forests	None yet
	Sirex woodwasp	<i>Sirex noctilio</i>	Forests	None yet

Type	Common Name	Scientific Name	Threatened Resource	County Extent
Insect	Southern pine beetle	<i>Dendroctonus frontalis</i>	Forests	No recent reports
	Spotted wing <i>Drosophila</i>	<i>Drosophila suzukii</i>	Farmlands; small fruits	In county
	Sweet potato weevil	<i>Cylas formicarius</i>	Farmlands; sweet potatoes	None yet
	The granulate ambrosia beetle	<i>Xylosandrus crassiusculus</i>	Open spaces; nurseries; orchards	In county
	Wireworms	<i>Conoderus vespertinus, C. falli</i>	Farmlands; tobacco; sweet potatoes	In county
Disease	Annosum root disease	Caused by a fungus – <i>Heterobasidion annosum</i>	Forests	In county
	<i>Armillaria</i> root rot	Caused by fungi – <i>Armillaria</i> species	Forests	In county
	Box blight	Caused by fungi – <i>Cylindrocladium</i> species	Open space	None yet
	Fusiform rust	Caused by a fungus – <i>Cronartium quercuum</i> f. sp. <i>fusiforme</i>	Forests	In county
	Oak decline	Caused by a combination of abiotic and biotic factors	Forests	In county
	Pierce’s disease	Caused by bacterium – <i>Xylella fastidiosa</i>	Farmlands; vineyards	In county
Non-native Invasive Plant	Alligatorweed	<i>Alternanthera philoxeroides</i>	Water resources	In county
	Bradford pear	<i>Pyrus calleryana</i> ‘Bradford’	Forests; open space	In county
	Chinaberry	<i>Melia azedarach</i>	Forests; open space	In county
	Chinese lespedeza	<i>Lespedeza cuneata</i>	Forests; open space	In county
	Chinese wisteria	<i>Wisteria sinensis</i>	Forests; open space	In county
	Chinese privet	<i>Ligustrum sinense</i>	Forests; Open space	In county
	Japanese honeysuckle	<i>Lonicera japonica</i>	Forests; open space; wetlands	In county
	Japanese stiltgrass	<i>Microstegium vimineum</i>	Forests; open space; wetlands	In county
	Kudzu	<i>Pueraria montana</i>	Forests; open space	In county

Type	Common Name	Scientific Name	Threatened Resource	County Extent
Non-native Invasive Plant	Mile-a-minute weed	<i>Persicaria perfoliata</i>	Working lands; open spaces	None yet
	Mimosa	<i>Albizia julibrissin</i>	Forests; open space	In county
	Tropical spiderwort	<i>Commelina benghalensis</i>	Working lands; open spaces; wetlands	None yet
	Witchweed	<i>Striga asiatica</i>	Working lands; open spaces	None yet

Invasive plant species are often associated with human activities, such as road construction, urban development, forest clearing, and unmanaged agricultural fields. Ways to avoid problems with NNI include minimizing land disturbance, not planting those known species, preventing accidental introductions, and removing or reducing the size of existing infestations. A complete list of NNI plants documented in Johnston County can be found at the following website:

www.eddmaps.org/tools/countyplants.cfm?id=us_nc_37101. Noxious weeds are monitored by the N.C. Department of Agriculture and Consumer Services Plant Industry Division, a list of which can be found at the following website: www.ncagr.gov/plantindustry/plant/weed/noxweed.htm.

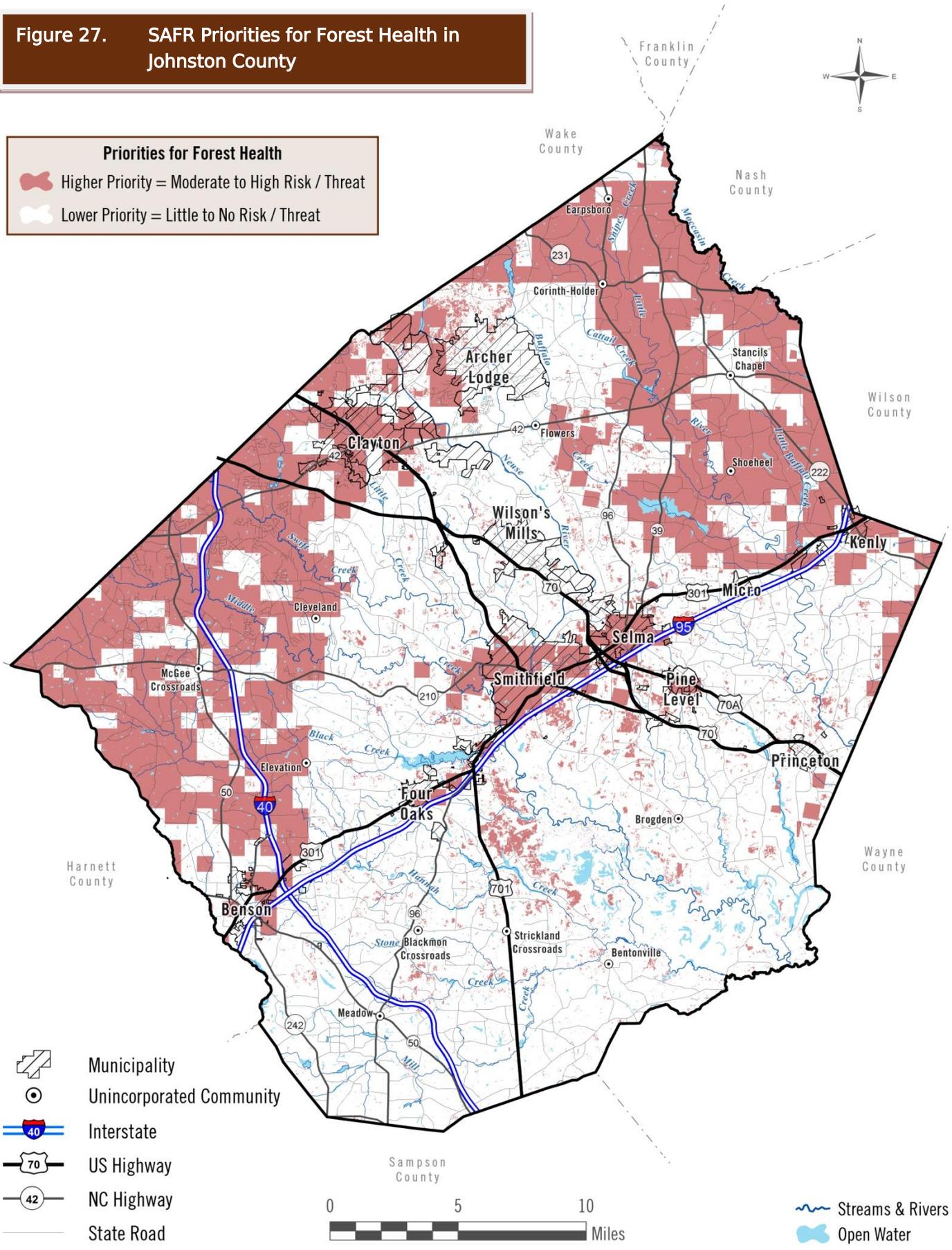
Statewide Assessment of Forest Resources (SAFR) – Forest Health Priority Analysis

The Statewide Assessment of Forest Resources (SAFR) included an analysis of areas within the state that currently have a moderate to high risk of damage from insects and diseases, both native and / or established and imminent invasive threats. The specific pests used in this analysis were: southern pine beetle*, littleleaf disease, annosus root rot*, fusiform rust*, hemlock woolly adelgid, balsam woolly adelgid, beach bark disease, redbay ambrosia beetle-laurel wilt♦, emerald ash borer♦, asian longhorned beetle♦, and sirex woodwasp♦. Pests marked with an asterisk (*) are known to occur in Johnston County and pests marked with a diamond are considered imminent threats (♦). Figure 27 on the next page depicts the SAFR priorities for forest health in Johnston County.

Figure 27. SAFR Priorities for Forest Health in Johnston County

Priorities for Forest Health

-  Higher Priority = Moderate to High Risk / Threat
-  Lower Priority = Little to No Risk / Threat



-  Municipality
-  Unincorporated Community
-  Interstate
-  US Highway
-  NC Highway
-  State Road



-  Streams & Rivers
-  Open Water

4.1.3 Fire Exclusion and Wildfire Hazard

Fire exclusion alters the structure, composition, and diversity of forests and wildlife habitats, and contributes to the decline or loss of plants and animals that rely on fire-dependent ecosystems (NCFS, 2010; CCP, 2011). In Johnston County, 37 percent of the forested landscapes have an estimated historic mean fire return interval (the number of years between fires) of less than or equal to five years. Another 22 percent of the County's forests are presumed to historically have had fire once every six to 10 years. These estimates of the mean fire return interval indicate that fire has historically played an important role in the functions and processes of Johnston County's ecosystems.

Preventing periodic fires also contributes to fuel conditions that can produce destructive wildfires (NCFS, 2010). As the human population increases, more structures (e.g., homes) are built in historically forested areas. As a result, the consequences of fire exclusion can extend beyond the ecological and into the built human environment. In 2000, approximately 57 percent of Johnston County was considered to be in a wildland-urban interface (WUI). The threat of wildfire impacting human life and property is higher in WUI areas, particularly where fire exclusion has led to unsafe fuel loads.

What is Wildland-Urban Interface (WUI)?

A WUI area is where homes and structures are in close proximity to the natural environment of forests and wildlands.

WUI is composed of both interface and intermix communities. In both interface and intermix communities, housing must meet or exceed a minimum density of one structure per 40 acres. Intermix communities are places where housing and vegetation intermingle. In intermix, wildland vegetation is continuous, more than 50 percent vegetation, in areas with more than 1 house per 40 acres. Interface communities are areas with housing in the vicinity of contiguous vegetation. Interface areas have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 miles of an area (made up of one or more contiguous Census blocks) over 1,325 acres that is more than 75 percent vegetated. The minimum size limit ensures that areas surrounding small urban parks are not classified as interface WUI.

Many new homes are constructed without community wildfire planning. This creates neighborhoods with little defensible space, limited accessibility, flammable building materials, and flammable landscaping. Currently, Firewise practices and principles are not incorporated into the state building code or into most county ordinances. Lack of Firewise planning greatly increases the probability of homes being threatened during a wildfire and increases the risk to emergency response personnel. The Firewise Communities USA Program was developed in the mid-1990s to help address wildfire risk to homes and communities through education and outreach. The Firewise program emphasizes the importance of planning, constructing, and landscaping safer homes and communities in high wildfire risk areas. Some key Firewise practices and principles include providing sufficient access to communities and homes for emergency response personnel, clearly marking home addresses, using non-combustible materials for home siding and roofing, keeping gutters clean and free of combustible material, landscaping with drought resistant plants, and maintaining defensible (cleared) space around the home.

Communities at risk from wildfire are recognized and designated through the creation of a Community Wildfire Protection Plan (CWPP), and include areas targeted for implementing Firewise practices and principles (NCFS, 2010). North Carolina implements the CWPP process at the fire department district level, which allows for local data collection; provides a tool for use by the local fire departments, fire managers, and emergency management officials; and captures county needs at a more detailed level. The communities at risk determined during the CWPP process are considered target communities for implementing the practices and principles of the Firewise Communities / USA program. As of 2011, there are four fire department districts working to develop CWPPs in Johnston County: Archer Lodge, Clayton, Cleveland, and Thanksgiving.

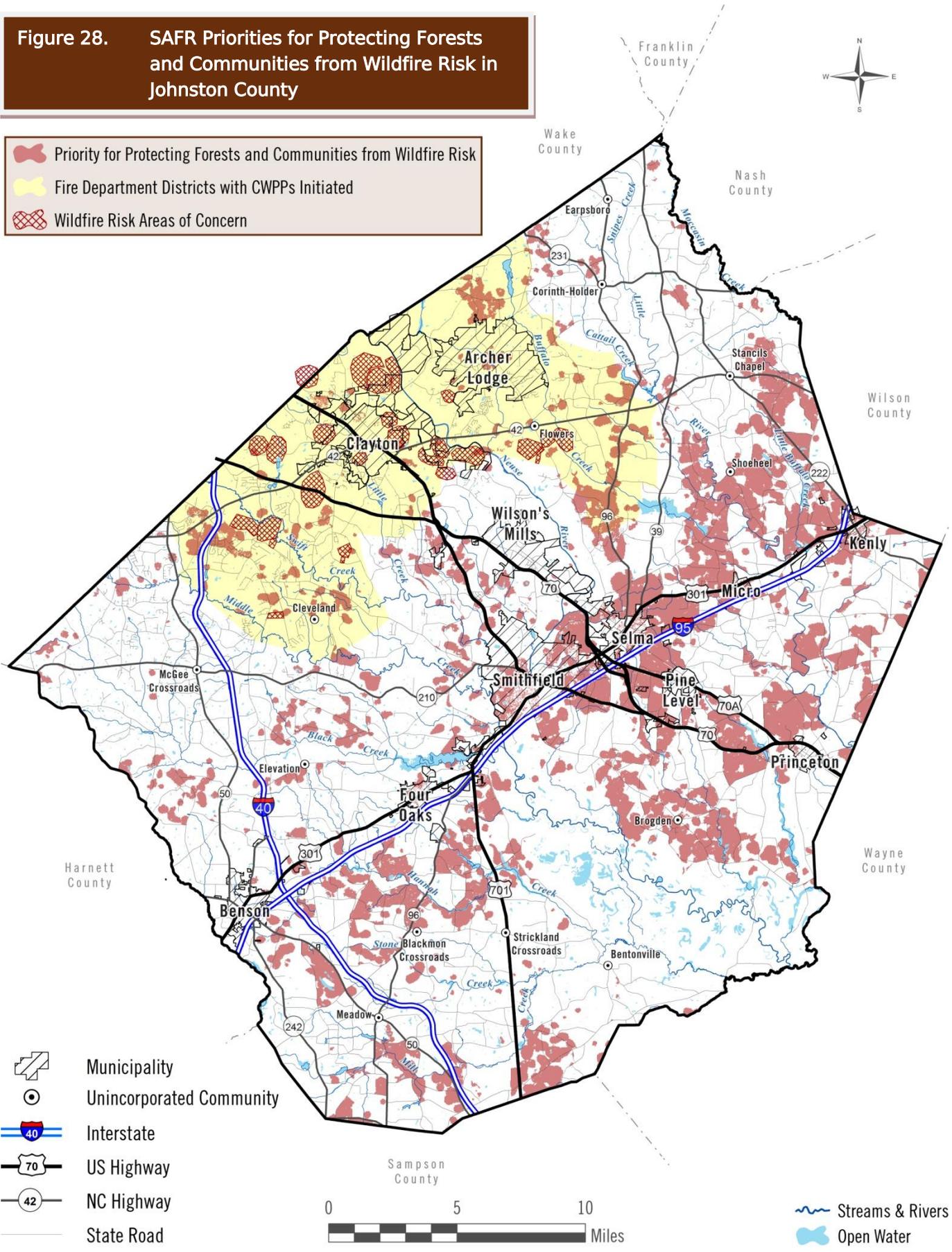
To learn more about WUI, the Firewise Communities USA program, and CWPPs, please visit the following website: ncforestservice.gov/fire_control/fc_wui.htm.

Statewide Assessment of Forest Resources (SAFR) – Protecting Forests and Communities from Wildfire Risk

The Statewide Assessment of Forest Resources (SAFR) included an analysis of areas within the state where wildfire mitigation and preparedness efforts can reduce loss of life and property, and prevent degradation of forest resources due to wildfire. These lands rank high for wildfire susceptibility according to the Southern Wildfire Risk Assessment (SWRA), which is a regional multi-year project to assess and quantify wildfire risk in the southern region of the U.S. More information on the SWRA project can be found at: www.southernwildfirerisk.com. Many of the lands prioritized in the SAFR analysis of wildfire risk are considered to be within the wildland-urban interface (WUI). Figure 28 on the next page depicts the SAFR priorities for protecting forests and communities from wildfire risk in Johnston County, as well as the fire department districts that have initiated the CWPP process and identified specific areas of concern.

Figure 28. SAFR Priorities for Protecting Forests and Communities from Wildfire Risk in Johnston County

-  Priority for Protecting Forests and Communities from Wildfire Risk
-  Fire Department Districts with CWPPs Initiated
-  Wildfire Risk Areas of Concern



-  Municipality
-  Unincorporated Community
-  Interstate
-  US Highway
-  NC Highway
-  State Road

-  Streams & Rivers
-  Open Water

4.1.4 Mining and Mineral Prospects

Sand and gravel mining in floodplain areas can have negative impacts on ground and surface water quality and flow, as well as aquatic habitats. Specifically, dry pit and wet pit mining in floodplains may reduce groundwater elevations, reduce stream flows, increase water temperature, degrade riparian ecosystems, and create potential fish entrapment (Langer, 2003; Packer et al., 2005). Sand and gravel mining operations in upland settings can result in nonpoint source pollution similar to other land disturbing activities, and can result in the direct conversion of working lands or upland natural communities to other uses.

As of 2010, there were 18 permitted sand and gravel mines and three crushed stone mines in Johnston County. Of the 18 permitted mines, seven are located in floodplain landscapes with the remaining occurring on upland sites. Based on the geology of the County, there are few mining and mineral prospects currently recognized other than sand, gravel, and stone.

Environmental review of mining and mineral exploration operations and proposals is conducted by the N.C. Department of Natural Resources Division of Land Resources Land Quality Section in accordance with state law.

4.2 Natural Resource Conditions and Trends

4.2.1 Natural Communities and Wildlife Habitats

Despite population growth and expanding urban centers, Johnston County remains predominately rural. As of 2006, natural communities and wildlife habitats occupied approximately 91 percent of the County, of which 44 percent represent agricultural areas with early successional habitats. Many of these areas have been altered to varying degrees by past land management (e.g., agriculture, silviculture, etc.) or by natural events (e.g., floods, hurricanes, beavers, etc.). Population growth and land use change represent the greatest threats to the condition and diversity of natural communities and wildlife habitats in the County. Table 25 on the next page includes the N.C. Wildlife Action Plan (NCWAP) habitat types that occur within Johnston County along with the status and general conditions of these habitats throughout the Coastal Plain and Piedmont ecoregions. Ecoregional habitat status and conditions approximate the status and conditions of these habitats in Johnston County.

Table 25. NCWAP Habitats – Status and General Conditions by Ecoregion

NCWAP Habitat Type (NCWRC 2005)	Ecoregion	Status and General Conditions Within the Ecoregion
Dry Coniferous Woodlands	Coastal Plain	Occurs throughout the region. Much is owned by forest industry or is actively managed. Habitat expected to remain relatively stable with localized impacts due to population growth, land use change, and habitat fragmentation.
Dry Coniferous Woodlands	Piedmont	Habitat relatively stable now. Conditions could worsen with population growth, land use change, and habitat fragmentation.
Dry Longleaf Pine Forest	Coastal Plain	Reduced to three percent of its historic range. An endangered habitat. Few, small examples remain in Johnston County with many habitat dependent species no longer present in the County.
Early Successional (grasslands, old fields, regenerating forests, etc.)	Coastal Plain	Relatively common because of agriculture and forestry activities, though habitat quality is degraded as land management intensifies. By its nature this habitat is ephemeral and requires periodic disturbance to maintain or create.
	Piedmont	Less common in Piedmont. Habitat patches smaller and fragmented by development.
Floodplain Forest	Coastal Plain	Reduced condition overall. Can be found in various conditions throughout the region. Habitat threatened by some development practices.
	Piedmont	Occurs along most Piedmont streams and rivers. True bottomland forests are rare.
Lakes and Reservoirs	Coastal Plain	Most lakes and reservoirs in Johnston County are man-made. This habitat type is relatively stable. However, caution should be used when considering constructing new lakes because of impacts to free-flowing stream habitats.
	Piedmont	Similar to Coastal Plain habitat.
Low Elevation Cliff / Rock Outcrops	Piedmont	Rare habitat type.
Mesic Forest	Coastal Plain	Relatively scarce and in poor condition.
	Piedmont	Common habitat type. Frequently impacted by fragmentation.
Nonalluvial Mineral Wetlands	Coastal Plain	Common habitat type. Often degraded by upstream impervious surface, hydrologic modification (e.g., ditching, draining, groundwater withdrawals), and impacts to natural vegetation both within and surrounding the wetland.
	Piedmont	Rare and in poor condition.

NCWAP Habitat Type (NCWRC 2005)	Ecoregion	Status and General Conditions Within the Ecoregion
Oak Forest	Coastal Plain	Scattered throughout the region in small patches. Once widespread but now commonly replaced by agriculture and pine plantation.
	Piedmont	Relatively common across the Piedmont, but total acreage is declining in some areas.
Pocosin	Coastal Plain	Pocosins are still relatively widespread across Coastal Plain, though habitat quality has been significantly degraded due to draining for agriculture, and changes to natural hydrology and fire regime. This habitat is not common in Johnston County.
Riverine Aquatic Communities	Coastal Plain	A critical and highly threatened resource for Johnston County. Primary threats include direct (e.g., wastewater discharge) and indirect (e.g., run-off from developed areas and agriculture) sources of pollution, altered hydrology, and dam construction, which alters flows and impedes movement of aquatic species.
	Piedmont	Similar to Coastal Plain, but with threats to water quality and hydrology exacerbated by higher levels of development and steeper slopes adjacent to streams. Less impact from agriculture and livestock than in Coastal Plain.
Small Wetland Communities	Coastal Plain	Greatly reduced by development and drainage. Includes various ephemeral pool communities. Often degraded by upstream impervious surface, hydrologic modification (e.g., ditching, draining, groundwater withdrawals), and impacts to natural vegetation both within and surrounding the wetland.
	Piedmont	Upland pools are rare. Upland depression swamp forests are scattered throughout the region. Greatly reduced by development and human impacts.
Wet Pine Savanna	Coastal Plain	Reduced condition due to fire suppression. Exists mostly on public lands.

The National Land Cover Database (NLCD) has produced three land cover mapping products in the last 20 years, including 1992, 2001, and 2006. While some differences exist in how these mapping products were produced between periods, comparisons of these datasets can provide a general indicator of the trends in the size and distribution of natural communities and wildlife habitats. Table 26 beginning on the next page provides the acreage and percentage representation within the County for generalized NLCD land cover types along with corresponding N.C. Natural Heritage Program (NCNHP) natural communities and NCWAP habitats.

Table 26. NCNHP Natural Communities, NCWAP Habitats, and NLCD Generalized Land Cover Types – Acreage and Percent Change from 1992, 2001, and 2006

NCNHP Natural Community	NCWAP Habitat Type	NLCD Generalized Land Cover Type	Acres (Percent of County)			Percent Change		
			1992	2001	2006	1992-2001	2001-2006	1992-2006
Piedmont / Coastal Plain Heath Bluff, Dry-Mesic Oak-Hickory Forest, Dry Oak-Hickory Forest	Low Elevation Cliff / Rock Outcrops, Oak Forest, Mesic Forest	Deciduous Forest	103,641 (20%)	72,264 (14%)	60,696 (12%)	-30%	-16%	-41%
Mesic Pine Flatwoods, Pine / Scrub Oak Sandhill, Pine Savannah, Xeric Sandhill Scrub	Mesic Forest, Dry Coniferous Woodlands, Dry Longleaf Pine Forest	Evergreen Forest	79,253 (16%)	54,806 (11%)	53,480 (11%)	-31%	-2%	-33%
Mesic Mixed Hardwood Forest (Coastal Plain & Piedmont subtypes)	Mesic Forest	Mixed Forest	44,164 (9%)	21,721 (4%)	17,234 (3%)	-51%	-21%	-61%
None	Early Successional (grasslands, old fields, regenerating forests)	Early Successional	193,695 (38%)	248,692 (48%)	247,245 (48%)	28%	-1%	28%
Coastal Plain and Piedmont / Mountain Semipermanent Impoundment, Coastal Plain Small Stream Swamp Cypress-Gum Swamp (Blackwater and Brownwater subtypes), Coastal Plain and Piedmont / Mountain	Floodplain Forest, Small Wetland Communities, Nonalluvial Mineral Wetlands, Wet Pine Savannah, Pocosin	Wetlands	71,473 (14%)	67,916 (13%)	81,335 (16%)	-5%	20%	14%

NCNHP Natural Community	NCWAP Habitat Type	NLCD Generalized Land Cover Type	Acres (Percent of County)			Percent Change		
			1992	2001	2006	1992- 2001	2001- 2006	1992- 2006
Bottomland Hardwoods, Coastal Plain and Piedmont / Mountain Levee Forest, Floodplain Pool, Pond Pine Woodland, Piedmont / Low Mountain Alluvial Forest, Streamhead Atlantic White Cedar Forest, Streamhead Pocosin, Low Elevation Seep, Pine Savanna, Wet Pine Flatwoods								
Oxbow Lake, Sand and Mud Bar	Lakes and Reservoirs, Riverine Aquatic Communities	Aquatic Communities	4,176 (1%)	4,546 (1%)	5,340 (1%)	9%	17%	28%

NLCD data indicates that upland forest and associated wildlife habitats have declined in Johnston County since 1992, with the largest decline occurring between 1992 and 2001. Loss in upland forest cover in the County during the last 20 years is primarily due to population growth and land use conversion to urban uses, but also the expansion of agricultural areas. The highest percent decline since the early 1990's has occurred with mixed forests, followed by deciduous and evergreen dominated forests. While upland forests declined during this period, early successional habitat increased. These habitats include grasslands, old field, and regenerating forests. Early successional habitat may also be present along the margins of agricultural and silvicultural areas. According to NLCD data, wetland communities have increased in Johnston County since 1992. These increases are likely due primarily to changes in land cover classification between NLCD data periods. However, wetland areas could have increased in some areas due to natural (e.g., beaver) and anthropogenic (e.g., excavation associated with mining) activities. Aquatic communities have also increased since 1992. These increases are likely due to the addition of agricultural ponds and other small open water areas.

While there is a declining trend in upland forest acreage, these natural communities and wildlife habitats still represent a majority of the total area of the County. However, the condition and extent are threatened by urban expansion and fragmentation. There were 63 upland forested tracts with greater than 500 contiguous acres in 1992. Due to land use conversion and fragmentation, this number decreased to 31 tracts in 2001 and 23 tracts in 2006. During the same period, the number of tracts with contiguous acres less than 500 and greater than 10 acres increased by more than 75 percent. NLCD data used to approximate the acreage and extent of upland forest natural communities and habitats indicates a downward trend in total acreage and fewer contiguous large tracts (greater than 500 acres).

4.2.2 Water Resources

Johnston County water resource conditions and trends are associated with activities conducted both inside and outside of the County. Many smaller watersheds drain into the County from adjacent counties, with approximately 1,470 square miles of drainage area upstream of the County's border. This section includes a discussion on water quality and supply (quantity).

Water Quality

Water quality conditions and trends can be estimated using land cover as an indicator. Many research studies have documented relationships between watershed land cover and water quality. Researchers have found that watershed water quality conditions commonly begin to deteriorate when forest / natural cover percentages drop below 60 percent. Watersheds with 60-70 percent forest cover often have transitioning water quality, and watersheds with at least 70 percent forest / natural cover often have water quality conditions that meet water quality standards for their intended uses (Black and Munn, 2008; NCDWQ, 2009; NCFS, 2010). Additional studies have shown that forest / natural cover percentages can be out-weighted by urban cover when urban areas exceed 15 percent of the watershed and forest / natural cover is below 50 percent (Carroll, 2009). Forest / natural cover in a source water area has also been documented to notably reduce water treatment costs. A study conducted by the Trust for Public Land and the American Water Works Association found that for every 10 percent increase in forest cover in a water supply watershed, treatment and chemical costs decrease approximately 20 percent – up to approximately 60 percent forest cover (Ernst, 2004).

Other research studies have identified impervious cover as a key indicator of water quality. The Center for Watershed Protection summarized the findings of several research studies on water quality and watershed impervious cover and integrated the findings into a watershed planning model known as the impervious cover model (ICM). The ICM predicts that most stream quality indicators decline when watershed impervious cover (IC) exceeds 10 percent, with severe degradation expected beyond 25 percent (CWP, 2003; Schueler et al., 2009). Other research studies have documented aquatic community degradation occurring in watersheds with less than 10 percent impervious cover (Morse et al., 2003).

In addition to land use / land cover indicators of water quality, the N.C. Division of Water Quality (NCDWQ) monitors surface water quality in accordance with the Federal Clean Water Act (CWA). As discussed previously, surface waters are classified by NCDWQ according to their best intended use (e.g., swimming, aquatic life support, water supply, etc.). The CWA requires states to assess the quality of their waters biennially and evaluate how well the waters are supporting their designated

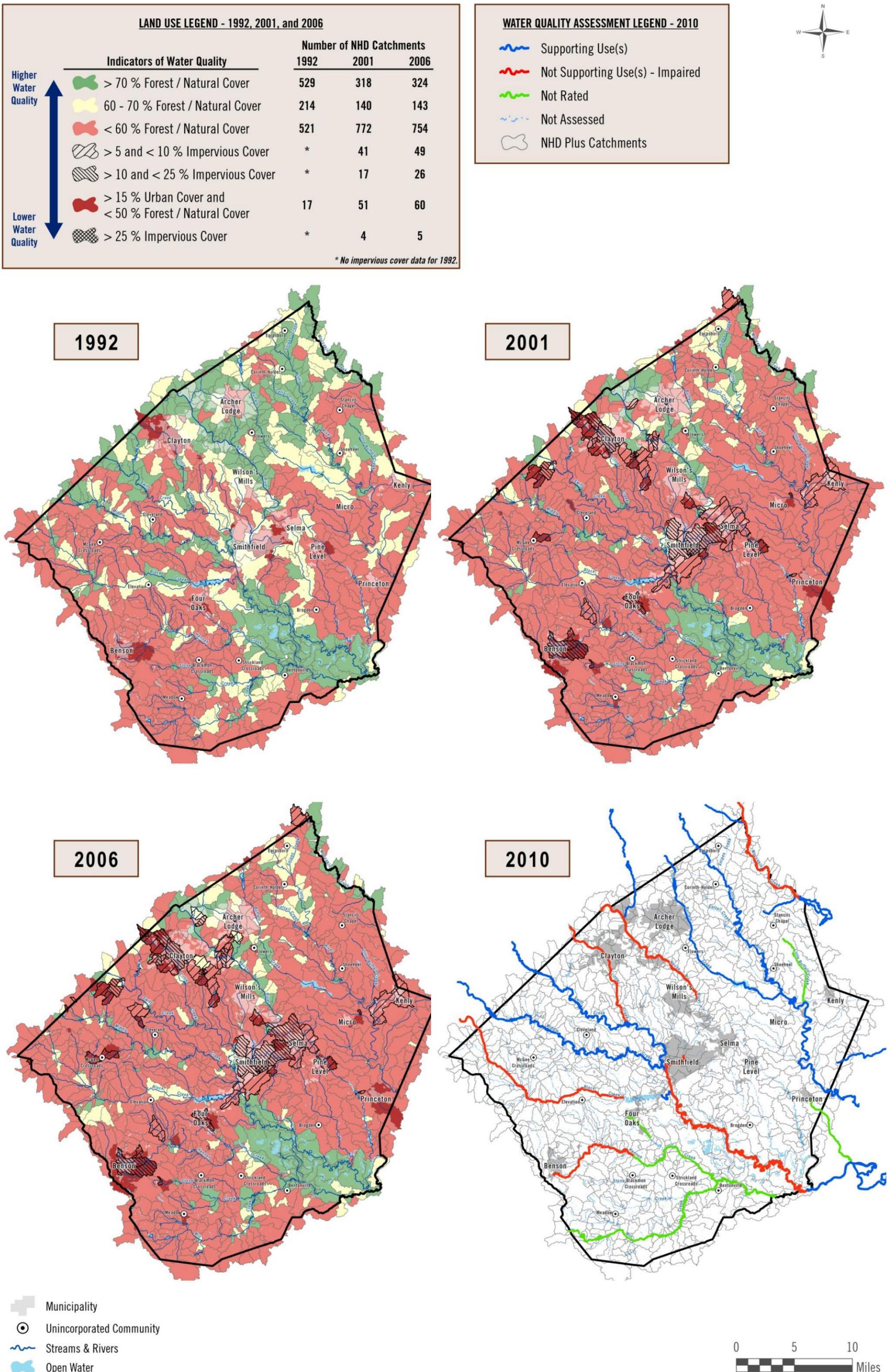
uses. Waters that fail to meet the water quality standards are designated as “impaired waters,” and are listed on the 303(d) list. The 303(d) listed waters require the development of a Total Maximum Daily Load (TMDL) within eight to 13 years of the original listing. A TMDL is a calculation of the maximum amount of pollutant that a waterbody can receive and still meet water quality standards. The TMDL is then used to establish limits on sources of the pollutant. More information about water quality assessments, the most current 303(d) list, and TMDLs can be found at the following website: portal.ncdenr.org/web/wq/ps/mtu. Table 27 below lists the surface waters not meeting their intended uses according to the NCDWQ 2010 Integrated Report.

Table 27. Impaired 303(d) Listed Waters in Johnston County

Name of Stream / River Reach	Location Description	Length (Miles)	Parameter (Violation)	Original Listing Year
Black Creek	From dam at Panther Lake to mouth of Sassarixa Creek	22.6	Low Dissolved Oxygen	2008
Hannah Creek	From source to NC 96	10.3	Low Dissolved Oxygen, Ecological / Biological Integrity Benthos, Low pH	2004, 2008, 2010
Little Creek	From source to Swift Creek	11.4	Ecological / Biological Integrity Benthos	1998
Moccasin Creek (Bunn Lake)	From source to Contentnea Creek	22.8	Low Dissolved Oxygen	2008
Neuse River	From mouth of Beddingfield Creek to a point 0.2 mile downstream of Johnston County SR 1700	4.3	Copper, Zinc, Turbidity	2008
Neuse River	From a point 0.2 mile downstream of Johnston County SR 1700 to point 1.4 mile downstream of Johnston County SR 1908	9.7	Turbidity	2008
Neuse River	From City of Smithfield water supply intake to a point 1.7 miles upstream of Bawdy Creek	26.2	Turbidity	2008
Neuse River	From a point 1.7 miles upstream of Bawdy Creek to subbasin 030402-030412 boundary	7.0	Turbidity	2010

Figure 29 on page 95 illustrates watershed water quality conditions and trends from 1992, 2001, and 2006 using the National Land Cover Database (NLCD) summarized at the National Hydrography Dataset (NHD) Plus catchment level. These catchments are smaller than the 12-digit hydrologic units and offer a more detailed analysis of land use / land cover trends as indicators of water quality. Figure 29 also includes data from the 2010 water quality assessment conducted by the NCDWQ, including 303(d) listed streams that are impaired for not meeting their intended use(s).

Figure 29. Trends in Forest / Natural Cover and Impervious Cover from 1992, 2001, and 2006 Summarized by NHD Plus Catchments and 2010 303(d) Listed Streams in Johnston County



The number of catchments with 70 percent or more forest / natural cover has declined approximately 39 percent since 1992, from 529 to 324 catchments. This decline corresponds with an increase in the number of catchments with less than 60 percent forest / natural cover as well as catchments with less than 50 percent forest / natural cover and greater than 15 percent urban cover. Similarly, watershed impervious surface area has increased from 2001 to 2006. While afforestation appears to have contributed to increases in forest / natural cover in some catchments, the predominant land use / land cover trends indicate that water quality conditions have likely worsened in the County since 1992. The impact of land use / land cover change on water quality is often long-term, generally requiring more time to improve water quality conditions once degraded.

Water Supply

Johnston County is one of the fastest growing and urbanizing counties in North Carolina, particularly west of I-95 and north of I-40. The County estimated in 2008 that there is adequate water supply to meet growth demands through approximately 2016. Planning estimates indicate that the population of the County will increase 73 percent by 2050. In response to this anticipated growth, the County is continually reviewing water supply alternatives to meet future demands (CH2M HILL 2008).

The County is currently evaluating long-term water supply options to meet water demands over a 20- to 50-year planning period. The preferred option under evaluation in the County involves supply from the lower Neuse River near the Wayne County line in concert with the use of two existing rock quarries as storage reservoirs for raw water. One of these quarries is currently inactive and available and the other, which is still in operation, could be converted into a raw drinking water storage reservoir when mining operations cease in approximately 15 to 20 years.

The 2008 estimated maximum potential water supply for Johnston County, through permits and purchase agreements, was 16.5 million gallons per day (mgd) and is expected to be exceeded on a peak-day basis by 2017 (CH2M HILL 2008).

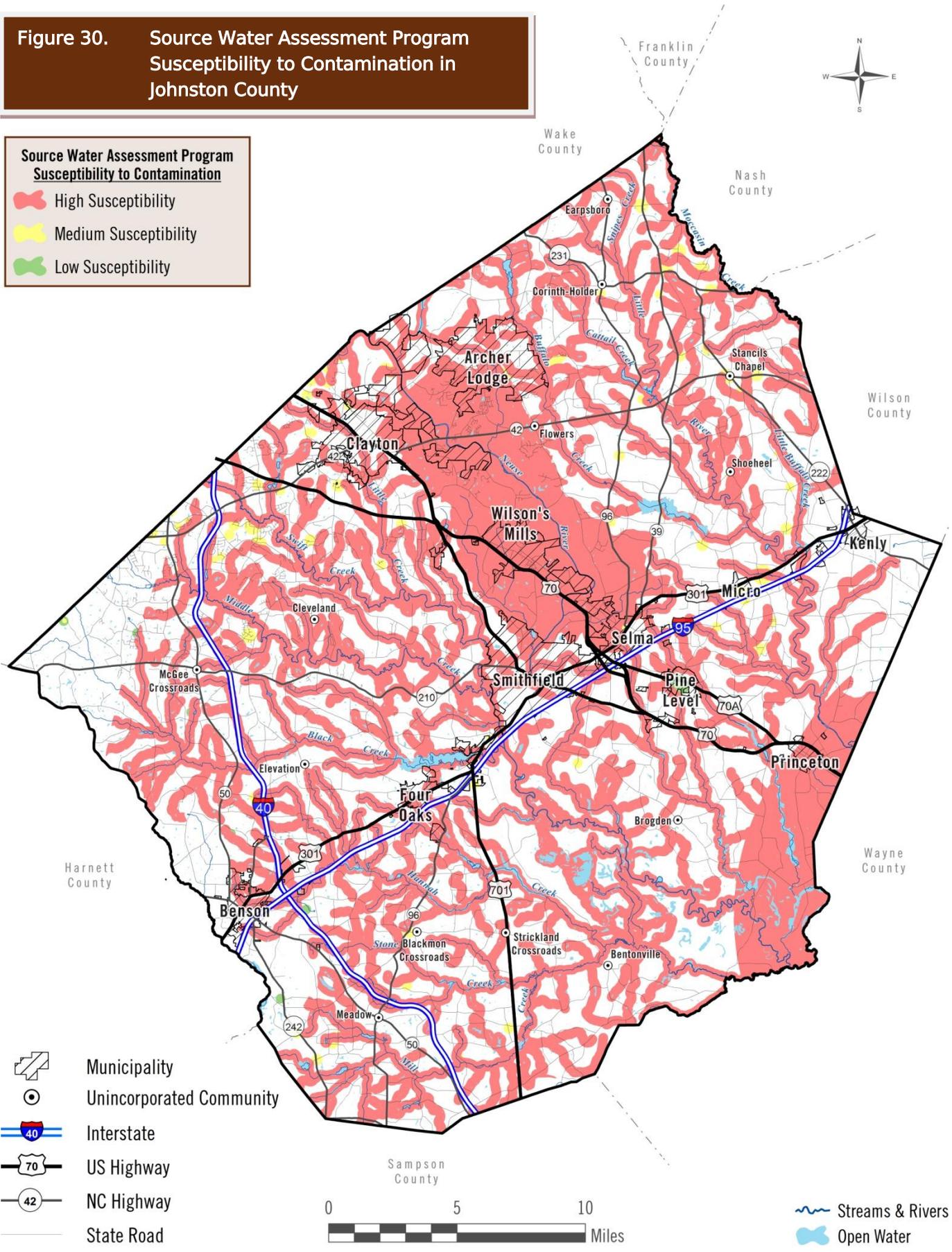
The N.C. Rural Economic Development Center's Water 2030 Initiative identified a majority of Johnston County as an area that would experience greater than or equal to a 75 percent increase in water supply demand in the next 20 years. While water quantity (supply) has historically not been a major issue in most areas of the Southeastern United States, including North Carolina, population growth and land use change coupled with changing climate and weather patterns are expected to increase the frequency of water supply shortages.

The N.C. Division of Water Resources Public Water Supply Section maintains a Source Water Assessment Program (SWAP) to monitor source water susceptibility to degradation due to contamination. Source water includes the untreated water from streams, rivers, lakes, or groundwater aquifers that are sources of public drinking water. Source water areas represent approximately 53 percent of the County, of which approximately 98 percent of the areas are considered high susceptibility. Figure 30 illustrates the SWAP data for Johnston County.

Figure 30. Source Water Assessment Program Susceptibility to Contamination in Johnston County

Source Water Assessment Program Susceptibility to Contamination

- High Susceptibility
- Medium Susceptibility
- Low Susceptibility



- Municipality
- Unincorporated Community
- Interstate
- US Highway
- NC Highway
- State Road

- Streams & Rivers
- Open Water

4.2.3 Working Lands

Farmlands

From 1987 to 2007, the total number of farms and the total acreage of farmlands have decreased in Johnston County for nearly every U.S. Census of Agriculture reporting cycle (Table 28). The average size of farms increased from 1987 to 1997 and decreased in 2002 and 2007. A majority of the farms in the County are less than 180 acres in size. However, from 1987 to 2002 there was a slight increase in the number of farms at least 1,000 acres in size. As the County's urban areas expand with some conversion of farmland to other uses, this may indicate a shift from many small to medium sized farmland tracts to fewer larger tracts. Meanwhile, the estimated market value of farmland and farm buildings has increased more than 140 percent in the last 20 years, which follows the inflation of land values associated with population growth in the area. The average market value of agricultural products sold per farm has also increased over the last 25 years from \$48,043 to \$163,014 (Table 28). However, the cost of producing agricultural products has also increased during the same period, with the cost representing approximately 86 percent of the total market value of the products in 2002 and 2007; leaving little profit for farmers.

Table 28. Trends in Farmlands from the Last 25 Years in Johnston County

Farmland Characteristic	1987	1992	1997	2002	2007
Number of Farms	1,713	1,406	1,212	1,144	1,245
Total Land in Farms, Acres	234,394	230,402	211,011	194,211	194,090
Average Size of Farms, Acres	137	164	174	170	156
Harvested Cropland, Acres	105,772	119,029	110,980	110,141	110,772
Average Value of Farm and Buildings, Dollars	\$196,635	\$276,838	\$418,861	\$599,437	\$672,607
Average Market Value of Machinery and Equipment, Dollars	\$28,003	\$42,604	\$52,307	\$67,625	\$77,828
Average Market Value of Agricultural Products Sold, Dollars	\$48,043	\$80,835	\$147,557	\$127,197	\$163,014
Average Total Farm Production Expenses, Dollars	\$36,324	\$59,162	\$100,144	\$108,902	\$140,067
Cost of Production as Percent of Market Value of Agricultural Products Sold, Percent	76 %	73 %	68 %	86 %	86 %

Since the completion of the original *Soil Survey of Johnston County, North Carolina* in 1911, approximately 21,400 acres of prime farmland have been converted to urban land uses as of 2006 (according to the National Land Cover Database). An additional 5,000 acres of land considered prime farmland when drained were converted to urban uses during this period. Approximately 7,000 acres of farmland of statewide importance were converted to urban uses from 1911 to 2006. As population growth and land use change increase in the County, proper planning will be necessary to retain the County's rich agricultural history.

Forestlands

From 1992 to 2006, upland forests declined approximately 42 percent. According to the National Land Cover Database, a majority of the loss was due to forestland conversion to agricultural uses (61 percent) with conversion to urban land representing 13 percent of the loss. The pressure to replace agricultural lands lost to urban development could be the driving factor in the conversion of forestlands to agriculture in some areas of the County. Also, a majority of the forestland conversion to agriculture occurred between 1992 and 2001, with urban growth driving a majority of the forestland conversion in the early- to mid-2000s.

Managed forests (timberlands) are threatened in developing areas of the County by competing urban development pressures. While urban development and land conversion from forestland to urban uses has slowed due to the economy, Johnston County is expected to continue growing along with the Triangle Region of North Carolina. Forest fragmentation and increasing urban / rural interface areas can influence the viability of timberland management. The value of merchandised timberland has steadily decreased in the last 10 years, due both to changes in timber markets and the quantity of timber harvested in the County (Table 29).

Table 29. Trends in Timberland Values from the Last 10 Years in Johnston County

Forestland Characteristic	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Stumpage Value, Dollars	\$11.7 MM	\$15.6 MM	\$10.7 MM	\$9.9 MM	\$7.1 MM	\$7.2 MM	\$6.5 MM	\$3.7 MM	\$3.2 MM	\$2.0 MM
Delivered Value, Dollars	\$11.1 MM	\$15.8 MM	\$14.8 MM	\$13.7 MM	\$10.7 MM	\$10.1 MM	\$10.4 MM	\$6.7 MM	\$6.3 MM	\$3.9 MM
Statewide County Rank	~20-27	~20-27	27	26	39	39	41	54	54	68

4.2.4 Urban Canopy and Air Quality

Urban forest can improve air quality by absorbing and filtering out nitrogen dioxide (NO₂), sulfur dioxide (SO₂), ozone (O₃), carbon monoxide (CO), and certain particulate matter in their leaves. This vital air cleaning service directly affects the well-being of urban citizens. The Urban Tree Canopy (UTC) study completed by NCDRC Imaging used CITYgreen software to estimate the annual air pollution removal rate of trees within Smithfield for the five pollutants. To calculate the dollar value of these pollutants, economists use “externality” costs, or indirect costs borne by society such as rising health care expenditures and reduced tourism revenue. The actual externality costs used in CITYgreen for each air pollutant are set by the reference city’s state Public Services Commission. In the UTC study the reference city used was Roanoke, VA. The UTC data was also used with the CITYgreen software package to estimate the annual air pollution removal rate of trees within Smithfield. Table 30 shows the effect of urban trees on air quality in Smithfield, NC.

Table 30. Effect of Urban Canopy on Air Quality in Town of Smithfield, Johnston County

Pollutant	Urban Tree Canopy Scenarios in Smithfield, NC			
	Current Total Tree Canopy: 2,625.1 acres (34.7%)		Total Tree Canopy Increase 8%: 3,230.2 acres (42.7%)	
	Lbs. Removed/yr	Dollar Value	Lbs. Removed/yr	Dollar Value
Carbon Monoxide (CO)	4,680	\$1,997	5,759	\$2,458
Ozone (O ₃)	107,640	\$330,693	132,456	\$406,933
Nitrogen Dioxide (NO ₂)	23,400	\$71,890	28,795	\$88,464
Particulate Matter (PM10)	93,600	\$191,989	115,179	\$236,252
Sulfur Dioxide (SO ₂)	25,740	\$19,317	31,674	\$23,770
TOTALS	255,059	\$615,886	313,863	\$757,877

As Table 30 shows, with a moderate increase of only eight percent, or about 600 acres in total urban tree canopy, the City of Smithfield could increase the amount of ozone removed from the air by 24,816 pounds per year, which equates to an estimated \$757,887 reduction in indirect costs to the County (or 23 percent savings).

The two other towns for which a UTC study was completed (Selma and Clayton) have areas where more trees could be planted and thus their total tree canopy could be increased. Likewise, all other cities and towns in Johnston County could realize air pollution reduction through increased tree canopy cover.

CHAPTER 5 - GREEN INFRASTRUCTURE PLANNING

5.1 Why Plan for Green Infrastructure?

Green infrastructure includes the natural resources necessary for optimal environmental, social, and economic health and sustainability. These natural resources, including farms, forests, water, land, air, and wetlands, are the building blocks of our communities, cities, and societies. Without these resources, our basic needs for food, shelter, and raw materials will not be met. In Johnston County, natural resources represent a major component of the economy. However, the intrinsic benefits and services, or “ecosystem services,” provided by the County’s natural resources far exceed the current monetary values recognized by society. Examples of ecosystem services include clean air, clean water, ample water supplies, biodiversity and wildlife habitat, plant / crop pollination, recreational opportunities, lower demands on energy, and human health. Green infrastructure planning represents one method of integrating conservation planning into the land planning process. In Johnston County, incorporating green infrastructure into land use planning would help sustain land for agriculture and forestry, which provides resource-based livelihoods, local food and resource production, and opportunities for agri- and eco-tourism. Green infrastructure planning and implementation will also help to ensure that the economic and environmental benefits of the County’s natural resources are conserved for current and future generations.

What makes a neighborhood walkable?

- **A center** – a main street or a public space.
- **People** – enough people for businesses to flourish and for public transit to run frequently.
- **Mixed income, mixed use** – affordable housing located near businesses.
- **Parks and public space** – plenty of public spaces to gather and recreate.
- **Pedestrian design** – buildings are close to the street, parking lots are relegated to the back.
- **Schools and workplaces** – close enough that most residents can walk from their homes.
- **Complete streets** – streets designed for bicyclists, pedestrians, and transit.

5.2 How Do You Plan for Green Infrastructure?

5.2.1 A Framework for Green Infrastructure Planning in Johnston County

Just like the grey infrastructure, green infrastructure should be carefully planned, designed, and funded far in advance of development. Green infrastructure planning should be the first step in the land-use planning and design process. It should also be coordinated with planning for grey infrastructure – roads, bike trails, water, electric, telecommunication and other essential community support systems. Integrated planning and design should connect the two in a more effective, economic, and sustainable network. Green infrastructure initiatives should use approaches similar to those used for the planning, design, and financing of built infrastructure (grey infrastructure).

Green infrastructure should be:

DESIGNED HOLISTICALLY — like the transportation system, green infrastructure should be designed to link diverse green space elements into a system that functions as a whole, rather than as separate, unrelated parts.

PLANNED COMPREHENSIVELY — like the electric power and telecommunication systems, a green space system needs to be planned comprehensively to provide ecological, social, and economic benefits, functions, and values.

LAID OUT STRATEGICALLY — like the roads and water systems, a green space system needs to be laid out strategically to cross multiple jurisdictions and incorporate green space elements at each level of government.

PLANNED AND IMPLEMENTED PUBLICLY — like the built infrastructure system, a green infrastructure system should be planned and implemented with input from and involvement of the public, including community organizations and private landowners.

GROUNDING IN THE PRINCIPLES AND PRACTICES OF DIVERSE PROFESSIONS — like the design and planning of transportation, water, electrical and phone systems, green space systems should be based on sound science and should build on the knowledge of professional disciplines such as landscape ecology, urban and regional planning, landscape architecture, and natural resource management.

FUNDED UP-FRONT — like other infrastructure systems, green space systems need to be funded as a primary public investment. In other words, green infrastructure should be funded up front with other essential services, rather than with money that is left over after all other services have been provided.

Green infrastructure planning can be conducted at many scales: from the individual parcel, to the community, municipal, and county levels. At the parcel level, it could mean designing homes and businesses around green space; at the community level, creating greenways to link existing parks; at the municipal level, planting more trees along streets to retain rainwater; and at the county level, conserving broad wildlife movement corridors that connect natural resources to the county from outside its boundaries.

Step 1 – Define Vision and Goals for Green Infrastructure

Visions and goals for the future of Johnston County have been stated in the recent adoption of the *Johnston County 2030 Comprehensive Plan* and the *Agricultural Development Plan for Johnston County*. Across the County, land use plans have recently been adopted or are being developed by different cities and towns.

Defining visions and goals for green infrastructure starts with asking basic questions:

- ✿ *What natural resources do Johnston County residents value?*
- ✿ *Are they forests for wildlife, recreation, and timber?*
- ✿ *Are they recharge areas that supply clean drinking water?*
- ✿ *Are they historic landscapes and battlefields?*
- ✿ *Are they working farms that provide local food and raw materials?*

Both the *Johnston County 2030 Comprehensive Plan* and the *Agriculture Development Plan for Johnston County* provide a framework for defining goals to achieve a land use vision in the County.

Most of the goals identified in the *Johnston County 2030 Comprehensive Plan* could be achieved in part through green infrastructure planning, including:

- Goal 1: Grow in a fiscally efficient, compact manner
- Goal 5: Protect existing neighborhoods
- Goal 6: Preserve farmland
- Goal 9: Preserve the rural landscape
- Goal 10: Protect natural, historic and cultural sites
- Goal 12: Upgrade development standards with respect to transportation issues

The objectives listed under each goal that could be accomplished with the use of green infrastructure components include:

- *Objective 1A: Encourage development within urbanized or urbanizing areas.* Lands identified as important parts of the green infrastructure can help define the boundaries for Extraterritorial Jurisdiction Areas and expected areas of annexation.
- *Objective 5C: Improve neighborhood connectivity.* Linkages such as trails are important parts of the green infrastructure.
- *Objective 6A: Ensure well planned rural development; Objective 6B: Support preservation efforts; Objective 6C: Full slate of farmland preservation strategies; Objective 6D: Minimize residential - agricultural use conflicts.* All of the listed objectives can be supported by green infrastructure planning.
- *Objective 9B: Work to provide connected open areas.* Green infrastructure is crucial in identifying linkages that would in fact connect open spaces.
- *Objective 10B: Protect ecologically sensitive areas.* Ecologically sensitive areas have been identified through this assessment report as well as previously published documents such as the *Strategic Plan for Open Space Protection in Johnston County* and *An Inventory of Significant Natural Areas in Johnston County*.
- *Objective 12C: Develop a Greenways and Trails Plan.* Linkages identified through green infrastructure planning could be evaluated as a natural choice for connectivity between communities.

Likewise, most of the recommendations in the *Agriculture Development Plan for Johnston County* can be complemented with green infrastructure planning, including:

- *Focus Area 1: Working Lands Protection*
 - *Recommendation 2: Create a county farmland conservation program.* Green infrastructure can identify components that are a priority for conservation.
 - *Recommendation 3: Update subdivision regulations and zoning to make land-use policies farm friendly.* Goals for green infrastructure could include recognizing the importance of compatible land uses adjacent to working farm lands.
- *Focus Area 2: County and Municipal Policy and Planning*
 - *Recommendation 3: Create an Outreach and Public Relations Program.* Understanding how green infrastructure and its components are vital to the County would be crucial to gaining public support.
- *Focus Area 3: State and Federal Public Policy and Regulation*
 - *Recommendation 1: Advocate for farm friendly state agricultural policies.* Green infrastructure would bolster policies that support working farms.

Green infrastructure could also accompany the following recommendations under the Agricultural Economic Development section:

- *Focus Area 2: Education and Training*
 - *Recommendation 1: Expand Education and Training Programs.* Education and training that includes how the natural resources of the County are linked would help show the importance of working lands.
- *Focus Area 3: Public Policy and Regulation*
 - *Recommendation 1: Create an Outreach and Public Relations Program.* Supplementary information that includes green infrastructure concepts will aid residents of Johnston County in understanding the role and benefits of working lands.
 - *Recommendation 2: Support Farm Friendly Land Use Policies and Programs.* Green infrastructure supports the connectivity of similar land uses.

All of the above stated goals, objectives, focus areas, and recommendations can be achieved through or complemented by green infrastructure planning and implementation. Therefore, they can serve as starting points to help define a vision and the goals for green infrastructure in Johnston County.

Step 2 – Coordinate with Conservation Partners to Leverage Efforts and Pursue Funding Opportunities for Green Infrastructure Planning and Implementation

Funding for green infrastructure planning and implementation will always be the first question asked. In this time of economic uncertainty, there are strong reservations about any new County departments, programs or fees being established. Therefore, outside funding sources such as private, non-profit, state, and / or federal may be required. Groups such as Triangle Land Conservancy, The Conservation Fund, The Nature Conservancy, and The Trust for Public Land are all possible partners in green infrastructure planning or implementation strategies. Other options to develop funding sources are listed in a publication from the U.S. Environmental Protection Agency (USEPA), *Guidebook of Financial Tools: Paying for Environmental Systems*. Typical strategies such as special taxes and fees are listed, but there are also unconventional strategies such as Forest Banks and Community Supported Agriculture Agreements. Additionally, the USEPA's Environmental Finance Center for Region 4 is housed at The University of North Carolina at Chapel Hill and their focus is on the environmental financing needs of communities that are considering regional arrangements for environmental infrastructure.

Step 3 – Continue Education Efforts and Building County-Wide Support

The success of strategic conservation efforts is largely dependent on the involvement of the public. While several public meetings were held to discuss the JCNRI project and solicit stakeholder input, continued efforts are needed to communicate the importance of natural resource and green infrastructure planning in the County. As more people move into Johnston County, it will be increasingly more important to educate residents about the importance of natural resources. JCNRI has established a website that can assist with educating Johnston County residents about green infrastructure and keep them informed about the efforts of the County (www.jcnri.wikispaces.com/). The JCNRI has also developed two brochures; one of which describes the JCNRI effort and the second provides an introduction of green infrastructure.

Step 4 – Develop a Green Infrastructure Plan

While the County has taken steps towards balancing growth and natural resource conservation with the adoption of the *Johnston County 2030 Comprehensive Plan* and the *Agriculture Development Plan for Johnston County*, opportunities still exist to more clearly define, plan, and implement the County’s natural resource conservation goals, priorities, and strategies. The development of a green infrastructure or comprehensive conservation plan would complement existing planning efforts and provide additional direction to ensure that the economic and ecologic benefits of the County’s natural resources are conserved. Without a green infrastructure plan to accompany the *Johnston County 2030 Comprehensive Plan*, the goals and objectives within the land use plan related to natural resources may be more difficult to achieve.

A key component to any green infrastructure or comprehensive conservation plan is the identification of priority areas. Defining priority areas is commonly done with the input of a citizen advisory group coupled with resource professionals. Green infrastructure priority areas commonly include unique natural communities, streams, wetlands, and riparian corridors; particularly those that provide habitat to rare species. In Johnston County, priority areas might also include working lands such as farm and forestlands as well as historic features such as the Bentonville Battlefield site. Existing conservation lands and public spaces, coupled with surrounding priority areas, often provide the hubs and core areas of green infrastructure as depicted in Figure 1 of this report. Natural resources discussed in this report, along with the asset maps, could provide a starting point for the identification of priority areas in Johnston County.

All of the partner agencies involved in this project are available for technical assistance and advisory support to Johnston County in further development of green infrastructure efforts or the preparation of a green infrastructure plan.

5.3 What Tools are Available for Implementing Green Infrastructure Planning?

Green Infrastructure planning, while new to Johnston County, is an already tried concept in many parts of the country. Counties in other parts of the state as well as in neighboring states have adopted green infrastructure plans. Green infrastructure planning has also been adopted at the statewide level, such as in North Carolina and Maryland. Below is a brief list of the various books, reports, websites, and tools that are available to assist with the planning process.

Books	
Green Infrastructure: Linking Landscapes and Communities	by Mark A. Benedict and Edward T. McMahon
Reports	
How Cities Use Parks for Green Infrastructure	American Planning Association City Parks Forum Briefing Paper, November 2003
Triangle GreenPrint	www.trianglegreenprint.org
Green Infrastructure: Smart Conservation for the 21st Century	by Mark A. Benedict, Ph.D. and Edward T. McMahon, J.D.

Organizations and Websites	
The Conservation Fund	www.greeninfrastructure.net
Green Infrastructure Center	www.gicinc.org/index.htm
American Planning Association	www.planning.org
NatureServe	www.natureserve.org/cons_issues/about.jsp
The Trust for Public Land	www.tpl.org
Tools	
N.C. Conservation Planning Tool	www.onencnaturally.org
Green Growth Toolbox	www.ncwildlife.org/greengrowth
Other County / Area Green Infrastructure Plans	
Chatham County, North Carolina	//chathamconservation.wikispaces.com
Cecil County, Maryland	www.conservationfund.org/sites/default/files/CecilCounty01.22.08.pdf
Lufkin-Angelina County, Texas	www.conservationfund.org/strategic_conservation/lufkin-angelina
Saratoga County, New York	www.saratogaplan.org/cp_GreenInfrastructure.html
New York City	www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_plan.shtml

5.4 What can Johnston County Residents do to Promote Green Infrastructure in the County?

This assessment describes components of green infrastructure within Johnston County that could serve as cores, hubs, and links of a network. It is important to support efforts to conserve or restore those natural features like forests, farms, floodplains, and wetlands that cover large areas, but it is also important to initiate practices on smaller parts of the land that contribute to the green infrastructure of the County. Actions such as installing rain gardens, planting appropriate trees, and creating backyard habitats will contribute to the green infrastructure of the County. Using porous pavements, green roofs, and infiltration planters on your property are all ways to help the natural functions of the environment while benefiting humans. The combination of these activities within a neighborhood will encourage more people to be involved with utilizing the green infrastructure to benefit the whole of Johnston County.

List of Acronyms

Ag Plan	Agricultural Development Plan for Johnston County
AMSL	Above Mean Sea Level
CO	Carbon Monoxide
COCS	Cost of Community Services
CPT	Conservation Planning Tool
CWA	Federal Clean Water Act
CWPP	Community Wildfire Protection Plan
GI	Green Infrastructure
GIS	Geographic Information System
HUC	Hydrologic Unit Code
IC	Impervious Cover
ICM	Impervious Cover Model
JCNRI	Johnston County Natural Resource Initiative
LHI	Landscape Habitat Indicator
LHIG	Landscape Habitat Indicator Guild
LULC	Land Use / Land Cover
LWP	Local Watershed Plan
LWSP	Local Water Supply Plan
MGD	Millions of Gallons Per Day
NCDA&CS	N.C. Department of Agriculture and Consumer Services
NCDC Imaging	Private company whose services were used
NCDENR	N.C. Department of Environment and Natural Resources
NCDPR	N.C. Division of Parks and Recreation
NCDWQ	N.C. Division of Water Quality
NCDWR	N.C. Division of Water Resources
NCEEP	N.C. Ecosystem Enhancement Program
NCFS	N.C. Forest Service
NCNHP	N.C. Natural Heritage Program
NCREDC	N.C. Rural Economic Development Center
NCWAP	N.C. Wildlife Action Plan
NCWRC	N.C. Wildlife Resources Commission
NHD	National Hydrography Dataset
NLCD	National Land Cover Database
NNI	Non-native Invasive
NO ₂	Nitrogen Dioxide

List of Acronyms

NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
O3	Ozone
PUV	Present-use Value
SAFR	Statewide Assessment of Forest Resources (a.k.a. N.C. Forest Action Plan)
SNHA	Significant Natural Heritage Area
SO2	Sulfur Dioxide
SPA	N.C. State Parks Act of 1987
SWAP	Source Water Assessment Program
SWRA	Southern Wildfire Risk Assessment
TLW	Targeted Local Watershed
TMDL	Total Maximum Daily Load
URW	Use Restoration Watershed
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
UTC	Urban Tree Canopy
VAD	Voluntary Agricultural District
WRIT	Watershed Restoration Improvement Team
WS	Water Supply
WUI	Wildland Urban Interface

List of References

- Active Living Research (ALR). (2010). The Economic Benefits of Open Space, Recreation Facilities and Walkable Community Design. Active Living Research, Robert Wood Johnson Foundation, San Diego, CA. Available online at: www.activelivingresearch.org/files/Synthesis_Shoup-Ewing_March2010.pdf.
- Agricultural and Community Development Services (ACDS). (2010). Agricultural Development Plan for Johnston County, North Carolina. Columbia, MD.
- Farmland Information Center (FIC). (2010). Fact Sheet: Cost of Community Services Studies. Farmland Information Center: A public/private partnership between the U.S. Department of Agriculture, Natural Resource Conservation Service and American Farmland Trust. Available online at: www.farmland.org/documents/Cost-of-Community-Services-08-2010.pdf.
- Benedict, Mark A. and Edward T. McMahon. (2006). Green Infrastructure: Linking Landscapes and Communities. Washington, DC: Island Press.
- Black, R.W. and M.D. Munn. (2004). Using Macroinvertebrates to Identify Biota-land Cover Optima at Multiple Scales in the Pacific Northwest, USA. *Journal of the North American Benthological Society* 18: 49-66.
- Bliley, Daniel J. (1994). Soil Survey of Johnston County, North Carolina. U.S. Department of Agriculture Soil Conservation Service.
- Campbell, B.G. and A.L. Coes, eds. (2010). Groundwater availability in the Atlantic Coastal Plain of North and South Carolina. U.S. Geological Survey Professional Paper 1773, 241pp., 7pls.
- Carpenter III, P. Albert. (1990). Bedrock Geology and Mineral Resources of the Powhatan 7.5-Minute Quadrangle, Johnston County, North Carolina. North Carolina Geological Survey Open-File Report 90-7, Raleigh, NC.
- Carpenter III, P. Albert, R.H. Carpenter, J.A. Speer, and E.F. Stoddard. (1995). Geology of the Stancils Chapel 7.5-Minute Quadrangle, Johnston, Nash, and Wilson Counties, North Carolina. North Carolina Geological Survey Open-File Report 94-3, Raleigh, NC.
- Carpenter III, P. Albert, R.H. Carpenter, J.A. Speer, and E.F. Stoddard. (1996a). Bedrock Geology of the Middlesex 7.5-Minute Quadrangle, Franklin, Johnston, Nash, and Wilson Counties, North Carolina. North Carolina Geological Survey Open-File Report 96-1, Raleigh, NC.
- Carpenter III, P. Albert, R.H. Carpenter, J.A. Speer, and E.F. Stoddard. (1996b). Bedrock Geology of the Zebulon 7.5-Minute Quadrangle, Franklin, Johnston, Nash, and Wake Counties, North Carolina. North Carolina Geological Survey Open-File Report 96-2, Raleigh, NC.
- Carpenter III, P. Albert, R.H. Carpenter, E.F. Stoddard, and J.R. Huntsman. (1998a). Bedrock Geologic Map of the Selma 7.5-Minute Quadrangle, Johnston County, North Carolina. North Carolina Geological Survey Open-File Report 98-1, Raleigh, NC.

- Carpenter III, P. Albert, R.H. Carpenter, E.F. Stoddard, J.R. Huntsman, and J.A. Speer. (1998b). Bedrock Geologic Map of the Flowers 7.5-Minute Quadrangle, Johnston County, North Carolina. North Carolina Geological Survey Open-File Report 98-2, Raleigh, NC.
- Carpenter III, P. Albert, R.H. Carpenter, and J.A. Speer. (1998c). Bedrock Geologic Map of the Clayton 7.5-Minute Quadrangle, Johnston and Wake Counties, North Carolina. North Carolina Geological Survey Open-File Report 98-4, Raleigh, NC.
- Carroll, Gwendolyn D. (2009). Improving Inference from Biological Assessments: Linkages between Ecological Drivers and Aquatic Communities in Piedmont Streams. (Doctoral Dissertation). University of Georgia, Athens, GA.
- Center for Watershed Protection (CWP). (2003). Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph No. 1.
- Chatham Conservation Partnership (CCP). (2011). A Comprehensive Conservation Plan for Chatham County, North Carolina. Prepared by: Robert J. Goldstein & Associates, Raleigh, NC and Biocenosis, Inc., Pittsboro, NC. Available online at: chathamconservation.wikispaces.com
- CH2M HILL. (2008). Draft Environmental Assessment of Water Supply and Water Storage Alternatives in Johnston County, North Carolina. CH2M HILL, Raleigh, NC.
- Clark, T.W., D.E. Blake, E.F. Stoddard, P.A. Carpenter, III, and R.H. Carpenter. (2004). Preliminary Bedrock Geologic Map of the Raleigh 30' x 60' Quadrangle, North Carolina. North Carolina Geological Survey Open-File Report 2004-02, Raleigh, NC.
- Cosgrove, William J. and F.R. Rijsberman. (2000). World Water Vision: Making Water Everybody's Business. Earthscan Publications Ltd, London, UK.
- Daniels, R.B., S.W. Buol, H.J. Kleiss, and C.A. Ditzler. (1999). Soil Systems in North Carolina. Technical Bulletin 314. North Carolina State University Soil Science Department, Raleigh, NC.
- Ernst, Caryn. (2004). Land Conservation and the Future of America's Drinking Water: Protecting the Source. The Trust for Public Land and The American Water Works Association.
- Fry, J., G. Xian, S. Jin, J. Dewitz, C. Homer, L. Yang, C. Barnes, N. Herold, and J. Wickham. (2011). Completion of the 2006 National Land Cover Database for the Conterminous United States. Photogrammetric Engineering & Remote Sensing, Vol. 77(9):858-864.
- Griffith, G.E., J.M. Omernik, J.A. Comstock, M.P. Schafale, W.H. McNab, D.R. Lenat, T.F. MacPherson, J.B. Glover, and V.B. Shelburne. (2002). Ecoregions of North Carolina and South Carolina, (color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, VA. (map scale 1:1,500,000).
- Hall, Stephen P. (2008). Statewide Assessment of Conservation Priorities at the Landscape Level. N.C. Department of Environment and Natural Resources, Natural Heritage Program, Raleigh, NC.

- Hall, Stephen P. (2009a). Statewide Assessment of Conservation Priorities at the Landscape Level: Upland and Interbasin Habitats, Eastern Piedmont Region (February 3, 2009). N.C. Department of Environment and Natural Resources, Natural Heritage Program, Raleigh, NC.
- Hall, Stephen P. (2009b). Statewide Assessment of Conservation Priorities at the Landscape Level: Upland and Interbasin Habitats, Northern Coastal Plain Region (July 9, 2009). N.C. Department of Environment and Natural Resources, Natural Heritage Program, Raleigh, NC.
- Johnston County Economic Development Office (JCEDC). (2011). Johnston County General Profile. Johnston County Economic Development Office, Smithfield, NC. Available online at: www.johnstonnc.com/files/econdev/publications/JohnstonCountyGP.pdf
- Johnston County Visitors Bureau (JCVB). (2009). Johnston County North Carolina Visitors Guide 2009. Johnston County Visitors Bureau, Smithfield, NC.
- Langer, William H. (2003). A General Overview of the Technology of In-Stream Mining of Sand and Gravel Resources, Associated Potential Environmental Impacts, and Methods to Control Potential Impacts. U.S. Department of the Interior, U.S. Geological Survey: Open File Report OF-02-153.
- Lassiter, Thomas J. and T.W. Lassiter. (2004). Johnston County: Its History Since 1746. Hometown Heritage Publishing Inc., Smithfield, NC.
- LeGrand, Harry E. Jr. (2001). An Inventory of Significant Natural Areas in Johnston County, North Carolina. N.C. Natural Heritage Program, Division of Parks and Recreation, Department of Environment and Natural Resources, Raleigh, NC.
- Floodplain Mapping Program, North Carolina Division of Emergency Management (NCDEM). (2002). NC Floodplain Mapping: Neuse Basin; LIDAR Bare Earth Mass Points, Jan-Mar 2001, Version 1. EarthData International of North Carolina, High Point, NC.
- Moore, R., T. Williams, E. Rodriguez, J.H. Cymmerman. (2011). Quantifying the Value of Non-timber Ecosystem Services from Georgia's Private Forests. Final Report Submitted to the Georgia Forestry Foundation. Athens, GA.
- Morse, Chandler C., A.D. Huryn, and C. Cronan. (2003). Impervious Surface Area as a Predictor of the Effects of Urbanization on Stream Insect Communities in Maine, U.S.A. Environmental Monitoring and Assessment, 89, 95-127.
- McPherson, E.G. (1993). Monitoring urban forest health. Environmental Monitoring and Assessment, 26(2), 165-174.
- National Agricultural Statistics Service, U.S. Department of Agriculture (NASS) and N.C. Department of Agriculture & Consumer Services (NCDA&CS). (2010). 2010 North Carolina Agricultural Statistics. NASS and NCDA&CS Publication No. 212. Raleigh, NC.
- N.C. Division of Water Quality (NCDWQ). (2009). Small Streams Biocriteria Development. N.C. Department of Environment and Natural Resources, Division of Water Quality. Raleigh, NC.

- N.C. Forest Service (NCFS). (2010). North Carolina's Forest Resources Assessment: A statewide analysis of the past, current and projected future conditions of North Carolina's forest resources. North Carolina Forest Service, North Carolina Department of Agriculture & Consumer Services, Raleigh, NC. Available online at: www.ncforestassessment.com
- N.C. Geological Survey (NCGS). (1988). Preliminary Explanatory Text for the 1985 Geologic Map of North Carolina. NCGS Contractual Report 88-1. Raleigh, NC.
- N.C. Natural Heritage Program (NCNHP). (2001). Descriptions of the Biological Themes of North Carolina, 2nd Edition. N.C. Natural Heritage Program, Division of Parks and Recreation, Department of Environment and Natural Resources, Raleigh, NC.
- N.C. Natural Heritage Program (NCNHP). (2011a). N.C. Natural Heritage Program GIS Data. (Accessed July 2011). N.C. Natural Heritage Program, N.C. Department of Environment and Natural Resources, Raleigh, NC.
- N.C. Natural Heritage Program (NCNHP). (2011b). N.C. Natural Heritage Program Heritage Data Website: www.ncnhp.org/Pages/heritagedata.html. (Accessed September 2011). N.C. Natural Heritage Program, N.C. Department of Environment and Natural Resources, Raleigh, NC.
- N.C. State University, Extension Forestry (NCSU). (2007). 2006 Income of North Carolina Timber Harvested and Delivered to Mills. Information compiled from multiple sources. Raleigh, NC.
- N.C. State University, Extension Forestry (NCSU). (2008). 2007 Income of North Carolina Timber Harvested and Delivered to Mills. Information compiled from multiple sources. Raleigh, NC.
- N.C. State University, Extension Forestry (NCSU). (2009). 2008 Income of North Carolina Timber Harvested and Delivered to Mills. Information compiled from multiple sources. Raleigh, NC.
- N.C. State University, Extension Forestry (NCSU). (2010). 2009 Income of North Carolina Timber Harvested and Delivered to Mills. Information compiled from multiple sources. Raleigh, NC.
- N.C. Wildlife Resources Commission (NCWRC). (2005). North Carolina Wildlife Action Plan. N.C. Wildlife Resources Commission, Raleigh, NC. Available online at: www.ncwildlife.org/plan
- Packer, David B., K. Griffin, and K.E. McGlynn. (2005). National Marine Fisheries Service National Gravel Extraction Guidance: A review of the effects of in- and near-stream gravel extraction on anadromous fishes and their habitats, with recommendations for avoidance, minimization, and mitigation. U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS): NOAA Technical Memorandum NMFS-F/SPO-70.
- Powell, William S., Ed. (2006). Encyclopedia of North Carolina. The University of North Carolina Press, Chapel Hill, NC. pp. 636-637.
- Schafale, Michael P. and Alan S. Weakley. (1990). A Classification of Natural Communities of North Carolina, 3rd Approximation. N.C. Natural Heritage Program, Raleigh, NC.

- Schueler, Thomas R., L. Fraley-McNeal, and K. Capiella. (2009). Is Impervious Cover Still Important? Review of Recent Research. *Journal of Hydrologic Engineering*, 14(4), 309-315.
- Sedell, James, M. Sharpe, D.D. Apple, M. Copenhagen, and M. Furniss. (2000). *Water and the Forest Service*. USDA Forest Service Publication FS-660, Washington, DC.
- The Southern Center for Urban Forestry Research and Information (SCUFR&I), Eds. (2006). *Urban Forestry Manual*. USDA Forest Service, Southern Center for Urban Forest Research and Information, Athens, GA.
- U.S. Census Bureau (USCB). (2010). 2010 Census QuickFacts, Johnston County, North Carolina.
- U.S. Department of Agriculture (USDA). (1992). *General Soil Map of Johnston County, North Carolina*. USDA Soil Conservation Service.
- U.S. Department of the Interior, Fish and Wildlife Service (USFWS) and U.S. Department of Commerce, (USDOC), U.S. Census Bureau. (2008). 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Available online at: www.census.gov/prod/2008pubs/fhw06-nc.pdf
- U.S. Environmental Protection Agency (USEPA). (2005). *Growth and Water Resources – The Link Between Land Use and Water Resources*. Factsheet: EPA 842-F-02-008. U.S. Environmental Protection Agency, Office of Water, Washington D.C.
- U.S. Environmental Protection Agency (USEPA) and U.S. Geological Survey (USGS). (2005). *National Hydrography Dataset Plus – NHDPlus, Version 1.0*. Available online at: www.horizon-systems.com/nhdplus/index.php.
- Wilson, William F., P.A. Albert Carpenter, III, and J.M. Parker, III. (1981). *Geologic Map of Region J, North Carolina*. North Carolina Geological Survey Open-File Report 81-5, Raleigh, NC.

Terms and Definitions

Agricultural District – Designation of an area of viable agricultural land. Initiated and self-selected by landowners, adopted by a county. Eligibility, minimum acreage is determined by each county. Land can go in and out at any time. Not tied to agricultural assessment.

Agricultural Landscapes – Agricultural lands appreciated for their aesthetic value at the landscape scale.

Archaeological Resources – Those areas and sites of identified and probable archaeological significance.

Area Sensitive Species – Animal species that show different levels of tolerance to habitat fragmentation. Species with a high area-sensitivity are those to be the most influenced by habitat fragmentation

Biodiversity – The variety and variability within and among living populations and the ecosystems within which they occur; a gradient including genes, species, ecosystems, and landscapes.

Buffer – Natural area or open space used to minimize the impacts of adjacent lands and their uses on core areas or areas selected for a particular management strategy.

Coastal Plain – An extensive, low-relief area that is bounded by the sea on one side and by a high-relief province on the landward side. Its geologic province actually extends beyond the shoreline across the continental shelf.

Connectivity – The creation of functionally contiguous blocks of land or water through linkage of similar ecosystems or native landscapes; the linking of trails, communities, and other human features.

Conservation Easement – A legally binding agreement that limits certain types of uses or prevents development from taking place on a piece of property from that point on while protecting the ecology of the site.

Core Area – A large area within a reserve network that is managed solely or primarily as an ecological reserve for the conservation of biological diversity.

Cultural Tourism – Tourism where historic and cultural resources are the primary attraction.

Development Rights – The rights to develop land in accordance with applicable local, state, and federal laws, as distinguished from ownership of it.

Easement – Authorization for the use, for a specified purpose, of land that is not owned by the user.

Ecosystem – The living and nonliving components of the environment that interact or function together.

Ecosystem Services – The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth.

Ecotourism – Tourism where natural features are the primary attraction and include such activities as hiking, photography, and river recreation.

Floodplain – Land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater and dissipate the destructive energy of a flood.

Greenway – A corridor of undeveloped land, as along a river or between urban centers, which is reserved for recreational use or environmental conservation.

Green Infrastructure – Strategically planned and managed networks of natural lands, working landscapes and other open spaces that conserve ecosystem values and functions and provide associated benefits to human populations.

Green Roof – A roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane thus reducing stormwater runoff and absorbing carbon dioxide from the air.

Historic and Cultural Resources – Those sites and districts registered with the National Park Service, as well as historic resources identified by the Johnston County Heritage Center such as districts, villages, civil war sites, and African-American heritage districts.

Hub – An area that anchors a green infrastructure network and provides space for native plant and animal communities, as well as an origin or destination for wildlife, people, and ecological processes moving through the system. Hubs can vary in size from large conservation areas to smaller regional parks.

Infiltration Planter – A structural landscaped reservoir used to collect, filter and infiltrate stormwater run-off. This allows pollutants to settle and filter out as the water percolates through the planter soil and infiltrates into the ground.

Land Conservation – Protecting a certain land because of its natural resources or animal life.

Link – The connection that enables a system or network to function and multiplies the utility of existing components by connecting them together like beads on a string. The term is synonymous with corridor.

Natural Capital – The land, natural resources, and ecosystems that yield direct and indirect economic benefits for the human population. Natural capital provides indirect economic value in the form of hydrologic services, ecosystem services, atmospheric regulation, pollution control, recreation, and culture.

Natural Community – A distinct, identifiable, and recurring association of plants and animals that is ecologically interrelated.

Natural Resources – Any aspect of the environment that species, including humans, depend on for their survival, such as land, soil, energy, and fresh water.

Open Space – An area of land that is valued for natural processes and wildlife, for agricultural and forest production, for active and passive recreation, and / or for providing other public benefits.

Parks and Recreational Areas – County, municipal, state, and federal lands used for outdoor activities such as athletics, hunting, and fishing.

Piedmont – The plateau or gently sloping land between the coastal plain and the Appalachian Mountains.

Porous Pavement – A permeable pavement surface with an underlying stone reservoir that temporarily stores surface water runoff before infiltrating into the subsoil.

Rain Garden – A depressed area of the ground planted with vegetation, allowing runoff from impervious surfaces such as parking lots and roofs the opportunity to be collected and infiltrated into the groundwater supply or returned to the atmosphere through evaporation.

Riparian (Riparian Zone or Riparian Area) – The interface between land and a stream. Riparian zones may be natural or engineered for soil stabilization or restoration. These zones are important natural biofilters, protecting aquatic environments from excessive sedimentation, polluted surface runoff and erosion. They supply shelter and food for many aquatic animals and shade that is an important part of stream temperature regulation.

Significant Sites – An area of land or water identified as being important for conservation of biodiversity.

Sprawl – The increased development of land in suburban and rural areas outside of their respective urban centers.

Stormwater Management – The mechanism for controlling stormwater runoff for the purposes of reducing downstream erosion, water quality degradation, and flooding and mitigating the adverse effects of changes in land use on the aquatic environment.

Trails – On- and off-road trails and paths used for hiking, biking, and walking.

Viewsheds – Landscapes appreciated for their aesthetic value.

Watershed – A region of land within which water flows down into a specified body, such as a river, lake, sea, or ocean; a drainage basin or catchment basin.

Working Lands – Those lands that provide direct sustainable income to landowners, e.g., farmland and forestland.

