A Conservation Assessment for the Neuse River and Mark's Creek

Wake and Johnston Counties, North Carolina

By Lorelei Costa
Triangle Land Conservancy

December 2001

Prepared by Triangle Land Conservancy for Conservation Trust for North Carolina and North Carolina Clean Water Management Trust Fund

A Conservation Assessment for the Neuse River and Mark's Creek

Wake and Johnston Counties, North Carolina

by Lorelei Costa, Triangle Land Conservancy

December 2001

Neuse River – Mark's Creek Planning Advisory Committee

Jimmy Thiem, Chairman
Heather Beard, Neuse River Foundation
George Clark, NC State University Central Crops Research Station
Rupert Conyers, Landowner
Dorothy Goodson, Landowner
Mike Huffman, Clemmons Educational State Forest
Larry Martin, Landowner
Gary Miller, Fred Smith Company
Fred Smith, Central Crops Research Station
Bailey and Sarah Williamson, Landowners
Dr. John Al Yeager, III, Landowner
John Yeager Jr., Landowner

Acknowledgments and Thanks

Triangle Land Conservancy gives heartiest thanks to the members of the project steering committee, an extraordinary group of landowners and professionals listed individually on the previous page. This group convened for over a year, brainstorming the special places in the watershed, sharing their extensive knowledge of local history, and discussing strategies to protectopen space, water quality, and rural character. The committee participated in a driving tour of the study area, identified scenic roads and views, and helped edit this report. In particular, Committee Chairman Jimmy Thiem devoted several Friday afternoons to driving the Shotwell roads, taking pictures of scenic spots, and offering spirited debate about scenic definitions and characteristics. Thanks also to Rupert and Mary Conyers for hosting a committee meeting in their beautiful historic home.

In addition to the members of the steering committee, David Connell and Knightdale planner Chad Meadows contributed significant time to researching and developing scenic analyses and identifying scenic areas. Landowners Marty Ringgold and Ray Earp contributed advice and knowledge. Thanks also to Chris Clarke for his help during a canoe trip of the Neuse River and to David Jessee for taking beautiful photographs of the Shotwell landscape.

Finally, thanks to the generous funding from North Carolina Clean Water Management Trust Fund and Conservation Trust for North Carolina for making this report possible. Rusty Painter of CTNC offered editorials and oversight, and Ben Isenberg provided spatial data, useful maps, help, and patience.

About TLC

Triangle Land Conservancy (TLC) is a non-profit land trust founded in 1983 to create a network of open space and natural areas in the six-country Triangle Region. TLC works with landowners on a voluntary basis to protect open space, farmland, natural areas, forestland, and riparian areas. As of December 2001 TLC has protected over 4,000 acres in Chatham, Durham, Johnston, Lee, Orange, and Wake counties.

For more information please contact: Triangle Land Conservancy, 1101 Haynes Street, Suite 205, Raleigh, NC, 27604; Phone: 919-833-3662; Email: info@tlc-nc.org; Web: www.tlc-nc.org.

TABLE OF CONTENTS

LIST OF MAPS

Please note: Maps 1, 2, 3, 5, 8, 10, and 12 created by Ben Isenberg, Conservation Trust for North Carolina

LIST OF FIGURES

I. Introduction

A. The Story of a Road

Ten miles east of Raleigh, running north to south and roughly parallel to the Neuse River, is a road that has been traveled for over 100 years (Wake Co. Historical Society). On a map Smithfield/Pritchard Road seems fairly innocuous, similar to any other eastern Piedmont road in North Carolina. Yet a trip down this road is like a journey on a time machine, traversing several eras of North Carolina's history, passing by relicts of our heritage alongside examples of our current growth and lifestyle.

Starting at Horton Road in Wake County, Smithfield Road first crosses through the Town of Knightdale, pushing its way through the congested suburban strip mall fringe near Highway 64, and then crossing over the railroad tracks through the heart of Knightdale's quiet, somewhat neglected downtown, at one time a dynamic town center that shoppers have since deserted for big box stores and malls. Continuing south towards Poole Road, Smithfield Road travels by a smattering of suburban subdivisions, one-acre residential lots next door to abandoned fields adorned with "For Sale" signs.

South of Poole Road, the scenery changes completely. Fields and woods in various stages of cultivation, rotation, and succession alternately line the road, along with an occasional mix of modern dwellings and old barns and farm houses. At Shotwell, a dilapidated country store and fraternal lodge stand as reminders of the rural community that once gathered here. Old oaks hide centuries-old plantation homes. The landscape opens up dramatically, and in the distance is a small country church under a single oak tree, a beacon of white above a sun-drenched field.

Traveling south into Johnston County, Smithfield Road changes names to Pritchard Road and changes character once again. Buildings are absent for a two-mile stretch, and forests of varying ages line both sides of the road, some recently cut. An open field on the right is bordered in the distance by a stand of pines and hardwoods buffering a far-off stream, and a single contemporary house is cleverly hidden within a grove of trees. The road loses elevation, then dips down dramatically as it crosses Mark's Creek, and curves sharply, highlighting the characteristic topography of the Piedmont, the road alignment itself adding to the scenery of the landscape.

Pritchard Road is one of only two roads that trisect this otherwise undeveloped, 7,500-acre block of forests and fields, the largest contiguous piece of undeveloped land in this part of Wake and Johnston counties. This nearly roadless area is not pristine; indeed, it is patchworked from 250 years of cutting, plowing, and hurricane and pine beetle damage, as seen from Pritchard Road. What is most significant about the roadless area is what cannot be seen from the road: an extensive system of bottomland hardwood forest running along the Neuse River, up Mark's Creek, through hundreds of acres of wetlands, and along many other smaller tributaries. The roadless area is a core wildlife habitat connected to a network of stream buffers and forested patches.

The roadless area is like a Thanksgiving turkey waiting to be carved. One mile after Mark's Creek, the fields and forests suddenly give way to a construction site for a 700-acre mixed-use development. Pritchard Road has just transported back to the 21st Century, back to the realities of a booming population and the demand for more housing. Like many other eastern Piedmont roads in North Carolina, Smithfield/Pritchard Road traverses a hodgepodge of old and new, rural and suburban, clean streams and muddy rivers, fields, forests, and subdivisions, country store and superstore. Smithfield/Pritchard crosses through the worst of the legacy we'll leave behind us, and the best of the heritage left before us.

B. Summary of Findings

This report examines the waterways, significant natural areas, and rural, historic qualities of the Mark's Creek and middle Neuse River watersheds in Wake and Johnston counties, North Carolina. Funding for the report was provided by the NC Clean Water Management Trust Fund and administered by the Conservation Trust for North Carolina. This study is one of several dozen water quality and open space related reports being conducted by selected local land trusts across North Carolina in an effort to establish conservation plans for the most significant streams and natural areas in our state.

A committee of landowners, stakeholders, and technical experts convened for over one year to identify the special features of this landscape, its threats, and the strategies we can pursue to preserve it. Our goal is to protect the water quality, natural areas, and scenic, rural, historic character of Shotwell and the surrounding area in Wake and Johnston counties for the greatest benefit for the community, while meeting individual landowner goals.

In summary:

Water Quality. The Neuse River is highly impacted by stormwater run-off that enters the river primarily from its tributaries, and it carries an enormous sediment load. As a result this section of the Neuse no longer supports any known rare freshwater mussel or fish species. This stretch of the mainstem is, for the most part, well-buffered by a wide strip of vegetation; it is the smaller tributaries and particularly the headwaters that lack a vegetated buffer. An extensive system of wetlands on Mark's Creek helps to maintain good water quality in this tributary, and Mark's Creek continues to support a good aquatic habitat. This network of wetlands must be protected in order to preserve the good water quality of Mark's Creek. In addition to land protection, strong enforcement of existing buffer regulations and sedimentation and erosion control ordinances is vital to protecting the water quality of the Neuse River, Mark's Creek, and all of their tributaries.

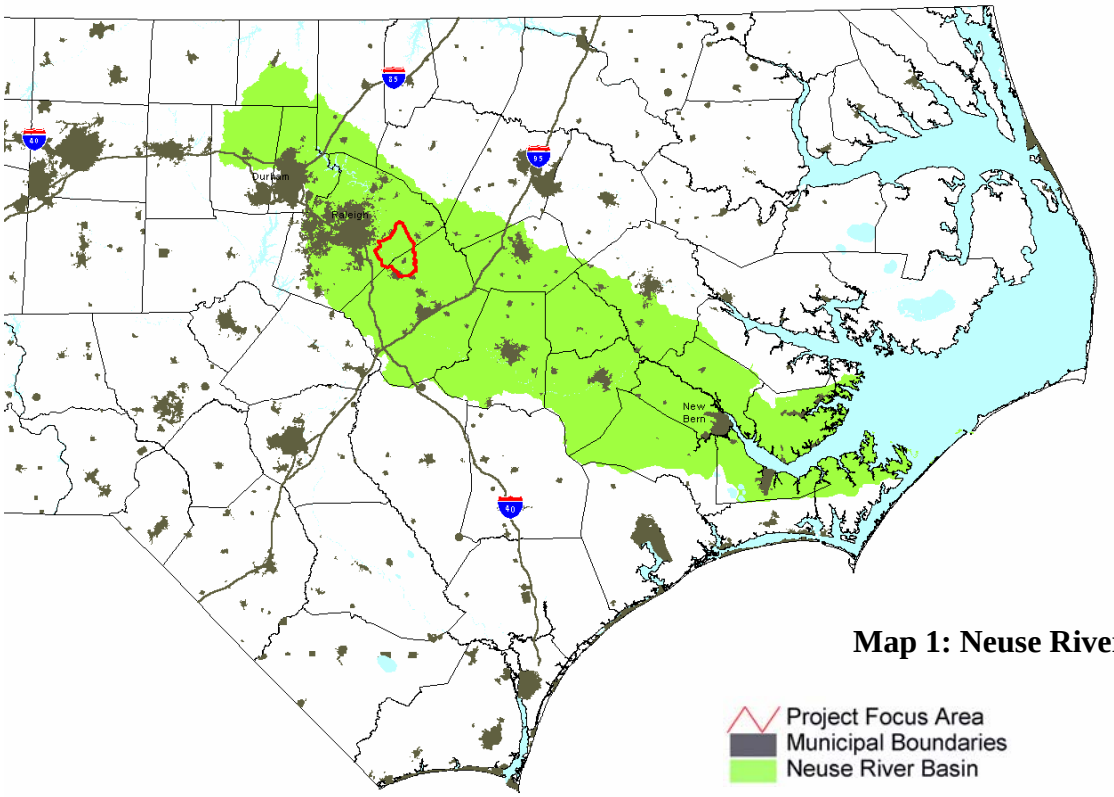
Natural Areas. Though much of the native hardwood forest has been cleared over the past three centuries, a significant network of bottomland forest runs along the stream corridors and should be protected for the benefit of native wildlife. A core, 3,500-acre roadless area at the Neuse River and Mark's Creek confluence, and the adjacent secondary roadless areas along lower Mark's Creek and Big Arm Creek, contain a mix of hardwood forest, pine forest, and farmland but are significant for their size and undeveloped state and have great potential in the long-term as important wildlife habitat. Michaux's sumac is the only known rare species in the watershed, but the NC Natural Heritage Program has identified several significant forest stands on the Neuse River and numerous intact granitic flatrocks north of the study area.

Scenic, Rural, Historic Character. The advisory committee for this report identified three core scenic areas for protection in the Shotwell vicinity: Lake Myra off of Poole Road in Wake County, Brookhill Farm in Johnston County, and Shotwell center in southern Wake County. The committee also listed several scenic roads winding throughout the Shotwell area that "buffer" these core scenic hotspots and create a larger scenic rural landscape. Yet the protection of a few historic houses and/or a few scenic tracts of land is not enough to protect the scenic rural landscape. The beloved vistas, historic structures, and picturesque farms are significant because of their rural context. Protection of the scenic, rural, historic landscape will require a multi-pronged approach including creative subdivision design, zoning for rural densities, direct land protection, and strengthening the rural economy.

II. Description of Project Area

A. Location

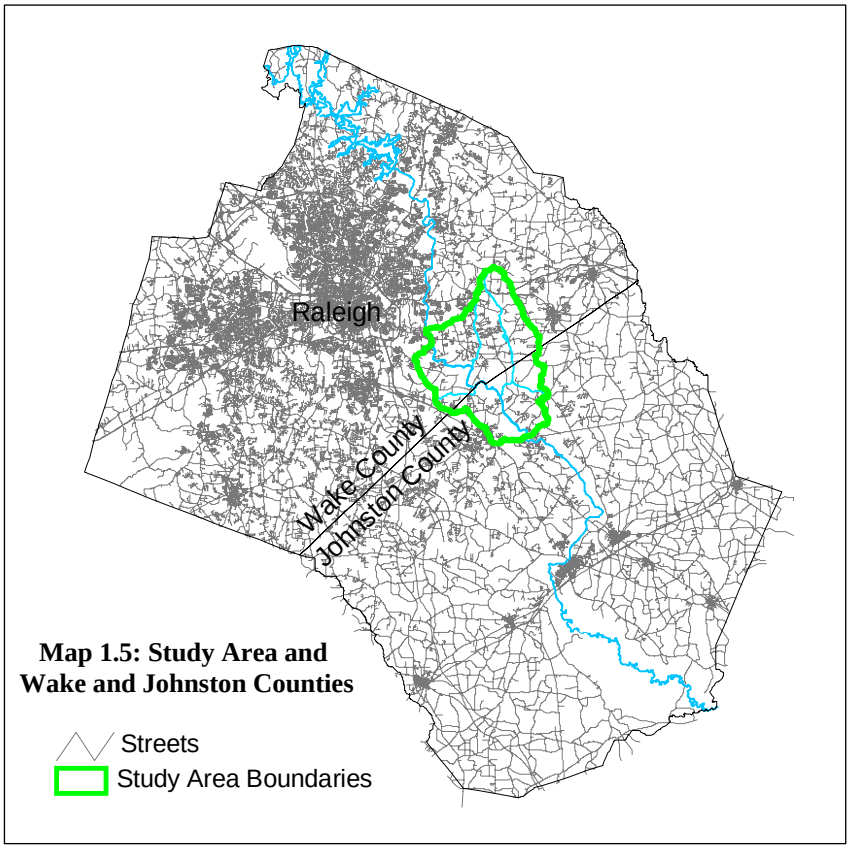
The Neuse River is formed by the waters of the Eno and Flat Rivers in the eastern Piedmont of North Carolina in Orange, Person, and Durham counties. In 1982 the U.S. Army Corps of Engineers dammed the upper Neuse to create a drinking water supply for Wake County. The resulting Falls Lake Reservoir now inundates the path of the first 22 miles of the mainstem of the river; therefore, the Neuse River can be first identified at the base of the dam, below the lake. The Neuse runs east of Raleigh and Clayton, flowing southeast through Wake County, Johnston County, and into the Coastal Plain. A few miles above New Bern, the Neuse transforms into a brackish, shallow, wide estuary. Eventually it empties into the Albemarle-Pamlico Sound, the second largest estuarine system in the United States. The Neuse River is approximately 200 miles long, measured from the Falls Lake Dam to the Pamlico Sound, and it has the widest mouth of any river in the continental United States. (NRF 2001). In terms of the volume of water it carries, the Neuse is the single most important waterway in Wake and Johnston counties (LeGrand 2001).



Map 1: Neuse River Basin

The headwaters of Mark's Creek are located in eastern Wake County, east of Raleigh and northeast of Knightdale. Mark's Creek flows south through Wake County into Johnston County, where it joins the Neuse northeast of Clayton. Big Arm Creek is the largest tributary of Mark's Creek. Starting just west of Archers Lodge in Johnston County, Big Arm Creek flows west, joining Mark's Creek approximately one-and-a-half miles west of the Neuse. Poplar Creek is another main tributary of the Neuse. Flowing south from its headwaters in Knightdale, Poplar Creek meets the Neuse just across the river from the Raleigh Wastewater Treatment Plant.

Our study area is comprised of the Mark's Creek, Poplar Creek, and middle Neuse River 14-digit hydrological units, as defined by the U.S. Department of Agriculture's Natural Resource Conservation Service. The size of the study area is approximately 50,000 acres. Two-thirds of the study area lies in Wake County, with the remaining one-third in Johnston County. (Map 1.5: Study Area and Wake and Johnston Counties)



Map 1.5: Study Area and Wake and Johnston Counties

The community of Shotwell is at the heart of the study area. (Map 2: Base Map of Study Area) Archers Lodge, Eagle Rock, and Auburn lie at the outskirts. Because none of these communities are incorporated as municipalities, the vast majority of the study area is zoned by the county governments, outside of any town limits and without municipal water and sewer. This will change over the next 10 to 20 years. In Johnston County, Clayton has already begun annexing land east of the Neuse River to accommodate new developments, and in all probability the town will continue to expand its boundaries as its population grows. In Wake County, all of the land in the

watershed lies within "urban service areas," which are eventually expected to be annexed by the neighboring municipalities of Garner, Raleigh, Knightdale, and Wendell.

B. Physical Characteristics

One of Triangle Land Conservancy's primary conservation goals is the protection of the significant natural areas and wildlife habitats in the Shotwell area. This section describes the physical characteristics of the study area and some of the most important natural areas that must be conserved.

1. Physiography, Topography, Geology, Soils

The Neuse River – Mark's Creek watershed is located in the transition zone between the Piedmont and Coastal Plain physiographic regions. While the Piedmont is characterized by slightly rolling topography and narrow floodplains, the Coastal Plain is typified by flatter terrain and slow, meandering streams with wide floodplains and sandy substrates. The transition zone between the two regions is often called the "Fall Line"; however, because the transition is gradual, it is better described as a zone than a line. The study area has characteristics of both the Piedmont and the Coastal Plain regions and an increased biodiversity because of it. Elevations range from 350 feet above sea level at Medlin Road and Lake Wendell Road, to 140 feet above sea level along the Neuse River at Covered Bridge Road. Along its 11-mile run from Poole Road to Covered Bridge Road, the Neuse River gradually loses 20 feet in elevation, from 160 feet to 140 feet. As it runs southeast, the Neuse continues to lose elevation slowly as it journeys through the Coastal Plain towards the ocean. There are no prominent mountains or hills in the watershed.

The major geological feature in the study area is the Rolesville Pluton, the granitic bedrock that extends from northern Johnston County through Wake County, and up as far as Franklin, Vance, and Warren counties to the north (LeGrand 1987). Map 3 illustrates the geology of the study area as classified and delineated by the North Carolina Division of Land Resources; PPmg represents the Rolesville Pluton. Most of the soils in the study area are derived from the Rolesville Pluton and, accordingly, are acidic, with pH values generally less than 6.0 (ibid.). Soils inventories from the U.S. Department of Agriculture (USDA) classify these Piedmont soils into Appling, Wedowee, Appling-Louisburg-Wedowee, and Cecil-Pacolet-Nason associations, all of which are well-drained and predominantly clayey. In Johnston County there are also some areas of Costal Plain

upland soils from the Wagram-Blanton-Bonneau and Norfolk-Goldsboro-Rains associations, mostly sandy and loamy, of varying drainage. The floodplain soils, classified into the Wedhadkee-Bibb-Chewacla association, are poorly-drained and consist of relatively young deposits of sediments. Appling soils are by far the most prevalent, constituting about 33% of the study area. In Johnston County Wedowee soils are the most common, constituting about 11% of the total study area and 33% of the Johnston County area. (Bliley 1994 and Cawthorne 1970) According to data compiled by the Triangle J Council of Governments, 40% of the soils in the study area are prime farmland soils.

Soil surveys for Johnston and Wake counties show that over 26% of the study area has severe limitations for septic tanks. These limitations include high water tables and potential for flooding (11% of study area), steep slopes (8%), slow percolation rates of soils (6%), high shrink-swell potential in the soils (3%), and/or a shallow depth to rock (2%). The surveys show that over 20% of the study area has severe limitations for homebuilding because of high water tables and potential for flooding (10% of study area), steep slopes (7%), high shrink-swell potential (3%), or a shallow depth to rock (1%). The majority of the study area, over 60%, has only slight or moderate limitations for building and septic tanks; most of these limitations can be overcome by modern technology. The most developable areas are concentrated on the uplands.

2. Forest Network, Forest Species, and Roadless Area

One of the Triangle Land Conservancy's primary conservation goals in the Shotwell area is the preservation of forest and wildlife habitat. Before European and African settlement, much of the Neuse River – Mark's Creek watershed was probably forested with hardwood trees. Historic records of red-cockaded woodpecker (NHP 2001a) and naval stores trade (Huffman 2001) also indicate that longleaf pine communities could have extended in the Shotwell vicinity, probably in the drier, sandier soils. Over the past 270 years, most of these hardwood and longleaf pine forests have been cut, cleared, or otherwise fragmented and disturbed, though some hardwood buffers remain in the riparian bottomlands. There are no known longleaf pine stands presently in the study area, except for a planted stand in Clemmons Educational State Forest.

A combination of satellite land cover data from 1993-1995 and parcel data from 2001 indicates that 30.2% of the study area is "mature forest" (bottomland forest and hardwood swamps, mixed hardwood/conifer, and mixed upland hardwood); 21.0% is farmland

(cultivated and managed herbaceous cover); 20.4% is forested in southern yellow pine; 15.2% is developed in roads or subdivided into 2.5-acre lots or smaller; 12.4% is shrubland consisting of deciduous, evergreen, and mixed trees; and 0.8% is water. (Map 4: Vegetative Cover in the Neuse – Mark's Creek Watershed)

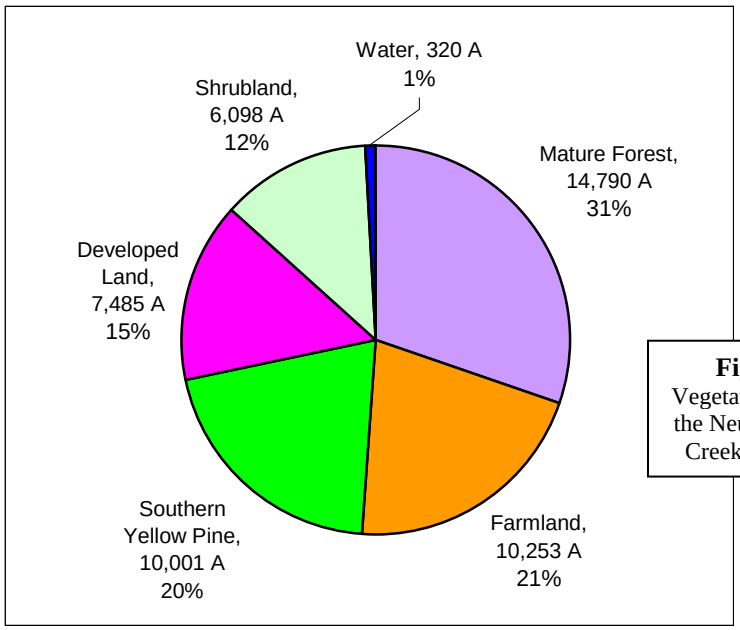


Figure 1: Vegetative Cover in the Neuse – Mark's Creek Watershed

In *An Inventory of Natural Areas in Johnston County, North Carolina* (LeGrand 2001), the NC Natural Heritage Program has identified several significant forest patches along the Neuse River, grouped together and named Neuse River (Clayton) Forests. A half mile below the county line along the south bank of the river is a natural levee with a forest of American beech (*Fagus grandifolia*) and American elm (*Ulmus americana*), and in the herb layer box-elder (*Acer negundo*) and trout-lily (*Erythronium umbilicatum*). At the mouth of Mark's Creek on the east side of the river and extending up Mark's Creek is another significant stand of hardwood forest, with cane (*Arundinaria gigantean*) and river oats (*Uniola latifolia*) on the levee. Further downstream on the west side of the river is a moderately extensive stand of Dry-Mesic Oak-Hickory forest, with herbs such as Catesby's trillium (*Trillium catebaei*) and bloodroot (*Sanguinaria canadensis*) carpeting the ground, and Mesic Mixed Hardwood Forest along the mid- and lower slopes. (Map 5: Significant Natural Heritage Sites and Element Occurrences)

Though there are no prominent hills in this area, there are some bluffs and moderately steep slopes along the river. Some of these slopes and bluffs, especially those facing north, contain Piedmont/Coastal Plain Heath Bluff natural communities, which are

regionally significant because the cooler microclimate created by the topography can support mountain laurel (*Kalmia latifolia*), Catawba rhododendron (*Rhododendron catawbiense*), galax (*Galax aphylla*), and related species that are locally rare, usually found in the mountains or in cooler climates. On the Neuse River in Johnston County, about 1½ miles below the county line, the NC Natural Heritage Program has identified a significant, 50-ft north-facing bluff with a substantial stand of mountain laurel and prominent rock outcrops. West of the bluff is a slope with a significant stand of hardwood forest, including American beech in the canopy and mayapple (*Podophyllum peltatum*) in the herb layer. This site is also identified as part of the Neuse River (Clayton) Forests site and described in *An Inventory of Natural Areas in Johnston County*. (ibid.)

The protection of these mature forest patches is critical for the conservation of many native wildlife species, especially those that depend on older-growth forest for their habitat. The Triangle region lost much of its indigenous hardwood forest cover 250 years ago when Europeans first settled in the area, and our current land use patterns have exacerbated the decrease and fragmentation of mature hardwood forest. Animal species such as pileated woodpecker, box turtle, bobcat, wood thrush, wild turkey, and spotted salamander are rapidly disappearing in the Triangle because they depend on large, contiguous tracts of undisturbed hardwood forest, which are quickly being cut and paved to accommodate growth. Yet in this highly splintered landscape, it is critical in the long-term to protect not only existing mature forests but also any large, contiguous undeveloped area, even if recently cut or cultivated. Some of our region's best forested wildlife habitat, like the forests in Umstead and Eno River state parks, are second-growth forest, cleared and farmed decades ago but allowed to mature into the wildlife refuges they are today. In the Triangle region, where an average of 40-45 acres are developed each day (Hess 2001), it is important to remember that a cleared forest will grow back, but urbanization is less reversible.

In the Neuse River – Mark's Creek watershed, significant acreage of undeveloped land is still unfragmented by roads and development. At the confluence of the Neuse River and Mark's Creek is a 3,500-acre undeveloped roadless area. Though patchworked in fields and forests of varying ages from generations of clearing and cultivation, the roadless area has stretches of hardwood forest, especially along the waterways, and has enormous potential to mature into a valuable, large forest habitat. Add to it another 2,000-acre roadless area across Pritchard Road, and another roadless area of nearly the same size across Medlin Road; the sum is one of the largest contiguous undeveloped areas in the

region, trisected by only two country roads. This land is highly threatened by residential development and may soon be fragmented by more roads and suburban subdivision. The best time to protect these places is now, before they are further carved into isolated patches of open space. (Map 6: Vegetative Cover and Core Wildlife Habitat and Wildlife Movement Corridors)

3. Rare Plants

The rarest species in our study area is Michaux's sumac (*Rhus michauxii*), a plant that is federally listed as endangered and considered "globally imperiled" because of its rarity (NHP 2001a). Michaux's sumac is low-growing and non-poisonous, preferring sandy, acidic soils. The species is intolerant of dense shade, and therefore prefers disturbed areas that are kept open by mowing, clearing, or fire (Moore and Murdock 1993). Endemic to the Coastal Plain and Piedmont regions of the Carolinas, Georgia, and Florida, there are approximately 21 remaining populations of Michaux's sumac, 20 populations in North Carolina and one population in Georgia, including one population near the confluence of Walnut Creek and the Neuse River (ibid.). According to the NC Plant Conservation Program, records from 1833 indicate that the plant could once be found in several locations along the Neuse from Raleigh to Smithfield (another clue indicating the historic presence of longleaf pine in the Shotwell area, since the two plants often cohabitate) (Frost 2000).

Historically the greatest threat to Michaux's sumac has been fire suppression and conversion of habitat to silvicultural and agricultural uses, but today urbanization could be a more serious threat. Urbanization has been a double-edged sword for Michaux's sumac. Of the approximate 21 remaining populations, 11 are located near roadsides, powerline easements, railroads, and other artificially maintained clearings, including the population in our study area (Moore and Murdock 1993). Although Michaux's sumac has benefited from this urban right-of-way vegetation management and is semi-protected through the Endangered Species Act, it is in danger in these places because the land management is focused on preservation of the utility or "gray infrastructure," rather than preservation of the plant. The Michaux's sumac population in our study area is located on a small tract owned by the City of Raleigh. Because it is closely surrounded on all sides by roads, it is vulnerable to roadside litter, stormwater run-off from the road, herbicides, and careless mowing or clearing. Shortly before the species was federally listed as endangered in 1989, a portion of the population was destroyed during the

construction of a public housing project just south of the city's property. As late as 1987 the species was threatened by the proposed widening of Barwell Road. (LeGrand 1987).

The preservation of the Michaux's sumac population in the Shotwell area is critical for the long-term health and viability of the entire species. Michaux's sumac has long been considered a dioecious species, which means that its staminate and pistillate flowers are not found on the same individual. In other words, one individual plant cannot reproduce with itself; it requires cross pollination between one "male" plant and one "female" plant (Moore and Murdock 1993). The population of Michaux's sumac in our study area is extremely significant because it is one of only four of the approximate 21 remaining populations that do contain individuals of both sexes (LeGrand 1987). The plants in the single-sex populations reproduce only vegetatively, if at all, so that many of the plants in the same-sex populations are actually clones of one or a few individuals. These single-sex populations have extremely low genetic variation, making them even more vulnerable to habitat change and extinction. (Moore and Murdock 1993) The Michaux's sumac population in our study area is therefore an important site for research of the plant and for collection of seeds for propagation of new colonies. Historic and potential sites for the plant along the Neuse River should be protected for the reintroduction of this species. (Map 5: Significant Natural Heritage Sites and Element Occurrences)

Southern skullcap (*Scutellaria australis*) is another rare species that occurs in our study area, at least historically. Southern skullcap is a vascular plant, endemic to floodplains near the Fall Zone, and is a candidate for state listing, considered to be critically imperiled in the state because of extreme rarity (LeGrand 2001). However, southern skullcap is also of questionable taxonomic status, making its state listing all the more complicated (NHP 2001a). Southern skullcap was found in 1957 in a swamp forest along the Neuse River close to the Wake / Johnston county line, and has not been sought since that date (LeGrand 2001). (Map 5: Significant Natural Heritage Sites and Element Occurrences)

Granitic flatrocks are another significant natural feature in the study area. These are an extension of the underlying Rolesville Pluton bedrock, which crops out on the land surface in several places in Wake County in the form of flatrocks. Just north of the headwaters of Mark's Creek are several occurrences of these outcrops, including Temple Flatrock, a TLC-owned nature preserve, Hodges Mill Creek Granitic Flatrocks, and Lake Mirl Granitic Flatrocks. (LeGrand 1987)

Flatrocks support their own unique natural communities, which include interesting plants such as succulent herbs, red cedar (*Juniperus virginiana*), and other trees that are adapted to dry sites. Temple Flatrock, for example, contains stonecrop (*Sedum smallii*), sandwort (*Arenaria glabra*), prickly pear cactus (*Opuntia humifusa*), and Carolina pink (*Silene caroliniana*). The Lake Mirl Flatrocks also support a large population of Small's portulaca (*Portulaca smallii*), a tiny succulent herb that is globally rare because of its limited local range and state-listed in North Carolina as threatened. (LeGrand 1987) (Map 5: Significant Natural Heritage Sites and Element Occurrences)

4. Aquatic Species

The waters of the Neuse River and its tributaries are a source of tremendous biodiversity. On a global scale, the United States is a leader in freshwater diversity. The United States harbors almost one-third of known freshwater mussel species and is by far the most

diverse nation on Earth for this group; we also harbor approximately 800 species of freshwater fish, making our nation home to 10% of known freshwater fishes worldwide, seventh among nations (Chaplin et al. 2000). Much of this freshwater diversity is concentrated in the southeastern United States. Because of its topography, the Southeastern region, including North Carolina, has a large number of small, distinct river basins, and over time, aquatic species, in genetic isolation from one river basin to the next, evolve and become endemic to one or two river basins.

Aquatic species in the United States stand out in another way; species that depend on freshwater ecosystems are, as a whole, faring the worst of any group of species in this country. Two-thirds of freshwater mussels in the United States, and 37% of freshwater fish, are vulnerable to extinction or already extinct (ibid.). These species face a number of threats, including all types of water pollution, especially metals and sediment- and nutrient-laden run-off from urban and suburban areas. As filter feeders, freshwater mussels are particularly susceptible to pollution, including siltation, which can clog their gills or bury them outright.

This stretch of the Neuse River was once home to a variety of rare freshwater fish and mussel species, but unfortunately most of them are now considered obscure or locally extinct from this segment. Neuse River waterdog (*Necturus lewisi*, an aquatic amphibian) might still survive here (LeGrand 1987), and an obscure population of Pinewoods Shiner (*Lythrurus matutinus*, a fish) has been found 2½ miles upstream of Poole Road on the Neuse River and may extend into this area. But Carolina madtom (*Noturus furiosus*, a fish) was last observed here in 1902, dwarf wedgemussel (*Alasmidonta heterodon*, a mussel) in 1951, alewife floater (*Anodonta implicata*, a mussel) in 1976, notched rainbow (*Villosa constricta*, a mussel) in 1951, Roanoke slabshell (*Elliptio roanokensis*, a mussel) in 1964, and Atlantic pigtoe (*Fusconaia masoni*, a mussel), in 1951 (NHP 2001a). The disappearance of the Carolina Madtom in this stretch of the river is particularly disturbing as this fish is endemic to North Carolina and currently found in just the Neuse and Tar river basins (NHP 2001b). In fact, the Nature Conservancy and the Association for Biodiversity Information has designated the Upper Neuse Watershed (which includes our study area) one of 15% of all watersheds in the United States that must be conserved in order to preserve all at-risk freshwater mussel and fish species in the country (Chaplin et al. 2000). (Map 5: Significant Natural Heritage Sites and Element Occurrences)

The aquatic habitat of Mark's Creek seems to be in better shape, but there have been very biological surveys conducted in the creek. The lack of rare aquatic species listed for Mark's Creek should not be misinterpreted as a lack of rare species; it simply reflects a lack of field work. There is a population of least brook lamprey (*Lampetra aepyptera*) in Mark's Creek above Lake Myra, a fish of "special concern" in North Carolina though "demonstrably secure globally" (NHP 2001a). Lampreys are one of the planet's least developed vertebrates, lacking a bony skeleton and growing a backbone-like cartilage instead. Lampreys have a somewhat notorious reputation because many lamprey species are parasitic and prey on large fish. Parasitic lamprey feed by attaching themselves to fish, scraping a hole through the skin, and sucking out blood and other body fluids. In the early 1900s parasitic sea lampreys all but destroyed the lake trout population in the Great Lakes, motivating biologists to erect electric fences across streams and treat waterways with chemicals in an attempt to control them. (Robison 2001)

Least brook lamprey, however, are nonparasitic and have slender, scaleless, elongated bodies. Least brook lamprey spend most of their lives as juveniles (called ammocoetes), buried in sand where they filter oxygen and nutrients from the water. In the spring the lamprey ammocoetes mature into adults and move into gravelly riffle areas to construct nests and spawn. Adults die shortly after spawning, and it is only during this short spawning run in their adult form that least brook lamprey are likely to be detected. (ibid.) Least brook lamprey can be found from Pennsylvania south to Georgia and west to Missouri and Arkansas (Nature Serve Explorer 2001), and in North Carolina in Wake, Franklin, Halifax, and Warren counties (NHP 2001a). Lamprey's main threats are fishermen, who use them as bait, and any type of water pollution, particularly siltation because as filter feeders they are easily suffocated (Robison 2001). (Map 5: Significant Natural Heritage Sites and Element Occurrences)

The known Mark's Creek population of the pollution-sensitive least brook lamprey indicates a good aquatic habitat and suggests that more interesting things might be found if more surveys were conducted in the creek. The population is centered near the Knightdale Eagle Rock Road crossing in the middle of a 225-acre stretch of wetlands. These wetlands naturally filter the Town of Knightdale's stormwater and are critical to the maintenance of good water quality in the creek.

This stretch of the Neuse and Mark's Creek is also considered the northern-most spawning area for anadromous fish such as striped bass, shad, and sturgeon that swim upstream from Pamlico Sound to spawn in freshwater (DWQ 1998). Local residents can

remember shad swimming up Mark's Creek as far as Lake Myra, but in recent years the number of migrating anadromous fish seems to have diminished. The removal of the Quaker Neck Dam on the Neuse River near Goldsboro (the first major dam in the United States to be removed solely for environmental reasons (Foushee 1999)), is expected to help the anadramous fishery. Now the dam at Falls Lake is the most downstream major dam on the mainstem of the Neuse (Beard 2001). Since the removal of Quaker Neck Dam, other dams have been removed or are in the process of being removed on tributaries of the Neuse, such as the Little River east of Mark's Creek. These larger dams can be highly destructive to aquatic habitat, and the removal of unused large dams will result in increased fish migration throughout the basin. (Foushee 1999)

C. Human History, Rural Character

The Neuse River is an estimated two million years old (Powell 1999), and archaeological evidence indicates that humans first settled in its basin as early as 14,000 year ago (NRK 1999). Tuscarora, Coree, Secotan, and Neusiok people are believed to have lived near the river, but there is little known trace of them in the Shotwell area (ibid.). "Neuse" means peace, and it was named after the Neusioks (Powell 1999). In 1701 John Lawson traveled the Neuse River and conducted the first documented European expedition through the region, though it was not until the 1730s that non-native settlers began to take permanent residence (Flournoy 1985). Agriculture is the common, recurring, and most important occupation in the history of these settlers and their ancestors.

From the colonial period until about the 1840s and 1850s, subsistence farming on relatively small plots was the way of life for most people. Families on small farms grew Indian corn, sweet potatoes, wheat, oats, and other food crops and raised hogs, poultry, and cattle. Surpluses, when there were any, were sold commercially. Water-powered gristmills, most of which were built on tributaries to the Neuse, served the important function of grinding corn and wheat into meal and flour. These mills were community gathering places and the centers of rural civilization, and some millponds, including Hood's Mill (current-day Lake Myra) were also popular spots for fishing, swimming, and picnicking. Mills were particularly common on tributary streams in the vicinity of the Fall Line, where the change in elevation from the Piedmont to the Coastal Plain often resulted in falls on the streams, ideal spots for mills. (Lally 1994)

Charles Penny Ellis owned and operated a mill close to his property in Johnston County (called The Maples) (NCSHPP), and historical maps show Griffice's Mill on a small

tributary just west of the current-day Raleigh Wastewater Treatment Plant, W.R. Poole's Mill near the Walnut Creek and Neuse River confluence, Fort's Mill on White Oak Creek near Auburn, A. Smith's Mill on an upper tributary to Mark's Creek, and several more mills on nearby Buffalo Creek, Little River, Hodges Mill Creek, and upstream on the Neuse River (Wake Co. Historical Association).

In the Neuse River Valley, soils were particularly fertile, and by the antebellum period some of the region's wealthiest families had acquired large estates on the productive land near Shotwell. Thomas Price of Oaky Grove owned 4,500 acres; A.T. Mial of Walnut Hill owned 2,700 acres; James Stallings owned 1,200 acres at Bend of the River; Charles Penny Ellis owned 1,000 acres at The Maples; and the Hinton family owned nine large plantations, including The Oaks, Beaver Dam, and Midway. (Lally 1994)

These plantations relied upon slave labor for their profits. African slaves were brought to the eastern Piedmont as early as the 1730s by the first British settlers, and in Wake County people of African descent constituted one third of the population by 1860. However, only a third of the county's households included slaves, illustrating that property – land and human – was concentrated in the hands of a few elite planters. The Hinton family was one of the top slave-holding families in the region. (ibid.)

Soils in this area were particularly well-suited for cotton and tobacco growing. Railroad construction in Raleigh in the 1840s and the 1850s encouraged some large planters to venture from food crops into the cash crop business; however, the transition from subsistence farming to cash crops was gradual. Cotton was the "king" cash crop until the 1880s and 1890s, when bright leaf tobacco started to gain popularity. The boll weevil infestation of the late 1920s caused thousands of more farmers throughout the region to abandon cotton, advancing the gradual changeover to tobacco. (ibid.)

After the Civil War, the slave-based plantation economy converted to a wage and tenant labor system highly dependent on these cash crops. Kelly Lally, the author of *The Historical Architecture of Wake County* (1994), writes, "After the war ended and the slaves were freed, former slave owners still needed laborers to work their fields, and former slaves needed food and shelter. The 'laborlord' elite of the antebellum period became a 'landlord' elite after the war." The passage of North Carolina's crop lien law in the 1860s established a credit system whereby tenants became even more dependent on cash crop production for their own food and supplies. The sharecropping system continued in this area well into the 1920s. (ibid.)

After the Civil War many large antebellum estates were sold and divided into smaller farms, and the high profitability of bright leaf tobacco allowed for the viability of smaller, individual farms. By 1910, for example, over three-fourths of Wake County's farms were less than 100 acres in size. Walnut Hill was a notable exception. After the war and through the late 1800s, Alonzo T. Mial managed to maintain his extensive landholdings, which were worked by both tenant and wage laborers, and by the 1890s he was Wake County's largest landowner. The community of Shotwell was centered around the common buildings that A.T. Mial built as part of Walnut Hill, including the cotton gin and the blacksmith shop. A.T. Mial also built the Oaky Grove Methodist Church, which served its congregation from the 1870s until the early years of World War II, and the Frog Pond Academy, built in 1863 as a school for the Mial offspring and the other children in the Shotwell area. (ibid.)

Though many farming families were never able to free themselves from debt, the tenant labor system did allow for a slightly more flexible rural class system. While the overwhelming majority of African-Americans in this area were tenants or wage laborers, a few individuals owned their own farms. Henry Rufus Goodson, for example, owned a 141-acre tobacco farm in Wake County in the early 1900s, and was one of the wealthiest and most prominent black landowners in Wake or Johnston County in his time. Goodson was an educator and a leader in the Wake and Johnston Baptist Associations, president of the Negro State Fair, and the only black jail warden in Wake County in the 1800s, before African-Americans were disfranchised and barred from office-holding after the Reconstruction period. (ibid.)

Agriculture in this area began its decline during the agricultural depression of the 1920s and the Great Depression of the 1930s. In 1920 the number of farms in Wake County

reached its all-time high, but declines in the prices of cotton and tobacco launched a trend away from agricultural employment to industrial, commercial, and "professional" employment – a trend that continues today. (ibid.) An advanced system of roads, the widespread introduction of electricity, the mechanization of many farming tasks, the exponential growth and outward sprawl of nearby urban areas, and the transition to the information- and computer-based "new economy" have permanently altered these rural communities, cultures, and landscapes. Today's farmer faces a whole new set of obstacles, including massive increases in property values, which lead to inflated property and estate taxes.

As some perceive a rapid shift away from agriculture and simpler, slower "country living," historic landmarks that represent our rural and agricultural roots become even more valued as they become more rare. North Carolina writer Melinda Ruley explains our sometimes-strange nostalgia for even the plainest, "no-count" farm structures: "The soul, separated too quickly from the body, lingers on earth, restless and unsure of itself… When a culture is separated too quickly from the objects that define it, there is a similar wrenching, and a sad (or outraged) lingering" (Ruley 2001). Some old farm houses, such as the Joseph Blake House, Oaky Grove, Bend of the River, and the Henry Goodson House, are intact and lovingly maintained by their owners, some of whom are descendents of the original builders. Yet even the run-down, old farm houses and barns that dot the landscape are treasured for the culture and heritage they represent.

Rural churches, country stores, and old lodges and mills are integral parts of this landscape; though often privately owned, these structures were important gathering places for entire communities. Unfortunately, many of these non-residence buildings are now in decay and unoperational. The Raleigh Union Lodge in Shotwell is dilapidated and vacant, and the Archers Lodge is no longer standing. Many of the old country stores, such as the Montague store in Shotwell and the general store at Lake Myra, are out of business. While many of the rural churches in the area no longer hold services, some of those that do have opted to build new facilities rather than restore the old ones because the latter option is usually more expensive. Adaptive reuses are being sought for some historic structures; for example, the cotton gin at Walnut Hill is being restored as a private dwelling. The adaptation of the cotton gin is one particularly creative example, but in general it is easier to restore historic homes and more difficult to find new uses for barns, churches, commercial buildings, and mills.

Many landowners have worked with local preservation commissions and the NC Division of Archives and History to register their properties on the National Register of Historic Places, and Walnut Hill was recently designated as a rural historic district on the National Register. Registration of these properties on the National Register is primarily a recognition and an honor – it does not place any regulations or restrictions on the property. Wake County has a similar but separate voluntary program for local historic properties that can afford landowners a 50% property tax deferral (see page 45). Yet designating, preserving, and restoring these historic *structures* is only the first step, because without the rural *landscape* the historic context of these landmarks is lost. The fields surrounding the Oaky Grove Methodist Church, the beautiful, quiet setting of Lake Myra, the oak trees on Covered Bridge Road, and the open vistas on Grasshopper Road, which allow one to see miles of rolling topography, are as important to the rural character of this place as the historic structures themselves. (Map 7: Local Historic Sites)

D. Water Quality

One of Triangle Land Conservancy's primary conservation goals is the protection and maintenance of the water quality of Mark's Creek and the Neuse River. Though this project was originally intended to focus solely on the middle Neuse River in southern Wake and northern Johnston counties, it became evident during field work that this stretch of the Neuse is much degraded, especially from siltation, and most of this sediment is delivered into the Neuse via its tributaries. Protecting the Neuse's tributaries from siltation is now one of the primary water quality goals for the middle Neuse watershed – hence the dual focus on the Neuse River and its tributary, Mark's Creek.

1. A History of Water Quality Problems

In 1995, 1996, and 1997 the Neuse River was named one of the United States' 20 Most Threatened Rivers by the national environmental watchdog group, American Rivers (AR 2001). The Neuse has made national headlines again and again because of its poor water quality and the massive fish kills that have occurred nearly every summer since the mid-1990s. Though much of the blame for this river's poor water quality is placed on agriculture, especially hog farms and other industrial livestock operations, many of its problems originate in the highly-urbanized upper watersheds.

The water quality of the Neuse River has been a concern for over 100 years. As early as the 19th Century, the Neuse was suffering from degradation. In 1887, for example, legislation was passed to "prevent the throwing of dead stock into the waters of the Neuse River and its tributaries" (Hardy et al. 2000). Water quality reports from the 1950s indicate very poor water quality below point dischargers, including high levels of coliform bacteria and low dissolved oxygen. Algal blooms became a major concern in the 1970s. Then, throughout the 1980s and 90s, extensive fish kills were discovered in the river from New Bern to Minnesott Beach.

Though occasional fish kills will occur naturally for various biological and/or hydrological reasons, the Neuse River fish kills of the 1990s were unprecedented because of the thousands of dead menhaden, flounder, croaker, and rock fish, sometimes with open sores on the lower portions of their bodies. (ibid.)

Perhaps the worst fish kills occurred in the summer and fall of 1995, when millions of dead fish were discovered in the Neuse (ibid.), and sections of the river were closed to fishing and swimming for five weeks (Beard 2001). Water quality tests in the affected areas revealed a prevalence of algal blooms and oxygen-depleted waters (Hardy et al. 2000), and research performed by NC State University discovered the presence of *Pfiesteria piscicida*, a microscopic dinoflagellate with at least 24 life stages that can become highly toxic in eutrophic waters (Springer 1999). *Pfiesteria* has since been found in waters across the country (ibid.), but it was first documented as *Pfiesteria* in North Carolina (Beard 2001) and has been connected with 30 to 50 percent of the fish kills in the Neuse (DWQ 1999). In some of its life stages, *Pfiesteria* is also extremely harmful to human beings, causing open sores and mental disorders (Springer 1999). Although unusually heavy rainfalls caused an abnormal amount of nutrient-laden run-off to enter the river in 1995, the long history of problems with nutrient pollution and algal blooms in the Neuse provided solid evidence that stronger measures were needed to bring the river back to health (Hardy et al. 2000).

2. The Neuse River Nutrient Management Strategy

In 1988 all of the surface waters in the Neuse Basin were classified as Nutrient Sensitive Waters by the NC Environmental Management Commission (EMC). This new classification resulted in, among other things, phosphorus restrictions on new and existing discharge facilities in the basin, and a state-wide phosphate detergent ban. (ibid.) Though phosphorus pollution has been reduced through these measures, according to the U.S. Geological Survey (USGS), the Neuse carries the highest percentage of phosphorus (45%) into the Albemarle-Pamlico Sound of any of the four major river systems that enter it, even though it drains only 20% of the contributing land area (Hardy et al. 2000). The algal blooms and fish kills are also connected with nitrogen pollution, and again the Neuse contains the highest percentage of nitrogen (35%) of the four main rivers that drain into the Sound (ibid.).

In 1997-1998 the Neuse River Nutrient Sensitive Water Management Strategy Rules (or Neuse River Rules) were adopted by the EMC and the NC General Assembly. The goal

of the Neuse River Rules is to reduce the nitrogen load in the river by 30% from its 1995 levels. To do this, the Rules: 1) limit nitrogen outputs from point source discharges; 2) require stormwater management plans for 15 local governments, including Wake County, Johnston County, Raleigh, and Garner; 3) require farmers to implement standard best management practices such as buffers, water control structures, and nutrient management plans on an individual basis to reduce nitrogen by 30%, or participate in a local cooperative to collectively reduce nitrogen by 30%; 4) mandate that any persons applying fertilizer to over 50 acres of land either train in nutrient management or develop a written nutrient management plan for all property where nutrients are applied; and 5) require a 50-foot vegetated buffer on all surface waters shown on the most recent USDA soil survey maps or USGS 1:24,000 topographic maps. The buffer rule requires that the first 30 feet of buffer from the stream remain mostly undisturbed, while allowing some selective tree cutting on the outer 20 feet. (DWQ 1999)

Though the Neuse River Rules are supposed to reduce the nitrogen in the river by 30% in five years, most of the plans and programs that have resulted from these rules are just now being implemented and may not be effective for another 20 years (Beard 2001). The exception is the buffer rule, which was operative almost immediately but is not retroactive (so that a buffer that was without vegetation prior to the rules is not required to revegetate).

Vegetated riparian buffers protect water quality in several ways. First, they filter pollutants from both overland flow and groundwater. A study by Tom Schueler (1995) concludes that buffers can remove up to 75% of the sediment, 40% of the nitrogen, 50% of the phosphorus, 70% of the trace metals, and 74% of the hydrocarbons from stormwater, depending on the width of the buffer, slope, soil types, and kind and amount of vegetative cover. The root structure of trees in the buffer serves to stabilize streambanks, thus reducing erosion, and shade from the vegetation keeps water temperatures cool in the stream, thus increasing the amount of dissolved oxygen the stream can hold. The buffer along this stretch of the Neuse River is intact and fairly wide in most places. Mark's Creek, too, enjoys a wide vegetated buffer along most of its length, probably because it has a broad, wet floodplain that is hard to disturb. The small tributaries of Mark's Creek, particularly in the upper reaches of the watershed, have little to no buffer in many places, especially in recently-cleared timber areas. Many people do not realize that the Neuse Buffer Rules apply to even the small streams as well as the wide river.

Buffers will not solve all of the water quality problems in this river. In our study area alone there are eleven point-source discharges that have been permitted through the National Pollutant Discharge Elimination System, including the Raleigh Wastewater Treatment Plant, which releases an average of 36 million gallons of wastewater to the river each day (almost 13 billion gallons a year). The Raleigh Wastewater Treatment Plant treats wastewater for customers in Raleigh, Rolesville, Garner, and Wendell, a service population of approximately 315,000 people (City of Raleigh 2000-2001). The Raleigh facility is the single largest source of wastewater in our study area and in the entire Neuse River basin (DWQ 1996). It is also one of the most modern. In 1989 it was recognized by the U.S. Environmental Protection Agency as the Best Operated and Maintained Large Advanced Wastewater Treatment Plant in the Nation (City of Raleigh 2000-2001).

The City of Raleigh reports an impressive record of permit compliance for fiscal years 1999-2000 and 2000-2001. The plant's NPDES permit limits it to 2.0 parts per million (ppm) of ammonia-nitrogen, and in 1999-2000 the plant's average concentration was 0.5, and in 2000-2001 it was 0.357. The permit limit for biochemical oxygen demand is 5.0 parts per million, and over the past two fiscal years the plant has averaged 2.3 ppm. The permit limit for phosphorus is 2.0 ppm, and Raleigh has averaged at 1.3 over the past two fiscal years. Total suspended solids is restricted to 30 ppm, and Raleigh's average was 1.55 ppm. The permit limit for nitrogen is 676,496 pounds, and in 1999 Raleigh released 590,000 pounds, and in the following year, 540,000 pounds. The Raleigh Wastewater Treatment Plant was ordered through the Neuse River Rules to reduce its nitrogen loading by 49% as compared to its 1995 levels (1,316,939 pounds). So far the Raleigh plant has achieved a 59% nitrogen reduction. (City of Raleigh 1999-2000 and City of Raleigh 2000-2001)

Two other wastewater facilities in our study area, Carolina Water Service's Willowbrook and Kings Grant facilities, have much poorer records and failed 11 out of 18 and 4 out of 19 effluent toxicity tests, respectively, between 1992 and 1996 (more recent data is not yet published) (DWQ 1996). These treatment plants are examples of "package" plants, which are built by a developer to treat the wastewater of a new residential development or mobile home park in areas where municipal sewer lines (to connect to a municipal treatment plant) do not extend. Building a "package plant" allows the developer to build houses at a greater density than what a septic system could handle, and they are sometimes used as a way to bypass low density zoning. "Package plants" are suspect of being under-funded and poorly monitored because they are not as visible as public wastewater treatments plants. The Division of Water Quality should take stronger steps to enforce permit compliance from these smaller plants. (Map 8: NPDES Sites)

3. Water Quality Tests and Ratings

The Division of Water Quality (DWQ) of the NC Department of Environment and Natural Resources is a leading source for water quality information for the Neuse River Basin. Within our study area boundaries DWQ has conducted tests on Mark's Creek at the Pritchard Road crossing in Johnston County and on the Neuse at the NC 42 crossing in Johnston, and on the Neuse at the US 64 crossing just upstream of our study area.

According to DWQ, benthic macroinvertebrate (a.k.a. benthos) tests – water quality tests that examine bottom-dwelling, pollution-intolerant aquatic insect larvae – yielded "fair" results in 1986 in the Neuse at the US 64 crossing, "good-fair" results in 1991, and "good" results in 1995. This might indicate an improvement in water quality over an eight-year period, but DWQ notes that the 1986 test followed a spill of dairy wastes into a tributary stream and therefore may have represented abnormally bad conditions. (DWQ 1996 and DWQ 1998)

The Neuse at the NC 42 crossing also showed improved results in its benthos data but less positive results from its ambient monitoring data. Benthos tests yielded "good-fair" results in 1983; "good" results in 1984; "good-fair" in 1985, 1986, and 1988; and "good" in 1990, 1991, and 1995. The improvement in the 1990s could have been partially due to the closure of several small wastewater treatment plants on Perry's Creek since 1988, or because of the phosphate ban of 1988. The ban, for example, resulted in a 55% reduction

in effluent phosphorus concentration from the Raleigh wastewater treatment plant, just a few miles above the testing site. (ibid.)

Ambient monitoring data from 1991-1995, however, showed an average increase of 400% in phosphorus levels and 200% in nitrogen levels from Falls Dam to NC 42, the largest increases for any stretch of the river. Average nitrogen concentration was higher at NC 42 than at any other monitoring point on the river. This same stretch exhibited a 10% decrease in dissolved oxygen levels. Ambient data at NC 42 showed high levels of fecal coliform in 7 of its 14 tests between 1991 and 1995 and high levels of manganese in 14 out of 16 tests during the same time period. Though the majority of the fish kills occur in the Lower Neuse, urbanization from Wake and Johnston counties is responsible for much of the river's nutrient load (ibid.).

Mark's Creek at the Pritchard Road crossing rated "good-fair" in both of its benthos tests in 1991 and 1995. In both years Mark's Creek was also the subject of the fish community structure test, which measures the structure and health of a stream's fish community and gives it a numerical score on the standardized North Carolina Index of Biotic Integrity (IBI). Mark's Creek was given a score of 42 on the IBI in 1991 ("fair") and a score of 46 ("fair-good") in 1996, indicating a possible improvement in water quality. (ibid.)

Based on all of this water quality data, the NC Division of Water Quality (DWQ) has rated Mark's Creek, Big Arm Creek, Poplar Creek, Beddingfield Creek, and the Neuse River between Poole Road and NC 42 as support threatened. "Support threatened" means that although these waters currently support their "designated uses" (defined below), some notable problems may exist, and/or the water may become impaired in the future unless some action is taken. (ibid.) Though the "support threatened" ranking is the second most favorable of four possible ranks, it must be interpreted with a grain of salt for three reasons.

First, the waters in our study area are ranked against Class C water quality standards, meaning they are ranked according to how well they support their designated human uses of wading and boating (ibid.). Other waters in the state may be designated as water supplies or swimming waters, and because of increased human contact, they would be ranked against higher standards. Because the waters in our study area are designated for a very small amount of human contact, they do not have to be very clean or pristine to be ranked "support threatened" or even "fully supporting."

Second, some streams, such as Poplar, Beddingfield, and Big Arm creeks, were rated even though no tests were conducted on them. Other streams were rated based on a very few biological samples taken at a single location at five-year intervals. The data is therefore highly variable and not statistically reliable because the infrequency of sampling creates a high likelihood of an anomalous test.

Third, although these ratings are the most up-to-date as of this writing (December 2001), they were published in 1998 and are based on water quality test results from 1995.

Therefore, these tests and ratings do not reflect the changes in water quality that may have occurred due to the cutting and paving of tens of thousands of acres of forest and fields in the upper Neuse basin since 1995, nor do they reflect the possible improvements of water quality that may have occurred from the extensive nutrient management strategies that were put in place as part of the Neuse River Rules. The results of water quality tests from 2000 will not be available until the publication of the next *Neuse River Basinwide Assessment,* which is due in the early spring of 2002.

The Neuse River has been the focus of intense media attention for several years; it has been tested, sampled, and analyzed thousands of times; it has been the subject of seemingly endless debate and negotiation over policy, management strategy, and regulation. All of the attention paid to the Neuse River provide two important lessons. First, though much attention has been focused on the estuary and the problems with hog farms, ambient data proves that many of the Neuse's problems originate in the tributaries in the upper watersheds. Second, restoration of rivers is a new science, untested by time, and extremely expensive. If the Neuse teaches us nothing else, perhaps we will learn that it is easier, less expensive, and better policy to keep our rivers healthy in the first place, rather than trying to restore their health after decades of degradation.

E. Identification of Scenic Areas

Perhaps the most beloved feature of the Shotwell area, by visitors and residents alike, is its scenic quality. Though most people would agree that the area is scenic, defining "scenic," and identifying all of the landscape features that make it scenic (and identifying those that would make it unscenic), are more difficult tasks. "Scenic" is a subjective label with few universal, objective standards with which to measure it. One person's scenic pasture is another person's clearcut. One person's ugly strip mall development is another person's much-needed job opportunity.

We have defined "scenic" in the Shotwell area as the ***vivid, unified, rural, historic landscape***. Because of the lack of public open space and trails in this area, most people experience the scenic landscape of the Shotwell area from the roads. Therefore, the viewsheds we analyzed were the vistas and visual corridors as seen from public, secondary through-roads.

On a bus tour of the study area, in countless automobile trips driving the country roads, and in the course of several meetings, the advisory committee for this report identified several components of the landscape that add to its ***vividness*** and scenic value:

- historic structures, especially farm-related, such as farm houses, mills, barns, etc.
- pastures, especially those framed by trees
- healthy stands of hardwood forest
- "champion" trees (especially oaks)
- open vistas/views
- rolling topography
- lakes, farm ponds, and other water features
- small country stores
- cultivated fields
- modern agricultural structures

The committee also described several features that distract from the scenic landscape, those features that are not in harmony with the rural, historic character and take away from the ***unity*** of the scenery. Non-farm-related structures such as communications towers, parking lots, landfills and dumps, strip malls, "big box" commercial development, and billboards were deemed inappropriate for the Shotwell area. Residential subdivisions are not necessarily disruptive if they are well-hidden behind a visually-impenetrable buffer of trees along the road, but "cookie-cutter" subdivisions in the wide open with rows of identical housing, no trees, and no roadside buffer were found to be disruptive. Though contextual unity of the man-made structures is a critical piece to the scenic factor, diversity of the natural features is just as important. A mixture of pastures and forest patches, and areas of dramatic topographic relief, add to the scenic quality.

Though we focused on the vistas and visual corridors as seen from the roads, the alignment, design, and level of congestion of the roads themselves are an important part of the scenic quality. The curve of Pritchard Road as it crosses Mark's Creek highlights the landscape's topographic change and allows the passer-by a long-distance view. Grasshopper Road criss-crosses a small stream several times, creating a scenic undulating effect. The curve of Poole Road west of Lake Myra adds to the scenery of the lake because the sudden openness of the lake after the curve is a surprise for the east-bound traveler. These roads are also scenic because they are two-lane, relatively narrow, and carry a light traffic load. Straightening any of these roads or widening them to four or more lanes would undermine their scenic quality, even if the views from the roads remained intact.

The landscape context of the historic landmarks and the approach from the roads to the vistas and scenic hotspots cannot be overemphasized. A beautiful, intact farm house and

barn are no longer scenic when closely surrounded by modern suburban homes in full view from the road. The Oaky Grove Church at Shotwell would lose its scenic appeal if it were located across the street from a fast food restaurant. The visual corridor along the roads leading to the scenic landmarks set the stage for the scenery ahead and can either enhance or destroy the rural experience for the passer-by. To keep it in rural context, the core scenic areas need at least a one-mile scenic "buffer" along all of the roads radiating outward from the core area. The core scenic areas identified by the committee are Shotwell (particularly the dirt road stretch of Mial Plantation Road), Lake Myra, and Brookhill Farm. Map 9 shows the scenic roads and core scenic areas as identified by the advisory committee for this report.

Conservation of the scenic, rural, historic landscape requires a multi-pronged approach and protection at a very large scale. To add to the complexity, the scenic open vistas in the Shotwell area are ephemeral and dependent on mowing and cutting to keep the sightline unobstructed, but a mixture of forest stands and open fields bordered by trees is essential to maintain visual interest. Farmland and working forest preservation is therefore one of the best tools available to maintain the rural, scenic character of the Shotwell area; however, the rural character will fade away if the agricultural or forestry economies fail. Direct land protection of the core scenic areas, zoning for rural densities, strengthening the agricultural economy, conservation and maintenance of historic structures, and creative subdivision designs are among the many strategies that must be pursued in order to protect the scenic landscape.

F. Land Uses, Land Use Plans, and Existing Ordinances

The Shotwell Area is on the threshold of enormous change, under pressure from the changing economy and growth of surrounding towns. While change is inevitable, a loss of open space, biodiversity, and sense of heritage is not. This section analyzes the current land uses in the Neuse River – Mark's Creek watershed, the regulations and land use plans that are guiding growth and development, and the changes ahead for this area.

1. Land Cover and Subdivision Patterns

The Neuse River – Mark's Creek watershed is still primarily rural and undeveloped. While there are approximately 7,500 acres of suburban residential development, roads, and commercial and industrial areas in the watersheds, there is almost twice as much bottomland and hardwood forest in the area. Open space accounts for almost 85% of the

study area (see Figure 1 and Maps 4 and 6). Over 27,000 acres in the study area, or 53%, is enrolled in local use value taxation programs. The use value tax program targets land in active agricultural, forestry, or horticultural use and affords eligible landowners with significant tax breaks according to the land's use value (as opposed to its unused developed value). (Map 10: Use Value and Conservation / Publicly-Owned Properties)

Development from nearby Raleigh, Knightdale, Clayton, and, to a lesser extent, Wendell and Garner, is beginning to appear in the Shotwell area, primarily in the form of suburban residential subdivisions. Figures 2 compares the number of tracts of different sizes in the watershed to the surface area (acres) in the watershed that these different-sized tracts comprise. Although 83% of the tax parcels in the watershed are suburban-sized residential lots (2.5 acres or less), these small lots represent only 11.4% of the surface area of the watershed. Most of the watershed (62% of the surface area) is divided into tracts of medium to large size, between 24 and 300 acres. This suggests that although the majority of the watershed is in rural land use, the vast majority of the residents live on suburban-sized lots and are employed outside of the agricultural or forestry professions. The almost complete lack of commercial and industrial uses in the watershed implies that most of the residents are commuting to work. Less than 1% of the parcels in the watershed are greater than 100 acres in size, but the combined surface area of these parcels constitutes over 30% of the watershed area.

Figure 2: Subdivision Patterns Shown by County

	Tracts Smaller than 2.5 Acres	Tracts Between 2.5 A and 10 A	Tracts Between 10 A and 25 A	Tracts Between 25 A and 100 A	Tracts Between 100 A and 300 A	Tracts Larger than 300 Acres	Total
Wake, Number of Tracts	5,611	575	213	287	44	5	6,735
Wake, Percentage of Tracts	83.3%	8.5%	3.2%	4.3%	0.7%	0.1%	100.0%
Wake, Number of Acres	3,813	2686	3,466	14432	6,436	2401	33,234
Wake, Percentage of Acres	11.5%	8.1%	10.4%	43.4%	19.4%	7.2%	100.0%
Johnston, Number of Tracts	2,733	313	111	125	31	4	3,317
Johnston, Percentage of Tracts	82.4%	9.4%	3.3%	3.8%	0.9%	0.1%	100.0%
Johnston, Number of Acres	2,082	1541	1,781	6246	5,169	1871	18,690
Johnston, Percentage of Acres	11.1%	8.2%	9.5%	33.4%	27.7%	10.0%	100.0%
Total Number of Tracts	8,344	888	324	412	75	9	10,052
Total Percentage of Tracts	83.0%	8.8%	3.2%	4.1%	0.7%	0.1%	100.0%
Total Number of Acres	5.895	4227	5,247	20678	11,615	4272	51,924
Total Percentage of Acres	0.0%	8.1%	10.1%	39.8%	22.4%	8.2%	88.7%

2. Protected Open Space and Other Publicly-Owned Land

There are approximately 1,031 acres of protected and semi-protected open space in the Neuse – Mark's Creek watershed, including State Forest land, university research areas, and city park land:

Clemmons Educational State Forest is a 500-acre working forest, recreation area, and "living outdoor classroom" (CESF Brochure). The largest and most significant piece of protected open space in the Shotwell area, Clemmons is managed for timber, but its emphasis is on forestry education, and it is a popular fieldtrip destination for schools across the region. The forest features campgrounds, picnic shelters, a Talking Tree Trail, a Forest Geology Trail with "talking rocks," and a Forestry Demonstration Trail with examples of forestry practices and longleaf pine restoration (ibid.). Clemmons was the first seed tree nursery in North Carolina and was a Civilian Conservation Corps Camp in the 1930s (Huffman 2001). Today Clemmons Educational State Forest is confined on two sides by residential development, leaving it little room to expand to meet the increased demands of a growing population. The State has plans to purchase an additional 300 acres close to the site in order to increase the capacity and viability of the forest (ibid.).

NC State University owns two research and educational facilities in the Shotwell area: Randleigh Farm, a 420-acre farm on the Neuse River, and Central Crops Research Station, a 489-acre facility straddling US 70 that is a few feet outside of our target watersheds but still inside the Neuse Basin. Both of these properties are under intense development pressure. Central Crops is slowly being surrounded by heavy commercial development on the highway, and Randleigh Farm, which has been inactive for several years (Clark 2001), sits in the path of the proposed Outer Loop around Raleigh. NC State University is currently reviewing its land holdings in an attempt to relocate some of its agricultural research areas into more rural areas (ibid.).

In addition to these three large sites, there are four small tracts of protected open space in the watershed. The Clayton Civitan Club owns 8 acres inside of Clayton's town limits, and the Town of Clayton owns another 25 acres northwest of town. The72-acre East Wake School Park near Knightdale is partly inside our study area, and the Town of Knightdale owns 6 acres of greenway on 0.4 miles of Poplar Creek.

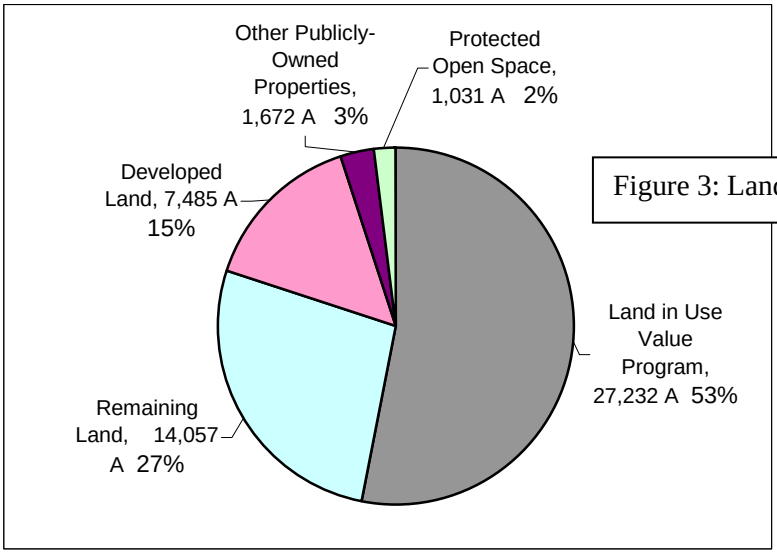


Figure 3: Land Use in Project Area

There are proposals for significantly more open space and greenways in the study area. NC Division of Parks and Recreation is planning a Mountains-to-Sea Trail that would start in western North Carolina and travel along the Neuse River from Falls Lake to the coast. As part of that project, the City of Raleigh is planning a regional park and greenway along its stretch of the river from Falls Lake to Poole Road. The City's Neuse River Regional Park Master Plan (1996) calls for fee-simple and/or easement acquisition of the 100-year floodplain or the 150-feet buffer, whichever is greater, on both sides of the river, plus the purchase and recreational development of several canoe launch and upland park sites along the river. Raleigh's Crabtree Creek and Walnut Creek greenways and Knightdale's Mingo Creek Greenway will eventually connect to the Neuse Greenway, in addition to several other proposed trails along other tributaries. South of Poole Road the greenway would enter the jurisdictions of Wake County, Johnston County, and the Town of Clayton, but formal plans for greenway acquisition and development have not yet been created by these governments, though it is mapped in Clayton's Strategic Growth Plan (2000). The Neuse River Greenway will be a great opportunity in the Shotwell area to add more parks and connecting trails to the regional network.

Finally, though not protected open space by definition, the City of Raleigh owns 1,672 acres of institutional land in the study area, most of which is farmland used for the application of biosolids from its wastewater treatment plant and for the growing of animal feed crops. This large chunk of publicly-owned property is the anchor of undeveloped land in the heart of our study area.

3. Zoning

Because our study area intersects with only the edges of the towns of Knightdale and Clayton, Wake and Johnston counties control the zoning for the vast majority of the study area. Over 97% of the Neuse – Mark's Creek watershed is zoned for residential development. Most of the residential zoning allows for 1 to 2 dwelling units per acre, but closer to Raleigh, Knightdale, and Clayton the zoning density increases to anywhere between R-4 and R-15. The small areas of industrial, commercial, and office zoning are primarily located near Clayton, Knightdale, and along US 64.

The zoning in this area may be intended to promote agricultural and rural uses. Knightdale's Unified Development Ordinance (1995), for example, describes its Residential and Agricultural District as planned "primarily for agricultural uses, the preservation of important natural areas, outdoor recreation space, and other very low intensity uses. These areas are not yet appropriate for development at higher densities." But because the ordinance does not prescribe or limit density, Knightdale's Residential and Agricultural District is not immune to suburban subdivision and development. In fact, several small subdivisions with half-acre and one-acre lots are already found within this district.

The Development Ordinance of Johnston County (2000) describes its Agricultural-Residential District (the most prevalent zoning district in the Johnston Co. portion of our study area) as intending to "encourage the continuance of agricultural uses as well as to insure that residential development will occur at sufficient densities to provide for a range of housing opportunities throughout the county." Unfortunately, in fast-growing regions like the Triangle, when land is zoned for residential development at suburban densities, the zoning actually increases land values because of the area's development potential, thus increasing property and estate taxes and making agriculture less likely to be profitable.

If every acre in the study area were developed to the fullest density allowed by existing zoning ordinances, there would be approximately 85,000 residences in this 50,000-acre area. That's an increase of about 75,000 houses and 150,000 people (assuming an average of two people per dwelling unit), most of whom would be commuting to work each day along the already congested US 70, US 64, and Poole Road. Though this development scenario is unlikely in the immediate future, these zoning ordinances guide growth more powerfully than any of the existing land use plans, which are well-

intentioned but sometimes impotent. The existing zoning regulations are not what is keeping this land rural; more often they enable and encourage a transition from rural to suburban land use and culture. (Map 11: Zoning)

4. Other Ordinances

In addition to zoning, Knightdale, Wake County, and Johnston County have instituted other regulations and ordinances that are noteworthy for their potential to affect development and land use in the study area.

Open Space Requirements and Cluster Subdivisions. Johnston County's Development Ordinance (2000) includes a new open space set-aside requirement that is mandatory for all new subdivisions. The set-aside must be equivalent to 10% of the total gross land area, and wetlands and riparian buffers can only count towards half of this 10%. This is dissimilar from a cluster ordinance in that the provision does not allow any extra lots in return for the open space. A fee-in-lieu of $800 per proposed lot is required if a developer opts against the open space set-aside. These fees are supposed to be used by the County for the acquisition of open space.

Wake County's Subdivision Ordinance (2000b) and Knightdale's Unified Development Ordinance (1995) both include a provision that allows for cluster or open space subdivisions, a development technique that clusters all of the allowed lots on the portion of the subdivision site best suited for development, conserving the remaining portions as undeveloped open space. The developer is allowed to build roughly the same number of lots in a cluster subdivision as in a traditional subdivision; the difference is that in a cluster subdivision, the lots are smaller and squeezed onto a smaller portion of the subdivision site. Wake County's Cluster Ordinance mandates that at least 10% percent of the subdivision site be dedicated as open space; Knightdale requires 25% open space, but land unsuitable for building cannot count towards the 25%. The ordinances of neither Wake County nor Knightdale mandate the use of a cluster subdivision in any situation.

When designed correctly, a cluster or open space subdivision has less adverse impact on the environment, allows a smaller and less costly network of roads and utilities, and reduces the amount of impervious surface in the subdivision. At its best this technique has great potential to protect stream buffers, wetlands, viewsheds, and significant natural areas on a subdivision site. However, most developers do not want to build on wetlands, steep slopes, and other sensitive areas anyway because of the impracticality and expense

and/or because of other regulations. In some cases, cluster ordinances simply allow the developer to build more lots for "protecting" a wetland that would have remained untouched, even in a traditional development. The best cluster subdivision regulations are those that require permanent protection of the open space, and, like Knightdale, a set-aside in excess of the unbuildable steep slopes, riparian buffers, and wetlands.

Floodplain Regulations. Both Johnston and Wake counties have floodplain regulations that control but do not prohibit development and construction within the 100-year floodplain. Both regulations require the floodproofing of buildings, the elevating of all structures at least one foot above the base flood elevation, and the issuance of special permits prior to construction (Johnston County 2000 and Wake County 2000c). (Map 12: Floodplains)

Buffer Regulations. The aforementioned Neuse River Buffer Rule, which requires 50 feet of vegetation along all perennial and intermittent streams in the Neuse Basin, is the only buffer regulation applicable to our study area. Under the Neuse Buffer Rule, the first 30 feet of buffer from the stream must remain undisturbed, but some selective cutting is allowed on the outer 20 feet. Neither Wake nor Johnston County has a stronger buffer rule that applies to the waters in our study area. Johnston County's Environmentally Sensitive Overlay District requires 100 feet of vegetated buffer on perennial streams and restricts development in the floodplain altogether, but the district does not apply to the Neuse River or Mark's Creek (Johnston County 2000).

Historic Preservation Ordinance. Wake County's Historic Preservation Ordinance (1999) is a voluntary program in which landowners can apply to place their historic properties on the list of Wake County's Historic Landmarks. If selected they receive an annual 50% city and county property tax deferral as long as the special character of the historic landmark is maintained (Pugh 2001a). To qualify for the deferral each year, a certificate of appropriateness must be issued by the Wake County Historic Preservation Commission before any substantial changes can be made to the exterior or grounds of the property (Wake County 1999). The tax incentive is called a deferral because a portion of back taxes may be due if the property were to lose its landmark status (Pugh 2001c). The Wake County program is totally separate from the National Register of Historic Places program; the two programs are administered by different agencies, and the National Register designation comes with no restrictions on the property (Pugh 2001a). A historic site could be honored with one or both of these designations. Currently Oaky Grove

Plantation is the only landmark in our study area designated as a Wake County Historic Landmark (Pugh 2001b).

5. Changes Coming

Several road projects in the Shotwell area promise increased growth and imminent land use change. The US 64 Bypass, a six-lane freeway intended to ease congestion on the existing US 64 corridor, promises a surge of growth in the Knightdale area (CAMPO 1999a). The proposed route for the bypass crosses the Neuse River just north of the Crabtree Creek confluence, passes south of Knightdale roughly parallel to Poole Road (about 1.5 miles north of Poole Road), crosses Mark's Creek near Eagle Rock Road (through the least brook lamprey population), and connects back to the existing US 64 close to Wendell Boulevard (Wake County 2000a). Interchanges are proposed at Hodge Road, Smithfield Road, and Knightdale Eagle Rock Road at Mark's Creek (ibid.). The stretch of the bypass from I-440 to US 64 near Wendell Boulevard is on the 2015 Capital Area Metropolitan Planning Organization (CAMPO) List (CAMPO 1999a).

The Outer Loop, or I-540, is also planned to cross through the Shotwell area (Wake County 2000a). The relevant stretch is on the 2025 CAMPO List (CAMPO 1999b). This six-lane freeway will be the second highway circling the City of Raleigh. The proposed route would cross Poole Road between Hodge Road and Grasshopper Road, cross the Neuse River just south of Auburn-Knightdale Road, pass through NC State's Randleigh Farm, cross Rock Quarry Road just east of Auburn-Knightdale Road, and continue south out of the watershed to US 70 and I-40 (Wake County 2000a). Interchanges are proposed for Poole Road, Auburn-Knightdale Road about 1,300 feet north of the Neuse River, and Rock Quarry Road (ibid.). Though there are some local lawmakers in opposition to the southwestern portion of the Outer Loop, this segment appears to be moving ahead with little controversy.

Other high-impact road projects are the widening of Poole Road from 2 lanes to 5 lanes from Maybrook Drive to Barwell Road just west of the Neuse River, and the US 70 4-lane bypass, which will not cross through the study area but may decrease congestion on the existing US 70 (CAMPO 1999a). The Clayton Strategic Growth Plan (2000) shows a proposed minor thoroughfare connecting Medlin Road to Pritchard Road close to Riverwood Athletic Club. Also on the Clayton map is a proposed major thoroughfare extending Covered Bridge Road to Old US 70. A proposed major thoroughfare is shown connecting US 42 to Covered Bridge Road close to Brookhill Farm, and a future

commercial development zone is mapped at the intersection. All of these proposed projects indicate a probable widening of Covered Bridge Road in the future. Finally, the Clayton Strategic Growth Plan shows a proposed major thoroughfare circling the downtown of Clayton.

III. Recommendations and Conservation Strategies

A. Vision

This report has examined the important open space components Neuse River – Mark's Creek watershed, and the water quality of the streams in these basins. Triangle Land Conservancy's goal is to protect the natural areas, water quality, and scenic, historic, rural character of this place for the greatest benefit for the community, while meeting individual landowner goals.

The population in this watershed will continue to grow as new residents make their homes in this beautiful place, yet our vision is that this area will grow in the *right way* with the continued input from landowners and residents. We believe that this area can maintain its rural, scenic, and historic character, and that we can protect its water quality, significant natural areas, and high quality of life while accommodating growth in these rapidly urbanizing counties.

B. Water Quality

Perhaps the most crucial resource in our study area is water: streams, rivers, lakes, and groundwater. Most of the residents in this area rely on groundwater for their drinking water, and just 10 miles downstream from NC 42, water from the Neuse River is withdrawn for Johnston County's public drinking water system. Farmers rely on water from streams to irrigate their fields. Rivers and streams add to the scenic character and serve as recreational areas for fishing, canoeing, and swimming.

But water is important for more than just human use and enjoyment. The incredible biodiversity in our country's rivers, streams, and ponds make the United States, and particularly the southeastern states, a global hotspot for freshwater biodiversity. Freshwater species are also the most threatened group of organisms in this country. Two-thirds of freshwater mussels and 37% of freshwater fish are vulnerable to extinction or already extinct. In fact, the Nature Conservancy and the Association for Biodiversity Information has designated the Upper Neuse Watershed (which includes our study area) one of 15% of all watersheds in the United States that must be conserved in order to preserve all at-risk freshwater mussel and fish species in the country. (Chaplin et al. 2000)

The protection and improvement of water quality in the Neuse River Basin will require a broad range of actions. The City of Raleigh, Wake County, Johnston County, and Clayton are planning a regional greenway system to run along the Neuse River from Falls Lake to NC 42 as part of the Mountains-to-Sea Trail, but building a greenway along the river will not be enough. Because a majority of the Neuse's nutrient and sediment load comes from its tributaries, protecting Mark's Creek, Big Arm Creek, Poplar Creek, and other tributaries is also a high priority. The Neuse River Buffer Rule mandates 50 feet of vegetated buffer along all perennial and intermittent streams in the basin; however, this rule is misunderstood by many landowners and not well-enforced. DENR must better educate landowners about the Neuse Buffer Rule and better enforce its requirements. In addition, the Neuse Buffer Rule does not require that land that was unvegetated before 1996 be revegetated; these areas are "grandfathered" out of the requirements. DENR should work with Wake and Johnston counties' Soil and Water Conservation District offices and Cooperative Extension offices to provide technical assistance and, in some cases, financial compensation to landowners for the restoration and revegetation of the buffers on their properties.

At the same time the scientific and environmental community has questioned whether 50 feet of vegetated buffer is enough to effectively filter sedimentation and nutrients from overland run-off. A study by Seth Wenger of the University of Georgia reports that most of the scientific literature regards 50 feet as an absolute minimum, and that buffers that effectively filter run-off also include an additional 2 feet per 1% slope, plus all adjacent wetlands and floodplains (1998). Wenger further recommends that impervious surfaces and slopes above a 25% grade not count towards the 50 feet, and that all major sources of contamination be restricted from the buffer, including impervious surfaces, logging roads, mining activities, agricultural fields, livestock, clear cutting, land disturbance, septic tank drain fields, and pesticide and fertilizer use. Though adequate in some circumstances, 50 feet of vegetated buffer would be easily overpowered by any severe storm, flood, or contamination event, so Wenger strongly recommends, wherever possible, a buffer of at least 100 feet, or to the floodplain edge, whichever is greater. To perform the additional function of providing wildlife habitat, Wenger goes on to recommend a buffer of 300 feet.

It may be politically unrealistic to pursue such a complex and arduous buffer ordinance such as the one Wenger suggests, and many landowners feel strongly that they should be compensated for such large areas of land excluded from development. We therefore recommend that local governments continue to enforce the State's existing 50-foot buffer

rules, but that vegetated buffers up to 400 feet be protected through voluntary measures, such as conservation easements and fee-simple acquisition. Johnston County should also consider extending its Environmentally Sensitive Area district to the Neuse River and Mark's Creek watersheds, which would require a 100-foot vegetated buffer on all perennial streams. At the same time, development in floodplains, even when raised above flood level, not only hurts water quality but, as with Hurricane Floyd in September of 1999, can result in structural failure, lives lost, and exacerbated flooding in downstream areas. Therefore, we recommend that development in floodplains be prohibited.

State and local governments and land trusts like TLC should work with landowners who volunteer to protect wider vegetated buffers on their properties. Landowners have several voluntary conservation options. Conservation easements, which are permanent legal restrictions on the use of a property, may be donated to a government or land trust with compensation in the form of estate and property tax breaks, or a landowner may donate the land itself. If a property is significant enough, a land trust or government may be interested in purchasing it from a willing landowner. The Conservation Reserve Enhancement Program (CREP), which has prioritized the entire Neuse Basin for its conservation work, "leases" riparian buffers from farmers for 10-30 years and works with them to plant trees, restore wetlands, and otherwise improve their riparian buffers. All of these programs are voluntary.

We recommend that CREP continue its important work in the Neuse Basin and that local governments and land trusts, such as Triangle Land Conservancy, better educate landowners about their other voluntary conservation options, including the financial benefits of land and easement donations. We also recommend that the federal, state, and local governments provide more funding for the purchase of land and conservation easements so that it is possible to assist more landowners.

The Neuse River Rules set a goal of reducing the nutrient loading in the Neuse by 30% in 2003. We recommend that the DWQ evaluate the State's success at that time to determine whether the 30% nitrogen reduction goal was achieved, and whether further reduction is necessary. In addition, we are concerned that two permitted dischargers in our study area have routinely failed effluent toxicity tests: the Carolina Water Service – Kings Grant facility, and the Carolina Water Service – Willowbrook facility, which discharge into unnamed tributaries of Poplar and Beddingfield Creeks, respectively. DWQ, which issues discharge permits to these facilities through the NPDES program,

should investigate these routine violations and remove their permits if conditions are not improved immediately. In the future DWQ should make information about wastewater violations more accessible and more visible to the public. Before approving "package plants" for future developments, counties should require treatment plant owners to reserve some funds in case of failing systems so that problems are addressed immediately and the burden does not fall onto taxpayers.

Turbidity and siltation, which is not directly targeted by the Neuse River Rules, is also a problem in this study area. While some sedimentation will be controlled by the protection of riparian buffers, for those riparian areas that are already developed, other strategies should be pursued, including best management practices. DWQ should improve its education efforts about best management practices to landowners, farmers, foresters, and developers. A study by Seth Reice at the University of North Carolina showed that while North Carolina has some of the strongest sedimentation and erosion controls in the country, enforcement is the key (Shiffer 2001). His study demonstrated that local governments that hire their own large corps of erosion inspectors have cleaner water because of more frequent monitoring of construction sites. The State has its own staff of inspectors, but their workload is so enormous that they rarely get to visit a site twice. We recommend that Wake and Johnston counties and the State hire additional sedimentation and erosion control inspectors to enforce compliance of the existing sedimentation and erosion rules.

Finally, water quality needs to be tested more frequently at more sites. Water quality samples are taken at a single location on a stream, usually once every four to five years, which is not adequate considering the dramatic changes in land use that occur every year. Some streams, such as Poplar Creek and Beddingfield Creek, have never been tested by DWQ. We recommend that DWQ test more streams more often so that water quality data is statistically reliable. Local governments should create their own adopt-a-stream programs to coordinate volunteers to clean up the streams and perform quarterly water quality tests, and the Neuse River Foundation can play a major role in this by recruiting its own members for such a program. DWQ's Stream Watch program should work with all of these volunteers to train them in water quality testing so the State can use this data to better inform its basinwide planning.

C. Direct Land Protection

1. Recreation and Education Areas

The City of Raleigh, Wake County, Johnston County, and Clayton are planning a regional greenway system to run along the Neuse River from Falls Lake to NC 42 and beyond. The Mountains-to-Sea Trail, a project under the Division of Parks and Recreation of the NC Department of Environment and Natural Resources (DENR), will piggy-back on these planned greenway systems and continue down the Neuse all the way to New Bern and the coast. Raleigh has planned for several park "nodes" along the greenway system, starting at the Falls Lake Recreation Area and including Hairpin Bend Park, Horseshoe Bend Park, the Milburnie Parks, and Anderson Point Park at the confluence of Crabtree Creek and the Neuse. These parks nodes are 50 to 135 acres and are spaced roughly 1 to 5 miles apart. To continue with this nodal design, the greenway system will need at least one park in the Shotwell area. In total this greenway and park project will help protect water quality by maintaining a vegetated buffer along the river, preserve bottomland and upland habitat, provide recreational opportunities for hiking and canoeing, and will increase access to the river to foster an appreciation for the Neuse.

We recommend that Johnston County, City of Raleigh, Wake County, Town of Clayton, Triangle Land Conservancy, and NC Division of Parks and Recreation work together to design the next 14 miles of the greenway system (from Poole Road to NC 42). This greenway plan should suggest trail designs and potential areas for park nodes and canoe access points. We recommend that this coalition consider the 3,500-acre roadless area at the confluence of the Neuse River and Mark's Creek for one of the park nodes. This roadless area contains bottomland hardwood forest in the floodplains and has even greater wildlife potential in the long-term as one of the largest contiguous roadless areas in the vicinity. Though this roadless area is much larger than the other park nodes on the

planned Neuse greenway, the Shotwell community will need a large regional park to serve its growing population.

Most importantly, the primary roadless and the two secondary areas across Pritchard and Medlin roads represent one of the best remaining opportunities for landscape-scale habitat protection and restoration in the region, and some tracts would be highly suitable as gamelands or for passive recreation. Other tracts might not be suitable for fee simple acquisition or public access and might be more appropriately protected through conservation easements and managed as working farms and forests. Protecting this land through easements will keep it in family ownership while buffering the core wildlife and park area. We recommend that land trusts, Wake and Johnston counties, NC Division of Parks and Recreation, and the appropriate municipal governments prioritize these areas for protection, focusing on the significant wetlands, core wildlife habitats, and riparian movement corridors as shown on Map 6.

In addition to a system of park nodes along the river greenway, a system of water access points should be developed so that canoeists, kayakers, and fishermen have a regular network of launch points to explore the river. The City of Raleigh already maintains a canoe launch on the Neuse at the Poole Road crossing; access ramps might also be built at the Auburn-Knightdale, Mial Plantation, and Covered Bridge road crossings. The more opportunities we give people to get out on the river, the more the community will want to protect it.

Clemmons Educational State Forest is another significant educational and passive recreation destination in our study area. Managed as a working forest, Clemmons' emphasis is on forestry education, and it is a popular fieldtrip destination for schoolchildren across the region. Today Clemmons is surrounded on two sides by residential development, leaving it little room to expand to meet the growing demands of a growing population. We recommend that TLC work with NC Forest Service to implement its plans to expand the park by 300 acres.

NC State University is another large landowner in this area, holding 420 acres at the Randleigh Farm and 489 acres at the Central Crops Research Station. These farms have been important research and educational facilities to the university while anchoring agriculture in this area in the face of rapid suburbanization. Despite intense development pressure, we recommend that the university hold on to these properties and continue to use them for research and education. If the university does decide to sell them, we

recommend that the university seek a conservation buyer or at least require a 400-foot buffer on all waterways if the buyer plans to develop the properties.

Historically, privately-owned areas have also served the recreational needs of the residents in this area, and some continue to do so. For example, Lake Myra has been a fishing, swimming, and picnicking site since the 19th Century, and the current owners still allow fishing for a small fee. These privately-owned sites are valuable resources to the community and should be maintained as long as the landowners are willing. Local governments should work with the landowners of these properties on a voluntary basis to help maintain these sites. Projects might including protecting the water quality of fishing spots and stabilizing structures for public safety.

2. Natural Areas

There are several significant natural areas that should be prioritized for protection in our study area. First, the roadless areas along the Neuse River and Mark's Creek should be top priority for the protection and restoration of a core wildlife area. Steep, north-facing bluffs along the river should be protected, especially those with mountain laurel and Acidic Cliff plant communities. The Neuse River (Clayton) Forests Natural Heritage Sites, and the wetlands system along Mark's Creek above and below Lake Myra in Wake and Johnston counties are two other priorities for protection. The Triangle's last remaining population of the federally-endangered Michaux's sumac is owned by the City of Raleigh and semi-protected through the Endangered Species Act. We recommend that the Plant Conservation Program identify other historic areas for Michaux's sumac along the Neuse so that these may be protected and Michaux's sumac reintroduced. Historic areas for longleaf pine might also be identified and protected for ecosystem restoration. (Map 5: Significant Natural Heritage Sites and Element Occurrences)

Other significant natural areas to prioritize for protection include vernal pools that serve as amphibian breeding grounds, groundwater recharge areas to protect groundwater, and significant geological sites, including the granite flatrocks to the north of the study area. A planned greenway along Hodges Mill Creek represents an excellent opportunity to expand TLC's Temple Flatrock nature preserve, protect the nearby flatrocks, protect the headwaters of Mark's Creek and Beaverdam Creek, protect the water quality of Hodges Creek, and connect it all to the proposed greenway. (Map 13: Flatrocks Area North of Mark's Creek)

Direct land protection through land and easement acquisition is only one strategy that can be used to protect these significant natural areas. There will surely be more development in the years to come throughout the study area, so the key is to ensure that future developments protect the most sensitive and significant portions of each tract. We recommend that local governments encourage developers to use innovative conservation designs in planning their subdivisions so that natural areas such as floodplains, steep slopes, wetlands, riparian buffers, and hardwood forests remain untouched while the lots are clustered onto the remaining portions of the tract. Local governments should require conservation designs for all projects requiring a rezoning, and open space set-asides for all developments. Fees-in-lieu are acceptable when significant open space will not be impacted by development, but these fees should be used solely for open space protection.

D. Rural Character

This plan has concentrated on three of the visual components of the rural character in the Shotwell area: 1) historic sites and communities (in their rural context); 2) working farms and forest land; and 3) scenic areas, including fields, pastures, open land, woodlands, and ponds.

1. Historic Sites and Communities

The historic landmarks in our study area reflect the agricultural past and present of Wake and Johnston counties. We have identified several of the most significant historic landmarks in our study area, including Walnut Hill, Blake Farm, Goodson Farm, The Maples, Lake Myra, Bend of the River, and Oaky Grove Plantation. Historic churches, general stores, cemeteries, mills, cotton gins, and lodges in and around Shotwell, Eagle Rock, and Archers Lodge are also integral parts of the historic fabric. (Map 7: Local Historic Sites)

We recommend that Capital Area Preservation (CAP) and Preservation North Carolina (PNC) prioritize this area for their historic preservation work. These organizations should work with Wake and Johnston counties and the NC Department of Cultural Resources to educate landowners about the benefits of designation on the National Register of Historic Places. For example, designation on the register makes a landowner eligible for tax credits for restoration work on the historic property and helps shield the property from state or federal development (such as road widenings or extensions). CAP and PNC, along with state and local governments, should educate landowners about the

historic tax credit program and other preservation options, including deed covenants and historic preservation easements. CAP and PNC might also work with landowners of historic churches, mills, stores, lodges, and other nonresidential structures to find adaptive reuses of these buildings.

Wake County has a notable voluntary historic preservation program that affords landowners a 50% property tax deferral for maintaining their historic properties. Wake County should spread the word about this program to landowners in the Shotwell area so that more properties may be preserved. We recommend that Johnston County publish its inventory of historic architecture to increase awareness of the local history and heritage of this place.

2. Farmland and Working Forests

The rural, historic landmarks in the study area are dependent on the surrounding pastoral landscape in order to maintain their beauty and historic context. Farmland and working forestland are integral parts of this landscape, yet farmers and forest landowners are struggling in the changing, urbanized economy. In addition to its historic and aesthetic value, the agricultural and forest economy should be a priority for local government because property in farm and/or forest use is a net contributor to the local budget. A 2001 study by Mitch Renkow of NC State University found that in Wake County, farm and forest property contributes $2.12 to local government coffers for every dollar of public services (roads, water and sewer, schools, etc.) received, while residential property contributes only $.65 for every dollar's worth of services it receives. If best management practices are employed, agricultural and forestry land provide better wildlife habitat and less environmental and water quality degradation than commercial, residential, or industrial uses.

A wide range of strategies must be considered if agriculture is to remain viable in this area, and many of these strategies are beyond the scope of this plan. We recommend that communities prioritize and work to strengthen the local agricultural economy. We suggest that local governments include agriculture as part of their local economic development programs and provide technical assistance and advice to farmers and forest landowners on how to develop business plans, diversify their operations, reach new markets, and take advantage of conservation tax credits.

Local governments should survey landowner interest in a voluntary agricultural district, in which landowners voluntarily agree to keep their land in agricultural use for ten years. Benefits include waivers from water and sewer utility assessments, additional notification to buyers of local property regarding the presence of farm operations (this can provide additional protection against nuisance suits), and hearings for public projects proposed in agricultural districts. Participation in such a program might promote community cohesiveness and help identify priority areas for conservation easement programs.

Land preservation can be an important strategy in helping an agricultural community remain viable. If agriculture is going to continue, land must be available for renting and buying at prices that can be covered through the sale of farm and timber products. Conservation easements can help keep land available for farming and forestry without forcing landowners to lose the value of their land. Under these programs, landowners donate or sell the development rights for their land but retain the right to farm and/or log it, sell it, and pass it on to their heirs. The value of the land is reduced, affording the landowners reduced property and estate taxes, but the land is still available to be sold at any time.

We recommend that land trusts and local governments better educate landowners about these land protection options and the financial benefits from enrolling. While some landowners will be able to donate conservation easements in exchange for tax benefits, others need to be compensated in cash. Federal, state, and local governments should dedicate more money into farmland preservation and purchase of development rights

programs so that more landowners may be compensated for their easements. Funding for the State's Farmland Preservation Trust Fund must be increased, and local governments should also provide local funding.

3. Scenic Roads and Views

The core scenic areas illustrated on Map 9 are high priority for protection through conservation easements or fee-simple acquisition. Yet preservation of the scenic quality of the Shotwell area requires more than just the protection of three or four tracts of land; maintaining the rural context and scenic views in the entire landscape is critical. Farmland and working forest preservation is one of the best tools available to preserve the rural, scenic character, yet the rural economy must be strengthened if these occupations are to remain viable.

We recommend that local governments promote creative subdivision designs that maintain scenic views from the roads identified on Map 9. For properties proposed for development, local governments should give special consideration to designs that hide new homes and structures behind vegetated buffers or earth berms along the main roads. Local governments should also survey landowner interest in designating these roads as NC Scenic Byways, a designation that does not come with any regulatory restrictions, but may attract tourists to the area by car or by bike. Already this area is a popular destination for cyclists because of its scenic roads; local governments should take steps to ensure the safety of cyclists by posting "Share the Road" signs and widening the shoulders.

Works Cited and GIS Data

American Rivers (AR). America's Most Endangered and Threatened Rivers. http://www.americanrivers.org/mostendangered2001/default.htm. Accessed December 2001.

Beard, Heather (Neuse River Foundation). May 2001. Written comments on the draft Neuse – Mark's Creek Conservation Assessment.

Bliley, Daniel J. October 1994. *Soil Survey of Johnston County, North Carolina*. U.S. Department of Agriculture, Soil Conservation Service.

Capital Area Metropolitan Planning Organization. July 1999a. Financially Constrained Transportation Plan 1999-2025: 2015 Project List. http://www.raleigh-nc.org/campo/2015.htm. Accessed November 2001.

Capital Area Metropolitan Planning Organization. July 1999b. Financially Constrained Transportation Plan 1999-2025: 2025 Project List. http://www.raleigh-nc.org/campo/2025.htm. Accessed November 2001.

Cawthorn, Joel W. November 1970. *Soil Survey of Wake county, North Carolina*. U.S. Department of Agriculture, Soil Conservation Service.

Chaplin, Stephen J. et al. 2000. The Geography of Imperilment: Targeting Conservation toward Critical Biodiversity Areas. *Precious Heritage: The Status of Biodiversity in the United States.* Edited by Jonathan Adams et al. Oxford University Press.

City of Raleigh. 1996. Neuse River Regional Park Master Plan.

Clark, George. Manager of NC State University's Central Crops Research Station. Personal communication. April 2001.

Clemmons Educational State Forest. Brochure distributed at facility.

Division of Water Quality, NC Dept. of Environment and Natural Resources (DWQ). February 1993. *Neuse Basinwide Water Quality Management Plan.* http://h20.enr.state.nc.us/basinwide/basinwide/neuse.htm. Accessed January 2000.

Division of Water Quality, NC Dept. of Environment and Natural Resources (DWQ). October 1996. *Basinwide Assessment Report, Neuse River Basin.* Environmental Sciences Branch.

Division of Water Quality, NC Dept. of Environment and Natural Resources (DWQ). December 1998. *Neuse River Basinwide Water Quality Management Plan.*

Division of Water Quality, NC Dept. of Environment and Natural Resources (DWQ). June 1999. Total Maximum Daily Load for Total Nitrogen to the Neuse River Estuary, North Carolina.

Earth Data International. 1995. Digital Orthophotos, Johnston County. Earth Data International: High Point, NC.

Earth Satellite Corporation. 1996. Land Cover – 1996. EarthSat: Rockville, MD.

Flournoy, William. 1985. The Future of Neuse River in Wake County. Triangle Land Conservancy and Triangle Greenways Council, Raleigh, NC.

Foushee, Rodney. November 1999. Dams: Harnessing Rivers. *Wildlife in North Carolina*. NC Wildlife Resources Commission.

Frost, Cecil. November 2000. Natural Areas and Water Quality Charrette Site Documentation Form. Triangle GreenPrint Project, Triangle Land Conservancy.

Hardy, D. et al. Agriculture and the Neuse River Basin. NC State University. http://ces.soil.ncsu.edu/net/agriculture.html. Accessed January 2000.

Hess, George. December 2001. Personal communication regarding 1997 National Resources Inventory land use change data from the U.S. Department of Agriculture Natural Resources Conservation Service.

Huffman, Mike. Ranger of Clemmons Educational State Forest. Personal communication. January 26, 2001.

Johnston County. *Development Ordinance: Johnston County, North Carolina*. Adopted July 10, 2000.

Johnston County. March 1999. *Proposed Strategical Plan: A Report to the Board of Commissioners*. Comprehensive Plan Workgroup.

LeGrand, Harry. October 2001. *An Inventory of Significant Natural Areas in Johnston County, North Carolina*. Johnston County, NC Natural Heritage Program, and Triangle Land Conservancy.

LeGrand, Harry. August 1987. *Inventory of the Natural Areas of Wake County, North Carolina*. NC Natural Heritage Program, Triangle Land Conservancy, and Wake County.

Moore, Julie and Nora A. Murdock. April 1993. *Recovery Plan for Michaux's Sumac*. U.S. Fish and Wildlife Service.

Neuse River Foundation (NRF). History of the Neuse River. http://www.neuseriver.org/

river_hist(1B).html. Accessed April 2001.

Neuse River Keeper (NRK). 1999. Neuse River History. http://www.neuseriverkeeper.com/history.html. Accessed March 2001.

Nature Serve Explorer: An Online Encyclopedia of Life. Association for Biodiversity Information. http://www.natureserveexplorer.org. Accessed December 2001.

North Carolina Natural Heritage Program (NHP). 2001a. GIS coverage: Natural Heritage Element Occurrences. Division of Parks and Recreation, North Carolina Department of Environment and Natural Resources. Received April 2001 (updated frequently).

North Carolina Natural Heritage Program (NHP). 2001b. Element Occurrence Online Database. http://www.ncsparks.net/nhp/search.html. Accessed December 2001.

North Carolina State Historic Preservation Program (NCSHPP). Miscellaneous historic records. Office of State Records, NC Dept. of Cultural Resources. Accessed February 2001.

Powell, Chris. November 1999. Neuse: The Fight for the River of Peace. *Wildlife in North Carolina*. NC Wildlife Resources Commission.

Pugh, Robin. October 2001a. Historic Landmark Designation. http://www.co.wake.nc.us/Planning/website.nsf/SubMenuEntriesYahoo/35C0A121427AC2C585256A620064E848!OpenDocument. Accessed November 2001.

Pugh, Robin. December 2001b. List of Historic Landmarks. http://www.co.wake.nc.us/planning/website.nsf/SubMenuEntriesYahoo/0FAA4EB9EDE46BF685256A6200644CD9!OpenDocument. Accessed December 2001.

Pugh, Robin. October 2001c. Tax Incentives for Historic Preservation. http://www.co.wake.nc.us/Planning/website.nsf/1d063a21be7edec48525685e00809baa/e21f3f5b7623d15c85256a65005a14d5!OpenDocument. Accessed November 2001.

Robison, Henry W. "Lamprey," Discovery Channel School, original content provided by World Book Online, http://www.discoveryschool.com/homeworkhelp/worldbook/atozscience/l/311020.html. Accessed November 2001.

Ruley, Melinda. October 2001. Sentimental Journey. *The Independent Weekly*. http://www.indyweek.com/durham/2001-10-24/ruley.html. Accessed December 2001.

Schiffer, James Eli. Clear Thinking on Muddy Problem. *The News and Observer*. February 14, 2001.

Schueler, Tom. December 1995. Site Planning for Urban Stream Protection. Metropolitan Washington Council of Governments and the Center for Watershed Protection.

Springer, Jeff. May 1999. *Pfiesteria piscicida* Page. NC State University Botany Library. http://www.pfiesteria.org/pfiesteria/pfiest.html. Accessed January 2000.

Town of Knightdale. November 1995. *Unified Development Ordinance*.

Triangle J Council of Governments (TJCog). January 1999. An Introduction to Riparian Buffers. TJCog Technical Memo, Riparian Buffer Series, No. 1.

U.S. Fish and Wildlife Service. National Wetlands Inventory. St. Petersburg, FL.

Wake County. East Raleigh-Knightdale Area Land Use Plan. May 2000a.

Wake County. *An Ordinance to Establish the Wake County Historic Preservation Commission*. Originally adopted May 1992; most recently amended and adopted May 1999.

Wake County. *Wake County Subdivision Ordinance Annotated*. Originally adopted May 1976; most recently amended and adopted January 2000b.

Wake County. *Wake County Zoning Ordinance Annotated*. Originally adopted January 1960; most recently amended and adopted December 2000c.

Wake County Historical Society. Date unknown (probably circa 1875). *Map of Wake County*.

Wenger, Scott. 1998. *Scientific Basis for Stream Corridor Protection in Georgia: A Review of Scientific Literature on Riparian Buffer Width, Extent, and Vegetation.* Institute of Ecology, University of Georgia.

Other GIS Coverages

Provided by Conservation Trust for North Carolina
Lakes
Railroads
Streams

Provided by Johnston County
Cadastral

Provided by NC Center for Geographic Information and Analysis
Benthic Monitoring Sites

Fish Monitoring Sites
Geology
Historic Sites
Johnston County Inventoried Natural Areas
National Per
Significant Natural Heritage Areas

Provided by Wake County
Cadastral
Digital Orthophotography (shot 1999)

Provided by Triangle J Council of Governments
Extra Territorial Jurisdictions
Prime Soils
Protected Open Space (Million Acres Database)
Soils
Topography Lines
Trails
Zoning