2.0 DATA ASSESSMENT

2.1 Overview

Characterization of the Swift Creek Watershed included analysis of a wide variety of available data (including natural resource information; water quality, habitat, biological data; and watershed trends such as population and land use with associated imperviousness) as well as information on local programs and initiatives. In addition, characterization of the watershed included a visual assessment of the watershed based on a windshield survey to document watershed conditions as well as potential mitigation opportunities.

Characterization of the Swift Creek Study area was completed on a sub-watershed basis to provide the data and information necessary for sub-watershed scoring and ranking. The sub-watershed ranking and prioritization was then used to identify sub-watersheds for focus during Phase 2 of the Local Watershed Plan effort (discussed in more detail in Sections 3 and 4). The following subsections present a summary of the data and information available for the Swift Creek Watershed, documentation of gaps in available data, and results of the visual assessment.

2.2 Characterization

The review of existing data and analysis to identify data gaps included the following components:

- Natural Resources including: geology, soils, stream network, wetlands, floodplains, stream buffers, significant natural heritage areas, natural heritage element occurrences (rare, threatened or endangered), historic sites, and protected lands (parks, open spaces and greenways);
- Documented Watershed Conditions including: water body classifications, designated use status, and existing monitoring data;
- Watershed Trends including population, land use and associated imperviousness, and aerial photography;
- Local programs and initiatives; and
- Visual assessment of watershed condition and potential mitigation sites.

Sources of the above information include spatial data (GIS, etc.), reports presenting or summarizing available information, interviews with municipal officials from jurisdictions within the watershed and the visual assessment field forms. Table 2-1 summarizes the available spatial data and sources (including data categories of environmental, administrative, imagery and elevation data). Table 2-2 presents the list of reports and associated data used for the existing data review (discussed in more detail in Section 2.2.2.2). Note that the report titled “Assessment Report: Biological Impairment in the Upper Swift Creek Watershed” which is also known as the WARP Report (Watershed Assessment and Restoration Project) represents the most recent study of the area and was conducted by the Division of Water Quality’s Planning Branch within NCDENR. Also note that this study only represents a portion of the study area presented in this report since the WARP study area terminates at Holly Springs Road above Lake Wheeler and does not extend downstream of Lake Benson. The following sections summarize the information obtained.

2.2.1 Natural Resources

The natural resources of the Swift Creek Watershed are an important component of the sub-watershed characterizations since the Ecosystem Enhancement Program (EEP) aims to protect these resources. For this watershed characterization, natural resources focused on:

- Geology/Topography
- Soils
- Streams/Waters/Hydrography
- Wetlands
- Floodplains
- Stream Buffers

- Significant Natural Heritage Areas
- Natural Heritage Elements Occurrences (Aquatic/Terrestrial/RTE Species)
- Historical and Archeological Sites
- Protected lands (greenways, parks and open spaces)
- Habitat (NC GAP habitat data, significant aquatic habitat)

2.2.1.1 Geology/Topography/Soils

Swift Creek is located within the Upper Neuse Basin and the study area is located in Wake County. The Neuse Basin originates in the piedmont physiographic province and ultimately flows through the coastal plain physiographic province.

Wake County is part of an uplifted peneplain, dissected in places by a network of streams (running in dendritic patterns) that generally flow in a southeasterly direction. The southern portions of the County are generally located in the Coastal Plain province, while the remaining portions are located in the Piedmont physiographic province. A portion of the County, located in the Coastal Plain, has topographical relief similar to that of both the Piedmont and the Coastal Plain. Because of this overlapping of physiographic characteristics, the area is considered to be a transitional zone between the two provinces and is often referred to as the fall zone or fall line.

Figure 2-1 illustrates the North Carolina geologic zones in the watershed include:

- Triassic Basin (northwestern tip of watershed)
- Carolina Slate Belt (northwestern portion of watershed)
- Raleigh Belt (majority of watershed)

The Neuse River and many of its high order tributaries are antecedent streams that flow in a southeasterly direction. The direction of the flow of the smaller order streams is primarily controlled by the local/regional structure and by resistance to erosion of the underlying rocks.

Throughout the County, erosion has altered the original topographical relief. Most areas are gently rolling, but the areas between streams are broad and flat. The areas in which relief is most broken are near the larger streams. Differences in elevation are more pronounced in the western part of the study than in the eastern part, as illustrated in Figure 2-2 (Digital Elevation Model – DEM). Topography significantly influences water quality and scientific approaches to water quality management. In the eastern end of the Swift Creek watershed, the valleys are U-shaped and the floodplains fairly wide. This eastern portion of the watershed is situated on the break between the formations. This basin is a swampy depression or lake where the rock and mineral deposits were made during formation. In the western portion of the Swift Creek watershed, the valleys are V-shaped and the flood plains generally narrower. Note that floodplains in the study area are discussed in more detail in a following section.

Soils are beneficial in determining areas susceptible to erosion, areas conducive to absorbing rainfall or wastes, as well as areas that could be potential wetlands. NCDENR and Wake County have data coverage for soil types, including hydric soils that can assist in identifying wetland areas and potential wetland restoration areas. In addition, soils for Wake County are mapped and described in the 1970 Soil Survey prepared by the Natural Resources Conservation Service (NRCS). The soil survey is in the process of being updated.

Since hydric soils are an indicator of floodplains and wetlands, their locations are valuable in assessing potential resources. Knowing their extent is also valuable in assessing historical hydrologic conditions, since these soils retain their characteristics post-hydration. The hydric soils series in Wake County have been identified and their locations are mapped and included in Figure 2-3 (for Hydric Soil Classes A and B). Table 2-3 summarizes the acres of hydric soils in each of the sub-watersheds by soil classes A and B. **As indicated in the table, there are over 7,000 acres of hydric soils in the Swift Creek Watershed (representing approximately 20% of the study area).** The hydric soils generally are associated with the major stream reaches and, therefore, are primarily located at the main branch of Swift Creek, Dutchmans Creek, and Yates Branch.

2.2.1.2 Streams/Waters/Hydrography

Streams in this part of the county generally flow in a southeasterly direction, are formed in a dendritic pattern based on topographic features, and vary in width, depth, and associated floodplain width. Many of the streams have been impounded at various times, initially for agricultural purposes and later for water supply purposes.

The location and extent of streams/waters in the watershed are presented in Figure 2-4. Table 2-4 summarizes the length of streams in each sub-watershed by major reaches. **The Swift Creek Watershed contains approximately 1.3 million feet of streams (242 miles).** As presented in the figure, the Swift Creek watershed contains several significant lakes:

- Apex Reservoir (also referred to as Summit Lake)
- MacGregor Downs Lake
- Lake Wheeler
- Yates Mill Pond
- Lake Benson

Named tributaries to Swift Creek include:

- Williams Creek
- Long Branch
- Lynn Branch
- Speight Branch
- Dutchmans Creek (note that this creek is referred to as Dutchmans Branch in some of our sources)
- Yates Branch
- Buck Branch
- Reedy Branch

In addition, there are numerous ponds and impoundments throughout the watershed, many of which are located on small tributaries or in headwaters. For example, Regency Park Lake is located on an unnamed tributary to Swift Creek in Sub-watershed 4BX. In addition, there are small ponds located on: 1) Long Branch (Sub-watershed 4BX)- Loch Lomond; 2) Speight Branch (Sub-watershed 4A1) and 3) Lynn Branch (Sub-watershed 4CX).

Some of these water body features may be opportunities for incorporation/expansion into urban watershed management while others may serve as opportunities for wetland/stream restoration through their removal. An inventory of the water bodies (including capacity, quality, historical use) in primary targeted sub-watersheds may be beneficial for future study purposes.

Refer to the separately bound document, Appendix D, for 22" by 34" exhibits for the 5 primary watersheds illustrating topography, hydrography and wetlands.

2.2.1.3 Wetlands

Wetlands are an important resource for water quality and habitat. They help filter pollutants, moderate stream flow, and provide cover and food for wildlife. Wetlands are subject to Section 404 jurisdiction and protection under the Clean Water Act, in addition, isolated wetlands and the draining of wetlands are subject to State of North Carolina regulations. For this characterization, wetlands are important for two reasons. First, they are an important indicator of watershed health. Second, they are an important indicator in locating potential compensatory mitigation opportunities.

The National Wetland Inventory (NWI) has the only currently available data set for mapped wetlands. More detailed wetlands information could be developed through aerial photographs (as well as other imagery sources and types), interpretation, and ground truthing with field work. Identifying areas of wetlands loss in the future may be beneficial in identifying potential mitigation opportunities.

The location and extent of wetlands in the watershed are illustrated on Figure 2-5. Table 2-5 summarizes the length of wetlands in each sub-watershed by the primary wetland categories of:

- Lake (L, PUB)
- Palustrine Emergent (PEM)
- Palustrine Forested (PFO)
- Palustrine (Scrub/Shrub) (PSS)

There are over 3,000 acres of wetlands in the Swift Creek Watershed representing almost 8% of the study area. PFO, L and PUB wetlands are the dominant wetlands in the study area. As illustrated in Figure 2-5, wetlands in the watershed are generally associated with the major stream reaches. They are primarily mapped in the same locations as hydric soils and floodplains. Most of the mapped wetlands are located on Swift Creek, Yates Branch, and Dutchmans Creek. Based on field reconnaissance and mapping, Swift Creek, Dutchmans Creek, and Yates Branch would be primary areas to focus on wetlands protection (preservation), enhancement, or restoration. Given the geographic setting, there are limited areas of large wetland flats. Most wetlands are forested wetlands, located along the stream channels in the narrow valleys. Most impacts to wetlands along these main channels appear to be from infrastructure encroachment and discharges in the headwaters from development activity.

As previously indicated, refer to the separately bound document, Appendix D, for 22" by 34" exhibits for the 5 primary watersheds illustrating topography, hydrography and wetlands.

2.2.1.4 Floodplains

Floodplains are an important resource in a watershed. Floodplains provide opportunities for natural water purification, habitat, and energy dissipation for stream flows. Increases in flood elevations and flow velocities are usually indicators of changes in a watershed. Floodplains have been mapped by the Federal Emergency Management Agency (FEMA) in this watershed. However, FEMA mapping is based on jurisdictional evaluations (water surfaces) rather than habitat. Mapping of floodplains based on habitat requires additional assessments using aerial photograph interpretation, ground truthing, and topographic analysis. The State of North Carolina is currently updating the floodplain maps for this area, however they are not scheduled to be available until Spring 2004.

The location and extent of floodplains in the watershed, based on available FEMA mapping, are illustrated on Figure 2-6. Table 2-6 summarizes the acreage of floodplains in each sub-watershed for Zone A (no base flood elevations determined) and Zone AE (base flood elevations determined). **There are approximately 4,000 acres of floodplains in the Swift Creek Watershed, representing approximately 10% of the study area.** Note that Table 2-6 also presents the total acreage within the floodway.

Large floodplains in the study area are generally associated with the main tributaries in the watershed (Swift Creek, Dutchmans Branch, and Yates Branch.) Narrow floodplains are associated with Lynn Branch, Williams Creek, Reedy Branch, and a few unnamed tributaries.

Encroachments into a floodplain can have negative affects on a watershed, and increased encroachment trends can be a sign of problems. In the future, it would be beneficial to assess the trends in total floodplain area and the encroachments in floodplains. There is currently only one data set for floodplains. A second data set of more recent conditions will be available in the near future (Spring of 2004 from State of North Carolina). This would then be a good time for a trends analysis to be completed.

Stream velocities also have a significant impact on a watershed. Velocities can be an indicator of current or potential future erosion problems. Hydrology and hydraulic modeling can be used to predict these flows and identify current locations subject to erosive flows. Each of the municipalities in the area has some information in that regard, but it is not easily summarized at this level of analysis. In addition, once the State of North Carolina publishes the new floodplain maps, preliminary modeling could be available for use and review. This issue is discussed in more detail in the recommendations section (Section 4.2).

2.2.1.5 Stream Buffers

Stream buffers are a well-recognized source of watershed protection. The Swift Creek watershed is located within the Neuse River Basin, which recognizes, plans for, and regulates stream buffers. Identification of unbuffered streams (streams in which there is development or encroachment in areas close to the banks) is valuable for identifying potential areas of degradation and potential opportunities for restoration of both the buffer and stream channel. Identification of wide and connected buffers can also be an indicator of potential stream corridor preservation opportunities.

The location and extent of development within the 300-foot buffer in the watershed are illustrated on Figure 2-7. The figure illustrates the high, medium and low-density urban development within the 300-foot buffer in the colors of red, orange and yellow, respectively. Note that this analysis was completed using GIS buffer files provided by EEP and 1999 land use data (described in more detail in Section 2.2.3). Table 2-7 summarizes the total buffered area for each sub-watershed along with the acres of high, medium and low-density development within the 300-foot buffer. **With a total 300-foot buffer area of approximately 27,000 acres (65% of the total study area), approximately 4,500 acres are encroached upon representing approximately 17% of the buffered area.** Sub-watersheds with over 20% encroachment in the 300-foot buffer include:

- 1DX
- 2A2
- 2A3
- 4BX
- 4DX
- 4E1
- 4E2
- 5XX

Findings of the visual assessment (discussed in more detail in Section 2.3) indicate that development within the buffers varied throughout the watershed. In many of the developed areas, vegetated buffers exist on most of the reaches reviewed but the buffer widths varied throughout the watershed. In many of the developed portions of the watershed, often the buffer included backyards of adjacent properties.

2.2.1.6 Significant Natural Heritage Areas and Natural Heritage Element Occurrences

Significant natural heritage areas (SNHAs) and Rare, Threatened, and Endangered (RTE) species are important for characterizing natural resources in need of special protection. In fact, protection efforts for these species and their habitat can often be important parts of a watershed management plan. Many of these species are associated with or rely upon streams and wetlands and their buffers for habitat and food supplies.

While Table 2-8 summarizes the significant natural heritage areas (in acres) by sub-watershed, Figure 2-8 illustrates the location of these areas within the watershed. **As illustrated in the table and figure, the significant natural heritage areas include approximately 2,300 acres in the study area including:**

- Dutchmans Branch Bluffs
- Hemlock Bluffs State Natural Area
- Lake Benson and Marsh
- Lake Wheeler
- Swift Creek Bluffs
- Swift Creek Bottomlands Forest above Lake Benson
- Swift Creek Bottomlands above Lake Wheeler
- Yates Mill Pond

While Table 2-9 summarizes the natural heritage element occurrences by sub-watershed, Figure 2-9 illustrates the locations and type of occurrences in the watershed. As indicated in the notes of the table and the legend of the figure, the occurrences include the following classifications:

Element Classes

- A: Vertebrate Animal
- C: Natural Community
- I: Invertebrate Animal
- N: Nonvascular plant
- P: Vascular Plant
- S: Special Animal Habitat

Element Occurrence Status

- E: Extant
- H: Historical but no evidence of destruction

State Protection Status

- E: Endangered
- T: Threatened
- SC: Special Concern
- C: Candidate
- SR: Significantly Rare
- C-SC: Candidate-Special Concern
- E-SC: Endangered - Special Concern
- PE: Proposed Endangered
- T-SC: Threatened - Special Concern
- EX: Extirpated

In the Swift Creek Watershed, there are a total of 14 natural heritage element occurrences including six vascular plants, four natural community, two invertebrate animals, and two vertebrate animals. Note that four of the vascular plant occurrences are historic while the remaining occurrences are extant. While there are two endangered occurrences and five significantly rare occurrences, there are also two special concern candidates and one candidate. The majority of occurrences are located within Sub-watershed 4BX. Additional studies to identify habitat for aquatic and riparian RTE species may be beneficial in future efforts of the project. **In addition to the natural heritage element occurrences located within the study area, Swift Creek also supports populations of rare, threatened and endangered mussels downstream of Lake Benson (WARP, 2003). The support includes 11 species of rare, threatened or endangered aquatic animals: one fish and ten mussel species, including the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*).**

2.2.1.7 Historical and Archeological Sites

Historic sites tend to be properties, structures, buildings, farms, etc. that have some type of historical significance. Archaeological sites tend to be either burial grounds or the sites where significant artifacts have been found. The location of historical properties and cultural/archaeological resources can help prioritize areas for further evaluation. These resources can assist in identifying areas for protection and preservation. Within the Swift Creek Watershed, the location of known historical structures is illustrated in Figure 2-10. Table 2-10 summarizes the historical sites by sub-watershed. The historical areas are categorized as follows:

- SL: Designated before the National Register Listing
- DOE: Determined eligible for National Register Listing
- NR: Listed on National Register
- LD: Locally Designated

There are a total of 13 historic sites in the Swift Creek Study area and they are located throughout the study area. Archaeological sites are presented in Exhibit 1 (included as Appendix A). The sites on the map are designated as follows:

- Shaded-Archaeological Site
- Hatched-Recommended to be surveyed
- Cross-hatched-Have been surveyed
- Outlined polygon-No comment
- Line-Not recommended to Survey
- Triangle-Archaeological Site
- Bar-Stream crossing - no comment
- Dashed line-Recommended to be surveyed
- Alternating dashed line-Have been surveyed

Table 2-11 summarizes information on the archeological sites by sub-watershed. **There are a total of 33 sites in the Swift Creek Watershed.** Note that these sites are indicated by "shading" in Exhibit 1 presented in Appendix A.

2.2.1.8 Protected Lands/Open Space/Greenways

Protected lands (including parks, open spaces, greenways, mitigation sites, research sites and schools) are an important component of watershed protection. These areas can be potential locations for future protection and may also be targeted areas for potential watershed improvements.

Locations of protected lands within the watershed are illustrated in Figure 2-11. Table 2-12 summarizes the protected lands by sub-watershed by category (greenway, open space, park, etc.). **There are over 5,000 acres of protected lands in the Swift Creek Watershed representing almost 12% of the total study area.**

Wake County has undertaken three major planning efforts: a Watershed Management Plan, a Growth Management Plan, and a Consolidated Open Space Plan. The County has identified the protection of stream health as the most important evaluation criteria to be used in developing a priority ranking for open space acquisition. In addition, as part of the open space objective, priority riparian corridors have been identified in Swift Creek. Land Conservation or open space protection has been identified nationally by watershed planners as one of the primary tools for protecting watershed quality.

Wake County has an active open space program in the Swift Creek Watershed and preservation opportunities will be identified in the Swift Creek corridor as part of the local watershed planning efforts.

The municipalities located in the Swift Creek watershed are all involved in Wake County's open space program and have each developed open space and greenway programs. Having the Ecosystem Enhancement Program networking into these already coordinated initiatives may provide additional opportunities in the watershed.

2.2.1.9 Habitat

The Biological Resources Division of USGS developed the North Carolina GAP Analysis Land Cover Data to support vertebrate species modeling in the state as well as the extent and pattern of land cover in North Carolina. The data represents 1992 era land cover for the state and includes 70 land cover classes. Additional data and information were utilized in development of the GAP data such as National Wetland Inventory data, National Elevation Dataset, Natural Resource Conservation Service Soils data, the Natural Heritage Plant Community Element Occurrence Records, and seven sources of ground truthing information.

Within the Swift Creek Study Area, there were a total of 30 land covers including:

- Agricultural Crop Fields

- Agricultural Pasture/Hay and Natural Herbaceous
- Barren; bare rock and sand
- Barren; quarries, strip mines, and gravel pits
- Coastal plain Dry to Dry Mesic Oak Forests
- Coastal Plain Mixed Bottomland Forests
- Coniferous Cultivated Plantation (natural/planted)
- Coniferous Regeneration
- Cypress-Gum Floodplain Forests
- Dry Mesic Oak Pine Forests
- Floodplain Wet Shrublands
- Mesic Longleaf Pine
- Oak Bottomland Forest and Swamp Forest
- Open Water
- Piedmont Dry Mesic Oak and Hardwood Forests
- Piedmont Dry Mesic Pine Forests
- Piedmont Mesic Forest
- Piedmont Mixed Successional Forest
- Piedmont Xeric Pine Forests
- Piedmont Xeric Woodlands
- Piedmont/Mountain Emergent Vegetation
- Piedmont/Mountain Mixed Bottomland Hardwood Forests
- Piedmont Mountain Submerged Aquatic Vegetation
- Residential Urban
- Riverbank Shrublands
- Successional Deciduous Forests
- Urban High Density Developed and Transportation Corridors
- Urban Low-Intensity Developed
- Xeric Longleaf Pine
- Xeric Pine-Hardwood Woodlands and Forests

Figure 2-12 presents the GAP habitat data in the Swift Creek Study Area which was aggregated into the following categories:

- Agricultural
- Barren
- Coastal Plain
- Coniferous
- Cypress-Gum Floodplain Forests
- Dry Mesic Oak Pine Forests
- Floodplain Wet Shrublands
- Mesic Longleaf Pine
- Oak Bottomland Forest And Swamp Forest
- Open Water
- Piedmont
- Residential Urban
- Riverbank Shrublands
- Successional Deciduous Forests
- Urban High (and Low Intensity)
- Xeric Pine

The land cover distribution is presented in Table 2-13. Additional study of the GAP habitat data is warranted to identify specifics habitats supporting threatened and endangered species.

Summary
As indicated in the previous sections, the Swift Creek Watershed contains an abundance of natural resources that require protection in order to preserve ecological functions. The natural resource information will be used in conjunction with documented water quality conditions, land use and historic trends, and visual assessment observations to not only characterize the watersheds but also to help prioritize sub-watersheds for future study efforts (described in more detail in Section 3).

2.2.2 Documented Water Quality Conditions

While the previous section focused on characterizing the Swift Creek sub-watersheds based on natural resources (geology, soils, etc), this section focuses on characterizing the sub-watersheds based on watershed conditions documented by the following sources:

- Neuse River Basinwide Water Quality Plan
- Existing Monitoring Information (from various sources)

Documented watershed conditions in the report titled "Assessment Report: Biological Impairment in the Upper Swift Creek Watershed" which is also known as the WARP Report (Watershed Assessment and Restoration Project) represents the most recent study of the area by the Division of Water Quality. Monitoring information from this report is presented in the "Existing Monitoring Information" Section below and analysis and conclusions of this study are presented in Section 3, Cumulative Analysis.

2.2.2.1 Neuse River Basinwide Water Quality Plan

The North Carolina Division of Water Quality (DWQ) has prepared Basinwide water quality plans for each of the seventeen major river basins in the state (including the Neuse River Basin). Each Basinwide plan is updated every five years. The first Basinwide plan for the Neuse River Basin was completed in 1993 and the second in 1998. The current Basinwide plan represents the third iteration and was completed in 2002. Table 2-14 summarizes information about the Swift Creek watershed based on information obtained from the 1998 and 2002 Neuse River Basinwide Water Quality Plans.

The Swift Creek Watershed is classified as a Water Supply Watershed – Level III which is defined as follows:

> *Water Supply III (WS-III): Waters used as sources of potable water where a more protective water supply classification (such as I or II) is not feasible. WS-III waters are generally in low to moderately developed watersheds. General discharge permits only are allowed near the water supply intake whereas domestic and non-process industrial discharges are allowed in the rest of the water supply watershed.*

While Figure 2-13 illustrates the location and classification of the water supply watersheds in the Swift Creek study area, Table 2-15 presents the length in feet of water supply water by sub-watershed. **There are approximately 460,000 feet (87 miles) of water supply waters representing approximately 35% of the stream lengths in the study area.**

2002 Impaired Waters
The Department of Environment and Natural Resource's (NCDENR) most recent water quality classifications are found in the North Carolina 2002 Impaired Waters List published in February 2003. "Impaired" water bodies are those that do not meet water quality uses such as fishing, water supply or propagation of aquatic life. Based on EPA guidance, NCDENR no longer distinguishes between "partially supporting" or "not supporting" designated uses. NCDENR now rates waters as "supporting", "impaired", "not rated" or "no data".

The North Carolina Water Quality Assessment and Impaired Waters List includes both the 305(b) and 303(d) reports of the previous years. The 305(b) report is compiled biennially to update the assessment

of water quality in North Carolina's waters as well as to meet the requirements of Section 305(b) of the Clean Water Act. In general, the 305(b) report presents the quality of surface waters, groundwaters and wetlands based on how well waters meet designated uses (e.g. fishing, swimming water supply). Water bodies listed as impaired are considered "active" 305(b) waters. The 305(b) report also addresses causes

and potential sources of impairment. Derived from the 305(b) report and representing a subset of the 305(b) water bodies, the 303(d) list is a comprehensive public accounting of all impaired waterbodies. The Clean Water Act requires that Total Maximum Daily Loads (TMDLs) be developed for waters on the 303(d) list.

North Carolina's 303(d) list includes two segments in the Swift Creek Watershed listed as impaired due to biological data. More specifically, these segments are considered impaired by DWQ since they are unable to support an acceptable community of aquatic organisms and therefore, are not supporting designated uses. The two segments are classified Water Supply –III, nutrient sensitive waters (WS-III NSW). As illustrated in Figure 2-14, the 303(d) listed stream reaches include:

- 27-43-(1)a - Swift Creek from the Western portion of the watershed in Apex to almost the mid point of the study area (located within Sub-watersheds 4E1, 4E2, 4BX, 4CX, and 4A2).
- 27-43-2 - Williams Creek from the Western portion of the watershed in Apex to the confluence with Swift Creek (located in Sub-watersheds 4E1 and 4E2).

Table 2-16 illustrates the lengths of 303(d) listed segments by sub-watershed. **As indicated in the table, there are over 49,000 feet (9 miles) of impaired streams in the study area representing approximately 4% of the streams in the study area. While 7 of these miles are in Swift Creek, 2 of these miles are in Williams Creek.** The sub-watersheds with the greatest lengths of 303d listed streams include 4E2 and 4E1 in Apex and Cary, respectively, followed by 4BX (Cary), 4A2 (Wake County), and 4A1 (Cary). Note that 1998 GIS data was utilized to generate Figure 2-14 and was manually revised to reflect the 2002 ratings. The adjustment is also reflected in Table 2-16.

Previously, a lower segment of Swift Creek within the study area (27-43-1(b)) was 303(d) listed in error due to low dissolved oxygen levels at the Holly Springs Road station operated by the Lower Neuse Basin Association. This segment is no longer considered impaired.).

The cause for impairment in the Swift Creek segment (27-43-(1)a listed in the Neuse River Basinwide Water Quality Plan is sediment based on biological data. This segment is listed as high priority for restoration. The cause of the Williams Creek impairment (27-43-2) is unknown and the priority for restoration is high. There are no currently defined Total Maximum Daily Loadings (TMDLs) for these impaired waters.

Potential sources of degradation for the impaired streams documented by the Neuse River Basinwide Water Quality Plan include:

- Land Development
- Agriculture
- Urban Runoff
- Storm Sewers

Causes of impairment and potential sources of degradation are discussed in more detail in Section 3, Cumulative Analysis. Section 3 presents the findings of the most recent study in the study area.

2.2.2.1.1 Priority Issues

This section includes a summary of existing published information regarding priority issues identified to date for the Swift Creek Watershed from the 1998 Neuse River Basinwide Water Quality Plan, NC

Division of Water Quality. Note that the 2002 Neuse River Basinwide Water Quality Plan did not include updated information in these areas.

Urban Stormwater Runoff

Water quality impacts from population growth and development are major issues in this sub-basin. These impacts occur both locally, as borne out by the following benthic macro-invertebrate data, and all the way to the Neuse estuary through nutrient contributions from runoff and wastewater treatment plants.

Monitored streams, which drain urban or residential areas, include the upper portions of Swift Creek. Based on benthic macro-invertebrate data, poor ratings were assigned to upper Swift Creek. This stream appears to be affected by poor water quality, poor habitat and highly variable flow. Increasing development is associated with an increase in the amount of impervious surface, leading to extremely high flows after rain events, and very low flows during low rainfall periods. Many of these small urban streams cease flowing during drought.

Swift Creek had Poor to Fair water quality in the developed headwaters near Cary and Raleigh, but showed gradual downstream recovery. Stonefly larvae, the most pollution-intolerant of the benthic macro-invertebrate indicator species, did not appear until the most downstream site, and were not abundant at any of the Swift Creek sites.

If impaired urban streams are to be restored within this sub-basin, major investments will be needed by the municipalities in stormwater controls. Because of the need for retrofitting controls in developed areas, costs will be high - probably in the range of several hundred million dollars. In addition, unless preventive measures are taken in the watersheds of currently unimpaired streams, they too will be degraded as development spreads outward from existing urban centers.

Raleigh, Cary and other discharges have already begun addressing nutrient reductions at their wastewater treatment plants. The new nutrient sensitive water (NSW) rules will also require some municipalities and counties to reduce nitrogen loading in stormwater runoff.

Nutrient Loading to Lakes Wheeler and Benson

The two lakes in the study area were evaluated by NCDENR for nutrient enrichment (trophic state) and the presence of a nuisance aquatic weed, *hydrilla*. Earlier samples in this sub-basin had shown a mixture of mesotrophic and eutrophic lakes, but all lakes were classified as eutrophic in 1995. Infestations of *hydrilla* have been recorded in most of these lakes. Spraying with herbicides and/or lake draw down achieved only temporary control in some areas, but stocking with grass carp has been effective in controlling *hydrilla* in Lake Wheeler and Lake Benson.

2.2.2.1.2 Specific Stream Reaches/Water Bodies

Upper Swift Creek, SR 1152 (Holly Springs Road)

Swift Creek at Holly Springs Road (above Lake Wheeler, but downstream of Cary) carries a heavy sediment load from residential and urban areas and tends to have high flow variability that stresses aquatic life. This site was rated as Fair based on benthos sampling in both 1989 and 1995, with no indication of any long-term change in water quality.

Lake Wheeler

Lake Wheeler is located in southwestern Wake County upstream of Lake Benson on Swift Creek. The lake has a drainage area of 38 square miles and a surface area of 12,450 acres (5039 hectares). The lake is relatively shallow with a maximum depth of 30 feet (nine meters) and an average depth of 13 feet (four meters). About half of the watershed is forested, but urban and agricultural areas are also significant. In addition to serving as an auxiliary water supply for the City of Raleigh, Lake Wheeler is used extensively for recreational purposes including sail and motorboat racing, triathlon competitions, and canoe and kayak racing.

Lake Wheeler was most recently sampled in August 1995. The data indicated that the lake was eutrophic at the time of sampling and no violations of state water quality standards were observed. Water lilies and *hydrilla* were observed in the more shallow areas of the lake. Lake Wheeler's uses were supported in 1995.

Lake Wheeler was previously sampled by DWQ in 1981, 1982, 1983, 1985 and 1991. In 1981, the lake was mesotrophic. In 1982, metals were below DWQ laboratory detection levels. In 1985, metals were below DWQ laboratory detection levels except for copper and zinc; however, the concentrations of these metals did not violate state water quality action levels.

In 1985, approximately 50% of the lake was infested with *hydrilla*. Efforts to control the *hydrilla* previously had included both chemical and biological treatments. In September 1985, the NC Division of Water Resources and the NC Wildlife Resources Commission introduced 2,000 sterile grass carp into the lake to serve as a biological control. Visual observations through 1986 indicated little or no control. Therefore, in the spring of 1987, an additional 2,000 carp were introduced into the lake. According to the Division of Water Resources (Dave Demont, Division of Water Resources, personal communication), the *hydrilla* problem in the main part of Lake Wheeler has been under control since due to the grass carp stocking.

Lake Benson

Lake Benson is a man-made impoundment located in southern Wake County. The first impoundment on the site, called Rand's Pond, was built in 1844. In 1927, the City of Raleigh purchased the land and the lake for use as a water supply. The reservoir was expanded in 1953. The lake has a surface area of 440 acres, maximum depth of 19 feet (6 meters) and a watershed area of 65 square miles. The primary tributary is Swift Creek.

Presently, the lake is used as a secondary water supply and for recreation. The topography of the drainage area is characterized by rolling hills with approximately half being forested. Urban land use will undoubtedly play a major role in the development of the watershed, as future development is inevitable.

Lake Benson was most recently sampled by DWQ on September 1, 1995. The more downstream of the two lake stations had a dissolved oxygen violation at the lake bottom. At both sampling sites, values for nutrients, suspended solids, chlorophyll *a* and metals were below the state water quality action levels. Aquatic macrophytes, primarily *hydrilla*, were reported along the shoreline of the lake and at the boat launch area. *Hydrilla* in the lake is currently being controlled with grass carp. Lake Benson was determined to be eutrophic in 1995 and the lake's designated uses were supported.

Lake Benson was previously sampled in 1981, 1983, 1987, 1988 and 1991. In 1981, the lake had dissolved oxygen violations on the bottom. At both sampling sites, values for nutrients, suspended solids, chlorophyll *a* and metals were below the state water quality action levels. In 1987, heavy *hydrilla* growth was observed at the dam and hypoxic conditions were observed on the bottom at the mid-lake sampling station. *Hydrilla* growth in the lake was observed at nuisance levels in 1991, particularly at the more upstream lake sampling station.

As previously indicated the report titled "Assessment Report: Biological Impairment in the Upper Swift Creek Watershed" which is also known as the WARP Report (Watershed Assessment and Restoration Project) represents the most up to date information on the watershed conditions. Monitoring information from the report is presented in the following section and analysis and conclusions are presented in Section 3, Cumulative Analysis.

2.2.2.2 Existing Monitoring Information

In addition to the monitoring documented in the Neuse River Basinwide Water Quality Plan (described in the previous section), other monitoring of the Swift Creek Watershed has been conducted by various agencies and organizations. The purpose of this section of the report is to summarize the available

monitoring data to report on existing watershed conditions, specifically for the portion of Swift Creek within Wake County (HU-110010, and HU-110020), and to identify gaps in available data. This information will be used (in conjunction with other sub-watershed characteristics) to prioritize sub-watersheds (refer to Section 3) and to identify recommended monitoring for Phase II of this project (refer to Section 4.1.2.1).

Several government and non-government agencies have conducted physical and/or chemical monitoring in the Wake County portion of Swift Creek. In 2000, the consulting firm CH2M Hill performed physical, chemical, and biological monitoring of many stream sections in the Swift Creek watershed for Wake County during the development of the County's Watershed Management Plan. DWQ performed chemical, physical, and biological monitoring, as noted in the previous section. USGS has a stream gauge site along one tributary stream and has performed limited chemical testing at that point. Other non-government agencies, such as the Neuse River Basin Association and the Neuse Discharger's Coalition, have performed monitoring.

Figure 2-15 identifies the location of monitoring conducted previously by DENR DWQ, the Lower Neuse River Basin Association, CH2M Hill for the Wake County Watershed Management Task Force (WCWMTF), the Neuse River Discharger's Coalition, and USGS. Sources for the figure include:

- The Wake County Watershed Plan prepared by CH2M Hill, Technical Memorandum No. 2 prepared July 2001 and No. 6 prepared December 2001 and revised September 2002;
- The Assessment Report: Biological Impairment in the Upper Swift Creek Watershed, NCDENR DWQ Planning Branch, June 2003;
- USGS Stream gauge site data for Wake County;
- Draft Swift Creek Summary of Existing Water Quality Data, NCDENR, DWQ, August 2003; (Included as Appendix B of this report) and
- Personal correspondence with DENR staff

Symbols on Figure 2-15 illustrate the monitoring agency while colors on the figure reflect the "worst condition" score of the data (good, marginal, etc.). For example, if a station has a fair score and a poor score, the station is colored "red" to reflect "poor" conditions as indicated by the monitoring data. Each agency monitored their respective locations at least once.

Table 2-17 presents an "at a glance" illustration of the most recent data available in the study area (based on the sources listed above) for the following categories:

- Benthic Macro-invertebrate Data
- Fish Community Data
- Aquatic Habitat Data
- Nutrients
- Turbidity
- Metals

The table also presents the relative scoring of the data in the categories of good (G), fair (F), or poor (P). If analysis of data was unavailable for the scoring, an "X" was placed in the table, and where data had been collected but the stream had not been rated, an "NR" was used. For nutrients and turbidity ratings, "elevated" means that the sampled pollutant was above acceptable levels.

Aquatic habitat ratings were based upon habitat scores given by DWQ during site investigations. Scores ranged from 0 (worst) to 100 (best). In Table 2-17, scores of poor, fair and good were assigned based upon the respective breakdowns of 0 – 33, 34 – 66, 67 – 100. The highest habitat score assigned by DWQ was 80 for Speight Branch at SR 1385.

To further illustrate the data and watershed conditions documented by available data, Table 2-18 was prepared to present the Data Gap Analysis. For each of the 5 primary watersheds, the availability of data, whether the data was old (possibly outdated) and whether the data indicated negative findings (poor ratings, criteria violations, toxicity test failures, etc.) was indicated for the following categories:

- Chemical issues (related to chemical water quality monitoring such as toxicity, nutrient, pH, dissolved oxygen, etc)
- Physical issues (related to stream and habitat assessments)
- Biological issues (related to benthic macro-invertebrate data as well as fish population data)

Figure 2-15 along with Table 2-17 and Table 2-18 illustrate that monitoring activities have thus far focused on Primary Watershed 4 (upstream half of the study area), with some monitoring occurring in Primary Watershed 3, Primary Watershed 5 and a USGS stream gauge located in Primary Watershed 2 near Yates Mill Pond. Monitoring in Primary Watershed 4 has included physical, chemical and biological monitoring and has yielded results that indicate watershed stressors include habitat degradation, toxic impacts and hydrologic modification. Streams in Primary Watershed 4 generally have poor to fair water quality and are affected by the cumulative impacts of urban development.

Table 2-19 summarizes the monitoring results by sub-watershed to give **a general idea of conditions observed in the various sub-watersheds**. **As indicated in the table, poor conditions were observed in 3AX, 4A2, 4 E2 with the majority of poor conditions in Sub-watershed 4A2 (based on an interpreted poor benthic macroinvertebrate score as well as indications of nutrient enrichment, turbidity problems and exceedances in metals criteria and Subwatershed 4E2 (based on poor benthic macroinvertebrate scores in several stations in this Sub-watershed).** Note that while Figure 2-15 presents only the "worst" condition score for each station, Table 2-19 presents all condition scores for the stations in the sub-watershed.

Swift Creek and the sampled tributaries in this area of the watershed have been considered impaired by DWQ for some time. Studies of this area by NCDENR DWQ in 2000 and 2001 confirmed that the impaired status has not changed and indicated that the causes appear to be watershed-wide impacts rather than localized problems that can be readily identified. Some tributaries to Swift Creek in this area have not been sampled, but many of these tributaries drain highly developed areas and are likely to be highly impacted. While full chemical and biological monitoring may not be warranted in these areas in the short term, it would be beneficial to gather stream corridor information through visual inspections to develop a baseline for each stream.

Water quality data is not available for many areas downstream from Holly Springs Road. Primary Watershed 3 contains Lake Wheeler and Primary Watershed 1 contains Lake Benson. Little lake water quality data is available. Data that is available for Lake Wheeler addresses invasive weed control. Reedy Branch and Buck Branch in Primary Watershed 1, and numerous other unnamed tributaries throughout the watershed, have not been monitored. Water quality monitoring is warranted in these areas. However, given the sizes of these streams, chemical and biological monitoring of these streams is not practical. Obtaining stream corridor data by walking these streams to gather physical condition data could prove valuable.

Primary Watersheds 2 and 3 have limited water quality data. Sampling in these areas is also warranted, though access to some areas may be limited due to terrain. Yates Branch is the largest tributary stream in these Primary Watersheds, and contains a USGS monitoring station.

More information is presented on the cumulative analysis of available data in Section 3, Cumulative Analysis and more information is presented on recommended monitoring in Section 4.2.

2.2.3 Land Use/Historic Trends Analysis

While previous sections characterized sub-watersheds based on natural resources and documented watershed conditions, this section focuses on characterizing the sub-watersheds based on trends such as population growth and land use. In addition, this section discusses projected trends in land use and infrastructure as well as existing potential pollution sources in the study area.

2.2.3.1 Population Study

To illustrate population trends in the Swift Creek Study Area, US Census data from 1990 and 2000 were utilized. Using GIS, the two data sets were compared to generate population rate changes from 1990 and 2000. Figure 2-16 presents population rate changes in the following categories:

- 10-20% population increase
- 20-30% population increase
- 30-40% population increase
- 40-50% population increase
- 50-60% population increase
- 60-80% population increase
- 80-90% population increase
- 100-150% population increase
- Greater than 150% population increase

The figure illustrates how population has increased over 100% for Sub-watersheds 5XX (Dutchmans Creek) and 4E1 (Apex) as well as for Sub-watersheds 4E2 and 4BX (Cary). The dramatic increase in population in Dutchmans Creek is expected since it was essentially undeveloped during the 1990 Census. The dramatic increases in the sub-watersheds located in Cary and Apex are due to higher development in the incorporated areas as well as the location of major highways in these areas (Hwy 1 and Highway 64). To further illustrate population changes for the sub-watersheds, weighted average population changes were calculated for each sub-watershed as presented in Table 2-20. A macro routine was written with ArcInfo to efficiently tabulate the weighted average of population change within each sub-watershed. The routine automatically determined the amount of area for each population tract and applied these totals to the total area of the sub-watershed in order to calculate an overall population change for the entire sub-watershed. **The table indicates that the highest population increase is in Sub-watershed 4BX located in Cary with a weighted average population increase of almost 300%.**

The analysis presented above is consistent with direct analysis of population growth for Cary and Apex using Census data. For example, Cary's population increased from 7,640 in 1970 to over 96,000 in 2000. Apex's population increased threefold since 1980 to the current population of over 20,000.

2.2.3.2 Land use and Associated Imperviousness

Land use trends in the study area were analyzed using available land use and/or land cover data including the following:

- 1976 Land Cover Data from EPA
- 1996 Land Cover Data from EPA
- 1999 Land Use Data from EPA
- Future Land use based on zoning from the municipalities of Apex, Cary, Garner, Raleigh and Wake County

Since the 1999 dataset was the most recent land use data available, it was selected to portray existing conditions in the watershed. The 1999 land use was developed from the Landscape Characterization Branch of EPA based on interpretation of SPOT 4 and Landsat 7 Satellite imagery from October of 1998 to October of 1999. In addition, this data set was utilized for the Wake County Watershed Management Plan in the following aggregated land use categories and associated imperviousness:

1) Urban – high density (85%)

2) Urban – medium density (53%)
3) Urban – low density (22.5%)
4) Agriculture (2%)
5) Woody Vegetation (1%)
6) Water (0%)
7) Wetlands (1%)
8) Barren (1%)

Additional information is presented in Appendix C of the Watershed Assessment and Restoration Project (WARP) report (June 2003) including associated imperviousness for each of the land use categories.

Since the 1999 land use was selected as the baseline condition for existing land use, the other land use and land cover data sets required manipulation into the seven land use categories listed above for comparison purposes. The manipulation required assumptions to be made about the various land cover data sets based on land cover descriptions and associated imperviousness and aggregation into the seven land use categories. Because of this, the land use trends analysis has some limitations. In some areas, a comparison of land use from an earlier year (1976 or 1996) with the current land use (1999) indicated a decrease in development (which is not feasible). However, for purposes of this local watershed plan and more specifically, for prioritizing sub-watersheds based on trends, the analysis has proven useful. This is especially true since the land use trends analysis was used in conjunction with other characterization parameters for the prioritization.

The earliest land cover data set is presented in Figure 2-17 and represents land cover for 1976. Table 2-21 presents the acres per sub-watershed for the various land use categories. In addition, the table indicates the percentage of each land use category in each sub-watershed. As illustrated in the table, as well as on the inserted pie chart on Figure 2-17, the land use distribution in 1976 (in order of dominance) in the watershed is as follows:

1) Woody Vegetation – 61%
2) Agriculture – 16%
3) Urban – medium density – 10%
4) Urban – high density – 8%
5) Water – 3%
6) Urban – low density – 2%
7) Wetlands – 1%
8) Barren – 0%

The 1996 land cover data set is presented in Figure 2-18 and Table 2-22. As indicated in the table and pie chart, the land use distribution (in order of dominance) is as follows:

1) Woody Vegetation – 60%
2) Wetlands – 17%
3) Urban – medium density – 7%
4) Urban – high density – 5%
5) Agriculture – 4%
6) Urban – low density –6%
7) Water – 3%
8) Barren – 0.1%

Existing land use based on the 1999 data is presented in Figure 2-19 and Table 2-23. This data set represents the "most realistic" land use of the various data sets examined and has the following distribution:

1) Woody Vegetation – 42%
2) Urban – low density –28%
3) Urban – medium density – 12%
4) Agriculture – 7%
5) Urban – high density – 4%
6) Wetlands – 3%
7) Water – 3%
8) Barren – 0.2%

To more fully illustrate land use trends in the Swift Creek Watershed, rates of impervious increases were analyzed. The analysis was completed using GIS to calculate impervious increases and aggregation of the impervious increases in the categories of:

- No change
- 1-10% increase in imperviousness
- 10-25% increase in imperviousness
- 25-40% increase in imperviousness
- 40-55% increase in imperviousness
- 55-70% increase in imperviousness
- 70-85% increase in imperviousness

Review of the red highlighted areas on Figure 2-20 illustrates the "hot spots" of development in the watershed since red indicates an impervious increase of 70-85%. As suspected, there are red markings in the incorporated areas of the study area (including Apex, Cary, Raleigh and Garner) as well as in areas along the major highways (including Highway 1, Highway 64, Highway 401 and Highway 70).

Figure 2-21 illustrates the impervious rate of change from 1996 to 1999. The figure illustrates a similar pattern to that of Figure 2-20 in that the hot spots of development are in the incorporated areas and along the major highways. Table 2-24 presents the dominant rate of impervious change for each sub-watershed. Since this analysis represents a relatively short time period of three years, the dominant rate of impervious change for each sub-watershed was zero.

Projected land use or future land use based on zoning is illustrated in Figure 2-22 and Table 2-25. The figure illustrates the difference between the detailed 1999 land use data set and the future zoning "blocks". The projected land use distribution is as follows:

1) Urban – low density –49%
2) Urban – medium density – 27%
3) Urban – high density – 18%
4) Water – 4%
5) Woody Vegetation – 2%
6) Agriculture – 0%
7) Wetlands – 0%
8) Barren – 0%

Note that the zoning data sets provided by the various municipalities did not include agriculture, wetlands or barren lands. To illustrate projected hot spots of development, the 1999 land use and future land use data sets were compared in order to develop the projected impervious rate of change (Figure 2-23). The dominant rate of impervious change from 1999 to the future is presented in Table 2-26.

Figure 2-23a and Table 2-26a present the weighted average percent imperviousness for each sub-watershed based on the 1999 land use data. As indicated in the table and figure the Sub-watersheds with the highest imperviousness include:

- **4E2 at 29%**
- **4BX at 27%**
- **1EX at 27%**

In addition to comparing land use data sets, land use changes can be interpreted from examination of historical aerial photographs. While Figure 2-24 presents an aerial photograph from 1949, Figure 2-25 presents an aerial photograph from 1981 (over 30 years later). Although the quality of the historical aerials is limited and there are some gaps in available data, the figures clearly indicate an increase in development in the study area – especially in the incorporated areas of Cary, portions of Raleigh and Garner.

2.2.3.3 Transportation Projects and Other Projected Infrastructure

Trends in development can often be determined with projected infrastructure such as transportation improvement projects (TIPs) or planned expansions in sewer lines. Businesses will be located in these areas and residential subdivisions will be built in these areas. Figure 2-26 illustrates the transportation improvement project in the Swift Creek Study Area which involves improvements to Highway 1 in the Cary portion of the study area and extending across Sub-watershed 4CX, 4BX, and 4DX.

2.2.3.4 Potential Pollution Sources

Potential pollution sources in the watershed indicate areas of potential concern in the watershed. The potential pollution sources in the Swift Creek Watershed are presented in Figure 2-27 and include the one NPDES discharge permit in the study area (in Sub-watershed 2A3). Other potential sources of pollution include confined animal operations such as the swine operation in Sub-watershed 2A1, the cattle operation in Sub-watershed 2B1, landfills in Sub-watersheds 2B2 and 2A3, and a hazardous waste site in Sub-watershed 2A2. In addition, existing sewer lines can be sources of pollution if the infrastructure is aging and deteriorating and releasing pollutants into the environment. Existing sewer lines are illustrated in Figure 2-27 in the incorporated areas of the study area. On the other hand, septic tanks can also be potential sources of pollution. Although not illustrated on the figure, the locations of septic tanks can be estimated based on a comparison of aerial photography and the existing sewer lines. Essentially, any homes not on existing municipal sewer systems are most likely on a septic tank system.

2.2.4 Local Programs/Initiatives

In addition to being characterized by its natural resources, documented watershed conditions, land use and trends (presented in previous sections), the Swift Creek Watershed is also characterized by the programs and initiatives of its local jurisdictions. The programs provide insight on the watershed management objectives throughout the study area (including protection of stream buffers and open spaces, as well as erosion control and development restrictions). The purpose of this section is to discuss the various initiatives planned or underway throughout the study area.

Municipalities within the Swift Creek Watershed include Apex, Cary, Garner, and Raleigh as well as unincorporated Wake County. "Wake County, and its local government partners within the County, have implemented a number of policies, ordinances, rules and regulations (tools) to address water quality and stream degradation issues for both inside and downstream of the County. *"(WCWMPTF, 2003)*

Table 2-27 Area of Local Governments in Swift Creek

Municipality	Approximate Area	Percentage of Area in Swift

	in Swift Creek (acres) *	Creek
Apex	1,976	5%
Cary	11,126	28%
Garner	7,071	18%
Raleigh	3,290	8%
Wake County	16,771	41%

*: Extracted from the Swift Creek Land Management Plan.

The County has focused on the following primary tools as described by the Center for Watershed Protection:

- Erosion and Sediment Control
- Land Conservation
- Stormwater Treatment Practices
- Aquatic Buffers
- Non-Stormwater Discharges
- Better Site Design
- Watershed Stewardship Programs

Wake County and the Swift Creek municipalities have made considerable progress in addressing these watershed issues as illustrated in the following table:

Table 2-28 Summary of Local Program and Initiatives Interviews

	Stormwater NPDES Permit Status	Watershed Program	Neuse Stormwater Program	Rip. Buffer Program	Sed. And Erosion Control Program	Allow Cluster Devel.	Growth Mgt Plan	Open Space Plan	NFIP
Apex	Phase 2	✓	N/A	✓	yes	✓	O	O	✓
Cary	Phase 2	✓	✓	✓	yes	✓	X	X	✓
Garner	Phase 2	✓	✓	✓	Wake Co.*	✓		O	✓
Raleigh	Phase 1	✓	✓	✓	yes	✓	O	X	✓
Wake County	Phase 2	✓	✓	✓	yes	✓	O	X	✓

✓ *Meets or exceeds requirements*
N/A Does not apply to this jurisdiction
X Plan adopted
O Plan in process
* *Garner's Sediment and Erosion Control program is delegated to Wake County.*
NFIP- National Flood Insurance Program

Stormwater NPDES Permits

The City of Raleigh was subject to the first phase of the NPDES stormwater permits. Apex, Cary, Garner and Wake County not previously subject to federal stormwater requirements were required to apply for stormwater permit coverage by March of 2003 (WARP, 2003). The permit involves six minimum measures including public education, public involvement, illicit discharge detection, construction site runoff control, post construction management, and pollution prevention.

Watershed Program

A Watershed Management Task Force was involved in the development of the Wake County Watershed Plan. The Plan identified actions to further protect and restore water quality. Additional information is provided on **http://projects.ch2m.com/WakeCounty.**

Neuse Stormwater Program
The Neuse River Basin Stormwater Rules include restrictions on nitrogen loading from new development, implementation of public involvement programs, identification of illegal discharges, and identification of suitable stormwater retrofits.

Riparian Buffers
The riparian buffer requirements of North Carolina's water supply watershed regulations and the Neuse River Basin Rules apply to the study area although some municipalities have even more restrictive buffer requirements (refer to the sections below presenting information specific to municipalities).

Sediment and Erosion Control Programs
The municipalities in the study area all have delegated programs under North Carolina's Sedimentation Pollution Control Act and therefore, regulate sedimentation and erosion from construction sites. Refer to the sections below presenting information specific to municipalities.

Open Space Plan
As previously indicated in Section 2.2.1.8, Wake County has an active open space program in the Swift Creek Watershed and preservation opportunities will be identified in the Swift Creek corridor as part of the local watershed planning efforts.

The municipalities located in the Swift Creek watershed are all involved in Wake County's open space program and have each developed open space and greenway programs. Having the Ecosystem Enhancement Program networking into these already coordinated initiatives may provide additional opportunities in the watershed.

The municipalities within Wake County as well as the County itself have distinctive program elements and priorities as described in the following sections.

Swift Creek Land Management Plan
The Swift Creek Land Management Plan (Plan) was jointly developed in the late 1980s and early 1990s by Wake County, Raleigh, Cary, Garner and Apex to guide development in the watersheds of Lake Wheeler and Lake Benson to protect water quality in those existing or potential water supply reservoirs. Adopted in 1990, the Plan was developed on the premise that good water quality management practices can be enforced by limiting the density of future growth, controlling point source discharges, and applying regulations to maintain the Swift Creek WS-II water supply watershed classification. The plan established critical areas and stream buffers for the following areas:

- Lake Benson (Sub-watershed 1AX)
- Swift Creek between Lakes Benson and Wheeler (Sub-watershed 3BX)
- Lake Wheeler (Sub-watershed 3BX)
- Swift Creek upstream of Lake Wheeler (Sub-watersheds located in Primary Watershed 4)
- Little Swift Creek and Yates Mill Creek (Subwatersheds located in Primary Watershed 2)
- Drainageways

In addition, the Plan established minimum performance standards (such as imperviousness limitations) for the critical and non-critical areas for new development (they are not proposed to effect existing or already approved development). Because of this, the Plan mostly applies to the less developed portions of the Swift Creek Watershed downstream of Holly Springs Road. As indicated in the Plan, **"the proposed impervious surface limit is 6% in the critical area and 12% in the non-critical area for areas without stormwater control measures. The proposed maximum impervious surface limit is 30% except for those areas designated as: a) critical: urban limited residential or (b) non critical: new urban residential and nonresidential, or existing urban."**

Additional information including maps is presented on www.wakegov.com/county/zoning/landplans. As previously indicated in Table 2-26a (presenting weighted average percent imperviousness for each sub-watershed), some of the sub-watersheds are close to the impervious limit guidance of 30%. The Plan also identifies issues for additional study including impoundments serving multiple properties, removal of existing point source discharges, sewer lines passing through critical areas, general enabling legislation, low pressure wastewater disposal systems, road construction standards and the amount of non-residential development to be allowed.

Apex

Apex is currently utilizing a 2010 land use plan available from the Planning Department with a new Comprehensive Plan under development. A Unified Development Ordinance (UDO) is available on the Apex website. Under the UDO, 40% of land in new development in the Resource Conservation Area is dedicated to Open Space. The Growth Management Plan is available online at http://www.apexnc.org/docs/plan/cp_growth_alts.pdf.

Apex utilizes a 100-foot riparian buffer on perennial streams and 50 foot on intermittent streams. Grading is allowed in the outer 20 feet of the buffer. The buffer regulations do not allow any uses dependent on mitigation. No residential development is allowed in the 100-year flood plain.

Current Apex ordinances require the capture of runoff from one inch of rain on properties exceeding 12% impervious area. The Town is considering the addition of requirements for 1 year and 10 year storm retention. The Town already has an 85% Total Suspended Solid removal requirement on these properties. Apex is not under the Neuse Rules and does not have a requirement for nitrogen reduction. However, the NPDES Phase II illicit discharge requirements will include a setback for use of fertilizers in the vicinity of the storm drainage system.

The Town of Apex does not have current plans for a restoration project and such a site would be difficult to obtain since the Williams Creek portion of the Swift Creek study area is essentially built out. The major new road project in the study area is the extension of the Apex Peakway inner loop from Old Raleigh Road across Laura Duncan to North Salem Street.

Apex has recently entered into a joint study, the Secondary Cumulative Impact Mitigation Program (SCIMP), related to the effects of wastewater on the Dwarf Wedge Mussel in the Swift and Middle Creeks. The project will be carried out in cooperation with Cary and Holly Springs.

The highest priority for clean water related projects is the 160 acre Nature Park and Environmental Education Center at the Beaver Creek Greenway, with land to be obtained with planned funding from the Clean Water Management Trust Fund, the Town Parks and Recreation Trust Fund, the Wake County Open Space Preservation Program, and the Ecosystem Enhancement Program. The Town believes this site might serve as a reference reach as an urban stream from the Highway 64/65 intersection through the urban setting. This would be a good opportunity for reference monitoring to test the results of future best management practices (BMPs).

Cary

The Town of Cary has led the State in many aspects of its stormwater and watershed programs. Cary is a signatory of the Swift Creek Watershed Management Plan, which imposes strict limits for impervious surface in a 950 acre area within the Town of Cary. Currently, based on plans for development in the Town Center Area Plan, approximately 25 acres of this protected area will exceed the standards for impervious surface. Cary is proactively seeking alternative strategies and has contracted with a consultant to study mitigation possibilities for downtown redevelopment.

Cary has recently entered into a joint study, the Secondary Cumulative Impact Mitigation Program (SCIMP), related to the effects of wastewater on the Dwarf Wedge Mussel in the Swift and Middle Creeks. The project will be carried out in cooperation with Apex and Holly Springs.

There are new ordinances targeted at reducing nitrogen runoff from new development and for regulating illegal discharges to the storm drain system. These ordinances include a new riparian buffer requirement for new development. The Town of Cary enforces a 100-foot buffer on perennial streams lakes, and ponds (with 50 feet on soil survey streams); this is in excess of the 50 -foot Neuse Rules buffers and applies to the entire jurisdiction of the Town rather than just to the portion in the Neuse Basin.

Cary does not allow any development in floodplains and does not plat residential lots in the riparian buffer. Cary is a delegated community with respect to Erosion and Sediment Control. The Town has its own standards that are more stringent than the State Minimum. Cary reviews, improves, and inspects local erosion control plans and activities.

Cary is a designated NPDES Phase II community based on the 1990 Census. The Town has submitted a Permit Application to the Division of Water Quality under the final temporary rules and is currently waiting for its permit to be issued. The Town will complete the second part of its Stormwater infrastructure inventory in February 2004. This inventory will contribute to detection of illicit discharges impacting the study area.

Cary's Growth Management Plan (http://www.townofcary.org/depts/dsdept/P&Z/growth/tasklist.htm)has led to the preparation of two detailed studies. The Town Center Plan and the Northwest Cary Plan are currently in place. The Southeast Gateway Plan is under consideration. No specific growth projections have been performed on the Swift Creek study area. The Town Council has set aside $12.5 million for open space purchases and protection.

Currently the Town of Cary practices internal mitigation banking in the Swift Creek area. A mitigation plan has been submitted to DWQ for a highway widening involving an unnamed tributary of Swift Creek at Maynard Road. The Town may be interested in a jointly funded Watershed Restoration Project involving Town-owned property at the Annie Jones Greenway, within the Swift Creek study area.

Garner
Garner relies on Wake County to implement its Sediment and Erosion Control Program. The Town has a Swift Creek Overlay District reflecting its signatory status to the Swift Creek Land Management Plan. Garner has ordinances for managing flood-plain development and watershed protection. In addition, the Town has adopted the Neuse Rules riparian buffers and rules for Nutrient Sensitive Waters (NSW). Garner recently received approval for its Regional Retention Pond BMP Retrofit Plan to install BMPs in the Swift Creek watershed. http://www.ci.garner.nc.us/Engr_StormwaterPgm.htm. Garner has no current plans for cooperative joint projects with Wake County or other municipalities.

Raleigh
The City operates its own Sediment and Erosion Control Program with standards that exceed the State minimum. The City approves plans and conducts on-site inspections of erosion control measures.
http://www.raleigh-nc.org/cengineering/Work_In_Progress/stormhome.htm

The City of Raleigh has adopted watershed protection rules that are included in the Planning Ordinance. Raleigh follows the Neuse buffer rules and has tight controls on floodplain development. Flood fringe development is allowed only with elevation. Raleigh follows the Neuse NSW restrictions.

Raleigh is not currently conducting any 404 mitigation projects. Raleigh has not conducted any watershed studies in the Swift Creek study area. The City does have an interest in such a study including erosion and pollutant sampling/monitoring. The City is particularly concerned with the Lake Benson water supply watershed and has budgeted $55 million in 2004-2005 for construction of a water treatment plant at Lake Benson.

Wake County
Wake County conducts its own Sediment and Erosion Control Program and also conducts the Program for the Town of Garner. Wake County is part of the Swift Creek Land Management Plan and is under

Neuse rules for riparian buffer and NSW nitrogen regulation. The buffer exceeds minimum requirements with a 100 ft. setback (50 ft. in zone 1- undisturbed vegetation.)

Wake County has a current land use plan on its website http://www.wakegov.com/county/zoning/landplans/wclup.htm#plan and is developing a new Unified Development Ordinance early this year. The growth plan does not provide a basin specific estimate for the Swift Creek study area. Wake County has recently had watershed plans done in all watersheds in the County.

Wake County controls minimum lot size with a requirement of 40,000 sq. ft. in non-critical areas and 80,000 sq. ft. in critical areas. The County would be interested in partnering with the State and municipalities in developing and monitoring standards for Low Impact Development.

Contacts

Table 2-29
Summary of Contacts for Local Program and Initiatives Interviews

Danny Bowden	City of Raleigh	Stormwater Division	(919) 890-3030
Betsy Pearce	Town of Cary	Stormwater Engineering	(919) 462-3932
Michael Babuin	Town of Cary	Engineering	(919) 462-3931
Frank Powell	Town of Garner	Engineering	(919) 772-4688
Dan LaMontagne	Town of Apex	Erosion Control	(919) 249-3413
Mike Coughlin	Wake County	Stormwater	(919) 856-6193

2.2.4 Summary and Gap Analysis

The previous sections have presented the following data:

- Natural Resources Data (available for all sub-watersheds)
- Documented Watershed Conditions (primarily available for the portion of the study area upstream of Holly Springs Road)
- Land Use/Historic Trends Analysis (available for all sub-watersheds)
- Local Programs and Initiatives (available for all sub-watersheds)

As indicated above, the study area has been well characterized by available data (presented in figures and tables by sub-watershed) except for documented watershed conditions for the area downstream of Holly Springs Road. Recommendations to address this gap in characterization are presented in Section 4.1.

2.3 Visual Assessment Atlas

In addition to the review of existing data and information to characterize the Swift Creek Watershed (including natural resources, documented watershed conditions, watershed trends and local programs), a "windshield survey" was conducted to document observed watershed conditions. Referred to as the visual assessment of the watershed, it involved written and photographic documentation of watershed conditions as well as documentation of any observed potential mitigation opportunities. A complete report including characterization by sub-watershed and an atlas of restoration, preservation and best management practice (BMP) opportunities is presented as Appendix C. The purpose of this section is to summarize the visual assessment report including observed conditions and potential mitigation opportunities.

2.3.1 Methodology

Visual assessment of the watershed was conducted in October and November 2003 and was limited to two days of assessment of the watershed along public rights-of way. Over 50 locations, accessible from public access corridors, were identified for review, in order to determine the general characteristics of the

watershed. These observation locations corresponded to areas of stream crossings on public lands (primarily transportation corridors and parks). At each of these locations, general site characteristics and an assessment of potential mitigation opportunities were noted. As part of the visual assessment, general patterns of land use were reviewed, and standard visual assessment field forms were completed for the observation locations.

The field forms included information easily gathered in a windshield survey. The data collected was qualitative in nature so that relative assessments and comparisons could be made. Information collected included the following:

- Adjoining Land Use – with the following characterization choices:
  - Agriculture
  - Silviculture
  - Residential
  - Commercial/Industrial
  - Open Space
  - Open Water

- Water Quality
  - Odor
  - Obvious Gross Contamination
  - Cloudy, Turbid

- Man-Made Features
  - Dam
  - Reinforcement
  - Utility Crossings
  - BMPs
  - Piped
  - Outfalls/ditches

- Upland Buffer
  - Absent (barren soil)
  - Present (forested/woody)
  - Manicured (grass)
  - Agricultural (pasture/crops)
  - Developed (fill/impervious)

- Bank/Slope Buffer
  - % vegetation/shade
  - Vegetation Type

- Channel Blockages
  - Type
  - Extent

- Floodplain
  - Present
  - Absent

- Wetlands
  - Present
  - Absent

- Channel/Bank Condition
  - Condition
  - Stability Problem
  - Vegetated Bank/Buffer
  - Channelized
  - Relocated
  - Incised

Detailed habitat, water quality, channel geomorphology, land use, etc. were not gathered since this type of data is out of the scope of this phase of the project. The field reconnaissance was limited to areas accessible by walking within transportation corridor right-of-ways or existing cleared pathways.

The locations chosen for observation were based on the following criteria: 1) Characterization of the 20 sub-watersheds and2) Assessment of land use, major water bodies, and available access. A total of 56 locations were identified for the visual assessment and are illustrated in Figure 2-28. The figure indicates the visual assessment site number as well as the surrounding land uses (since the sites are overlaid on the 2002 aerial photography).

For each watershed, locations were chosen which would provide a general sampling of the stream reaches (by stream order) and water bodies as well as land uses. As an example, if a major water body was located in the sub-watershed, an assessment location was chosen upstream and downstream on the main stream reach or water body. Additional locations were selected on contributing tributaries in primary land uses and along a couple stream order lengths, as appropriate.

In addition to the assessment of streams, habitat, and water quality observations at road crossings, several areas representative of various development activities (land use) were reviewed. These areas were divided into two general categories: agricultural and urban/suburban development. For these locations, general land use practices, characteristics, and conditions were assessed and noted by driving the area. Characteristics included density of development, development techniques (clear cutting versus natural grades, cluster), stormwater management practices, open spaces and any evident water quality protection measures. Representative areas for each sub-watershed were visually assessed.

2.3.2 Observations

Observed conditions at the 56 visual assessment sites are summarized in Table 2-30 and illustrated in Figure 2-29. Table 2-30 includes the sub-watershed identification, nearest road, municipality(s), water body(s), observed condition and potential mitigation opportunity(s) (discussed in more detail in the following section). Figure 2-29 illustrates the locations and conditions of each of the 56 visual assessment sites on the transportation network of the study area. As indicated in the table and figure, observations in the Swift Creek Watershed included:

- Good – 1 site (less than 2%)
- Fair to Good – 10 sites (approximately 18%)
- Fair – 8 sites (approximately 14%)
- Poor to Fair – 21 sites (approximately 37%)
- Poor – 16 sites (approximately 29%)

Therefore, the majority of the sites are in poor condition based on the information documented on the visual assessment field forms and photographs (refer to the first appendix within Appendix C of this report for additional information). A summary of the observed conditions by sub-watershed is presented in Appendix C of this report. Note that only one sub-watershed (2AX) of the 20 was not characterized by the visual assessment.

2.3.2 Potential Mitigation Opportunities

During the course of the visual assessment in the Swift Creek Watershed, five potential mitigation opportunities were identified and are illustrated in Figure 2-30. These opportunities are for wetland, stream, and riparian buffer restoration and include the following:

- I – Kildaire Farm Road (Swift Creek) in Sub-watershed 4BX
- II – Holly Springs Road (Dutchmans Creek) in Sub-watershed 5XX
- III – Blaney Franks Road (Dutchmans Creek) in Sub-watershed 5XX
- IV – Mid Pines Road/Lake Wheeler Road (Unnamed Tributary to Yates Mill Branch near NC State Agricultural Labs)
- V – Lake Wheeler Road (Yates Mill Pond) in Sub-watershed 2B2

Note that opportunities for urban BMP improvements will require additional detailed field assessment, planning/coordination with zoning/municipal jurisdictions, and review of existing stormwater management plans.

More detailed information on the five potential mitigation sites is provided in Appendix C of this report and includes the following:

- Description of site location
- Associated Sub-watershed
- Description of area surrounding site
- Description of potential mitigation opportunity
- Comments (as appropriate)
- Photographs (including views upstream and downstream)

2.4 Summary of Characterization

The purpose of this section is to summarize the characterization of the Swift Creek Watershed presented in previous sections addressing the following information:

- Available data documenting watershed conditions
- Problem areas based on existing data
- Visual assessment problem areas
- Visual assessment mitigation opportunities
- Local programs and initiatives
- Trends analysis

Characterization forms for all 20 of the sub-watersheds are presented in Appendix D. The first two pages of the forms include the following characterization information:

Resource Statistics

- Stream lengths
- Water supply watershed lengths
- 303 d listed stream lengths
- Unbuffered streams (development in the 300-foot buffer)
- Floodplains
- Hydric Soils
- Wetlands
- Habitat
- Public – Protected Lands/Open Space
- Natural Heritage element occurrences
- Significant Natural Heritage Areas
- Archeological sites
- Historical sites

- Point Source discharges/potential pollution sources

Additional Information

- Existing monitoring data availability
- Existing monitoring data condition
- Visual assessment condition
- Visual assessment mitigation opportunities

Land Use and Other Trends

- 1996 land use distribution
- 1999 land use distribution
- Change from 1996 to 1999
- Population trends from 1990 and 2000
- Future land use distribution
- Projected impervious increase from 1999 to future land use

Note that information on the first and second pages of the sub-watershed characterization forms in Appendix D was discussed in more detail in Sections 2.2 through 2.3 of this report.

Table 2-31 provides an "at a glance" summary of select characteristics for all 20 sub-watersheds:

- Hydrologic Unit
- Municipal Jurisdictions
- Water Body(s)
- Drainage Area in square miles, acres and percentage of total study area
- Length of Water Supply Watershed streams and percentage in sub-watershed
- Length of 303d listed streams and percentage in sub-watershed
- Acres of floodplain and percentage in sub-watershed
- Acres of wetlands and percentage in sub-watershed
- Acres of protected lands and percentage in sub-watershed
- Documented water quality conditions
- Visual assessment condition
- Potential mitigation site identified

Additional information is presented in the following section, Cumulative Analysis and Prioritization.