Brunswick County
Interbasin Transfer Petition

Prepared for

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Executive Summary

Brunswick County (County), through Brunswick County Public Utilities, provides water to more than 34,000 retail customers and 11 wholesale customers through its two water treatment plants (WTP). The Northwest WTP is located near the City of Northwest and supplied by water from the Cape Fear River via the Lower Cape Fear Water and Sewer Authority. The 211 WTP, near the Town of St. James, is supplied by groundwater wells into the Castle Hayne Aquifer. To meet future demand for water, the County is considering expansion of the Northwest WTP. The expansion is expected to trigger the need for an interbasin transfer (IBT) certificate from the North Carolina Environmental Management Commission (EMC) under the Regulation of Surface Water Transfers Act. A portion of the surface water treated at the Northwest WTP in the Cape Fear IBT River Basin (and Cape Fear Major River Basin) is distributed to customers in the Shallotte IBT River Basin and the Waccamaw IBT River Basin, both of which are in the Lumber Major River Basin.

Under the grandfather provision of the Regulation of Surface Water Transfers Act, the County may transfer up to 10.5 MGD from one designated river basin to another without an IBT certificate. The County is requesting an IBT certificate from the EMC for an increase of 7.8 MGD over the grandfathered transfer, with all the increase going to the Shallotte IBT River Basin and resulting in a maximum transfer from the Cape Fear IBT River Basin of 18.3 MGD. This increase is based on water demand projections and need through approximately 2042, representing nearly a 30-year period for the IBT certificate. No increase in IBT is being requested for the Waccamaw IBT River Basin: minor growth is expected in this area and future water will be supplied by the Little River Water and Sewerage Company in South Carolina via an agreement with the County.

The certification process was initiated by the County in February 2009 by filing a Notice of Intent (NOI) to File a Petition to the EMC as described in G.S.§143-215.22L(c). The NOI letter described the County's plan to petition for an IBT. As required by the IBT provisions in effect during that time, public notice was given, and four public meetings were held. In addition, a scoping document was circulated through the State Environmental Review Clearinghouse.

The County prepared an environmental assessment (EA) pursuant to the procedures and standards set out in G.S.§143-215.22I effective July 1, 2007, as specified in Session Law 2010-155 passed by the North Carolina General Assembly in the summer of 2010. The EA supports the request for an IBT certificate only and does not involve any construction activities. Any potential impacts associated with construction of WTP improvements or associated distribution upgrades would be reviewed under environmental documents prepared specifically for these projects as required by statute and regulation. An EA for the plant expansion and associated improvements as described would be prepared and reviewed if an IBT certificate is approved.

The EA includes detailed descriptions of environmental characteristics in the source and receiving basins, an analysis of alternatives considered to IBT, analyses of the potential impacts, and mitigation to reduce the potential impacts to an insignificant level. Additional IBT associated with an expansion of the Northwest WTP is recommended as the preferred alternative because of a lower cost (capital, O&M), low technical difficulty, an equivalent or lower level of permitting difficulty, a low level of direct impacts, and an equivalent level of secondary and cumulative impacts.

Combined with additional IBT associated with the expansion of the Northwest WTP, the County proposes to use a combination of measures to limit the transfer of water. Water conservation and reuse are key elements of the County's current water management plan, and they already reduce water demand and associated IBT of water. In addition, the County has reduced the need to transfer additional water by developing an interconnection and agreement to purchase water from the Little River Water and Sewerage Company for future potable water service in the Waccamaw River subbasin. The County is conducting a study to assess the feasibility of residential water reuse (costs, demand and public acceptance issues) at the Saint James Plantation and Winding River developments. The County estimates that these developments might have a seasonal reclaimed water demand of up to 1.3 MGD. Finally, the County is planning a study of aquifer storage and recovery at the 211 WTP to reduce withdrawal of surface water during peak demand periods.

The EA was provided for review to the NC Division of Water Resources (NCDWR), other agencies within the Department of Environment and Natural Resources, US Fish and Wildlife Service, NC Wildlife Resources Commission, and through the State Environmental Review Clearinghouse as required by statute. NCDWR issued a Finding of No Significant Impact for the proposed IBT in April 2013.

The next step in the certification process is a petition to the EMC for an IBT certificate. This petition for an IBT certificate is organized to address the following nine primary elements:

1. Facilities used to transfer water.
2. Proposed consumptive and nonconsumptive uses of the water to be transferred.
3. Water quality of the source river and receiving river, including information on aquatic habitat for rare, threatened, and endangered species; in-stream flow data for segments of the source and receiving rivers that may be affected by the transfer; and any waters that are impaired.
4. Water conservation measures used by the applicant at the time of the petition and any additional water conservation measures that the applicant will implement if the certificate is granted.
5. Analysis of alternative sources of water within the receiving river basin.
6. Registered water transfers and withdrawals from the source river basin and planned transfers or withdrawals.
7. How the proposed transfer, if added to all other transfers and withdrawals within the source basin would not reduce the amount of water available for use to a degree that would impair existing uses or existing and planned uses of the water.
8. Present and future water supply needs of the County and other public water systems with service area located within the source river basin.
9. The County's Local Water Supply Plan.

1 Introduction

Brunswick County (County), through Brunswick County Public Utilities, provides water to more than 34,000 retail customers and 11 wholesale customers through its two water treatment plants (WTP), Northwest WTP and 211 WTP. To meet future demand for water, the County is considering expansion of the Northwest WTP, which treats raw water from the Cape Fear River, from 24 to 36 MGD. The expansion is expected to trigger the need for an interbasin transfer (IBT) certificate from the North Carolina Environmental Management Commission (EMC) under the Regulation of Surface Water Transfers Act since a portion of the surface water treated at the Northwest WTP in the Cape Fear IBT River Basin is distributed to customers in the Shallotte IBT River Basin and the Waccamaw IBT River Basin.

Under the grandfather provision of the Regulation of Surface Water Transfers Act, the County may transfer up to 10.5 MGD from one designated river basin to another without an IBT certificate. The County is requesting an IBT certificate from the EMC for an increase of 7.8 MGD over the grandfathered transfer, with all the increase going to the Shallotte IBT River Basin and resulting in a maximum transfer from the Cape Fear IBT River Basin of 18.3 MGD (Table 1). This increase is based on water demand projections and need through approximately 2042, representing nearly a 30-year period for the IBT certificate. No increase in IBT is being requested for the Waccamaw IBT River Basin: minor growth is expected in this area and future water will be supplied by the Little River Water and Sewerage Company in South Carolina via an agreement with the County.

Table 1. Brunswick County Maximum Daily Surface Water Transfer (Actual 2010; Projected 2020 – 2050)

Year	Total Water Demand (MGD) – Max Day	Withdrawal from Surface Water Source (MGD) [1]	Total Return to Source Basin (MGD)	IBT – Shallotte (MGD)	IBT – Waccamaw (MGD)	Total IBT (MGD)
2010	21.32	16.83	8.31	7.71	0.81	8.52
2020	28.47	22.47	11.09	10.57	0.81	11.38
2030	33.76	27.76	13.70	13.25	0.81	14.06
2040	39.52	33.52	16.54	16.17	0.81	16.98
2050	45.11	39.11	19.30	19.00	0.81	19.81
IBT Request (~2042)		36 [2]	17.76	17.43	0.81	**18.3** [3]
IBT Exceeding Grandfathered Amount of 10.5 MGD				**7.8** [3]		

Notes:

[1] The flow amounts are surface water only for the Northwest WTP and do not include flows from the 211 WTP.
[2] Based on the proposed treatment capacity of 36 MGD finished water for the Northwest WTP. Additional raw water that is withdrawn from the river for backwash, clarifier blowdowns, and process water is not included. This water is discharged back to the Cape Fear source basin via NPDES permit.
[3] Values have been rounded up for the IBT request.

The certification process was initiated by the County in February 2009 by filing a Notice of Intent (NOI) to File a Petition to the EMC as described in G.S.§143-215.22L(c). A NOI letter described the County's plan to petition for an IBT. As required by the IBT provisions in effect during that time, public notice was given, and four public meetings were held within 90 days of the NOI letter. In addition, a scoping document was circulated through the State Environmental Review Clearinghouse.

Following these initial steps required by G.S.§143-215.22L, the North Carolina General Assembly passed Session Law 2010-155 in the summer of 2010. This change in the statute directed the County to proceed with the certification process using the procedures and standards set out in G.S.§143-215.22I effective July 1, 2007. The County has prepared an environmental assessment (EA) pursuant to this statute to support the request for an IBT certificate. Any potential impacts associated with construction of WTP improvements in the source basin, and transmission line upgrades in the source and receiving basin would be reviewed under environmental documents prepared specifically for these projects as required by statute and regulation.

Components of the EA include detailed descriptions of environmental characteristics in the source and receiving basins, an analysis of alternatives considered to IBT, analyses of the potential impacts, and mitigation to reduce the potential impacts to an insignificant level. Factors considered during alternatives analyses included the technical viability of the option, the constructability of the alternative, potential environmental impacts, technical difficulty, permitting issues, and estimates of probable costs, both construction costs and O&M.

The EA was provided for review to the NC Division of Water Resources (NCDWR), other agencies within the Department of Environment and Natural Resources (NCDENR), US Fish and Wildlife Service, NC Wildlife Resources Commission, and through the State Environmental Review Clearinghouse as required by statute. NCDWR issued a Finding of No Significant Impact (FONSI) for the IBT request in April 2013 (Appendix A).

The next step in the certification process is a petition to the EMC for an IBT certificate. This petition is organized to address the following nine primary elements:

1. Facilities used to transfer water.
2. Proposed consumptive and nonconsumptive uses of the water to be transferred.
3. Water quality of the source river and receiving river, including information on aquatic habitat for rare, threatened, and endangered species; in-stream flow data for segments of the source and receiving rivers that may be affected by the transfer; and any waters that are impaired.
4. Water conservation measures used by the applicant at the time of the petition and any additional water conservation measures that the applicant will implement if the certificate is granted.
5. Analysis of alternative sources of water within the receiving river basin.
6. Registered water transfers and withdrawals from the source river basin and planned transfers or withdrawals.
7. How the proposed transfer, if added to all other transfers and withdrawals within the source basin would not reduce the amount of water available for use to a degree that would impair existing uses or existing and planned consumptive and nonconsumptive uses of the water.
8. Present and future water supply needs of the County and other public water systems with service area located within the source river basin.
9. The County’s Local Water Supply Plan.

2 Description of Facilities

The County has two WTPs: the Northwest WTP, near the City of Northwest and supplied by water from the Cape Fear River, and the 211 WTP, near the Town of St. James and supplied by 15 wells that draw groundwater from the Castle Hayne Aquifer (Figure 1). The Lower Cape Fear Water and Sewer Authority (LCFWSA) supplies raw water to the Northwest WTP from intakes on the Cape Fear River above Lock and Dam 1. LCFWSA has two intake pipelines: a 48-inch intake pipeline constructed in 1984 and a relatively new 60-inch intake pipeline, constructed in 2010, providing a combined 100 MG withdrawal capacity. In addition to the County, LCFWSA currently supplies raw water to a number of other customers, the largest of which is the Cape Fear Public Utility Authority.

The County's water system serves the majority of the County, including more than 34,000 retail customers and 11 wholesale customers, and does not serve customers outside the County. The southwest portion of the County uses the most water relative to the northeast and southeast. Current customers include the following wholesale entities: Bald Head Island, Leland, Caswell Beach, Holden Beach, Brunswick Regional Water and Sewer (H2GO), Northwest, Oak Island, Ocean Isle Beach, Shallotte, Navassa, and Southport. The system also serves retail and industrial customers in the County's jurisdiction as well as customers residing in the towns of Sunset Beach, Carolina Shores, Bolivia, Calabash, and Varnamtown. The County owns and operates the water systems in these small municipalities. Recently, the County entered into an agreement with the Little River Water and Sewerage Company in South Carolina for an emergency water connection and to supply water to meet future demand in Carolina Shores.

The Northwest WTP and 211 WTP have permitted capacities of 24 and 6 MGD, respectively. Surface water treated at the Northwest WTP is distributed to customers across the basin divide from the Cape Fear Major River Basin to the Lumber Major River Basin. Water from the two plants is routinely mixed within the distribution system in the southeastern portion of the County. To meet future demand for water, the County is considering expansion of its Northwest WTP to a capacity of 36 MGD. The proposed expansion of the Northwest WTP plant is expected to trigger the need for an IBT certificate because a portion of the surface water treated at the Northwest WTP is distributed to customers across the basin divide into the Shallotte IBT River Basin and the Waccamaw IBT River Basin, both of which are in the Lumber Major River Basin. Under the grandfather provision of the Regulation of Surface Water Transfers Act, the County may transfer up to 10.5 MGD from one designated river basin to another without an IBT certificate. The County is requesting an IBT certificate from the EMC for an increase over the grandfathered transfer, with all of the increase going to the Shallotte IBT River Basin (i.e., no increase in the Waccamaw IBT River Basin). This increase is based on water demand projections and need through approximately 2042, representing nearly a 30-year period for the IBT certificate.

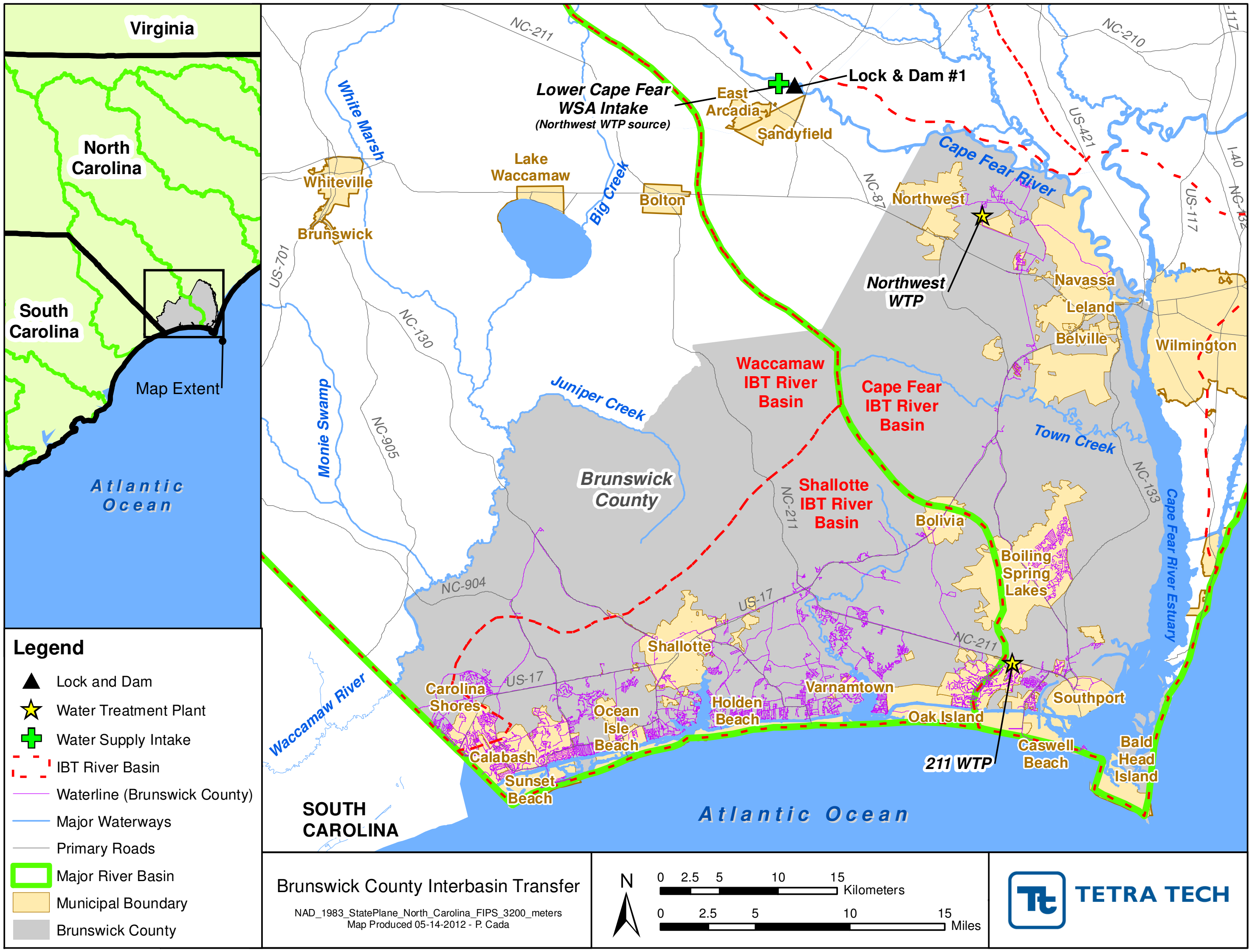

Figure 1. Location Map for Brunswick County IBT

3 Proposed Uses of the Water

The following section provides a discussion of the consumptive and nonconsumptive uses of water in the County based on recent trends and future projections.

3.1 Recent Water Demand Synopsis

Previous water demand projections prepared for the County's recent Water Master Plan suggested that *peak day* demand was estimated to reach 80 percent of the water treatment capacity for the Northwest and 211 plants *combined*, in about 2007 (Hazen and Sawyer, 2006). Additionally, data from 2005 through 2007 suggested that the Northwest WTP was approaching capacity on peak days which typically occur mid-summer (Hazen and Sawyer, 2008).

Since these earlier projections, finished water demand increased in 2008, but then declined in 2009 and 2010 before increasing to pre-2009 levels again in 2011 (Figure 2). The number of customers served increased modestly over this 4-year period (approximately 15% between 2008 and 2011), but slower than had been projected because of the economic downturn that became more pronounced in 2008.

It is believed that there are several reasons that average and peak water demands have not clearly increased despite an increase in the number of customers served including:

- Weather related effects (discussed below)
- Increased water efficiency, conservation and reuse (see Figure 4 and discussion of *per capita* water demand in Section 1.3.3)
- Decreased industrial demand (see Figure 5 and discussion of *industrial* water demand in Section 1.3.3)

It is likely that weather played a significant role in observed water demand (annual average and peaks) over the 2008-2011 period. Monthly precipitation data superimposed on Figure 2 appear to show some correlation between rainfall and water use (an inverse relationship as expected in a system with seasonal increases in water use associated with landscape irrigation). However, the simplified presentation of precipitation data in Figure 2 does not tell the complete story. For example, drought conditions leading up to the summer of 2008 resulted in a precipitation deficit of over 23 inches for calendar year 2007 at the National Weather Service's Wilmington, NC monitoring station. On the other hand, measured precipitation for calendar years 2008 and 2009 tracked closely with historical averages (+3.76 inches and +2.68 inches, respectively). However, 2010, which like 2008 saw a spike in water demand, finished with a 13.65 inch annual precipitation deficit.

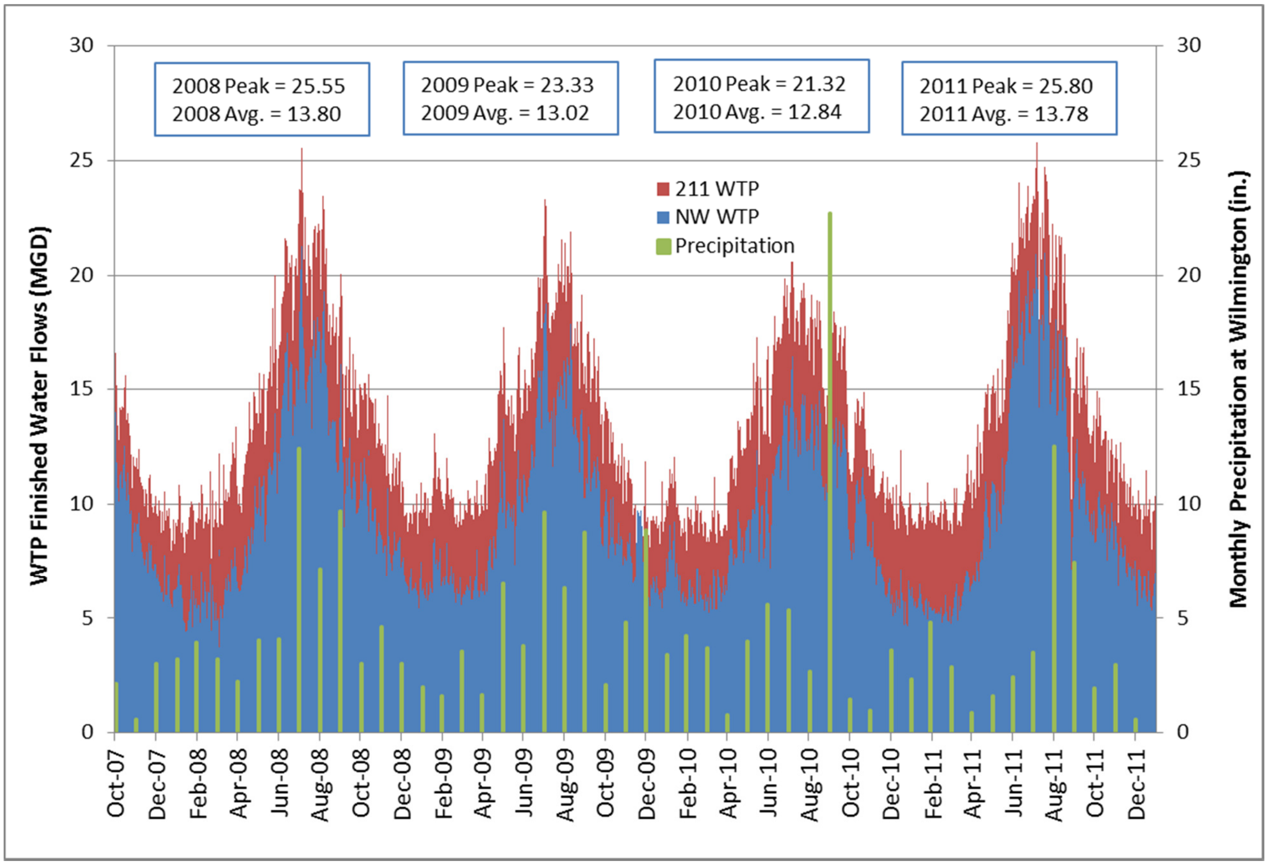

Figure 2. Brunswick County - Actual Finished Water Flows for October 2007 through 2011

Additional historical water demand trend analyses in support of future projections are provided in Section 1.3.3.

3.2 Current (2011) Water Demand Analysis

An analysis of water use for the most recent full calendar year (2011) was developed using data from the following sources:

- Daily finished water pumping data from Brunswick County Drought Report to NCDENR (2011)
- BCPU Monthly Reports for FY 2011 and FY 2012
- BCPU Monthly Total, Industrial and Wholesale Customer summary (2011)
- U.S. Census Data (2010)

The County meters the following water demand elements: total water pumped, retail pumped, large industrial pumped, wholesale pumped and operational (unbilled) uses pumped.

Unaccounted water is calculated as the difference between total water pumped and the sum of the other metered sectors. Unaccounted water losses averaged 0.56 MGD in 2010 and 1.01 MGD in 2011, with significant monthly variability. Operational (unbilled) uses averaged 0.31 MGD and 0.33 MGD for 2010 and 2011 respectively, but also varied widely from month to month.

Figure 3 provides a graphical summary of monthly water demand by sector for calendar year 2011. In 2011, total daily demand averaged 13.78 MGD. The peak day flow reported for 2011 was 25.80 MGD (approximately 86 percent of permitted water treatment capacity of 30 MGD), occurring in July, resulting in a peak day peaking factor of 1.87. Monthly average daily water demand ranged from about 68 percent (January, February, December) to 160 percent (July) of the annual average. In 2011, the average daily water demand for July was approximately 2.35 times the February water demand because of a combination of seasonal outdoor water uses and seasonal population increases associated with beach communities in County's service area. In Figure 3, the gray hatched segment at the top of each column represents the increase above the average demand associated with the peak day for that month.

Additional water sector demand analyses in support of future projections are provided in Section 1.3.3.

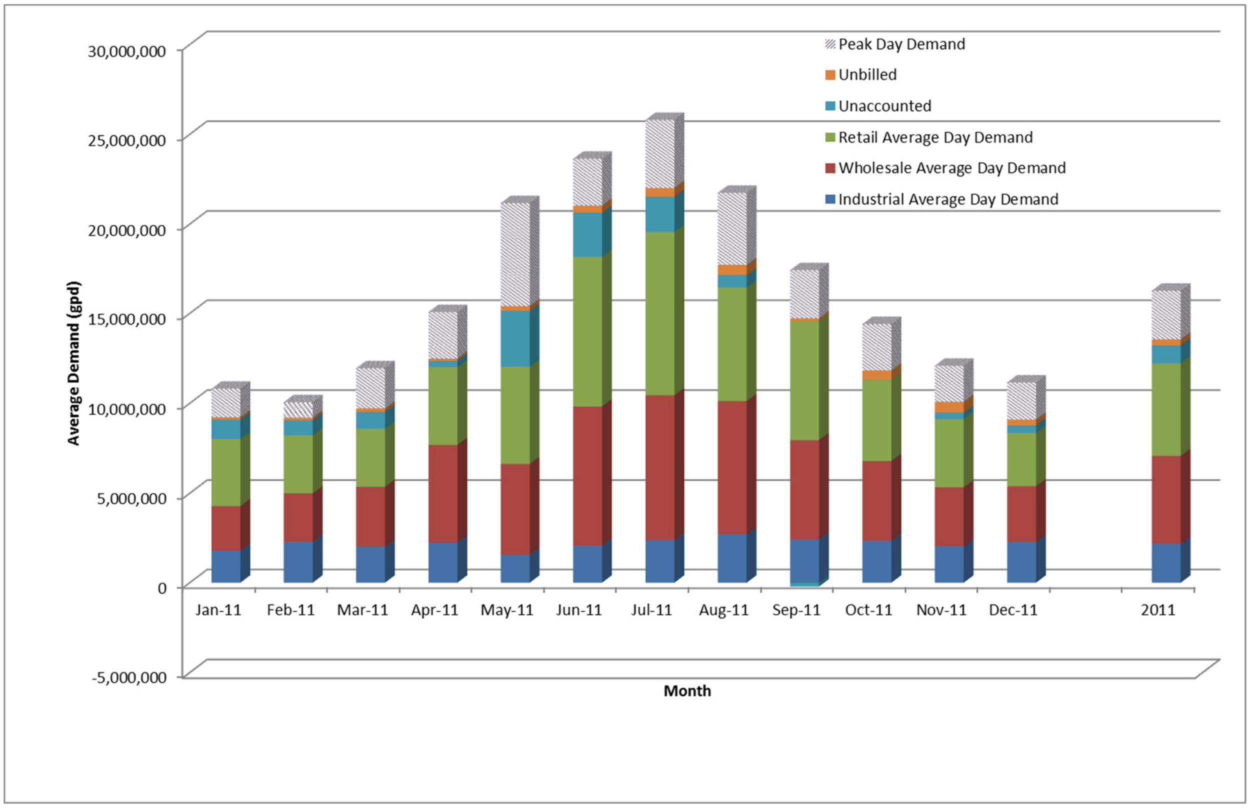

Figure 3. Brunswick County 2011 Water Sector Demands

3.3 Projected Water Demand

The sectoral breakdowns summarized in Figure 3 were used along with population data and associated projections from various sources to estimate future water demand.

Water demand projections were based on the following main assumptions:

- A constant *per capita* water demand was used to estimate future *retail water demand* based on population growth projections
- *Wholesale water demand* was assumed to increase at a rate proportional to population growth projections
- *Industrial water demand* was assumed to be constant over the planning horizon
- *Non-revenue water demand* was assumed to increase at a rate proportional to population growth projections
- *Peak month and peak day peaking factors* were assumed to be constant over the planning horizon

Note that *per capita* and wholesale water demands as well as peaking factors associated with the County water systems are most likely influenced by the seasonal nature of some of its customer base. This seasonal effect likely results in somewhat lower than typical *per capita* demand (because a portion of the water user base is only present during tourist seasons and times) and higher than typical peaking factors, (since, in addition to seasonal water uses such as irrigation during summer months, more water users may also be present during these times).

Additional discussion on these water demand elements is provided below.

3.3.1 Retail Water Demand

The average *per capita* water demand for 2011 of 71.94 gallons per day (gpd) was used to estimate future retail demands. *Per capita* water demand was calculated by dividing the annual average daily retail demand by the average number of customers served in 2011. The average number of customers was calculated by multiplying the average number of connections (tracked monthly by BCPU) by 2.21, which is the average number of persons per household derived from 2010 U.S. Census for the County (U.S. Census, 2010). On a per connection basis, retail water demand for the County system was 158.99 gpd/connection for calendar year 2011 (note: because calculated *per capita* demand is directly proportional to per connection demand, the choice of which to use has no bearing on the following water demand projections).

For this projection, a constant *per capita* retail demand was applied throughout the planning horizon. Annual average *per capita* retail water use data for the period of 2006 to 2011 are presented in Figure 4. Although the figure appears to show a slight declining trend in *per capita* demand, the correlation is weak and it is likely that external factors account for annual variations. For example, as previously described, the drought of 2007 is likely to have resulted in a higher *per capita* water use for irrigation for that year which influences the apparent declining trend in demand.

Nevertheless, it is possible that the assumption of a constant *per capita* retail demand will somewhat overestimate actual future flows for this sector since no allowances have been made for potential demand reduction measures (e.g., water conservation, reuse) that might occur over the planning period. However, it should be noted that, in general, predicting future *per capita* water demand has proven to be difficult, as water use efficiencies in some areas can be offset by increases in others.

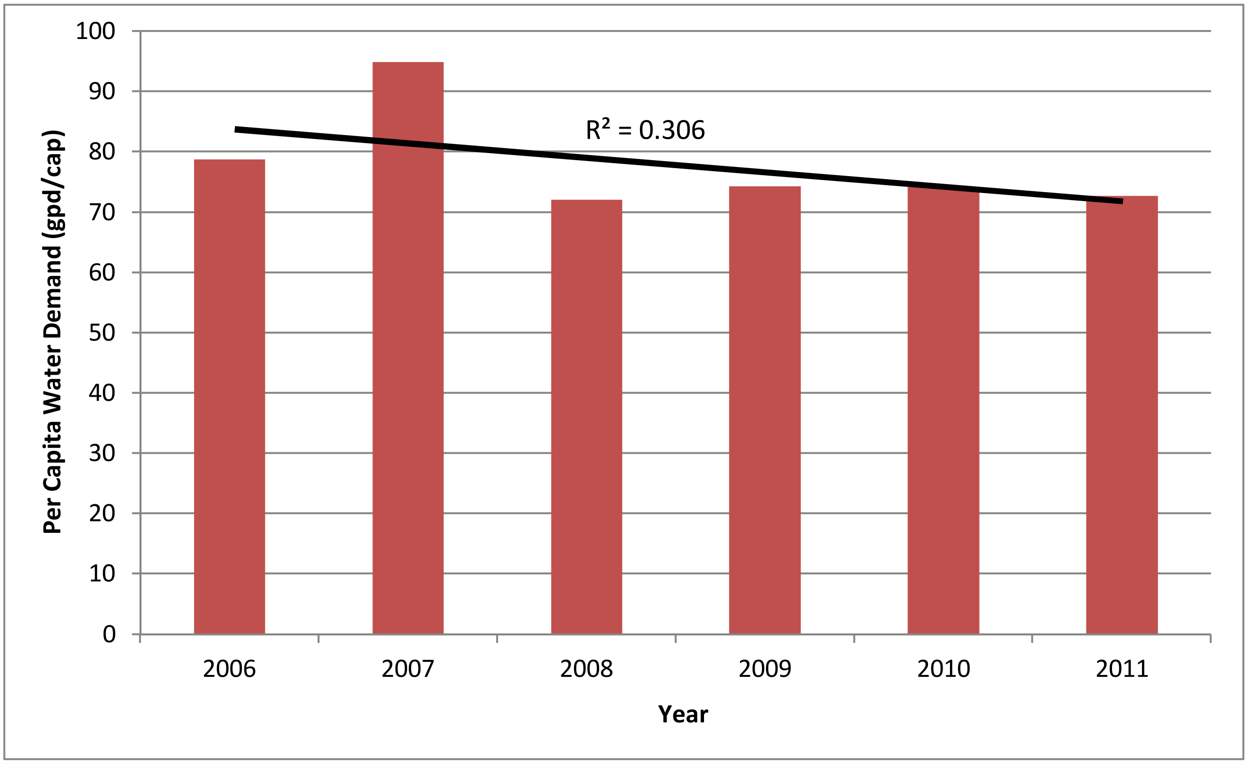

Figure 4. Historical *Per Capita* Retail Water Demand

3.3.2 Wholesale Water Demand

Although wholesale water demand remained relatively constant (and likewise the proportion of wholesale demand relative to retail demand declined) between 2006 and 2011, a constant wholesale-to-retail demand ratio (based on year 2011 data) was used to project future wholesale water demand. In other words, it was assumed that wholesale water demand will grow at the same rate as will retail demand (i.e., both are assumed to be proportional to projected County population growth). For this assumption to hold true, increases in wholesale water demand will need to come from customer growth for existing wholesale water users, the addition of new wholesale customers to County's water system or some combination of the two.

Despite uncertainties regarding the magnitude of wholesale water demand in the future, it is important to note that the apportioning of demand between retail and wholesale customer sectors should have no impact on total water demand over the planning horizon. The assumption that total non-industrial water demand (retail + wholesale) will increase in proportion to population growth is logical. It may however be that this total non-industrial demand turns out to be apportioned differently between the retail and wholesale sectors than projected.

3.3.3 Industrial Water Demand

Large industrial water usage was assumed to be constant over the planning period at the average 2011 demand of 2,192,911 gpd. As illustrated in Figure 5, linear regression of historical annual data shows a relatively strong declining trend in industrial water demand over the past decade, believed to be due to multiple factors, including greater water use efficiency and recycling at industrial facilities and a decreasing number of industrial facilities in the service area. Therefore, it is likely that the assumption of constant industrial water demand over the planning period is conservative (i.e., it may overestimate industrial demand). However, the addition of one or two large industrial facilities is possible and could have an effect on future industrial sector water demands, so this conservatism may be warranted.

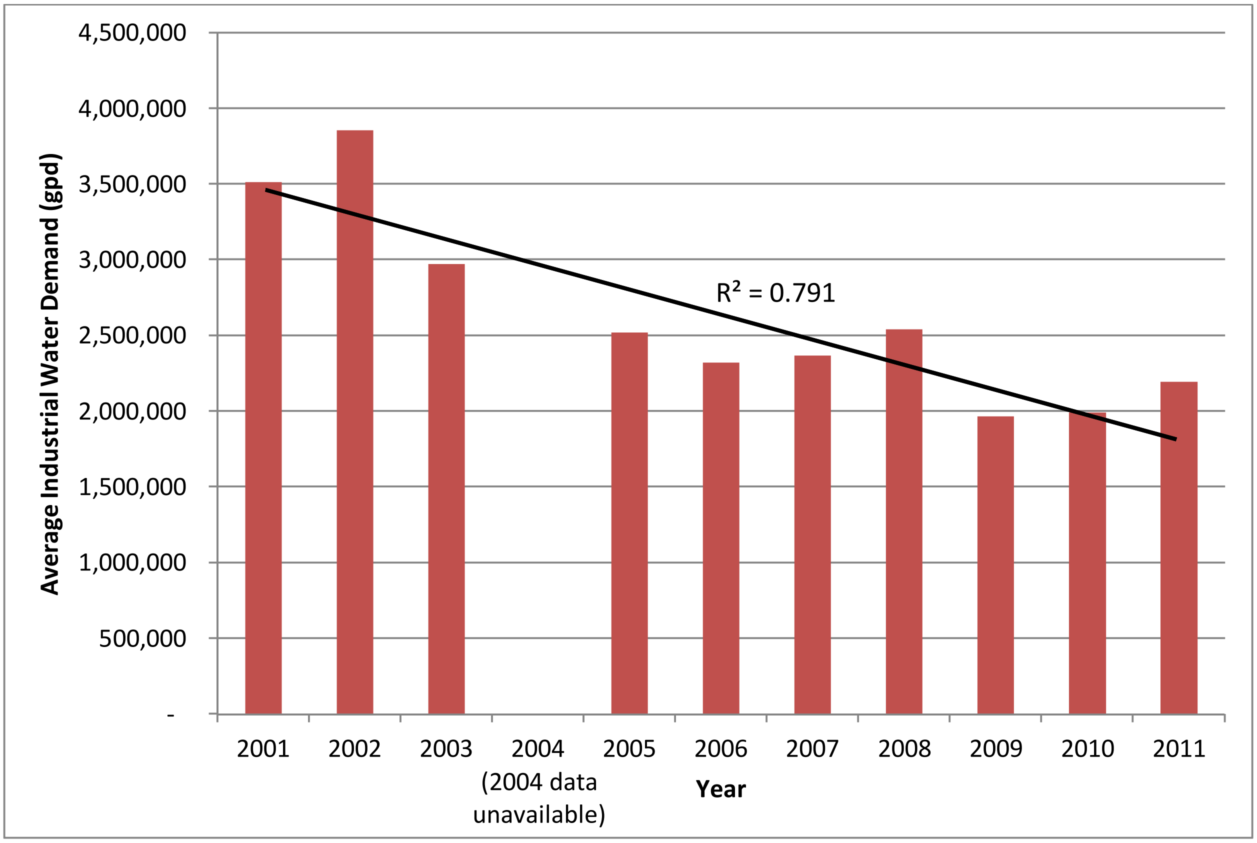

Figure 5. Historical Industrial Water Demand (2001-2011)

3.3.4 Non-Revenue Water Demand

Non-revenue water demands including unbilled (operational) uses and unaccounted water were assumed to grow in proportion to population served, using as a basis the latest data from 2011 which shows an average non-revenue demand of approximately 1.33 MGD (approximately 10 percent of the total demand for 2011).

Although it is logical to assume that operational water demands would increase with an increasing population and that unaccounted water demand would increase with additional service connections, pipeline and other infrastructure that could potentially leak, non-revenue water demand for 2006 through 2011 appears to show a declining trend (Figure 6). Additionally, a plot of non-revenue demand versus total billed water demand (which is related to the number of service connections and other infrastructure) shows no clear correlation (Figure 7). Possible explanations for the decreasing trend in unbilled demand with time could include effective programs for reducing leaks and for metering and billing all water users. Conservation efforts undertaken by unbilled (operational) users could also be contributing to the decreasing trend.

Nevertheless, because these apparent trends are somewhat uncertain and because the 2011 non-revenue demand of approximately 10 percent of total demand is in line with typical water system allowances, water demand projection calculations were based on the 2011 non-revenue data, assumed to grow in proportion to population served.

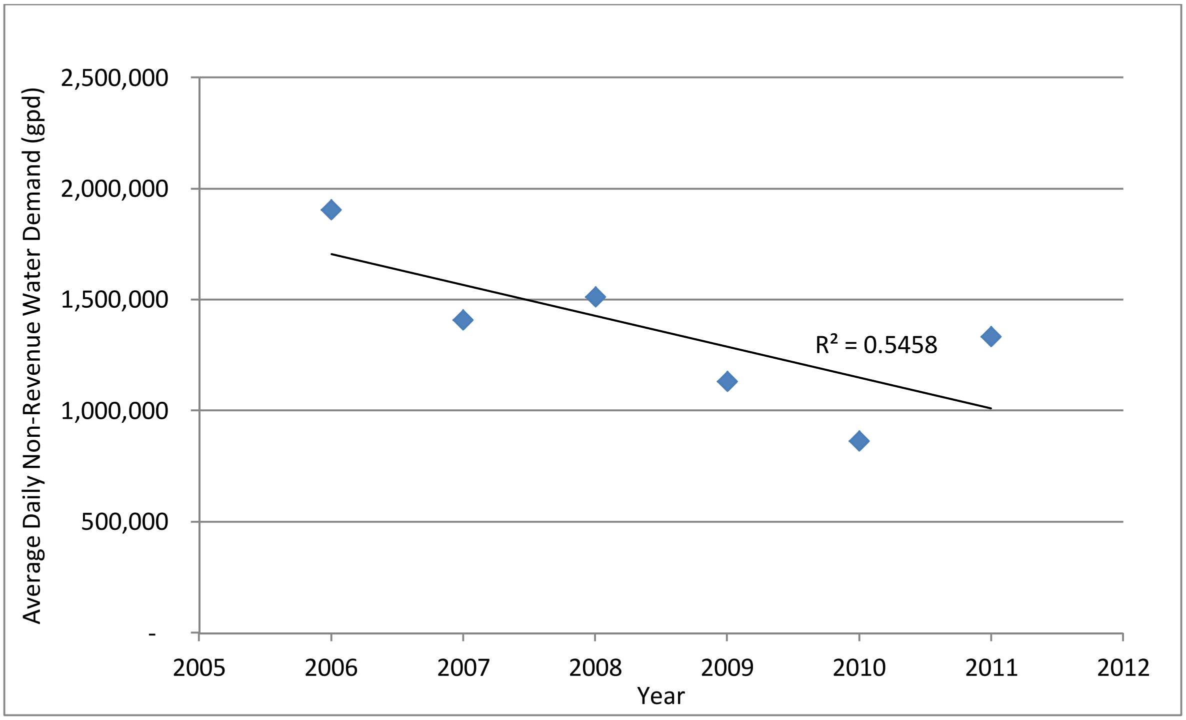

Figure 6. Non-Revenue Water Demand Trend

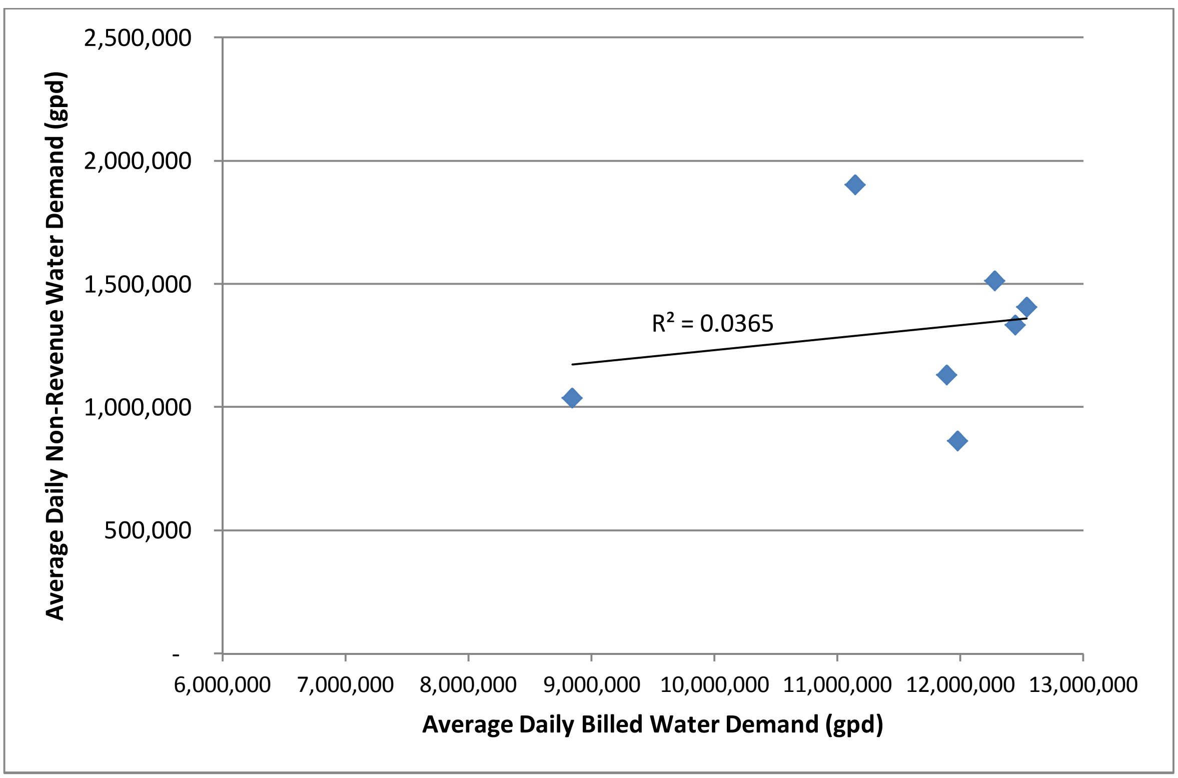

Figure 7. Non-Revenue Water Demand as a Function of Billed Water Demand

3.3.5 Peaking Factors

To project future peak day demands, the average annual peak day peaking factor (1.72) from the past 12 years was used. An analysis of annual average, peak month average day and peak day flows for 2000 through 2011 showed modest annual variability (standard deviation of 0.09 or 5.4%) and little correlation between peak day peaking factors and year (Figure 8). By contrast, there is a relatively strong correlation for peak month peaking factor as a function of time (R^2 = 0.74, relative standard deviation of 10.8%). However, there is no reason to believe that peak month peaking factors will continue to increase and visual observation of Figure 8 appears to show the peak month peaking factor plateauing between 2006 and 2011.

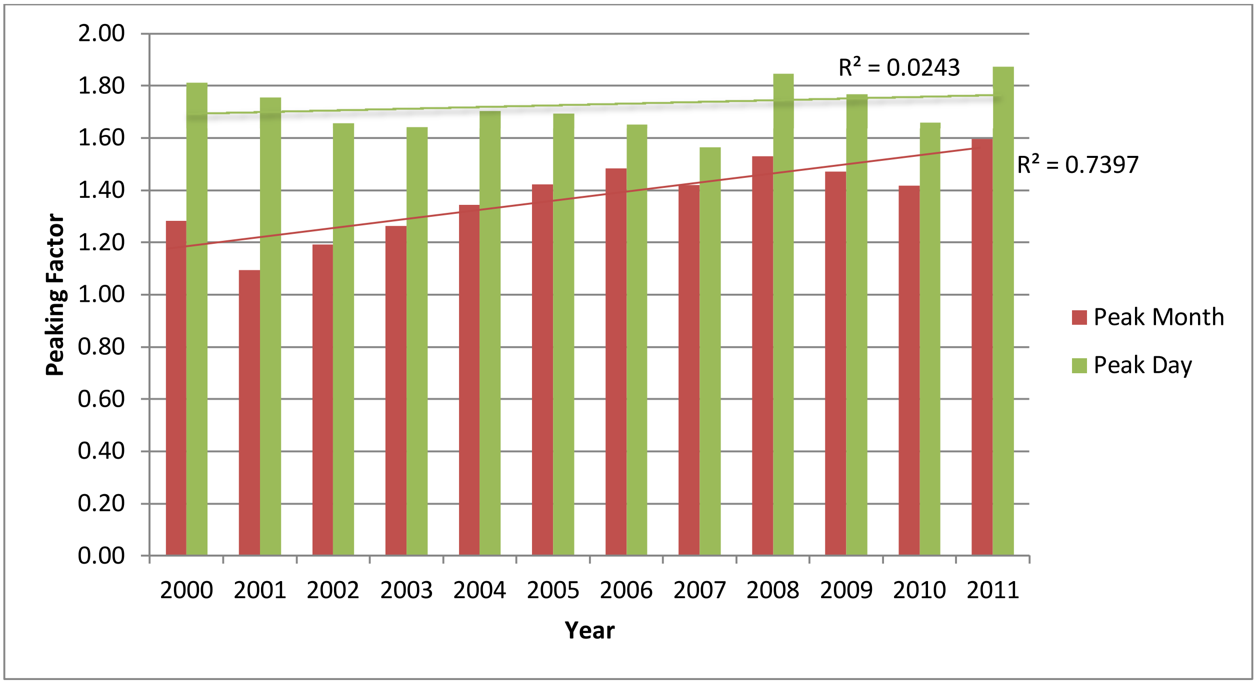

Figure 8. Analysis of Historical Water Demand Peaking Factors

The bottom line for the purposes of projecting water demand is that maximum day peaking factors appear to be historically stable and that there is no compelling reason to believe that the peaking factor will change significantly in the future. For example, although we could speculate that improved irrigation system efficiency should decrease peak water demand at the site scale, more widespread use of irrigation systems (new development and retrofits) could offset individual irrigation unit efficiencies from a system-wide perspective.

3.3.6 Future Demand Projection

As indicated, water demand projections are dependent in large part on projected growth in population, as retail, wholesale and non-revenue water demands were assumed to grow at the same rate as population. For example, to project non-revenue water demand in 2020, the non-revenue demand for the most recent calendar year of 2011 was multiplied by the ratio of County population projected for 2020 to the 2011 population (estimated by interpolation between the 2010 and 2020 population numbers). Table 2 provides a summary of the population projections used for this analysis.

Based on the analysis and assumptions described above, Table 3 summarizes water demand projections through 2050 and Figure 9 provides a graphical representation of average and peak day demand for 2000 through 2050.

Table 2. Population Projections for Brunswick County

Year	Population	Percent Change
2000	73,143 [1]	--
2010	108,176 [1]	47.9%
2020	137,677 [2]	27.3%
2030	167,178 [2]	21.4%
2040	199,323 [3]	19.2%
2050	230,483 [3]	15.6%

Notes:
[1] Actual population numbers (U.S. Census for 2000 and 2010)
[2] North Carolina State Data Center, http://linc.state.nc.us/
[3] Based on linear regression of values from 2000-2030.

Table 3. Brunswick County Water Demand Projections (MGD)

Year	2000[1]	2010[1]	2011[1]	2020	2030	2040	2050
Retail Demand	1.903	5.088	5.370	6.653	8.078	9.631	11.137
Industrial Demand	3.934	1.993	2.193	2.193	2.193	2.193	2.193
Wholesale Demand	3.005	4.895	4.885	6.052	7.348	8.761	10.131
Non-Revenue Demand	1.039	0.865	1.334	1.652	2.006	2.392	2.766
Average Demand	9.880	12.841	13.781	16.549	19.626	22.978	26.227
Peak Month Demand[2]	12.680	18.192	22.009	26.479	31.401	36.764	41.963
Peak Day Demand[3]	17.900	21.319	25.798	28.465	33.756	39.522	45.111
Peak Day Capacity (%)[4]	60%	71%	86%	95%	113%	132%	150%

Notes:
[1] All entries for 2000, 2010 and 2011, including Peak Month and Peak Day, are from actual water demand data
[2] For 2020-2060, Peak Month Demand = Average Demand x 2011 Monthly PF (1.60)
[3] For 2020-2060, Peak Day Demand = Average Demand x 1.72 (average Maximum Day Peaking Factor for the combined output from the plants over the past 12 years)
[4] Peak Day Capacity = Peak Day Demand / 30 MGD (existing treatment capacity)

An examination of Figure 9 shows that the slight decreases in demand between 2008 and 2011 are likely temporary and that the overall trend is increasing in good agreement with projections. Demand for water is expected to accelerate as economic conditions improve and new customers are brought online. To meet this future demand, the County has proposed to expand the existing Northwest WTP from 24 to 36 MGD.

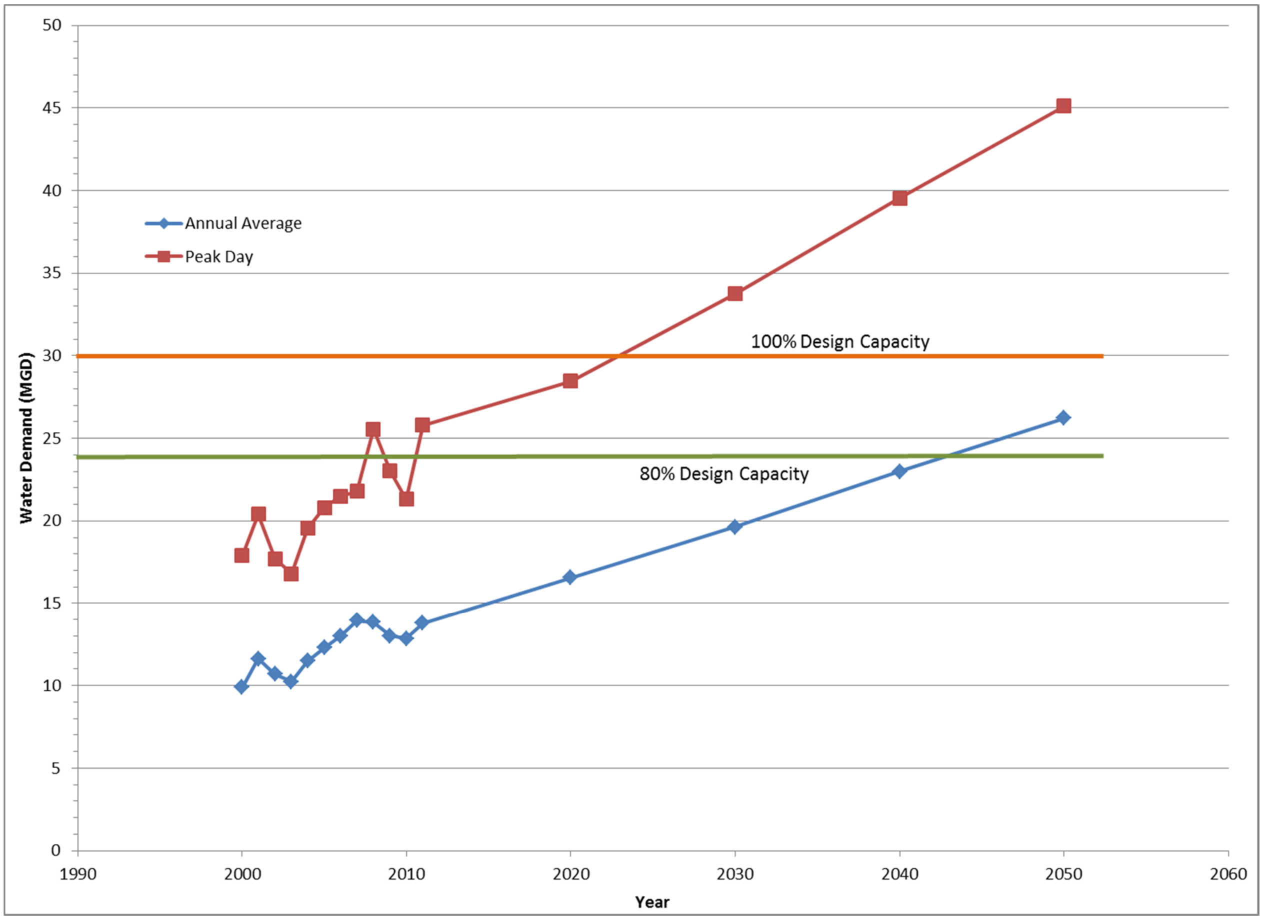

Figure 9. Water Demand (2000-2011) and Projections through 2050

4 Water Quality and Aquatic Habitat

The request for an IBT certificate should include a description of the water quality of the source river and receiving river, including information on aquatic habitat for rare, threatened, and endangered species; in-stream flow data for segments of the source and receiving rivers that may be affected by the transfer; and any waters that are impaired pursuant to section 303(d) of the federal Clean Water Act (33 U.S.C. § 1313(d)). These descriptions for the source (Cape Fear) and receiving (Shallotte) basins are provided below.

4.1 Cape Fear IBT River Basin (Source)

The LCFWSA supplies water to the Northwest WTP from an intake on the Cape Fear River above Lock and Dam #1. For this assessment, the study area is composed of a portion of the Cape Fear IBT River Basin in the vicinity of Lock and Dam #1 extending downstream to include the remainder of the basin, hereafter referred to as the *Cape Fear Study Area* (Figure 10). The northern terminus of the study area begins 1 mile north (as Euclidean distance) of the intake above Lock and Dam #1. The inclusion of area above the intake is meant to capture portions of the source basin that might be affected by the withdrawal without including areas farther upstream (extending another 130 miles upstream) that would reasonably be expected to have no impact.

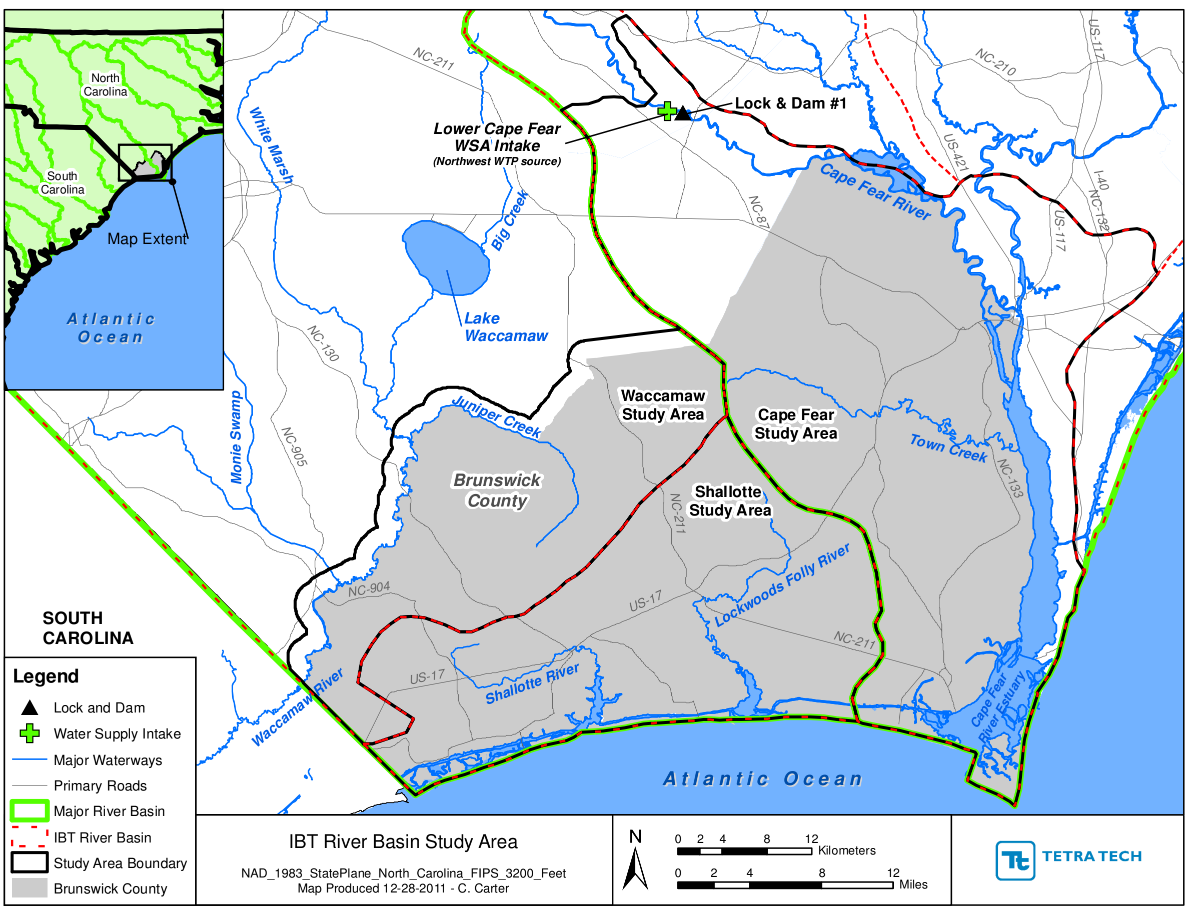

Figure 10. Overview Map of the IBT River Basins Study Area

4.1.1 Surface and Groundwater Resources

4.1.1.1 Drainage Basins and Surface Water Supplies

The Cape Fear Study Area is in the Cape Fear *Major* River Basin. The majority of the Cape Fear Study Area is in the Lower Cape Fear subbasin, in U.S. Geological Survey (USGS) Hydrological Unit 03030005, and two North Carolina DWQ subbasins (03-06-16 and 03-06-17). This portion drains the coastal plain wetlands and bay lakes and includes slow-moving tannin stained tributary streams, the large Cape Fear River estuary, and tidal creeks. A small section in the northeast portion of the Cape Fear Study Area is in the Northeast Cape Fear subbasin, in USGS Hydrological Unit 03030007, and North Carolina DWQ subbasin 03-06-23.

4.1.1.2 Surface Water Use Classifications

All surface waters in North Carolina are assigned a primary classification by DWQ. All waters must at least meet the standards for Class C (fishable/swimmable) waters except in the case where natural conditions have led to additional classification (e.g., swampwaters). The other primary classifications provide additional levels of protection for primary water contact recreation (Class B) and drinking water (Water Supply Classes I through V). Classifications for major waterbodies are displayed in Figure 11 and described below.

Most tributaries to and mid-stream sections of the Cape Fear River in the Cape Fear Study Area are classified as C and Sw waters. Class C classification is for waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life, and agriculture. Sw classification is for swamp waters and is a supplemental classification intended to recognize those waters that have low velocities and other natural characteristics that are different from adjacent streams.

Directly downstream from the LCFWSA intake, the waters of the Cape Fear River and associated tributaries (Weyman Creek, Copper Smith Branch, Turkeypen Branch, Turner Branch, Beaverdam Creek, Horsepen Branch, Double Branch, and Natmore Creek) are classified as WS-IV and Sw. WS-IV classification is for waters used as sources of water supply. In the Cape Fear Study Area, waters of Toomers Creek also are classified as WS-IV.

A large portion of the Cape Fear River and the Brunswick River (from source to the Cape Fear River) are classified as SC waters. SC classification is for tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife.

Several of the tidal creeks, outlet channels, the mouth of the Cape Fear River, and the Intracoastal Waterway (ICWW) are classified as SA;HQW waters. SA waters are tidal salt waters that are used for commercial shellfishing or marketing purposes. All SA waters are also HQW by supplemental classification. HQW is a supplemental classification intended to protect waters that are rated excellent on the basis of biological and physical/chemical characteristics through DWQ monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and other functional nursery areas designated by the Marine Fisheries Commission.

Pretty Pond, Clear Pond, Allen Creek (Boiling Springs Lake), and a section of Toomers Creek are all class B and Sw. Class B waters are protected for all Class C uses in addition to primary recreation.

Walden Creek and associated tributaries (White Spring Creek, Nigis Creek, Nancy’s Creek, Gum Log Branch, Governors Creek, Fishing Creek), the upstream portion of Dutchman Creek, Beaverdam Creek (from the source to the mouth of Polly Gully Creek), and Polly Gully Creek (from the source to Beaverdam Creek) are SC, Sw, and HQW waters.

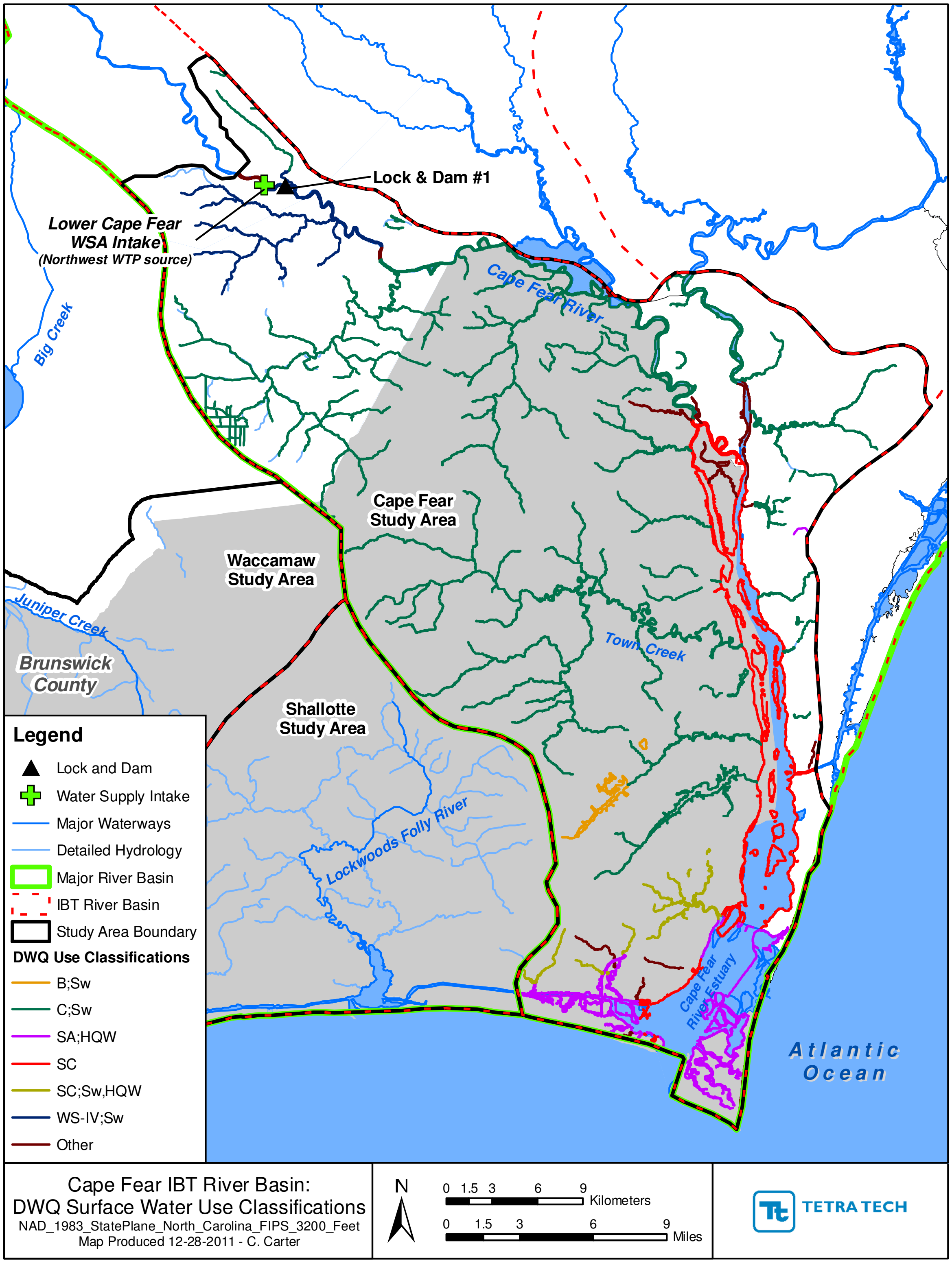

Figure 11. DWQ Surface Water Use Classifications for the Cape Fear Study Area

4.1.1.3 Existing Surface Water Quality

The North Carolina Water Quality Assessment and Impaired Waters List is an integrated report that includes both the Clean Water Act section 305(b) and 303(d) reports. DWQ's 2010 integrated report assessment lists 25 waterbodies in the Cape Fear Study Area as impaired for various designated use categories (e.g., recreation, shellfish harvesting, or aquatic life; NCDWQ, 2010a). Of the 25 waterbodies listed, 19 consist of coastal waters and tidal creeks, the Brunswick River, the Northeast Cape Fear River, Burnt Mill Creek, and Hewletts Creek (Table 4, Figure 12), and the remaining 6 waterbodies are sections of the Cape Fear River (Table 5).

Table 4. Waters with Impaired Use Support Rating in the Cape Fear Study Area (not including the Cape Fear River)

Waterbody	Use Category	Reason for Impairment	Parameter
Atlantic Ocean (Dolphin Court in Kure Beach to Spartanburg Avenue in Carolina Beach)	Recreation	Standard Violation	Enterococcus
Bald Head Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Beaverdam Creek (from the mouth of Polly Gully Creek to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Brunswick River	Aquatic Life	Standard Violation	Low Dissolved Oxygen
Burnt Mill Creek	Aquatic Life	Poor Bioclassification	Ecological/biological Integrity Benthos
Coward Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Denis Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Dutchman Creek (from CP&L Discharge Canal to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Dutchman Creek Outlet Channel	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Dutchman Creek Shellfish Area	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Elizabeth River (the section of Elizabeth River exclusive of the Elizabeth River Shellfishing Area)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited

Waterbody	Use Category	Reason for Impairment	Parameter
Elizabeth River Shellfishing Area	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Fishing Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Hewletts Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
ICWW	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Molasses Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Northeast Cape Fear River (from the mouth of Ness Creek to the Cape Fear River)	Aquatic Life	Standard Violation	Copper
Piney Point Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Southport Restricted Area	Aquatic Life	Standard Violation	Arsenic, Copper, Nickel

Table 5. Impairment Ratings for the Cape Fear River in the Cape Fear Study Area

Location along Cape Fear River	Use Category	Reason for Impairment	Parameter
From a line across the river between Lilliput Creek and Snows Cut to a line across the river from Walden Creek to the basin	Aquatic Life	Standard Violation	Arsenic
			Copper
			Nickel
From the raw water supply intake at Federal Paper Board Corporation (Riegelwood) to Bryant Mill Creek	Aquatic Life	Fair Bioclassification	Ecological/biological Integrity Benthos
From upstream of the mouth of Toomers Creek to a line across the river between Lilliput Creek and Snows Cut	Aquatic Life	Standard Violation	Turbidity
			Copper
			Low Dissolved Oxygen
			Low pH
Prohibited area east of the ICWW in the Cape Fear River	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area north of Southport Restricted Area and west of the ICWW in the Cape Fear River	Aquatic Life	Standard Violation	Arsenic
			Copper
			Nickel
	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area near Southport	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Prohibited area south of the Southport Restricted Area	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open

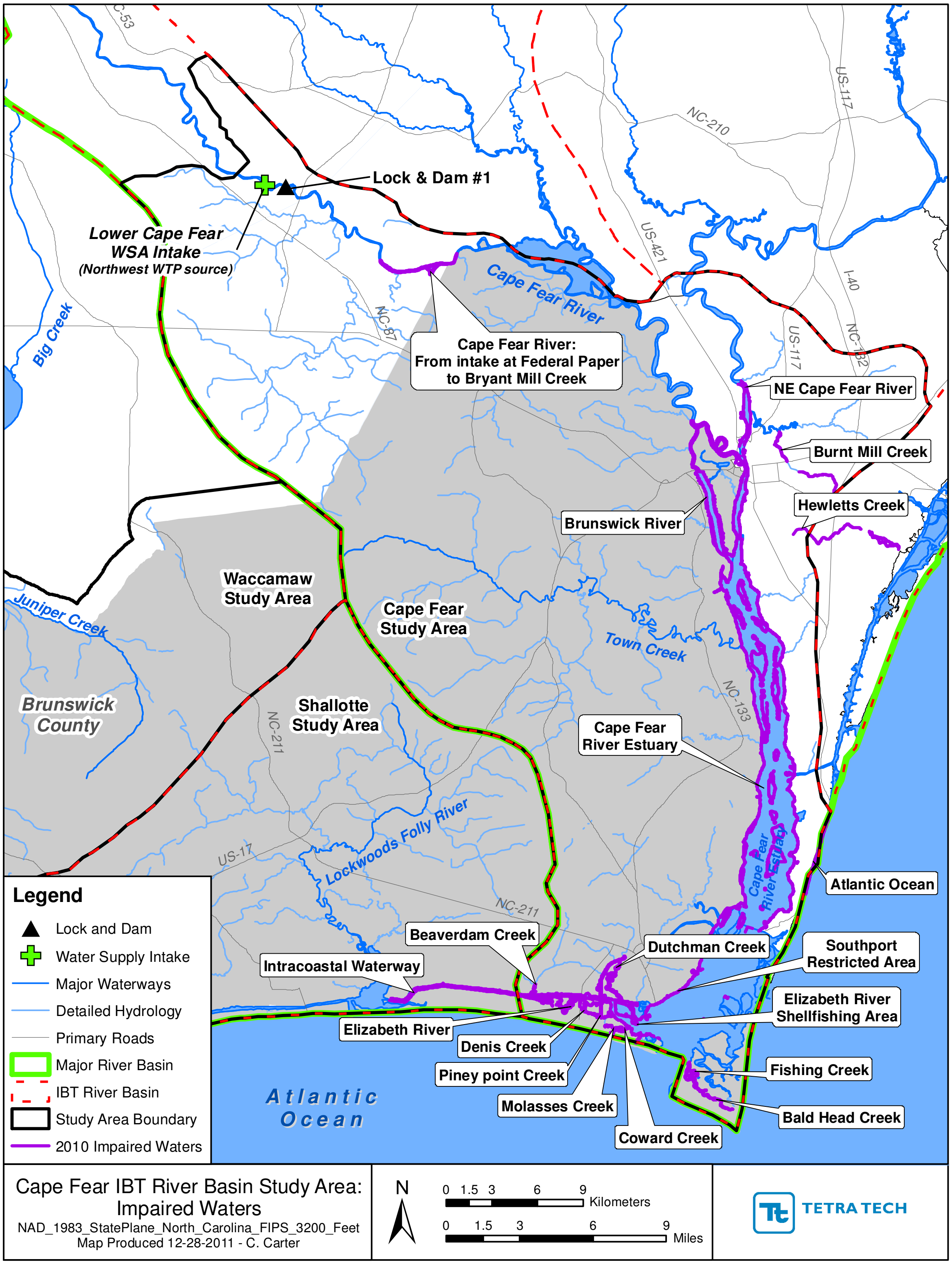

Figure 12. Impaired Waters of the Cape Fear Study Area

4.1.1.4 Total Maximum Daily Load (TMDL)

A TMDL was being developed for the Cape Fear Estuary (NCDWQ, 2005). The Cape Fear Estuary has been listed since 1998 as impaired for aquatic life because of dissolved oxygen standard violations (from upstream mouth of Toomers Creek to a line across the river between Lilliput Creek and Snow's Cut; NCDWQ, 2008). Sources of oxygen demand that cause the low dissolved oxygen levels include a considerable volume of blackwater and swamp drainage that contributes natural sources of oxygen-consuming materials and point and nonpoint sources from anthropogenic sources (e.g., agriculture and urban runoff). This portion of the estuary is influenced both by ocean tides and high freshwater flows from the entire upstream basin and therefore goes through many extreme changes in water column chemistry over the course of a year (NCDWQ, 2005). The University of North Carolina at Charlotte completed a final report discussing the results of the Cape Fear Estuary Dissolved Oxygen Model (Bowen et al. 2009). The model was used to investigate the effects of various organic matter and ammonia load reduction scenarios on the dissolved oxygen concentrations in the estuary. Given questions of natural versus anthropogenic sources of oxygen demand and what the dissolved oxygen criteria for the lower Cape Fear River should actually be, DWQ has placed the TMDL development on hold.

North Carolina has issued a statewide fish consumption advisory for mercury; therefore, all surface waters in the state are considered impaired by mercury (NCDWQ, 2013). As a result, a statewide mercury TMDL was developed by NCDWQ and approved by EPA in October 2012. The TMDL estimated the proportions of mercury contributions to water and fish from wastewater discharges, in-state air sources, and out-of-state air sources, and calculated the reductions needed to protect North Carolina waters from mercury impairment and remove the fish consumption advisory. Using statistical analysis and the Community Multi-scale Air Quality (CMAQ) model, NCDWQ determined that a 67% reduction is needed from the 2002 baseline mercury loading. Reductions in both point and nonpoint sources are required, though the most significant source of mercury is nonpoint atmospheric deposition. The NPDES program will play a role in managing mercury from wastewater point sources, which account for 2% of the mercury load, while reductions in atmospheric deposition will require strategies involving other agencies outside of NCDWQ such as the NC Division of Air Quality.

4.1.1.5 Groundwater

The Cape Fear Study Area is in the Coastal Plain physiographic province in the southern coastal portion of North Carolina. The aquifers underlying the Cape Fear Study Area include the surficial aquifer, the Castle Hayne aquifer, and aquifers of the Cretaceous Aquifer System including the Lower Cape Fear, Upper Cape Fear, Black Creek, and Pee Dee aquifers (NCDWR, 2011).

The surficial aquifer is widely used throughout North Carolina for individual home wells. The surficial aquifer is the shallowest and most susceptible to contamination from septic tank systems and other pollution sources (NCDWR, 2011). It is the saturated portion of the upper layer of sediments. The thickness of this layer, from the surface down to the first major confining bed, is typically from 20 to 50 feet. The surficial aquifer is unconfined, meaning that its upper surface is the water table rather than a confining bed. The composition of the surficial aquifer varies across the region, but it is generally 50 to 70 percent sand, allowing high infiltration rates (Huffman, 1996).

The Castle Hayne aquifer, underlying the eastern half of the Coastal Plain, is the most productive aquifer in the state. It is primarily limestone and sand. The Castle Hayne is noted for its thickness (more than 300 feet in places) and the ease of water movement within it, both of which contribute to high well yields. It lies fairly close to the surface toward the south and west, deepening rapidly toward the east. Water in the Castle Hayne aquifer ranges from hard to very hard because of its limestone composition. Iron concentrations tend to be high near recharge areas but decrease as the water moves further through the limestone (Huffman, 1996).

The Cretaceous aquifer system is a grouping of several of the oldest and deepest sedimentary deposits that lie directly over the basement rock. The Cretaceous is the primary source of water for the western half of the coastal plain with the exception of the Sandhills region. To the east, the Cretaceous dips underneath the Castle Hayne. Toward the west, it rises near the surface, covered only by the surficial deposits. Water cannot move as easily in the Cretaceous as it does in the Castle Hayne, but the Cretaceous aquifer is very thick, allowing deep and productive wells. Water from the Cretaceous is generally soft and slightly alkaline, requiring no treatment for most uses (Huffman, 1996).

4.1.2 Aquatic and Wildlife Habitat and Resources

4.1.2.1 Significant Natural Heritage Areas

The North Carolina Department of Environment and Natural Resources, Division of Parks and Recreation, Natural Heritage Program (NHP) in cooperation with the North Carolina Center for Geographic Information and Analysis (NCCGIA), developed the Significant Natural Heritage Areas (SNHAs) digital data to determine the areas containing ecologically significant natural communities or rare species (NCDENR, 2011b).

Just over 25 percent of the Cape Fear Study Area has been identified as SNHA (Figure 13). The NHP has assigned a level of significance to SNHA on the basis of national, state, regional, or county significance. The Cape Fear Study Area has 9 sites that are SNHA and identified as areas of national significance. These sites total approximately 7 percent of the Cape Fear Study Area and include Bald Head Island, Battery Island, Boiling Spring Lakes Wetland Complex, the Green Swamp, MOTSU Governors Creek Natural Area, Northeast Cape Fear River Floodplain, Orton Pond Aquatic Habitat, Town Creek Aquatic Habitat, and Town Creek Marshes and Swamp (Table 6).

Twenty-three sites were identified as areas of state significance and occupy approximately 14 percent of the Cape Fear Study Area (Table 6). Eighteen sites were identified as areas of regional significance and currently occupy approximately 4 percent of the area, and eight sites were identified as areas of county significance and occupy less than 1 percent of the area.

Table 6. SNHAs in the Cape Fear Study Area

Significance	Site Name
National (6.8% of Cape Fear Study Area)	Bald Head Island, Battery Island, Boiling Spring Lakes Wetland Complex, Green Swamp, MOTSU Governors Creek Natural Area, Northeast Cape Fear River Floodplain, Orton Pond Aquatic Habitat, Town Creek Aquatic Habitat, Town Creek Marshes and Swamp
State (13.7% of Cape Fear Study Area)	421 Sand Ridge, Battle Royal Bay, Bluff Island and East Beach, Boiling Spring Lakes Limesink Complex, Brunswick River/Cape Fear River Marshes, Bryant Mill (Greenbank) Bluff, Carolina Beach State Park, Hog Branch Ponds, Hood Creek Floodplain and Slopes, Lower Black River Swamp, Lower Cape Fear River Aquatic Habitat, Lower Cape Fear River Bird Nesting Islands, MOTSU Buffer Zone Natural Area, MOTSU Northwest Natural Area, MOTSU Three Ponds Natural Area, Natmore Sandhills, Orton Sandhills and Limesinks, Pleasant Oaks/Goose Landing Plantations, Pretty Pond Limesink Complex, Southport Ferry Landing Forest, Upper Smith Creek Natural Area, White Spring Ponds Complex, Zekes Island Estuarine Sanctuary

Significance	Site Name
Regional (4.5% of Cape Fear Study Area)	Alligator Branch Sandhill and Flatwoods, Blue Pond/Allen Creek, Cape Fear River Lowlands, Clarendon Plantation Limesinks, Coast Guard Loran Station Natural Area, Doctor Point Hammocks, Fort Caswell Dunes and Marshes, Fort Fisher State Recreation Area, Funston Bays, Goose Pond Limesinks, Lords Creek Natural Area, Middle Island, Neils Eddy Landing, Rabontown Limesinks, Rattlesnake Branch Sandhills, South Wilmington Sandhills, Sturgeon Creek Tidal Wetlands, Winnabow Savanna and Sandhill
County (0.3% of Cape Fear Study Area)	Barnards Creek, Greenfield Lake, Henrytown Savanna, Little Green Swamp, MOTSU Brunswick Forest Natural Area, Mott Creek Natural Area, Orton Powerline Loosestrife Site, Turkey Branch Sandhill

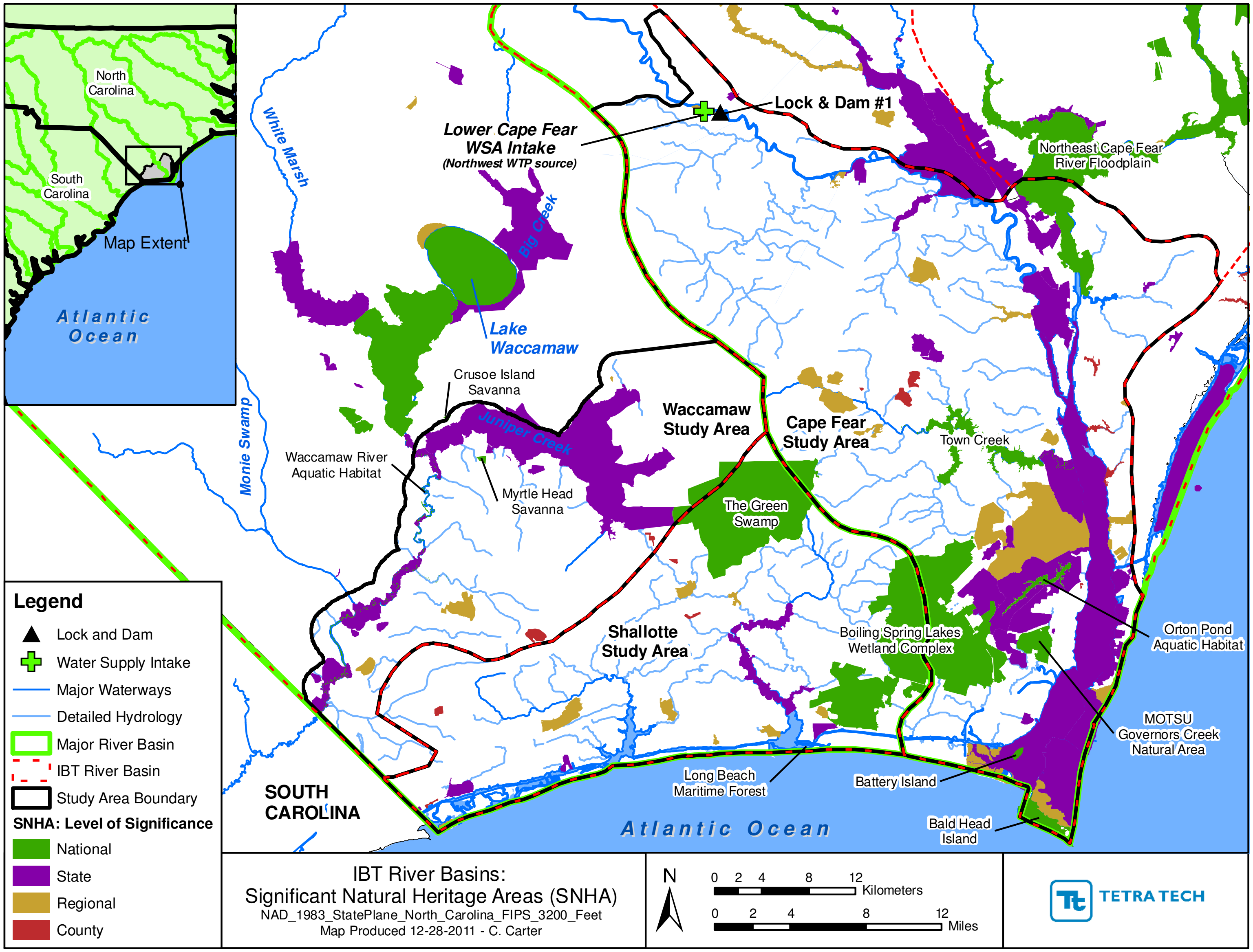

Figure 13. SNHAs in the IBT River Basins Study Area (Sites with National Level of Significance are Labeled)

4.1.2.2 Aquatic Habitat and Resources

The Cape Fear River and its tributaries in the Cape Fear Study Area have low-gradient sandy substrata. Dominant fishes in these waters are the longnose gar (*Lepisosteus osseus*), American eel (*Anguilla rostrata*), shad (*Alosa* and *Dorosoma* spp.), carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), ironcolor shiner (*Notropis chalybaeus*), silver redhorse (*Moxostoma collapsum*), creek chubsucker (*Erimyzon oblongus*), channel catfish (*Ictalurus punctatus*), bullheads (*Ameiurus* spp.), pirate perch (*Aphredoderus sayanus*), Atlantic needlefish (*Strongylura marina*), mosquitofish (*Gambusia affinis*), white perch (*Morone americana*), striped bass (*M. saxatilis*), sunfishes (*Lepomis* spp.), largemouth bass (*Micropterus salmoides*), black crappie (*Pomoxis nigromaculatus*), tessellated darter (*Etheostoma olmstedi*), and yellow perch (*Perca flavescens*) (Marotti, 2011).

The lower reach of the Cape Fear River, an important SNHA, is brackish and supports numerous rare marine fishes, including the endangered shortnose sturgeon (*Acipenser brevirostrum*), and freckled blennies (*Hypsoblennius ionthas*), marked gobies (*Gobionellus stigmaticus*), spinycheek sleepers (*Eleotris pisonis*), and opossum pipefish (*Microphis brachyurus*). The endangered manatee (*Trichechus manatus*) is an occasional visitor, especially in summer (NCDWQ, 2005).

Town Creek, a nationally significant site, is a short creek that flows eastward in eastern Brunswick County and empties into the Cape Fear River. Despite its short length, it contains the only known population of the Greenfield ramshorn snail (*Helisoma eucosmium*), a globally rare and imperiled mollusk, and several other rare animals and plants (NCDWQ, 2005).

In the Cape Fear Study Area, the Cape Fear River, Northeast Cape Fear River, Town Creek, Sturgeon Creek (and its tributary, Mill Creek), Indian Creek, Hood Creek, Liliput Creek, Mallory Creek, Little Mallory Creek, and Livignston Creek are anadromous fish spawning areas (One NC Naturally, 2011) (Figure 14).

In the Cape Fear Study Area, the following areas are designated fish nursery areas: Cape Fear River, Northeast Cape Fear River, tributaries to Walden Creek (Governor's Creek, Nancy's Creek, White Spring Creek, and Nigis Creek), the Intercoastal Waterway, and tidal creeks such as Deep Creek, Cape Creek, Bald Head Creek, Dutchman Creek, Molasses Creek, Denis Creek, Jump and Run Creek, Gulf Gully Creek, Beaverdam Creek, and Polly Gully Creek (Figure 15). Past and present sampling indicates that these areas support a high abundance and diversity of juvenile fish species (One NC Naturally, 2011).

Shellfish Growing Areas (SGAs) open for shellfish harvesting in the Cape Fear Study Area include waters on the east bank near the mouth of the Cape Fear River and Bald Head Island Area, including Bay Creek, Deep Creek, and Cape Creek (NCDEH-SSB, 2011), all other SGAs in waters of the lower Cape Fear River and select tributaries, the Northeast Cape Fear River, Town Creek, and the Intercoastal Waterway and associated tidal creeks are closed for harvesting because of the extent of contamination of waters in each SGA. Of the areas closed for harvesting, Fishing Creek and Bald Head Creek in the Bald Head Island Area and Elizabeth River in the Southport Area are closed only conditionally and could be reopened if water quality in these areas is improved (NCDEH-SSB, 2011) (Figure 16).

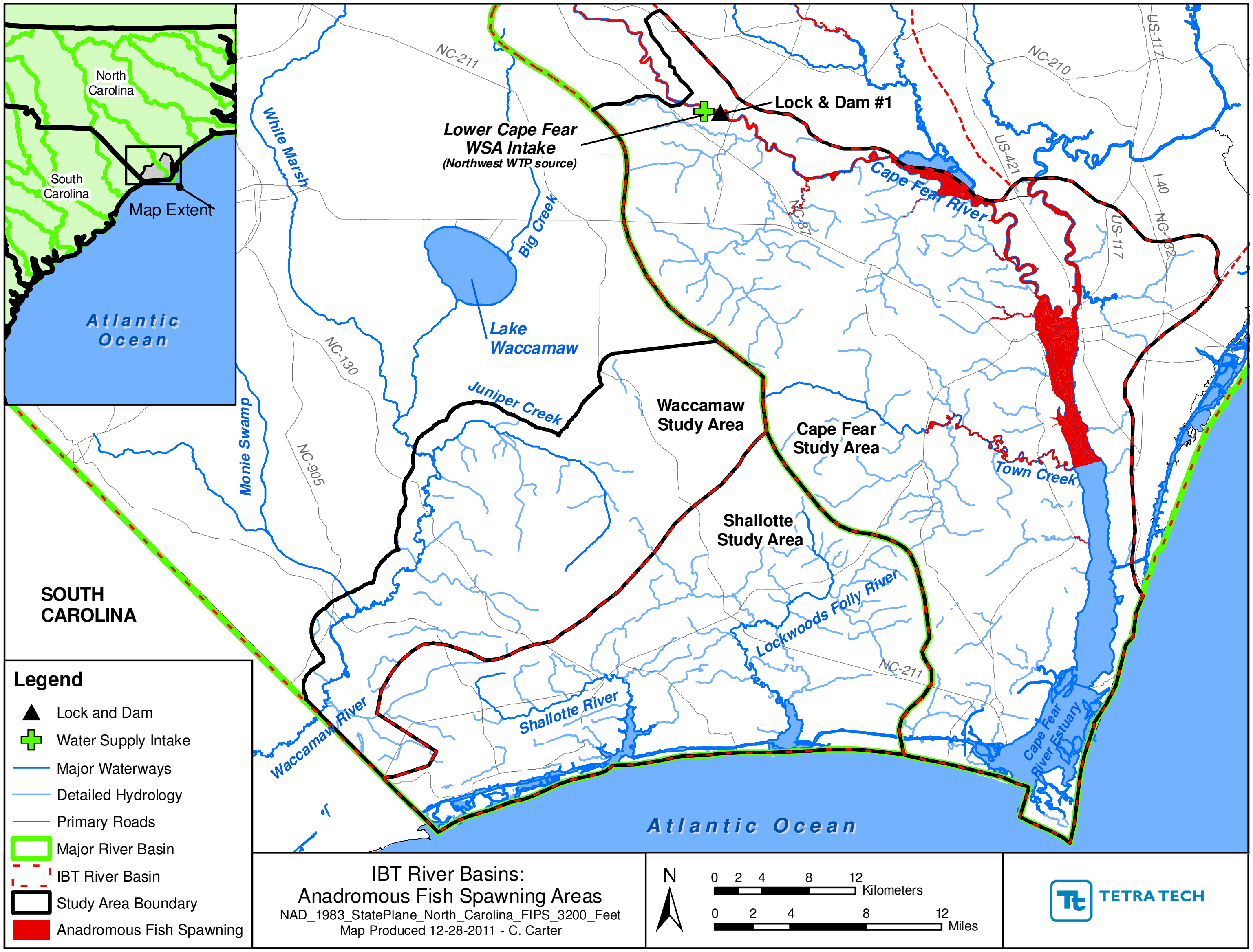

Figure 14. Anadromous Fish Spawning Areas in the IBT River Basins Study Area

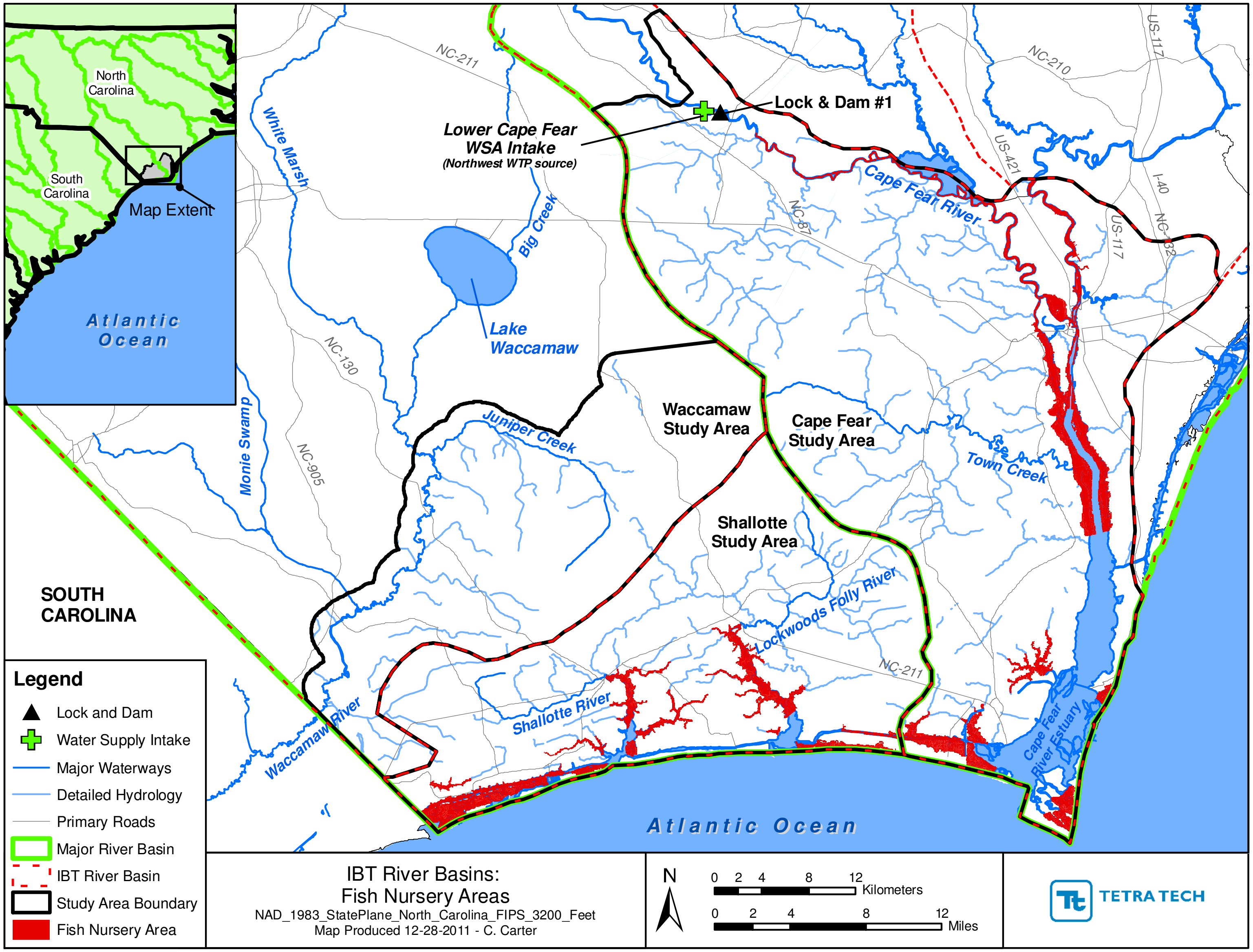

Figure 15. Fish Nursery Areas in the IBT River Basins Study Area

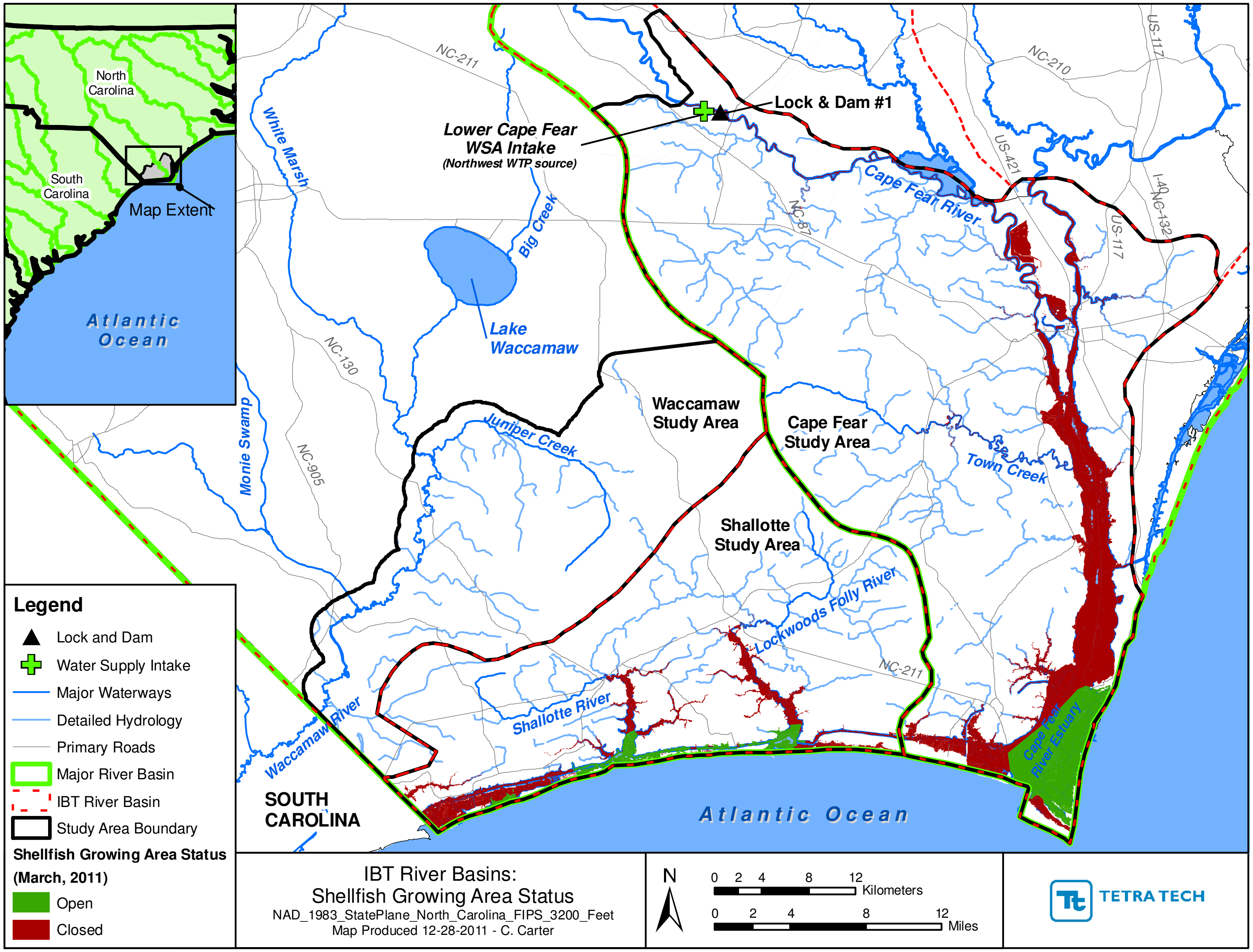

Figure 16. SGAs in the IBT River Basins Study Area

4.1.2.3 Rare and Protected Species

The Cape Fear Study Area boundary includes sections of five counties: Brunswick, New Hanover, Columbus, Bladen, and Pender. In these counties, several species are protected at the state or federal level. North Carolina NHP's Biotic Database (NCNHP, 2011) lists all protected species. In the study area are 28 invertebrate animals, 1 nonvascular plant, 157 vascular plants, and 54 vertebrate animals. A complete list of state and federally protected species in counties of the study area is in Appendix B.

4.1.3 In-Stream Flow

Changes in hydrology can affect habitat for aquatic species. Given the size of the withdrawals relative to the river's low flow regime and the tidal nature of the river below Lock and Dam #1, NCDWR deemed that a field study of stream flow impacts on habitat and recreation downstream of the dam would not be conducted (July 17, 2009 letter from NCDWR to Tetra Tech; provided in the EA). Cumulative withdrawals represent about 3% of mean river flow (5,063 cfs), 6% of median river flow (2,540 cfs), and 17% of 10th percentile river flow (969 cfs) based on the most recent USGS Water Data Report. The cumulative withdrawals incorporate all LCFWSA customers including Brunswick just above the Lock and Dam and are 164 cfs for the 2050 planning horizon. Section 8 provides an analysis of withdrawals on the Cape Fear River using the Cape Fear Hydrologic Model.

4.2 SHALLOTTE IBT RIVER BASIN (RECEIVING)

The Shallotte IBT River Basin is entirely within the County and will be referred to as Shallotte Study Area in this section (see Figure 10 at the beginning of this Section 4).

4.2.1 Surface and Groundwater Resources

4.2.1.1 Drainage Basins and Surface Water Supplies

The Shallotte Study Area is in the Lumber River Basin. It contains a small system of coastal rivers that empty into the Atlantic Ocean. The significant majority of the Shallotte Study Area is in the Long Bay Subbasin, in USGS Hydrological Unit 03040208. This subbasin is mainly in the poorly drained flatwoods ecoregion of the Coastal Plain but also has barrier islands, coastal marshes, and swampy peat lands (NCDWQ, 2010b)

4.2.1.2 Surface Water Use Classifications

All surface waters in North Carolina are assigned a primary classification by NCDWQ. Classifications of major waterbodies are displayed in Figure 17 and described below.

The Intercoastal Waterway, mouth of the Shallotte River, mouth of Lockwoods Folly River, Saucepen Creek, and Calabash River are classified as SA and HQW waters. SA waters are tidal salt waters that are used for commercial shellfishing or marketing purposes. All SA waters are also HQW by supplemental classification. HQW is a supplemental classification intended to protect waters that are rated excellent on the basis of biological and physical/chemical characteristics through DWQ monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and other functional nursery areas designated by the Marine Fisheries Commission.

Upstream sections of the mainstem of both the Shallotte River and the Lockwoods Folly River are classified as SC and HQW waters. SC classification is for tidal salt waters protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; fish and noncommercial shellfish consumption; aquatic life propagation and survival; and wildlife.

Tributaries throughout the Shallotte Study Area and Cawcaw Swamp are generally classified as either C; SW, HQW waters or C and Sw waters. Class C is for waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life, and agriculture.

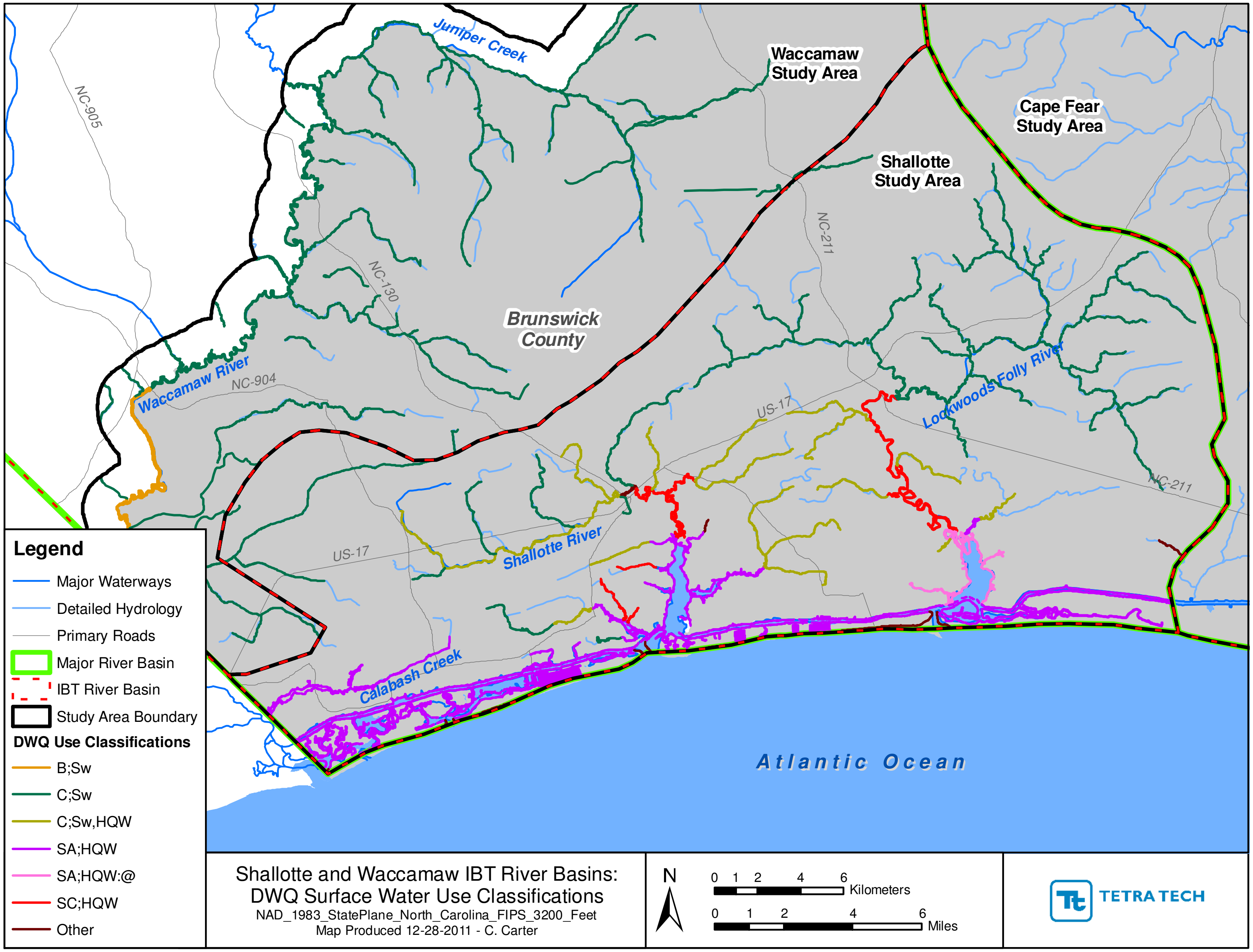

Figure 17. DWQ Surface Water Use Classifications for the Shallotte and Waccamaw Study Areas

4.2.1.3 Existing Surface Water Quality

DWQ's 2010 integrated report assessment of North Carolina waterbodies lists 37 waterbodies in the Shallotte Study Area as impaired for the designated use of shellfish harvesting (Figure 18; NCDWQ, 2010a). Of the 37 waterbodies listed, 2 are also impaired for the aquatic life designated use category. Table 7 lists all impaired waterbodies in the Shallotte Study Area. New coastal stormwater rules as a result of Session Law 2008-211 went into effect on October 1, 2008 place stricter stormwater standards on the County and 19 other coastal counties. Upon implementation, these rules should reduce fecal coliform bacteria from future developments.

Table 7. Waters with Impaired Use Support Rating in the Shallotte Study Area

Waterbody	Use Category	Reason for Impairment	Parameter
Big Gut Slough	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed
Blane Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Bonaparte Creek (from the ICWW to the Little River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Bull Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Calabash River (from the source to the North Carolina-South Carolina state line)	Aquatic Life	Standard Violation	Copper, High Water Temperature, Turbidity
	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Clam Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Clayton Creek (from the ICWW to the Little River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Cooter Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Dead Backwater	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
East River	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Eastern Channel	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Fox Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Gause Landing Creek (from Kilbart Slough to the	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited

Waterbody	Use Category	Reason for Impairment	Parameter
ICWW)			
Goose Creek (from Brunswick County SR 1143 to Saucepan Creek)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Hangman Branch	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
ICWW (several sections)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area (either Conditionally Approved Open, Conditionally Approved Closed, or Prohibited)
Jinks Creek (from the Eastern Channel to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Jinnys Branch (from Brunswick County SR 1143 to Saucepan Creek)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Kilbart Slough	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Little River	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Lockwoods Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Lockwoods Folly River (several sections)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area (either Prohibited or Conditionally Approved Closed)
Marina south of the ICWW (Holden Beach Marina)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Mill Creek (from Brunswick County SR 1112 to Lockwoods Folly River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Montgomery Slough (from the ICWW west of Lockwoods Folly Inlet extending eastward 2.4 miles)	Aquatic Life	Standard Violation	Low Dissolved Oxygen
	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Mullet Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Salt Boiler Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open

Waterbody	Use Category	Reason for Impairment	Parameter
Sams Branch (from the proposed dam approximately 3/4 mile upstream from the Shallotte River channel to the Shallotte River 0.56 miles)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Saucepan Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
Shallotte Creek (from Bell Branch to Shallotte River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed
Shallotte River (several sections)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area (either Prohibited or Conditionally Approved Closed)
Sols Creek (from Eastern Channel to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
Spring Creek	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed
Still Creek (from Eastern Channel to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
The Big Narrows (from Jinks Creek to the ICWW)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Open
The Mill Pond (from a point 1.0 mile below Brunswick County SR 1145 to the Shallotte River)	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Prohibited
The Swash	Shellfish Harvesting	Loss of Use	Shellfish Growing Area-Conditionally Approved Closed

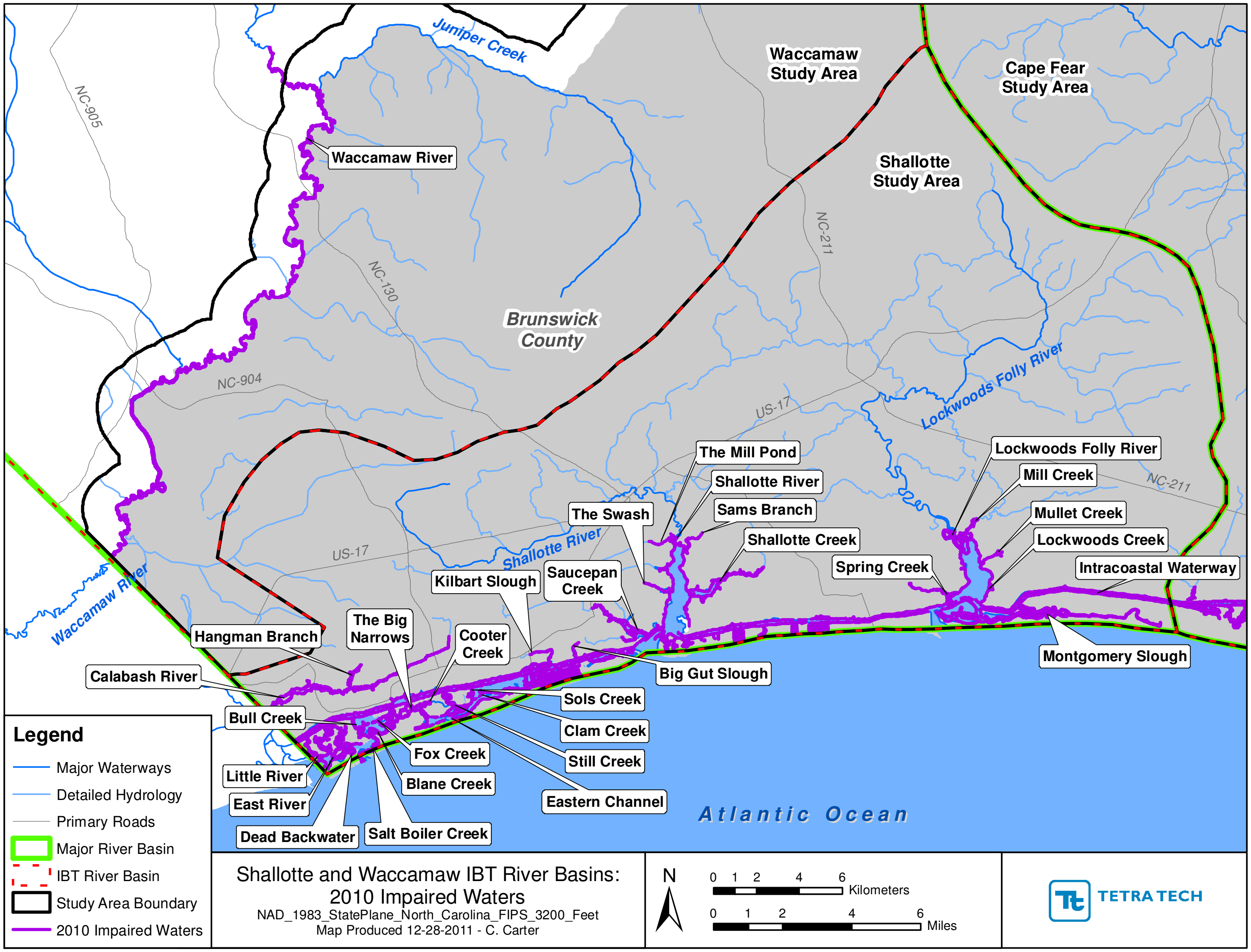

Figure 18. Impaired Waters in the Shallotte and Waccamaw Study Areas

4.2.1.4 Total Maximum Daily Load (TMDL)

The Lockwoods Folly River and the upriver portion of the estuary are prohibited for shellfish harvesting because of excessive levels of fecal coliform bacteria (NCDWQ, 2010c). In 2007 the NCDWQ Watershed Assessment Team completed a water quality study in the Lockwoods Folly River watershed as part of an agreement with the North Carolina Ecosystem Enhancement Program (NCDWQ, 2010c). Also in 2007 a local watershed plan for the Lockwoods Folly watershed was created by the North Carolina Coastal Federation, North Carolina Ecosystem Enhancement Program, North Carolina Department of Transportation, and the North Carolina Shellfish Sanitation Program, with support from Stantec. Nonpoint Source 319 Grant Program funds were subsequently approved to support third-party development of the Lockwoods Folly River Fecal Coliform TMDL. EPA approved the TMDL, and it will be implemented with the goal to reduce high fecal coliform concentrations to levels whereby the designated uses for these waterbodies will be met (NCDWQ, 2010c).

North Carolina has issued a statewide fish consumption advisory for mercury; therefore, all surface waters in the state are considered to be impaired by mercury (NCDWQ, 2011). A brief discussion is provided in Section 4.1.1.4.

4.2.1.5 Groundwater

The Shallotte Study Area is in the Coastal Plain physiographic province in the southern coastal portion of North Carolina. The aquifer underlying the Shallotte Study Area is the surficial aquifer composed of unconsolidated sand and gravel (NCDWR, 2011). Surficial aquifers are described in Section 4.1.1.5.

4.2.2 Aquatic and Wildlife Habitat and Resources

4.2.2.1 Significant Natural Heritage Areas

Approximately 19 percent of the Shallotte Study Area has been identified as SNHA (NCDENR, 2011a) (Figure 13). The Shallotte Study Area has three sites that are SNHA that have been identified as areas of national significance. These sites total approximately 16 percent of the Shallotte Study Area and include the Boiling Spring Lakes Wetland Complex, the Green Swamp, and the Long Beach Maritime Forest (Table 8).

Seven sites were identified as areas of state significance and occupy approximately 2 percent of the Shallotte Study Area (Table 8). Eight sites were identified as areas of regional significance and occupy approximately 1 percent of the Shallotte Study Area, and 4 sites were identified as areas of county significance and occupy less than 1 percent of the area. A description for each level of significance is provided in Section 4.1.2.1.

Table 8. SNHAs in the Shallotte Study Area

Significance	Site Name
National (15.9% of Shallotte Study Area)	Boiling Spring Lakes Wetland Complex, Green Swamp, and Long Beach Maritime Forest
State (2.0% of Shallotte Study Area)	Brantley Island, Colkins Neck Remnant, Juniper Creek Floodplain, Juniper Creek/Driving Creek Aquatic Habitat, Lockwoods Folly River Tidal Wetlands, Sunset Beach Wood Stork Ponds, Sunset Harbor/Ash Swamp

Significance	Site Name
Regional (1.4% of Shallotte Study Area)	Big Cypress Bay and Ponds, Bird Island, Fall Swamp/Middle River Limesink Complex, Royal Oak Swamp Marl Outcrop, Sandy Branch Sand Ridge and Bay Complex, Secession Maritime Forest, Shallotte Creek Sandhills, Stanly Road Coastal Fringe Forest
County (0.2% of Shallotte Study Area)	Bonaparte Landing Maritime Forest, Cumbee Pond and Sandhills, Gause Savanna, Middle Swamp

4.2.2.2 Aquatic Habitat and Resources

Carolina flatwoods are regions where flow is often slow and ephemeral. This low flow contributes to the coastal plain being dominated by blackwater systems that often consist of braided streams, wide floodplains and pocosin wetlands. The water is usually absent of sediment but has a dark color from tannins that are leached from organic matter. This tannic acid produces a pH that is naturally much lower than other river systems. Also these low-flow streams and wetlands can have natural dissolved oxygen levels below the 5 milligrams per liter (mg/L) freshwater standard (NCDWQ, 2010b). Two major rivers within the Shallotte Study Area are the Shallotte and Lockwoods Folly rivers.

A unique type of wetland known as Carolina bays are throughout much of the basin. Carolina bays are a type of isolated depressional wetland that range in size from a few acres to several hundred acres. They are on the Atlantic Coastal Plain from northern Florida to southern New Jersey, but are most highly concentrated in southeastern North Carolina and northeastern South Carolina. These depressional wetlands are distinguished from other wetlands by their elliptical shape, orientation, and an eolian sand rim that is most pronounced along the southeastern shoreline. Many of these wetlands, especially the smaller ones, are ephemeral and provide an ideal habitat for amphibians. They have a high degree of biodiversity mainly from varying amounts of soil moisture from inundated in the center to increasingly drier at the edges. Because these wetlands are often isolated from interaction with other surface waters, rare or endemic species are in and around many of them (NCDWQ, 2010b).

In the Shallotte Study Area, the Shallotte River including Sharron Creek, the Lockwoods Folly River including Mill Creek and Pamlico Creek, Long Bay, The Millpond, the ICWW, and Calabash Creek are designated fish nursery areas (Figure 15). Past and present sampling indicates that these areas support a high abundance and diversity of juvenile fish species (One NC Naturally, 2011).

SGAs open for shellfish harvesting in the Shallotte Study Area include waters of the inlets and downstream portions of the Shallotte and Lockwoods Folly rivers, Tubbs Inlet Area, and the Calabash Area (NCDEH-SSB, 2011); all other SGAs in the Shallotte Study Area are closed for harvesting because of the extent of contamination of waters in each SGA. Of the areas closed for harvesting, Shallotte Creek, Saucepen Creek, Davis Creek, upstream portions of the Shallotte and Lockwoods Folly rivers, portions of the Calabash Area and ICWW west of the Shallotte River inlet, Calabash/Sunset Beach/Boneparte Creek Area, and the Ocean Isle Beach Area are closed only conditionally and could be reopened if water quality in these areas is improved (NCDEH-SSB, 2011) (Figure 16).

Anadromous fish spawning areas have not been identified in the Shallotte Study Area (One NC Naturally, 2011).

4.2.2.3 Rare and Protected Species

The Shallotte Study Area is entirely within the County. Several species are protected either on the state or federal level in the County. The North Carolina Natural Heritage Program's (NCNHP's) Biotic Database

(NCNHP, 2011) lists all protected species. In the Shallotte Study Area are 13 invertebrate animals, 1 nonvascular plant, 114 vascular plants, and 43 vertebrate animals. A complete list of state and federally protected species in the Shallotte Study Area is provided in Appendix B.

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5 Water Conservation Measures

The County's water demand projections assume a constant *per capita* retail usage throughout the planning period (which is also directly related to the wholesale demand estimates). However, increased water conservation and water reuse could result in lower *per capita* demands over time.

The County has a water conservation program that includes voluntary and mandatory water use restrictions, price signals (tiered water rates and separate irrigation metering), customer education, and water reuse.

5.1 Water Use Restrictions

The County has the authority to impose water restrictions if a public water supply shortage occurs. All water customers are subject to the water use restrictions. The water use restrictions are organized in stages, with Stage 1 being voluntary and Stages 2 and 3 being mandatory. The stages are defined as follows (Chapter 1-13, Article V of County ordinances, http://library.municode.com/index.aspx?clientId=19946):

1) Stage 1—Water conservation alert. A Stage 1 water shortage emergency may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there are three (3) consecutive days when water demand exceeds eighty (80) percent of the water production capacity. Water production capacity shall be defined as the maximum volume of water that meets or exceeds state and federal standards that the water treatment process can produce during a twenty-four (24) hour period. Water production capacity can vary depending on system component reliability and/or raw water conditions. During a declared Stage 1 water shortage emergency the following voluntary water conservation practices shall be encouraged:
    a. Inspect and repair all faulty and defective parts of faucets and toilets.
    b. Use shower for bathing rather than bathtub and limit shower to no more than five (5) minutes.
    c. Do not leave faucets running while shaving, brushing teeth, rising or preparing food.
    d. Limit the use of clothes washers and dishwashers and when used, operate fully loaded. Operate dishwashers after the peak demand hours of 6:00 p.m. to 10:00 p.m.
    e. Limit lawn watering to that necessary for plant survival. Water lawns before the peak demand hours of 6:00 a.m. to 10:00 a.m.
    f. Water shrubbery the minimum required. Water shrubbery before the peak demand hours of 6:00 a.m. to 10:00 a.m.
    g. Limit vehicle washing to a minimum.
    h. Do not wash down outside areas such as sidewalks, driveways, patios, etc.
    i. Install water saving showerheads and other water conservation devices.
    j. Use disposable and biodegradable dishes where possible.
    k. Install water saving devices in toilets such as early closing flappers.
    l. Limit hours of water cooled air conditioners.
    m. Do not fill swimming or wading pools.
2) Stage 2—Water shortage warning. A Stage 2 water shortage emergency may be declared in the

event of an immediate water shortage, as so declared by state and/or local officials, or when there are two (2) consecutive days when water demand exceeds ninety (90) percent of the water production capacity. Water production capacity shall be defined as the maximum volume of water that meets or exceeds state and federal standards that the water treatment process can produce during a twenty-four (24) hour period. Water production capacity can vary depending on system component reliability and/or raw water conditions. During a declared Stage 2 water shortage emergency the following activities shall be prohibited:

a. Watering lawns, grass, shrubbery, trees, flower and vegetable gardens except by hand held hoses, container, or drip irrigation system. A person who regularly sells plants will be permitted to use water on their commercial stock. A golf course may water their greens. State and county licensed landscape contractors may water any plants by hand held hose or drip irrigation under a written warranty.

b. Filling swimming or wading pools, either newly constructed or previously drained. Make up water for pools in operation will be allowed.

c. Using water-cooled air conditioners or other equipment, in which cooling water is not recycled, unless there are health or safety concerns.

d. Washing any type of mobile equipment including cars, trucks, trailers, boats or airplanes. Any persons involved in a business of washing motor vehicles may continue to operate.

e. Washing outside surfaces such as streets, driveways, service station aprons, parking lots or patios.

f. Washing the exterior of office buildings, homes or apartments.

g. Using water for any ornamental fountain, pool, pond, etc., unless recycled.

h. Serving drinking water in food establishments such as restaurants or cafeterias, unless requested to do so by a customer.

i. Using water from a public or private fire hydrant for any reason other than to suppress a fire or other public emergency or as authorized by director or his authorized representative.

j. Using water to control or compact dust.

k. Intentionally wasting water.

l. Commercial and industrial water customers shall achieve mandatory reductions in water usage through whatever means are available. A minimum reduction of twenty (20) percent shall be the target, however a greater target reduction percentage may be required depending on the severity of the water shortage emergency. Compliance with the reduction target shall be determined by the director or his authorized representative. Variances to the target reduction may be granted by director or his authorized representative to designated public health facilities.

3) Stage 3—Water shortage danger. A Stage 3 water shortage emergency may be declared in the event of an immediate water shortage, as so declared by state and/or local officials, or when there is one (1) day when water demand exceeds one-hundred (100) percent of the water production capacity. Water production capacity shall be defined as the maximum volume of water that meets or exceeds state and federal standards that the water treatment process can produce during a twenty-four (24) hour period. Water production capacity can vary depending on system component reliability and/or raw water conditions. During a declared Stage 3 water shortage emergency the following activities shall be prohibited, in addition to activities prohibited under

Stage 2:

a. Watering lawns, grass, shrubbery, trees, and flowers.

b. Washing motor vehicles at commercial car wash establishments.

c. Watering any vegetable garden except by hand held hose, container, or drip irrigation.

d. Commercial and industrial water customers shall achieve mandatory reductions in water usage through whatever means are available. A minimum reduction of fifty (50) percent shall be the target, however a greater target reduction percentage may be required depending on the severity of the water emergency. Compliance with the reduction target shall be determined by the director or his authorized representative. Variances to the target reduction may be granted by the director or his authorized representative to designated public health facilities.

e. In the event that the prohibition of the activities listed above is not sufficient to maintain an adequate supply of water for fire protection, all use of water for purposes other than maintenance of public health and safety shall be prohibited. Residential water use shall be limited to the amount necessary to sustain life through drinking, food preparation and personal hygiene.

5.2 Pricing Signals

The main elements of the County's water service pricing that affect water demand are tiered rates and separate metering for outdoor (irrigation) uses.

The rates for retail meters include a base charge that increases with larger service meter sizes from $11/month (for ¾-inch retail meters) to $27/month (for 4-inch retail meters). In addition to this base charge, retail water rates include three usage tiers, charged at $3.05, $3.10 and $3.15 per 1,000 gallons, as monthly usage increases. For ¾ to 1-1/2 inch service connections, the three tiers are 0–6,000 gallons, 6,001–20,000 gallons and > 20,000 gallons. For 2-inch service connections, the three tiers are 0–20,000 gallons, 20,001–100,000 gallons and > 100,000 gallons. For 3- and 4-inch service connections, the tiers are 0–50,000 gallons, 50,001–250,000 gallons and > 250,000 gallons. Industrial and wholesale water rates are based on a service charge depending on the size of the meter and a constant rate of $2.76 per 1,000 gallons (there is also a minimum usage charge).

Irrigation meter rates have five tiers, ranging from $3.05 per 1,000 gallons to $4.00 per 1,000 gallons. The five residential irrigation meter tiers have usage cutoffs of 6,000, 12,000, 20,000 and 50,000 gallons. Commercial and multifamily irrigation meter cutoffs are at 20,000, 50,000, 100,000 and 200,000 gallons. The monthly base service charge is the same as that for retail meters but is waived for irrigation meters where the facility has another retail meter.

Although the use of irrigation meters is not mandatory, there is a strong incentive to use them because irrigation water is not included in the user's sewer bill, and all residential wastewater flows over 3,000 gallons per month are billed at the relatively high rate of $6.50 per 1,000 gallons (note that all commercial wastewater flows are billed at a constant rate of $6.50/1,000 gallons and that industrial wastewater flows are billed using a declining block rate structure).

The County is also in the process of retrofitting meters with Automated Meter Reading, or Advanced Metering Infrastructure systems that will allow meters to be read quickly and remotely, enhancing the County's ability to both analyze water use to improvement management and identify abnormal water usage and notify customers as appropriate. The County is about one-third of the way through retrofitting its retail customers' meters.

Detailed rate and fee information for water and wastewater services are at http://www.brunsco.net/Departments/LandDevelopment/Utilities/WaterSewerRates.aspx.

The County's wholesale customers are required to adopt the County's conservation measures at a minimum. In some cases, the wholesale customer has enacted more stringent measures than the County.

5.3 Customer Education

The County provides water conservation information to its customers through various means including their website, in water bill mailers and at public events. For example, the County has developed a water conservation brochure which is available in hard copy and on their website at http://www.brunsco.net/Departments/LandDevelopment/Utilities/BrochuresUtilities.aspx. The County also maintains a Frequently Asked Questions list (http://www.brunsco.net/Portals/0/bcfiles/finance/fin_faqs.pdf) and produces annual water quality and wastewater performance reports, available at http://www.brunsco.net/Departments/LandDevelopment/Utilities/AnnualReports.aspx.

The County also works with the Cooperative Extension Agency on water conservation and sustainable landscaping practices, and with property owners associations in a number of large subdivisions to promote water conservation.

5.4 Water Reuse

The County has four wastewater treatment plants (WWTPs) that are permitted for reuse: Ocean Ridge Plantation, Sea Trail, West Brunswick Regional and Northeast Brunswick Regional. Two additional facilities recharge the surficial groundwater aquifer via spray irrigation: Shallotte and Carolina Shores. Several other small reuse systems and a number of other land application (surface or subsurface) systems are located in the County but not owned or operated by them; these systems are discussed in Section 1.5 below.

The largest water reclamation plant in the County is the West Regional plant, with a permitted capacity of 6.0 MGD. This plant includes a reclaimed water line that extends to four golf courses, in addition to three dedicated land application sites. The Northeast Regional plant produces reuse quality water and is permitted for reuse, but it is not currently reusing water except within the boundaries of the plant.

The County is conducting a study to assess the feasibility of residential water reuse (costs, demand and public acceptance issues) at the Saint James Plantation and Winding River developments. The County estimates that these developments might have a seasonal reclaimed water demand of up to 1.3 MGD.

5.5 ASR Study

The County is planning a study of aquifer storage and recovery (ASR) at the 211 WTP to reduce withdrawal of surface water during peak demand periods. The technical viability of this option is unknown.

6 Water Supply Alternatives

An analysis of water supply alternatives was conducted as part of the IBT evaluation and environmental documentation and is important for determining the most viable alternative for the County. Options for an increase in IBT associated with an expansion of the Northwest WTP were weighed against alternatives that do not require additional IBT or combinations of alternatives that could limit the quantity of the IBT. Factors considered during alternatives analysis were the technical viability of the option, the constructability of the alternative, potential environmental impacts, technical difficulty, permitting issues, and estimates of opinions of probable costs, both construction costs and O&M. A discussion of the reasons for choosing the preferred alternative over other alternatives is provided.

6.1 No Additional IBT Alternative

A No Additional IBT alternative must be considered as an alternative to an IBT. This alternative is defined as one in which no amount of water *over the grandfathered IBT* is transferred to customers in the Shallotte IBT River Basin as a result of any changes or improvements to the County's water treatment facilities would occur. The 1999 *Preliminary Engineering Report* (PER) (HDR, 1999a), the 2008 PER (Hazen and Sawyer, 2008), and the *Water Master Plan* (Hazen and Sawyer, 2006) discuss reasons why the system is not reliable in its existing condition and how future water demands could further erode its reliability.

To determine whether a No Additional IBT alternative could be considered viable, future growth projections and current permitted capacities of the County's facilities were examined. This information, which is presented in Section 1.3 (Water Demand Projections), indicates that future growth is projected in the County, resulting in a projected increase in water demand. Nearly half of the future demand is in the Shallotte IBT River Basin.

Typically, municipalities begin a WTP expansion process when the maximum day demand reaches 80 percent of treatment plant capacity. The County provided finished water quantity data of water produced by its WTPs, the Northwest WTP and NC 211 WTP. A review of the 2008 through 2011 data indicates the following:

- In 2008 the daily flow averaged 13.80 MGD. The peak day flow reported for 2010 was 25.55 MGD (approximately 85 percent of permitted water treatment capacity of 30 MGD) on July 5, 2008, resulting in a peak day peaking factor of 1.85.
- In 2010 the daily flow averaged 12.820 MGD. The peak day flow reported for 2010 was 21.32 MGD (approximately 70 percent of permitted water treatment capacity of 30 MGD) on July 5, 2010, resulting in a peak day peaking factor of 1.66.
- In 2011 the daily flow averaged 13.78 MGD. The peak day flow reported for 2011 was 25.80 MGD (approximately 86 percent of permitted water treatment capacity of 30 MGD) on July 6, 2011, resulting in a peak day peaking factor of 1.87.

The data indicate that average and maximum daily flows decreased and then increased since 2008. The most recent annual flows (2011) are similar to the 2008 flows. The 2011 data also indicate that the maximum day demand exceeded 80 percent of the plant capacity in 2008 and 2011, suggesting that a water treatment system expansion process should begin.

If the County's ability to provide reliable, high-quality potable water to its customers is limited, the County will have difficulty in accommodating growth in the service area and particularly in the Shallotte IBT River Basin. On the basis of the data provided, the County has demonstrated the need for an expansion of its water treatment system and a No Additional IBT alternative is not recommended.

6.2 Increase in IBT from Cape Fear - Northwest WTP Expansion

The existing Northwest WTP provides the majority of the County's potable water. The WTP is permitted to produce 24 MGD of potable water. The source of the raw water supply is the Cape Fear River. Because the County's water service area is in the Waccamaw and Shallotte IBT river basins of the Lumber Major River Basin in addition to the Cape Fear Major River Basin, increased withdrawals from the Cape Fear River to meet demand would result in an IBT. NCDWR has concluded that full demand for all withdrawals at Lock and Dam #1 would be met through 2050 (NCDWR, 2008).

Various treatment options are discussed in the *Expansion of Brunswick County Northwest Water Treatment Plant Preliminary Engineering Report* (NWWTP PER) prepared by Hazen and Sawyer (2008) and the earlier *Water Supply/Treatment Study* (WS/TS), prepared by HDR (1999b). On the basis of raw water quality results from January 2008 to April 2011, the raw water quality appears to be similar to the raw water quality identified in the 2008 NWWTP PER, and the proposed water treatment processes identified in the 2008 NWWTP PER are still applicable. Review of raw water quality results for DWQ Ambient WQ Station #B8350000 from January 2008 to April 2011 indicates that the average raw water turbidity was approximately 16.2 nephelometric turbidity units (NTU), which is similar to the raw water turbidity documented in the NWWTP PER (17 NTU). Additionally, the average raw water pH from January 2008 to April 2011 was about 6.5 NTU, which is similar to the average pH of approximately 6.7 NTU that is documented in the NWWTP PER.

The WTP expansion will not only include improved treatment capabilities but also increase the capacity of the plant. Construction cost estimates from the 2008 NWWTP PER have been updated to reflect 2012 construction pricing and are used for comparison to other alternatives. Per Table 1 of the 2008 NWWTP PER, the preliminary construction cost estimate for expanding the facility to a treatment capacity of 36 MGD is $34,640,000. The breakdown of this cost is shown provided in the EA.

This preliminary cost was increased by a factor of 1.12 to account for inflation using *Engineering News-Record's* (ENR's) Construction Cost Index (CCI) for July 2008 (8293) and the March 2012 CCI (9267.57), resulting in a preliminary cost of approximately $38.8 million as reflected in Table 4-2.

The existing WTP site was master planned in the 2008 NWWTP PER and is considered to have adequate room to support the expansion, so no additional land would need to be acquired. The expansion plans would allow the WTP to maintain its current operations with minimal disruption. An expansion would increase the reliability of the WTP, which is crucial because the WTP is the main potable water supply for the County. The reliability of the WTP has been discussed in the *Preliminary Engineering Report* prepared by HDR (1999a).

The location of the surface water WTP is in the northern portion of the County's service area; the growth is mainly occurring in the southern and southwestern areas. Thus, the expansion alternative includes an evaluation of the costs to upgrade the distribution system and high service pumping as discussed in the WS/TS and further developed in the *Water System Master Plan* prepared by Hazen and Sawyer (2006). The *Water System Master Plan* includes hydraulic modeling to determine the necessary improvements. The following improvements are included in the preliminary opinion of cost to expand the Northwest WTP:

- Modification IIA-3 (Parallel 30-inch Pipeline to Bell Swamp PS)
- Modification IIA-5 (Parallel 30-inch Pipeline, Bell Swamp PS to Highway 211/17 Intersection)
- Modification IIB-3 (Bell Swamp Southwest Booster Pumps)

The preliminary opinion of construction cost for expanding the Northwest WTP from 24 to 36 MGD is $90.7 million. The breakdown of this cost is provided in the EA.

O&M costs attributed to expanding the Northwest WTP to 36 MGD are based on existing O&M costs as documented by the County and O&M costs that would be associated with the new 30-inch diameter pipelines. The County's budget for years 2010 and 2011 for the Northwest WTP were reviewed to develop budgetary O&M costs for expanding the Northwest WTP from 24 to 36 MGD. It is assumed that no additional personnel will be needed to operate the Northwest WTP at 36 MGD. Costs that are expected to change because of the plant expansion are listed in Table 4-3 below. Annual O&M costs for the pipelines are projected to be 1 percent of the pipeline construction costs and additional annual O&M costs for the Bell Swamp Pump Station are projected to be 2.5 percent of the pump station modification costs.

On the basis of this information, the budgetary O&M costs for expanding the Northwest WTP from 24 to 36 MGD are approximately $1.54 million per year.

6.3 WATER SUPPLY ALTERNATIVES IN RECEIVING BASINS

State policy gives preference to alternatives that involve water supply transfers in the receiving river basin as opposed to alternatives that would require transfer from another major river basin. In the receiving river basin, the potential sources of water include surface water impoundments, purchase of water from other suppliers in the basin, groundwater wells, and seawater desalination. Alternatives for water supply in the receiving river basins are discussed below.

6.3.1 New Surface WTP

A new surface WTP would improve overall system reliability and could be closer to the future growth projected in the southwest portion of the service area. The Waccamaw River is the only potential surface water supply source in the area. The Waccamaw River is in the Waccamaw subbasin of the Lumber River Basin. Withdrawals from the Waccamaw River would require an IBT to transfer water from the Waccamaw to the Shallotte IBT River Basin. The WS/TS (HDR, 1999b) evaluates the Waccamaw River as a source and determined that there are low flows during the summer months and extremely low to potentially no flow during drought conditions. The WS/TS also provides a cursory review of expected water quality and determines that the Waccamaw River water quality is not as desirable as the Cape Fear River water quality because of high color, total and dissolved organic carbon, and possibly high levels of iron and manganese.

To confirm sufficient availability of source water, the most recent 7Q10 low-flow discharge estimate for the Waccamaw River at Highway 130 (upstream of the confluence with Bear Branch) was requested from the USGS. Per North Carolina regulations, no in-stream flow study is required if the run-of-river withdrawal for the proposed project is less than 20 percent of a source's 7Q10. Per communication with the USGS in April 2012, the most recent and provisional 7Q10 low-flow discharge estimate for monitoring station #02109500 (Waccamaw River at Freeland, NC) is 1.5 cfs. Twenty percent of 1.5 cfs is 0.3 cfs, which is approximately 193,923 gpd. The Northwest WTP is proposed to be expanded from 24 MGD to 36 MGD. If the Northwest WTP is not expanded, the additional 12 MGD of finished water would need to be provided by another WTP. Up to 12.5 MGD of source water would need to be withdrawn from the Waccamaw River to produce 12 MGD of finished water (accounting for treatment losses). This volume is 60 times greater than 20 percent of the 7Q10 low-flow discharge estimate (193,923 gpd); therefore, an in-stream flow study would be required for a withdrawal on the Waccamaw River. A review of the USGS flow data for station #02109500 beginning October 1, 2010 through September 30, 2011, indicates that, river flow is typically less than 20 cfs (approximately 13 MGD) in June, July, and August. Thus, an in-stream reservoir (i.e., impoundment) on the Waccamaw River, an off-stream reservoir, or an Aquifer Storage and Recovery (ASR) system would be necessary to provide the water supply for a 12-MGD WTP and to ensure supply reliability when Waccamaw River flows are low. It is anticipated that at least a 1.5-billion gallon reservoir covering up to 400 acres would be necessary to store excess flow collected in the wet season to meet average annual water supply demands of a 12-MGD WTP. Flow studies of the Waccamaw River would need to be conducted to determine if enough volume of water could be stored in the wet season to provide source water supply year-round and not affect the ecological health of the Waccamaw River.

Raw water quality data from January 2008 to April 2011 were analyzed to compare the Waccamaw River with the Cape Fear River source waters and provide a basic assessment of the type and level of treatment required compared to the alternative of expanding the Northwest WTP. Review of raw water quality results for DWQ Ambient WQ Station #I8970000 from January 2008 to April 2011 indicates that the average raw water turbidity was approximately 4.4 NTU, and all turbidity results were no greater than 12 NTU. The turbidity in the Waccamaw River is generally more variable than for the Cape Fear.

Additionally, the average raw water pH from January 2008 to April 2011 was about 4.7, which is significantly lower than the average pH of the Cape Fear River from January 2008 to April 2011 (6.5) and 6.7 as documented in the 2008 NWWTP PER. A lower pH requires greater volumes of chemicals to adjust the water to a neutral or higher pH for surface water treatment.

Because the Waccamaw WTP would be on an undeveloped site, construction costs are associated with developing a *greenfield* WTP including site work, stormwater facilities, operations and control facilities, and new potable water distribution piping to reach the existing distribution system. Also, the costs for a raw water storage reservoir are included in this option. A factor in evaluating this alternative also includes the increased permitting efforts required for a new facility and its associated storage reservoir and a new withdrawal point along the river. Last, an in-stream flow study would need to be conducted to determine the feasibility of a 12-MGD WTP using Waccamaw River water as source water because of the potential effects on the river's habitat and aquatic biota. Budgetary cost estimates for this alternative are $162.5 million. The breakdown of this cost is provided in the EA.

The Waccamaw River has average raw water turbidity values (4.4 NTU), which are less than those of the Cape Fear River (16.2 NTU), less coagulant would be required, resulting in lower operational costs. However, because the raw water average pH value for the Waccamaw River (4.7 NTU) is lower than that of the Cape Fear River (6.5 NTU), additional sodium hydroxide (NaOH) would need to be added to raise the pH of the Waccamaw River source water, resulting in increased operational costs. Additionally, per the WS/TS (HDR 1999b), higher color, total and dissolved organic carbon and iron and manganese in the Waccamaw River (as compared to the Cape Fear River) would increase the cost of treating source water from the Waccamaw River.

O&M costs attributed to operating a new 12-MGD WTP are based on existing O&M costs associated with the Northwest WTP and O&M costs that would be associated with the new 30-inch diameter pipeline and with the off-stream reservoir. Additionally, new water treatment personnel would be assigned to the Waccamaw WTP. Annual O&M costs for the pipeline are projected to be 1 percent of the pipeline construction costs.

On the basis of this information, the budgetary O&M costs for a 12-MGD Waccamaw River WTP and associated raw water storage reservoir and pipelines are approximately $3.4 million per year.

6.3.2 Purchase Water from Existing Utility in Receiving Basin

The County has entered into agreements, in the form of a water purchase contract and an water system interconnection infrastructure cooperative agreement, with the Little River Water and Sewerage Company, Inc. (Little River) in South Carolina for Little River to establish an emergency interconnection and to provide up to a maximum of 170,000 gallons per day of potable water to the County. This value is an upper quantity limit, and Little River does not guarantee emergency supply for the County. This quantity provides additional potable water to the County and will be used to supply the Waccamaw IBT River Basin with future supply (eliminating the need for additional IBT water), but because the maximum quantity is 170,000 gallons per day, the County would need to proceed with an alternative that will supply additional potable water to meet demand in the Shallotte IBT River Basin. The emergency interconnection with the Little River Water Company has been planned for a number of years. No additional infrastructure beyond the actual connection is required since the Little River system is immediately adjacent to the Waccamaw portion of the County's water system.

6.3.3 Expanded or New Groundwater WTP

Withdrawals of raw water from a groundwater source would not require an IBT. Two groundwater source/treatment options have been evaluated. One option is to expand the County's existing 211 WTP in the southeastern portion of the County's service area. The second option is to construct a new groundwater WTP in the western portion of the service area, closer to where future growth is expected to occur.

6.3.3.1 Expansion of 211 WTP

The existing 211 WTP is a lime-softening plant with a permitted capacity of 6 MGD. Its source water is fresh groundwater from the Castle Hayne aquifer, which occurs only in the southeastern portion of the County. The Castle Hayne aquifer is approximately 175 feet below land surface. It is regarded as fairly permeable, but because it has limited thickness (< 60 feet), the transmissivity is fairly low according to the USGS Water Resources Investigations Report 03-4051 (Harden et al. 2003). The low transmissivity would limit the yield of each well, requiring more wells. Increasing withdrawal from the Castle Hayne aquifer could also cause unacceptable effects on surface water quality, existing water users, and sensitive ecological systems. In many areas, the Castle Hayne aquifer is poorly confined or unconfined, and in places exposed to rapid recharge of surface water via sinkholes.

The existing wellfield would need to be expanded to supply additional capacity. Because drawdown is an issue for this aquifer, future wells could require considerable setbacks from other wells so as not to increase the drawdown or reduce the yield of the well site. A review of the existing wellfield layout indicates that, in general, the existing wells are at least 1,500 linear feet away from each other. The existing wellfield includes 15 wells. If the Northwest WTP were not expanded and the 211 WTP were required to produce the additional 12 MGD of water, the 211 WTP would need to be expanded from a 6-MGD plant to an 18-MGD plant. If the new wells produced water quantity and quality similar to the existing groundwater wells, it is expected that 30 additional wells would be required. Groundwater modeling needs to be conducted to determine the potential hydraulic conditions of an expanded wellfield and the potential for migration of higher TDS water into the wellfield.

Lime softening might be an option for treatment and further evaluation of the groundwater quality is necessary to confirm the required treatment process. Because of the potential variability of the groundwater quality and the potential for saltwater intrusion, a nanofiltration water treatment system is proposed, and the costs associated with a nanofiltration system are provided. As documented in the *Water Supply Master Plan* (Hazen & Sawyer, 2006), preliminary costs for a new 6-MGD nanofiltration WTP at the 211 WTP are approximately $14 million. This cost was increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57) and the preliminary cost is adjusted to account for a 12-MGD WTP.

A review of the County's water mains indicates that the water distribution system piping paralleling Highway 211 from the 211 WTP west to Highway 17 ranges from 12 inches to 16 inches in diameter. The water distribution system piping would need to be upsized or a parallel pipeline would need to be installed along Highway 211 to accommodate the additional 12 MGD of potable water flow from the 211

WTP. Hydraulic modeling would be needed to confirm the recommended diameter of the pipeline. For the purposes of this IBT evaluation, a 30-inch diameter pipeline is assumed in the preliminary opinion of cost for this option. Because the 211 WTP is an existing site, permitting requirements and ancillary facilities are anticipated to be less than for an undeveloped site.

The nanofiltration process produces a concentrate stream that would need to be discharged. Typically, nanofiltration processes operate at 85 to 95 percent recovery, so for a 12-MGD WTP, the concentrate stream would likely range from 0.6 to 2.1 MGD. North Carolina does not allow deep-well injection, so the most feasible option for discharge of the concentrate is to a wastewater collection system or directly to a WWTP. The preliminary opinion of cost, $141.3 million assumes the installation of a concentrate pump station and pipeline to discharge the concentrate at the West Brunswick Water Reclamation Facility (WRF) (approximately 72,000 LF away). The nanofiltration concentrate is proposed to be discharged at the *tail end* of the West Brunswick WRF so that upsizing of the WRF's treatment processes to accommodate the concentrate flow is minimized. Further evaluation of the concentrate water quality is necessary to confirm the concentrate discharge location at the WRF.

O&M costs attributed to expanding the 211 WTP from 6 to 18 MGD with 12 MGD of nanofiltration treatment are based on O&M costs as documented in the *Technology and Cost Document for the Final Ground Water Rule* (USEPA, 2006) and increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57). Additionally, the cost includes O&M for a concentrate discharge pipeline to the West Brunswick WRF. On the basis of this information, the budgetary O&M costs for adding 12 MGD of nanofiltration treatment at the 211 WTP are approximately $2.3 million per year.

6.3.3.2 New Groundwater WTP

A new groundwater-source WTP in the western area of the County would use the Peedee aquifer, which is a freshwater source. The Peedee aquifer is present throughout coastal Brunswick County at depths between 30 and 170 feet below sea level (Harden et al. 2003). It comprises sand and clays in the confining beds and calcareous sandstone to sandy limestone in the transmissive beds. It has lower permeability but is much thicker than the Castle Hayne aquifer. In general, the transmissivity is comparable to or greater than that of the Castle Hayne aquifer. A conceptual cost estimate for an exploratory well program and a production wellfield is $103.1 million. The breakdown of this cost is provided in the EA.

On the basis of water quality data in the USGS report, *Hydrogeology and Ground-water Quality of Brunswick County, North Carolina* (Harden et al., 2003), the required level of treatment can range from lime softening to membrane softening or nanofiltration. Because of the potential variability of the groundwater quality and the potential for saltwater intrusion, a nanofiltration water treatment system is proposed, and the costs associated with a nanofiltration system are provided. As documented in the *Water Supply Master Plan* (Hazen & Sawyer, 2006), preliminary costs for a new 6-MGD nanofiltration WTP at the 211 WTP are approximately $14 million. This cost was increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57) and the preliminary cost is adjusted to account for a 12-MGD WTP.

The potential for saltwater intrusion must be evaluated as part of a qualitative evaluation of potential environmental impacts. If saltwater intrusion is determined to be an issue for this aquifer, it might not be feasible to proceed with plans to increase fresh groundwater withdrawals.

As with other proposed new WTPs on undeveloped sites, the construction costs and permitting activities would be higher than those associated with expanding existing facilities. Other significant cost elements are land acquisition and off-site distribution. For this estimate, it was assumed that the concentrate discharge from a nanofiltration WTP would be delivered to a County WRF for disposal and that the groundwater WTP would be close to the WRF such that concentrate discharge pumping and piping costs are minimized. The West Brunswick Regional WRF is rated at 6 MGD and is the County's largest WRF. Because of its capacity and proximity to a large water distribution main (30-inch diameter), it could be considered as a potential location for a co-located groundwater WTP. Distribution system modeling is recommended to determine how 12 MGD of finished water delivered into the 30-inch water main near the West Brunswick Regional WRF (near the intersection of Highway 211 and Highway 17) would affect flow dynamics and distribution system water quality. Water main sizing upgrades might be necessary, but because of the proximity of this south-central location to the projected growth areas, the upgrades might be minimal and no distribution system upgrades are included in the conceptual costs of this alternative.

The County has indicated that a new WRF might be constructed farther west and south of the West Brunswick Regional WRF, on property that the County purchased in the past few years. This WRF would be closer to the areas of population growth. Similar to the discussion above, a new WTP could be co-located on that property to reduce the amount of discharge piping necessary to dispose of the nanofiltration concentrate.

O&M costs attributed to a new 12-MGD groundwater nanofiltration WTP are based on O&M costs as documented in the *Technology and Cost Document for the Final Ground Water Rule* (USEPA 2006) and increased by a factor of 1.2 to account for inflation using ENR's CCI for July 2006 (7721) and the March 2012 CCI (9267.57). On the basis of this information, the budgetary O&M costs for a new 12-MGD nanofiltration treatment plant adjacent to a WRF are approximately $2.15 million per year.

Further consideration of this alternative would require a groundwater quality and quantity evaluation, which would be included in an exploratory well program. Additionally, confirmation that a water treatment process waste stream could be discharged to and treated by the West Brunswick Regional WRF or another WRF would be necessary. Also, the development of a new raw water source would need to be evaluated to determine if any conflict exists with the County's contract with LCFWSA.

6.3.4 Seawater Desalination WTP

The County is adjacent to the ICWW and Atlantic Ocean, which has a virtually unlimited quantity of water available for treatment. A new WTP could be in the County's service area where the population growth is occurring. For the purposes of this evaluation, the Holden Beach area is the area of consideration because it is centrally located along the coastal area of the County. Historically, seawater desalination has proven to be cost-prohibitive compared to treating other sources of raw water. A conceptual level cost evaluation was completed for the treatment facilities, intake structures and raw water mains, distribution mains and site work associated with a new desalination facility. Costs are also included for a distribution system blending water analysis to determine if there are any projected effects on the water quality as the treated seawater mixes with the treated surface water and groundwater from the existing treatment plants.

Disposal of concentrate or brine is typically a costly component for a seawater desalination plant. Because North Carolina does not allow deep injection wells, the most feasible option for concentrate management is to return the concentrate to the ICWW. Water quality modeling of the brine discharge and its effect on the ICWW would need to be performed as part of permitting the facility. Seawater desalination also requires additional environmental permitting for both withdrawal of water and concentrate disposal. It is anticipated that the conceptual costs are $334 million. These budgetary capital costs were developed using Tetra Tech's historical cost database. The breakdown of this cost is provided in the EA.

Seawater desalination's O&M costs are very high, primarily because of the power costs associated with operating the treatment processes, particularly operating the high-pressure feed pumps for the reverse osmosis treatment process. The budgetary costs for this water supply option are shown below and are expected to be at least $12.1 million per year.

6.4 Other Options for Reducing the IBT

6.4.1 Surface Water Storage

Two options for storing surface water from the Cape Fear River are being evaluated. One option is a surface water off-line storage reservoir, and the other option is an ASR system. The first ASR system in North Carolina was built by Greenville Utilities Commission and began operation in 2010. The Cape Fear Public Utility Authority (CFPUA) is beginning an ASR Well Testing Program in 2012 at its elevated tank site on Westbrook Avenue in Wilmington. Results from this study will be included in a pending study by the County of whether ASR at the County's 211 plant could result a reduction in supply from surface water withdrawal from the Cape Fear River to meet potable water demands during the dry season and during peak demand events such as the July 4th holiday.

6.4.2 Water Conservation and Reuse

The County's water conservation program is described in detail in Section 5. Further development of water conservation programs in the County is expected to reduce the *per capita* demand for potable water in the service area, although no specific *per capita* demand targets have been set. Although water conservation alone would not be sufficient to offset future water demands and alleviate the need for an IBT, *per capita* water demand would be evaluated annually and used to project future flows as a part of the County's capital planning processes. Likewise, although the reuse of reclaimed wastewater in the Shallotte IBT River Basin will help to offset potable demands and minimize IBTs from the Cape Fear IBT River Basin, consumptive reuse in the Shallotte IBT River Basin would still count toward the proposed IBT. The County's current and future planned water reuse are discussed in Section 5.

6.4.3 Return of Wastewater to Source Basin

Treated wastewater in the Shallotte IBT River Basin can be returned to the Cape Fear IBT River Basin for discharge or land application, or as reclaimed water for a variety of residential, commercial and industrial uses. As discussed in Section 1.5, four of the County's six existing municipal WWTPs (representing approximately 89 percent of permitted wastewater treatment capacity) produce reuse quality effluents. Several options exist for returning wastewater from the Shallotte to the Cape Fear IBT River Basins:

1) Pumping treated effluent from the West Regional plant to the Cape Fear IBT River Basin for discharge, land application, or reuse. The West Regional Plant already has a 6.0-MGD capacity (half of the proposed IBT) and is expandable to 12 MGD.
2) Pumping raw sewage from the Shallotte IBT River Basin to an expanded Northeast Regional plant (or one of the other plants that discharges in the Cape Fear IBT River Basin).
3) Building a new treatment plant or multiple decentralized plants in or closer to the Cape Fear IBT River Basin to treat wastewater from Shallotte IBT River Basin for dispersal in the Cape Fear IBT River Basin.

Although each option listed above has merit, it is believed that option #1, pumping treated effluent from the West Regional plant to the Cape Fear IBT River Basin would be the least costly option because a significant portion of the treatment capacity is already installed. Conveyance costs are presumed to be the same order of magnitude for all the options listed. Because option #1 is likely to be least costly, it will be used to provide a baseline cost estimate for the *return of wastewater to source basin* management options.

As indicated, the West Regional plant already has 6 MGD of treatment, storage, and spray irrigation capacity, and plans are to eventually upgrade to the full proposed IBT flow of 12 MGD. Accordingly, treatment costs are not included as a line item for the cost estimates. Capital costs are $38.7 million for the rapid infiltration sub-option and $120.6 million for the spray irrigation sub-option.

Because approval for a new, major discharge to the lower Cape Fear River is likely to be subject to significant permitting obstacles, only land application is considered in this option. On the basis of NRCS soil data for the County, it appears that the Cape Fear IBT River Basin features several areas with Baymeade and Kureb soil series, which are well-drained, sandy soils and are generally suitable for land application. However, without more detailed investigation, it is unclear whether these areas would be available for purchase by the County for effluent dispersal. Assuming that land is available, several options could be considered for land application. Two options have been considered for this option: traditional spray irrigation and rapid infiltration.

The spray irrigation and rapid infiltration options would both require similar transfer pumping and piping (to convey treated effluent from the West Regional plant to the land application area) and distribution system pressurization pumping systems. Compared to rapid infiltration, traditional spray irrigation systems generally require substantial amounts of suitable land on which to apply effluent. Spray irrigation system also require relatively large storage reservoirs to hold treated effluent during wet or freezing periods. Although sizing of storage for spray irrigation systems is based on a site-specific water balance, the DWQ typically requires a minimum of 30 days of storage and, in fact, the existing spray irrigation system at the West Regional plant has 30 days of storage. Depending on soil and site characteristics, rapid infiltration systems (which are defined by DWQ for the Coastal Plain as sites receiving more than 1.75 inches of effluent per week) in the Coastal Plain are often loaded at rates of up to 5 gpd per square foot (gpd/sf) and sometimes up to 10 gpd/sf. Because of their high loading rate, rapid infiltration systems are more susceptible to subsurface constraints that limit the movement of water away from the site and toward a receptor (i.e., surface water). Although sites that are suitable for rapid infiltration typically do not require on-site effluent storage, on the basis of hydrogeologic investigations and modeling, rapid infiltration systems could require artificial drainage to ensure that the resulting groundwater mound that forms beneath the application area does not impede movement out of the infiltration area and that effluent does not surface downgradient.

The County uses a combination of traditional (i.e., slow rate) spray and drip irrigation and rapid infiltration, along with irrigation at golf courses to manage reclaimed water from the West Regional plant. Costs for the County’s existing land application/reuse system, sized to manage 6.0 MGD of reclaimed water (in the Shallotte IBT River Basin), were about $21.5 million, for a unit cost of approximately $3.58/gpd land application capacity. Land application in the Cape Fear IBT River Basin, not including transmission from the West Regional plant, was estimated to range between $10,631,250 for 100 percent rapid infiltration to $92,452,500 for 100 percent spray irrigation, with much of the cost difference attributable to land acquisition, site preparation and storage requirements. For comparison purposes, the unit costs of these options range from $0.89/gpd (rapid infiltration with gravity subsurface drainage) to $7.70/gpd (for slow rate spray irrigation). These budgetary capital costs were developed based on a variety of sources including RSMeans CostWorks® cost estimation tool using 2012Q1 data for Wilmington, North Carolina, EPA’s 2006 update to *Land Treatment of Municipal Wastewater Effluents* guidance manual, the County’s previous costs for the West Regional WWTP land application system and professional experience and judgment.

Note that the feasibility of both options is highly dependent on locating and acquiring suitable property of sufficient size and proximity in the Cape Fear IBT River Basin.

Under this option, it is assumed that the existing land application and reuse would be discontinued, or at least greatly decreased, in the Shallotte IBT River Basin and instead shifted to the Cape Fear IBT River Basin. Because the facilities being operated would be very similar to those in operation, there would be no additional O&M demands above those associated with the West Regional WWTP and land application system. Additional O&M demands associated with the new effluent pumping station and conveyance piping are $782,000 per year.

6.5 SUMMARY OF ALTERNATIVES

The preceding sections provide discussion of a number of alternatives including a No Additional IBT alternative. The No Additional IBT alternative is not recommended because the County has demonstrated the need for an expansion of its water treatment system; not doing so would compromise its ability to provide reliable, high-quality potable water to its customers, particularly those in the Shallotte IBT River Basin. Additional alternatives to the increase in IBT associated with Northwest WTP expansion are summarized in Table 9 including costs and qualitative assessments of permitting and potential environmental impacts. A rating of permitting difficulty reflects the general regulatory requirements, cost, and time involved in obtaining the necessary permits and approval. Technical difficulty is related to the planning, design, permitting, and construction effort to implement the project. For example, a project with low technical difficulty is expected to have the least amount of effort from conception to construction, whereas a project with high technical difficulty is expected to require considerable effort to implement.

Environmental impacts can be direct, secondary, and cumulative in nature. Direct impacts are those effects caused by a project that occur at the same time and place, and result from project construction and the project itself. Secondary and cumulative impacts, particularly growth-inducing effects, on natural resources occur later in time or farther removed in distance as a result of the project's construction and operation.

Additional IBT associated with an expansion of the Northwest WTP is recommended as the preferred alternative because of a lower cost (capital, O&M), low technical difficulty, an equivalent or lower level of permitting difficulty, a low level of direct impacts (e.g., new WTP alternatives would have additional construction impacts for a new site), and an equivalent level of secondary and cumulative impacts. Return of additional wastewater to the source would add a minimum of $39 million to the cost of the preferred alternative without significant benefit to the resource.

Table 9. Summary Water Supply Alternatives to Additional IBT

Alternative	Estimated Capital Construction Costs (Budgetary)	Estimated Annual O&M Costs	Technical Difficulty	Permitting Difficulty	Direct Environmental Impacts	Secondary and Cumulative Impacts
Additional IBT – (Associated w/ Northwest WTP Expansion)	$90.7M	$1.5M	Low	Medium	Low	Medium
Waccamaw Surface WTP	$163M	$3.4M	Medium	High	High	Medium
Expand 211 WTP	$141M	$2.3M	Medium	Medium	Low	Medium
New Groundwater WTP	$103M	$2.1M	Medium	Medium	Medium	Medium
Seawater Desalination Plant	$334M	$12M	High	High	Medium/High	Medium

Alternative	Estimated Capital Construction Costs (Budgetary)	Estimated Annual O&M Costs	Technical Difficulty	Permitting Difficulty	Direct Environmental Impacts	Secondary and Cumulative Impacts
Return of Additional Wastewater to Source Basins (includes cost to expand NW WTP)	Low End: $129M ($38.7M + $90.7M) High End: $212M ($121M + $90.7M)	$2.3M ($0.78M + $1.5M)	Medium	Medium	Medium	Medium

Combined with expansion of the Northwest WTP and associated increase in IBT, the County proposes to use a combination of alternatives to limit transfer of water. As indicated, water conservation and reuse are key elements of the County's current water management plan and they reduce demand and associated IBT. It is not known how changes to these programs would result in additional demand reduction and future water transfer. In addition, the County has reduced the need to transfer additional water by developing an interconnection and agreement to purchase water from the Little River Water and Sewerage Company for potable water service in the Waccamaw River subbasin. The County is conducting a study to assess the feasibility of residential water reuse (costs, demand and public acceptance issues) at the Saint James Plantation and Winding River developments. The County estimates that these developments might have a seasonal reclaimed water demand of up to 1.3 MGD. Finally, the County is planning a study of ASR storage at the 211 plant to reduce withdrawal of surface water during peak demand periods. The technical viability of this option is unknown.

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7 Cape Fear IBT River Basin Water Supply

The petition for an IBT certificate requires a description of water transfers and withdrawals registered under G.S 143-215.22H or included in a local water supply plan prepared pursuant to G.S. 143-355(l) from the source river basin as well as information on planned or reasonably foreseeable transfers or withdrawals. There are no current IBT certificates within the source basin. Public water systems required to prepare a local water supply plan within the Cape Fear IBT River Basin are summarized in Table 10. Water users withdrawing more than 100,000 gpd (and agricultural users withdrawing more than 1 MGD) are required to register their withdrawal under G.S 143-215.22H. A listing of the current withdrawals in the Cape Fear IBT River Basin is provided in Table 11. Those over 0.1 MGD are included in the Cape Fear Hydrologic Model, which provides the best available tool to analyze existing and future water supply within the source basin. A presentation of analysis conducted using the model is provided in the next section.

Table 10. Public Water Systems in the Cape Fear IBT River Basin

Public Water System ID	System Name	System Owner	Water Source Name
0326010	Fayetteville PU	Fayetteville Public Works Commission	Cape Fear River and Glenville Lake
0326344	Fort Bragg	Fort Bragg Public Works Center	Little River (lower)
0343045	Harnett Department of Public Utilities	Harnett County	Cape Fear River
0343010	City of Dunn	City of Dunn	Cape Fear River
0353010	City of Sanford	City of Sanford	Cape Fear River
0363025	Town of Carthage	Town of Carthage	Nicks Creek
0410045	Brunswick County Water System	Brunswick County	Cape Fear River
0465010	City of Wilmington	City of Wilmington	Cape Fear River
0465010	City of Wilmington	City of Wilmington	Cape Fear River (via Lower Cape Fear Water and Sewer Authority)

Table 11. Registered Water Withdrawals in the Cape Fear IBT River Basin

ID	Owner Name	Facility Name	City
0009-0001	Archer Daniels Midland Company	Southport Plant 789	Southport
0033-0001	Progress Energy Carolinas, Inc.	Brunswick Steam Electric Plant	Southport
0033-0004	Progress Energy Carolinas, Inc.	Cape Fear Steam Electric Plant	Moncure
0033-0007	Progress Energy Carolinas, Inc.	Sutton Steam Electric Plant	Wilmington
0033-0011	Progress Energy Carolinas, Inc.	Harris Nuclear Plant	New Hill

ID	Owner Name	Facility Name	City
0056-0001	Capital Power Corp. NC	Capital Power Corp. - Southport	Southport
0059-0003	Dupont	Dupont Company - Fayetteville	Fayetteville
0066-0001	International Paper	Riegelwood Mill	Riegelwood
0141-0001	Elementis Chromium L.P.	Elementis Chromium Castle Hayne	Castle Hayne
0150-0005	Pinehurst, Inc.	Pinehurst Resort #6	Pinehurst
0150-0007	Pinehurst, Inc.	Pinehurst Resort #8	Pinehurst
0199-0015	Vulcan Construction Materials, L. P.	Stokesdale Quarry	Charlotte
0218-0003	Aqua North Carolina	Mill Creek Farms	Cary
0218-0004	Aqua North Carolina	Stoney Point - Cumberland	Cary
0218-0006	Aqua North Carolina	Bragg Estates	Cary
0218-0008	Aqua North Carolina	Wrightsboro	Denver
0218-0066	Aqua North Carolina	Braxton Hills/Simmons Heights	Cary
0218-0079	Aqua North Carolina	Brookwood South	Denver
0218-0116	Aqua North Carolina	Copeland Acres	Cary
0218-0235	Aqua North Carolina	Happy Valley	Cary
0218-0314	Aqua North Carolina	Lake Springs	Cary
0219-0006	Martin Marietta Materials, Inc.	Cumberland Quarry	Spring Lake
0219-0039	Martin Marietta Materials, Inc.	Fuquay Quarry	Raleigh
0219-0043	Martin Marietta Materials, Inc.	Lemon Springs Quarry	Sanford
0293-0001	Pine Needles & Mid Pines Lodge And	Pine Needles Lodge & Country Club	Southern Pines
0293-0002	Pine Needles & Mid Pines Lodge And	Mid Pines Inn & Golf Club	Southern Pines
0340-0007	Hanson Aggregates Southeast, Inc.	Elliot Sand & Gravel	Morrisville
0340-0010	Hanson Aggregates Southeast, Inc.	Holly Springs Quarry	Morrisville
0340-0016	Hanson Aggregates Southeast, Inc.	Gardner Quarry	Morrisville
0347-0002	UNC-Chapel Hill	Finley Golf Course	Chapel Hill
0358-0002	Invista Sarl	Invista Sarl	Wilmington
0378-0053	Utilities, Inc.	Quail Ridge	Charlotte
0378-0057	Utilities, Inc.	Tanglewood Estates	Charlotte
0378-0065	Utilities, Inc.	Olde Point	Charlotte
0378-0094	Utilities, Inc.	CWS Systems, INC. - Treasure Cove	Charlotte
0379-0001	Devils Ridge Golf Club	Devils Ridge Golf Club	Holly Springs
0380-0001	Mcneill Farms	McNeill Farms	Hope Mills
0381-0001	Methodist University	Methodist College Golf Course	Fayetteville
0381-0002	Methodist University	King's Grant Golf Course	Fayetteville

ID	Owner Name	Facility Name	City
0383-0001	Performance Fibers Inc.	Performance Fibers - New Hill Facility	New Hill
0385-0001	Arauco Panels USA LLC	Moncure Division	Moncure
0429-0002	Smithfield Foods	Smithfield Packing - Tar Heel Division	Tar Heel
0434-0001	Dak Monomers, LLC	DAK Americas - Cape Fear Site	Leland
0608-0001	Bald Head Island Club	Bald Head Island Club	Bald Head
0615-0001	Birchwood Farms, Inc.	Cypress Lakes Golf Course	Hope Mills
0628-0001	Carolina Golf Development	The Carolina Golf Course	Whispering
0628-0002	Carolina Golf Development	Woodlake Resort and Country Club	Vass
0638-0001	Carolina Turf Farms	Bayonet At Puppy Creek	Raeford
0644-0001	MDC II, LLC	Gates Four Golf & Country Club	Fayetteville
0646-0001	Highland Country Club	Highland Country Club	Fayetteville
0648-0001	Charlie Walker	Beau Rivage Golf Resort	Wilmington
0661-0001	Cape Fear Country Club, Inc.	Cape Fear Country Club, Inc.	Wilmington
0662-0001	The Clubs at St. James, LLC	Founders Club at St. James Plantation	Southport
0662-0002	The Clubs at St. James, LLC	Members Club at St. James Plantation	Southport
0662-0004	The Clubs at St. James, LLC	Reserve Club at St. James Plantation	Southport
0664-0001	Country Club of Landfall	Country Club of Landfall	Wilmington
0667-0001	Klaussner Investment Group	Pinewood Country Club	Asheboro
0681-0001	Tobacco Road Golf, LLC	Tobacco Road Golf, LLC	Sanford
0687-0001	Magnolia Greens, Inc.	Magnolia Greens Golf Plantation	Leland
0694-0001	Seven Lakes Country Club	Seven Lakes Country Club	Seven Lakes
0703-0001	Avestra, LLC	Country Club of Whispering Pines	Whispering
0703-0002	Avestra, LLC	Southern Pines Country Club	Southern Pines
0710-0001	Lee, William Denny	Farm	Erwin
0711-0001	Lee, Charles Benny	R. D. Lee Farms, Inc.	Sanford
0725-0001	Oceanico USA	Little River Golf Resort	Carthage
0734-0001	Robert Levy Jr.	Mid South Golf Club	Southern Pines
0734-0002	Robert Levy Jr.	Talamore Resort	Southern Pines
0739-0001	Eagle Point Golf Club	Eagle Point Golf Club	Wilmington
0742-0001	Pinewild Country Club of Pinehurst	Azalea/Challenge Course	Pinehurst
0742-0002	Pinewild Country Club of Pinehurst	Magnolia course	Pinehurst
0742-0003	Pinewild Country Club of Pinehurst	Holly course	Pinehurst
0756-0001	Claude Smith	National Golf Club	Pinehurst
0763-0001	Carl Bunnell	Quail Ridge Golf Course	Sanford

ID	Owner Name	Facility Name	City
0765-0001	Bob Hanson	Dormie Club	West End
0771-0001	Coharie Country Club	Coharie Country Club	Clinton
0772-0001	Anderson Creek Partners	Anderson Creek Golf Club	Spring Lake
0779-0001	Corning Incorporated	Corning - Wilmington Plant	Wilmington
0780-0001	Carolina Trace Country Club	Carolina Trace Country Club	Sanford
0781-0001	Starmount Forest Country Club	Starmount Forest Country Club	Greensboro
0785-0001	Campbell University	Keith Hills Country Club	Lillington
0790-0001	G.S. Materials, Inc.	Hall Rackley & Cameron Pits	Burlington
0794-0001	Funston Land & Timber	Cape Fear National Golf Club	Leland
0804-0001	United States Army	Stryker Golf Course	Fort Bragg
0804-0002	United States Army	Ryder Golf Course	Fort Bragg
0823-0001	American Materials	Wade Mine	Wilmington

8 Cape Fear IBT River Basin Impact Analysis

This section includes a discussion regarding the potential direct impacts of the proposed IBT. The purpose is to demonstrate that the proposed transfer if added to all other transfers and withdrawals within the source basin would not reduce the amount of water available for use in the source river basin to a degree that would impair existing uses or existing and planned consumptive and nonconsumptive uses of the water.

8.1 Impact Analysis

Direct impacts associated with the additional IBT alternative include those related to withdrawal of water from the Cape Fear River above Lock and Dam #1. The LCFWSA supplies raw water to the Northwest WTP from an intake on the Cape Fear River above Lock and Dam #1. This low head dam causes the river to impound slightly behind it before spilling over and continuing down the river. The County is one of several LCFWSA customers receiving a portion of the withdrawal. A FONSI for expansion of the LCFWSA's intake to accommodate a 96-MGD withdrawal above Lock and Dam #1 was issued by the NC Division of Environmental Health in 2009. The new LCFWSA intake has now been constructed and is in operation.

The Cape Fear Basin Water Supply Plan (NCDWR, 2002) suggests that a surrogate for safe yield at Lock and Dam #1 is 20 percent of the published 7Q10. However, rather than relying upon a safe yield value such as this, NCDWR requested during scoping for the EA that the County utilize the Cape Fear Hydrologic Model to determine whether any difficulties would exist in meeting future demands. Therefore, the following analysis builds on the previous modeling analysis by DWR and focuses on the direct impact of the County withdrawal and the cumulative impact of all existing and projected withdrawals at the dam, and whether water supply needs are met in the future. In addition, a summary of analysis of potential water quality impacts is provided.

8.1.1 Impacts Above Lock and Dam #1

8.1.1.1 Hydrology Analysis

NCDWR (2008) undertook an investigation of surface water supplies in the Cape Fear, including increased withdrawals from behind Lock and Dam # 1, using a calibrated hydrology model. The Cape Fear Hydrologic Model or CFHM (HydroLogics, 2006) is an implementation of OASIS (HydroLogics, 2009), which is a generalized mass balance model designed to assess the impacts of different water allocation policies and facilities over the historic record of inflows.

The existing CFHM is based on records from 46 streamflow gages, running from January 1930 to September 2004. There are approximately 40 irrigation source nodes, 40+ municipal and industrial demand nodes, and 60+ discharge nodes in the model. The original model data stopped in September 2004. The model has already been updated through water year 2005 (NCDWR, 2008), but not for subsequent years. NCDWR is leading a process to update the model, but, it was not available during preparation of the environmental document. Therefore, the existing model is being used to support the County's IBT request.

Previous analysis with a cumulative 2050 withdrawal from behind Lock and Dam #1 indicates that full demand at this model node and throughout the Cape Fear IBT River Basin was met (NCDWR, 2008). To support the IBT request, results of this analysis are presented with data taken directly from the existing model and include updates to the County portion of the withdrawal that are based on revised demand data.

The model's terminus is at Lock and Dam #1. Only one water intake is below Lock and Dam #1: International Paper. The industrial withdrawal is just downstream of the dam. Withdrawals for 2010 averaged 34.7 MGD (NCDWR, 2010); however, nearly all this water is discharged in close proximity of the withdrawal.

Changes in hydrology can affect habitat for aquatic species. Given the size of the withdrawals relative to the river's low flow regime and the tidal nature of the river below Lock and Dam #1, NCDWR deemed that a study of stream flow impacts on habitat and recreation downstream of the dam would not be needed (July 17, 2009 letter from NCDWR to Tetra Tech). Cumulative withdrawals represent about 3% of mean river flow (5,063 cfs), 6% of median river flow (2,540 cfs), and 17% of 10th percentile river flow (969 cfs) based on the most recent USGS Water Data Report. The cumulative withdrawals incorporate all LCFWSA customers including Brunswick just above the Lock and Dam and are 164 cfs for the 2050 planning horizon.

The hydrologic analysis prepared for the EA explores three general scenarios derived from the CFHM: 2003, the baseline condition for the OASIS application, and 2030 and 2050, which are future projected conditions. The 2003 baseline scenario reflects the discharges and withdrawals (represented as monthly averages) that were reported for 2003 applied to the model's long-term simulation (1930–2005). Likewise, the 2030 and 2050 projected scenarios are the projected 2030 and 2050 withdrawals applied to the 76-year simulation. Since the previous CFHM analysis was conducted by NCDWR in the mid-2000s through about 2008, the County has revised its 2030 and 2050 water demand to a small degree. Therefore, the previous withdrawal estimates have been replaced with the revised values. Additional detail is provided within the EA.

Comparison of the incremental increase in the projected withdrawals with and without the additional County withdrawal under the 2050 scenario is shown Table 12. The percent difference from the incremental increase at some of the lowest flows is 5 percent (for flows exceeded 95% of the time).

Table 12. Incremental Impact of Brunswick Withdrawal for 2050 Scenario on Stream Flow

Flow Statistic	Description	Simulated Flow with 2050 Cumulative Withdrawals Except for Brunswick County at 2003 Withdrawal (cfs)	Simulated Flow with 2050 Cumulative Withdrawals (cfs)	Percent Difference Due to Increase in Brunswick County Withdrawal (2003 to 2050)
5th Percentile	Flow exceeded 95% of time	525.30	499.10	-5.0%
10th Percentile	Flow exceeded 90% of time	690.97	667.20	-3.4%
50th Percentile	Median Flow	2,807.42	2,784.97	-0.80%
Mean	Average Flow	5,130.55	5,108.16	-0.44%

An additional 2050 scenario, representing a potential maximum withdrawal, was used to further assess impacts of water withdrawal. This scenario uses the 2050 demands as described previously but assigns maximum daily flow values for the duration of the month of July rather than average monthly values. July is the month of maximum demand based on consistent historical patterns. The July daily maximum withdrawal just above model junction 820 was based on the 2011 LWSP for LCFWSA. This value is assumed to incorporate all demands at this point in the river (i.e., LCFWSA including Brunswick County, Wilmington or CFPUA, and Bladen County) and assumes a value of 106 MGD or 164 cfs, the reported surface supply in the LWSP. This withdrawal value is also equal to the LCFWSA annual demand of 88.627 MGD for 2050 multiplied by the July peaking factor from 2011 (equal to 1.192), and is only slightly greater that the unadjusted average July withdrawals (149 cfs or 96 MGD) in the base 2050 scenario.

Table 13 shows a minor departure between 2050 average and maximum scenarios with differences of about one percent or less.

Note that while these results represent the impacts of cumulative withdrawal at Lock and Dam #1, a vast majority of the water that is withdrawn remains in the source basin.

Table 13. Incremental Impact of Cumulative Withdrawal for July at Daily Maximum for 2050 Scenario on Simulated Flow at Lock and Dam #1

Flow Statistic	Description	Simulated Flow with 2050 *Monthly Average* Withdrawals (cfs)	Simulated Flow with 2050 *July Daily Maximum* Withdrawals (cfs)	Percent Difference (2050)
5th Percentile	Flow exceeded 95% of time	499.10	493.85	-1.1%
10th Percentile	Flow exceeded 90% of time	667.20	663.48	-0.6%
50th Percentile	Median Flow	2,784.97	2,783.72	-0.04%
Mean	Average Flow	5,108.16	5,105.81	-0.05%

An unimpaired scenario run was performed by NCDWR (2008) representing hypothetical conditions with all discharges, withdrawals, and impoundments in the basin removed. A comparison by NCDWR (2008) showed that under all three demand scenarios, the simulated flows for the scenarios were higher during low flow periods than the unimpaired scenario because of regulation from Jordan Lake.

The preceding analysis does not change NCDWR's (2008) conclusion that full demand for all withdrawals at Lock and Dam #1 and within the Cape Fear IBT River Basin would be met through 2050 because the revisions to Brunswick demand are minor and the maximum withdrawal scenario differs little from the average day scenario. In addition, the increase from the Brunswick County withdrawal would be small, and predicted flows passing over the dam at the 95th percentile flow exceedence (i.e., a fairly low flow) in 2050 remain substantial at nearly 500 cfs. Accordingly, the direct impact of the County withdrawal on water supply would not be significant.

8.1.1.2 Water Quality Analysis

Water withdrawals could also degrade water quality conditions in the pool behind Lock and Dam #1. While this section of the Cape Fear River is not listed as impaired on the 303(d) list, NCDWQ requested an evaluation of dissolved oxygen, algal dynamics, and pH in this reach. Downstream of Lock and Dam #1, however, the Cape Fear River Estuary is on the 303(d) list of impaired waters for dissolved oxygen and has been the subject of recent study. The potential impacts on water quality upstream and downstream of the dam are discussed in the sections that follow.

A USGS observation station (02105769) and a North Carolina Ambient Monitoring System station (B8350000) were used to investigate possible relationships of flow or water temperature with response variables of dissolved oxygen, pH, and chlorophyll *a*. Several statistical regressions were applied to the data by varying the independent and dependent variables. Insufficient observed data exist for chlorophyll *a* to construct a statistical relationship, so this parameter was removed from consideration (six total observations).

The critical period of interest for the response variables is during the summer (June, July, and August) when withdrawals are typically near the annual maximum, stream flow is generally low, and water temperature is high. Data associated with flows above 5,000 cfs were removed as the relationship of dissolved oxygen to flow appears to change at high flow. On a given sample date, only the surface observations (generally 0.1 meter below the surface) were retained because vertical differences were negligible. The resulting data set included 31 days of observed data over the period from June 26, 1997, through August 12, 2010, with which to investigate relationships.

Predictive models for pH and dissolved oxygen were developed. A predictive model of pH can be formulated and is described in Table 14. All model coefficients are significantly different from zero. Analyses of the data show that neither flow nor water temperature nor their combination provides statistically significant explanatory models of observed dissolved oxygen (Table 15). All attempts resulted in adjusted R^2 values less than zero and the lowest probability value is 0.49 (typically a value of less than 0.05 is required for model significance). In addition, the 95 percent confidence interval on the coefficient on flow is not significantly different from zero.

Table 14. Predictive Models for pH

Model	Intercept	Coefficients on: Water Temperature	ln (Flow)	Water Temperature x ln (Flow)	Adjusted R^2	Probability value
PH-1	15.676	-0.141	-0.67	-	0.2807	0.004

Table 15. Predictive Models for Dissolved Oxygen

Model	Intercept	Coefficients on: Water Temperature	ln (Flow)	Water Temperature x ln (Flow)	Adjusted R^2	Probability value
DO-1	5.716	0.024	0.014	-	-0.0687	0.965
DO-2	6.739		-0.035		-0.0338	0.889
DO-3	5.899	0.021			-0.0319	0.790
DO-4	-39.48	1.65	6.062	-0.218	-0.0178	0.497

The statistical models tell us that the variability in observed dissolved oxygen is primarily due to factors other than flow and temperature. Nonetheless, the coefficients obtained in a least squares fit provide a best unbiased estimate of the partial contribution of these factors to dissolved oxygen. Therefore, estimates can be made of the potential impact of additional water withdrawal using the three models that represent the effect of flow on dissolved oxygen, as well as the model for pH. The analysis focuses on July, a critical period, when the maximum monthly withdrawals typically occur and at mean water temperature of 28.3 °C.

Permitted facilities associated with withdrawal at Lock and Dam #1 include the Northwest WTP (24 MGD), CFPUA's Sweeney WTP (35 MGD), Pender County (2 MGD; expandable to 6 MGD), along with two small industrial users supplied by LCFWSA (~2.6 MGD). For 2011, the max day withdrawal for the County is taken directly from Northwest WTP records. To arrive at the cumulative withdrawal, maximum day values from CFPUA and LCFWSA were combined for a value of 51.13 MGD (41.5 plus 9.63) as provided in their respective LWSPs. The basis for the 2050 cumulative, maximum withdrawal of 106 MGD was discussed previously. Table 16 provides a summary of these withdrawals.

Table 16. Maximum Brunswick County and LCFWSA Withdrawals for Water Quality Analysis

Year	Brunswick County Withdrawal (MGD)	Brunswick County Withdrawal (cfs)	Cumulative Withdrawal (MGD)	Cumulative Withdrawal (cfs)
2011	21.3	33.0	51.1	79.1
2050	38.8 [1]	60.5	106	164

[1] Based on the proposed treatment capacity of 36 MGD finished water for the Northwest WTP plus additional raw water that is withdrawn from the river for backwash, clarifier blowdowns, and process water is not included. This water is discharged back to the Cape Fear source basin via NPDES permit.

To evaluate dissolved oxygen and pH response for an extreme case, the 7Q10 is used. USGS published a previous estimate for the Cape Fear River at Lock and Dam #1 in 2001: 825 cfs or 533 MGD using data reflecting the period of regulation from Jordan Lake, 1982-1997 (Weaver and Pope, 2001). USGS was contacted for an updated 7Q10, and provided a *provisional* value of 500 cfs (323 mgd) using data for 1982–2009 climatic years. The decrease can be attributed to, "a combination of the recent droughts on flows in the Cape Fear River and the regulated flow conditions from Jordan Lake during this period," according to USGS (personal communication; provided in the EA).

The 2011 maximum cumulative withdrawal (i.e., Brunswick plus others) at Lock and Dam #1 was 79.1 cfs, and the potential 2050 maximum cumulative withdrawal is 164 cfs, resulting in an increase in max of withdrawal of 85 cfs. The resulting predicted changes in dissolved oxygen when applied to the provisional 7Q10 flow are shown in Table 17. Two of the models predict increased dissolved oxygen as a result of the increased withdrawal, but none of the changes are significant.

Table 17. Predicted Dissolved Oxygen (mg/L) Response Maximum Withdrawal at Lock and Dam #1

Model	Predicted Dissolved Oxygen with 2011 Maximum Cumulative Withdrawal	Predicted Dissolved Oxygen with 2050 Maximum Cumulative Withdrawal	Change in Dissolved Oxygen	Percent Change
DO-1	6.4827	6.4801	-0.0026	-0.04%
DO-2	6.5215	6.5280	0.0065	0.10%

Model	Predicted Dissolved Oxygen with 2011 Maximum Cumulative Withdrawal	Predicted Dissolved Oxygen with 2050 Maximum Cumulative Withdrawal	Change in Dissolved Oxygen	Percent Change
DO-4	6.5535	6.5743	0.0208	0.32%

The regression model for pH predicts an increase in pH from 7.519 to 7.644 under these 2050 7Q10 low flow conditions equal to a 1.66 percent change (Table 18).

Table 18. Predicted pH (s.u.) Response to Increase in Maximum Withdrawal at Lock and Dam #1

Model	Predicted pH with 2011 Maximum Cumulative Withdrawal	Predicted pH with 2050 Maximum Cumulative Withdrawal	Change in pH	Percent Change
PH-1	7.5191	7.6438	0.1247	1.66%

In sum, both the dissolved oxygen and pH changes are predicted to be minimal and insignificant, and further modeling analysis is not warranted.

8.1.2 New Fish Passage Structure at Lock and Dam #1

A new fish passage structure (FPS) at Lock and Dam #1 on the Cape Fear River was completed in November 2012 by the US Army Corps of Engineers. The Basis of Design report provided the design, associated analyses (e.g., hydrologic and hydraulic analysis), and the biological rationale for the project (US Army Corps of Engineers, 2010). The rock arch rapids design is a type of rock ramp that provides fish passage over low-head dams by emulation of natural rapids and facilitation of fish hydrodynamics. The FPS alternative was chosen over others including removal of the dam in part due to the need to protect the water supply intake structures located just upstream (e.g., LCFWSA intake).

The FPS is designed to increase fish passage and increase spawning opportunities for anadromous fish. Spawning migration in the Atlantic coastal region occurs primarily during periods of increased but moderate river flow and temperature such as late winter and spring (NOAA, 2013). The design of the FPS accounts for flows during this period including an assumed “spawning flow” of 5,000 cfs, a flow level near the mean flow for the river (5,063 cfs based on 1982-2012), and typical spring flows during March and April which are somewhat greater (i.e., up to about 9,000 cfs; US Army Corps of Engineers, 2010). Maximum, cumulative withdrawals for 2050 (164 cfs; incorporates all LCFWSA customers including Brunswick) just above the FPS represent 2 to 3 percent of these flow values. Maximum withdrawal is more likely to occur in the summer given seasonal water use patterns; therefore, water withdrawals from the river during the spawning migration would represent an even smaller proportion of flow (as would considering only Brunswick’s portion). As such the impact of withdrawals on FPS function would be insignificant.

8.1.3 Impacts Below Lock and Dam #1

The section of the Lower Cape Fear River Estuary (LCFRE) from upstream of Toomers Creek to a line across the river between Lilliput Creek and Snows Cut has been on North Carolina’s 303(d) list as impaired for dissolved oxygen since 1998. In 2006 the DWQ added pH as impaired for this segment, and in 2008 DWQ added copper and turbidity to the listing. Emphasis by DWQ has been on developing a better understanding of loads and processes influencing dissolved oxygen.

Since the original listing for dissolved oxygen, many technical studies of the LCFRE have been conducted by DWQ, the Lower Cape Fear River Program, other agencies and academic researchers, and consultants. As a result, an extensive technical foundation of knowledge on the LCFRE has been created including information on physical, chemical, and biological features and processes. Monitoring programs have provided insight regarding ambient conditions over many years on water quality, benthos and fish. The Lower Cape Fear River Program has conducted monitoring in coordination with DWQ since 1995, and a considerable amount of data is available before that. Extensive data have been collected by the Middle Cape Fear River Basin Association upstream of Lock and Dam #1 since mid-1998. Additionally, sophisticated hydrodynamic modeling tools have been developed for the entire estuary and the portion of the river up to Lock and Dam #1.

An application of the three-dimensional water quality model Environmental Fluid Dynamics Code (EFDC) was developed for the LCFRE by the University of North Carolina-Charlotte for DWQ (Bowen et al. 2009). The model was used to investigate the effects of various organic matter and ammonia load reduction scenarios, both point and nonpoint source, on the dissolved oxygen concentrations in the estuary. The model region included the tidally affected portions of the Cape Fear (i.e., portion below Lock & Dam 1), Black, and Northeast Cape Fear rivers near Wilmington, North Carolina, and extended south to the mouth of the Cape Fear River near Southport, North Carolina.

The 21 state variable EFDC water quality model included multiple dissolved and particulate organic carbon constituents, and organic and inorganic nutrients, dissolved oxygen, and three phytoplankton constituents. To adequately characterize the various organic matter decomposition rates of the riverine and wastewater inputs, both labile and refractory dissolved organic matter constituents were used. The water quality model considered inputs from the three riverine sources at the model boundaries, 20 wastewater point source inputs in the estuary, and 14 additional point sources that simulated other freshwater inputs to the estuary from tidal creeks and wetlands. Over the 3-year period (2002–2005) for which the freshwater and point source loadings were developed, approximately 10 percent of the organic matter loading and 50 percent of the ammonia loading to the estuary came from the 20 wastewater point sources that discharge directly to the estuary (Bowen et al. 2009).

The calibrated model achieved an excellent fit to observed data (more than 5200 measurements at 18 estuary sites) for complex estuary models. Bowen et al. (2009) report that the mean model error was less than 0.01 mg/L, and the root mean square error was 0.92 mg/L, which corresponds to 13.8 percent of the mean value. DWQ found the calibrated model to be suitable for conducting scenario tests on the effect of changes in organic matter and ammonia loadings on the dissolved oxygen concentrations in the estuary.

A number of scenarios were examined by Bowen and DWQ to test the sensitivity of dissolved oxygen to reductions in point and nonpoint source loads of oxygen-demanding pollutants. With all point sources eliminated, the 10th percentile dissolved oxygen concentration increased by approximately 0.3 mg/L, from 4.3 to 4.5 mg/L. Nonpoint source loading reductions of 30 percent, 50 percent, or 70 percent were assumed for the three river inputs (Cape Fear, Black, and Northeast Cape Fear), and from the 14 creeks and wetland inputs in the estuary. Despite these large reductions, dissolved oxygen concentrations increased by only 0.2, 0.3, and 0.4 mg/L, respectively, from 4.3 to either 4.5, 4.6 or 4.7 mg/L. On the basis of the modeling results, DWQ has temporarily suspended its development of a TMDL for oxygen-demanding loads while it considers the relative impact of natural and anthropogenic sources on the water quality in the LCFRE.

The studies by Bowen et al. (2009) and Hamrick et al. (2001) show that during low-flow summer conditions, hydrology and pollutant transport are dominated by tidal exchange with the ocean. The EFDC model uses a historical period of flow at its upper boundary (i.e., Lock and Dam #1) that reflects flows above 20 cms (~700 cfs). The withdrawal associated the proposed flow transfer for the County corresponds to 60 cfs (39 mgd), which represents approximately 9 percent of the lowest model flows entering the LCFRE. Because tidal flow dominates pollutant fate and transport during the lowest flow periods and transfer of flow would actually remove some pollutants from entering the LCFRE, the IBT would not be expected to have a noticeable effect on water quality in the river below Lock & Dam #1.

8.1.4 Reservoirs in the Cape Fear IBT River Basin

There are no reservoirs located on the Cape Fear River in the Cape Fear IBT River Basin.

9 Future Water Supply Needs

An analysis of existing and future water supply needs for the Cape Fear River IBT River Basin was conducted to support the County's request for an IBT certificate. Brunswick County's future water supply needs, summarized in Section 3, were combined with other public water systems in the source basin (listed in Table 10) within the Cape Fear Hydrologic Model described in Section 8. This model provides the best compilation of existing and future water supply needs in the source river basin and provides a platform to determine whether those needs can be met in the future. Water demands in the model were estimated using local water supply plan data and additional information received from water systems and other registered water users. It also includes industrial and agricultural demands as described within NCDWR (2008). The original analysis by NCDWR concluded that demand for future withdrawals within the Cape Fear IBT River Basin is met. Additional analysis conducted for the EA and IBT request using the model, as described in Section 8, supports this conclusion.

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10 Brunswick Local Water Supply Plan

Brunswick County's 2011 local water supply plan is provided in Appendix C.

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Appendix A Finding of No Significant Impact

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NCDENR
North Carolina Department of Environment and Natural Resources
Division of Water Resources

Pat McCrory
Governor

Thomas A. Reeder
Director

John E. Skvarla, III
Secretary

FINDING OF NO SIGNIFICANT IMPACT
ENVIRONMENTAL ASSESSMENT FOR THE BRUNSWICK COUNTY PUBLIC UTILITIES INTERBASIN TRANSFER CERTIFICATE

Pursuant to the requirements of the Surface Water Transfers Act [G.S. 143-215.22l] and the State Environmental Policy Act (G.S. 113A), Brunswick County Public Utilities (the County) has prepared an environmental assessment (EA) to support the County's request for an interbasin transfer certificate.

Brunswick County Public Utilities currently provides water to more than 34,000 retail customers and 11 wholesale customers through its two water treatment plants (WTP). The Northwest WTP, permitted for 24 million gallons per day (MGD), is located near the City of Northwest and receives raw water from the Cape Fear River via the Lower Cape Fear Water and Sewer Authority. The 211 WTP is permitted for 6 MGD and treats groundwater from the Castle Hayne Aquifer. Wastewater within the County is handled through individual onsite septic systems, clustered and centralized land application, reuse, and surface water discharging systems. This treatment, service, and disposal of water creates an interbasin transfer from the Cape Fear River Basin to the Shallotte and Waccamaw River Basins, both of which are subbasins to the Lumber River Basin.

The County is requesting an interbasin transfer certificate from the Environmental Management Commission to transfer 18.3 MGD, limited on a maximum daily basis, from the Cape Fear River Basin to the Shallotte River Basin. The County currently has a grandfathered transfer capacity of 10.5 MGD. This increase is based on a 30-year water demand projection (through the year 2042). No increase in IBT is being requested for the Waccamaw IBT River Basin: minor growth is expected in this area and future water will be supplied by the Little River Water and Sewerage Company in South Carolina via an agreement with the County.

A hydrologic analysis was performed using the Division of Water Resources' Cape Fear Hydrologic Model to evaluate the County's impact on flow in the Cape Fear River, and determine whether future demands will be met for public water systems in the source basin. The proposed IBT increase did not change NCDWR's (2008) previous conclusion that full demand for all withdrawals at Lock and Dam #1 are met through 2050. Similarly, the impacts of the transfer on water quality are predicted to be insignificant based on a statistical data analysis and the Division of Water Quality's water quality model of the Lower Cape Fear River Estuary.

Secondary and cumulative impacts for the project are those that could be derived from growth inducement in the Shallotte IBT River Basin. Future growth in the County is expected to primarily occur as low- and medium-density residential uses. Due to the fact that Brunswick County falls under the Coastal Area Management Act (CAMA), there are numerous state and local regulatory measures in place to mitigate the effects of growth including the CAMA Land Use Plan and Areas of Environmental Concern requirements, the 20 Coastal Counties Stormwater Law, and the NPDES Phase II Stormwater Rules.

There are no construction activities associated with this request. Any potential impacts associated with construction of WTP improvements and transmission lines in the source or receiving basin would be reviewed under environmental documents prepared under SEPA specifically for these projects as required by state and federal regulations. An EA for the Northwest WTP plant expansion and associated improvements will be prepared as required by SEPA if an IBT certificate is approved.

Based on the findings of the EA, the Division of Water Resources has concluded that the proposed project will not result in significant adverse effect on the environment. This decision is based upon the requirements of NC GS 143-215.22I, information in the attached EA, and review by governmental agencies. Therefore the EA supports a Finding of No Significant Impact such that preparation of an environmental impact statement will not be required. This FONSI completes the environmental review record, which is available for inspection and comment for 30 days at the State Clearinghouse.

4/25/13

Thomas A. Reeder
Director, Division of Water Resources

Date

Appendix B Protected Species

Table B-1. State and Federally Protected Species in Counties of the Cape Fear IBT River Basin Study Area

Common Name	Row Labels	State Status	Federal Status	County
Invertebrate Animal				
a dart moth	*Agrotis carolina*	SR	FSC	Bla, Bru, Pen
Waccamaw Snail	*Amnicola sp. 1*	SC	-	Col
Barrel Floater	*Anodonta couperiana*	E	-	Bla, NH
Arogos Skipper	*Atrytone arogos arogos*	SR	FSC	Bru, NH
Loammi Skipper	*Atrytonopsis loammi*	SR	FSC	Bru, NH
Waccamaw Ambersnail	*Catinella waccamawensis*	T	-	Col
Waccamaw Siltsnail	*Cincinnatia sp. 1*	SC	-	Col
Pod Lance	*Elliptio folliculata*	SC	-	Bla, Bru, Col, Pen
Cape Fear Spike	*Elliptio marsupiobesa*	SC	-	Bla, NH, Pen
Roanoke Slabshell	*Elliptio roanokensis*	T	-	Bla
Waccamaw Spike	*Elliptio waccamawensis*	E	FSC	Bru, Col
Atlantic Pigtoe	*Fusconaia masoni*	E	FSC	Bla, Pen
Greenfield Rams-horn	*Helisoma eucosmium*	E	FSC	Bru, NH
Venus Flytrap Cutworm Moth	*Hemipachnobia subporphyrea*	SR	FSC	Bla, Bru, Pen
Yellow Lampmussel	*Lampsilis cariosa*	E	FSC	Bla, Col, Pen
Waccamaw Fatmucket	*Lampsilis fullerkati*	T	FSC	Col
Eastern Lampmussel	*Lampsilis radiata*	T	-	Bla, Col, Pen
Tidewater Mucket	*Leptodea ochracea*	T	-	Col
Eastern Pondmussel	*Ligumia nasuta*	T	-	Bru
Graceful Clam Shrimp	*Lynceus gracilicornis*	SC	-	NH
Magnificent Rams-horn	*Planorbella magnifica*	E	FSC	Bru, NH
Rare Skipper	*Problema bulenta*	SR	FSC	Bru, NH

Common Name	Row Labels	State Status	Federal Status	County
Waccamaw Crayfish	*Procambarus braswelli*	SC	-	Bru, Col
Belle's Sanddragon	*Progomphus bellei*	SR	FSC	Bla
Carter's Noctuid Moth	*Spartiniphaga carterae*	SR	FSC	Bla, Bru, Pen
Townes' Clubtail	*Stylurus townesi*	SR	FSC	Col
Savannah Lilliput	*Toxolasma pullus*	E	FSC	Col
Cape Fear Threetooth	*Triodopsis soelneri*	T	FSC	Bru, Col, NH
Nonvascular Plant				
Savanna Campylopus	*Campylopus carolinae*	SR-T	FSC	Bru
Vascular Plant				
Venus Hair Fern	*Adiantum capillus-veneris*	T	-	Col
Branched Gerardia	*Agalinis virgata*	T	-	Bru, NH, Pen
Savanna Onion	*Allium sp. 1*	SR-L	FSC	Bru, Pen
Seabeach Amaranth	*Amaranthus pumilus*	T	T	Bru, NH, Pen
Savanna Indigo-bush	*Amorpha confusa*	T	FSC	Bla, Bru, Col, NH
Georgia Indigo-bush	*Amorpha georgiana*	E	FSC	Pen
Bog Bluestem	*Andropogon mohrii*	T	-	Bru, Col, Pen
Big Three-awn Grass	*Aristida condensata*	T	-	Bla, NH, Pen
Chapman's Three-awn	*Aristida simpliciflora*	E	-	Bru, Col, Pen
Savanna Indian-plantain	*Arnoglossum ovatum*	E	-	Bla, Bru, Col, Pen
Savanna Milkweed	*Asclepias pedicellata*	SC-V	-	Bla, Bru, Col, NH, Pen
Carolina Spleenwort	*Asplenium heteroresiliens*	E	FSC	Bla
Sandhills Milk-vetch	*Astragalus michauxii*	SC-V	FSC	Bla, NH, Pen
Silverling	*Baccharis glomeruliflora*	SC-H	-	Bru
Blue Water-hyssop	*Bacopa caroliniana*	T	-	Bla, Bru, Col, NH, Pen
Tropical Water-hyssop	*Bacopa innominata*	SC-H	-	NH, Pen
Purple-disk Honeycomb-head	*Balduina atropurpurea*	E	FSC	Bla, Bru

Common Name	Row Labels	State Status	Federal Status	County
Ware's Hair Sedge	*Bulbostylis warei*	SC-H	-	Bru
Many-flower Grass-pink	*Calopogon multiflorus*	E	FSC	Bru, Pen
Long's Bittercress	*Cardamine longii*	SC-V	-	Bla, NH, Pen
Cherokee Sedge	*Carex cherokeensis*	E	-	Pen
Cypress Knee Sedge	*Carex decomposita*	SC-V	-	Bru, NH
Golden Sedge	*Carex lutea*	E	E	Pen
Kidney Sedge	*Carex reniformis*	T	-	Bla, Pen
Nutmeg Hickory	*Carya myristiciformis*	E	-	Bru, Pen
A Spanglegrass	*Chasmanthium nitidum*	T	-	Pen
Woody Goldenrod	*Chrysoma pauciflosculosa*	E	-	Col
Leconte's Thistle	*Cirsium lecontei*	SC-V	-	Bla, Bru, Col, Pen
Georgia Calamint	*Clinopodium georgianum*	E	-	Bru, Pen
Roughleaf Dogwood	*Cornus asperifolia*	E	-	Pen
Swamp-lily	*Crinum americanum*	SC-H	-	NH
Carolina Sunrose	*Crocanthemum carolinianum*	E	-	Bru, NH, Pen
Pinebarren Sunrose	*Crocanthemum corymbosum*	T	-	Bru
Georgia Sunrose	*Crocanthemum georgianum*	E	-	Bru, NH
Florida Scrub Frostweed	*Crocanthemum nashii*	E	-	Bru, NH
Toothed Flatsedge	*Cyperus dentatus*	SC-H	-	Bru
Leconte's Flatsedge	*Cyperus lecontei*	T	-	Bru, NH
Four-angled Flatsedge	*Cyperus tetragonus*	SC-V	-	Bru, NH, Pen
Nerved Witch Grass	*Dichanthelium aciculare ssp. neuranthum*	SC-V	-	Bru, NH
Blue Witch Grass	*Dichanthelium caerulescens*	E	-	Bru, Pen
Venus Flytrap	*Dionaea muscipula*	SC-V	FSC	Bla, Bru, Col, NH, Pen
Sebastian-bush	*Ditrysinia fruticosa*	SC-V	-	Bru, Col, Pen

Common Name	Row Labels	State Status	Federal Status	County
Threadleaf Sundew	*Drosera filiformis*	SC-V	-	Bla, Bru, Col
Dwarf Burhead	*Echinodorus tenellus*	E	-	Bru
Florida Spikerush	*Eleocharis elongata*	E	-	Bru
Robbins' Spikerush	*Eleocharis robbinsii*	SC-V	-	Bla, Bru, NH
Viviparous Spikerush	*Eleocharis vivipara*	E	-	NH, Pen
Terrell Grass	*Elymus virginicus var. halophilus*	SC-V	-	Bru
Green Fly Orchid	*Epidendrum magnoliae*	T	-	Bla, Bru, Col, NH, Pen
Seven-angled Pipewort	*Eriocaulon aquaticum*	SC-V	-	Bla, Bru, Col
Southern Wild-buckwheat	*Eriogonum tomentosum*	SC-H	-	Bla
Coralbean	*Erythrina herbacea*	E	-	Bru, NH
Limesink Dog-fennel	*Eupatorium leptophyllum*	E	-	Bru, NH
Heartleaf Sandmat	*Euphorbia cordifolia*	T	-	Bla
Harper's Fimbry	*Fimbristylis perpusilla*	T	FSC	Bru, Col
Soft Milk-pea	*Galactia mollis*	T	-	Bru
Confederate Huckleberry	*Gaylussacia nana*	E	-	NH
Swamp Jessamine	*Gelsemium rankinii*	SC-V	-	Bru, Col, NH, Pen
Golden Hedge-hyssop	*Gratiola aurea*	SC-V	-	Bla, Bru, Col, Pen
Littleleaf Sneezeweed	*Helenium brevifolium*	E	-	Bru
Spring Sneezeweed	*Helenium vernale*	E	-	Bru, Col
Florida Sunflower	*Helianthus floridanus*	T	-	Bla, Bru, Col
Comfortroot	*Hibiscus aculeatus*	T	-	NH
Waccamaw River Spiderlily	*Hymenocallis pygmaea*	T	FSC	Bru, Col
Coastal Plain St. John's-wort	*Hypericum brachyphyllum*	SC-V	-	Bru, Col, Pen
Peelbark St. John's-wort	*Hypericum fasciculatum*	E	-	NH
Pineland St. John's-wort	*Hypericum suffruticosum*	SC-H	-	Bla
Beach Morning-glory	*Ipomoea imperati*	T	-	Bru

Common Name	Row Labels	State Status	Federal Status	County
Thin-wall Quillwort	*Isoetes microvela*	T	FSC	Bru, Pen
Brown Bogbutton	*Lachnocaulon minus*	T	-	Bru, NH, Pen
Torrey's Pinweed	*Lechea torreyi*	E	-	Bru, Pen
Long-awned Spangletop	*Leptochloa fascicularis var. maritima*	E	-	Bru
Pondberry	*Lindera melissifolia*	E	E	Bla
Yellow-fruited Flax	*Linum floridanum var. chrysocarpum*	T	-	Bru, Col, Pen
Small-flowered Hemicarpha	*Lipocarpha micrantha*	SC-H	-	Col
Pondspice	*Litsea aestivalis*	SC-V	FSC	Bla, Bru, NH
Boykin's Lobelia	*Lobelia boykinii*	E	FSC	Bla
Golden-crest	*Lophiola aurea*	E	-	Bru, Col, NH
Lanceleaf Seedbox	*Ludwigia lanceolata*	E	-	Bru, NH
Flaxleaf Seedbox	*Ludwigia linifolia*	T	-	Bru, Col, NH
Raven's Seedbox	*Ludwigia ravenii*	T	FSC	Bru, Col, NH
Globe-fruit Seedbox	*Ludwigia sphaerocarpa*	E	-	Bla, Col, NH
Shrubby Seedbox	*Ludwigia suffruticosa*	T	-	Bla, Bru, NH
Rough-leaf Loosestrife	*Lysimachia asperulifolia*	E	E	Bla, Bru, Col, NH, Pen
Carolina Bogmint	*Macbridea caroliniana*	E	FSC	Bla, Bru, Col, Pen
Florida Adder's-mouth	*Malaxis spicata*	SC-V	-	Bru, Pen
Pinebarren Smokegrass	*Muhlenbergia torreyana*	SC-V	-	Bru, Pen
Loose Water-milfoil	*Myriophyllum laxum*	E	FSC	Bru
Leafless Water-milfoil	*Myriophyllum tenellum*	E	-	Bla
Bosc's Bluet	*Oldenlandia boscii*	E	-	Bru, Col
Large-seed Pellitory	*Parietaria praetermissa*	SC-V	-	Bru, NH
Carolina Grass-of-parnassus	*Parnassia caroliniana*	T	FSC	Bla, Bru, Col, Pen
Large-leaved Grass-of-parnassus	*Parnassia grandifolia*	T	FSC	Bru, Col, Pen

Common Name	Row Labels	State Status	Federal Status	County
Mudbank Crown Grass	*Paspalum dissectum*	E	-	Bru, Col, Pen
Hairy Smartweed	*Persicaria hirsuta*	E	-	Bru
Small Butterwort	*Pinguicula pumila*	E	-	Pen
A Silkgrass	*Pityopsis graminifolia var. graminifolia*	E	-	Bru, Col
Pineland Plantain	*Plantago sparsiflora*	T	FSC	Bla, Bru, Col, Pen
Yellow Fringeless Orchid	*Platanthera integra*	SC-V	-	Bru, Col, Pen
Snowy Orchid	*Platanthera nivea*	T	-	Bla, Bru, Col, NH, Pen
Hooker's Milkwort	*Polygala hookeri*	SC-V	-	Bru, Col, NH, Pen
Seabeach Knotweed	*Polygonum glaucum*	E	-	Bru, NH
Shadow-witch	*Ponthieva racemosa*	T	-	Bru, Pen
Spiked Medusa	*Pteroglossaspis ecristata*	E	FSC	Bla, NH
Carolina Bishop-weed	*Ptilimnium ahlesii*	SR-L	FSC	Bru, NH
Ribbed Bishop-weed	*Ptilimnium costatum*	T	-	Bru, NH
Sandhills Pyxie-moss	*Pyxidanthera brevifolia*	SR-L	FSC	Bru
Awned Meadow-beauty	*Rhexia aristosa*	SC-V	FSC	Bla, Bru
Swamp Forest Beaksedge	*Rhynchospora decurrens*	T	FSC	Bru, Col
Harper's Beaksedge	*Rhynchospora harperi*	SC-V	-	Bru
Fragrant Beaksedge	*Rhynchospora odorata*	SC-V	-	Bru, Pen
Coastal Beaksedge	*Rhynchospora pleiantha*	T	FSC	Bru, NH
Thorne's Beaksedge	*Rhynchospora thornei*	SC-V	FSC	Bru, Pen
Tracy's Beaksedge	*Rhynchospora tracyi*	T	-	Bru, NH
Limestone Wild-petunia	*Ruellia strepens*	E	-	Pen
Cabbage Palm	*Sabal palmetto*	T	-	Bru
Plymouth Gentian	*Sabatia kennedyana*	T	-	Bru, Col
Small-flowered Buckthorn	*Sageretia minutiflora*	T	-	Pen
Chapman's Arrowhead	*Sagittaria chapmanii*	E	-	Bla, Col

Common Name	Row Labels	State Status	Federal Status	County
Quillwort Arrowhead	*Sagittaria isoetiformis*	T	-	Bla, Bru, Col, NH
Grassleaf Arrowhead	*Sagittaria weatherbiana*	E	FSC	Bla, Bru, Col, NH, Pen
Hooded Pitcher Plant	*Sarracenia minor*	E	-	Bru, Col, NH
Chaffseed	*Schwalbea americana*	E	E	Bla, Pen
Drooping Bulrush	*Scirpus lineatus*	T	-	Bru, NH, Pen
Baldwin's Nutrush	*Scleria baldwinii*	T	-	Bru, Col, Pen
Netted Nutrush	*Scleria reticularis*	T	-	Bru, NH
Smooth-seeded Hairy Nutrush	*Scleria sp. 1*	SR-L	FSC	Pen
Sticky Afzelia	*Seymeria pectinata*	SC-H	-	Bru
Tough Bumelia	*Sideroxylon tenax*	T	FSC	Bru, NH
Leavenworth's Goldenrod	*Solidago leavenworthii*	T	-	Col
Twisted-leaf Goldenrod	*Solidago tortifolia*	E	-	Bla, Bru, NH
Spring-flowering Goldenrod	*Solidago verna*	SR-O	FSC	Bla, Bru, Col, NH, Pen
Coastal Goldenrod	*Solidago villosicarpa*	E	FSC	Bru, NH, Pen
Eaton's Ladies'-tresses	*Spiranthes eatonii*	E	-	Bla, Bru, Pen
Lace-lip Ladies'-tresses	*Spiranthes laciniata*	SC-V	-	Bla, Bru, Col, NH
Giant Spiral Orchid	*Spiranthes longilabris*	E	-	Bla, Bru, Pen
Wireleaf Dropseed	*Sporobolus teretifolius*	T	FSC	Bru, Col
Saltmarsh Dropseed	*Sporobolus virginicus*	T	-	Bru
Water Dawnflower	*Stylisma aquatica*	E	-	Bru
Pickering's Dawnflower	*Stylisma pickeringii var. pickeringii*	SC-V	FSC	Bla, Bru, NH, Pen
Cooley's Meadowrue	*Thalictrum cooleyi*	E	E	Bru, Col, NH, Pen
Small-leaved Meadowrue	*Thalictrum macrostylum*	SR-L	FSC	NH, Pen
Appalachian Golden-banner	*Thermopsis mollis*	SC-V	-	Col
Dune Bluecurls	*Trichostema sp. 1*	SR-L	FSC	Bru, NH
Chapman's Redtop	*Tridens chapmanii*	T	-	Bla, Pen

Common Name	Row Labels	State Status	Federal Status	County
Spike Triodia	*Tridens strictus*	SC-H	-	Pen
Carolina Clover	*Trifolium carolinianum*	SC-H	-	NH
Carolina Least Trillium	*Trillium pusillum var. pusillum*	E	FSC	Pen
Horned Bladderwort	*Utricularia cornuta*	T	-	Bru, Col, NH
Two-flowered Bladderwort	*Utricularia geminiscapa*	SC-V	-	Pen
Dwarf Bladderwort	*Utricularia olivacea*	T	-	Bru, NH, Pen
Northeastern Bladderwort	*Utricularia resupinata*	E	-	Col
Cranberry	*Vaccinium macrocarpon*	T	-	Bla, Bru
Florida Yellow-eyed-grass	*Xyris floridana*	T	-	Bru, Col, Pen
Acid-swamp Yellow-eyed-grass	*Xyris serotina*	T	-	Col
Pineland Yellow-eyed-grass	*Xyris stricta*	E	-	Bru, Pen
Rain Lily	*Zephyranthes simpsonii*	E	FSC	Bru
Vertebrate Animal				
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E	Bla, Bru, Col, NH, Pen
American Alligator	*Alligator mississippiensis*	T	T(S/A)	Bla, Bru, Col, NH, Pen
Eastern Henslow's Sparrow	*Ammodramus henslowii susurrans*	SC	FSC	Bru, Col, Pen
Loggerhead Seaturtle	*Caretta caretta*	T	T	Bru, NH, Pen
Atlantic Highfin Carpsucker	*Carpiodes sp. cf. velifer*	SC	-	Bla
Piping Plover	*Charadrius melodus*	T	T	Bru, NH, Pen
Wilson's Plover	*Charadrius wilsonia*	SC	-	Bru, NH, Pen
Green Seaturtle	*Chelonia mydas*	T	T	Bru, NH, Pen
Star-nosed Mole - Coastal Plain population	*Condylura cristata pop. 1*	SC	-	Bla, Bru, Col, NH, Pen
Rafinesque's Big-eared Bat - Coastal Plain subspecies	*Corynorhinus rafinesquii macrotis*	SC	FSC	Bla, Bru, Col, NH, Pen
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*	E	-	Bla, Bru, Col, NH, Pen

Common Name	Row Labels	State Status	Federal Status	County
Timber Rattlesnake	*Crotalus horridus*	SC	-	Bla, Bru, Col, NH, Pen
Thinlip Chub	*Cyprinella sp. 1*	SC	-	Bla
Black-throated Green Warbler - Coastal Plain population	*Dendroica virens waynei*	SR	FSC	Bla, Bru
Leatherback Seaturtle	*Dermochelys coriacea*	E	E	Bru, NH
Little Blue Heron	*Egretta caerulea*	SC	-	Bru, Col, NH
Snowy Egret	*Egretta thula*	SC	-	Bru, Col, NH
Tricolored Heron	*Egretta tricolor*	SC	-	Bru, NH
Carolina Pygmy Sunfish	*Elassoma boehlkei*	T	FSC	Bru, Col
Pinewoods Darter	*Etheostoma mariae*	SC	FSC	Bla
Waccamaw Darter	*Etheostoma perlongum*	T	FSC	Col
Dwarf Salamander	*Eurycea quadridigitata*	SC	-	Bla, Col
Peregrine Falcon	*Falco peregrinus*	E	-	Bru
Waccamaw Killifish	*Fundulus waccamensis*	SC	FSC	Col
Gull-billed Tern	*Gelochelidon nilotica*	T	-	Bru, NH
American Oystercatcher	*Haematopus palliatus*	SC	-	Bru, NH, Pen
Bald Eagle	*Haliaeetus leucocephalus*	T	-	Bla, Bru, Col, NH, Pen
Four-toed Salamander	*Hemidactylium scutatum*	SC	-	Bla, Pen
Least Killifish	*Heterandria formosa*	SC	-	Bru, NH
Southern Hognose Snake	*Heterodon simus*	SC	FSC	Bla, Bru, NH, Pen
Least Bittern	*Ixobrychus exilis*	SC	-	Bru, NH, Pen
Loggerhead Shrike	*Lanius ludovicianus*	SC	-	Bla, Bru, Col, NH
Northern Yellow Bat	*Lasiurus intermedius*	SC	-	Bru, NH
Black Rail	*Laterallus jamaicensis*	SC	FSC	NH
Kemp's Ridley Seaturtle	*Lepidochelys kempii*	E	E	Bru
Diamondback Terrapin	*Malaclemys terrapin*	SC	FSC, in part	Bru, NH, Pen

Common Name	Row Labels	State Status	Federal Status	County
Waccamaw Silverside	*Menidia extensa*	T	T	Col
Eastern Coral Snake	*Micrurus fulvius*	E	-	Bla, Bru, NH, Pen
Wood Stork	*Mycteria americana*	E	E	Bru, Col
Southeastern Myotis	*Myotis austroriparius*	SC	FSC	Bla, Col, NH, Pen
Eastern Woodrat - Coastal Plain population	*Neotoma floridana floridana*	T	-	Bru, NH, Pen
Broadtail Madtom	*Noturus sp. 2*	SC	FSC	Bla, Bru, Col, Pen
Mimic Glass Lizard	*Ophisaurus mimicus*	SC	FSC	Bla, Bru, Col, NH
Eastern Painted Bunting	*Passerina ciris ciris*	SC	FSC	Bru, NH, Pen
Bachman's Sparrow	*Peucaea aestivalis*	SC	FSC	Bla, Bru, Col, Pen
Red-cockaded Woodpecker	*Picoides borealis*	E	E	Bla, Bru, Col, NH, Pen
Northern Pine Snake	*Pituophis melanoleucus melanoleucus*	SC	FSC	Bru, NH
Glossy Ibis	*Plegadis falcinellus*	SC	-	Bru, NH
Carolina Gopher Frog	*Rana capito*	T	FSC	Bla, Bru, NH, Pen
Black Skimmer	*Rynchops niger*	SC	-	Bru, NH, Pen
Pigmy Rattlesnake	*Sistrurus miliarius*	SC	-	Bla, Bru, NH, Pen
Common Tern	*Sterna hirundo*	SC	-	NH, Pen
Least Tern	*Sternula antillarum*	SC	-	Bru, NH, Pen
West Indian Manatee	*Trichechus manatus*	E	E	Bru, NH, Pen

Table B-2. State and Federally Protected Species in Counties of the Shallotte IBT River Basin Study Area

Common Name	Scientific Name	State Status	Federal Status	County
Invertebrate Animal				
a dart moth	*Agrotis carolina*	SR	FSC	Bru
Arogos Skipper	*Atrytone arogos arogos*	SR	FSC	Bru
Loammi Skipper	*Atrytonopsis loammi*	SR	FSC	Bru
Pod Lance	*Elliptio folliculata*	SC	-	Bru
Waccamaw Spike	*Elliptio waccamawensis*	E	FSC	Bru
Greenfield Rams-horn	*Helisoma eucosmium*	E	FSC	Bru
Venus Flytrap Cutworm Moth	*Hemipachnobia subporphyrea*	SR	FSC	Bru
Eastern Pondmussel	*Ligumia nasuta*	T	-	Bru
Magnificent Rams-horn	*Planorbella magnifica*	E	FSC	Bru
Rare Skipper	*Problema bulenta*	SR	FSC	Bru
Waccamaw Crayfish	*Procambarus braswelli*	SC	-	Bru
Carter's Noctuid Moth	*Spartiniphaga carterae*	SR	FSC	Bru
Cape Fear Threetooth	*Triodopsis soelneri*	T	FSC	Bru
Nonvascular Plant				
Savanna Campylopus	*Campylopus carolinae*	SR-T	FSC	Bru
Vascular Plant				
Branched Gerardia	*Agalinis virgata*	T	-	Bru
Savanna Onion	*Allium sp. 1*	SR-L	FSC	Bru
Seabeach Amaranth	*Amaranthus pumilus*	T	T	Bru
Savanna Indigo-bush	*Amorpha confusa*	T	FSC	Bru
Bog Bluestem	*Andropogon mohrii*	T	-	Bru
Chapman's Three-awn	*Aristida simpliciflora*	E	-	Bru
Savanna Indian-plantain	*Arnoglossum ovatum*	E	-	Bru
Savanna Milkweed	*Asclepias pedicellata*	SC-V	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Silverling	*Baccharis glomeruliflora*	SC-H	-	Bru
Blue Water-hyssop	*Bacopa caroliniana*	T	-	Bru
Purple-disk Honeycomb-head	*Balduina atropurpurea*	E	FSC	Bru
Ware's Hair Sedge	*Bulbostylis warei*	SC-H	-	Bru
Many-flower Grass-pink	*Calopogon multiflorus*	E	FSC	Bru
Cypress Knee Sedge	*Carex decomposita*	SC-V	-	Bru
Nutmeg Hickory	*Carya myristiciformis*	E	-	Bru
Leconte's Thistle	*Cirsium lecontei*	SC-V	-	Bru
Georgia Calamint	*Clinopodium georgianum*	E	-	Bru
Carolina Sunrose	*Crocanthemum carolinianum*	E	-	Bru
Pinebarren Sunrose	*Crocanthemum corymbosum*	T	-	Bru
Georgia Sunrose	*Crocanthemum georgianum*	E	-	Bru
Florida Scrub Frostweed	*Crocanthemum nashii*	E	-	Bru
Toothed Flatsedge	*Cyperus dentatus*	SC-H	-	Bru
Leconte's Flatsedge	*Cyperus lecontei*	T	-	Bru
Four-angled Flatsedge	*Cyperus tetragonus*	SC-V	-	Bru
Nerved Witch Grass	*Dichanthelium aciculare ssp. Neuranthum*	SC-V	-	Bru
Blue Witch Grass	*Dichanthelium caerulescens*	E	-	Bru
Venus Flytrap	*Dionaea muscipula*	SC-V	FSC	Bru
Sebastian-bush	*Ditrysinia fruticosa*	SC-V	-	Bru
Threadleaf Sundew	*Drosera filiformis*	SC-V	-	Bru
Dwarf Burhead	*Echinodorus tenellus*	E	-	Bru
Florida Spikerush	*Eleocharis elongata*	E	-	Bru
Robbins' Spikerush	*Eleocharis robbinsii*	SC-V	-	Bru
Terrell Grass	*Elymus virginicus var. halophilus*	SC-V	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Green Fly Orchid	*Epidendrum magnoliae*	T	-	Bru
Seven-angled Pipewort	*Eriocaulon aquaticum*	SC-V	-	Bru
Coralbean	*Erythrina herbacea*	E	-	Bru
Limesink Dog-fennel	*Eupatorium leptophyllum*	E	-	Bru
Harper's Fimbry	*Fimbristylis perpusilla*	T	FSC	Bru
Soft Milk-pea	*Galactia mollis*	T	-	Bru
Swamp Jessamine	*Gelsemium rankinii*	SC-V	-	Bru
Golden Hedge-hyssop	*Gratiola aurea*	SC-V	-	Bru
Littleleaf Sneezeweed	*Helenium brevifolium*	E	-	Bru
Spring Sneezeweed	*Helenium vernale*	E	-	Bru
Florida Sunflower	*Helianthus floridanus*	T	-	Bru
Waccamaw River Spiderlily	*Hymenocallis pygmaea*	T	FSC	Bru
Coastal Plain St. John's-wort	*Hypericum brachyphyllum*	SC-V	-	Bru
Beach Morning-glory	*Ipomoea imperati*	T	-	Bru
Thin-wall Quillwort	*Isoetes microvela*	T	FSC	Bru
Brown Bogbutton	*Lachnocaulon minus*	T	-	Bru
Torrey's Pinweed	*Lechea torreyi*	E	-	Bru
Long-awned Spangletop	*Leptochloa fascicularis var. maritime*	E	-	Bru
Yellow-fruited Flax	*Linum floridanum var. chrysocarpum*	T	-	Bru
Pondspice	*Litsea aestivalis*	SC-V	FSC	Bru
Golden-crest	*Lophiola aurea*	E	-	Bru
Lanceleaf Seedbox	*Ludwigia lanceolata*	E	-	Bru
Flaxleaf Seedbox	*Ludwigia linifolia*	T	-	Bru
Raven's Seedbox	*Ludwigia ravenii*	T	FSC	Bru
Shrubby Seedbox	*Ludwigia suffruticosa*	T	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Rough-leaf Loosestrife	*Lysimachia asperulifolia*	E	E	Bru
Carolina Bogmint	*Macbridea caroliniana*	E	FSC	Bru
Florida Adder's-mouth	*Malaxis spicata*	SC-V	-	Bru
Pinebarren Smokegrass	*Muhlenbergia torreyana*	SC-V	-	Bru
Loose Water-milfoil	*Myriophyllum laxum*	E	FSC	Bru
Bosc's Bluet	*Oldenlandia boscii*	E	-	Bru
Large-seed Pellitory	*Parietaria praetermissa*	SC-V	-	Bru
Carolina Grass-of-parnassus	*Parnassia caroliniana*	T	FSC	Bru
Large-leaved Grass-of-parnassus	*Parnassia grandifolia*	T	FSC	Bru
Mudbank Crown Grass	*Paspalum dissectum*	E	-	Bru
Hairy Smartweed	*Persicaria hirsuta*	E	-	Bru
A Silkgrass	*Pityopsis graminifolia var. graminifolia*	E	-	Bru
Pineland Plantain	*Plantago sparsiflora*	T	FSC	Bru
Yellow Fringeless Orchid	*Platanthera integra*	SC-V	-	Bru
Snowy Orchid	*Platanthera nivea*	T	-	Bru
Hooker's Milkwort	*Polygala hookeri*	SC-V	-	Bru
Seabeach Knotweed	*Polygonum glaucum*	E	-	Bru
Shadow-witch	*Ponthieva racemosa*	T	-	Bru
Carolina Bishop-weed	*Ptilimnium ahlesii*	SR-L	FSC	Bru
Ribbed Bishop-weed	*Ptilimnium costatum*	T	-	Bru
Sandhills Pyxie-moss	*Pyxidanthera brevifolia*	SR-L	FSC	Bru
Awned Meadow-beauty	*Rhexia aristosa*	SC-V	FSC	Bru
Swamp Forest Beaksedge	*Rhynchospora decurrens*	T	FSC	Bru
Harper's Beaksedge	*Rhynchospora harperi*	SC-V	-	Bru
Fragrant Beaksedge	*Rhynchospora odorata*	SC-V	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Coastal Beaksedge	*Rhynchospora pleiantha*	T	FSC	Bru
Thorne's Beaksedge	*Rhynchospora thornei*	SC-V	FSC	Bru
Tracy's Beaksedge	*Rhynchospora tracyi*	T	-	Bru
Cabbage Palm	*Sabal palmetto*	T	-	Bru
Plymouth Gentian	*Sabatia kennedyana*	T	-	Bru
Quillwort Arrowhead	*Sagittaria isoetiformis*	T	-	Bru
Grassleaf Arrowhead	*Sagittaria weatherbiana*	E	FSC	Bru
Hooded Pitcher Plant	*Sarracenia minor*	E	-	Bru
Drooping Bulrush	*Scirpus lineatus*	T	-	Bru
Baldwin's Nutrush	*Scleria baldwinii*	T	-	Bru
Netted Nutrush	*Scleria reticularis*	T	-	Bru
Sticky Afzelia	*Seymeria pectinata*	SC-H	-	Bru
Tough Bumelia	*Sideroxylon tenax*	T	FSC	Bru
Twisted-leaf Goldenrod	*Solidago tortifolia*	E	-	Bru
Spring-flowering Goldenrod	*Solidago verna*	SR-O	FSC	Bru
Coastal Goldenrod	*Solidago villosicarpa*	E	FSC	Bru
Eaton's Ladies'-tresses	*Spiranthes eatonii*	E	-	Bru
Lace-lip Ladies'-tresses	*Spiranthes laciniata*	SC-V	-	Bru
Giant Spiral Orchid	*Spiranthes longilabris*	E	-	Bru
Wireleaf Dropseed	*Sporobolus teretifolius*	T	FSC	Bru
Saltmarsh Dropseed	*Sporobolus virginicus*	T	-	Bru
Water Dawnflower	*Stylisma aquatica*	E	-	Bru
Pickering's Dawnflower	*Stylisma pickeringii var. pickeringii*	SC-V	FSC	Bru
Cooley's Meadowrue	*Thalictrum cooleyi*	E	E	Bru
Dune Bluecurls	*Trichostema sp. 1*	SR-L	FSC	Bru
Horned Bladderwort	*Utricularia cornuta*	T	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Dwarf Bladderwort	*Utricularia olivacea*	T	-	Bru
Cranberry	*Vaccinium macrocarpon*	T	-	Bru
Florida Yellow-eyed-grass	*Xyris floridana*	T	-	Bru
Pineland Yellow-eyed-grass	*Xyris stricta*	E	-	Bru
Rain Lily	*Zephyranthes simpsonii*	E	FSC	Bru
Vertebrate Animal				
Shortnose Sturgeon	*Acipenser brevirostrum*	E	E	Bru
American Alligator	*Alligator mississippiensis*	T	T(S/A)	Bru
Eastern Henslow's Sparrow	*Ammodramus henslowii susurrans*	SC	FSC	Bru
Loggerhead Seaturtle	*Caretta caretta*	T	T	Bru
Piping Plover	*Charadrius melodus*	T	T	Bru
Wilson's Plover	*Charadrius wilsonia*	SC	-	Bru
Green Seaturtle	*Chelonia mydas*	T	T	Bru
Star-nosed Mole - Coastal Plain population	*Condylura cristata pop. 1*	SC	-	Bru
Rafinesque's Big-eared Bat - Coastal Plain subspecies	*Corynorhinus rafinesquii macrotis*	SC	FSC	Bru
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*	E	-	Bru
Timber Rattlesnake	*Crotalus horridus*	SC	-	Bru
Black-throated Green Warbler - Coastal Plain population	*Dendroica virens waynei*	SR	FSC	Bru
Leatherback Seaturtle	*Dermochelys coriacea*	E	E	Bru
Little Blue Heron	*Egretta caerulea*	SC	-	Bru
Snowy Egret	*Egretta thula*	SC	-	Bru
Tricolored Heron	*Egretta tricolor*	SC	-	Bru
Carolina Pygmy Sunfish	*Elassoma boehlkei*	T	FSC	Bru
Peregrine Falcon	*Falco peregrinus*	E	-	Bru

Common Name	Scientific Name	State Status	Federal Status	County
Gull-billed Tern	*Gelochelidon nilotica*	T	-	Bru
American Oystercatcher	*Haematopus palliatus*	SC	-	Bru
Bald Eagle	*Haliaeetus leucocephalus*	T	-	Bru
Least Killifish	*Heterandria formosa*	SC	-	Bru
Southern Hognose Snake	*Heterodon simus*	SC	FSC	Bru
Least Bittern	*Ixobrychus exilis*	SC	-	Bru
Loggerhead Shrike	*Lanius ludovicianus*	SC	-	Bru
Northern Yellow Bat	*Lasiurus intermedius*	SC	-	Bru
Kemp's Ridley Seaturtle	*Lepidochelys kempii*	E	E	Bru
Diamondback Terrapin	*Malaclemys terrapin*	SC	FSC, in part	Bru
Eastern Coral Snake	*Micrurus fulvius*	E	-	Bru
Wood Stork	*Mycteria americana*	E	E	Bru
Eastern Woodrat - Coastal Plain population	*Neotoma floridana floridana*	T	-	Bru
Broadtail Madtom	*Noturus sp. 2*	SC	FSC	Bru
Mimic Glass Lizard	*Ophisaurus mimicus*	SC	FSC	Bru
Eastern Painted Bunting	*Passerina ciris ciris*	SC	FSC	Bru
Bachman's Sparrow	*Peucaea aestivalis*	SC	FSC	Bru
Red-cockaded Woodpecker	*Picoides borealis*	E	E	Bru
Northern Pine Snake	*Pituophis melanoleucus melanoleucus*	SC	FSC	Bru
Glossy Ibis	*Plegadis falcinellus*	SC	-	Bru
Carolina Gopher Frog	*Rana capito*	T	FSC	Bru
Black Skimmer	*Rynchops niger*	SC	-	Bru
Pigmy Rattlesnake	*Sistrurus miliarius*	SC	-	Bru
Least Tern	*Sternula antillarum*	SC	-	Bru
West Indian Manatee	*Trichechus manatus*	E	E	Bru

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Appendix C Local Water Supply Plan

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Brunswick County

2011

The Division of Water Resources (DWR) provides the data contained w ithin this Local Water Supply Plan (LWSP) as a courtesy and service to our customers. DWR staff does not field verify data. Neither DWR, nor any other party involved in the preparation of this LWSP attests that the data is completely free of errors and omissions. Furthermore, data users are cautioned that LWSPs labeled **PROVISIONAL** have yet to be review ed by DWR staff. Subsequent review may result in significant revision. Questions regarding the accuracy or limitations of usage of this data should be directed to the w ater system and/or DWR.

1. System Information

Contact Information

PROVISIONAL

Water System Name:	Brunsw ick County	PWSID:	04-10-045
Mailing Address:	PO Box 249 Bolivia, NC 28422	Ow nership:	County
Contact Person:	Jerry W. Pierce, P.E.	Title:	Public Utilities Director
Phone:	910-253-2657	Fax:	910-253-4304

Distribution System

Line Type	Size Range (Inches)	Estimated % of lines
Asbestos Cement	6-16	1.00 %
Ductile Iron	6-42	12.00 %
Other	6-18	1.00 %
Polyvinyl Chloride	2-16	86.00 %

What are the estimated total miles of distribution system lines? 949 Miles

How many feet of distribution lines w ere replaced during 2011? 0 Feet

How many feet of new w ater mains w ere added during 2011? 63,360 Feet

How many meters w ere replaced in 2011? 7,000

How old are the oldest meters in this system? 10 Year(s)

How many meters for outdoor w ater use, such as irrigation, are not billed for sew er services? 4,500

What is this system's finished w ater storage capacity? 18.350 Million Gallons

Has w ater pressure been inadequate in any part of the system since last update? Yes

Programs

Does this system have a program to w ork or flush hydrants? Yes, As Needed

Does this system have a valve exercise program? Yes, Annually

Does this system have a cross-connection program? Yes

Does this system have a program to replace meters? Yes

Does this system have a plumbing retrofit program? No

Does this system have an active w ater conservation public education program? Yes

Does this system have a leak detection program? Yes

> We annually inspect all lines and repair all reported leaks w ithin 24 hours regardless of severity. We have an active meter replacement program w ith a goal of replacing all meters w ithin 10 years.

Water Conservation

What type of rate structure is used? Increasing Block

How much reclaimed w ater does this system use? 0.000 MGD For how many connections? 0

Does this system have an interconnection w ith another system capable of providing w ater in an emergency? No

> We are in the process of negotiating an agreement w ith a neigboring utiity from South Carolina. All other interconnections are not feasible at this time.

2. Water Use Information

Service Area

Sub-Basin(s)	% of Service Population	County(s)	% of Service Population
Cape Fear River (02-3)	52 %	Brunswick	100 %
Shallotte River (09-4)	46 %		
Waccamaw River (09-3)	2 %		

What was the year-round population served in 2011? 75,230

What was the seasonal population and months served in 2011? (if applicable) 195,600 (May Jun Jul Aug Sep)

Has this system acquired another system since last report? No

This system has been identified as a Surface Water Transfer. Please download the IBT Worksheets and submit to your Review Engineer, Wayne Howard.

Water Use by Type

Type of Use	Metered Connections	Metered Average Use (MGD)	Non-Metered Connections	Non-Metered Estimated Use (MGD)
Residential	34,120	5.370	0	0.000
Commercial	0	0.000	0	0.000
Industrial	4	2.193	0	0.000
Institutional	0	0.000	0	0.000

How much water was used for system processes (backwash, line cleaning, flushing, etc.)? 1.026 MGD

Commercial and Institutional flows are not tracked spearately and are included in the retail or residential category.

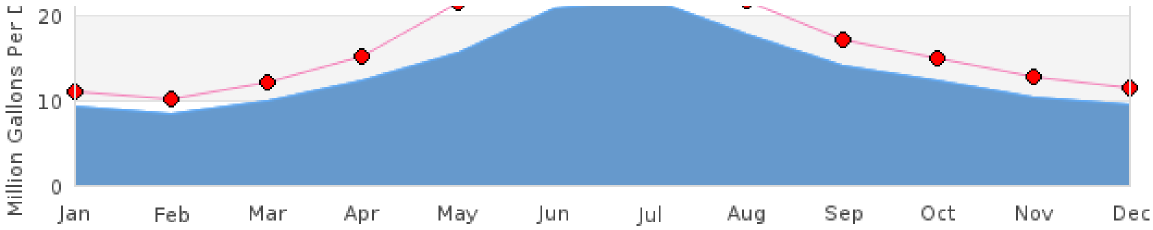
Water Sales

Purchaser	PWSID	Average Daily Sold (MGD)	Days Used	Contract			Required to comply with water use restrictions?	Pipe Size(s) (Inches)	Use Type
				MGD	Expiration	Recurring			
Bald Head Utilities	04-10-130	0.034	365	0.500	2050	Yes	Yes	10	Regular
Brunswick Regional (H2GO)	04-10-070	1.650	365	0.940	2034	Yes	Yes	24;12	Regular
Caswell Beach	04-10-055	0.138	365	0.300	2020	Yes	Yes	12	Regular
Holden Beach	04-10-060	0.396	365	0.818	2020	Yes	Yes	12;12	Regular
Leland, Town of	70-10-058	0.166	365	2.000	2035	Yes	Yes	16	Regular
Navassa	04-10-065	0.094	365		2023	Yes	Yes	12	Regular
Northwest	70-10-045	0.072	365		2027	Yes	Yes	12	Regular
Oak Island	04-10-020	0.787	365	1.380	2020	Yes	Yes	12;16	Regular
Ocean Isle Beach	04-10-035	0.681	365	1.062		Yes	Yes	12;8	Regular
Shallotte	04-10-025	0.398	365			Yes	Yes	30;12	Regular
Southport	04-10-010	0.461	365		2020	Yes	Yes	24;24	Regular

3. Water Supply Sources

Monthly Withdrawals & Purchases

	Average Daily Use (MGD)	Max Day Use (MGD)		Average Daily Use (MGD)	Max Day Use (MGD)		Average Daily Use (MGD)	Max Day Use (MGD)
Jan	9.350	10.940	May	15.660	21.430	Sep	14.050	17.220
Feb	8.450	10.210	Jun	20.740	24.030	Oct	12.350	14.920
Mar	9.910	12.140	Jul	22.000	25.800	Nov	10.350	12.690
Apr	12.220	15.210	Aug	17.730	21.740	Dec	9.430	11.480



Ground Water Sources

Name or Number	Average Daily Withdrawal (MGD) MGD	Average Daily Withdrawal (MGD) Days Used	Max Day Withdrawal (MGD)	12-Hour Supply (MGD)	CUA Reduction	Year Offline	Use Type
1	0.240	107	0.24	0.900			Regular
11	1.020	347		1.660			Regular
12	0.620	299		0.620			Regular
12-A	0.300	327		0.300			Regular
15	0.570	297		0.820			Regular
16	0.730	214		0.720			Regular
17	0.290	137		0.300			Regular
18	0.340	197		0.350			Regular
19	0.300	204		0.730			Regular
2	0.187	238		0.260			Regular
3	0.300	245		0.300			Regular
5	0.240	165		0.240			Regular
6a	0.365	332		0.375			Regular
8	0.950	200		1.300			Regular

Ground Water Sources (continued)

Name or Number	Well Depth (Feet)	Casing Depth (Feet)	Screen Depth (Feet) Top	Screen Depth (Feet) Bottom	Well Diameter (Inches)	Pump Intake Depth (Feet)	Metered?
1	175	174	90	170	10	84	Yes
11	164	164	0	0	10	84	Yes
12	96	96	0	0	8	50	Yes
12-A	114	114	60	110	10	63	Yes
15	129	129	75	125	10	74	Yes
16	155	155	63	153	10	52	Yes
17	155	155	0	0	8	70	Yes
18	155	155	0	0	10	0	No
19	150	150	64	144	10	0	No
2	163	163	60	160	10	65	Yes
3	159	159	70	155	10	72	Yes
5	156	156	68	148	10	73	Yes
6a	280	180	100	160	12	90	Yes
8	153	153	65	150	10	70	Yes

Are ground water levels monitored? Yes, Daily

Does this system have a wellhead protection program? No

Water Purchases From Other Systems

Seller	PWSID	Average Daily Purchased (MGD)	Days Used	Contract MGD	Contract Expiration	Contract Recurring	Required to comply with water use restrictions?	Pipe Size(s) (Inches)	Use Type

Cape Fear WASA	04-65-999	10.260	365	24.000	Yes	Yes	48	Regular

Water Treatment Plants

Plant Name	Permitted Capacity (MGD)	Is Raw Water Metered?	Is Finished Water Ouput Metered?	Source
NC Highw ay 211 WTP	6.000	Yes	Yes	Castle Hayne Aquifer
Northw est WTP	24.000	Yes	Yes	Cape Fear River

Did average daily w ater production exceed 80% of approved plant capacity for five consecutive days during 2011? No

If yes, w as any w ater conservation implemented? No

Did average daily w ater production exceed 90% of approved plant capacity for five consecutive days during 2011? No

If yes, w as any w ater conservation implemented? No

Are peak day demands expected to exceed the w ater treatment plant capacity in the next 10 years? Yes

4. Wastewater Information

Monthly Discharges

	Average Daily Discharge (MGD)		Average Daily Discharge (MGD)		Average Daily Discharge (MGD)
Jan	2.850	May	3.220	Sep	3.600
Feb	3.930	Jun	3.350	Oct	3.400
Mar	3.100	Jul	3.830	Nov	3.260
Apr	3.320	Aug	3.870	Dec	3.300

How many sew er connections does this system have? 9,961

How many w ater service connections w ith septic systems does this system have? 24,090

Are there plans to build or expand w astew ater treatment facilities in the next 10 years? Yes

Wastew ater discharges include flow s from other w ater systems. The County operates thw o w astew ater treatment plant: the Northeast Brunsw ick Regional w astew ater treatment Plant and the West brunsw ick Water Reclamation facility. Flow s into the Northeast Brunsw ick WWTP include flow s from Brunsw ick Regional Water and Sew er, Tow n of Leland, Tow n of Navassa, Tow n of Sandy Creek, and City of Northw est. The West Brunsw ick WRF includes flow s from the Tow n of Oak Island, Tow nof Holden Beach, Tow n of Shallotte, and City of Southport.

Wastewater Permits

Permit Number	Permitted Capacity (MGD)	Design Capacity (MGD)	Average Annual Daily Discharge (MGD)	Maximum Day Discharge (MGD)	Receiving Stream	Receiving Basin
NC0040061	0.000	0.000	0.000	0.000	Beaverdam Creek	Cape Fear River (02-3)
NC0044873	0.535	0.535	0.478	0.700	Caw Caw Drainage Canal	Waccamaw River (09-3)
NC0057533	0.000	0.000	0.698	2.500	Hood Creek	Cape Fear River (02-3)
NC0086819	1.650	1.650	1.200	2.100	Low er Cape Fear	Cape Fear River (02-3)
WQ0000798	0.500	0.500	0.081	0.113	Non Discharge	Lumber River (09-1)
WQ0011614	0.300	0.300	0.143	0.200	None	Shallotte River (09-4)
WQ0012748	0.500	0.300	0.074	0.300	None	Shallotte River (09-4)
WQ0023693	6.000	6.000	1.200	2.100	None	Cape Fear River (02-3)

5. Planning

Projections

	2011	2020	2030	2040	2050	2060
Year-Round Population	75,230	96,374	117,025	138,790	158,803	182,622
Seasonal Population	195,600	240,935	292,561	345,222	397,007	456,556

Residential	5.370	6.693	8.078	9.631	11.137	12.580
Commercial	0.000	0.000	0.000	0.000	0.000	0.000
Industrial	2.193	2.190	2.193	2.193	2.193	2.193
Institutional	0.000	0.000	0.000	0.000	0.000	0.000
System Process	1.026	1.026	1.026	1.026	1.026	1.026
Unaccounted-for	1.247	1.248	1.516	1.807	2.090	2.362

Commerical and Institutional flow s are not tracked separately and are included inthe retail or residential category.

Future Water Sales

Purchaser	PWSID	Contract MGD	Contract Year Begin	Contract Year End	Pipe Size(s) (Inches)	Use Type
Brunsw ick County - Wholesale	04-10-045	0.029	2040			Regular
Brunsw ick County - Wholesale	04-10-045	1.399	2050			Regular
Brunsw ick County - Wholesale	04-10-045	2.720	2060			Regular

Brunsw ick County anticipates the above increases to our interconnected customers beyond their current contracted amounts.

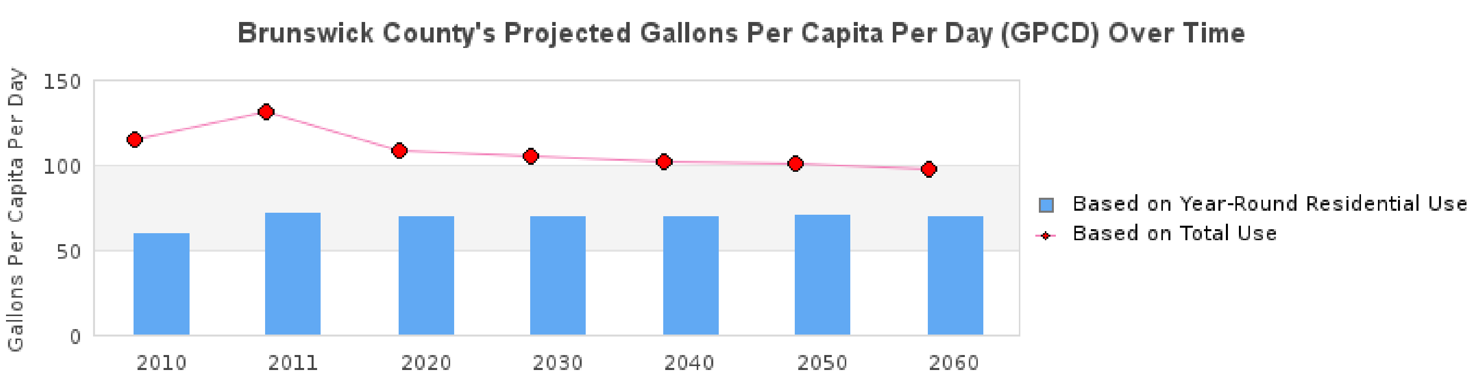
Future Supply Sources

Source Name	PWSID	Source Type	Additional Supply	Year Online	Year Offline	Type
Castle Hayne Aquifer	04-10-045	Ground	0.500	2014		Regular

We plan to drill an additional w ell for the NC 211 Water Treatment Plant and negotiate an interconnection agreement w ith the Little River Water Company.

Demand v/s Percent of Supply

	2011	2020	2030	2040	2050	2060
Surface Water Supply	0.000	0.000	0.000	0.000	0.000	0.000
Ground Water Supply	8.875	8.875	8.875	8.875	8.875	8.875
Purchases	24.000	24.000	24.000	24.000	24.000	24.000
Future Supplies		0.500	0.500	0.500	0.500	0.500
Total Available Supply (MGD)	32.875	33.375	33.375	33.375	33.375	33.375
Service Area Demand	9.836	10.535	12.277	14.216	16.096	17.896
Sales	4.877	8.735	8.735	8.735	8.735	8.735
Future Sales		0.000	0.000	0.029	1.428	4.148
Total Demand (MGD)	14.713	19.270	21.012	22.980	26.259	30.779
Demand as Percent of Supply	45%	58%	63%	69%	79%	92%



The purpose of the above chart is to show a general indication of how the long-term per capita w ater demand changes over time. The per capita w ater demand may actually be different than indicated due to seasonal populations and the accuracy of data submitted. Water systems that have calculated long-term per capita w ater demand based on a methodology that produces different results may submit their information in the notes field.

Your long-term w ater demand is 71 gallons per capita per day. What demand management practices do you plan to implement to reduce the per capita w ater demand (i.e. conduct regular w ater audits, implement a plumbing retrofit program, employ practices such as rainw ater harvesting or reclaimed w ater)? If these practices are covered elsew here in your plan, indicate w here the practices are discussed here.

Are there other demand management practices you w ill implement to reduce your future supply needs? We plan to implement a residential effluent reuse program to to decrease the demand for potable w ater used for irrigation.

What supplies other than the ones listed in future supplies are being considered to meet your future supply needs? We also plan to drill an additional w ell to supplement the NC 211 Water Plant supply. We w ill enter into a new agreement w ith the Low er Cape Fear Water and Sew er Authority for additional raw w ater supply.

How does the w ater system intend to implement the demand management and supply planning components above? We have already begun w ork on the IBT certificate needed for the expansin of the Northw est Water Treatment Plant. We have already constructed a signiciant amount of the improvements needeed to

expand the w ater plant. LCFWASA has started planning and design to increase the amount of available w ter supply to brunsw ick County and CFPUA.

Additional Information

Has this system participated in regional w ater supply or w ater use planning? No

What major w ater supply reports or studies w ere used for planning? Brunsw ick County Water Master Plan

Please describe any other needs or issues regarding your w ater supply sources, any w ater system deficiencies or needed improvements (storage, treatment, etc.) or your ability to meet present and future w ater needs. Include both quantity and quality considerations, as w ell as financial, technical, managerial, permitting, and compliance issues: The County must obtain an IBT Certitifcate prior to expanding the Northw est Water Treatment Plant for additional long term potable w ater capacity.