Total Maximum Daily Loads for Fecal Coliform for the White Oak River, North Carolina

[Waterbody IDs 20-(18)a1, 20-(18)a2, 20-(18)b, 20-(18)c1, 20-(18)c3, 20-(18)c5, 20-(18)c6, 20-(18)c7, 20-(18)c8, 20-(18)d, 20-(18)e2, 20-(18)e3]

Final Report
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White Oak River Basin

Prepared by:
NC Department of Environment and Natural Resources
Division of Water Quality
1617 Mail Service Center
Raleigh, NC 27699-1617

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List of Abbreviations

BMP	Best Management Practice
CAFO	Confined Animal Feeding Operations
cfs	Cubic Feet per Second
CFR	Code of Federal Regulations
CWA	Clean Water Act
CWP	Center for Watershed Protection
DEH	Division of Environmental Health
EPA	Environmental Protection Agency
FA	Future Allocation
GPD	Gallons Per Day
HUC	Hydrologic Unit Code
LA	Load Allocation
LDC	Load Duration Curve
MF	MF is an abbreviation for the membrane filter procedure for bacteriological analysis.
ml	Milliliter(s)
MLW	Mean Low Water
MOS	Margin of Safety
MPN	Most Probable Number
MRLC	Multi-Resolution Land Cover
NOAA	National Oceanic and Atmospheric Administration
NCAC	NC Administration Code
NCDWQ	North Carolina Division of Water Quality
NCDENR	North Carolina Department of Environment and Natural Resources
NSSP	National Shellfish Sanitation Program
SA	Class SA water body: suitable for commercial shellfishing and all other tidal saltwater use
SSO	Sanitary Sewer Overflows
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
WLA	Waste Load Allocation

WWTF Waste Water Treatment Facility

SUMMARY SHEET

Total Maximum Daily Load (TMDL)

1. 303(d) Listed Waterbody Information

State: North Carolina

County: Carteret, Craven, Jones, Onslow

Major River Basin: White Oak River Basin

Watershed: Headwaters White Oak River, Outlet White Oak River (USGS HUC 0302030101, 0302030102)

Impaired Waterbody (2008 303(d) List):

Waterbody Name – [ID]	Description	Water Quality Classification	Acres
White Oak River – [20-(18)a1]	DEH closed area from Hunters Creek to DEH closure line	SA HQW	792.6
White Oak River – [20-(18)a2]	DEH closed area from Hunters Creek to DEH closure line	SA HQW	1177.6
White Oak River – [20-(18)b]	From DEH Conditionally Approved Closed Line to DEH Conditionally Approved Open Line	SA HQW	230.5
White Oak River – [20-(18)c1]	From DEH Conditionally Approved Closed line to the DEH Conditionally Approved Open line	SA HQW	183.0
White Oak River – [20-(18)c3]	From DEH Conditionally Approved Closed line to the DEH Conditionally Approved Open line	SA HQW	1849.8
White Oak River – [20-(18)c5]	From DEH Conditionally Approved Closed line to the DEH Conditionally Approved Open line	SA HQW	28.1
White Oak River – [20-(18)c6]	From DEH Conditionally Approved Closed line to the DEH Conditionally Approved Open line	SA HQW	31.3
White Oak River – [20-(18)c7]	From DEH Conditionally Approved Closed line to the DEH Conditionally Approved Open line. Prohibited area at Hwy 24 bridge	SA HQW	21.4

White Oak River – [20-(18)c8]	From DEH Conditionally Approved Closed line to the DEH Conditionally Approved Open line. Prohibited area Dolphin Bay Estates and Canal	SA HQW	6.9
White Oak River – [20-(18)d]	DEH closed area adjacent to the east side of the White Oak River restricted area	SA HQW	7.7
White Oak River – [20-(18)e2]	From the DEH Conditionally Approved Open line to the Atlantic Ocean excluding the ICWW	SA HQW	31.9
White Oak River – [20-(18)e3]	From the DEH Conditionally Approved Open line to the Atlantic Ocean excluding the ICWW. Dudleys Marina and Boataminiums	SA HQW	5.5

Constituent(s) of Concern: Fecal Coliform Bacteria

Designated Uses: Shellfish harvesting, biological integrity, propagation of aquatic life, and recreation.

Applicable Tidal Salt Water Quality Standards for Class SA Waters:

"Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions."

For the approval of shellfish growing areas "**the median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of water shall not exceed 14 per 100 milliliters, and not more than 10 percent of the samples shall exceed a fecal coliform MPN of 43 per 100 milliliters (per five tube decimal dilution) in those portions of areas most probably exposed to fecal contamination during most unfavorable hydrographic conditions**"(15A NCAC 18A .0431 Standards for an Approved Shellfish Growing Area). In addition "**a minimum of the 30 most recent randomly collected samples from each sample station shall be used to calculate the median or geometric mean and 90th percentile to determine compliance with this standard" (NSSP, 2007).**

2. TMDL Development

Development Tools (Analysis/Modeling):

Load duration curves are based on cumulative frequency distribution of flow conditions in the watershed. Allowable loads are average loads over the recurrence interval between the 95th and 10th percent flow exceeded (excludes extreme drought (>95th percentile) and floods (<10^{th} percentile). Percent reductions are expressed as the average value

between existing loads (typically calculated using an equation to fit a curve through actual water quality violations) and the allowable load at each percent flow exceeded.

Critical Conditions:

The 90th percentile concentration of 43 MPN/100 ml is the concentration exceeded only 10% of the time. Since the data used in the load duration curve spans ten years (2000-2009), the critical condition is implicitly included in the value of the 90th percentile of the load duration curve results. Given the length of the monitoring record and load duration curve calculation and the standard's recognition of unusual and infrequent events, the 90th percentile is used instead of the absolute maximum.

Seasonal Variation:

Seasonal variation in hydrology, climatic conditions, and watershed activities are represented through the use of a continuous flow gage and the use of water quality data collected in the watershed.

3. TMDL Allocation Summary

The load duration curve results show that the 90th percentile component of the standard, rather than the median component, requires the highest reduction; therefore to be protective, the allocation is established based on 90th percentile load.

Waterbody	Pollutant	Existing Load	WLA	LA	Explicit MOS[1]	TMDL
White Oak River 20-(18)a1, 20-(18)a2, 20-(18)b, 20-(18)c1, 20-(18)c3,, 20-(18)c5, 20-(18)c6, 20-(18)c7, 20-(18)c8, 20-(18)d, 20-(18)e2, 20-(18)e3	Fecal Coliform (cfu/day)	5.40E+11	7.32E+9	1.09E+11	1.77E+10	1.34E+11

1. The Margin of safety is included in the TMDL by lowering the fecal coliform standard from 43 to 38 cfu/100 ml. The MOS shown here is the difference between the TMDL calculated at the 43 and 38 cfu/100 ml standards.

4. Contributing Municipalities TMDL Allocation Summary: N/A

5. Contributing NPDES Facilities TMDL Allocation Summary:

NPDES Permittee	Existing Load (cfu/day)	WLA (cfu/day)	Percent Reduction Required
Maysville WWTP	2.73E+09	2.73E+09	0%
Silverdale Elementary School WWTP	4.5E+07	4.5E+07	0%
Webb Creek WWTP	4.54E+09	4.54E+09	0%

NC DOT	N/A	N/A	75.2%

6. Public Notice Information

Summary:	The TMDL public comment period was announced on the NC Modeling and TMDL website on 7/12/10, on the WRRI listserv on 7/14/10, and the Carteret County News-Times on 7/16/10.
Did notification contain specific mention of TMDL Proposal?	Yes
Were comments received from the public?	Yes
Was a responsiveness summary prepared?	Yes

7. Public Notice Date: 7/12/10

8. Submittal Date: 8/20/10

9. Establishment Date: 9/7/10

10. EPA Lead on TMDL (EPA or blank):

11. DOT a Significant Contribution (Yes or Blank): Yes

12. Endangered Species (yes or blank):

13. MS4s Contributions to Impairment (Yes or Blank):

14. TMDL Considers Point Source, Nonpoint Source, or both: Both

1 INTRODUCTION

Section 303(d) of the federal Clean Water Act (CWA) and the U.S. Environmental Protection Agency's (EPA) implementing regulations direct each State to develop a Total Maximum Daily Load (TMDL) for each impaired water quality limited segment on the Section 303(d) list, taking into account seasonal variations and a protective margin of safety (MOS) to account for uncertainty. A TMDL reflects the total pollutant loading that a waterbody can receive and still meet water quality standards.

TMDLs are established to achieve and maintain water quality standards. A water quality standard is the combination of a designated use for a particular body of water and the water quality criteria designed to protect that use. Designated uses include activities such as swimming, drinking water supply, and shellfish propagation and harvest. Water quality criteria consist of narrative statements and numeric values designed to protect the designated uses. Criteria may differ among waters with different designated uses.

The White Oak River is located in the White Oak River Basin (NC Subbasin 30501 – HUCs 0302030101 and 0302030102) along the North Carolina coast in Carteret, Craven, Jones, and Onslow Counties. The river is located within the shellfish area designated D-3 by the North Carolina Division of Environmental Health (NCDEH). Over two-thirds of the shellfish growing areas are conditionally open or closed, or are prohibited (Figure 1.1). Conditionally Approved Closed waters are closed except after extended dry periods when the areas may be opened for shellfish harvesting. Rainfall of 0.5 inches or greater within a 24-hour period or 0.75 inches within a 48-hour period immediately closes the waters to shellfish harvesting.

When shellfish harvesting is the designated use, the problem parameter that might impair this use is fecal coliform bacteria. Fecal coliform bacteria are found in the intestinal tract of humans and other warm-blooded animals. Few fecal coliform bacteria are pathogenic; however, the presence of elevated levels of fecal coliform in shellfish waters indicates recent sources of pollution. Some common waterborne diseases associated with the consumption of raw clams and oysters harvested from polluted water include viral and bacterial gastroenteritis and hepatitis A. Fecal coliform in surface waters may come from point sources (e.g., NPDES stormwater conveyances) and nonpoint sources.

1.1 TMDL Components

The 303(d) process requires that a TMDL be developed for each of the waters appearing in Category 5 of a state's Integrated Report. The objective of a TMDL is to estimate allowable pollutant loads and allocate to known sources so that actions may be taken to restore the water to its intended uses (USEPA, 1991). This TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving North Carolina's water quality criteria for shellfish waters. Currently, TMDLs are expressed as a "mass per unit time, toxicity, or other

appropriate measure" (40 CFR 130.2(i)). It is also important to note that the TMDLs presented herein are not literal daily limits. These loads are based on an averaging period that

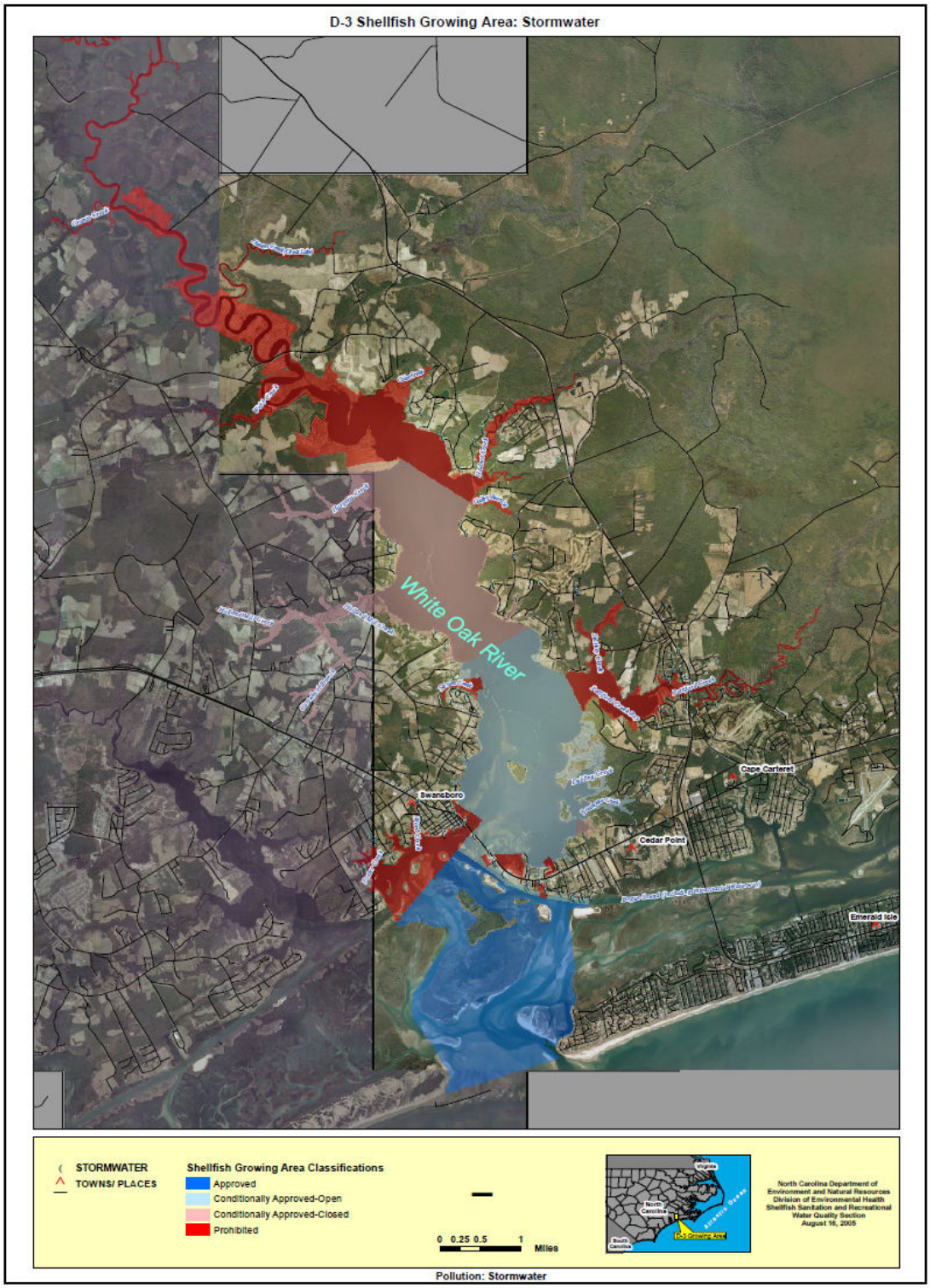

Figure 1.1: White Oak River Shellfish Growing Area (D-3) Classifications

is defined by the water quality criteria (i.e., 30 samples per station). The averaging period used for development of these TMDLs requires at least 30 samples and uses the most recent 2.5-year window of data, assuming one sample per month. Generally, the primary components of a TMDL, as identified by EPA (1991, 1999) and the Federal Advisory Committee (USEPA, 1998) are as follows:

Target Identification or selection of pollutant(s) and end-point(s) for consideration. The pollutant and end-point are generally associated with measurable water quality related characteristics that indicate compliance with water quality standards. North Carolina indicates known pollutants on the 303(d) list.

Source Assessment. All sources that contribute to the impairment should be identified and loads quantified, where sufficient data exist.

Reduction Target. Estimation or level of pollutant reduction needed to achieve water quality goal. The level of pollution should be characterized for the waterbody, highlighting how current conditions deviate from the target end-point. Generally, this component is identified through water quality modeling.

Allocation of Pollutant Loads. Allocating pollutant control responsibility to the sources of impairment. The wasteload allocation portion of the TMDL accounts for the loads associated with existing and future point sources. Similarly, the load allocation portion of the TMDL accounts for the loads associated with existing and future non-point sources, stormwater, and natural background.

Margin of Safety. The margin of safety addresses uncertainties associated with pollutant loads, modeling techniques, and data collection. Per EPA (2000a), the margin of safety may be expressed explicitly as unallocated assimilative capacity or implicitly due to conservative assumptions.

Seasonal Variation. The TMDL should consider seasonal variation in the pollutant loads and end-point. Variability can arise due to stream flows, temperatures, and exceptional events (e.g., droughts, hurricanes).

Critical Conditions. Critical conditions indicate the combination of environmental factors that result in just meeting the water quality criterion and have an acceptably low frequency of occurrence.

Section 303(d) of the CWA and the Water Quality Planning and Management regulation (USEPA, 2000a) require EPA to review all TMDLs for approval or disapproval. Once EPA approves a TMDL, then the waterbody may be moved to Category 4a of the Integrated Report. Waterbodies remain in Category 4a until compliance with water quality standards is achieved.

Where conditions are not appropriate for the development of a TMDL, management strategies may still result in the restoration of water quality.

TMDL is comprised of the sum of individual wasteload allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and natural background levels. The TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody, and in the scientific and technical understanding of water quality in natural systems.

TMDL = WLAs + LAs + MOS

1.2 Documentation of Impairment

The North Carolina Division of Water Quality (DWQ) Surface Water and Wetlands classification for these impaired waters is Class SA, HQW Waters – Shellfish Harvesting Waters (15A NCAC 02B.0221 Tidal Salt Water Quality Standards for Class SA Waters). Class SA waters are waterbodies suitable for commercial shellfishing and all other tidal saltwater use (NCAD 2003).

Thirteen segments, or assessment units, of the Southeast White Oak River have been included in Category 5 the 2008 North Carolina Integrated Report. These restricted shellfish harvesting areas are identified as areas in this basin that do not meet their designated uses. Waters within this classification, according to 15A NCAC 02B.0221 (Tidal Salt Water Quality Standards for Class SA Waters), must meet the following water quality standard in order to meet their designated use: **"Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions."** In addition, for the approval of shellfish growing areas "**the median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of water shall not exceed 14 per 100 milliliters, and not more than 10 percent of the samples shall exceed a fecal coliform MPN of 43 per 100 milliliters (per five tube decimal dilution) in those portions of areas most probably exposed to fecal contamination during most unfavorable hydrographic conditions**"(15A NCAC 18A .0431 Standards for an Approved Shellfish Growing Area). In addition "**a minimum of the 30 most recent randomly collected samples from each sample station shall be used to calculate the median or geometric mean and 90th percentile to determine compliance with this standard" (NSSP, 2010).**

For this report, the monitoring data-averaging period was based on monitoring procedures from the National Shellfish Sanitation Program, i.e. fecal coliform concentration cannot exceed a median or a geometric mean of an MPN of 14 per 100 ml and the 90th percentile of an MPN of 43 per 100 ml, for six samples per year and 30 samples per station. The averaging period for the monitoring data required at least 30 samples. The water quality impairment was assessed using the median and 90th percentile concentrations.

1.3 Watershed Description

The White Oak River is a 42-mile long blackwater river located along the central North Carolina coast. The watershed encompasses portions of Jones, Carteret, Craven, and Onslow counties and covers 273 square miles. Figure 1.2 shows the location of the river and watershed. The headwaters are located within 35 square miles of Hoffman Forest, a forestry research laboratory, and Croatan National Forest covers the majority (105 sqmi) of the eastern portion of the watershed. Agriculture and forest are dominant land uses in the upper watershed. The river begins to widen approximately nine miles before flowing into Bouge Sound; here the river classification changes from class C,HQW to class SA,HQW. This point marks the northern boundary of the Division of Environmental Health Shellfish Growing area D-3 which extends south to Bogue Sound. Uncharacteristic steep slopes and grades characterize upland portions of the growing area. This area has seen rapid residential development in recent years. Oyster and clam production are good throughout the area, however approximately two-thirds of the shellfish beds areas are prohibited, or conditionally closed or open, due to high fecal coliform pollution. The dominant tide in this region is the lunar semi-diurnal (M_2) tide with a mean tidal range of 3.11 ft based on the NOAA station at Beaufort, NC (NOAA, 2010).

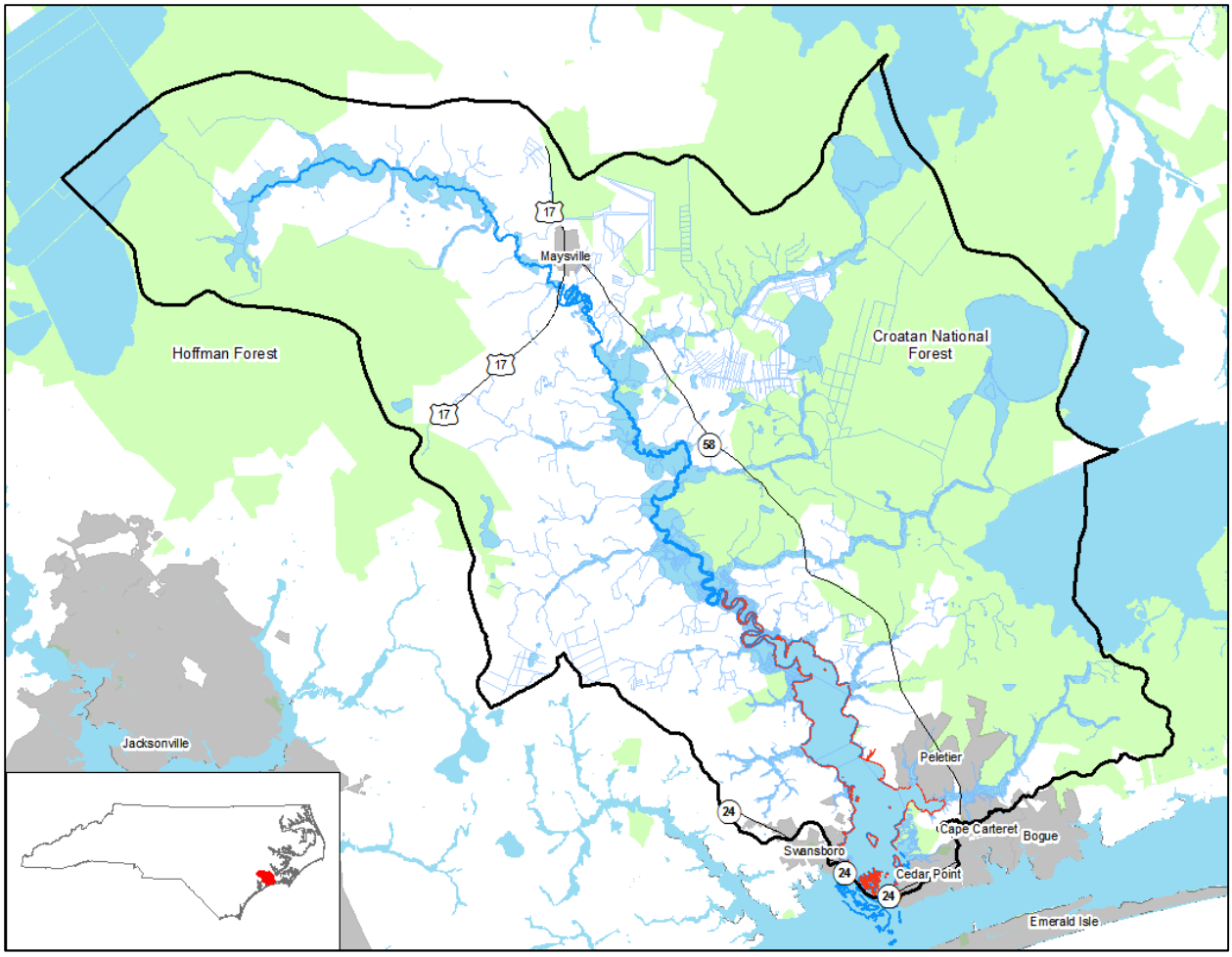

Figure 1.2 Location Map of the White Oak River

The 2001 National Land Cover Database (NLCD) was used to obtain land cover characteristics of the watershed. Land cover distribution is shown in Figure 1.3 and land cover statistics are shown in Table 1.1. It is likely that some crop land along the southern portion of the river has been converted to residential developments since 2001. The next planned land cover database (2006 NLCD) is currently under development.

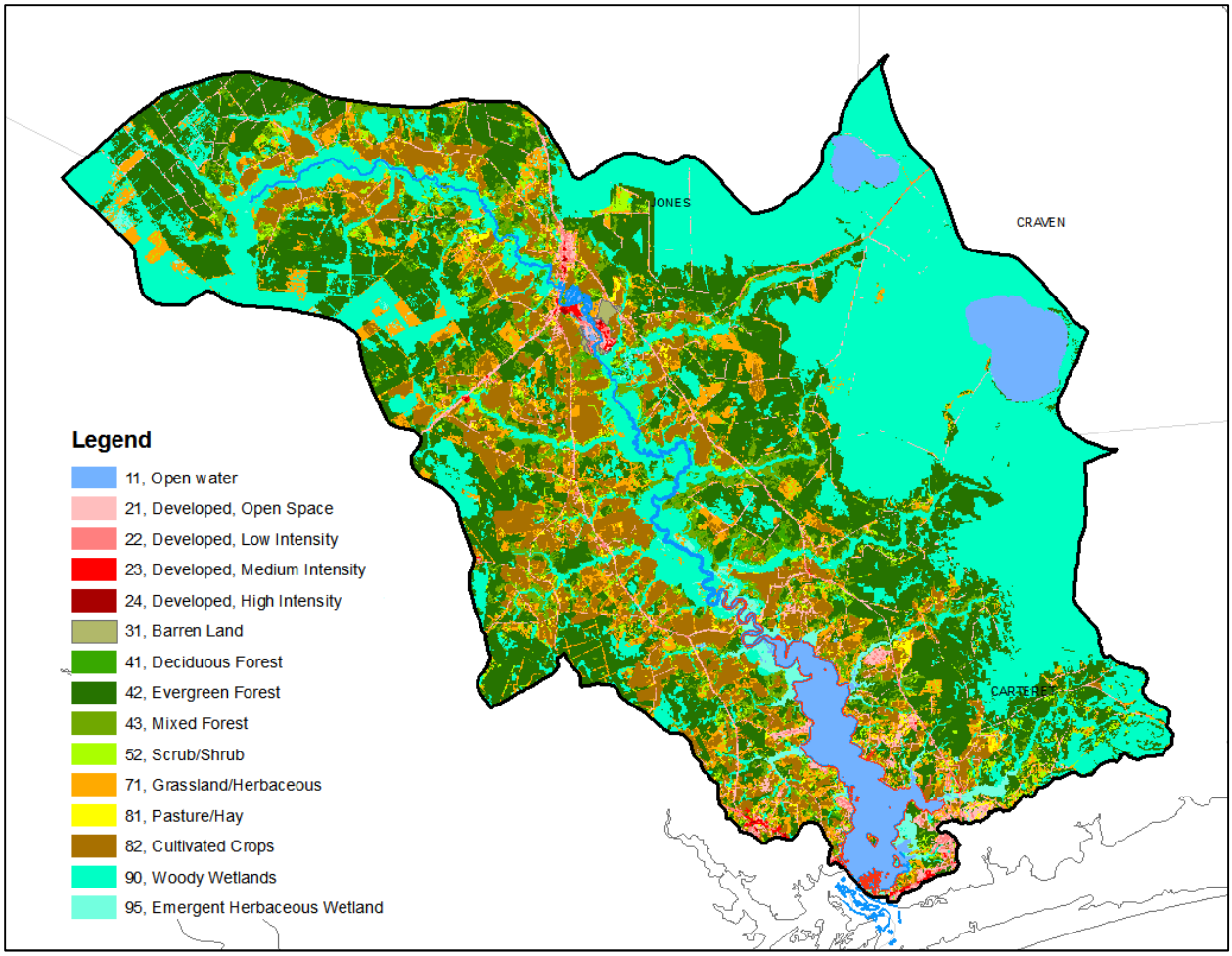

Figure 1.3 2001 NLCD Land Cover of the White Oak River Watershed

Table 1.1 Land Cover Distribution of the WOR Watershed

Land Cover Description	Percent	Square Miles
Woody Wetlands	36.3%	99.24
Evergreen Forest	25.9%	70.72
Cultivated Crops	11.0%	30.17
Grassland/Herbaceous	6.8%	18.66
Mixed Forest	5.2%	14.25
Open water	5.1%	13.82
Developed, Open Space	2.8%	7.56
Scrub/Shrub	2.4%	6.53
Emergent Herbaceous Wetland	1.6%	4.25
Deciduous Forest	1.3%	3.50
Developed, Low Intensity	0.7%	1.93
Pasture/Hay	0.7%	1.85
Developed, Medium Intensity	0.2%	0.48
Barren Land	0.1%	0.34
Developed, High Intensity	0.0%	0.07
Total	100%	273.37

1.4 Water Quality Characterization

The NC Division of Water Quality Ambient Monitoring System (AMS) is a network of stream, lake, and estuarine stations strategically located for the collection of physical and chemical water quality data. AMS station P6400000 is located on the White Oak River near Stella, NC (shown in Figure 3.2). This station was established in 1969 and monthly routine sample collection here provided long term data on fecal coliform concentrations for this project. A statistical summary of data from this station is included in Table 1.2.

Table 1.2. White Oak River Sampling

Station	Sampling Period	Number of Samples Collected	Approximate Sampling Frequency	Sample Median	Sample 90th Percentile
P6400000	1/13/2000–4/15/2009	101	Monthly	42 cfu/100 mL	150 cfu/100 mL

The Shellfish Sanitation and Recreational Water Quality Section of the Division of Environmental Health (DEH) is responsible for classifying shellfish harvesting waters to ensure oysters and clams are safe for human consumption. NCDEH adheres to the requirements of the National Shellfish Sanitation Program, with oversight by the U.S. Food and Drug Administration. NCDEH conducts shoreline surveys and collects routine bacteria water quality samples in

the shellfish-growing areas of North Carolina. The data are used to determine if the water quality criteria are being met. If the water quality criteria are exceeded, the shellfish areas are closed to harvest, at least temporarily, and consequently the designated use is not being achieved. DEH data from 2005-2009 are summarized in Appendix A.

NCDEH has monitored shellfish growing regions throughout North Carolina for the past several decades. The White Oak River is sampled using the systematic random sampling strategy as outlined in the National Shellfish Sanitation Program's Model Ordinance and guidance document. In addition to the routine bacteriological monitoring of the areas, conditional area samples are collected after rainfall events for some stations. There are 37 fecal coliform monitoring stations sampled by the NC DEH; during the 2006 Sanitary Survey 6 stations did not meet standards for growing area criteria. In general, a decline in water quality was observed between the 2003 and 2006 Sanitary Survey Reports (DEH, 2006). The next Sanitary Survey of the D-3 growing area is scheduled for summer 2010.

2 SOURCE ASSESSMENT

2.1 Nonpoint Source Assessment

Non-point sources are diffuse sources that typically cannot be identified as entering a water body at a single location. Nonpoint source loading typically occurs during rain events when surface runoff transports water carrying fecal coliform over the land surface and discharges it into the stream network. The transport of fecal coliform from the land to the restricted shellfish harvesting area is dictated by the hydrology, soil type, land use, and topography of the watershed.

There are many types of nonpoint sources in watersheds that contribute to the restricted shellfish harvesting areas. Fecal coliform bacteria from non-human sources originate from excretions from wildlife, livestock and pets. Wildlife in the watershed are considered to make up background concentrations of fecal coliform. For Dubling Creek, Boathouse Creek, and Hills Bay watersheds (embayments on the WOR), wildlife source loads were estimated to make up an average of 94.3% of daily fecal coliform counts, followed by pet and failing septic sources at 5.6% and 0.3% respectively (NCDENR, 2009). A more direct path to the shellfish areas occurs when wildlife defecate in, or even inhabit, the drainage network, including stream and wetland channels, and stormwater conveyance pipes.

Grazing animals contribute fecal coliform through either direct access to streams or runoff from deposition or manure spreading. Land cover data for the watershed indicates that pasture/hay land area (grazing land) represents less than 1 percent of the watershed. The cultivated crops land cover is concentrated near the river (Figure 1.3) and runoff could be a contributing factor if manure is improperly applied, particularly if just before a storm event. Table 2.1 represents the number of county wide farms and animals for counties in the White Oak River drainage area.

Table 2.1. Number of Farms and Animals by County (2007 Agricultural Census)

County	Cattle and calves		Horses and Ponies		Sheep and Lambs		Goats	
	Farms	Animals	Farms	Animals	Farms	Animals	Farms	Animals
Carteret	8	159	47	306	no data	no data	13	63
Craven	31	932	40	278	10	11	34	423
Jones	38	3538	29	172	12	239	15	256
Onslow	89	1986	109	765	11	116	47	643

Nonpoint source contributions to the bacterial levels from human activities generally arise from malfunctioning or improperly-sited septic systems and their associated drain fields, or illicit connections of sanitary sewage to the stormwater conveyance system. However the human contribution is not expected to be significant. Two possible illicit connections and two potential septic systems failures were identified in the 2006 sanitary survey and were reported to the Onslow County Health Department (NCDEH, 2006). In addition, as part of the North Carolina Coastal Federation's White Oak Restoration Project, 220 bacteria samples were collected from the three embayment watersheds. DNA from 15 of the highest samples were analyzed by the University of North Carolina's Institute of Marine Sciences and all samples were from natural sources (non human) (NCCF, 2009).

2.2 Point Source Assessment

All wastewater discharges to surface water in the State of North Carolina must receive a permit to control water pollution. The Clean Water Act of 1972 initiated strict control of wastewater discharges with responsibility of enforcement given to the Environmental Protection Agency (EPA). The EPA then created the National Pollutant Discharge Elimination System (NPDES) to track and control point sources of pollution. The primary method of control is by issuing permits to discharge with limitations on wastewater flow and constituents. The EPA delegated permitting authority to the State of North Carolina in 1975. Table 2.2 shows dischargers in the White Oak River. Locations of dischargers are shown in Figure 2.1.

Table 2.2 NPDES Waste Water Dischargers in the White Oak River Watershed

Facility	Permit	Type	Permitted Flow (GPD)	Monthly Average Limit	Weekly Average Limit	Daily Max Limit
Maysville WWTP	NC0021482	Municipal <1 MGD	180,000	200#/100ml	400#/100ml	
Silverdale Elementary School WWTP	NC0050849	100% Domestic <1 MGD	3,000	200#/100ml		400#/100ml

Facility	Permit	Type	Permitted Flow (GPD)	Monthly Average Limit	Weekly Average Limit	Daily Max Limit
Webb Creek WWTP	NC0062624	100% Domestic <1 MGD	300,000	200#/100ml		400#/100ml

Human sewage can be discharged to surface waters during sanitary sewer overflow (SSO) events due to a failure at a pump station or storm water infiltration. Five SSOs were recorded in the watershed during years 2000-2010. At this frequency it is unlikely that SSOs are a significant source fecal coliform concentrations. In addition Swansboro has slip lined some of the sewer lines in recent years to decrease groundwater infiltration. (NC DEH 2006 – Sanitary survey)

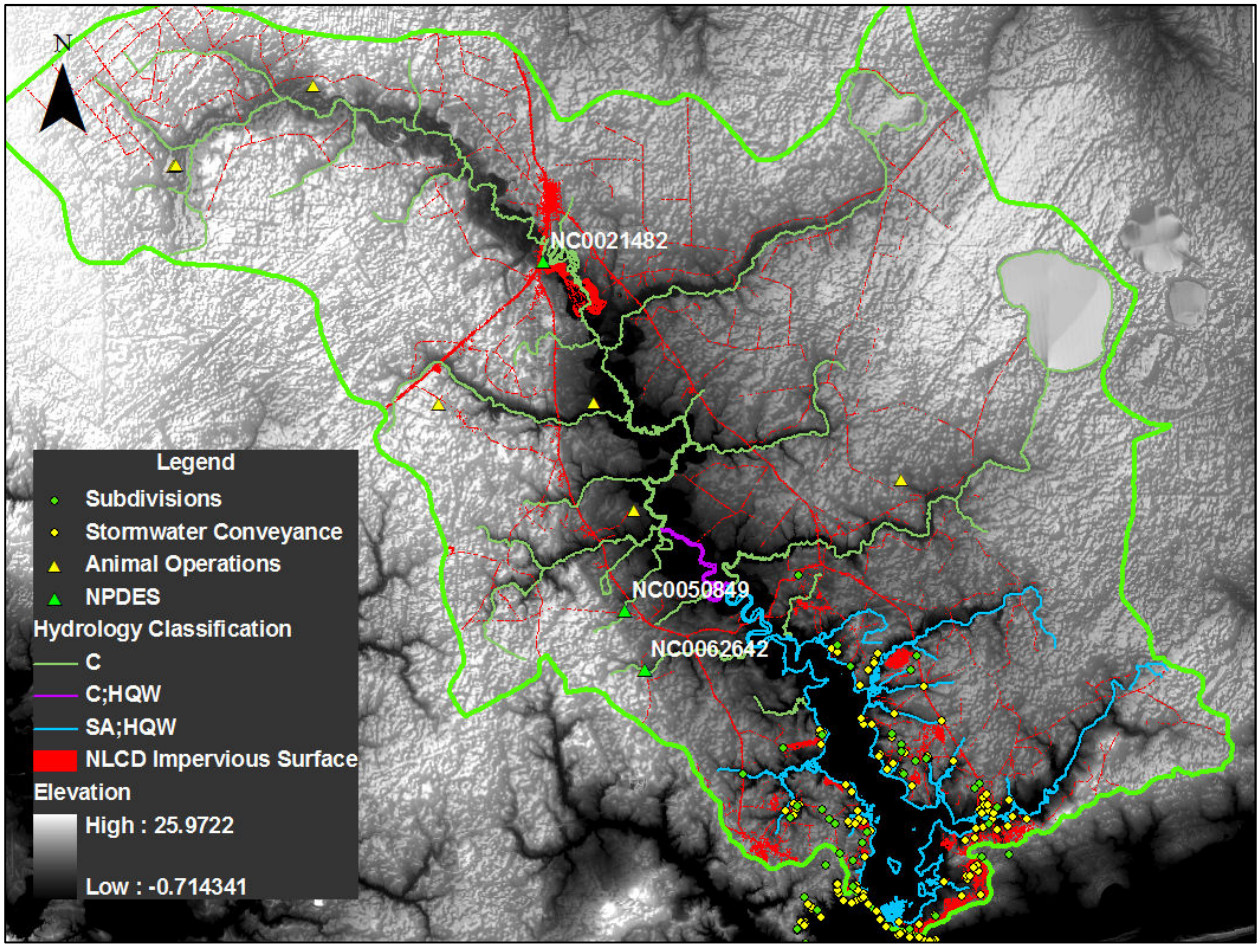

Figure 2.1- Potential Fecal Coliform Sources in the White Oak River Watershed.

Note: The subdivisions and stormwater conveyance locations are from the 2006 shoreline survey conducted by the NC DEH, data is limited to the vicinity of the shellfish growing areas.

The NC Department of Transportation (NCDOT) has a number of roads in the project area, including Highways 24 and 58, which are covered under their statewide Phase I NPDES stormwater permit (NCS000250). Stormwater has previously been considered to be a nonpoint source; however, NPDES-permitted sources are to be included in the wasteload allocation (WLA) per EPA guidance (USEPA, 2002).

Six swine operations hold North Carolina animal operation permits in the watershed (NC DWQ 2003). Two permit violations were found, one for over-application of land applied waste and a freeboard violation for a waste lagoon. If operating according to the permit requirements, these facilities should not be a source of fecal coliform in the White Oak River.

3 TOTAL MAXIMUM DAILY LOADS AND LOAD ALLOCATION

3.1 TMDL Objective

The TMDL objective is to meet North Carolina water quality fecal coliform standards of a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml. In addition, the National Shellfish Sanitation Program (NSSP) standard for the approved classification of growing areas requires that fecal coliform concentrations not exceed a median or geometric mean of a MPN of 14 per 100 ml and the 90^{th} percentile of a MPN of 43 per 100 ml, with a minimum of the 30 most recent samples used to calculate compliance.

Both standards have the same numeric targets but the NSSP standard uses a minimum 30-sample averaging period. For the purpose of this TMDL, data collected from 2000 through 2009 were used. The longer period of data accounts for the variation in precipitation and flow from year to year.

3.2 Previous Studies

Several Studies on the White Oak River have been conducted recently. In March, 2008, Tetra Tech, Inc. (Tetra Tech) was contracted by the US EPA to develop a TMDL development protocol for shellfish waters in the White Oak River. In this report, three tiers of TMDL approaches were developed: the load duration curve methodology (tier 1), spreadsheet tidal prism (tier 2), and a 3-dimensional, hydrodynamic, fate, and transport model (tier 3). The river was segmented into 3 different sections, A, B and C, based on how the Ambient Station and DEH stations were grouped. Results and reductions required by segment and tier are provided in Table 3.1.

Table 3.1 – Excerpt of Results and Reductions from the Fecal Coliform TMDL 3 Tiered Approach (Tetra Tech, 2008)

Segment	Number of Observations	Statistical Parameter	Standard	Tier 1 Results	Tier 1 %Reduction	Tier 2 Results	Tier 2 %Reduction	Tier 3 Results	Tier 3 %Reduction
P6400000	111	Geometric Mean	14	44.1	68.3%	-----	-----	-----	-----
		Median	14	41.0	65.8%	-----	-----	-----	-----
		90%ile	43	150.0	71.3%	-----	-----	-----	-----
Seg_A	466	Geometric Mean	14	17.1	18.1%	N/A	N/A	6.5	No Reduction
		Median	14	13.0	No Reduction	N/A	N/A	2.8	No Reduction
		90%ile	43	79.0	45.6%	68.6	37.3%	16.1	No Reduction
Seg_B	799	Geometric Mean	14	12.0	No Reduction	N/A	N/A	2.2	No Reduction
		Median	14	8.0	No Reduction	N/A	N/A	1	No Reduction
		90%ile	43	49.0	10.0%	45.1	4.7%	4.2	No Reduction
Seg_C	401	Geometric Mean	14	6.0	No Reduction	N/A	N/A	<1	No Reduction
		Median	14	5.0	No Reduction	N/A	N/A	1	No Reduction
		90%ile	43	27.0	No Reduction	33.6	No Reduction	1.3	No Reduction

Note: White Oak River (loading) station appears in yellow, and White Oak River Embayment stations (response) appear in grey.

In March 2009, a TMDL was approved by the US EPA for fecal coliform in several embayments on the southeast White Oak River. This TMDL serves as a valuable source of watershed specific information including aerial orthophotography based land cover, landowner surveys, and additional bacteria monitoring. The fecal coliform load was estimated by using the linked watershed and Tidal Prism modeling approach and was used to simulate fecal coliform concentrations in embayments. The model results showed that the 90th percentile portion of the standard required the most reduction. Table 3.2 shows the TMDL allocation and reductions required based on the 90th percentile load. This TMDL can be viewed on the internet at http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls#white_oak.

Table 3.2- Excerpt of reductions required for the WOR Embayment TMDL

Waterbody	Pollutant	Existing	WLA	LA	MOS[1]	Reduction Required[2]	TMDL
Boathouse Creek - (20-31)	Fecal coliform (counts/day)	**6.17×10^{11}**	**9.91×10^{9}**	**1.75×10^{11}**	**2.41×10^{10}**	66%	**2.09×10^{11}**
Dubling Creek - (20-30)	Fecal coliform (counts/day)	**1.77×10^{11}**	0.00	**1.53×10^{11}**	**5.00×10^{9}**	11%	**1.58×10^{11}**
White Oak River – (20-(18)c4)	Fecal coliform (counts/day)	**2.88×10^{10}**	**6.60×10^{8}**	**1.24×10^{10}**	**1.44×10^{9}**	50%	**1.45×10^{10}**

Notes: WLA = wasteload allocation, LA = load allocation, MOS = margin of safety

[1] Margin of safety (MOS) equivalent 11.6 percent of the target concentration in all embayments. Used a target of 38 instead of 43. MOS load in table represents the difference between total loading using those targets.

[2] The reduction required in this table includes the margin of safety. The actual reduction required should not count the margin of safety so the overall reductions required would be 70%, 14%, and 55%, respectively.

3.3 Methodology

The load duration curve method is intended to be a simplistic method to calculate pollutant reductions. This method was chosen for the White Oak River because of the availability of long-term data and is an efficient method to calculate a percent load reduction from non-point

sources. The required load reduction was determined based on water quality monitoring and stream flow data from January 2000 through April 2009.

3.3.1 Flow Duration Curve

Development of a flow duration curve is the first step of the load duration approach. A flow duration curve employs a cumulative frequency distribution of measured daily stream flow over the period of record. The curve relates flow values measured at the monitoring station for the percent of time the flow values were equaled or exceeded. Flows are ranked from lowest, which are exceeded nearly 100 percent of the time, to highest, which are exceeded less than 1 percent of the time. Reliability of the flow duration curve depends on the period of record available at monitoring stations. Accuracy of the curve increases when longer periods of record are used. The flow duration curve, shown in Figure 3.1, was used to determine the seasonality and flow regimes during which the exceedances of the pollutants occurred.

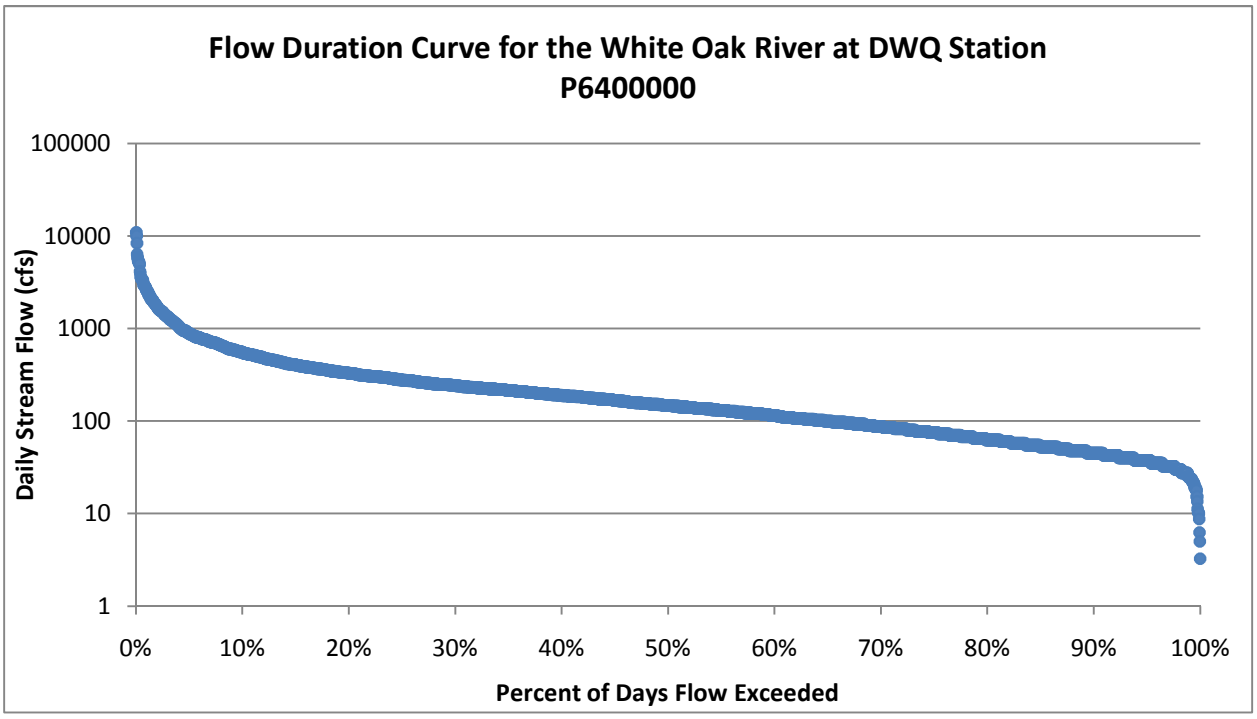

Figure 3.1 – Flow Duration Curve for the White Oak River at DWQ Station P6400000

Daily flow data was used from USGS New River gauging station 2093000, located adjacent to the west of the White Oak River. The drainage area ratio of 2.5 was applied to the daily flows to compensate the larger drainage area of the White Oak River at the ambient monitoring station.

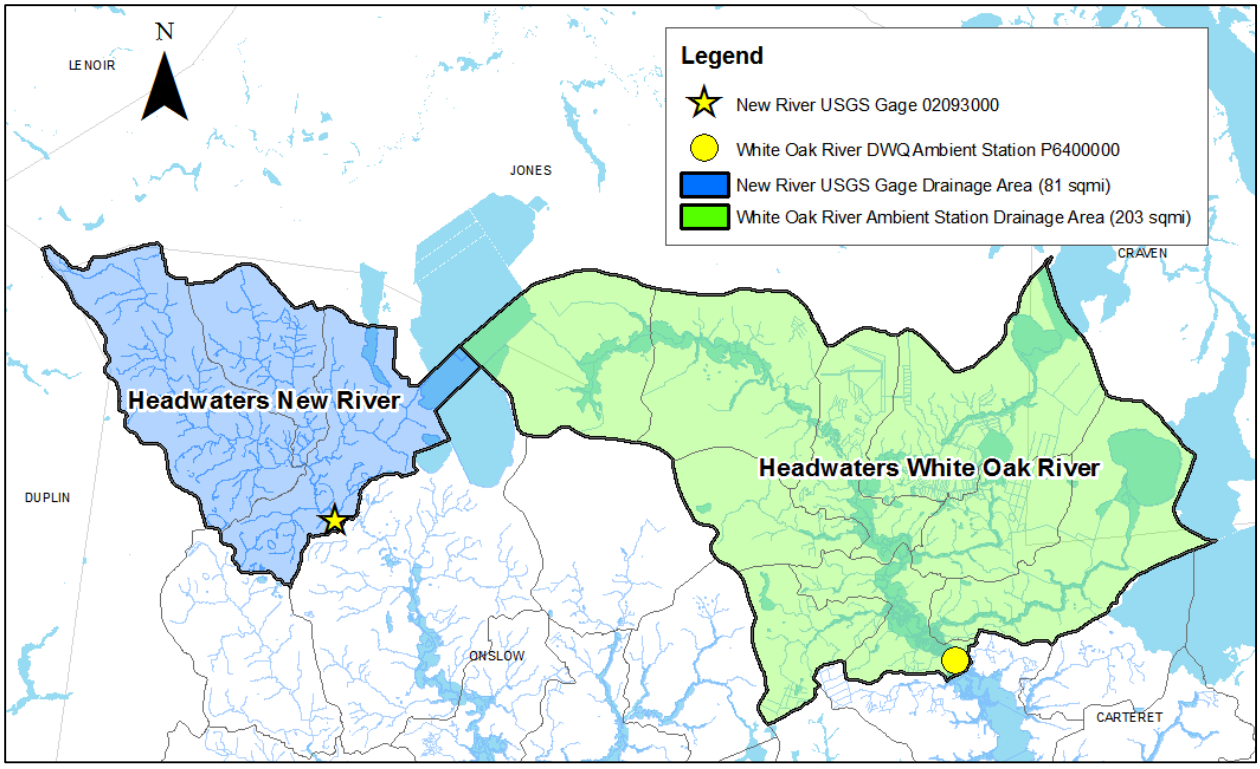

Figure 3.2 – Comparison of Drainage Areas on the New and White Oak Rivers

3.3.2 Load Duration Curve

A load duration curve is developed by multiplying the flow values along the flow duration curve by the pollutant concentration and the appropriate conversion factors. The allowable load assumes a fecal coliform concentration based on water quality numeric criteria and margin of safety. The target, or allowable load line, resembles the flow duration curve; hence it determines the assimilative capacity of a stream or river under different flow conditions. Values above the line are exceeded loads and values below the line are acceptable loads. Therefore, a load duration curve can help define the flow regime during which exceedances occur. Four variations of the load duration curve were developed for this TMDL to account for different numeric targets and averaging periods (Table 3.3).

Table 3.3 – Variations of the Load Duration Curve based on different targets within the standards.

Pollutant	Target with MOS	Statistical Parameter	Data Averaging Period	Number of Observations	Data Points used in LDC
Fecal Coliform (cfu/day)	12cfu/100ml	Median	All data	101	101
	38cfu/100ml	90th %ile	All data	101	101
	12cfu/100ml	Median	30 samples	101	72
	38cfu/100ml	90th %ile	30 samples	101	72

Figure 3.3 shows existing loads plotted against the allowable load. Figure 3.4 shows a second flow duration curve using 30-sample 90th percentiles. For the White Oak River, the criteria violations occurred at all ranges of flows, suggesting that contamination due to fecal coliform occurred during both wet and dry conditions.

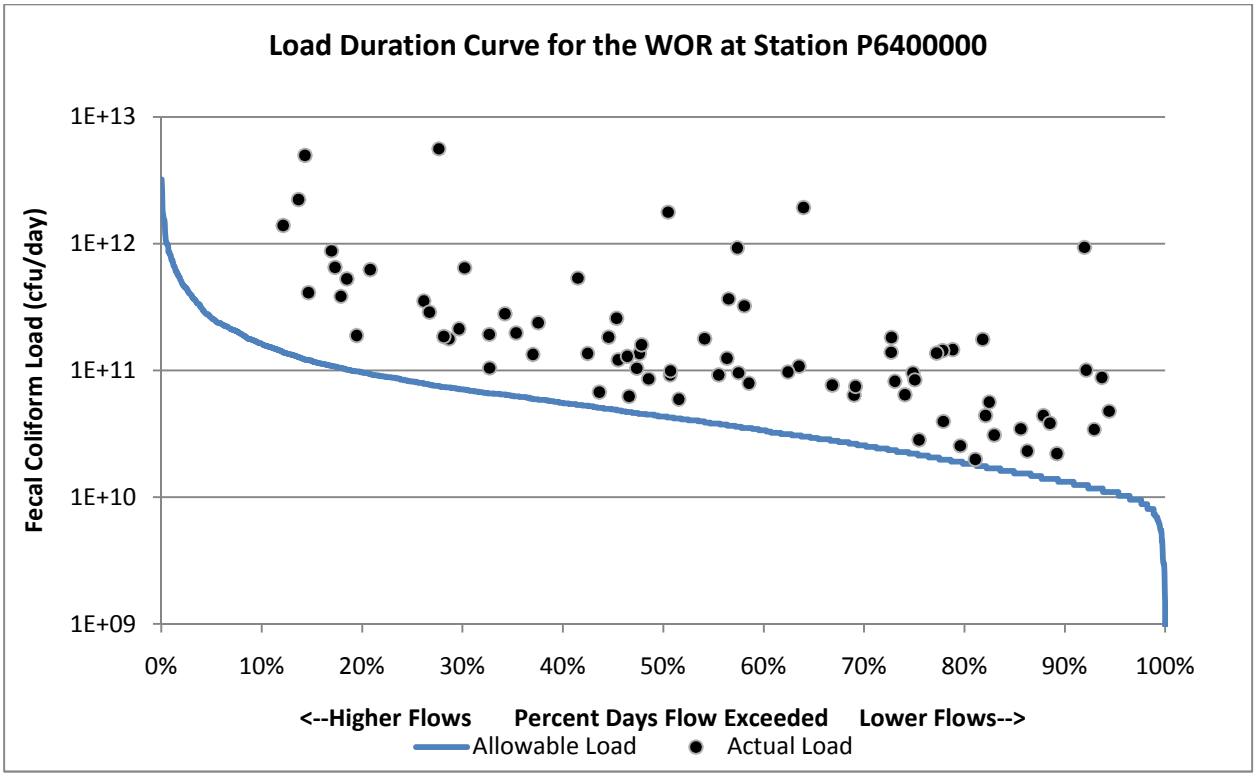

Figure 3.3 – Load Duration Curve for the WOR at DWQ Station P6400000

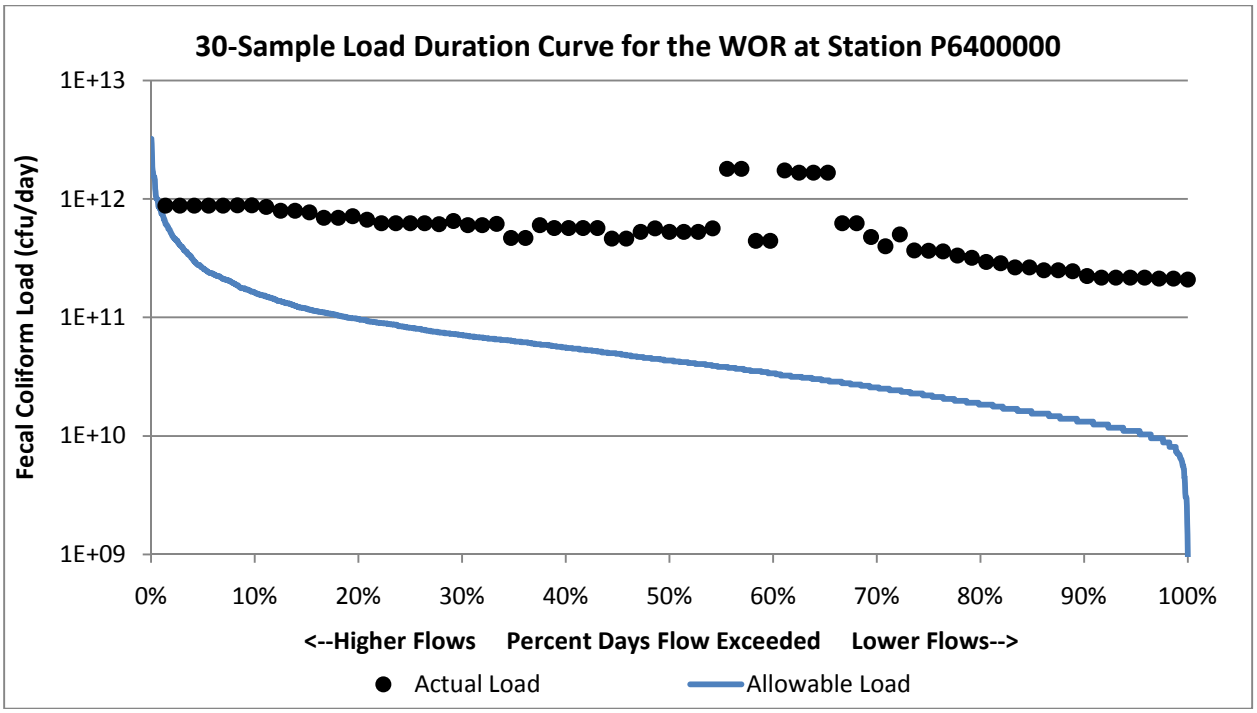

Figure 3.4 – 30-Sample Averaging Period Load Duration Curve for the WOR at Ambient Station P6400000. The Actual Load is based on 30-sample 90th percentiles and the median flow and the Allowable Load is based on daily flow and calculated at the standard of 38 cfu/100ml.

3.4 Total Maximum Daily Load

Total Maximum Daily Load (TMDL) can be defined as the total amount of pollutant that can be assimilated by the receiving water body while achieving water quality standards. A TMDL can be expressed as the sum of all point source allocations (WLAs), nonpoint source allocations (LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality. This definition can be expressed by equation 3.1.

$$TMDL = \sum WLAs + \sum LAs + MOS \qquad (3.1)$$

The objective of the TMDL is to estimate allowable pollutant loads and to allocate those loads in order to implement control measures and to achieve water quality standards. The Code of Federal Regulations (40 CFR § 130.2 (1)) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures. For fecal coliform contamination, TMDLs are expressed as counts, or colony forming units (cfu), per 100 milliliters. TMDLs represent the maximum one-day load the river can assimilate and maintain the water quality criterion. A load duration curve approach was utilized to estimate the TMDL for fecal coliform. The systematic procedures adopted to estimate TMDLs are described below.

3.4.1 Margin of Safety (MOS)

The MOS is included in the TMDL estimation to account for the uncertainty in the simulated relationship between the pollutants and the water quality standard. In this study, the MOS was explicitly included in the following TMDL analysis by setting the TMDL target at 10 percent lower than the water quality target for fecal coliform. The water quality standard and the target can be seen in Table 3.4.

Table 3.4 - Water Quality Standards and Margin of Safety

Pollutant	Standard	Standard w/ MOS
Fecal Coliform (cfu/day)	<14cfu/100ml	<12cfu/100ml
	<43cfu/100ml	<38cfu/100ml

3.4.2 Target Reduction

The load reduction needed to meet the fecal coliform standards was estimated with the observed data that exceeded the applicable water quality standard within the 10^{th} to 95^{th} percentile flow recurrence range. Typically the remaining flow recurrence range is not included in the TMDL calculation to allow cases of extreme drought or flood to be excluded. The reductions required are shown in table 3.5

Table 3.5 – Load Reduction Requirements under variations of standard criteria

Pollutant	Target with MOS	Statistical Parameter	Data Averaging Period	Estimated Exceeding Load	Allowable Load (TMDL-MOS)	Average Reduction Required
Fecal Coliform (cfu/day)	12cfu/100ml	Median	None	1.33E+11	4.08E+10	**69.5%**
	38cfu/100ml	90^{th} %ile	None	5.53E+11	3.29E+11	**40.6%**
	12cfu/100ml	Median	30 samples	1.34E+11	4.24E+10	**68.3%**
	38cfu/100ml	90^{th} %ile	30 samples	5.4E+11	1.34E+11	**75.2%**

The greatest reduction required was calculated under the NSSP standard of using the 90^{th} percentile of 38 cfu/100 ml (including explicit MOS). This standard was used to calculate the TMDL. Figure 3.5 shows the actual load calculated from the thirty sample 90^{th} percentile and the median flow and the allowable load calculated from the standard and the 30 sample median flow.

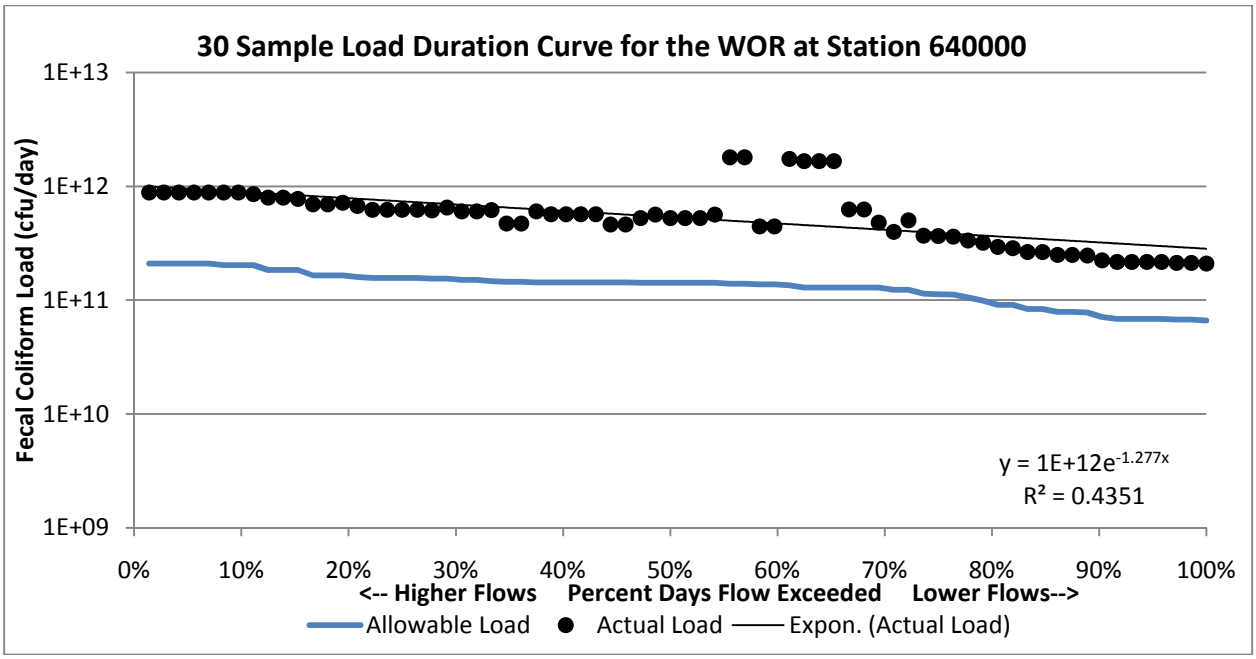

Figure 3.5 – Load Duration Curve with Allowable and Estimated Exceeding Loads of Fecal Coliform in the WOR at Station P6400000

The exponential curve equation for these data points violating the water quality criterion is shown in Equation 3.2.

$$y = 1E+12E^{-1.277x} \; R^2 = 0.4351 \qquad (3.2)$$

Where, y = fecal coliform (cfu/100ml) and x = Percent Flow Exceeded.

To present the TMDL as a single value, the existing load was calculated from the exponential curve equation as the average of the load violations occurring when the flow exceeded at a frequency greater than 10 percent and less than 95 percent. Additionally, the average load was calculated by using percent flow exceedances in multiples of 5 percent. The allowable loads for each exceedance were calculated from the TMDL target value, which includes the 10 percent MOS.

The required reduction of 75.2 percent was calculated by taking the difference between the average of the exponential curve load estimates and the average of the allowable load estimates. For example, at each recurrence interval between 10 and 95 (again using recurrence intervals in multiple of 5), the equation of the exponential curve was used to estimate the existing load. The allowable load was then calculated in a similar fashion by substituting the allowable load curve. The estimated values are given in Appendix Table B.2.

The reduction established based on the 90th percentile criterion indicates that the water body will meet the water quality standard requiring not more than 10% of the samples to exceed an MF count of 43/100 ml. Using the 90^{th} percentile in this manner is consistent with the procedure used by DEHSS on their sample data for determining whether shellfish areas should be open, conditionally prohibited, or closed.

3.5 TMDL Allocation

3.5.1 Waste Load Allocation (WLA)

Three waste water treatment facilities (WWTF) plus the NC Department of Transportation hold NPDES permits in the White Oak River watershed. The three WWTF load contributions are shown in Table 3.6

Table 3.6 – Existing NPDES Load Contributions

Facility Name	Permit Number	Flow (mgd)	Flow (cfs)	Permit Limit	Load (cfu/day)	% of Median Ambient Station Load	Stream Miles to DWQ station
Maysville WWTF	NC0021482	180000	0.2785	400#/100ml	2.73E+09	2.0%	16
Silverdale Elementary School WWTF	NC0050849	3000	0.0046	400#/100ml	4.54E+07	0.03%	8
Webb Creek WWTF*	NC0062642	300000	0.4642	400#/100ml	4.54E+09	3.33%	3 to White Oak *

* This facility discharges 1.5 miles below the DWQ station but was assumed to discharge at the DWQ station for this calculation.

In order to estimate contributions from the WWTFs, it was assumed that all discharges were located at the ambient station, and that all fecal coliform discharged reaches the ambient station with no attenuation. Based on facility limits of flow and the more stringent daily or weekly fecal coliform concentrations, the combined WWTF load could contribute 5.36% of the median load at DWQ station 6400000 based on data from years 2000 through 2009. However, this load percentage assumes all facilities discharge at the Ambient Station. Factoring actual distances from the Ambient Station, bacteria die-off, and the relatively small loading percentage calculated above, it appears that these WWTFs do not present a significant load to the White Oak River. Therefore it was assumed that the WWTFs are adequately regulated under existing permits and the waste load allocations in this TMDL were calculated at the existing permit limits. The waste load allocation for NPDES permittes in the White Oak River watershed are shown in Table 3.7.

Table 3.7 – NPDES Waste Load Allocations and Required Reductions

NPDES Permittee	Existing Load (cfu/day)	WLA (cfu/day)	Percent Reduction Required
Maysville WWTP	2.73E+09	2.73E+09	0%
Silverdale Elementary School WWTP	4.5E+07	4.5E+07	0%
Webb Creek WWTP	4.54E+09	4.54E+09	0%
NC DOT	N/A	N/A	75.2%

Because of the non-point source nature of drainage from roads and highways, data is not available to calculate a WLA load reduction for the NCDOT as a load or concentration. Therefore, the percent reduction for the NCDOT was assumed to be the same as the non-point source load reduction.

3.5.2 Load Allocation (LA)

All fecal coliform loadings from nonpoint sources such as non-MS4 urban land, agriculture land, and forestlands are reported as LAs. The estimated contributions of fecal coliform from the nonpoint sources are presented in Table 3.8. The estimated percent reduction from nonpoint sources is 75.2%, as shown in Table 3.9.

Table 3.8 – Estimated TMDL and Load Allocation for Fecal Coliform for the White Oak River

Waterbody	Pollutant	Existing Load	WLA	LA	Explicit MOS_1	TMDL
White Oak River 20-(18)a1, 20-(18)a2, 20-(18)b, 20-(18)c1, 20-(18)c3, 20-(18)c5, 20-(18)c6, 20-(18)c7, 20-(18)c8, 20-(18)d, 20-(18)e2, 20-(18)e3	Fecal Coliform (cfu/day)	5.40E+11	7.32E+9	1.09E+11	1.77E+10	1.34E+11

Note: The Margin of safety is included in the TMDL by lowering the Fecal Coliform standard from 43 to 38 cfu/100 ml. The MOS shown here is the difference between the TMDL calculated at both standards.

Table 3.9 – Estimated Load Reduction by Source for Fecal Coliform (shown in cfu/day) for the White Oak River

	WLA	LA
Existing Load (cfu/day)	7.32E+9	5.40E+11
Load Allocation (cfu/day)	7.32E+9	1.09E+11
Percent Reduction	0%	75.2%

3.6 Critical Condition and Seasonal Variation

Critical conditions are considered in the load duration curve analysis by using an extended period of stream flow and water quality data, and by examining the flows (percent flow exceeded) where the existing loads exceed the target line.

Seasonal variation is considered in the development of the TMDLs, because allocation applies to all seasons. According to the load duration curve (Figure 3.4), the existing load violation for fecal coliform occurred at all flow conditions throughout the year. Therefore, both dry and wet weather is critical for fecal coliform.

3.7 Margin of Safety

A Margin of Safety (MOS) is required as part of a TMDL in recognition of many uncertainties in the understanding and simulation of water quality in natural systems. For example, knowledge is incomplete regarding the exact nature and magnitude of pollutant loads from various sources and the specific impacts of those pollutants on the chemical and biological quality of complex, natural water bodies. The MOS is intended to account for such uncertainties in a manner that is conservative from the standpoint of environmental protection.

As a conservative estimate in the TMDL calculation, an explicit MOS was included. The explicit MOS was achieved by lowering the targeted 90th percentiles to 38 MPN/100 ml. This is an 11.6% reduction from the standard 90th percentile of 43 MPN/100 ml. The MOS, in terms of load, was calculated by subtracting the TMDL loading needed to meet a 90th percentile target of 38 from the model loading needed to meet a target of 43. These loads are shown in the Table 3.8.

3.8 Monitoring

Monitoring should continue on a monthly interval at the existing ambient monitoring station, as well as DEH stations. The continued monitoring of fecal coliform will allow for the evaluation of progress towards the goal of reaching water quality standards by comparing the instream data to the TMDL target.

4 TMDL IMPLEMENTATION PLAN

An implementation plan is not included in this TMDL. Local stakeholder groups, governments, and agencies are encouraged to develop an implementation plan and utilize funding sources for water quality improvement projects targeted at BMP construction and public outreach. Some potential funding sources include the North Carolina Clean Water Management Trust Fund, and

Section 319 and 205j funds. Individual land owners may apply for the Community Conservation Assistance Program and Agriculture Cost Share Program to improve the condition of their property. The upcoming DEH Sanitary Survey for the D-3 shellfish growing area will help further identify current sources of bacteria and drainage pathways that allow bacteria to enter the White Oak River.

5 PUBLIC PARTICIPATION

A draft of the TMDL was publicly noticed through various means. The TMDL was public noticed on the NC Modeling and TMDL website on July 12, 2010. The TMDL was also public noticed on July 14, 2010 through the North Carolina Water Resources Research Institute email list-serve. In Addition, the TMDL was public noticed in the relevant counties through a local newspaper (Carteret County News-Times) on July 16, 2010. Copies of the public notices are included in Appendix C.

Finally, the TMDL was available on DWQ's website (http://portal.ncdenr.org/web/wq/ps/mtu) during the comment period. The public comment period lasted until August 16, 2010.

DWQ received one public comment on the White Oak River TMDL. Summaries of the comments and DWQ responses are included in Appendix D.

6 FURTHER INFORMATION

Further information concerning North Carolina's TMDL program can be found on the Internet at the Division of Water Quality website:
http://portal.ncdenr.org/web/wq/ps/mtu

Technical questions regarding this TMDL should be directed to the following members of the DWQ Modeling/TMDL Unit:

Andy Painter
e-mail: andy.painter@ncdenr.gov

Kathy Stecker
e-mail: kathy.stecker@ncdenr.gov

7 REFERENCES

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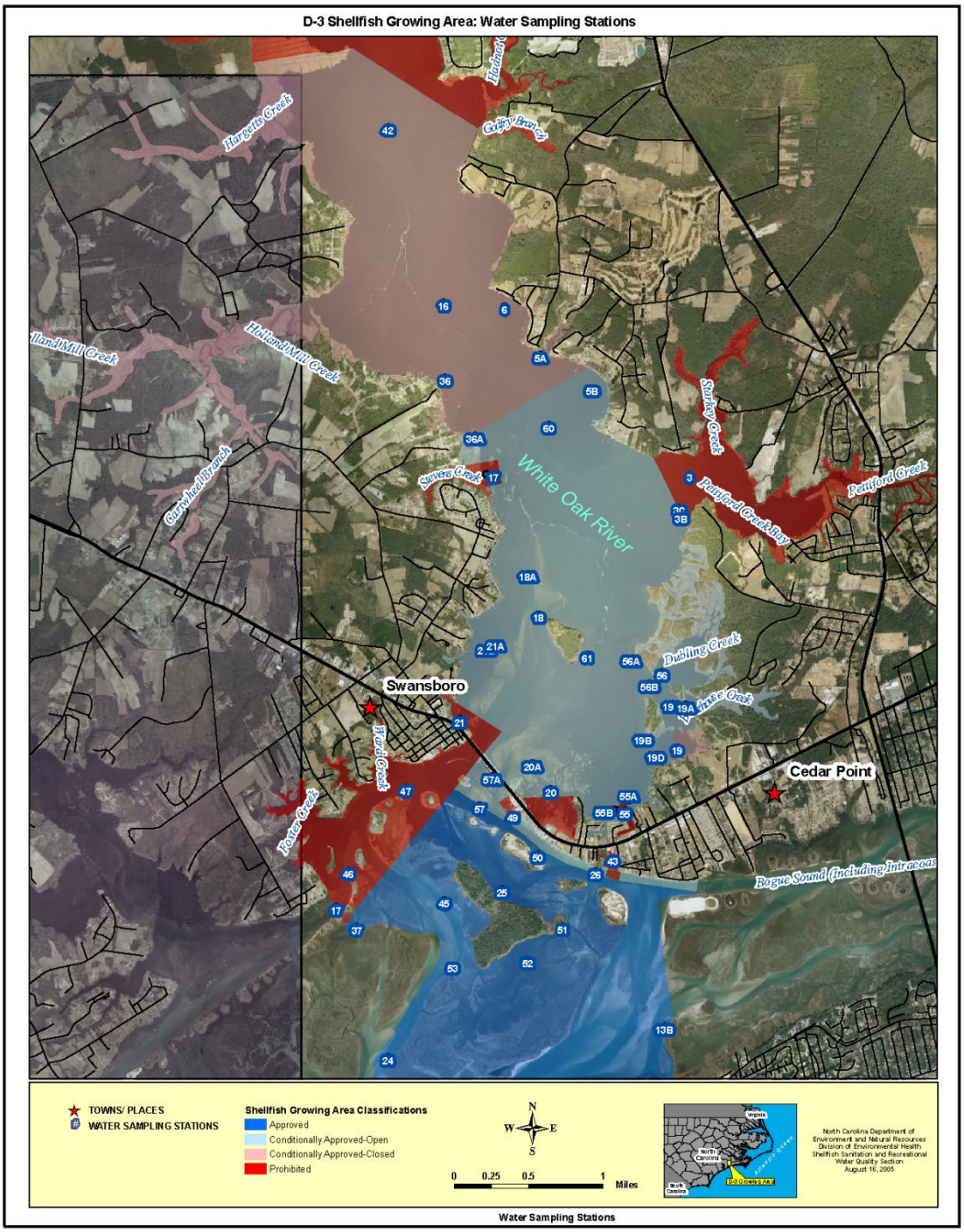
Appendix A: 2005-2009 Division of Environmental Health Fecal Coliform Data

Station	# Samples	Median	Geometric Mean	90th Percentile
17	32	13.0	15.5	70.0
18	125	7.8	10.1	70.0
19	30	11.0	9.1	33.0
20	30	4.5	5.2	17.6
21	30	5.7	6.8	27.6
24	54	4.5	5.4	30.0
25	30	4.3	3.7	11.1
26	30	4.5	4.6	13.4
36	31	9.3	8.3	33.0
45	30	4.3	4.0	13.0
46	30	4.5	4.2	13.1
47	30	4.3	4.1	13.0
49	30	4.3	4.1	8.3
50	30	3.3	3.7	11.0
51	52	4.5	7.5	47.4
52	30	4.0	3.5	7.9
53	30	2.0	3.1	8.3
56	30	3.3	4.3	11.6
57	30	4.0	3.7	9.6
60	130	12.0	13.2	79.0

A station location map is located on the following page.


D-3 Shellfish Growing Area: Water Sampling Stations
Hargetts Creek
Gaggy Branch
Holland Mill Creek
Garthwheel Branch
Stevens Creek
White Oak River
Stucky Creek
Pettiford Creek Bay
Pettiford Creek
Swansboro
Hurst Creek
Dublin Creek
Intuse Creek
Foster Creek
Cedar Point
Bogue Sound (including Intracoastal
TOWNS/ PLACES
WATER SAMPLING STATIONS
Shellfish Growing Area Classifications
Approved
Conditionally Approved-Open
Conditionally Approved-Closed
Prohibited
N
W
E
S
0 0.25 0.5 1
Miles
North Carolina Department of Environment and Natural Resources
Division of Environmental Health
Shellfish Sanitation and Recreational Water Quality Section
August 16, 2005
Water Sampling Stations

Appendix B: TMDL Data

Table B.1. Water Quality and Flow Data for the White Oak River at DWQ Ambient Station P6400000

Date	Result (cfu/100 mL)	Flow (cfs)	Remark[1]
1/13/2000	36	242.5	
2/22/2000	10	252.5	K
3/14/2000	36	155	
4/13/2000	64	165	
5/24/2000	73	365	
6/20/2000	500	145	
7/27/2000	110	872.5	
8/31/2000	490	415	
9/14/2000	120	125	
10/4/2000	27	202.5	
11/28/2000	900	255	
12/12/2000	54	267.5	
2/26/2001	45	262.5	
5/17/2001	55	132.5	Q
6/19/2001	41	410	Q
7/16/2001	16	72.5	Q
8/29/2001	33	95	Q
9/25/2001	92	65	B4,Q
10/31/2001	10	35	Q
11/29/2001	38	47.5	Q
1/8/2002	30	165	Q
2/14/2002	33	160	Q1
4/1/2002	150	717.5	Q1,B1
4/29/2002	110	120	Q1
5/21/2002	40	57.5	Q1
6/20/2002	27	52.5	Q1
7/9/2002	35	40	Q1
8/8/2002	52	37.5	Q1
9/26/2002	87	67.5	Q1
10/30/2002	770	102.5	Q1
11/21/2002	16	172.5	Q1
12/17/2002	26	145	Q1
1/30/2003	5	125	Q1
2/18/2003	46	702.5	Q1
3/20/2003	140	1127.5	Q1
4/23/2003	35	225	Q1
5/29/2003	140	1550	Q1
6/25/2003	23	335	Q1
8/4/2003	19	225	Q1
8/18/2003	160	1362.5	Q1
9/22/2003	120	182.5	Q1
10/27/2003	110	240	Q1
11/17/2003	38	212.5	Q1
12/17/2003	160	1055	Q1
1/22/2004	28	145	Q1
2/24/2004	44	357.5	Q1
3/17/2004	80	320	Q1
4/21/2004	16	160	Q1
5/24/2004	24	67.5	Q1
6/15/2004	42	155	Q1
7/22/2004	33	47.5	Q1
9/20/2004	210	435	B4,Q1
10/21/2004	23	152.5	Q1
11/16/2004	29	250	Q1
12/15/2004	310	122.5	B4,Q1
1/31/2005	97	370	Q1
2/23/2005	9	120	Q1
3/29/2005	150	775	Q1
4/25/2005	52	75	Q1
5/17/2005	30	252.5	Q1
6/28/2005	42	105	Q1
7/25/2005	71	80	B4,Q1
8/30/2005	93	80	Q1
10/25/2005	110	757.5	Q1
11/17/2005	37	107.5	Q1
3/23/2006	17	142.5	Q1

Date	Result (cfu/100 mL)	Flow (cfs)	Remark[1]
4/19/2006	29	90	Q1
5/31/2006	22	57.5	Q1
7/19/2006	32	122.5	Q1
8/29/2006	27	157.5	Q1
9/20/2006	67	1165	Q1
10/18/2006	44	170	Q1
12/5/2006	62	347.5	B4,Q1
1/3/2007	120	475	Q1
1/23/2007	110	952.5	Q1
3/1/2007	52	220	Q1
4/3/2007	27	120	Q1
4/30/2007	34	77.5	Q1
5/31/2007	120	60	Q1
6/28/2007	23	32.5	Q1
7/24/2007	200	25	Q1
8/22/2007	80	70	Q1
9/19/2007	18	52.5	Q1
10/31/2007	46	75	Q1
12/5/2007	10	32.5	Q1
12/18/2007	900	42.5	Q1
1/31/2008	16	65	Q1
3/25/2008	34	90	Q1
5/1/2008	31	180	B1,Q1
5/28/2008	13	62.5	Q1
6/19/2008	97	42.5	Q1
7/31/2008	90	40	B4,Q1
8/26/2008	35	35	Q1
9/24/2008	30	60	Q1
10/23/2008	19	47.5	Q1
11/18/2008	42	80	Q1
12/10/2008	5	72.5	Q1
2/3/2009	29	130	Q1
2/23/2009	40	127.5	Q1
3/18/2009	48	202.5	Q1
4/15/2009	120	1395	Q1

[1]**Fecal Coliform Remark Codes:**

B1 Countable membranes with less than 20 colonies. Reported value is estimated or is a total of the counts on all filters reported per 100 ml.

B4 Filters have counts of both >60 or 80 and <20. Reported value is a total of the counts from all countable filters reported per 100 ml.

K Actual value is known to be less than value given

L Actual value is known to be greater than value given

Q Holding time exceeded.

Q1 Holding time exceeded. Holding time exceeded prior to receipt by lab.

(The TMDL margin of safety should account for any uncertainty caused by the holding time exceedance.)

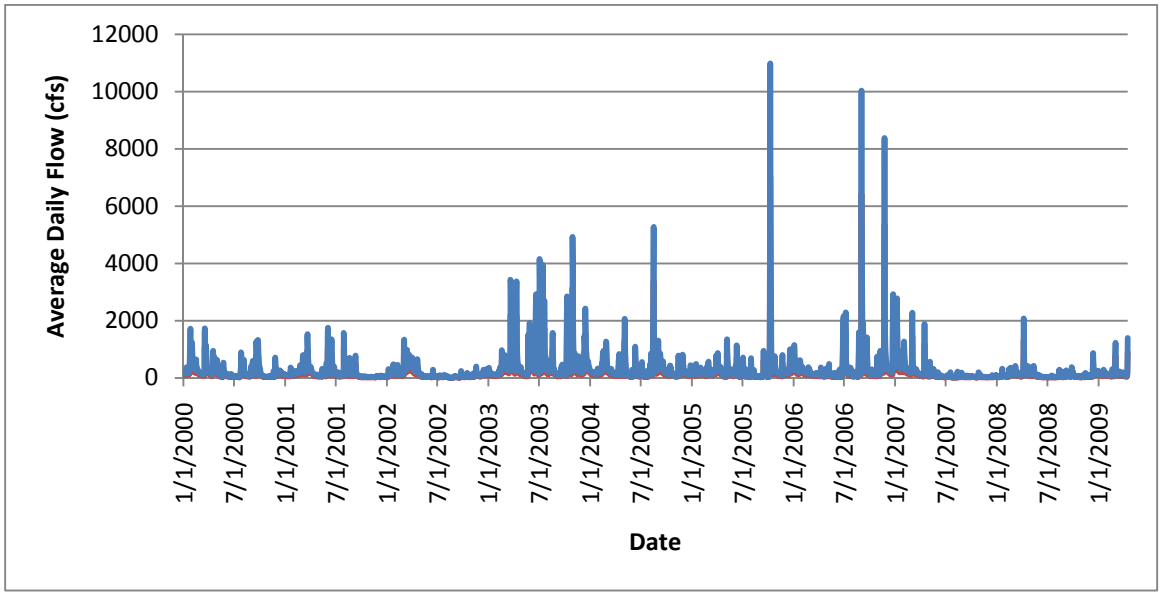


Figure B.1 - Daily average flow (cfs) measured at New River USGS Gage 2093000 with 2.5 drainage area ratio applied.

Table B.2. Estimation of Load Reduction Required for Fecal Coliform in the White Oak River at DWQ Ambient Station P6400000.

% Flow Exceeded	Flow (cfs)	Actual Load	Allowable Load (cfu/day)	Reduction Needed
0.1	218.75	8.80117E+11	2.0346E+11	
0.15	197.5	8.25678E+11	1.8369E+11	
0.2	177.5	7.74607E+11	1.6509E+11	
0.25	168.75	7.26694E+11	1.5695E+11	
0.3	166.25	6.81745E+11	1.5463E+11	
0.35	156.25	6.39576E+11	1.4533E+11	
0.4	153.75	6.00015E+11	1.43E+11	
0.45	153.75	5.62902E+11	1.43E+11	
0.5	152.5	5.28084E+11	1.4184E+11	
0.55	152.5	4.9542E+11	1.4184E+11	
0.6	147.5	4.64776E+11	1.3719E+11	
0.65	138.75	4.36027E+11	1.2905E+11	
0.7	138.75	4.09057E+11	1.2905E+11	
0.75	121.25	3.83755E+11	1.1277E+11	
0.8	106.25	3.60018E+11	9.8822E+10	
0.85	90	3.3775E+11	8.3708E+10	
0.9	83.75	3.16858E+11	7.7895E+10	

0.95	73.75	2.97259E+11	6.8594E+10	
Numeric Standard	Statistical Measure			
38	Average	5.40019E+11	1.3422E+11	**75.15%**

Appendix C: Public Notification of TMDL for Fecal Coliform for the White Oak River

The TMDL public comment period was announced on the NC Modeling and TMDL website on 7/12/10, on the WRRI listserv on 7/14/10, and the Carteret County News-Times on 7/16/10.

- Notice on the Modeling and TMDL Website: http://portal.ncdenr.org/web/wq/ps/mtu

> **7/12/10** The **Lockwood Folly** and **White Oak River** Public Review Draft TMDLs are available for review. The comment period extends through August 13, and August 16 for each TMDL respectively. Comment submittal instructions are available with the above links

- WRRI listserv email received regarding public comment period:

From: Kelly_Porter@ncsu.edu
To: <wrri-news@lists.ncsu.edu>
Subject: Now available for public review - DRAFT Total Maximum Daily
Loadfor the Shellfish Harvesting Areas in the White Oak River
Message-ID: <4C3DB443.423B.0001.0@gw.ncsu.edu>

Now Available for Public Comment

This draft TMDL report was prepared as a requirement of the Federal Water Pollution Control Act, Section 303(d). Interested parties are invited to comment on the draft TMDL report by August 16, 2010. Comments concerning the report should be directed to Andy Painter at andy.painter@ncdenr.gov or write to:

Andy Painter
NC Division of Water Quality
Planning Section
1617 Mail Service Center
Raleigh, NC 27699

If you wish to obtain a hard copy of the TMDL, please contact Linda Chavis at (919) 807-6305 or email at linda.chavis@ncdenr.gov

The draft TMDL can also be downloaded from the following website:
http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls

Date: Wed, 14 Jul 2010 13:54:05 -0400

CARTERET COUNTY,
NORTH CAROLINA

AFFIDAVIT OF PUBLICATION

Before the undersigned, a notary public of said County and State, duly commissioned, qualified, and authorized by law to administer oaths, personally appeared

Patti J. Lyerly who being

first duly sworn, deposes and says that he (she) is Clerk

(Owner, partner, publisher or other officer or employee authorized to make this affidavit)

of THE CARTERET PUBLISHING CO., INC., engaged in the publication of a newspaper known as CARTERET COUNTY NEWS-TIMES, published, issued, and entered as second class mail in the Town of Morehead City, in said County and State; that he (she) is authorized to make this affidavit and sworn statement; that the notice or other legal advertisement, a true copy of which is attached hereto, was published in CARTERET COUNTY NEWS-TIMES on the following

dates: 07/16/2010

and that the said newspaper in which such notice, paper, document, or legal advertisement was published was, at the time of each and every such publication, a newspaper meeting all of the requirements and qualifications of Section 1-597 of the General Statutes of North Carolina and was a qualified newspaper within the meaning of Section 1-597 of the General Statutes of North Carolina.

This 16th day of July, 2010

Patti J. Lyerly
(Signature of person making affidavit)

Sworn and subscribed to before me, this:

16th day of July, 2010

Melodie B Hall
Notary Public

My commission expires November 11, 2012

Public Notice
State of North Carolina
Division of Water Quality

Draft Total Maximum Daily Load for Fecal Coliform for White Oak River in White Oak River Basin, North Carolina.

To review, visit http://portal.ncdenr.org/web/wq/ps/mtu/tmdl/tmdls or call 919-807-6409. Written comments will be accepted until August 16, 2010.

Send comments to andy.painter@ncdenr.gov or NCDWQ Planning Section, Attn: Andy Painter, 1617 Mail Service Center, Raleigh NC 27699. Jy16

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Appendix D: Public Comments

Public Comment White Oak River Fecal Coliform Bacteria TMDL Responsiveness Summary

August 2010

The public comment period extended from July 12, 2010 through August 16, 2010. Comments were received from the North Carolina Department of Transportation. These comments with the NC Division of Water Quality responses are provided in the Responsiveness Summary presented below.

1) One comment stated that waterbody ID 20-(18)c4 was already addressed in the Southeast White Oak River Fecal Coliform TMDL approved by EPA on April 10, 2009, and suggested that this waterbody ID should be removed from this TMDL to avoid confusion and conflicting load reduction calculations.

Response: DWQ will remove waterbody ID 20-(18)c4 from this TMDL document.

2) One comment stated that the drainage area for station P6400000 is 203 mi2 and that for the New River USGS gauging station 2093000 is 81 mi2 and the ratio for these two drainage areas should be 2.5.

Response: DWQ has revised the drainage area ratio in the text and TMDL calculations to 2.5. This change resulted in altering the flows at the percent flow exceedance intervals in the TMDL calculation and caused an increase in the percent reduction needed from 73.5 to 75.2 percent.

3) One comment stated that the report appeared to assign NCDOT a load allocation as opposed to a wasteload allocation (WLA) which is contrary to EPA guidance regarding allocations to NPDES permittees.

Response: Because of the nature of drainage from roads and highways, the percent reduction for the NCDOT was assumed to be the same as the nonpoint source load allocation. The NCDOT is included in each NPDES table and WLA section in the TMDL, with the exception of table 3.6 which has been renamed "Existing WWTF Load Contributions" from "Existing NPDES Load Contributions."

4)

A) One comment stated that it is unclear which sources DWQ considers as contributing to the water quality impairment. It does not appear that many of the potential sources identified by Shellfish Sanitation were analyzed in the report and the commenter questions why reductions are not called for the sources identified in Figure 2.1.

Response: Reductions for the potential nonpoint sources mentioned in section 2.1 of the report need a reduction of 75.2 percent as stated in the LA percent reduction. Nonpoint sources are generally aggregated into one load allocation in TMDLs. The Shellfish Sanitation report contains information on local sources, and an excellent resource for where to implement BMPs.

B) The commenter states that grazing farm animals were the only identified potential source whose numbers were quantified, and that illicit connections, SSOs, and swine operations are not believed to be significant load contributors. The commenter questions whether a 73.5 % reduction in loads from grazing farm animals will be sufficient to restore water to standards.

Response: The required reduction applies to all nonpoint sources as defined in the first paragraph in section 2.1. Grazing animals are a potential source of bacteria, thus information on the quantity of animals is included in the nonpoint source assessment. The text states in Section 2.2 that five SSO violations were found in the watershed during the years 2000-2009. One permit violation for a swine operation was found, which did not result in a release of waste. The following information has been included in Section 2.1 of the text: Two potential septic system failures and one illicit connection were identified in the 2006 sanitary survey.

C) The commenter stated that the report calls for 73.5% reduction from nonpoint source in the upper watershed (above station P6400000) a 0% reduction from NPDES permittees and no reduction required for point or nonpoint sources in the lower watershed.

Response: The percent reduction applies to all listed waterbody IDs identified in the TMDL.

5) The commenter states that they were not able to replicate the data presented in Figure 3.4 and 3.5 because it was not clear how the 90^{th} percentile running thirty sample population were plotted against measured flow values. The commenter also stated it would be useful to see flow values presented in table A.1 as well as fecal coliform concentrations presented in table A.2.

Response: DWQ will provide the load duration curve spreadsheet calculations to interested parties upon request, and text had been added in section 3.4 to clarify the figures. Table A.1 has been revised to show flow values with each sample date.

6) The commenter requests that the data used to determine the use support rating for the impaired shellfish waters be summarized in Section 1.4.

Response: Data are not used to determine use support for shellfish waters. Any shellfish water not fully open for harvesting is considered impaired. The data collected by the NC DEH have been summarized in Appendix A of the TMDL.