

## Chapter 24

# Nutrient Sensitive Waters (NSW) Management Strategy

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### 24.1 Introduction

Eutrophication became a water quality concern in the lower Neuse River basin in the late 1970s and early 1980s. Nuisance algal blooms prevalent in the upper estuary prompted investigations by DWQ. These investigations, as well as other studies, indicated that algal growth was being stimulated by excess nutrients entering the estuarine waters of the Neuse River. In 1988 the lower Neuse River basin received the supplemental classification of nutrient sensitive waters (NSW). As part of this early nutrient strategy, new and expanding NPDES discharges, as well as existing facilities with design flows greater than 0.05 MGD, were given a quarterly average phosphorus limit of 2 mg/l. Phosphorus loading was greatly reduced and algal blooms in the river and freshwater portions of the estuary were reduced as a result of this action.

The 1993 Neuse River Basinwide Water Quality Plan recognized that eutrophication continued to be a water quality problem in the estuary below New Bern. Extensive fish kills in 1995 prompted further study of the problem. Low dissolved oxygen levels associated with algal blooms were determined to be a probable cause of many of the fish kills. Researchers also suggested that the toxic dinoflagellate, *Pfiesteria piscida*, may have been responsible for a number of the fish kills.

The severe fish kills, algal blooms, and correspondingly high levels of chlorophyll *a* prompted DWQ to place the Neuse River estuary on the 1994 303(d) list of impaired waters. In 1996, the NC Senate Select Committee on River Water Quality and Fish Kills sponsored a workshop with numerous scientists familiar with the Neuse River water quality problems. The group reached consensus that a 30 percent reduction in total nitrogen entering the estuary was a good starting goal to reduce the extent and duration of algal blooms. In 1996, the 30 percent reduction was put into law (Session Laws 1995, Section 572). The state funded the Neuse Modeling and Monitoring Project (MODMON) to quantitatively assess the interactions and pathways between nutrients, phytoplankton and dissolved oxygen in the estuary. A Total Maximum Daily Load (TMDL) was developed in two stages and approved by EPA in 2002 to address the nitrogen overloading to the estuary. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant. The TMDL developed for the Neuse estuary showed a 30% reduction in nitrogen loading is needed.

The North Carolina Environmental Management Commission (EMC) adopted a comprehensive set of permanent rules that became effective August 1, 1998 to implement the Neuse Nutrient Strategy. While individual implementation dates varied, all of the rules were fully implemented by 2003. Below is a summary of the current progress of the nutrient strategy followed by an evaluation of the strategy which identifies additional opportunities and research needs to address nutrient loading to the Neuse Estuary. For the complete NSW rules, visit [http://h2o.enr.state.nc.us/admin/rules/documents/redbook\\_1may07\\_full\\_with\\_cover.pdf](http://h2o.enr.state.nc.us/admin/rules/documents/redbook_1may07_full_with_cover.pdf). For the approved TMDL, visit [http://h2o.enr.state.nc.us/tmdl/TMDL\\_list.htm](http://h2o.enr.state.nc.us/tmdl/TMDL_list.htm)

### **24.1.1 Summary of key findings/opportunities**

The Neuse River Basin nutrient management strategy has been fully implemented since 2003. Since this time there have been a number of implementation successes as well as challenges to the nutrient reduction strategy in the basin as whole. The goal of a 30% reduction in nitrogen loading to the Neuse Estuary has not yet been achieved. However, it is important to note that the data window for this basin plan cycle ends in 2006 and the assessment of progress under the strategy is based on just four years of post implementation water quality data (2003-2006) at this time. Due to the complex dynamics of the estuarine system, the variability associated with climatic change, and the time required to discern trends, staff believes it will likely be a number of years before a definitive assessment of the effect of the reduction strategy on the estuary can be made. However, since the loading data to date do not show distinct improvement, and given the estuary's continued impairment, DWQ believes it is appropriate to continue to evaluate the limitations of the current strategy and identify additional research needs that may reveal opportunities for developing a better understanding of the nutrient dynamics of this complex system.

#### **Successes:**

- Point source dischargers as a whole met and surpassed their 30% nitrogen reduction target years in advance of the 2003 rule compliance deadline. Through 2006 they have reduced delivered N load by as much as 65% below the 1995 baseline.
- Annual reports from the Basin Oversight Committee (BOC) established under the agriculture rule estimate that agriculture has met and exceeded its goal of 30% reduction in nitrogen loss since 2003. In crop year 2006, basin agriculture collectively achieved an estimated 45% nitrogen reduction compared to the 1991-1995 baseline, and seven of the seventeen counties reported a reduction of more than 40%.
- Each of the fifteen local governments covered under the Neuse Stormwater Rule have adopted and are implementing permitting programs to require new residential and commercial development activities to control stormwater runoff and the resulting nitrogen loading. All fifteen communities' implemented ordinances and programs that in addition to requiring the nutrient export goal be met, carry out public education activities, and identify and remove illegal discharges.

#### **Challenges:**

- Two recent nutrient loading studies conducted by DWQ conclude that the goal of a 30% reduction in nutrient load to the Neuse Estuary has not yet been achieved.
- The estuary remains impaired and the total acreage of impairment has expanded.

<b>Opportunities</b>
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- Existing developed lands were not assigned a loading allocation under the strategy and are not addressed through rules. Evaluate the magnitude of nitrogen loading in runoff from existing development areas and develop recommendations on the need to address this source under the strategy.
- Only forty percent of the Neuse Basin is subject to the Neuse Stormwater Rule nutrient export goal requirements. Develop a full assessment and recommendations on stormwater programmatic coverage gaps and need to meet nutrient strategy goals on new development activities. Include recommendations on most appropriate regulatory approach.
- Research indicates that atmospheric contributions accounts for approximately 24% of the total nitrogen load to the Neuse Estuary. Atmospheric N deposition has risen over the last twenty years, largely as volatilized ammonia (NH<sub>3</sub>) from confined animal feeding operations (CAFOs) (Walker et al, 2004). These NH<sub>3</sub> emissions from CAFOs have not been directly regulated. Coordinate efforts with the Division of Air Quality to assess atmospheric nitrogen contributions to the watershed and develop recommendations on better ongoing characterization of atmospheric nitrogen deposition and emission source regulatory considerations. Specifically address better characterization of the contribution of ammonia emissions from CAFO operations.
- Groundwater may be a significant pathway of nutrient loading to the Neuse Estuary. Nutrients in groundwater can result from fertilization of vegetation as well as land application of treated wastewater and biosolids from municipal wastewater treatment plants and confined animal feeding operations (CAFOs) and may take as long as decades to appear in surface waters. This loading from groundwater sources is not being captured in the overall nutrient accounting process. Characterize the potential for groundwater contamination and transport of nutrients from biosolids and wastewater land application fields to the surface waters of the Neuse Basin.
- Develop a more detailed analysis of current and historic data in order to better quantify the status of nutrient loading to the estuary; conduct additional trend and loading analysis upstream of the Neuse estuary focusing on smaller watersheds with dominant land use types; this will allow staff to better gauge the effectiveness and progress of strategy implementation.

#### **24.1.2 Neuse River TMDL for Total Nitrogen**

A Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant. Pollutant sources are characterized as either point sources or nonpoint sources. The nutrient rules put in place in the Neuse River Basin were adopted in 1997 using a 30 percent reduction goal established through a legislative mandate (Session Laws 1995, Section 572). A TMDL was subsequently developed with the potential to

revise the goal at some point in the future. The Neuse estuary TMDL specifically addresses chlorophyll *a* as its endpoint and seeks to manage total nitrogen, which is the nutrient that has the best potential to limit excessive growth of algae, and thus, chlorophyll *a* in the estuary. Specifically, the TMDL target is to have less than 10 percent of chlorophyll *a* samples collected in the estuary over a specific time period to be over 40 µg/l. The TMDL assesses the amount of total nitrogen load reduction that is necessary to comply with this criterion. The second phase of the TMDL was completed in July 2001. The EPA approved the TMDL in March 2002. The second phase of the TMDL model results and estuary monitoring indicate that a 30 percent total nitrogen load reduction from the 1991-1995 baseline is currently sufficient. However, based on the overall range of results seen in the TMDL modeling, more than a 30 percent total nitrogen reduction may be needed in the future.

The second phase incorporated the latest tools and data from the Neuse River Modeling and Monitoring Project (MODMON). Continued monitoring will be used to evaluate the effectiveness of the TMDL and to make adjustments in the implementation strategy as needed to recover the Neuse River estuary. Specifically, the Neuse River will continue to be monitored to determine if the 30 percent total nitrogen load reduction is being achieved, and the estuary will continue to be monitored to determine if the chlorophyll *a* criterion is met. This information will inform an adaptive management approach to TMDL compliance.

With continued data collections and updating the models and analyses, DWQ and MODMON will be able to improve analysis of various input scenarios and reduce the prediction uncertainty to narrow the range of total nitrogen load reduction that may be required. It is important to note that no matter where the reduction target is set in this phase of the TMDL, the estuary will not be removed from the list of impaired waters until it meets its designated uses.

Reductions in nutrient inputs may take time to detect in measured loading, due to year-to-year variability in precipitation and flow. Based on the results of recent trend analysis (see trend analysis summary review section) in the basin, it is evident that it will take more than five years to discern a 30 percent decrease in load to the estuary.

### **24.1.3 Wastewater Discharge Rule**

#### **Rule Requirements**

The Wastewater Discharge Requirements rule (02B .0234) was adopted in 1997 and technical corrections were made in 2002. The rule applies to all wastewater treatment facilities in the basin that receive nutrient-bearing wastewaters and are governed by individual NPDES permits. The aim of the rule is to achieve the mandated 30% reduction in nitrogen load from these dischargers to the Neuse River estuary. The point source strategy:

- establishes nitrogen allocations for the affected dischargers that:
  - are calculated to achieve the necessary 30% reduction.
  - are technology-based.
  - are assigned to existing dischargers.
  - account for differences in transport losses at points of discharge across the basin.
- requires nitrogen limits for discharges  $\geq 0.5$  MGD.
- extends phosphorus limits to a greater number of dischargers.
- provides dischargers a group compliance option.

- provides for the transfer of allocation upon regionalization or consolidation of discharges.

The rule caps the total delivered loading from the affected dischargers to the estuary at 1.64 million lb/yr Total Nitrogen (TN). This is the same as the Wasteload Allocation established in the Phase I TN TMDL for the estuary and approved by the EPA in July 1999 and verified in the Phase II TMDL, approved by the EPA in March 2002.

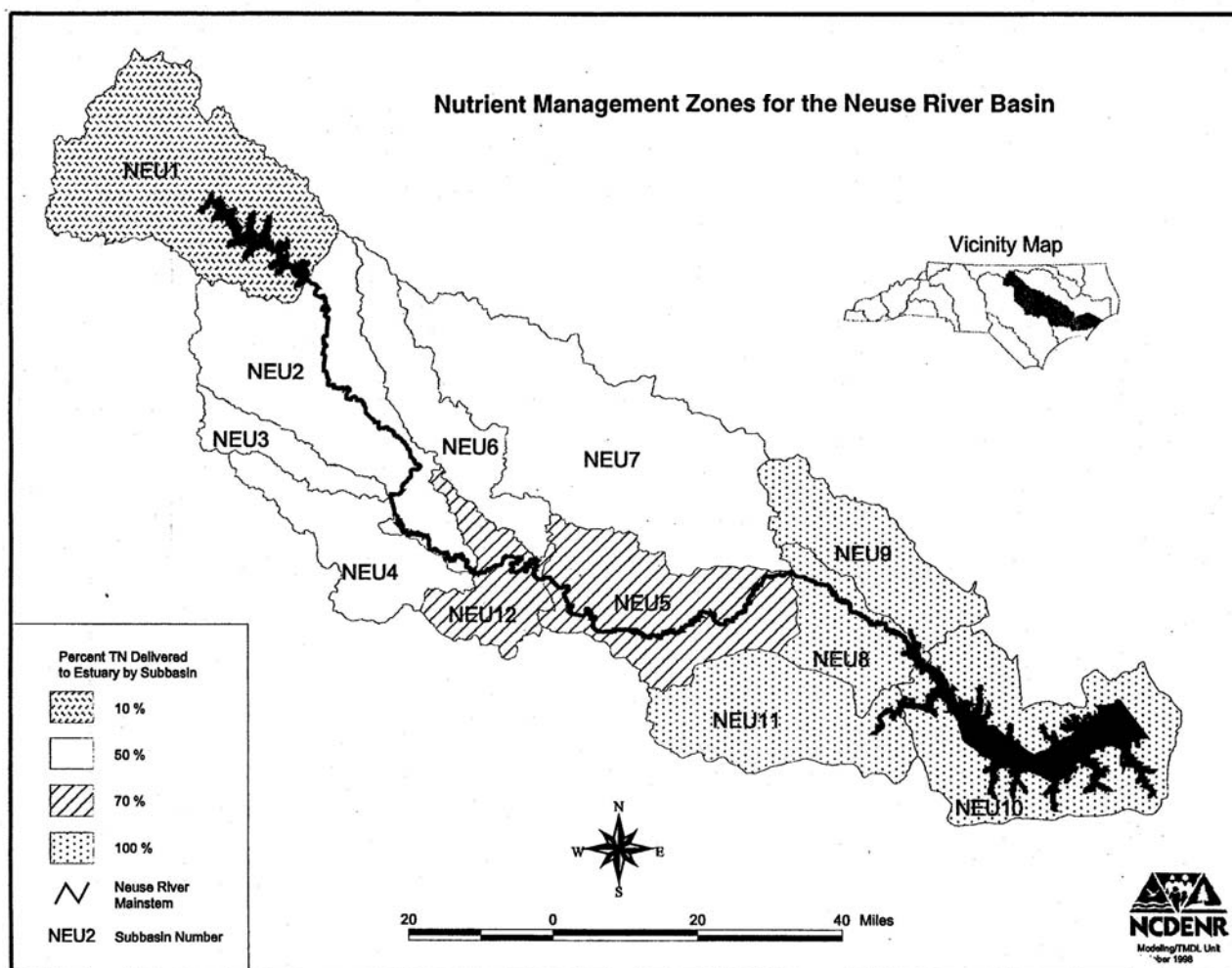
The rule divides the total allocation among groups of dischargers according to their size, type, and location. The discharger groups are large ( $\geq 0.5$  MGD) municipal WWTPs upstream of Falls Lake Dam, large municipal WWTPs downstream of the dam, large industrial WWTPs (all are downstream of the dam), and small facilities (those  $< 0.5$  MGD, regardless of location). Facilities with flows less than 0.5 MGD are not subject to nitrogen limits under the rule. They contribute relatively little of the point source load, and the estuary allocation assigned in the rule is 25% greater than their 1995 loading. Thus, they were not expected to need limits for at least one or two permit cycles. If the group does, in fact, approach its allocation, the Division would have to take additional steps - perhaps adding nitrogen limits to those permits - to ensure continued compliance with the nitrogen TMDL.

The rule requires permit limits for dischargers permitted at or above 0.5 MGD. Thus, the strategy focuses on the largest dischargers, which comprise 30% of the affected permits but accounted for over 95% of the point source nitrogen load in 1995. The rule does not list the individual dischargers' allocations but does specify that each group allocation is to be divided among the dischargers in proportion to their permitted flows. As a result, every allocation within a group is equivalent to the same TN concentration, meaning that comparable treatment facilities are ultimately expected to all provide the same degree of nitrogen treatment technology.

The rule assigned all total nitrogen allocation available to existing dischargers. It requires new and expanding discharges to acquire allocation from existing dischargers or from the Ecosystem Enhancement Program prior to applying for the necessary NPDES permit modification. It also requires that new or expanding facilities provide greater nitrogen treatment than required of existing facilities.

The allocations set in the rule take into account the fate and transport of nitrogen in the river system. A considerable portion can be "lost" as the result of nutrient uptake, denitrification, and other instream processes before it can reach the estuary. The basin is divided into four "transport zones" with average delivery rates of 10, 50, 70, and 100% (see Figure 50), and the supporting calculations behind the nitrogen allocations take into account the losses affecting the various discharge points across the basin.

Figure 50 Nutrient Management Zones



The rule provides NPDES dischargers the option of forming a compliance association in which members work collectively to reduce their nitrogen loadings to the estuary. Association members are subject to a combined nitrogen limit rather than to their individual permit limits and can decide the most practical and cost-effective means of meeting the group limit. Any such association and its members are governed under a special NPDES permit issued by the DWQ, in addition to the individual permits already issued to the members.

#### *Discharger Population*

In 1995, 168 facilities held individual NPDES permits and discharged into the Neuse River or one of its tributaries. Of these, 111 facilities treated and discharged nitrogen-bearing wastewaters, mostly domestic, and were directly affected by the nutrient rule; 34 were large enough to be subject to permit limits for nitrogen in 2003. The remaining 58 facilities included water treatment

plants (filter backwashes), groundwater remediation sites, utility discharges (boiler blowdown, cooling tower blowdown, etc.), and other less significant sources of nitrogen.<sup>2</sup>

Table 68 summarizes the make-up of the discharger groups in 1995 and the nitrogen allocations and equivalent concentrations for each group.

Table 68 Discharger Groups and Allocations, Point Source Rule – 1995.

Discharger Group	No.	Q <sub>pmt</sub>	Discharge TN Allocation (lb/yr)	Delivered TN Allocation (lb/yr)	Equivalent Discharge TN Conc. (mg/L)
Municipal $\geq$ 0.5 MGD					
- upstream of Falls Dam	3	26.5	443,678	44,368	5.5
- downstream	28	179.5	2,021,401	1,150,139	3.7
Industry $\geq$ 0.5 MGD (downstream only)	3	40.6	396,900	361,902	3.2
Small (all < 0.5 MGD)	77	6.8	137,979	83,591	6.6
<b>Total</b>	111	253.4	2,999,958	<b>1,640,000</b>	---

Notes: Q<sub>pmt</sub> = Permitted Flow

By the end of 2006, the total number of permitted facilities has decreased from 168 to 138, a net reduction of 30 facilities. Changes from 2003 to 2006 include the rescission of approximately 40 permits, mostly for facilities that ceased discharge after connecting to neighboring utilities; and approximately 10 new permits for water treatment plants or groundwater remediation systems (neither considered to be significant sources of nitrogen). By that time, 74 of the original 111 facilities with nitrogen allocations remained in operation.

Table 69 Discharger Groups and Allocations, Point Source Rule – 2006.

Discharger Group	No.	Q <sub>pmt</sub>	Delivered TN Allocation (lb/yr)
Municipal $\geq$ 0.5 MGD			
- upstream of Falls Dam	3	28.5	
- downstream	25	189.8	
Industry $\geq$ 0.5 MGD (downstream only)	2	35.6	
Small (all < 0.5 MGD)	44	5.0	
<b>Total</b>	71	258.9	<b>1,640,000</b>

### **Implementation Results**

In the 2000 renewal cycle<sup>3</sup>, the DWQ modified all Neuse wastewater permits to include nitrogen and phosphorus monitoring and reporting. Where appropriate, the permits included nutrient limits

<sup>2</sup> Facilities covered under NPDES general permits or the state's non-discharge (land application and/or reuse) permits are handled under the nonpoint provisions of the Strategy or considered *de minimus* sources.

and related conditions. The limits were written as annual mass limits equal to the assigned allocations and became effective with calendar year 2003.

### *General WWTP Improvements*

Large dischargers continued to make improvements in their treatment facilities and have invested in excess of two hundred million dollars in construction and retrofit projects to improve their nutrient reduction capabilities. New Bern completed construction of its new facility with biological nutrient removal. Goldsboro completed the planned expansion and upgrade of its facility and a constructed wetlands system. Kinston eliminated its Peachtree plant and expanded and upgraded its Northside plant to treat all of its wastewater flows. The Cherry Point MCAS made dramatic improvements in its treatment capabilities between 2003 and 2005 with the encouragement and support of the Neuse River Compliance Association.

### *Neuse River Compliance Association*

In 2002 interested permittees established the Neuse River Compliance Association (NRCA) to pursue the rule's group compliance option. DWQ issued the first group permit of its kind to the Association and its co-permittee members that same year. In 2006, the Association was comprised of 21 permittees with 24 facilities and had a combined estuary limit of 1,138,739 lb/yr TN. Most of the NRCA members are also members of the Lower Neuse Basin Association, an ambient monitoring coalition that has operated in the basin since 1994.

The Association's permit establishes the group's nitrogen limit, representing the sum of its members' individual delivered allocations. It also contains monitoring and reporting requirements and describes how compliance with the group and individual limits will be determined. If the Association meets its group limits, all members are deemed to have complied with their individual limits for the year. However, if the group exceeds its limit, both the Association and any members exceeding their limits are in violation of the permit and subject to enforcement by the DWQ. The Association has internal enforcement procedures to insure its members comply with their individual nitrogen allocations. If an individual member does exceed their allocation they are required to pay an assessment to the association which would increase each year that the member stays in noncompliance. As an additional enforcement incentive, members of the Association can be removed from membership for failure to comply.

### *Point Source Performance In Meeting The Nutrient Reduction Targets*

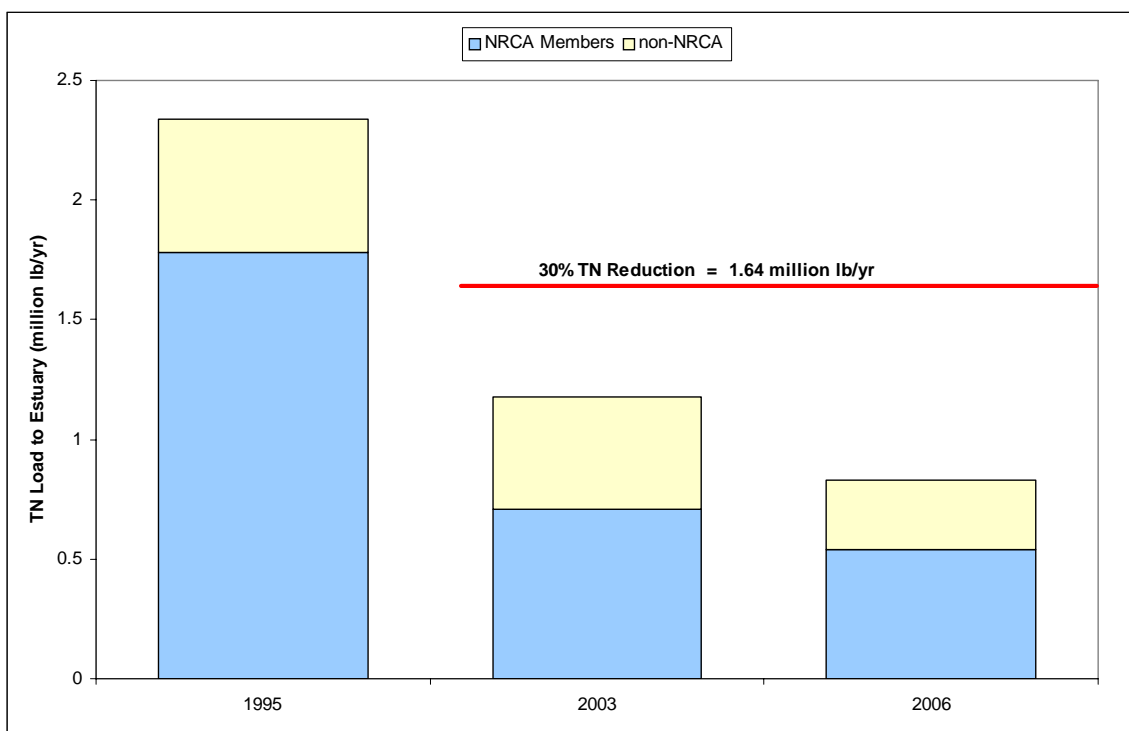
The point source dischargers, as a whole, met and surpassed their 30% reduction target from 2003 through 2006. In 2003, the dischargers reported a total *delivered* load of 1.18 million pounds. This represented a 50% reduction from their 1995 baseline load. In 2006, they reported a delivered load of 0.83 million pounds, a 65% reduction from 1995 levels. Figure 51 illustrates the delivered nitrogen loading for all point sources in 1995, 2003, and 2006 and partitions the portion of the combined load and subsequent reductions over time attributed to the NRCA and non-NRCA point sources.

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<sup>3</sup> The regular schedule for the renewals was 1998, but action was delayed until the rule could be modified with a temporary rule in 2000.



Figure 51 Point Source Performance, 1995 -2006



The members of the Neuse River Compliance Association account for three-quarters of the permitted flow among the dischargers with nitrogen allocations. Figure 52 shows the performance of the NRCA members' facilities from 1995 through 2006. The group achieved a 70% loading reduction even though wastewater flows had increased by 23. The group's actual discharge flows have varied with changes in membership and with changes in precipitation; for example, their 2003 flow reflect drought conditions in much of the basin.

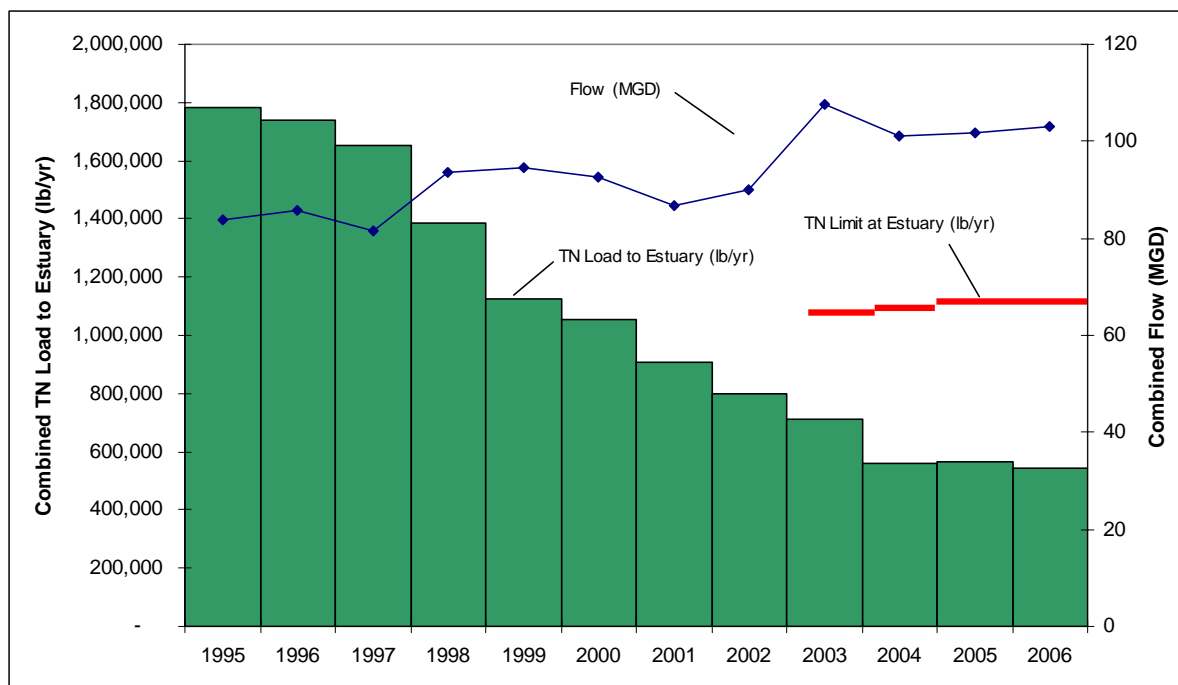


Figure 52 NRCA Performance, 1995 - 2006

#### 24.1.4 Stormwater Rule

##### Rule Requirements

The Neuse stormwater rule establishes a set of objectives for reducing nitrogen runoff from new development projects within the planning and zoning jurisdictions of fifteen of the largest and fastest-growing local governments in the Neuse River basin including Cary, Durham, Garner, Goldsboro, Havelock, Kinston, New Bern, Raleigh, Smithfield, Wilson; and Durham, Johnston, Orange, Wake and Wayne counties. Each of these local governments was required to develop and adopt a local stormwater program that includes the following:

- Review of stormwater management plans for new development,
- Protection of riparian buffers
- Public education action plans
- Removal of illegal discharges and identification of stormwater retrofits.

Under the requirements of the rule, the nutrient export goal for new development projects is limited to a total nitrogen export of 3.6 lbs/acre/yr with limits on peak flows to not exceed the predevelopment conditions for the 1-year 24-hour storm. The 3.6 lbs/ac/yr export target represents the 30% reduction goal applied to new development. It represents a 30% reduction from the average pre-development loading conditions. The nitrogen export goal is achieved through a combination of site design and the use of on-site best management practices (BMPs). Developers also have the option to offset the nutrient export offsite by participating in the North Carolina Ecosystem Enhancement Program (NCEEP) nutrient offset program. If the nitrogen export for a planned project site is calculated to be greater than 6.0 lbs/ac/yr or 10.0 lbs/ac/yr for

residential or commercial development respectively, the developer must first implement onsite BMPs or take part in an approved regional or jurisdiction-wide stormwater strategy to lower the nitrogen export to at least those levels before being allowed to “buy down” the remainder of their nitrogen export to the 3.6 lbs/ac/yr target through the NCEEP nutrient offset program.

### Implementation Results

By 2002, each of the fifteen local governments subject to the Neuse Stormwater Rule adopted and implemented their local permitting programs requiring new development projects to control stormwater runoff. As of December 2006 EEP has received 1,338 nutrient offset payments for new development projects to offset 837,387 pounds of nitrogen over the next 30 years, which equates to offsetting approximately 29,113 pounds of nitrogen annually from new development in the basin.

A number of public education programs have been implemented in the various communities, as required under the rule. All of the local governments under the rule are supporting partners of the Clean Water Education Partnership (CWEP) which is a cooperative effort between local governments, state agencies, and nonprofit organizations to educate the general public about water quality in the Tar-Pamlico, Neuse, and Cape Fear River Basins. The education and outreach programs conducted include workshops, development of web sites, newsletters, brochures, storm drain stenciling, participation at school programs such as science fairs, field days, development of environmental fact sheets, and implementation of demonstration projects for stormwater control. Several communities have also partnered with other agencies such as the NC Cooperative Extension Service and local Soil and Water Conservation Districts to aid in the development of their public education and outreach programs.

All of the local governments subject to the Neuse Stormwater Rule have also developed ordinances and programs that, in addition to requiring the nutrient export goal be met, establish local authority for the removal of illegal discharges. This includes establishing a 24-hour hotline the public can use to report an illegal discharge. Each local program is also responsible for maintaining a database that tracks illicit discharge detection and removal activities, and a number of local governments have noted in their annual reports to DWQ that this element of the stormwater program has resulted in the removal of several illicit dischargers to date.

Each reporting year, local governments also identify a pre-set number of viable stormwater retrofit sites for existing developments in their jurisdictional areas. These sites are made available to groups that may have funding to implement retrofit activities for nitrogen reduction. In addition to identifying retrofit sites, a few local governments have reported activities completed or underway that have worked to reduce existing nitrogen loading. One example of such an effort is the development of local programs to buy out properties in floodplain areas and restore these areas to natural conditions for water quality improvements.

### 24.1.5 Agriculture Rule

#### Rule Requirements

The Neuse Agricultural Rule requires all persons engaging in agricultural operations in the basin to collectively achieve and maintain a 30% net nitrogen loading reduction from the 1991-1995 baseline. The agricultural rule provides each farmer with the option of becoming part of a collective local strategy for implementing BMPs or independently implementing standard BMPs as specified in the rule. A Basin Oversight Committee (BOC) and seventeen Local Advisory Committees (LACs) were established to implement the rule and to assist farmers with compliance. The BOC is required to submit an annual progress report to the Environmental Management Commission.

#### Implementation Results

The BOC began submitting annual reports in 2001, and agriculture has been meeting its goal of 30% reduction in nitrogen loss since 2003. As of 2006, agriculture achieved an estimated 45% nitrogen loss reduction compared to the 1991-1995 baseline for the entire basin. In 2006, seven of the seventeen counties reported a reduction in nitrogen loss from agricultural lands of more than 40%. The seven counties that reported reduction estimates exceeding 40% were Carteret; Craven; Greene; Johnston; Jones; Wake; and Wilson county. To view the Annual Progress Reports on the Neuse Agriculture Rule, visit <http://h2o.enr.state.nc.us/nps/ag.htm>.

Nitrogen loss reduction from agricultural land was accomplished through best management practice (BMP) installation, fertilizer application reduction, and cropland attenuation. The BOC will continue to focus its efforts in maintaining the loss reductions that have been achieved and promoting further implementation of conservation practices. Table 70 summarizes estimates of each factors relative contribution to the cumulative percent reduction in nitrogen loss.

Table 70 Factors Influence on Nitrogen Reduction by Percentage on Agricultural Lands, Neuse River Basin.

Factor	2006
BMP Implementation	8%
Fertilization Management	16%
Cropping Shift	5%
Cropland converted to grass/tree	1%
Cropland lost to idle land	10%
Cropland lost to development	5%
Total	45%

Local nitrogen reduction strategies were based on BMP implementation projections done by the LACs to meet the 30 percent reduction target using NLEW. The LACs determined the practices that would be most acceptable to participating farmers and predicted the number of acres that could be enrolled in these practices. Table 71 summarizes the BMP implementation goals and current status.

Table 71 Best Management Practices Receiving Nitrogen Reduction Credits Installed in the Neuse River Basin from 1996 to 2006.

BMP Types	BMP Enrollment Goals (ac)	Actual Enrollment 1996-2006 (ac)	Goal Exceedence as of 2006 (ac)
20' Buffer	1,370	70,017	68,647
30' Buffer	700	10,442	9,742
50' Buffer	2,000	30,613	28,613
70' Riparian buffer	0	11,483	11,483
100' Riparian buffer	0	109,656	109,656
Scavenger crop	5,200	31,209	26,009
Nutrient management	280,000	267,869	-12,131

The BOC and LACs rely on information generated from the Nitrogen Loss Evaluation Worksheet (NLEW), developed to provide a scientifically valid accountability method for nitrogen reduction. The essence of NLEW is an empirically derived spreadsheet model that estimates nitrogen export from agricultural management units. The primary use of NLEW is to estimate relative reduction in nitrogen export through a pre and post-BMP implementation calculation, rather than estimating delivery to surface waters. The results generated by NLEW represent edge of field nutrient reductions and not actual load inputs to stream and river segments directly discharging to the estuary.

The NLEW tool was developed to serve a five-fold purpose:

1. Estimate nitrogen losses from agricultural sources in the Neuse River Basin during the baseline period of 1991-1995.
2. Distribute goals for nitrogen reduction to local entities.
3. Facilitate local BMP planning and implementation.
4. Track implemented BMPs.
5. Account for reduction in nitrogen losses due to the implementation of BMPs throughout the basin.

In September 2007, NCSU scientists completed a revised version of NLEW. This latest version incorporates updated soil series data and nitrogen reduction values based on buffer width. The use of buffers now generates a percent reduction in nitrogen that is not tied to a specific vegetation type. The revised nitrogen reduction credit for buffers ranges from 30% for buffers that are 20 feet wide, to 60% reduction credit for buffers that are 100 feet wide. Because of these revisions, the estimated nitrogen loss during the baseline period has been recalculated using the updated version of NLEW.

Significant quantities of agricultural BMPs have been installed since the adoption and implementation of the nutrient management strategy. However, the measurable effects of these BMPs on overall in-stream nitrogen reduction may take years to develop due to the nature of nonpoint source pollution.

### **24.1.6 Protection and Maintenance of Existing Forested Riparian Areas**

#### **Rule Requirements**

The riparian buffer protection rule requires that existing vegetated riparian buffers in the basin be protected and maintained on both sides of intermittent and perennial streams, lakes, ponds, and estuarine waters. Where the rule applies, a total of 50 feet of riparian area is required on each side of waterbodies. Within this 50 feet, the first 30 feet, referred to as zone 1, is to remain undisturbed with the exception of certain activities. The outer 20 feet, referred to as zone 2, must be vegetated, but certain additional uses are allowed. This rule does not establish new buffers unless the existing use in the buffer area changes. Implementation of the riparian buffer protection rule is done by DWQ staff out of the Raleigh and Washington Regional Offices unless a local government is granted delegation of local authority by the EMC.

#### **Implementation Results**

Since implementation of the Neuse buffer rule there have been a total of 39 major variances and 168 minor variances. A major variance request pertains to activities that are proposed to impact any portion of Zone 1 or any portions of Zone 1 and Zone 2 of the riparian buffer. A minor variance request pertains to activities that are proposed only to impact any portion of Zone 2 of the riparian buffer. DWQ began tracking buffer enforcement cases in 2005 and records indicate that from 2005 through 2006 there were 5 buffer violations resulting in enforcement cases with \$24,500 in civil penalties assessed. Delegation of local authority for implementing the buffer rule was granted to Orange County and Pitt County in 2001 and 2006 respectively.

### **24.1.7 Nutrient Management Rule**

#### **Rule Requirements**

The Nutrient Management Rule requires landowners, leasees and commercial applicators that are applying nutrients to 50 or more acres of residential, agricultural, commercial, recreational or industrial land as of the effective date of the rule, August 1, 1998, to either attend nutrient management training or to develop nutrient management plans for their lands within five years of the rule's effective date.

#### **Implementation Results**

Through a partnership between the NCSU Soil Science Department and North Carolina Cooperative Extension staff, seventeen nutrient management training sessions were held throughout the basin between 2000-2001, resulting in 1,850 applicators being trained. In December 2007 a follow-up training was promoted and conducted by NC Cooperative Extension staff in Wilson County. That supplemental offering trained an additional 48 applicators from both the Neuse and Tar-Pamlico Basins that had not been originally. A similar joint training session will be held once a year for the foreseeable future. DWQ continues to seek opportunities to improve participation in the training programs through outreach to turf industry applicators.

## 24.2 Trends in Nutrient Loading to the Neuse Estuary

This section provides brief summaries of two nutrient loading studies conducted by DWQ to answer the question of whether the TMDL is being met; that is, whether the required 30% reduction in nitrogen loading to the Neuse Estuary is being achieved. The following two analyses were chosen because they directly evaluate the effect of the nutrient strategy on nitrogen inputs to the estuary at the TMDL compliance point (Fort Barnwell) using strategy implementation timeframes. In addition, over the past decade a number of nutrient concentration and load studies by various researchers and DWQ staff have measured nutrient trends in the Neuse Estuary and elsewhere using different timeframes. All of these studies shed light on the dynamics of eutrophication and changes over time. For this reason we provide brief summaries of these studies in Appendix V.

### 24.2.1 Trend Analysis of N&P in the Neuse River at Fort Barnwell Ambient Monitoring Station (Rajbhandari, 2007)

This DWQ study concluded that there was no significant trend in total nitrogen(TN) loading at the Ft. Barnwell station in the Neuse Basin. This study was a monotonic trend evaluation of seasonally adjusted nutrient concentration at the Ft. Barnwell ambient monitoring station, which is the TMDL compliance point and is located 23 miles above New Bern, over the study period (1991-2006) to evaluate the Phase II Neuse Estuary TMDL from the baseline period (1991-1995). A monotonic trend is the determination of whether the nutrient concentrations are consistently increasing and never decreasing or consistently decreasing and never increasing. Seasonal adjustment is a statistical technique that attempts to measure and remove influences of predictable seasonal patterns to reveal how concentrations change from month to month. These seasonal adjustments make it easier to observe the underlying trend and other non-seasonal movement in the data set.

The Water Quality/ Hydrology Graphics / Analysis System (WQHYDRO) was used in this study to compute the nonparametric Seasonal Kendall test to determine nutrient concentration trends. A Seasonal Kendall test is a nonparametric trend test that is used with data sets that are non-normal, vary seasonally and contain outliers and censored values. Analysis used average monthly concentrations for TKN, NO<sub>x</sub>, TN, and TP.

This trend analysis was not performed for flow adjusted concentrations because there was no significant trend in flow at the 95% confidence interval (Figure 53). The results of the Seasonal Kendall test found significant decreasing trends in concentration of TN (-24%) (Figure 54), TP (-27%) and NO<sub>x</sub> (-56%) at the Ft. Barnwell station when compared to the baseline period at the 95% confidence interval. TKN concentrations were shown to be slightly increasing but the trend is not significant at the 95% confidence interval. However, a significant upward trend of TKN load (+45%) was observed. Upward trends of TP and TN load were also observed but they were not statistically significant at the 95% confidence interval (Figure 55).

There are multiple factors contributing to variation in water quality over time, many of which can hide or exaggerate trend components in the data. In this case the upward trend in TKN load and increase in flow, though the flow increase was not statistically significant, likely played a large role in the inability to discern a clear TN loading trend as a result of this study. Load is the

product of flow and concentration with the flow being the dominant factor in the calculation. The annual variability of flow from year to year expressed in this basin can hide or “mask” the reduction in TN concentration when calculating the total load. Similarly, TN load is the sum of TKN and NO<sub>2</sub> and NO<sub>3</sub> loads. In this study TKN load was found to have increased by 45% while the NO<sub>x</sub> load only dropped by 8% and was not statistically significant. This increase in TKN load factors strongly in the TN load calculation and offsets the decrease in NO<sub>x</sub> load calculated. In the end, the variability of flow with its fluctuation of high and low flow years over the study period along with the increase in TKN load overshadow the measured drop in TN concentration when calculating total load at the Fort Barnwell station.

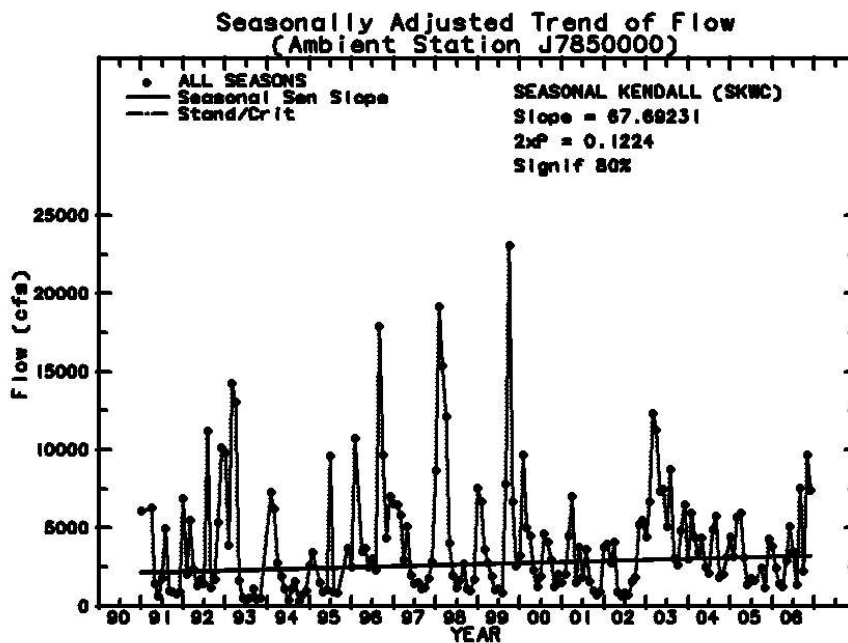


Figure 53 Trend slope representing flow rates during water sample collected period at ambient Fort Barnwell station from 1991 through 2006.



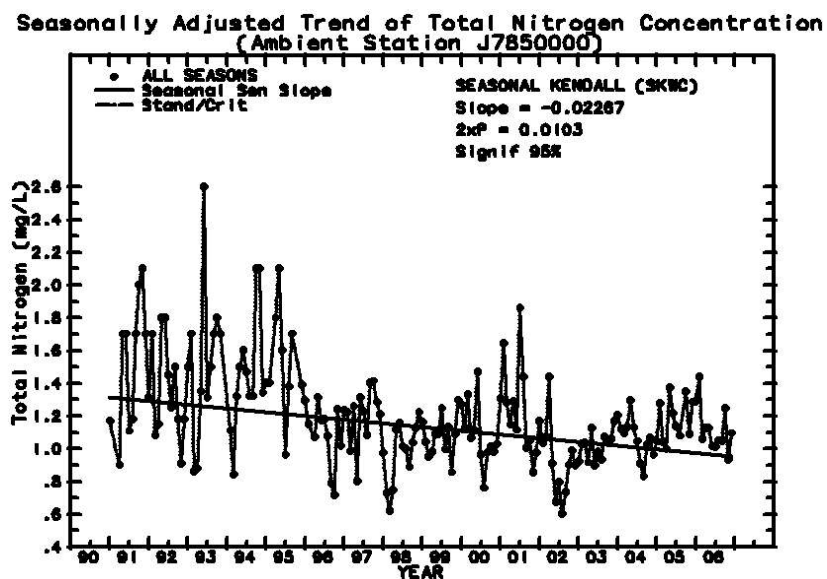


Figure 54 Trend slope representing average rate of change in seasonal-adjusted total nitrogen concentration at ambient Fort Barnwell station from 1991 through 2006.

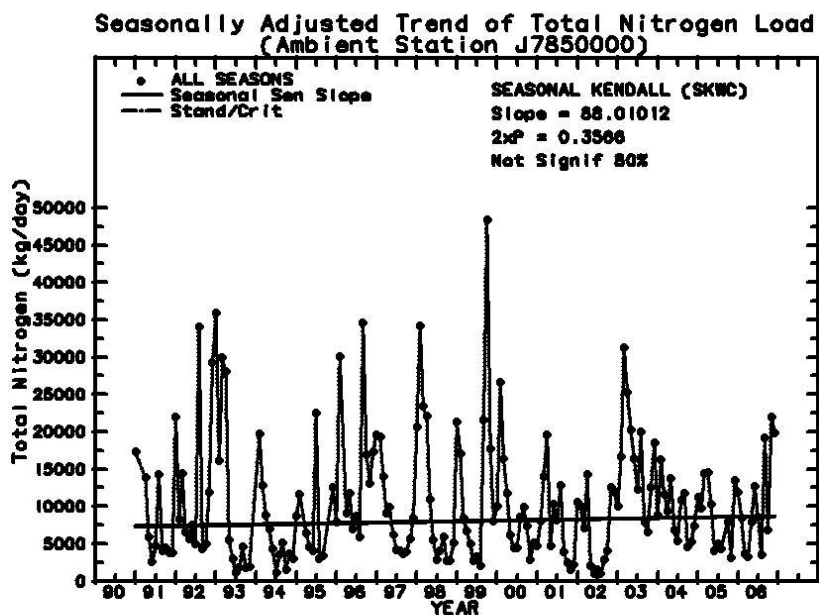


Figure 55 Trend slope representing average rate of change in seasonal-adjusted total nitrogen load at ambient Fort Barnwell station from 1991 through 2006.

### 24.2.2 “Pre & Post” Strategy Implementation Analysis: Fort Barnwell Ambient Station (McNutt, 2007)

This DWQ analysis was conducted to begin to evaluate compliance with the Neuse estuary TMDL. It is a pre/post comparison of unadjusted annual mass loading of nutrients to the estuary using DWQ ambient data collected at the Fort Barnwell station. The ‘pre’ data spans the time period from January 1991 to December 1996, which corresponds to the baseline for the Neuse NSW Rules. The ‘post’ data spans from January 1999 to December 2006. This post period includes five years during which implementation was carried out, 1999-2003, and four years following full implementation. The following parameters were reviewed: ammonia, TKN, nitrate, nitrite, and total phosphorus. Daily and monthly nutrient concentrations and flows were combined into monthly average loads, which were totaled into annual loads that were then averaged across each set of years.

It is important to note that this is not a statistical analysis of the data and does not take variability or confidence intervals into account. The findings of this analysis show average total nitrogen loads at the Fort Barnwell station during the baseline and the post implementation periods were 7.53 million lbs/year and 8.35 million lbs/year respectively. This equates to an increase in nitrogen loading at Fort Barnwell of approximately 11% as opposed to the 30% reduction target (Figure 56). As discussed in Section 24.2.3, below, these study results do provide a meaningful assessment of progress, or lack thereof, towards meeting the 30 percent load reduction goal. The graph, however, does effectively demonstrate the high variability and influence of annual mean flow on nitrogen loading, thus pointing out the significant contribution of nonpoint sources of nitrogen.

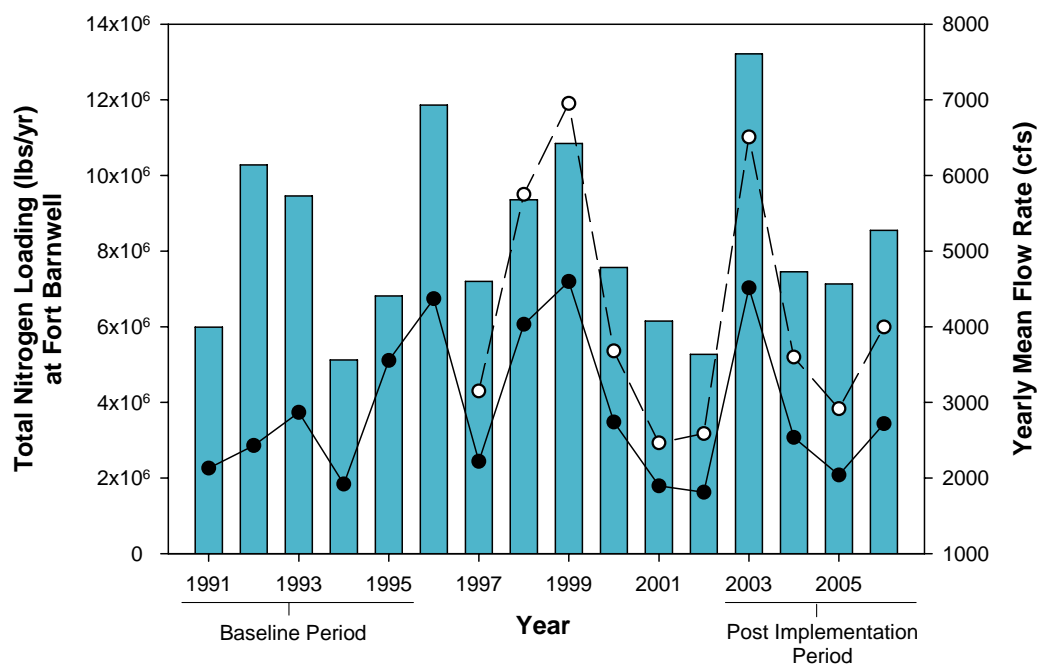


Figure 56 Estimated TN Loading at Fort Barnwell Ambient Monitoring Station (1991-2006)

### 24.2.3 Trend Analysis Conclusions & Next Steps

The two studies summarized above appear to indicate that not only has the 30% goal not been reached, but that nitrogen load to the estuary may have remained unchanged or even increased. In evaluating these results, we first discuss how they may compare to general expectations based on the strategy results reported in the previous section. We then recognize inherent limitations of the trend studies themselves. Lastly, we consider factors within the basin and with the strategy design that may contribute to the trend study results seen.

Based on implementation results reported in the previous section, in general it would seem reasonable to expect both concentrations and loads of N to the estuary to decrease substantially post-baseline. Wastewater discharge load estimates carry probably the greatest certainty given the relative ease and frequency of monitoring. In the baseline period, these were estimated to contribute on the order of one-quarter of N load flowing into the estuary, and are estimated to have decreased by approximately 65% post-baseline. For a number of reasons, significantly greater uncertainty is associated with agricultural reduction estimates. Some of the factors contributing to this uncertainty include the relative variability of nonpoint source BMP effectiveness, the inherent uncertainty of the baseline nitrogen loss estimates which current reductions are compared against, and the fact that reductions reported for agriculture are edge of field reduction estimates and not in stream load reduction calculations based on water quality monitoring data. With this in mind, agriculture was estimated to contribute over half of all N load to the estuary in the baseline, and annual implementation reports estimate that N loss from basin agricultural lands has decreased by approximately 45% post-baseline. Based on these estimates, reductions from these two sources together might be expected to have substantially achieved the 30% goal.

The gap between these expectations and the trend study results may be explained in part by the inherent limitations of the trend studies. Climatic variability plays an important role in the mobilization, processing, and delivery of nutrients to the Neuse estuary. The estuarine water quality response is affected by climatic events and this variability obscures clear trends in nutrient loading and the estuary's response to these loads, despite efforts to reduce point and non-point source loads. Several factors that are in a state of change must be included in the consideration of the data analysis. (Paerl, 2008). The first study discussed above yields seemingly conflicting results. A downward trend in N concentration and concurrently no change in N load should only be explainable with an increase in flow over the study period, since load is the product of concentration and flow. But the analysis found no trend in flow. Perhaps the most plausible explanation lies in the relative uncertainties associated with each of these determinations. However, we can say that 24% and 27% decreases in concentration at a 95% confidence provide relatively strong indication of real and substantial improvement. In the longer term, we might expect the loading trend to follow suit as the variability in year-to-year flow averages out over time. In the interim, we intend to both conduct additional evaluations on the data used here toward clarifying the apparent inconsistencies, and to continue collecting data and conducting additional trend studies at intervals into the future.

The second study has two key limitations. First, the 'post' period contains only three years of true post-implementation data. While this limitation was unavoidable, a statistical comparison using such a brief data span is of relatively limited value. Its value is further limited by the inclusion of

5 years of ‘during’ implementation data, years in which compliance was not yet required. The second limitation is that this analysis did not include steps to remove the influence of known sources of variability, primarily season and flow. As with the first study, we might expect the value of this type of analysis to grow when repeated with additional data over time as these sources of variability tend to average out over longer time spans.

By expanding the analysis outside of the TMDL compliance point and focusing on specific watersheds with dominant land use types, staff may be able to better gauge the effectiveness and progress of strategy implementation. For this reason will be necessary to conduct additional trend analysis on tributaries within the basin that represent predominately agriculture and urban watersheds respectively. While we believe that further analysis of existing data and additional years of data collection will provide greater certainty as to the effect of the strategy on the estuary, we also recognize other basin factors that may contribute to the results seen in these analyses and the lack of improvement in the estuary. We first note two key biophysical process factors, then in the following sections we enumerate factors involving the design of the strategy and individual rules.

An important factor in interpreting agricultural effects is the variable rate of groundwater movement to surface waters. Research is increasingly finding that some fraction of water introduced to groundwater through infiltration may take as long as decades to reach surface waters, while some does so on much shorter timeframes, years or months. Thus to some degree the effects of recent improvements in N application rates through both inorganic fertilizer and animal waste are not likely to be seen instream for years or decades to come.

A factor that bears on estuary improvement directly is the generally complex nature of estuary dynamics and more specifically the potential for nutrient cycling out of sediments for some time as water column nutrient concentrations decrease. Study is needed to gauge the extent to which purging of estuary sediments may be expected to delay improvements in estuary productivity response.

Section 24.3 identifies gaps and potential gaps in strategy design that may present opportunities for further reducing nutrient inputs to the estuary.

### **24.3 Strategy Analysis and Opportunities for Additional Nutrient Reductions**

While DWQ recognizes the need to take a longer-term view on judging success in decreasing nitrogen inputs to the estuary and the estuary’s response to reduced inputs, we also believe it is appropriate to begin evaluating the potential limitations of the current strategy and the limitations in our understanding of nutrient input sources and opportunities for improving both. This section of the Basin Plan discusses possible opportunities to strengthen the existing nutrient reduction strategy and identifies potential nitrogen loading sources not addressed by the strategy that may merit further evaluation and management recommendations.

### 24.3.1 New Development Stormwater Rule

The Neuse stormwater rule establishes a nutrient export goal of 3.6 lbs/ac/yr of TN for new residential and commercial development projects within the planning and zoning jurisdictions of 15 of the largest and fastest-growing local governments in the Neuse River Basin. Each of these local governments has successfully implemented its stormwater program since 2001 and continues to achieve the nutrient export target through a combination of onsite BMPs and off site nutrient offsets. DWQ has begun to assess the extent to which the stormwater rule does not address new development activities in the basin. A key factor in this assessment is increases in population and the corresponding growth in residential and commercial development activities in municipalities and counties that are currently not subject to the stormwater rule.

Tables 72 & 73 below detail the population growth of the major municipalities and counties in the Neuse River Basin. Table 74 provides an analysis of the percentage of basin area covered by the requirements of the Neuse Stormwater Rule. The tables are sorted in descending order of total population growth, and local governments currently subject to the rule are shown in bold. Those currently subject to Phase II stormwater requirements are italicized.

Between 2000 and 2006, approximately 68% of the population growth within the 33 municipalities in the basin with populations greater than 2,000 occurred in areas subject to the Neuse stormwater rule. However, the remaining 45% of the total growth during this same period occurred in areas of the basin where the rule does not apply. In terms of geographic coverage, the Neuse Stormwater Rule currently applies to approximately 40% of the basin. Adding population growth within the nine fastest growing municipalities not currently subject to the rule represents an additional 92% of the total population based on this data. Approximately 18% of the population growth during this same period took place in areas within the basin that are not subject to either the Neuse stormwater rule or Phase II.

In addition to the ten municipalities subject to the Neuse Stormwater Rule, three of the remaining twenty-three communities with populations greater than 2,000 are subject to Phase II stormwater regulations. The requirements of Phase II stormwater regulations and the Neuse Stormwater Rule do share some similarities in that they both include provisions for implementing illicit discharge detection and elimination programs, public outreach and education, and some type post construction stormwater controls. However, there are additional protective measures provided for in the Neuse Stormwater Rules that specifically address nutrients that are not present in the Phase II regulations. As shown in Table 74 below, an additional 8% of the basin area not subject to the rule is subject to Phase II stormwater regulations. While Phase II stormwater regulations do not currently address nutrients, DWQ could consider including nutrient requirements under Phase II programs when existing permits are renewed or future Phase II designations are made.

Table 72 Growth of Largest Municipalities from April 2000 to July 2006 (Population > 2K).

Municipality	Year 2000 Population	Year 2006 Population	% Growth 2000- 2006	Total Growth
<b>Raleigh</b>	<b>276,094</b>	<b>352,919</b>	<b>21.8%</b>	<b>76,825</b>
<b>Cary</b>	<b>94,536</b>	<b>122,139</b>	<b>22.6%</b>	<b>27,603</b>
<b>Durham</b>	<b>187,035</b>	<b>214,492</b>	<b>12.8%</b>	<b>27,457</b>
Greenville	61,209	72,227	15.3%	11,018
Wake Forest	12,588	22,628	44.4%	10,040
Apex	20,212	28,830	29.9%	8,618
Morrisville	5,208	13,501	61.4%	8,293
Holly Springs	9,192	17,165	46.4%	7,973
<b>Garner</b>	<b>17,787</b>	<b>23,507</b>	<b>24.3%</b>	<b>5,720</b>
Fuquay-Varina	7,898	12,913	38.8%	5,015
Clayton	8,126	12,118	32.9%	3,992
<b>Wilson</b>	<b>44,405</b>	<b>48,316</b>	<b>8.1%</b>	<b>3,911</b>
Winterville	4,794	8,192	41.5%	3,398
Knightdale	5,958	8,671	31.3%	2,713
<b>New Bern</b>	<b>23,111</b>	<b>25,456</b>	<b>9.2%</b>	<b>2,345</b>
<b>Smithfield</b>	<b>10,867</b>	<b>12,456</b>	<b>12.8%</b>	<b>1,589</b>
Wendell	4,247	5,421	21.7%	1,174
Selma	5,914	7,008	15.6%	1,094
Hillsborough	5,446	6,240	12.7%	794
Zebulon	4,046	4,781	15.4%	735
Creedmoor	2,232	2,718	17.9%	486
Benson	2,993	3,450	13.2%	457
<b>Havelock</b>	<b>22,442</b>	<b>22,772</b>	<b>1.4%</b>	<b>330</b>
Grifton	2,123	2,365	10.2%	242
Ayden	4,622	4,861	4.9%	239
Farmville	4,421	4,619	4.3%	198
Roxboro	8,696	8,866	1.9%	170
River Bend	2,923	3,028	3.5%	105
Trent Woods	4,224	4,321	2.2%	97
Mount Olive	4,567	4,594	0.6%	27
La Grange	2,844	2,804	-1.4%	-40
<b>Kinston</b>	<b>23,688</b>	<b>22,962</b>	<b>-3.2%</b>	<b>-726</b>
<b>Goldsboro</b>	<b>39,147</b>	<b>37,396</b>	<b>-4.7%</b>	<b>-1,751</b>
<b>Total</b>	<b>1,143,736</b>	<b>933,595</b>	<b>18.4%</b>	<b>210,141</b>

Notes:

Bold = Subject to Neuse stormwater rule

Italics= Subject to Phase II stormwater rule

Table 73 Growth of All Counties in the Basin from April 2000 to July 2006.

County	% County in the Basin	Year 2000 Population	Year 2006 Population	Population in Basin 2006	% Growth 2000-2006	Total Growth in Basin 2000-2006
<b>Wake</b>	<b>85</b>	<b>627,866</b>	<b>790,007</b>	<b>533,686</b>	<b>20.5%</b>	<b>137,820</b>
<b>Johnston</b>	<b>98</b>	<b>121,900</b>	<b>151,589</b>	<b>119,462</b>	<b>19.6%</b>	<b>29,095</b>
<b>Durham</b>	<b>73</b>	<b>223,314</b>	<b>246,824</b>	<b>163,019</b>	<b>9.5%</b>	<b>17,162</b>
Pitt	42	133,719	146,403	56,162	8.7%	5,327
<b>Orange</b>	<b>49</b>	<b>115,537</b>	<b>123,766</b>	<b>56,613</b>	<b>6.6%</b>	<b>4,032</b>
Craven	95	91,523	95,558	86,947	4.2%	3,833
Wilson	81	73,811	77,468	59,787	4.7%	2,962
Carteret	50	59,383	63,558	31,779	6.6%	2,088
Greene	100	18,974	20,833	18,974	8.9%	1,859
<b>Wayne</b>	<b>91</b>	<b>113,329</b>	<b>114,930</b>	<b>103,129</b>	<b>1.4%</b>	<b>1,457</b>
Granville	25	48,498	53,840	12,125	9.9%	1,336
Nash	20	87,385	92,220	17,477	5.2%	967
Franklin	10	47,260	55,315	4,726	14.6%	806
Person	32	35,623	37,448	11,399	4.9%	584
Pamlico	83	12,934	13,097	10,735	1.2%	135
Beaufort	2	44,958	46,346	927	3.0%	28
Jones	81	10,419	10,318	8,439	-1.0%	-82
Lenoir	99	59,598	58,172	59,002	-2.5%	-1,412
<b>Total</b>	<b>N/A</b>	<b>1,926,031</b>	<b>2,197,692</b>	<b>1,560,271</b>	<b>12.4%</b>	<b>207,997</b>

**Notes:**

Bold = Subject to Neuse stormwater rule

Italics= Subject to Phase II stormwater rule

Table 74 Neuse Stormwater Rule and Phase II Stormwater Program Coverage.

Stormwater Program	Basin Area (%)	Approximate Area (Square Miles)
<b>Total Area Subject to Neuse Rule</b>	<b>40%</b>	2,433
Neuse Only	<b>14%</b>	844
Both Neuse and Phase II	<b>26%</b>	1,589
<b>Additional Area Subject to Phase II Only</b>	<b>8%</b>	509

**Notes:**

% Area covered based on 2005 municipal boundaries and Phase II designations as of February 1, 2008

Total basin area = 6,109 square miles

DWQ also recognizes that greater oversight of local stormwater programs by the state should provide more assurance of full implementation of the rule as well as provide better data to assess the effectiveness of the rule and its various components. One method being considered by staff is conducting periodic audits of each individual stormwater program. The audits would serve to help identify improvements needed in both implementation and reporting.

In addition to the rule's geographic coverage limitations, it does not set a quantitative reduction target for nitrogen loading from existing developed lands. According to land cover data collected by the National Resources Inventory (NRI), as of 1997 there were 481,000 acres of urban and built-up land cover in the Neuse Basin, or approximately 13% of the entire basin. Since the current nutrient strategy addresses stormwater from new development starting in 2001, the stormwater runoff from these 481,000 developed acres, plus any lands developed between 1997 and 2001, and any land developed after 2001 on which a vested development right was established, has not been subject to the rule. The great majority of these lands are not being treated to achieve nutrient reductions. Treating nutrient runoff from existing development through stormwater retrofit BMPs and other load reducing measures, both structural and management oriented, represents a real opportunity to further reduce existing nutrient loads to the basin from this significant source. A rule to address nutrient contributions from stormwater runoff from existing development could provide municipalities opportunities to receive nutrient reduction through practices such as removing existing impervious cover, buffer restoration, street sweeping, and removal of illicit discharges, in addition to structural retrofits.

There are also potential low cost opportunities to address existing sources of nutrients in runoff from existing development. Existing sources include nutrients from pet waste and over fertilization of turf and landscape areas. Controls could be incorporated into local stormwater programs and ordinances to address these two sources of nutrients. Educational opportunities addressing these issues could be incorporated into the public education and outreach requirement already part of the established local stormwater programs. Some local governments in North Carolina already implement pet waste ordinances. Local governments in other parts of the country are beginning to place limitations on home fertilizer use with success as well. One recent example is the 2005 Minnesota phosphorus fertilizer law (18C.60, MN Statutes 2006) which prohibits use of phosphorus lawn fertilizer unless new turf is being established or a soil or tissue test shows need for phosphorus fertilization. The law also requires fertilizer of any type to be cleaned up immediately if spread or spilled on a paved surface, such as a street or driveway.

### **24.3.2 Agriculture Rule**

The progress achieved by the agriculture sector in implementing the Neuse Agriculture Rule is well documented in the Annual Agricultural Progress Reports submitted to the EMC every fall since 2002. As discussed in section 24.1.5, as of 2003 the agriculture sector exceeded its collective 30% nutrient reduction goal and as of 2006 is reporting a 45% reduction in estimated nitrogen loss to the basin through a combination of BMP implementation, crop shifts, fertilization rate reductions, and loss of overall cropland acres. During implementation, improvements have been made to the accounting of these reductions as more research and data becomes available concerning the effectiveness of agriculture BMPs. Opportunities remain for further improvement to the accounting process and identifying additional agricultural sources that may be contributing nutrients that are not accounted for under the current strategy.



Staff will continue to consult with University researchers and Division of Soil and Water Conservation (DSWC) staff as more data becomes available concerning the efficiencies of agricultural BMPs and how this information can be used to further refine the nutrient reduction credits applied under the current program. In addition to revisiting BMP efficiencies, DWQ plan to continue collaborating with an interagency workgroup started in 2007 to identify methods to better track land use changes. Specifically, staff will be working to develop a “whole basin” land accounting strategy that will work to ensure that accounting for land that goes out of agriculture does not result in double counting of nutrient reductions.

One potential limitation of the agriculture rule involves pastured livestock nitrogen contributions. Nutrient loading from pasture-based livestock operations has not been well characterized generally, including in NC, and the accounting tool used for rule compliance does not include the ability to quantify the effects of livestock management on N loading. A recent survey conducted by DSWC staff estimates that at least 50% of the pasture acres within the basin use fencing out practices to keep livestock out of streams. However, additional research is still needed to better quantify the nutrient benefits of various pasture management practices like fencing out livestock and restoring riparian buffers. While pasture operations were originally considered to be a small part of agriculture in the basin, their contributions to agriculture nitrogen loading have not been well quantified and could represent an opportunity to achieve additional nutrient reductions to the basin.

In addition to better potential nutrient loading from pasture, staff also recognizes the need to better understand the role that artificial drainage, such as subsurface tile drains, plays in contributing nutrient loads to the basin. Interception of shallow ground water beneath agricultural fields through tile drains to ditches can increase nitrogen loading into receiving streams. While the number of ditches (channelized runoff) and tile drains has likely not increased since the baseline, the “short circuiting” effect these existing systems create represents an opportunity for improvement that could result in additional nutrient load reductions. Quantifying the extent of the drains has proven challenging because tile drain maps are either outdated or nonexistent. Additional research is needed to determine the location and geographic extent of tile drains in the Neuse, since available studies have shown evidence of elevated nitrate-nitrogen concentrations in tile drainage water. Such a study should also include some form of functional assessment that will allow for the evaluation of potential options for mitigating the impacts of tile drains.

There is also a need to better understand the potential magnitude of nutrient loading from spray fields and directly from animal housing and holding, and waste storage facilities on confined animal feeding operations (CAFOs), such as dairies, hog farms, and poultry operations. Also, subsurface seepage from waste lagoons and ammonia emissions from CAFOs are not captured under the Neuse agriculture rule, but are to some degree addressed under other state rules and programs addressing animal operations. These programs are discussed in the groundwater and atmospheric portions of this section.

Through our interactions with DSWC staff, Division staff will focus particularly on increasing the coverage of certain more lasting and verifiable practices like water control structures and restoring riparian buffers. To help address some of the knowledge questions raised here, funding

from the EPA 319 grant program has been awarded to fund a project that would statistically sample farms in the basin and conduct on-ground surveys of a host of current conditions and practices. This project, to be conducted by NCSU Department of Soil Science and the USDA National Agriculture Statistical Survey, would be a follow-up to a similar study carried out in 2000 and would also allow evaluation in changes over the intervening years. Since the performance of certain BMPs like water control structures rely on their proper management, it would be useful to evaluate the effectiveness of current compliance processes at ensuring these practices are being maintained and operated properly throughout their contract lives.

### **24.3.3 Point Source Rule**

As summarized in Section 24.1.3, wastewater discharge nitrogen loading reductions have been substantial. Point sources are meeting their nutrient allocations and have reduced their combined wastewater discharge nitrogen loads by 65% through 2006 compared to the baseline. One question relates to increases in land application of treated wastewater that has occurred as a means of complying with this rule. It would be useful to evaluate the extent to which such land application may be yielding a net increase in nutrient loading over previous uses of the acres involved. Other questions relate to land application program compliance and compliance criteria.

A recent example of how nutrient loading to groundwater can occur from land application of biosolids is the situation at the City of Raleigh WWTP. Errors in the estimation of agronomic rates resulted in long-term over-application of biosolids. This led to elevated nitrate levels in private wells in the vicinity of the land application site. Previous studies showed that nitrogen loads are being delivered to the Neuse River from the application field previously used by the Raleigh WWTP due to this over-application (Showers et al, 2006). Land application practices have ceased at the facility while negotiations to resolve the issue are ongoing. This situation, while an extreme case, demonstrates the need for more research to quantify the potential for groundwater contamination and transport of nutrients from biosolids and wastewater land application fields to the surface waters of the Neuse Basin.

A variation on new land application systems is the growing practice in the coastal plain of high-rate infiltration systems. This recent innovation is being proposed to address wastewater needs of some new developments where receiving waters would not accommodate direct discharge of treated wastewater and no POTW is available. The new nutrient load from these systems is not captured by the point source rule or other strategy accounting mechanisms and concerns have been raised that the ability of landscape features to treat these discharges prior to entering the surface waters has not been well quantified.

### **24.3.4 Nutrient Contributions from Land Application Sources of Waste**

As touched on in the previous sections pertaining to indirect nutrient loads from point sources and agriculture, groundwater is a significant source of nutrient loading to the Neuse Estuary. While there is a limited amount of research available that explores the nutrient contributions or changes in those contributions from this source in the basin, initial research shows that land application of treated wastewater, biosolids from municipal wastewater treatment systems, animal waste from confined animal feeding operations (CAFOs) and onsite wastewater systems are all considered likely sources of nutrients found in groundwater in the Neuse River Basin.

The predominant wastewater treatment systems used in CAFOs are lagoons and sprayfields, in which waste is flushed from confined animal housing units into large waste lagoons and then periodically sprayed onto agricultural fields. Similarly, municipal wastewater treatment plants commonly land apply the sludge that is a bi-product of the treatment process to agriculture fields as a means of disposal. In both cases the nitrogen contained in the land-applied products will either be assimilated by crops, volatilize into the atmosphere, run off into adjacent streams, or infiltrate into the groundwater system and eventually discharge into streams in the basin (Paerl, 2002).

While most regulations require that land application not exceed realistic yield-based agronomic rates, recent studies have shown that nitrate concentrations are higher in groundwater under crop fields sprayed with animal wastes than in groundwater beneath crop fields fertilized with commercial fertilizers (Spruill, 2004). Ideally, nutrient application should be based on crop needs and for a given crop, there should be no difference in nitrogen loss between nutrient types applied. Given the use of land application is expected to continue, and in light of the projected increase in human population in the Neuse Basin, the continued use of this waste disposal method from such high volume sources highlights the importance of seeking a better understanding of the relative impacts of these practices on nutrient loading to surface waters.

Export of land-applied nutrients to surface waters, whether originating from municipal, commercial, or animal facility is enhanced when the field in question has artificial drainage systems like tile drains. The NLEW accounting tool used for agriculture rule compliance does not capture the effects of drain tiles nor does it reflect the research findings cited above regarding nitrogen concentrations under waste-applied fields. Since waste applied fields may represent a nutrient loading source not captured through the agriculture rule accounting process, the reductions reported by the agriculture community as a whole could be over estimated.

While not part of the Neuse agriculture rule, there are other state rules that regulate land application. These include the 15A NCAC 2T rules, which specify requirements for systems that treat, store and dispose of wastes that are not discharged to surface waters of the state. These rules went into effect in 2006 and replaced the “.0200” or non-discharge rules. While these regulations do not contain nutrient reduction requirements and were not developed to specifically address the 30% nitrogen reduction goal, the rules do require management practices such as that could serve to help reduce nutrient inputs to the Neuse Basin from land application operations

In addition, in 2007 the NC General Assembly incorporated the findings of the Smithfield Agreement into Senate Bill 1465 (Session Law 2007, Section 523). Senate Bill 1465 prohibits permitting of a new or expanding swine management system utilizing an anaerobic lagoon and sprayfield as the swine farm’s primary method of treatment and land application. Senate Bill 1465 also charged the Environmental Management Commission (EMC) to adopt rules to make the performance standards permanent thus allowing for the construction of innovative swine waste management systems for either new farms or for the expansion of existing farms. The swine waste management system performance standards are to:

- Eliminate swine waste discharge to surface water and groundwater through direct discharge, seepage or runoff

- Substantially eliminate atmospheric emission of ammonia
- Substantially eliminate odor detectable beyond the swine farm property boundaries
- Substantially eliminate disease-transmitting vectors and pathogens
- Substantially eliminate nutrient and heavy metals in soils and groundwater

Senate Bill 1485 also established a grant program called the North Carolina Lagoon Conversion and Methane Capture Pilot Program that will be used in conjunction with the North Carolina Agriculture Cost Share Program to assist farmers interested in voluntarily converting existing lagoons to cleaner technologies that will meet the performance standards. The EMC approved rules to implement the new provisions of Senate Bill 1465 in November 2008. Once approved by the Rules Review Commission the rules could go into effect as early as January 1, 2009.

Other regulatory activity, likely result in additional monitoring requirements for CAFOs with NPDES general permits, is currently underway. While these new monitoring requirements are not directly related to the 30% reduction goal, the information collected under these proposed requirements will provide valuable information that will be useful in identifying high priority areas of nutrient inputs from animal waste land application sites. In 2007 a petition filed by several environmental groups sought to compel the EMC to expand the monitoring requirements for general permits for animal feeding operations to ensure compliance with non-discharge effluent limitations. This petition for rulemaking resulted in a public stakeholder process that generated draft rules requiring CAFO facilities to develop monitoring plans that would serve to track the performance of the permitted system, verify that the system is protective of surface water standards and document water quality parameter concentrations in adjacent surface waters and compliance with permit discharge limitations. The draft rules that resulted from the stakeholder process during the summer of 2008 went before the EMC in November 2008 and were approved to go out for public comment in early 2009. Under the current timeline these rules are may be adopted and go into effect by the summer of 2010.

#### **24.3.5 Nutrient Contributions from On-site Wastewater Systems**

In addition to land application of waste as a potential nutrient source, initial evidence suggests that residential on-site wastewater systems may be a source of nutrients to the Basin. A recent study conducted by researchers at the NCSU Department of Soil Science is instructive regarding the nitrogen loading generated by households in the basin that use onsite wastewater systems. It estimates that approximately 39% of households in the Neuse Basin use onsite systems, and the cumulative nitrogen load generated by these systems is 3.9 million lb N/yr (Pradham, 2007). While the study is somewhat limited in that it used 1990 Census data, were this magnitude of loading delivered directly to streams it would rival that delivered to the Neuse estuary by all other sources combined. Of course these disposal systems rely on nitrogen removal through landscape processes, primarily denitrification and plant uptake. These processes are believed to remove the vast majority of nitrogen generated by onsite systems before it reaches surface waters. However, such landscape processes are variable in nature, and a question requiring additional study is quantifying the extent to which such ground absorption systems may increase N loading to streams as compared to centralized collection of wastewater, and under what landscape conditions. A second question, which is discussed in the following section, involves understanding the temporal pattern of nitrogen movement through groundwater to surface water

toward better understanding the relationship between population increases and nitrogen delivery to streams.

One study that begins to answer this question is an unpublished study conducted through a joint effort between the North Carolina Division of Public Health and the United States Geological Survey (USGS) compared the effects of onsite and offsite wastewater treatment on the occurrence of nitrogen in the Upper Neuse River Basin. It concluded that onsite systems contribute slightly more nitrogen to the nutrient load in recharging surface water than the load contributions from similar residences served instead by municipal sewer systems (Grimes & Ferrell, 2005). In light of these findings it is evident that additional research in this area is needed to better quantify the role on-site wastewater treatment systems play in contributing nitrogen to the Neuse Basin.

### **24.3.6 Nutrient Loading from Groundwater**

An area of growing interest involves improving our understanding of the role of groundwater in nitrogen loading to the estuary. A study published by USGS in 2008 estimates groundwater nitrogen flux into the Neuse estuary and this initial research suggests groundwater as a possible loading pathway. The study found nutrient fluxes from groundwater to the estuary account for 6% of the nitrogen inputs derived from all sources and approximately 8% of the nitrogen annual inputs from surface-water inflow to the Neuse River estuary (Spruill et al. 2008). The nitrogen load delivered by groundwater was not identified as part of the Neuse TMDL nor assigned a reduction requirement. This was in part because quantitative knowledge was limited at the time on either direct groundwater flux into the estuary or the makeup of groundwater's contribution to loading into basin streams. In addition, from a management standpoint DWQ views groundwater primarily as a pathway rather than a source, and currently we look to manage inputs to this pathway rather than considering treatment of groundwater itself. Over sufficient time, the groundwater nitrogen flux should respond to reductions in landscape inputs. Research is increasingly showing that deeper groundwater flow paths may take on the order of decades to express themselves as surface discharges. This raises several questions. To what extent have the Neuse nutrient rules and other regulations resulted in reductions to landscape N inputs? Can we characterize the temporal pattern of groundwater nitrogen delivery to streams? Can we reliably monitor changes to both stream and estuary nitrogen inputs over time?

To begin answering these questions, we recognize that the set of landscape activities that add nitrogen to groundwater are primarily the variety of human and animal waste disposal and crop fertilization activities mentioned in sections above. An additional contribution is the overlay of atmospheric deposition of nitrogen across the landscape, as described in the following section. Much of these groundwater additions occur under the practice of agriculture. The agriculture rule focuses on surface water and does not require reduction of groundwater N inputs by 30%. Certain practices used to meet the agriculture rule, primarily decreasing N fertilization rates, should decrease groundwater N concentrations. Applying the 30% goal to N application would be problematic since the business of growing crops relies on certain application rates, and crops have inherent N use efficiencies that result in the loss of a fraction of that N, often on the order of half, to groundwater. But we believe that actions taken by producers to comply with the Neuse agriculture rule should yield decreases in cropland N contributions to groundwater. Similarly, as detailed in the previous section, other regulations should result in decreased groundwater N inputs. The state CAFO regulations initiated in the mid-1990's have yielded significant decreases

in waste N land application rates. Changes to residuals application included in the 2T rules should yield similar reductions to application rates for this activity.

The other questions will require us to pursue knowledge improvements by seeking additional monitoring and research into groundwater-to-surface water N dynamics. It will be important to assess the magnitude of contributions through this pathway over years and decades.

#### **24.3.7 Nutrient Loading From Atmospheric Deposition**

Atmospheric deposition of nitrogen oxides ( $\text{NO}_x$ ) and ammonia ( $\text{NH}_3$ ) is a significant source of nitrogen input into the Neuse Estuary (Whitall et al., 2003). However due to lack of available data at the time, contributions through atmospheric deposition were likely vastly underestimated in developing the Neuse TMDL nor was it assigned a reduction requirement. And much like groundwater, this was in part because quantitative knowledge was limited at the time on the magnitude of either direct deposition to the surface of the estuary or its contribution to N loading to basin streams. And much like groundwater, from a management standpoint we view atmospheric deposition primarily as a pathway rather than a source, and currently we look to manage inputs to this pathway rather than considering treatment of atmospheric nitrogen itself. Over sufficient time, atmospheric N deposition rates should respond to reductions by emissions sources. As with groundwater, this raises several questions. To what extent are air quality regulations resulting in reductions to atmospheric N emissions? Can we characterize the relationship between reductions in N emissions and reductions in N deposition? Can we reliably monitor changes to nitrogen deposition over time?

While the scientific understanding of atmospheric deposition continues to evolve, some general observations can be made about atmospheric deposition as a source of nitrogen input into the Neuse Estuary. Atmospheric inputs can be divided into two main types: direct: those that fall directly into the estuary and indirect: those that are deposited on various land surfaces throughout the basin, some portion of which is transported into streams and eventually delivered to the estuary. As the population grows in airshed of the Neuse Basin, an increase in  $\text{NO}_x$  emissions from increased fossil fuel combustion is likely to occur. Ammonia also contributes to atmospheric nitrogen. The great majority of ammonia volatilizes from confined animal operations, but sewage treatment plants and fertilizers applied to the land also contribute small amounts. In North Carolina, animal agriculture is responsible for over 90 percent of all ammonia emissions; in turn, ammonia comprises more than 40 percent of the total estimated nitrogen emissions from all sources (Aneja et al., 1998).

Studies have been conducted to assess the direct and indirect contribution from wet atmospheric N deposition to the Neuse River Basin. The results of one such study completed in 2003 are provided in Table 75 below. The research indicates that atmospheric contributions of nitrogen vary seasonally and spatially within the watershed but that overall it accounts for approximately 24% of the total nitrogen load to the Neuse Estuary (Whitall & Paerl, 2003). These contributions have risen over the last twenty years.

While some of the land-based portion of this loading is addressed through stormwater rules and adjustments to crop fertilization rates, attaining the 30% reduction in nitrogen load to the Neuse Estuary may be challenging without first quantifying atmospheric contributions to the watershed

more accurately, and eventually seeking appropriate management measures on all significant emission sources.

Table 75      Atmospheric Nitrogen Deposition Estimates for the Neuse Basin.

<b>Metric</b>	<b>Nitrogen in (lbs/yr)</b>
Total (from all Sources) N flux to the estuary	16,534,669
Atmospheric* N deposition to land areas in the Neuse Basin	37,258,122
Direct atmospheric* N deposition to the estuary	881,849
Estimated estuarine flux of indirect & direct atmospheric* N deposition	2,425,084 – 9,033,952

Note: \* = Wet atmospheric N deposition only  
Source: (Whitall et al., 2003)

There is very little data available on the concentrations of dry nitrogen deposition in the Neuse Basin. As with wet deposition, dry deposition rates are expected to vary across the basin depending on the proximity to the source. Initial research by the NC DAQ and EPA suggest that the amount of nitrogen contributed to an area from dry deposition is likely to be at least comparable to if not greater than that contributed through wet deposition.

Figures 57 and 58 below provide emission estimates from 2002 through 2018 that generated by the NCDAQ during a recent modeling effort to project emission of NO<sub>x</sub> and NH<sub>3</sub> in North Carolina. The emission sources are broken down into four main categories in the graphs. Point sources are the large stationary sources that have permits and are required to submit emissions inventories periodically. Mobile source are the vehicle emissions that can use the highway networks, like cars and trucks. Nonroad mobile sources are sources that move but do not use the highway systems, like airplanes, railroad locomotives, construction equipment, lawn mowers, agricultural tractors, golf carts, etc. Area sources are small stationary sources that generally are too small to have permits, but combined could have substantial emissions. Emissions from CAFOs fall under the “Area” category for projected NH<sub>3</sub> emissions. The projections in Figure 57 show total NO<sub>x</sub> emissions decreasing over time while Figure 58 shows total NH<sub>3</sub> emissions slightly increasing over time. The projections are not surprising considering that NO<sub>x</sub> emissions are addressed through various current and planned regulations while NH<sub>3</sub> emissions go largely unregulated.

Figure 57 NOx Emission Trend

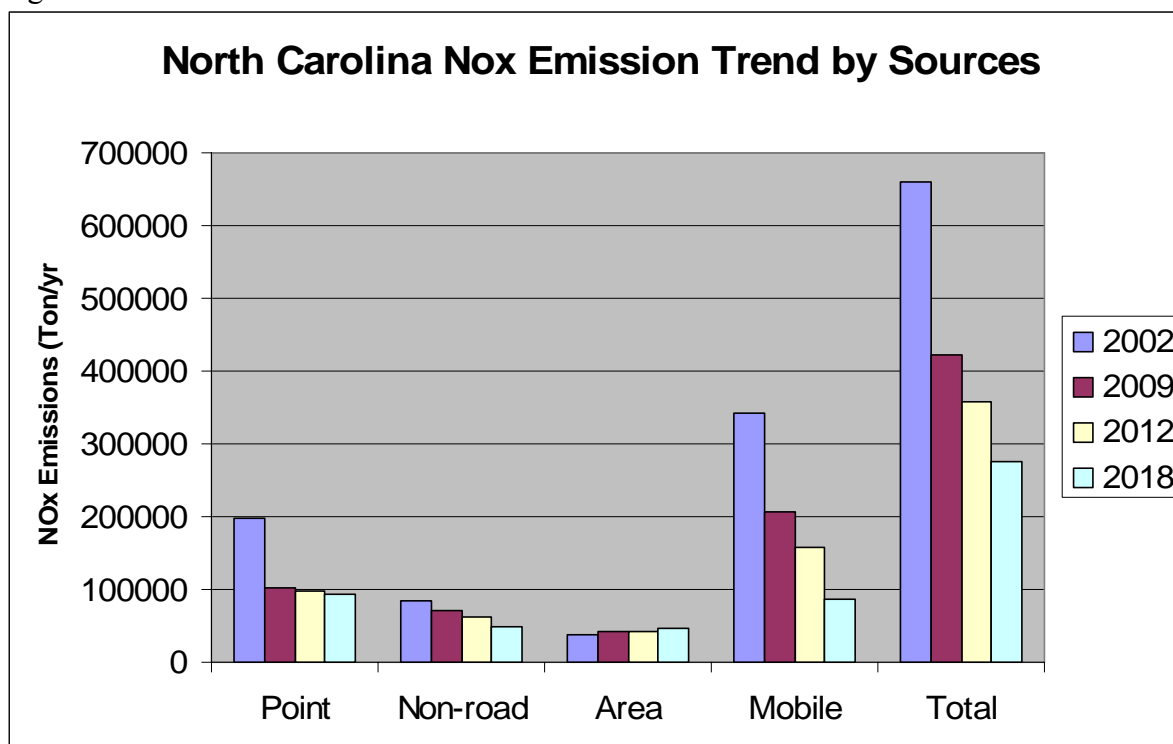
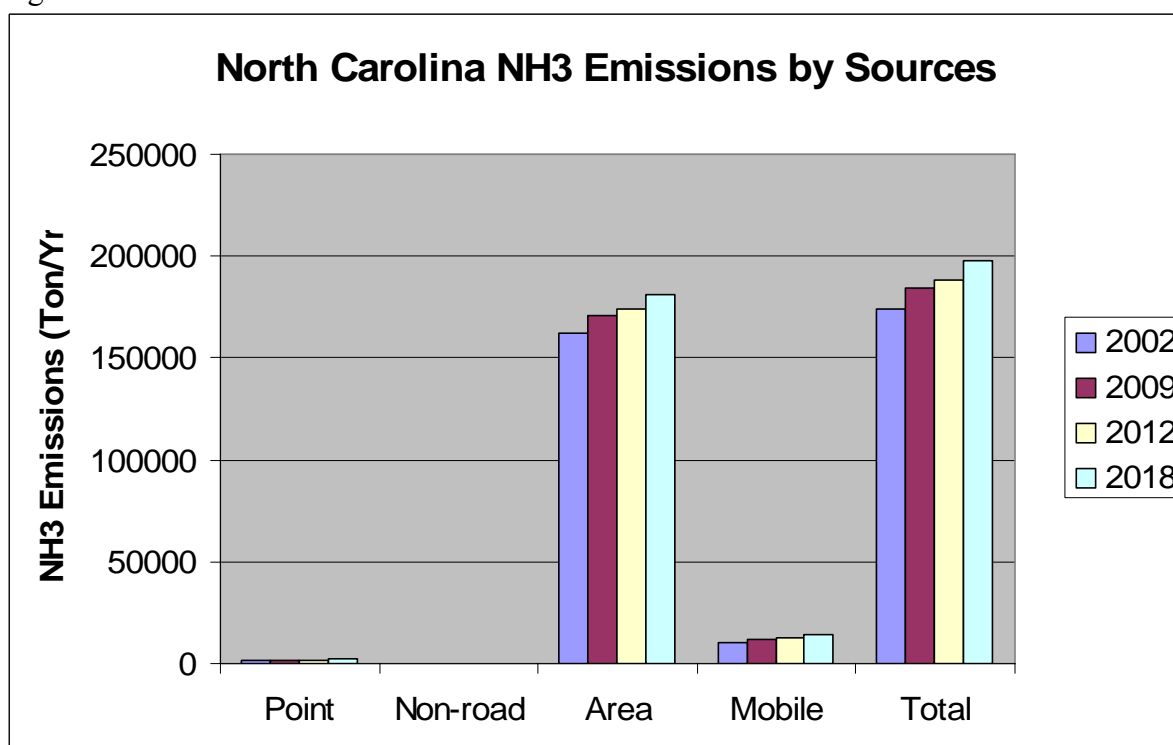


Figure 58 NH3 Emissions





In terms of regulating emissions, recent state and federal regulatory actions are projected to have a positive, reducing effect on NO<sub>x</sub> in the coming years while NH<sub>3</sub> emissions remain largely unregulated. NO<sub>x</sub> emissions are regulated federally, by USEPA, and in the state by the EMC through the Division of Air Quality. Both have enacted major new requirements on NO<sub>x</sub> emissions from two key source types - stationary and mobile - in the last few years. These measures are expected to substantially reduce NO<sub>x</sub> emissions in the coming years. Specifically, the laws adopted by the General Assembly in 2002, the Clean Smokestacks Act, and by EPA in 2005, and the pending temporary NO<sub>x</sub> SIP Call Rule may combine to reduce NO<sub>x</sub> emissions from stationary sources in the southeast by as much as 60% overall by 2014. For mobile sources, the EPA recently adopted “Tier 2” vehicle emissions and fuel standards that are projected to reduce vehicle NO<sub>x</sub> emissions by up to 80% over the next 30 years as the current fleet of private and commercial vehicles phases out. Uncertainties associated with these improvements include the extent to which federal regulations in particular will be fully executed, and the relationship between reductions in NO<sub>x</sub> emissions and correlated reductions in deposition.

Emissions from concentrated animal operations comprise the great majority of atmospheric ammonia emissions (Aneja et al., 1998). These outputs are not directly regulated currently. One recent improvement addresses new and expanding operations. In 2007 the legislature enacted a new law and the EMC is currently considering rule amendments to require animal waste systems that serve new and expanding swine farms to meet or exceed five performance standards. One of the standards requires such farms to “substantially eliminate atmospheric emission of ammonia.” This performance standard specifically requires that “Swine waste management system ammonia emissions from the swine farm must not exceed an annual average of 1.0 kg NH<sub>3</sub>/wk/1,000 kg of steady state live weight.” This new regulation may be expected to substantially cap NH<sub>3</sub> emissions from swine farms at current levels. However, it does not require reductions from existing operations, nor does it apply to other types of CAFOs, such as cattle and poultry operations. Thus NH<sub>3</sub> emissions from existing CAFOs remain the largest unregulated source of atmospheric nitrogen emissions.

Additional research and monitoring is needed to obtain a complete understanding of the magnitude and variability of all atmospheric nitrogen inputs into the Neuse Estuary. Due to the dynamic nature of the airshed, it is also necessary to develop a better understanding of the relationship between emission levels and deposition rates of atmospheric nitrogen. DWQ is working with DAQ staff to identify research opportunities. One such opportunity comes from DAQ modeling work using Community Multi-scale Air Quality modeling system (CMAQ) to conduct emissions modeling. The CMAQ modeling system simulates various chemical and physical processes that are thought to be important for understanding atmospheric trace gas transformations and distributions. The modeling system contains three types of modeling components: a meteorological modeling system for the description of atmospheric states and motions, emission models for man-made and natural emissions that are injected into the atmosphere, and a chemistry-transport modeling system for simulation of the chemical transformation and fate. It is possible that the use of an add-on tool to this model in the future may make it possible to use the output of this model to develop estimates of projected atmospheric nitrogen deposition rates.

### 24.3.8 Summary & Next Steps

Since full implementation of the nutrient reduction strategy was reached in 2003, nitrogen loads from point sources have been reduced by 65% and the agriculture community has reduced their estimated nitrogen loss from cropland and pastureland by approximately 45%. Over 1,850 fertilizer applicators have received nutrient management training and the fifteen local governments covered under the Neuse Stormwater Rule have all adopted and implemented local stormwater programs to limit nitrogen inputs from stormwater runoff resulting from new development. Despite this successful implementation, the goal of a 30 percent reduction in nitrogen loading does not appear to have been met, and the Neuse River Estuary impairment has increased in acreage.

The estuary is a very complex and dynamic system. Climatic variability plays an important role in the mobilization, processing, and delivery of nutrients to the Neuse estuary. The estuarine water quality response is affected by climatic events and this variability obscures clear trends in nutrient loading and the estuary's response to these loads, despite efforts to reduce point and non-point source loads. It is important to note that the data window for this basin plan cycle ends in 2006 and the assessment of progress under the strategy is based on just four years of post implementation water quality data (2003-2006) at this time. Due to the decades of chronic overloading, the time lag required for nonpoint source input reductions to be fully expressed, and the likelihood of nutrient cycling within the estuary, it may be some time before current reductions in nutrient loading will reflect in improved water quality, and before a definitive assessment of the effect of the strategy on the estuary can be made.

In light of the fact that trend evaluations suggest that the 30% reduction has not been met, and recognizing that certain sources are not addressed or not fully addressed under the current strategy, staff have begun an evaluation of the limitations of the current strategy and identified opportunities for developing a better understanding of the nutrient dynamics of this complex system. While we believe that further analysis of existing data and additional years of data collection will provide greater certainty as to the effect of the strategy on the estuary, we also recognize the limitations of the existing strategy and other basin factors that may contribute to the lack of improvement in the estuary. Listed below are the more overarching recommendations and research needs identified in this chapter which will be pursued during this next basin plan cycle. The action plan and time frames for implementing these recommendations is included in Table v of the basin plan summary.

#### Source Assessment and Trends

- Coordinate efforts with the Division of Air Quality to assess atmospheric nitrogen contributions to the watershed and develop recommendations on better ongoing characterization of atmospheric nitrogen deposition and emission source regulatory considerations.
  - Specifically address better characterization of the contribution of ammonia emissions from CAFO operations.
- Identify the need for additional monitoring locations and parameters to better characterize basin nutrient sources and relative contributions.

- Develop a more detailed analysis of current and historic data in order to better quantify the status of nutrient loading to the estuary; conduct additional trend and loading analysis upstream of the Neuse estuary focusing on smaller watersheds with dominant land use types; this will allow staff to better gauge the effectiveness and progress of strategy implementation.
- Lead in the development of the Falls of the Neuse Reservoir Nutrient Management Strategy per legislative timeline.
- Complete the CAFO monitoring plan rulemaking process.
- Review Neuse Buffer compliance assessment.

#### Stormwater Needs

- Develop a full assessment and recommendations on stormwater programmatic coverage gaps and need to meet nutrient strategy goals on new development activities. Include recommendations on most appropriate regulatory approach.
  - Designate new Phase II stormwater communities where criteria are appropriate.
  - Review Phase II stormwater permit holders to evaluate nutrient controls upon permit renewal or designation as Phase II if appropriate.
  - Assessment of stormwater Phase II and Neuse Stormwater permitting programs. Make recommendations on how to strengthen the current program to be more environmentally protective. Need to address hydrologic, sediment and nutrient issues.
  - Audit local stormwater programs for effectiveness and work with local governments to strengthen their implementation.
- Evaluate the magnitude of nitrogen loading in runoff from existing development areas and develop recommendations on the need to address this source under the strategy.
- Review stormwater and sediment and erosion control compliance activities; assess need for additional staff for inspection and enforcement needs.

### Additional Issues

- Lead the interagency workgroup established to improve accounting of land use changes and net progress toward strategy goals.
- Evaluate regulatory issues associated with nutrient loading potential from high rate infiltration wastewater systems in the basin.
- Work with the Division of Coastal Management and the Clean Marina Program to assess the cumulative impacts of marinas and their impact on nutrient related water quality.

### Research needs identified

- Develop monitoring to better characterize the nature, magnitude and trends in atmospheric and groundwater derived nutrient contributions to the Neuse estuary.
- Characterize the location, geographic extent and functionality of tile drains under agricultural fields.
- Quantify the potential magnitude of nutrient loading from spray fields, directly from animal housing and holding, and waste storage facilities on confined animal feeding operations (CAFOs).
- Characterize the geographic extent and quantify the potential magnitude of nutrient loading from dry litter poultry facilities, animal housing and waste storage.
- Characterize the potential for groundwater contamination and transport of nutrients from biosolids and wastewater land application fields to the surface waters of the Neuse Basin.
- Quantify the nitrogen contributions from conventional on-site wastewater treatment systems to surface waters of the Neuse Basin.
- Better quantification of BMP effectiveness (agricultural and stormwater BMPs); improve accounting tools.
- Characterize nutrient loading from various pasture management practices which leads to a better understanding of pasture's nutrient contributions and the value of different management options.

### Voluntary Actions

- Require stormwater best management practices for existing and new development.
- Develop, strengthen and enforce riparian buffer ordinances.

- Develop and enforce local erosion control ordinances.
- Implement pet waste and residential fertilizer reduction ordinances.
- Work with local resource agencies to install appropriate BMPs in order to reduce the contribution of nutrient, sediment, bacteria and toxicants as well as addresses stormwater volume and velocity issues.
  - Community Conservation Assistance Program
  - Agriculture Cost Share Program
  - Conservation Reserve Enhancement Program
- Cultivate local champions in impaired watersheds toward initiating voluntary watershed projects.