Neuse River Compliance Association: A Success Story but What Does the Future Hold?

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ABSTRACT

The Neuse River Basin, which is a major river basin located within North Carolina, is subject to one of the earlier nutrient total maximum daily loads (TMDLs) / nutrient management strategies implemented in the United States. In 1988, the Neuse River Estuary was classified a nutrient sensitive water (NSW) based on repeated occurrence of algal blooms and fish kills. Following its classification as a NSW, North Carolina developed and, in 1997, implemented the Neuse River Nutrient Sensitive Waters Management Strategy which was based on achieving a 30% nitrogen reduction goal in the Neuse Estuary from a 1991 – 1995 mean baseline. EPA-approved TMDLs established nitrogen load allocations to achieve the 30% reduction goal. Since 2003, NPDES discharges within the Neuse River Basin with permitted flows of greater than 0.5 million gallons per day (mgd) have been subject to complying with stringent annual average load based nitrogen allocations. In addition, discharges also must comply with moderate, quarterly average phosphorus concentration limits beginning in 1993, as required by the NSW classification.

As part of the development of the Neuse River Management Strategy, dischargers worked closely with regulatory agencies to allow development of a trading organization. The Neuse River Compliance Association (NRCA) was created in 2002 for the Neuse River Basin and allows for collective watershed compliance with the nitrogen load allocation for participating NPDES dischargers and sets in place a mechanism for nutrient trading, including point and nonpoint trading. The NRCA received its NPDES permit effective January 1, 2003.

As one of the earliest such compliance associations, the NRCA makes for an excellent case study for discussing the benefits, drawbacks, and challenges of a nutrient trading organization for effective watershed-level nutrient management. The Neuse River Nutrient Management Strategy has resulted in significant reduction of nitrogen point source loads to the Neuse River Basin. The NRCA has provided flexibility to its members to collectively comply with the nitrogen TN load allocation and has been a success to date. Although the Neuse River Nutrient Management Strategy requires 30% nitrogen reduction goals be met for other sources, including nonpoint and stormwater, water quality monitoring indicates that the nitrogen load limit for the Neuse Estuary is not being met and that there has been an increase in nitrogen loads to the Neuse Estuary in recent years. While the NRCA has been a success to date, members face significant challenges ahead in securing nitrogen mitigation credits needed to accommodate growth in the area with the NRCA anticipated to be at its total TN discharge allocation before 2040. The challenges with the current rules for obtaining cost effective mitigation credits stress the importance of reasonable trading rules for promoting point to nonpoint source trading.

KEYWORDS

Nutrient Trading, TMDLs, Watershed Management

INTRODUCTION

The Neuse River Basin, which is a major river basin located within North Carolina, is subject to one of the earlier nutrient total maximum daily loads (TMDLs) / nutrient management strategies implemented in the United States. In 1988, the Neuse River Estuary was classified a nutrient sensitive water (NSW) based on repeated occurrence of algal blooms and fish kills. Following its classification as a NSW, North Carolina developed and, in 1997, implemented the Neuse River Nutrient Sensitive Waters Management Strategy which was based on achieving a 30% nitrogen reduction goal in the Neuse Estuary from a 1991 – 1995 mean baseline. EPA-approved TMDLs established nitrogen load allocations to achieve the 30% reduction goal. Since 2003, NPDES discharges within the Neuse River Basin with permitted flows of greater than 0.5 million gallons per day (mgd) have been subject to complying with stringent annual average load based nitrogen allocations. In addition, discharges also must comply with moderate, quarterly average phosphorus concentration limits beginning in 1993, as required by the NSW classification.

As part of the development of the Neuse River Management Strategy, dischargers worked closely with regulatory agencies to allow development of a trading organization. The Neuse River Compliance Association (NRCA) was created in 2002 for the Neuse River Basin and allows for collective watershed compliance with the nitrogen load allocation for participating NPDES dischargers and sets in place a mechanism for nutrient trading, including point and nonpoint trading. The NRCA received its NPDES permit effective January 1, 2003.

As one of the earliest such compliance associations, the NRCA makes for an excellent case study for discussing the benefits, drawbacks, and challenges of a nutrient trading organization for effective watershed-level nutrient management. This case study covers the following topics:

- Provides an overview and brief history on the development of the Neuse River Nutrient Management Strategy and the NRCA.
- Reviews nutrient reduction drivers for the Neuse River, including the 30% reduction nitrogen goal and drivers to why phosphorus concentration limits were established in addition to the nitrogen load allocations.
- Describes goals and objectives of the NRCA at its inception.
- Highlights benefits and achievements to date, including substantial point source nitrogen load reductions and effective trading among point source dischargers.
- Discuss drawbacks and lessons learned over the last 15 years of implementation, including the challenges with achieving Neuse Estuary nitrogen reduction goals.

- Explains additional challenges and twists that have been encountered since inception of the NRCA, including the development of a more stringent TMDL for the Upper Neuse River and ongoing investigation for potential development of alternative nutrient criteria in North Carolina.
- Highlights challenges that utilities face in planning for the future, particularly as many of the participating utilities are projected to reach their nitrogen allocation within the 20-year planning window.

OVERVIEW / HISTORY OF THE NEUSE RIVER MANAGEMENT STRATEGY

The Neuse River is one of the larger river basins in North Carolina and is located completely within North Carolina. It begins in the piedmont area of North Carolina, near Roxboro, and travels southeast through the coastal plain where it flows into the tidal waters of the Neuse Estuary upstream of New Bern and ultimately flows to the Pamlico Sound. The river basin watershed encompasses 6,200 square miles, with approximately 3,400 miles of fresh water streams and 371,000 of estuarine / saltwater acres. The Neuse Estuary in a broad, shallow estuary with an average depth of 15 feet (NCDWR, 2018).

Figure 1 illustrates the geographical location of the Neuse River Basin. Falls Lake is a major reservoir located in North Raleigh / Durham area. The sub-basin area that drains to Falls Lake is referred to as the Upper Neuse River Basin. There are three sub-basins located downstream of Falls Lake. Collectively, the sub-basins that drain downstream of Falls Lake to the Neuse River Estuary are referred to as the Lower Neuse River Basin.

Today, there are a total of 33 major (greater than or equal to 0.5 mgd) point source dischargers to the Neuse River Basin, with three located in the Upper Neuse River Basin and thirty located in the Lower Neuse River Basin. There are 42 minor (less than 0.5 mgd) point source discharges to the Neuse River Basin. Some of the larger municipalities that discharge to the Neuse River Basin include the City of Durham, the Town of Cary, the City of Raleigh, Johnston County, the City of Wilson, and Goldsboro.

Eutrophication issues were already noted in the Neuse River Estuary in the late 1970s and 1980s, as noted by fish kills attributed to lack of oxygen in the Estuary during summer months (Howell, 1990 and NC DENR, DWQ, 1999). A supplemental "Nutrient Sensitive Water" classification was approved by the North Carolina Environmental Management Commission (EMC) in 1979 and was defined as "waters subject to excessive growth of microscopic and macroscopic vegetation requiring limitations on nutrient inputs" (Howell, 1990). Following adoption of the new supplemental classification, Falls Lake was classified as a Nutrient Sensitive Water in 1983 and the Lower Neuse River was classified as a Nutrient Sensitive Water in 1988 (Howell, 1990).

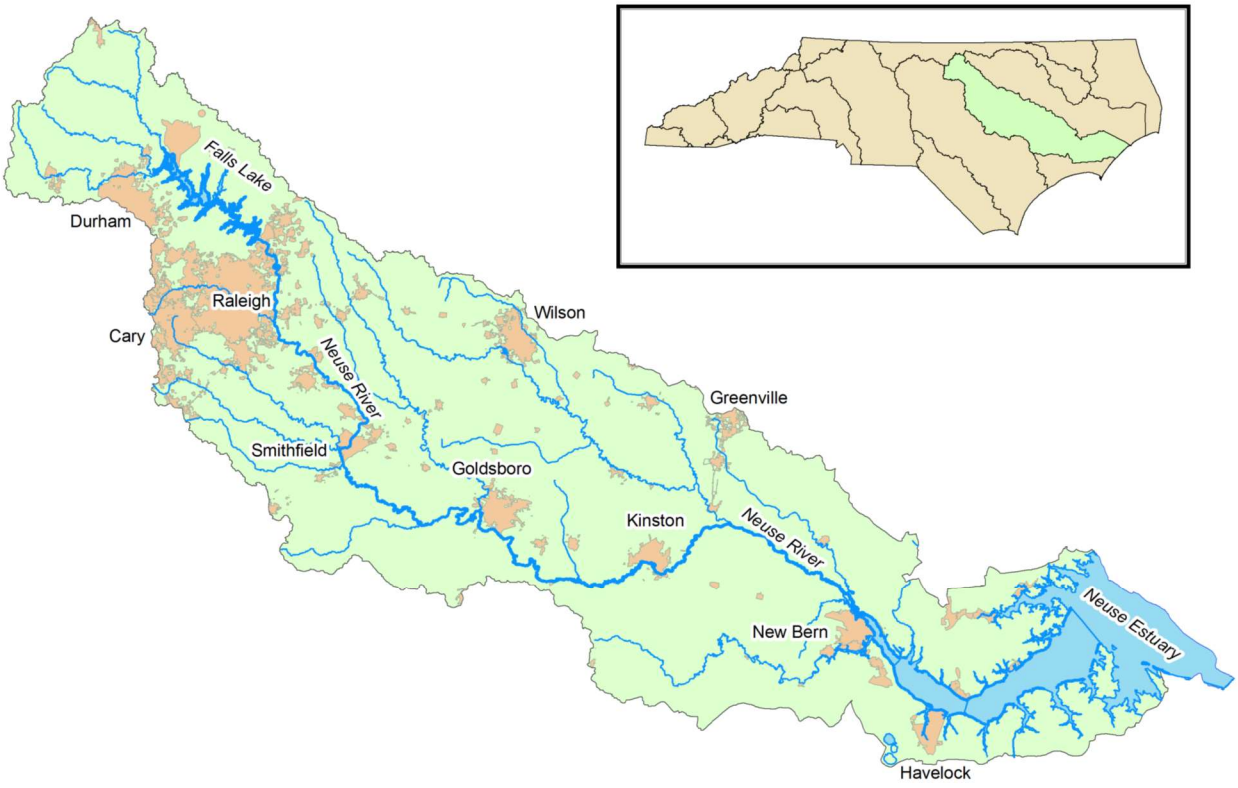

Figure 1. Neuse River Basin Map (LNBA, 2018)

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The first nutrient reduction steps achieved in the Neuse River Basin following its classification as an NSW were associated with phosphorus reduction measures. A law requiring a statewide ban on phosphate detergents was implemented in 1988 (NC DENR, DWQ, 1999). In addition, point source discharges to the Upper and Lower Neuse River Basin were required to meet phosphorus discharge limits required by the NSW classification. Dischargers with permitted flows greater than 0.05 mgd to the Upper Neuse were required to meet a 2 mg/L quarterly total phosphorus discharge limit by 1990. For the Lower Neuse River Basin, existing dischargers with permitted flow greater than 0.5 mgd and new or expanding dischargers with permitted flows of greater than 0.05 mgd were required to meet the new 2.0 mg/L quarterly average concentration TP limit by 1993 (NCDEM, 1993).

Although significant phosphorus reductions were achieved in the Neuse River Basin, there was continued pressure in the 1990s to reduce nitrogen loads to the address continued fish kills and algal blooms in the Neuse River estuary. The 1993 Basin Wide Plan for the Neuse River Basin

Water Quality Management Plan noted that despite significant reductions in phosphorus loads, eutrophication in the estuary was still prevalent, requiring additional potential nutrient reduction measures, including potential nitrogen reduction. It was also noted that potential additional nutrient reduction gains would be recognized through implementation of nonpoint nutrient source reduction (NCDEM, 1993).

To assist with water quality data monitoring and information sharing among NPDES dischargers, the Lower Neuse Basin Association (LNBA) was formed in 1994 as a non-partisan, not for profit organization that entered into a Memorandum of Agreement (MOA) with the North Carolina Department of Environment and Natural Resources, Division of Water Quality as a coalition monitoring group. The LNBA assists with collecting ambient water quality data, including parameters such as temperature, DO, pH, conductivity, turbidity, total suspended solids, nutrients, chlorophyll a, and fecal coliform. The water quality data collected was utilized in subsequent water quality modeling and assessment for development of the TMDL and continues to be used today for water quality assessment of the Neuse River Basin (LNBA, 2018).

In 1995, shortly after the formation of the LNBA, extensive fish kills occurred in the Neuse River Basin, which was attributed to low DO conditions and algal blooms. In addition, research found the presence of *Pfiesteria piscada*, a toxic dinoflagellate, in portions of the Neuse River Basin. The Neuse River Estuary was also listed on the 303(d) impaired waters list in 1994, 1996, and 1998 for elevated chlorophyll a above North Carolina's water quality standard of 40 µg/L. The occurrence of these events led to additional action in development of nutrient reduction management strategies for the Neuse River Basin, including the development of a TMDL for nitrogen and the implementation of a nutrient management strategy for the Neuse River Basin (NC DENR, DWQ, 1999).

In 1997, North Carolina developed the Neuse River Nutrient Sensitive Waters Management Strategy, which included nitrogen reduction rules to achieve a goal of reducing the total nitrogen load received in the Neuse Estuary by 30% from a 1991 – 1995 mean baseline (15A NCAC 02B .0232 - .0240). The Neuse River Nutrient Management Strategy is intended to regulate nutrient loads to the basin from different sources, including point sources, such as wastewater and stormwater discharges, and nonpoint sources, such as agricultural practices. The rules also establish requirements for 50-ft riparian buffers that limit allowable activities with buffer areas. Both point and nonpoint sources are required to meet the 30% reduction nitrogen goal. However, no specific nitrogen load allocations are given for nonpoint source activities. In contrast, dischargers with flows greater than 0.5 mgd are given individual nitrogen load allocations.

In parallel to development of the Neuse River Nutrient Management Strategy, a total maximum daily load (TMDL) was developed and approved by the USEPA to address elevated chlorophyll-a concentrations in the Neuse River Estuary. A phased TMDL approached was used, which established initial nitrogen load allocations to achieve the 30% TN reduction goal. Phase I of the

TMDL was approved by the EPA in 1999 and Phase II was approved in 2002. Nitrogen was selected for management in the TMDL because, based on review of studies and research, it was identified as the "nutrient that has the best potential to limit excessive growth of chlorophyll in the estuary" (NC DENR, DWQ 2001). The Phase I TMDL established an initial 30% TN reduction goal based on estimated levels of nitrogen reduction that were thought to yield water quality improvements in the Neuse Estuary. At that time, there was limited water quality modeling available for the Neuse Estuary. Additional water quality modeling was conducted for the Phase II TMDL based on more recent water quality monitoring data. Based on the additional water quality modeling and review of more recent estuarine monitoring data, the Phase II TMDL concluded that additional nitrogen reduction beyond the initial 30% reduction target from the 1991 – 1995 baseline was not warranted (NC DENR, DWQ, 1999).

The resulting EPA-approved TMDLs established nitrogen load allocations to achieve the 30% TN reduction goal. The effective date for point source compliance with the rules was January 1, 2003. The TMDL established a 1991 – 1995 mean baseline nitrogen load at the Neuse River Estuary of 9.65 million pounds per year (Mlbs/yr) at New Bern. The 30% TN reduction goal results in a total nitrogen cap of 6.76 Mlbs/year of nitrogen delivered to the Neuse Estuary. Existing point source allocations were estimated based on available discharge flow and effluent TN concentration data for point source dischargers to the Neuse River. The baseline point source load was estimated at 2.34 Mlbs/year of nitrogen delivered to the estuary. Baseline nonpoint sources were estimated at 7.31 Mlbs/year of nitrogen delivered to the estuary based on the difference between total load and point source loads (NC DENR, DWQ, 1999).

Table 1 summarizes Neuse Estuary nitrogen TMDL allocations listed in the Phase I TMDL (NC DENR, DWQ, 1999), which are based on a 30% reduction from the baseline nitrogen loads. Based on the established allocations, nonpoint sources are the largest source of nitrogen load to the Neuse Estuary.

Table 1. Neuse Estuary TMDL TN Allocations (NC DENR, DWQ 1999)

Category	TN Allocation (Mlbs/year)
Point Source	1.64
Nonpoint Sources:	5.12 (Total)
Agricultural	3.09
Urban	0.39
Open Water	0.26
Forest (Background)	1.38
Total	6.76

Under the Neuse River Nutrient Management Strategy, the Wastewater Discharge Rule establishes a total point source TN allocation of 1.64 million lbs of nitrogen / year delivered to the Neuse Estuary (15A NCAC .02B .0234). The point source TN load cap was allocated among existing NPDES permit dischargers in the Neuse River Basin with permitted flows at or greater

than 0.5 mgd. Small point source dischargers with flows less than 0.5 mgd did not receive TN limits. The total TN allocation was assigned to individual dischargers based on permitted flows and also accounting for respective TN delivery factors to the Estuary based on location relative to the Neuse River Estuary. There are four different TN transport zones, varying from 10% for dischargers located in the Upper Neuse to 50% for dischargers located along the middle Neuse, to 70% and 100% for dischargers located closest to the Neuse Estuary. Based on the applied TN delivery factors, discharge limits of approximately 3.0 million lbs of nitrogen / year were established to meet the estuary TN allocation of 1.64 million lbs of nitrogen / year. Discharges with flows greater than or equal to 0.5 mgd that discharge below Falls Lake were given TN load allocations based on an annual average TN concentration limit of 3.7 mg/L at permitted flow condition. Dischargers with flows greater than or equal to 0.5 mgd that discharge above Falls Dam were given TN load allocations based on an annual TN concentration limit of 5.5 mg/L at permitted flows ((NC DENR, DWQ, 1999).

The Wastewater Discharge Rule also establishes requirements for trading of nitrogen allocation credits for point source discharges. New and/or expanding facilities should first try to get estuary allocation from other existing dischargers. The equivalent estuary nitrogen allocation (discharge load allocation x transport factor) can be transferred from one point source to another point source within the Neuse River Basin at a 1:1 ratio. If a facility cannot obtain estuary nitrogen allocation from existing dischargers, then the rule allows for purchase of nonpoint source allocation provided that 30-years of offset credit is purchased at 200% of the estuary allocation needed at the cost set per 15 A NCAC 02B .0240. For the Lower Neuse River Basin, nonpoint load reductions need to occur within the same 8-digt HUC as the point source discharger. For the Upper Neuse River Basin, nonpoint load reductions need to occur within the Falls Lake Watershed to apply to dischargers to Falls Lake (15A NCAC 02B .0240). New facilities and expanding facilities' nitrogen credit equivalent must not exceed 3.5 mg/L TN at permitted flows for domestic facilities and 3.2 mg/L TN at permitted flows for industrial facilities. New facilities are also required to achieve a 1 mg/L TP quarterly average phosphorus limit (15A NCAC .02B .0234).

Apart from wastewater dischargers, no other sources were allocated a specific TN budgets in the Neuse River Nutrient Management Strategy. In other words, there is no specified TN load allocation or budget by nonpoint source type. However, rules are established under the Neuse River Nutrient Management Strategy do require implementation of nonpoint nutrient management practices, riparian buffer protection, and stormwater management programs to meet the 30% nitrogen reduction goal (15A NCAC 02B .0232 - .0240, except .0234).

DEVELOPMENT OF THE NEUSE RIVER COMPLIANCE ASSOCIATION

The Neuse River Nutrient Management Strategy allows for the development of a group compliance association for point sources allow for collective compliance with the point source nitrogen allocation to the Neuse Estuary (15A NCAC .02B .0234). The Neuse River Compliance Association (NRCA), a non-partisan, not for profit organization, was created in 2002 for the

Neuse River Basin and allows for collective watershed compliance with the nitrogen load allocation for participating NPDES dischargers and sets in place a mechanism for nutrient trading, including both point and nonpoint trading. The NRCA was set up as a separate organization from the LNBA because the LNBA members only included entities located downstream of Falls Lake, whereas the trading association needed to be open to dischargers located in both the Upper and Lower Neuse River Basin (LNBA, 2018).

Invitations to join the NRCA were extended to all NPDES Permit Holders in the Neuse Basin with a permitted capacity greater than 0.5 mgd that were required to meet a total nitrogen allocation in their permit. Most members of the LNBA joined the NRCA. There were also a few additional members that joined the NRCA that were not members of the LNBA. Currently, there are 24 permit holders that are members of the NRCA. Members with permitted flows greater than 0.5 mgd having to meet a TN load based limit became "co-permittee members" of the NRCA. A co-permittee member has voting rights in the NRCA. The NRCA has a membership category for those who would like to join but do not meet the above requirements, known as "Monitoring member", with no voting rights (LNBA, 2018).

In 2002, the NRCA applied for and received an NPDES Permit No. NCC000001 that became effective January 01, 2003. The permit established the NRCA's total nitrogen allocation (TN) as the sum of all of its members' nitrogen allocations. The 2018 total nitrogen allocation for the NRCA is 1,195,428 lbs. (or 73% of the point source TMDL allocation). Nitrogen limits established under NCC000001 are annual average load based limits (LNBA, 2018).

The NRCA members are allowed to make annual transfers of TN within the total TN limited allocated in Permit No. NCC000001. Members are allowed to sell or lease nitrogen allocation to other members of the NRCA without NRCA approval. However, members cannot lease or sell nitrogen outside of the NRCA. A member of the NRCA is considered in compliance with the Estuary TN allocation if the NRCA meets the combined total nitrogen allocation, even if an individual discharger exceeds its individual allocation. In the event that the NRCA does not meet the combined total nitrogen allocation, then an individual discharge is considered in compliance provided that discharger complies with its individual TN load allocation (15A NCAC .02B .0234). The NRCA assesses members a penalty if they exceed their individual TN allocation. Up to 80% of the assessed penalty is eligible for a refund if the entity is able to achieve a timely correction to the causes of the allocation exceedance (LNBA, 2018).

ACHIEVEMENTS TO DATE

Table 2 summarizes the total nitrogen load delivered to the Neuse Estuary by members of the NRCA since 1995. Between 1995 and 2002, prior to the effective date of the new nitrogen load limits, members of the LNBA implemented facility operational optimizations which resulted in a significant initial reduction in nitrogen delivered to the Neuse Estuary from the Lower Neuse from 1.784 Mlbs/year to 0.798 Mlbs/year.

Table 2. Summary of NRCA's Annual Average Total Nitrogen Load Delivered to the Neuse Estuary since 1995.

Year	Total Average Flow (MGD)	Total Nitrogen (lbs.) Delivered to the Neuse Estuary
1995	83.808	1,784,130
1996	85.675	1,741,492
1997	81.444	1,653,262
1998	93.442	1,387,717
1999	94.659	1,123,169
2000	92.582	1,056,202
2001	86.818	907,381
2002	89.926	797,991
2003	107.463	711,398
2004	101.203	558,553
2005	101.757	566,627
2006	102.970	542,205
2007	92.994	461,325
2008	90.563	489,798
2009	98.570	497,002
2010	101.852	584,192
2011	93.384	513,269
2012	97.248	540,892
2013	102.847	514,847
2014	108.359	568,387
2015	108.721	610,915
2016	108.734	593,145
2017	101.510	491,822

Collectively, the NRCA members have spent more than $400 million in nutrient reduction upgrades resulting in significant point source reductions in nitrogen loads compared to 1995 levels. For example, in 2007, following the effective date for the new TN load limits, the total nitrogen delivery to the Neuse Estuary had been reduced to 0.461 million pounds in 2007, which is a 74% reduction from 1995 levels. The NRCA members have maintained a high level of nitrogen removal at their respective facilities since implementation of the Neuse River Nutrient Management Strategy. In 2016, the NRCA discharges delivered 0.593 million pounds of nitrogen to the Neuse Estuary, which represents approximately 50% of the NRCA's permitted nitrogen allocation of 1.187 million pounds of nitrogen.

The Neuse River Basin has experienced tremendous growth over the past 20 years. Figure 2 illustrates member discharge total flow and nitrogen delivery to the Neuse Estuary compared to the NRCA's collective nitrogen allocation. In 1995, the average daily flow of the members was 83.8 mgd, the total nitrogen delivery to the Neuse Estuary was 1.784 million pounds (or 7.3 mg/L TN) with a basin population of approximately 1.1 million people. In 2014, the total nitrogen delivery to the Neuse Estuary was 0.568 million pounds (or 1.7 mg/L TN) at an average daily flow of 108 mgd with a population increase to approximately 1.85 million or an increase greater than 50% in population.

To date the NRCA provides significant flexibility for its members by providing a means for collective compliance with the Neuse Estuary TN allocation. For example, Contentnea MSD (CMSD) required several years to arrange funding for the construction of a new 3.0 mgd facility. CMSD was able to lease nitrogen during this time period to remain compliant until construction was completed. The cost of the new facility was approximately $30 million to serve a population of 15,000.

The NRCA also provides a good mechanism for nitrogen trading. Table 3 summarizes point source nitrogen leases and sales that have occurred to date. To date, most transactions have been short-term leases, although a few permanent nitrogen sale transactions have occurred. The average nitrogen sale price currently is approximately $500 / lb of nitrogen.

The NRCA has been the primary vehicle for the point source achievement and nitrogen reductions through its innovative approach allowing the members reduce nitrogen through incentives and trading in the organization. Member facilities are achieving effluent nitrogen concentrations that are below the standard best available technology of 3.0 mg/L. For example, in 2017, members achieved a total nitrogen concentration delivery to the Neuse Estuary of 2.81 mg/L in 2017 including the City of Raleigh's land application debit and 2.53 mg/L, excluding the City of Raleigh's land application debit.

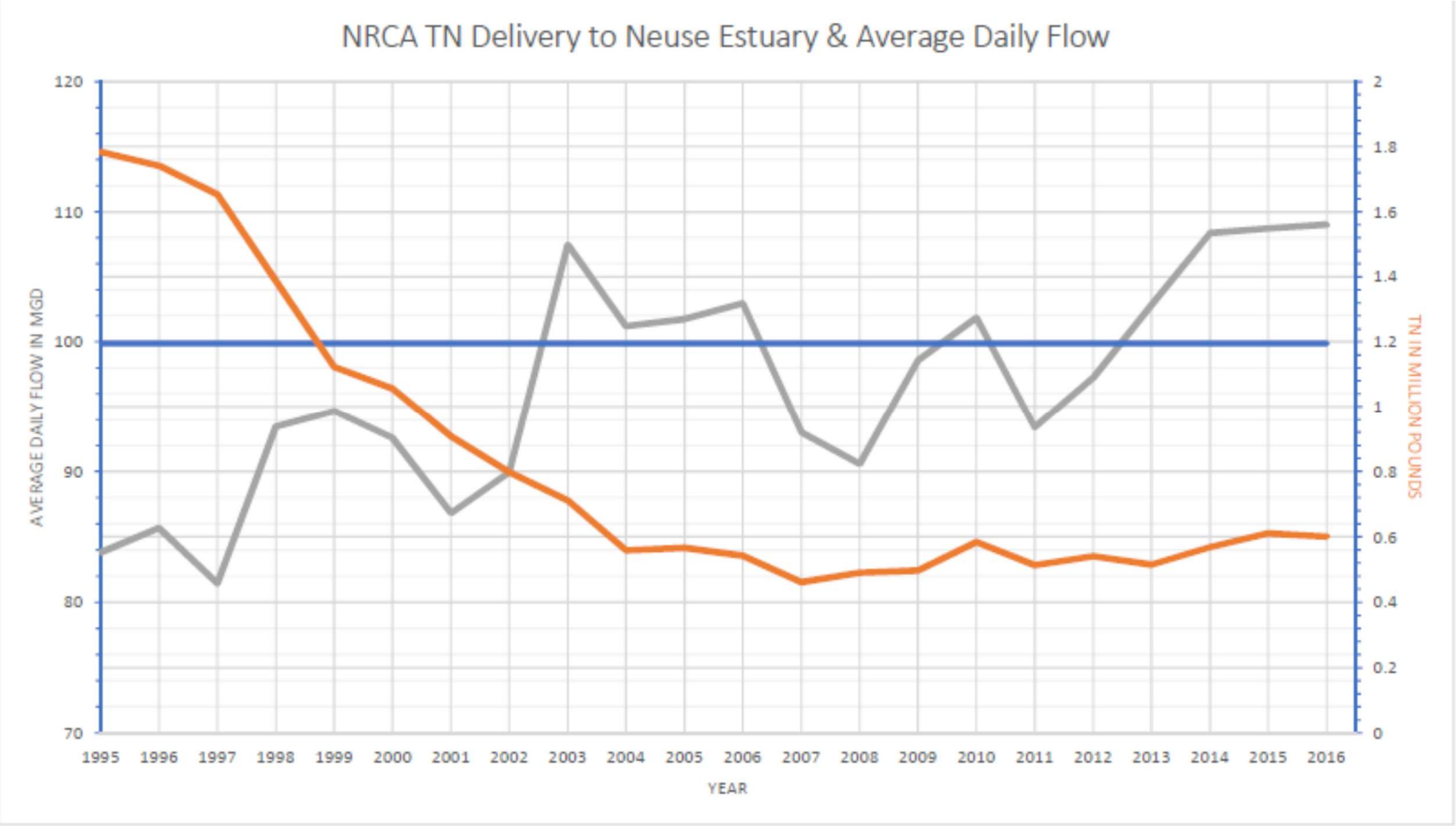

Figure 2. TN Delivery to the Neuse Estuary and Average Daily Flow for the Neuse River Compliance Association compared to TN Permit Allocation of Approximately 1.2 Mlbs/year.

Table 3. Summary of NRCA Point Source Nitrogen Leases and Sales.

Year	Type of Nitrogen Transaction	Seller/Leasor	Buyer/Leasee	Estuary Lbs. of Nitrogen *	Cost per Pound
2017	Lease	Contentnea MSD	CWS, Inc.	7,000	$ 5.00
	Lease	NRCA	Craven County	50	9.00
	Lease	Dow-Dupont	Craven County	307	4.00
2016	Lease	Contentnea MSD	Town of LaGrange	1,000	$ 4.00
	Lease	NRCA	Craven County	50	9.00
2015	Lease	Contentnea MSD	Aqua, N.C., Inc.	750	$ 4.00
	Lease	Contentnea MSD	Town of LaGrange	1,300	4.00
	Lease	NRCA	Craven County	50	9.00
2014	Lease	Contentnea MSD	Aqua, N.C., Inc.	4,000	$ 4.00
	Lease	Contentnea MSD	Town of LaGrange	1,300	4.00
	Lease	NRCA	Craven County	50	9.00
2013	Lease	NRCA	CWS Systems, Inc.	1,000	$ 9.00
2012	Lease	NRCA	CWS Systems, Inc.	1,000	$ 9.00
	Sale	SGWASA	City of Raleigh, N.C.	2,445	330.00
2010	Lease	NRCA	Progress Energy	9,000	$ 9.00
	Lease	Dupont - Kinston	Aqua, N.C., Inc.	1,200	4.00
	Lease	Johnston County, N.C.	Town of Kenly, N.C.	1,577	8.18
	Lease	Dupont - Kinston	Contentnea MSD	15,000	4.00
	Sale	UNIFI, LLC, Kinston, N.C.	Contentnea MSD	3,500	4.00
2009	Lease	NRCA	Progress Energy	9,000	$ 9.00
	Lease	Dupont - Kinston	Aqua, N.C., Inc.	2,500	4.00
	Lease	Johnston County	Town of Kenly, N.C.	1,745	8.18
2008	Lease	Johnston County, N.C.	Town of Kenly, N.C.	2,100	$ 8.18
	Lease	UNIFI, LLC, Kinston, N.C.	Aqua, N.C., Inc.	3,500	4.00
	Sale	Town of Benson, N.C.	Johnston County, N.C.	360	490.80
2007	Lease	Johnston County, N.C.	Town of Kenly, N.C.	1,800	$ 8.18
	Lease	NRCA	MCAS Cherry Point	5,000	3.00
	Sale	UNIFI, LLC, Kinston, N.C.	Johnston County, N.C.	1,645	490.80
	Sale	UNIFI, LLC, Kinston, N.C.	Town of Clayton, N.C.	1,645	490.73

Table 3. Summary of NRCA Point Source Nitrogen Leases and Sales, Continued

Year	Type of Nitrogen Transaction	Seller/Leasor	Buyer/Leasee	Estuary Lbs. of Nitrogen *	Cost per Pound
2006	Lease	UNIFI, LLC, Kinston, N.C.	Contentnea MSD	5,000	$ 2.00
	Lease	Johnston County, N.C.	Town of Kenly, N.C.	3,000	3.00
	Lease	NRCA	MCAS Cherry Point	10,000	2.00
	Sale	SGWASA	Town of Clayton, N.C.	3,668	490.73
2005	Lease	UNIFI, LLC, Kinston, N.C.	Contentnea MSD	1,800	$ 2.00
	Lease	Johnston County, N.C.	Town of Kenly, N.C.	1,800	3.00
	Lease	NRCA	MCAS Cherry Point	20,000	1.50
2004	Sale	Bay River MSD	Town of Butner, N.C.	6,113	$ 275.00

Notes:

1 Town of Butner, N.C. transferred their WWT facilities (and nitrogen allocation) to SGWSA in 2006.
2 NRCA - Neuse River Compliance Association
3 MCAS Cherry Point - Marine Corp Air Station, Cherry Point, Havelock, N.C. (mulitple year lease).
4 Bay River MSD - Bay River Metropolitan Sewer District, Bayboro, N.C.
5 Contentnea MSD - Metropolitan Sewer District, Grifton, N.C.
6 SGWASA - South Granville Water & Sewer Authority, Butner, N.C.
7 Nitrogen lease - Temporary annual transfer for individual permit compliance.
8 Nitrogen sale - Permanent transfer of nitrogen allocation between two parties.
9 * Transport factor for "end of pipe" nitrogen value must be calculated for each individual permit holder.

CHALLENGES AND UNIQUE TWISTS TO DATE

Despite the significant point source reductions achieved by the NRCA, the Neuse Estuary nitrogen reduction goals have not been achieved based on ongoing water quality monitoring (See Figure 3). The Estuary does experience reduced nutrient response effects, such as less frequent fish kills, and less excursions of the chlorophyll-a water quality criteria of 40 µg/L. Despite significant decreases in point source nitrogen loads, the Estuary has experienced an increase in organic nitrogen concentrations over time, which studies have attributed to nonpoint sources (AquAeTer, 2016). This trend stresses the importance of including all different sources of nitrogen loads for effective watershed-level nutrient management. It is important to note that the 1997 Nutrient Management Strategy's 30% reduction goal was established without a model to allocate TN among all sources. For example, nonpoint sources have no allocated TN budget and small point discharges of less than 0.5 mgd do not have TN limits.

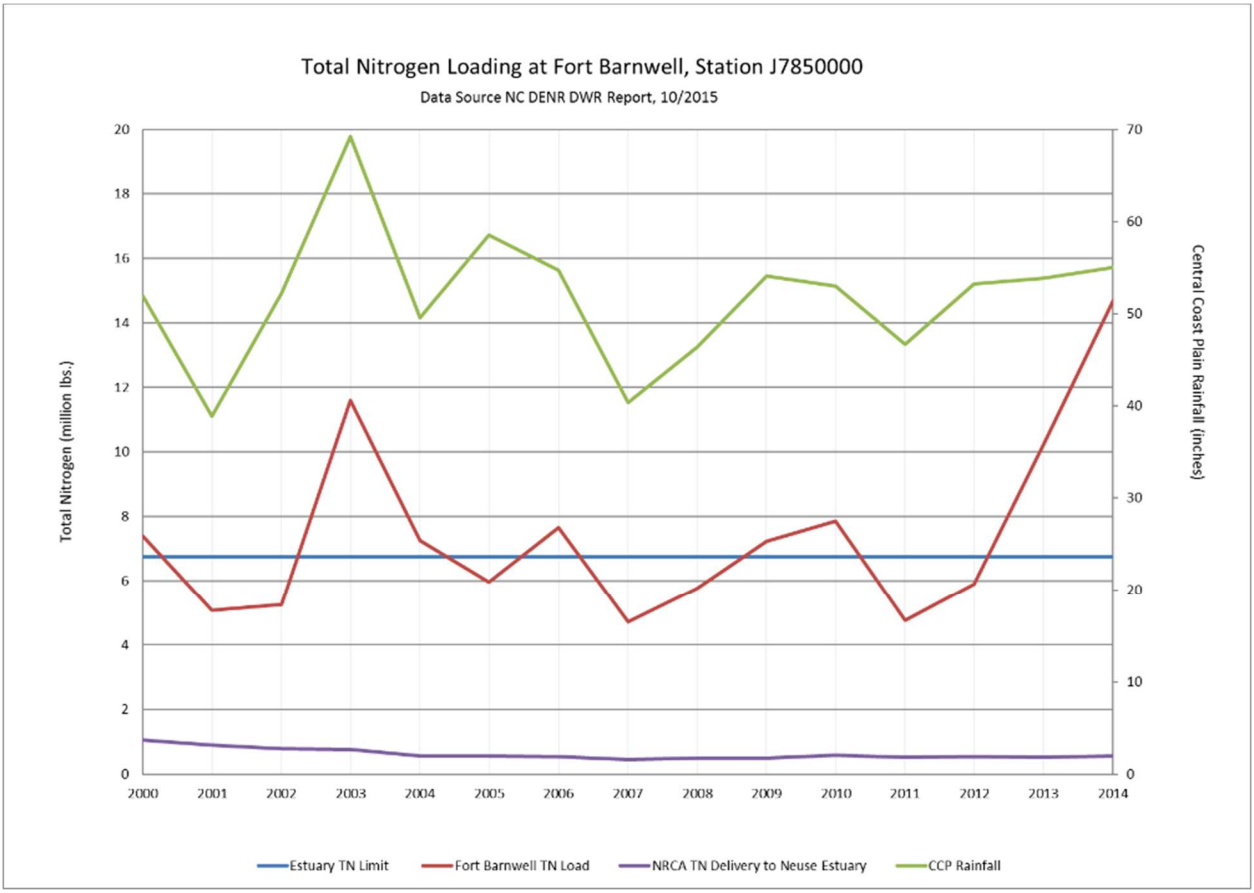

Figure 3. Example TN Loading at one of Monitoring Stations (note this does not represent total load to the Neuse Estuary as does not include Trent River).

One unique twist that has been experienced since inception of the NRCA was the development of additional management strategy for Falls Lake in 2011 which resulted in more stringent limits for dischargers located in the Upper Neuse River Basin. This resulted in further point source reductions for the Neuse Estuary, which provided additional benefits for freeing up some nitrogen allocation that can be traded among the point source discharges. However, it is noted that the transport factor for the Upper Neuse dischargers is 10%, which means that 1 lb of nitrogen reduction achieved in the Upper Neuse, translates to only 0.1 lb of nitrogen reduction in the Neuse Estuary.

Another potential unique twist is the potential for development of additional or more stringent nutrient related water quality criteria for North Carolina's waters. In 2014, the North Carolina Division of Water Resources adopted a Nutrient Criteria Development Plan which sets out a path for the state to evaluate the need for alternative nutrient criteria for different types of watersheds within North Carolina. Initial steps are to explore the need to alternative nutrient criteria for three different pilot watersheds, which include a lake, a river, and an estuarine water. The criteria developed from the three different pilot watersheds are anticipated to then serve as a basis for applying to similar watersheds in the future. The NC Division of Water Resources has previously indicated that they do not anticipate that the NCIP will affect existing nutrient TMDLs, but the potential for alternative or more stringent water quality criteria is still a possibility that is being closely monitored because it could potentially trigger new listings on the 303(d) list for nutrient impaired water bodies. The development of a more stringent nutrient management strategy for Falls Lake is an example of how additional nutrient reduction requirements can be triggered for another sub-basin within a river basin that has an existing TMDL.

CHALLENGES AHEAD

Some of the biggest challenges for the NRCA still lay ahead. In 2017, the NRCA projected that, based on 3% growth in the basin, the NRCA could reach its permitted total nitrogen limit prior to 2040 (See Figure 4). In addition, one member is currently in need of obtaining additional nitrogen allocation credits for a proposed permit expansion. So, while there is point source nitrogen allocation available for point source trading currently, the availability of point source nitrogen credits will dwindle and are not a sustainable solution for meeting the NRCA's projected nitrogen allocation needs in the future. In addition, it is noted that many of the facilities are already meeting very low levels of TN discharge concentrations that are below what is considered the limit of conventional treatment technology, so it is anticipated that additional nitrogen reduction treatment improvements will not be a solution for meeting the estuary nitrogen load allocation. For example, for the year 2016, twelve out of 23 facilities achieved an annual average effluent TN of less than 3 mg/L. With many of the member facilities achieving less than 3 mg/L effluent TN, strategies for nutrient discharge compliance must go beyond technology reduction improvements alone.

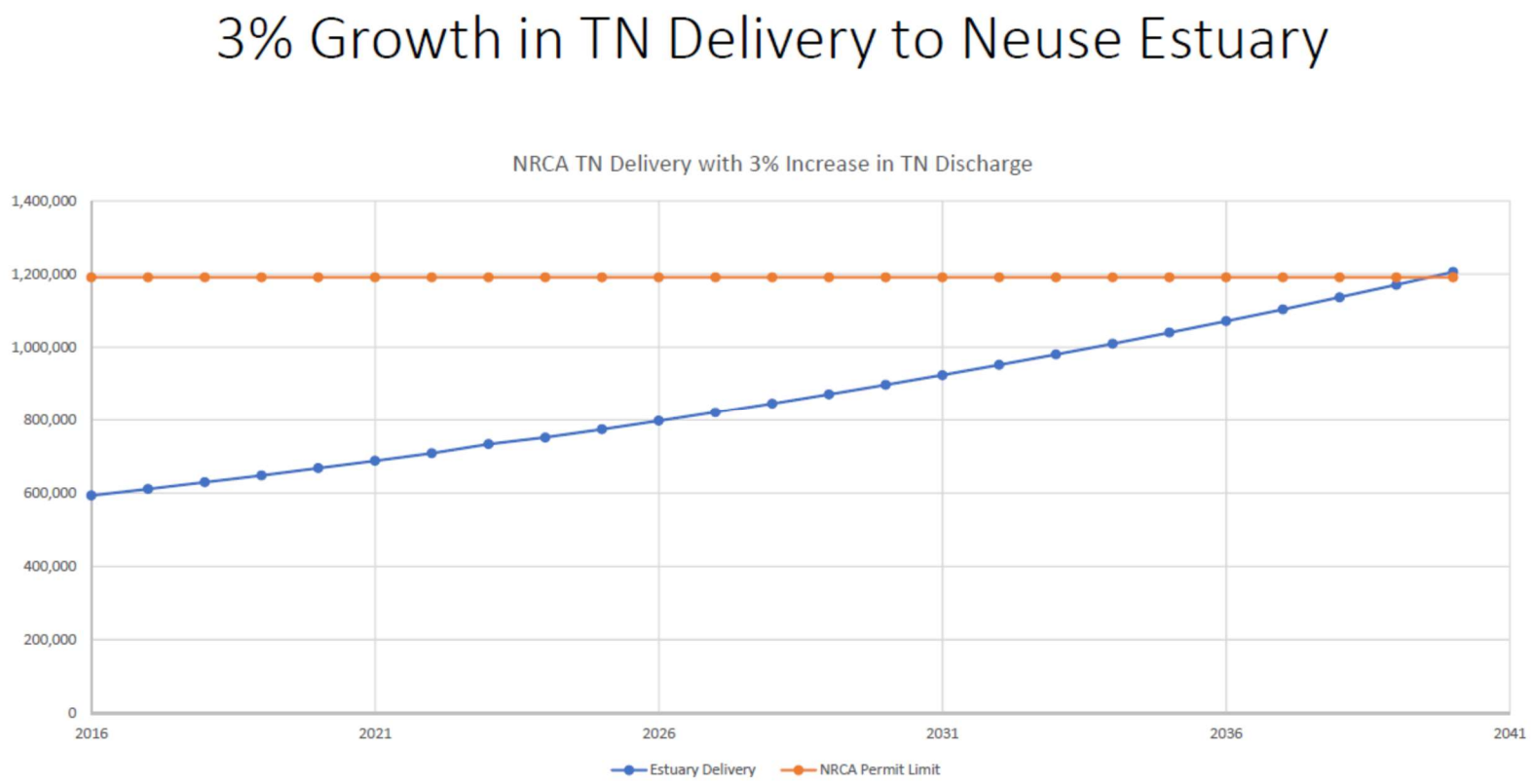

Figure 4. Projected TN Delivery to the Neuse Estuary assuming 3% Increase in Discharge TN per Year.

Another potential solution is point to nonpoint source trading. The current program allows for purchasing nonpoint nitrogen mitigation credits. However, the current rules for point to nonpoint source trading are very costly to point source dischargers, whom are required to purchase an equivalent nitrogen credit at two times the standard offset rate for nonpoint source controls and requires that 30 years of nitrogen credit be purchased ahead of requesting the additional allocation. For example, if a utility needs 10 mgd of additional nitrogen allocation at 3.5 mg/L TN, then the current offset rules would require that the entity purchase $136 million of nitrogen offset credits prior to applying for the requested permit expansion. It is noted that this does not include any costs related to construction improvements needed to meet the nitrogen discharge limits for the expanded flow.

This has prompted discussions on how the NRCA and its members will address the nitrogen reserve depletion with continued growth and continued discussions for additional point to nonpoint trading in the future. Proposed changes to the point to nonpoint source trading rules are currently under discussion and consideration by the EMC (NC Department of Environmental Quality, 2018). The trading rules are considered overly conservative in comparison to more recently adopted point to nonpoint trading rules adopted for other major watersheds in the country. The proposed changes under consideration would allow point source discharges to purchase credits for 10-years at a rate of 1.1 to 1 for nonpoint source to point source allocation with no nitrogen monitoring and 1 to 1 if nonpoint nitrogen reductions are monitored. In addition, it is proposed that the entity be required to show that a contractual obligation to purchase the credit is in place at the time that the permit expansion is requested, but that purchase of credits is not needed until the entity moves forward with construction of the expansion. These proposed changes would significantly reduce the costs to point sources to purchase offset credits. In the same example as described above, a utility needing 10 mgd of additional nitrogen allocation at 3.5 mg/L TN, would need to have entered into contractual agreements to purchase 10-years of nitrogen credits at an estimated cost of $23 million which is a significant cost reduction in comparison to the cost burden under the existing rules.

SUMMARY AND CONCLUSIONS

In summary, the Neuse River Nutrient Management Strategy has resulted in significant reduction of nitrogen point source loads to the Neuse River Basin. The NRCA has provided flexibility to its members to collectively comply with the nitrogen TN load allocation and has been a success to date. Although the Neuse River Nutrient Management Strategy requires 30% nitrogen reduction goals be met for other sources, including nonpoint and stormwater, water quality monitoring indicates that the nitrogen load limit for the Neuse Estuary is not being met and that there has been an increase in nitrogen loads to the Neuse Estuary in recent years. Despite significant decreases in point source nitrogen loads, the Estuary has experienced an increase in organic nitrogen concentrations over time, which studies have attributed to nonpoint sources (AquAeTer, 2016). This trend stresses the importance of implementing effective nutrient management / reduction strategies that address all different sources of nitrogen loads for effective watershed-level nutrient management.

While the NRCA has been a success to date, members face significant challenges ahead in securing nitrogen mitigation credits needed to accommodate growth in the area with the NRCA anticipated to be at its total TN discharge allocation before 2040. The challenges with the current rules for obtaining cost effective mitigation credits stress the importance of reasonable trading rules for promoting point to nonpoint source trading.

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