June 2007

A Study of the Costs Associated with Providing Nutrient Controls that are Adequate to Offset Point Source and Nonpoint Source Discharges of Nitrogen and Other Nutrients

Final Report

Prepared for

Environmental Review Commission

Prepared by

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EXECUTIVE SUMMARY

In the 2005 General Assembly session, Senate Bill 1862 called for the General Assembly's Environmental Review Commission to conduct a study of the Nutrient Offset Fee Payment Program (NOFPP). The NOFPP is administered by the Ecosystem Enhancement Program (EEP), which can use the funds paid by excess emitters to construct nutrient controls within the river basin that offset the excess nutrients they emit. The objectives of this study include the following:

- Objective 1: Evaluate the sustainability of the program at the current fee of $11 per pound of nitrogen
- Objective 2: Develop a proposed fee based on the cost-effectiveness analysis
- Objective 3: Develop a formula for calculating the offset payment fee
- Objective 4: Assess the advantages and disadvantages of expanding the nutrient offset payments to other nutrients and additional areas of the state
- Objective 5: Evaluate the ability of public (other than the EEP) and private entities to provide nutrient offsets
- Objective 6: Develop a comprehensive review of potential nutrient mitigation efforts available

This study was contracted to RTI International in the spring of 2007. To assess the issues, RTI held meetings with all stakeholder groups and solicited best management practice (BMP) cost data from all available groups. The findings from the analysis are summarized below.

Because the type of offset projects undertaken by the EEP in the future significantly influences the financial analysis, three scenarios are evaluated for Objectives 1, 2, and 3.

- ***Scenario A: All Buffers***. The EEP implements exclusively riparian buffers on land obtained through conservation easements and purchased land. Based on RTI's assessment of the amount of land in the 50-foot buffer zone and projections of future competing demand for that land, this option should be viable for the foreseeable future (i.e., through 2020).
- ***Scenario B: Integrated Implementation***. In addition to buffers, the EEP pursues a number of stormwater wetland offset projects to target integrated environmental objectives. This results in higher costs per pound of nitrogen and phosphorous.
- ***Scenario C: All Stormwater Wetland Retrofit.*** The EEP does not undertake any buffer projects and instead installs all stormwater wetland projects, which again enables offset projects to be implemented closer in proximity (e.g., in local

watersheds) to where development is occurring, and again increasing the costs per pound of nitrogen and phosphorous.

E.1 Objective 1: Program Sustainability at $11 per Pound of Nitrogen

NOFPP program expenditures exceed revenue in the first year of the analysis for all three scenarios analyzed. The gap between offset fee revenue and program expenditures then widens with time as maintenance costs are incurred for projects initiated in previous years. In summary, given an $11/lb of nitrogen fee, the NOFPP program is currently unsustainable.

E.2 Objective 2: Proposed Fee Based on Cost-Effectiveness

We define cost-effectiveness as the offset fee that would be required for the NOFPP to be sustainable through the year 2020. The fixed offset fees for both river basins that yield a sustainable program through 2020 for each scenario are presented in Tables E-1 and E-2. Cost differences between the Neuse and Tar-Pamlico river basins are due to differences in land costs (design, construction, and maintenance costs are the same in the two river basins).

Table E-1. Cost-Effective Offset Fee for the Neuse River Basin

	Cost-Effective Offset Fee[a] ($/lb-30 N)	Cost-Effective Offset Fee ($/0.10 lb-30 P)
Scenario A	$25.77	$33.19
Scenario B	$43.94	$41.23
Scenario C	$94.80	$62.91

[a] Offset fee that allows the program to be sustainable through 2020.

Table E-2. Cost-Effective Offset Fee for the Tar-Pamlico River Basin

	Cost-Effective Offset Fee[a] ($/lb-30 N)	Cost-Effective Offset Fee ($/0.10 lb-30 P)
Scenario A	$19.70	$26.02
Scenario B	$39.40	$35.38
Scenario C	$90.21	$59.77

[a] Offset fee that allows the program to be sustainable through 2020.

E.3 Objective 3: Formula for Offset Payment Fee

The specification of the formula for the offset payment fee varies depending on the type of mitigation options pursued and the underlying rationale for pursuing them. For Scenarios A and C, we recommend the simple fixed cost-effective dollar per pound factors (presented in Table E-1 and Table E-2) with a 10% administrative surcharge. Both scenarios are implemented through as a single BMP option; thus, there is minimal variation in NOFPP expenditures with respect to where the offset payments originate.

Payment = ($/lb)(#of lbs/year)(30 years)(1.1 AdminCosts)

Scenario B implements a mixture of buffers and stormwater wetlands. For this scenario we recommend incorporating the cost of the land being developed as a proxy for the type of mitigation project that would be needed to meet local environmental objectives.

Payment = [($/lb)(#of lbs/year)(30 years)* (Total Land Cost $/14,000)^(Exp)* (1.1 AdminCosts)

E.4 Objective 4: Expanding Nutrient Offset Payments

Other waterbodies in North Carolina, such as the Chowan River Basin, Jordan and Falls reservoirs, High Rock Lake, and other large reservoirs in the Catawba and Yadkin basins, could be considered candidates for extending the nutrient offset program. In terms of the potential extension of the program to nutrients besides nitrogen and phosphorus, RTI is not currently aware of any studies in North Carolina indicating that other nutrients (e.g., silica) should be considered.

E.5 Public versus Private Implementation

The EEP currently serves as the sole gateway for purchasing nutrient offsets in the Neuse and the Tar-Pamlico river basins. It receives payment for excess nutrients emitted by nonpoint sources, which it then uses to construct BMPs that will offset them. However, there are a wide range of alternative operational structures that could be developed, such as a market-style nutrient trading system.

Market-style structures can have significant advantages. In particular, the price paid by demanders of nutrient offsets would be determined by the interaction of market forces (supply and demand), which would ultimately ensure that the price these individuals pay for their excess nutrient loads will be enough to fund the BMP projects required to offset them. As a consequence, market-style structures will have great flexibility in the face of changes in supply (e.g., increasing costs of offsetting nutrients) and demand (e.g., increasing development driven by population growth). However, a regulatory body would be required to ensure that suppliers of nutrient offsets are generating the offsets they claim and to provide other regulation and oversight. If such a market-style structure were pursued, the EEP would be among the most well-suited government entities for providing this supervision because of their past experience managing the NOFPP program.

The NOFPP seems well suited for market trading. That demand is sufficient to support such a structure is illustrated by the large amount of nutrient offsets already purchased under the program. In addition, the successful completion of several full-delivery projects under the current program illustrates the fact that private entities have the capabilities to generate the nutrient offset credits that would be required in such a market.

E.6 Mitigation Options Available

Current mitigation options being implemented in North Carolina primarily fall into the categories of riparian buffers, stormwater wetlands, bioretention ponds, and wet ponds. Additional mitigation projects identified include sand filters, underground sand filters, infiltration practices, and water quality swales. However, in general, these mitigation options are more costly.

E.7 Stakeholder Concerns

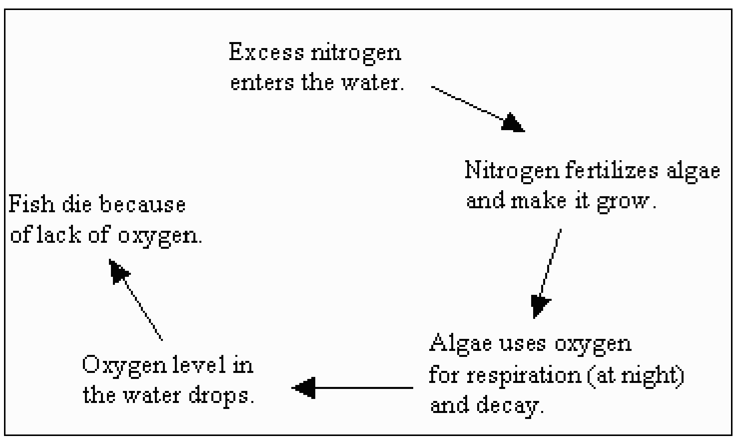
During our interviews with stakeholders, several shared the concerns that instituting higher nutrient offset fees could potentially have serious consequences for the pace and distribution of economic growth in the state of North Carolina. By raising the offset fee, one is also raising the cost of new development in the Neuse and Tar-Pamlico river basins. This could lead to people and firms locating in other parts of the state, slowing economic growth in areas affected by the NOFPP, or lead to less development overall, thus slowing growth for the entire state. Therefore, stakeholders urge policy makers to weigh the benefits of environmental protection against the potential costs to the state economy. In addition, stakeholders representing point sources, such as wastewater treatment facilities, expressed concern about the possibility that its members will need to use the NOFPP when they seek to expand their facilities to accommodate population growth, which would significantly increase their cost of service.

SECTION 1
HISTORICAL BACKGROUND

Nutrient pollution has been a concern in the Neuse River since the mid-1970s. By 1988, the entire Neuse River Basin had been classified as nutrient sensitive waters (NSW) by the Environmental Management Commission (EMC). This new classification led to more stringent nutrient limits for wastewater facilities and inspired a variety of other actions aimed at reducing nutrient discharges, such as a statewide ban on phosphate detergents (NCDWQ, 2002).

However, despite these initiatives, the Neuse River continued to face water quality problems. These problems came to a climax in the summer of 1995 when record rainfalls delivered a tremendous load of nitrogen into the river system. This excess nitrogen stimulated the growth of algae blooms and deprived hundreds of fish of the oxygen they needed to survive (see Figure 1-1).

Figure 1-1. Consequences of Excess Nitrogen in the Neuse River



Source: NCDWQ, 1998.

The General Assembly responded to the situation by passing House Bill 1339, which established the goal of reducing the amount of nitrogen delivered to the Neuse River Estuary by 30% over 5 years (NCDWQ, 1998). On December 11, 1997, the EMC followed this legislation with the adoption of the Nutrient Sensitive Waters Management Strategy, a collection of rules that outlined the nutrient loading limits for point and nonpoint sources, as well as other regulations that would be used to meet the legislature's reduction goal. This strategy was subsequently reviewed by the North Carolina Rules Review Commission and the General Assembly in its 1998 short session (NCDWQ, 2002a).

1.1 Nutrient Offset Fee Payment Program

Under the NSW Management Strategy, all new residential and commercial developments in the Neuse River Basin had to limit the amount of nitrogen released into the river to 3.6 pounds per acre per year. If a development failed to meet this limit, the development's owner had the option of either installing nutrient controls on the development site (also known as best management practices or BMPs) or voluntarily paying a specified fee to the North Carolina Wetland Restoration Fund as part of the Nutrient Offset Fee Payment Program (NOFPP). Table 1-1 provides an overview of the key rules.

Table 1-1. Pollutant Load Limits in the Neuse and Tar-Pamlico River Basins

River Basin	Rule
Neuse	The requirements in the Neuse Stormwater Rule 15A NCAC 2B.0235B for new developments require a 30% reduction in nitrogen loads, based on 1995 land use data, in nonurban areas of the Neuse River Basin and no net increase in the stormwater runoff volume generated by the 1-year, 24-hour storm.
Tar-Pamlico	The requirements in the Tar-Pamlico Stormwater Rule 15A NCAC 2B.0258 for new developments require a 30% reduction in nitrogen loads, based on predevelopment land use data, and no increase in phosphorus loads.

The Ecosystem Enhancement Program (EEP), which has administered the Wetland Restoration Fund under the Department of Environment and Natural Resources (DENR), would use the fees collected under this program to construct BMPs elsewhere in the river basin to offset the excess nutrients those developers emit (NCDWQ, 2006). It is important to note that, as the law and the rules are written, the EEP can construct the BMP anywhere in the Neuse River Basin as long as it prevents nutrients from reaching the Neuse River Estuary.

However, it should be noted that developers only had the option of using the NOFPP if they met certain requirements. These requirements differed based on whether the development was commercial or residential. If it was a residential development, the owner had to use (if necessary) on-site nutrient controls to reduce their nitrogen discharges to 6.0 pounds per acre per year before he/she was eligible to take advantage of the NOFPP. On the other hand, if the development was commercial, the owner had to use on-site BMPs to reduce nitrogen discharges to 10 pounds per acre per year before it was eligible to use the NOFPP.

The original offset fee paid by developers for excess nitrogen discharges was set in 1998 at a fixed rate of $11 per pound of nitrogen per year. However, this fee was estimated without the benefit of historical data for what offset mitigation projects would cost (NCDWQ, 2006).

1.2 Recent Changes to the Nutrient Offset Payment Program

In 2005, a series of amendments were proposed to the NSW Management Strategy. These amendments sought to expand the offset program to cover new river basins and nutrients; update the way nutrient offset payments are calculated to reflect the true and changing costs of mitigation, as well as to make pursuing projects closer to the location of environmental impact more feasible; and finally to reorganize and change the destination of nutrient offset payments from the Wetland Restoration Fund to the Riparian Buffer Restoration Fund.

First among the changes proposed by these amendments was that the offset payment program be expanded to the Tar-Pamlico River Basin to allow developers in that river basin the option of participating in the program in lieu of complying with the strict nutrient loading limits in the Tar-Pamlico NSW Rule (15A NCAC .0258) (NCDENR, 2005b).

However, there were several key differences between the offset payment program in the Neuse and the one proposed for the Tar-Pamlico. First, the nitrogen loading requirements were different in each river basin. The Neuse rules require that developers limit their nitrogen discharges to 3.6 pounds per acre per year, whereas the rules in the Tar-Pamlico region only require emitters to limit their nitrogen loading to 4.0 pounds per acre per year (NCDENR, 2005b).

Second, since the Tar-Pamlico NSW Rule also specifies limits for the amount of phosphorus developers can emit into the river basin (0.4 pounds per acre per year), the offset payment program in the Tar-Pamlico would provide developers with the option of paying an offset fee similar to the one paid for nitrogen in lieu of complying with the strict phosphorus limit.[1] According to these amendments, developers would be charged $45 per tenth of a pound of phosphorus per year (NCDENR, 2005b).

In addition to these changes, the 2005 amendments also proposed to change the methods and prices used to calculate a developer's total nutrient offset fee. First, the amendments would raise the price of loading nitrogen into the Neuse and Tar-Pamlico river basins from $11 per pound per year to $57 per pound per year. This new fee was intended to better reflect the true cost of mitigation and to provide the EEP with more flexibility as to the types of nutrient controls it could afford to pursue (NCDENR, 2005b).

[1] In cases where a developer wishes to use the nutrient offset payment option, but emissions of both nitrogen and phosphorus exceed mandatory limits, the developer would only be expected to pay the more expensive of the two fees. This procedure was established to avoid charging developers twice for the same nutrient emissions.

Second, the amendments proposed using a new formula for calculating the total fee that developers would have to pay to participate in the nutrient offset program. This new formula was intended to establish an automatic updating mechanism and incorporate the land costs associated with mitigation requirements to allow the EEP the flexibility of pursuing BMP projects closer to the point of impact. The proposed formula for nitrogen is included as follows (the formula for phosphorus is similar in structure) (NCDENR, 2005b):

Nitrogen Payment = [($/lb)(# of lbs/year)(30 years) + (Land Cost $/Ac) (1 Ac/35 Ac) (Devel. in Ac)] x (1.1 Ad Costs)

where

$/lb	=	the cost of mitigation in dollars per pound of nitrogen mitigation. As stated earlier, this fee was to be established at $57 per pound of nitrogen and $45 dollars per tenth of a pound of phosphorus by the proposed amendment. This fee would be updated annually based on the construction cost index, published in the *Engineering News Record*.
# of lbs/year	=	the number of pounds of nitrogen discharged each year for which mitigation is being requested.
Land Cost $/Ac	=	the current value of the property being developed as measured in dollars per acre. This value is based on the most recent county tax assessment.
1 Ac / 35 Ac	=	an adjustment factor, indicating that 1 acre of mitigation is required for every 35 acres of development.
Devel. in Ac	=	the overall size of the development, as measured in acres, for which mitigation is being requested.
1.1 Ad Costs	=	an adjustment factor used to reflect the administrative costs associated with the requested mitigation.

The final change proposed in the amendments was that the destination of nutrient offset payments from the NC Wetland Restoration Fund be changed to the Riparian Buffer Restoration Fund. This change was intended to provide the EEP with more flexibility in disposing of funds obtained from the nutrient offset program, because the projects that could be pursued under the Riparian Buffer Restoration Fund did not face the same restrictions as those that could be pursued under the NC Wetland Restoration fund (NCDENR, 2005b).

These changes proposed by the amendments became effective on March 1, 2006, during the 2005 short session of the North Carolina General Assembly (NCDWQ, 2006). However, later in the session, some of these changes were temporarily rescinded by Senate Bill 1862. This bill required that a) nutrient offset fees be temporarily lowered to $11 per pound of nitrogen and $11 per tenth of a pound of phosphorus, b) that a study of the nutrient offset payment be commissioned, and c) that payments made under the higher fee structure be refunded.

SECTION 2
NUTRIENT OFFSET PROGRAM ACTIVITIES TO DATE

Since the NOFPP's inception, the EEP has received $10,682,594 in fees ($11,670,996 in inflation-adjusted 2006 dollars) to offset 961,477 pounds of nitrogen and 391 pounds of phosphorus in the Neuse and Tar-Pamlico river basins. Table 2-1 provides nutrient offset payments into the program dating back to May 2001. In this section, we discuss the BMP projects EEP has installed to offset these nutrients and the methods used to implement them.

Table 2-1. Nutrient Offset Payments, May 2001 through February 2007

Year	Current-Year Dollars	Inflation Adjusted, 2006 Dollars
2001	$387,065 [a]	$475,322 [a]
2002	$1,375,443	$1,729,008
2003	$1,281,030	$1,528,702
2004	$1,540,816	$1,730,923
2005	$2,314,203	$2,423,003
2006	$2,938,989	$2,938,989
2007	$845,049 [a]	$845,049 [a]
TOTAL	**$10,682,594**	**$11,670,996**

[a] Partial year data.

Source: Provided by the EEP in March of 2007.

2.1 EEP Nutrient Offset Projects

To date, the EEP has initiated 14 BMPs in the Neuse River Basin that were funded by the NOFPP. According to the EEP's estimates, these projects account for more than 532,400 pounds of nitrogen and 36,500 pounds of phosphorus reduction. In 2006, a temporary hold was placed on starting new nutrient offset projects pending the results of the proposed amendments described in the previous section.

Thus far, 8 of the 14 projects pursued by the EEP have been riparian buffers. The remaining six projects are stormwater wetlands and other structural BMPs. Figure 2-1 graphically juxtaposes the locations of the nutrient offset projects the EEP has pursued to date with the origin of offset payments the NOFPP has received. As this figure illustrates, the majority of projects are located in Wake and Johnston counties. These counties also account for a sizeable portion of the offset payments received by the NOFPP.

Figure 2-1. Nutrient Offset Projects and Payments by County of Origin

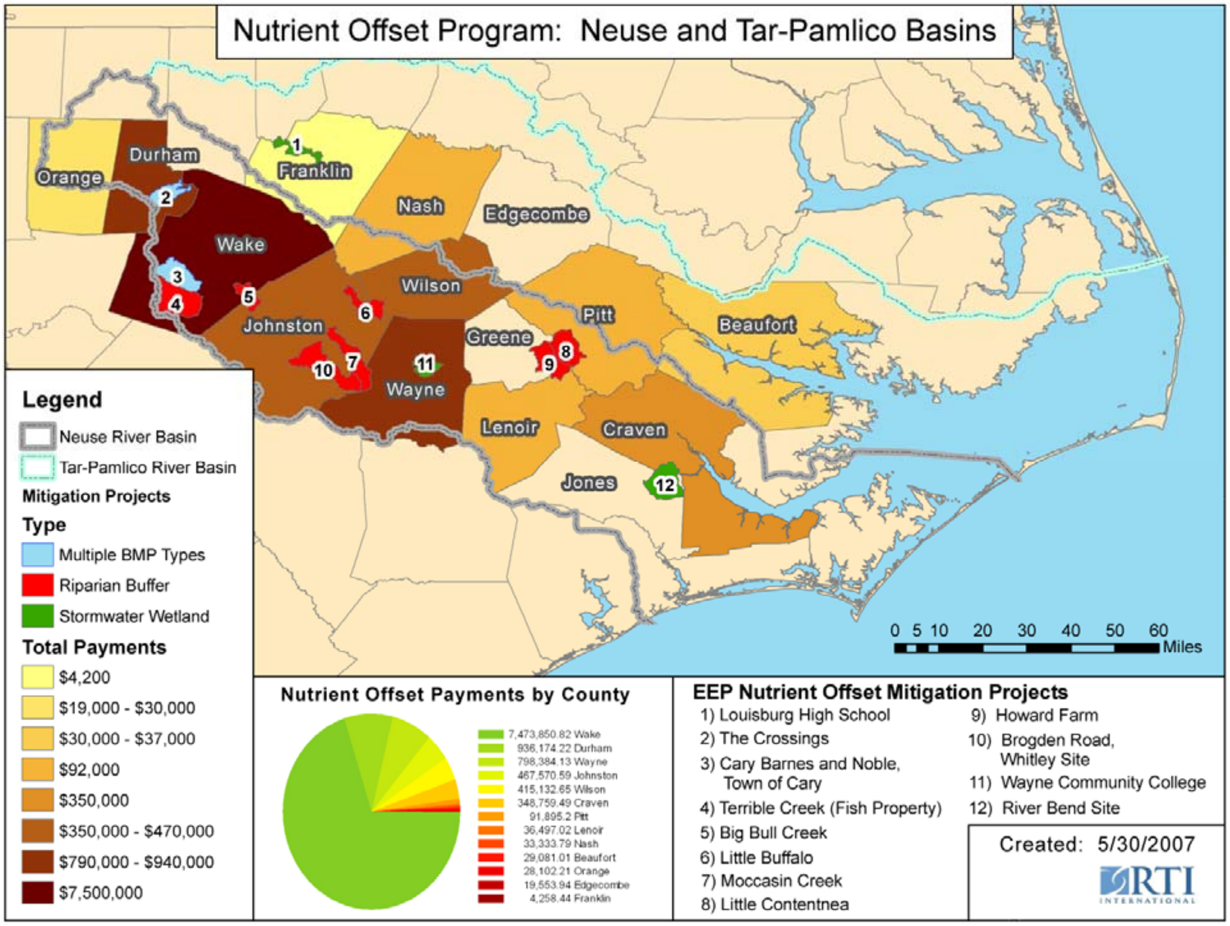


Table 2-2 summarizes specific information for each project initiated by the EEP. Included in this summary is the contract cost paid by the EEP and the pounds of nitrogen and phosphorus the EEP estimates that these projects offset over 30 years. By dividing the total cost for each project by the amount of nutrients it is believed to offset, we can calculate a dollars-per-pound-of-nutrient figure that can simplify comparisons between different projects. These calculations are reported in Table 2-3.

2.2 Project Design and Implementation Methods

The EEP uses two different methods for delivering these BMPs—design-bid-build and full delivery. Under the design-bid-build method, the EEP selects the mitigation site and type of BMP to be installed. Next, they contract with a private firm to design the project. Finally, they solicit bids from private contractors to construct the BMP and maintain it after its completion.

Table 2-2. EEP Nutrient Offset Mitigation Projects

Project Name	County	Type of Project	Stream Buffer (acreage)	Nitrogen Nutrient Reduction (pounds over 30 years)	Phosphorus Nutrient Reduction (pounds over 30 years)	Project Cost	Description	Consultant
Brogden Road	Johnston	Buffer project	15.00	34,096.50	2,196.00	420,000.00	Full delivery	Restoration Systems
Little Buffalo	Johnston	Buffer project	18.50	42,052.35	2,708.40	594,000.00	Full delivery	Restoration Systems
Big Bull Creek	Johnston	Buffer project	35.00	79,558.50	5,124.00	980,000.00	Full delivery	Restoration Systems
Terrible Creek Buffer (Fish Property)	Wake	Buffer project	45.60	103,653.36	6,675.84	29,555.50	Design only	Axiom
Whitley Site	Johnston	Buffer project	27.50	62,510.25	4,026.00	976,250.00	Full delivery	EBX
Moccasin Creek-Buffer	Johnston	Buffer project	20.20	45,916.62	2,957.28	427,815.80	Full delivery	Greene Environmental
Little Contentnea-Buffer	Greene	Buffer project	54.16	123,111.10	7,929.02	1,098,852.24	Full delivery	Greene Environmental
Howard Farm[a]	Greene	Buffer project	10.00	22,731.00	1,464.00	426,060.00	Full delivery	Land Management Group
BMP (River Bend Site) [b]	Craven	Stormwater wetland	0.00	5082	1560	58,275.00	Design, bid, build	NCSU
BMP (Town of Cary)	Wake	Multiple BMP Types	0.00	2820	450	400,950.00	Design, bid, build	Stantec
BMP (Wayne Community College)	Wayne	Stormwater wetland	0.00	4431	450	133,200.00	Design, bid, build	TetraTech
BMP (Cary Barnes and Noble) [b]	Wake	Multiple BMP Types	0.00	2820	510	$524,475	Design, bid, build	NCSU
The Crossings	Durham	Multiple BMP Types	0.00	2820	399	$435,350	Design bid, build	KO
Louisburg HS[b]	Franklin	Stormwater wetland	0.00	840	90	$63,500	Design, bid, build	NCSU

[a]Only portion of project funded with NOFPP. The reduction amounts listed are only those associated with what the NOFPP funded.

[b]Only portion of project costs reported. Other costs incurred as part of separate contracts.

Table 2-3. EEP Nutrient Offset Project Costs

Project Name	Restoration Practice	Project Cost ($/lb-30 N)[a]	Project Cost ($/0.10 lb-30 P)[b]
Brogden Road	Buffer project	$12.3	$19.1
Little Buffalo	Buffer project	$14.1	$21.9
Big Bull Creek	Buffer project	$12.3	$19.1
Terrible Creek Buffer (Fish Property)[c]	Buffer project	$0.3	$0.4
Whitley Site	Buffer project	$15.6	$24.2
Moccasin Creek-Buffer	Buffer project	$9.3	$14.5
Little Contentnea-Buffer	Buffer project	$ 8.9	$13.9
Howard Farm	Buffer project	$18.7	$29.1
BMP (River Bend Site)[c]	Stormwater wetland	$11.5	$3.7
BMP (Town of Cary)	Multiple BMP Types	$142.2	$89.1
BMP (Wayne Community College)	Stormwater wetland	$30.1	$29.6
BMP (Cary Barnes and Noble)[c]	Multiple BMP Types	$186.0	$102.8
The Crossings	Multiple BMP Types	$154.4	$109.1
Louisburg HS[c]	Stormwater wetland	$75.6	$70.6

[a] Cost per pound of nitrogen removed over 30 years.

[b] Cost per pound of phosphorus removed over 30 years.

[c] Does not report total cost.

Thus far, all of the structural stormwater BMP projects initiated by the EEP are being or have been delivered through the design-bid-build-process.

In full-delivery projects, the EEP plays a much less direct role in orchestrating the project. Using this method, the EEP first issues an RFP (request for project proposal) that indicates that it is looking for a contractor to construct a BMP in a certain river basin to offset a given amount of nutrients. Private construction firms identify potential sites and submit their project proposals to the EEP. The EEP then evaluates these proposals based on a number of criteria, such as total cost and whether the project fits with the EEP's overarching goal of improving watershed protection. As Table 2-2 indicates, almost 60% of the NOFPP BMPs have been full-delivery riparian buffer projects.

SECTION 3
BMP COST DATA

Any nutrient offset fee chosen by policy makers will ultimately have to cover the costs of pursuing the various BMPs required to offset the nutrient discharges of nonpoint sources. Therefore, understanding the costs of various BMP projects is essential and became the focus of RTI's data collection efforts. In this section, we describe the North Carolina BMP cost data collected for this study and the methods that were used to collect it.

3.1 Components of BMP Cost Data

For this study, we broke down the cost of constructing BMPs into four main cost components. The components include land, design, construction, and maintenance costs. The definition of each of these components is straightforward and similar for other types of construction projects.

- **Land** costs are incurred in obtaining access to or purchasing the land where the BMP will be placed.
- **Design costs** are the design and engineering fees. Design costs for a typical mitigation project are about 32% of construction costs (Schueler et al., in press), although design and engineering fees for stormwater retrofits requiring significant permitting efforts (e.g., retrofit projects requiring wetland permits) can run as high as 40%.
- **Construction** costs relate to the actual time, labor, capital, and materials used in designing and constructing the BMP.
- **Maintenance** costs are incurred in repairing, maintaining, and monitoring the BMP after it is constructed. For this analysis, we assumed a 30-year maintenance period, which corresponds to the offset fee formula.

An important distinction between these costs is that land, design, and construction costs are only incurred once in the life of the BMP, while maintenance costs will be incurred continually.

However, not all of the cost components may be relevant when calculating EEP offset expenditures. For example, land costs may not be incurred if public lands are available for pursuing mitigation projects. Maintenance costs may also not be relevant if local municipalities assume future maintenance responsibilities for offset projects. In the instances where land or maintenance activities are donated, we are not inferring that land opportunity costs or maintenance costs do not exist; they are just not incurred by the EEP and hence do not need to be covered by offset payments when assessing the fee structure needed to keep the NOFPP solvent.

In addition, it is also important to note that land costs may vary significantly based on the type of agreement involved. For example, costs are usually significantly lower when conservation easements are obtained as opposed to fee-simple purchases of land. Although the EEP has made outright purchases of land in the past, the vast majority of their projects are installed on land obtained through conservation easements. As a result, the remainder of this report exclusively deals with this form of agreement.

3.2 Identifying Stakeholders and their Concerns

The cost data collected by RTI were obtained from a wide range of stakeholder groups. To communicate the methods and objectives of this study and to facilitate data collection, several meetings with individual stakeholders were conducted:

- First stakeholder meeting at the Legislative Office Building, March 2, 2007
- Meeting with North Carolina Home Builder’s Association (NCHBA), March 8, 2007
- Meeting with Restoration Systems, March 13, 2007
- Meeting with Environmental Defense Fund, March 14, 2007
- Meeting with the EEP, March 15, 2007
- Meeting with Neuse River Compliance Association, March 19, 2007
- Second meeting at the Legislative Office Building, May 7, 2007
- Meetings with county and city representatives, May, 2007

In this section, we report the comments and suggestions that these stakeholders offered on the general approach and purpose of our study.

3.2.1 First Stakeholder Meeting at the Legislative Office Building

The primary purpose of this meeting was for RTI to present the methodology it proposed for accomplishing the objectives of the study of the NOFPP. However, the meeting also proved to be an excellent way to establish contacts with stakeholders, because it was attended by different stakeholder groups including private firms affected by the NOFPP—such as members of the North Carolina Homebuilders Association and EEP contractors—as well as employees of government entities such as the EEP and the North Carolina Division of Water Quality (NCDWQ).

The main topic of discussion during this meeting was the scope of RTI’s study and the purpose of the NOFPP in general. In particular, many individuals wondered whether it was appropriate for RTI to include land costs in the payment formula it was analyzing, because including them would only be relevant if BMPs had to be constructed close to the location of impact. However, the answer to this question hinged on the policy decision of whether the purpose of the NOFPP is to reduce the amount of nutrients in the Neuse and Tar-Pamlico river basin estuaries at the lowest cost, or whether its goal is to protect watersheds. As a result, it was suggested that RTI look at multiple scenarios that would encompass the spectrum of plausible policies.

The topic of land costs was closely related to another concern expressed during the meeting—that the EEP was trying to pursue expensive stormwater wetland projects, when there was still plenty of land available for buffer projects. Once again, the answer to this question would depend on the NOFPP's ultimate goal.

3.2.2 Meeting with North Carolina Home Builders Association

The purpose of this meeting was for RTI to meet directly with members of the NCHBA, to listen to their concerns, and to approach them for information on the costs of constructing BMPs and the predicted value of land in the future. This meeting was primarily attended by developers and representatives of private contracting and engineering firms.

The conversation during this meeting covered a wide variety of topics. The issue of the ultimate goal of the NOFPP was revisited from the first stakeholders meeting, as was the question of which BMPs were most appropriate for the EEP to pursue. However, new concerns were also expressed. In particular, many of the attendees worried about the impact that higher fees would have on the future of development in the two river basins. Their concerns led them to suggest ways of lowering the overall cost faced by developers when complying with nutrient loading limits.

For example, one individual noted that BMP projects installed in developments offer more benefits than just offsetting nutrients. In fact, these projects reduce the amount of other pollutants that reach the river system and contribute to the amount of open space available in the development. Therefore, if developers could be compensated for the additional benefits generated by the BMPs they construct—for example, if their stormwater wetlands counted toward their open space requirements—this would significantly reduce the costs developers face when complying with nutrient loading limits.

The NCHBA submitted additional comments in an e-mail received on May 21 from Suzanne Harris, Vice President of Governmental Affairs. In this e-mail, the NCHBA expressed concern with including administration costs as a multiplier in the formulas RTI proposed for calculating nutrient offset fee. They suggested that the multiplier could be incorrect if there are significant economies of scale (it becomes cheaper to manage more projects than a few). In this e-mail, NCHBA also expressed its support for reorganizing the NOFPP into a market-style trading program (as discussed in Section 5.2).

3.2.3 Meeting with Restoration Systems, LLC

Restoration Systems, LLC, is a private company that has constructed a variety of riparian buffer and wetland projects for the EEP. The purpose of the March 13th meeting was for RTI to obtain a better understanding of how private contractors operate under the NOFPP. Topics discussed included how potential project sites were selected and the various factors involved in constructing riparian buffers and wetlands.

In addition, the topic of expanding the private sector's role in the offset payment program was discussed. In particular, Restoration Systems recommended establishing a nutrient offset trading program in North Carolina. It was suggested that such a trading program, which linked suppliers of nutrient offsets like mitigation banks with nutrient emitters like private developers, would result in a variety of efficiencies over the current program, which uses the state to coordinate decisions between suppliers and consumers of nutrient offsets.

3.2.4 Meeting with Environmental Defense Fund

The purpose of this meeting was for the Environmental Defense Fund (EDF), represented by Joe Rudek, to express their opinions on the goals of RTI's study. In particular, EDF said that they hoped RTI paid adequate attention to BMPs other than riparian buffers, which have comprised the majority of nutrient offset projects thus far. Dr. Rudek said that other BMPs should be considered to allow the EEP the flexibility to pursue mitigation close to the location of environmental impact, which would not only achieve the NOFPP's goal of reducing nutrients in the estuary, but also work to protect local watersheds.

3.2.5 Meeting with the Ecosystem Enhancement Program

The purpose of this meeting was for RTI to obtain a better understanding of how the EEP administered the NOFPP. This meeting was attended by Suzanne Klimek, EEP Director of Operations, and other members of the EEP's staff.

As a result of this meeting, RTI was able to better understand what types of projects the EEP would like to pursue in coming years and the methods it uses to implement them (full delivery versus design-bid-build methods). In particular, RTI learned that the EEP would prefer to have more flexibility in the types of projects they pursue to allow them to better meet their broader goal of watershed protection as well as reducing nitrogen in the estuaries. In addition to improving RTI's overall understanding of the NOFPP, Ms. Klimek and her staff provided RTI with data on nutrient offset payments dating back to 2001.

3.2.6 Meeting with Neuse River Compliance Association

The purpose of this meeting was for RTI to meet with representatives of the Neuse River Compliance Association (NRCA)—Cindy Finan, Haywood Phthisic, and Glenn Dunn. This organization represents point sources—such as wastewater treatment facilities operating in the Neuse River Basin.

To date, point sources have not used the NOFPP. However, during this meeting Ms. Finan and Mr. Phthisic expressed their concern that point sources will eventually have to use the NOFPP when they exhaust the technology options that have enabled them to avoid exceeding their current nutrient loading limits to date. According to Ms. Finan and her colleagues, when the original nutrient loading allocations were created, point sources given their nitrogen allocations based on their current National Pollutant Discharge Elimination System (NPDES) discharge permit with no reserve for growth. This becomes a problem when population growth demands that wastewater facilities and other point sources expand their operations, because NCDENR will not issue the necessary permit for an expansion unless the permittee can show (in advance) how they will accommodate its nitrogen loading levels over the next 30 years. If the permittee projects its nitrogen loading to exceed the original nitrogen loading allocation, they will either have to abandon the expansion or potentially purchase offsets through NOFPP.

The NRCA was not able to say when this possibility could occur. In 2006, nitrogen discharges by NRCA's members were 52% below state-mandated limits (NRCA, 2007). However, according to Ms. Finan, most of the NRCA's members are already pushing the limits of abatement technology—treating nitrogen in their wastewater well below the accepted Best Available Technology (BAT)—making it harder for them to accommodate future growth within the confines of their current nitrogen loading allocation. Therefore, according to Ms. Finan, it is possible that point sources could begin purchasing nutrient offsets from the NOFPP within the next few years.

3.2.7 Second Stakeholder Meeting at the Legislative Office Building

A second stakeholder meeting was held on May 7, 2007, so that RTI could present the preliminary findings of their study of the NOFPP. Individuals attending this meeting offered many excellent suggestions on how RTI could refine the results.

One of the major topics discussed during this meeting was the impact that the NOFPP could have on economic development. Several individuals, including representatives from Wayne County and the North Carolina Home Builders Association, remarked that nutrient offset fees would deter economic growth by making new construction projects more expensive to pursue. Although this is certainly a valid concern that policy makers will have to consider when determining where the fee should be set, an economic impact assessment was not included in the scope of this study.

A second issue related to these concerns is the question of whether predominantly rural areas would be subsidizing urban areas under higher fee structures that are intended to support more stormwater wetland projects. The reasoning underlying this concern is that rural counties may have to pay higher fees to support these stormwater wetland projects, even though those projects will most likely be installed in more urban counties where the environmental impacts are greatest.

In addition to questions of growth and equity, another issue that featured prominently during discussion was the fact that the Division of Water Quality potentially would not award nutrient offset credit to buffer projects pursued by the EEP unless they could ensure diffuse sheet flow across the buffer. In many cases, this would require the construction of concrete level spreaders. To address this concern, RTI said they would adjust their riparian buffer cost estimates by adding level spreader construction and maintenance costs to a certain percentage of projects (this issue is addressed in greater detail in Section 3.3.3).

Over the course of the meeting, several other important suggestions were made to refine RTI's results, including expanding the discussion of the role the private sector can play in administering the program, as well as the potential of market-based systems to set fee prices (looking into the Pennsylvania Nutrient Trading Program as an example of market-based nutrient trading); looking into Conservation Reserve Enhancement Program's experience with obtaining land for mitigation projects; considering the use of the purchase value of land rather than the tax-assessed value in RTI's basin-wide land cost estimates; reconsidering the inclusion of administration costs in RTI's proposals for offset fee formulas; and identifying other factors that could contribute to a reduction of available land for buffer projects over the next 20 years.

3.2.8 Meeting with Nash County and Rocky Mount City Planning Representatives

On May 11, 2007, RTI interviewed two representatives from Nash County: Nancy Nixon, County Planner, and Jonathan Boone, Public Works Director of the City of Rocky Mount. The purpose of this interview was to better understand Nash County's concerns about the NOFPP.

The primary issue discussed during this interview was that, if the fee became too high, the NOFPP would not be a viable alternative for developers in Nash County. They said they recognize that reducing the amount of nutrients in the estuary was a worthy goal and that they believed the NOFPP would allow the state government to construct larger BMP projects in better locations than would be available on the developing site. However, they worried that a fee that was too high would prevent many developers from seeing NOFPP as a viable alternative to constructing BMPs on site. This, they said, could potentially lead to slower economic growth in the county and the pursuit of less cost-effective mitigation practices.

An additional concern expressed by Ms. Nixon and Mr. Boone during this meeting was also voiced during the second stakeholders meeting— counties that are predominantly rural would be subsidizing urban counties under higher fee structures that are intended to support more stormwater wetland projects. As before, this concern is motivated by the fact that rural counties will have to pay higher fees to support these stormwater wetland projects, even though those projects will most likely be installed in more urban counties where the environmental impacts are greatest.

3.2.9 Meeting with Wayne County Representatives

On May 25, 2007, RTI interviewed County Manager Lee Smith to better understand Wayne County's concerns about the NOFPP. During this interview, the primary issue discussed was the consequences that the NOFPP could have on economic development in Wayne County. Mr. Smith explained that he was very much in favor of having an in-lieu fee system in place, but that environmental considerations must also be weighed against a desire for economic growth. Like several other stakeholders, he worried that significantly higher fees might result in slower economic growth in Wayne County and the entire river basin.

Following this line of reasoning, Mr. Smith discussed that higher nutrient offset fees could also lead to a redistribution of development throughout the state away from counties located in the Neuse River Basin. Firms that might usually locate in Wayne County, he said, might instead move to another county where nutrient offset fees were not charged, and this could possible lead to eutrofication in other watersheds. As a result, Mr. Smith recommended that a state-wide nutrient offset fee be adopted to improve North Carolina's overall water quality and to avoid problems associated with inequitable growth.

In addition to these concerns, Mr. Smith also stated that decreasing flow in the Neuse River resulting from increased water consumption could be a barrier to achieving the legislative goals of reducing nitrogen concentration in the estuaries. If water flow is reduced, he said, we might see nitrogen concentration levels stabilize or possibly rise even if there was no net increase in nitrogen loading. He suggested a study was needed to investigate these issues.

3.3 BMP Cost Data for North Carolina

To determine the costs of constructing BMPs in North Carolina, RTI interviewed over 30 individuals in the private and public sectors. In this section, we describe the structure of these interviews, the type of BMPs for which data were eventually collected, and the cost data itself.

3.3.1 Description of Data Collection Method

In March and April of 2007, RTI approached 36 academics, private environmental engineering firms, and government agencies to request detailed cost information on BMP projects they had pursued in the state of North Carolina. Although each interview was unique, they all sought to obtain the following information:

- **A description of each BMP project itself**. Specifically, RTI asked for the year of construction for each BMP project, its geographic location, its size (in acres), drainage area (acres), the percentage of the drainage area that is impervious to rainfall, and a description of how the land surrounding the BMP was used (e.g., residential community, cattle grazing).
- **A detailed description of the costs involved in building each BMP project.** In particular, RTI asked that costs be broken down into the four categories described in Section 3.2—land, design, construction, and maintenance costs. During interviews with private firms, RTI also requested an estimate of the profit the firm received by doing the project (revenue over costs). We made this request to account for the overhead costs of conducting business, as well as the opportunity costs faced by the entrepreneur building the BMP. These elements are important because they will both ultimately be incorporated into the price charged by firms for installing BMPs.

RTI used the descriptions of individual BMP projects to estimate the total amount of nutrients each project would be expected to remove over its lifetime. This allowed RTI to express the cost information for that project in terms of dollars per pound of nitrogen ($/lb-N) and dollars per tenth of a pound of phosphorus ($/0.10 lb-P) offset, which is a measure of cost-effectiveness and applying the data to our financial analysis (explained in Section 4).

3.3.2 Description of Data and Sources

RTI collected detailed cost information for 45 separate BMP projects that have been constructed in North Carolina over the past 10 years. These projects were divided into four groups based on BMP type: riparian buffers, stormwater wetlands, large bioretention areas,[2] and wetponds. A brief description of each BMP category follows.

- ***Riparian buffers:*** Strips of land covered in vegetation (such as trees, shrubs, or grass) and located between a potential pollutant source (such as an agricultural field) and a body of surface water. These buffers are designed to trap nonpoint source pollution, such as runoff from agricultural fields, and to prevent it from entering the body of water. (Osmond et al., 2002). Thus far, the EEP has only constructed forested buffer projects.
- ***Stormwater wetlands:*** Constructed wetlands that are heavily vegetated and contain a shallow amount of standing water. These structures remove nutrients by acting as a natural filter—as stormwater flows through the wetland, many of the nutrients it contains will either settle to the bottom or be absorbed through biological update (Wossink and Hunt, 2003).
- ***Large Bioretention Areas:*** A shallow depression in the landscape that is heavily vegetated. Stormwater is directed into the depression where nutrients will settle and be absorbed in the biological process (Wossink and Hunt, 2003).
- ***Wetponds:*** Runoff holding facilities that constantly contain standing water. Storm flows are held in the pond temporarily and then released to minimize large-scale flooding. Wetponds primarily remove nutrients from stormwater by allowing them to settle while the runoff resides in the pond (Wossink and Hunt, 2003).

Table 3-1 reports the number of projects included in each BMP type and the sources of cost data associated with each project. Although private-sector companies were often approached for information, the vast majority of detailed cost data collected was obtained from academic and government sources.

3.3.3 Adjusting Riparian Buffer Cost Estimates to Reflect the Cost of Level Spreaders

To be eligible for nutrient offset credit, riparian buffer projects must be able to guarantee that stormwater will flow evenly over the buffer. For nonagricultural BMPs, this will possibly require constructing concrete linear structures (called level spreaders) along the edge of the buffer in areas where physical characteristics of the land may increase the risk of concentrated water flow.

Since none of the buffer cost estimates collected by RTI included the cost of constructing and maintaining level spreaders, and it is likely that future buffer projects will have these structures, it was necessary to obtain additional data to adjust for these costs.

[2] Information was also collected for small bioretention retrofits, but we determined these mitigation projects are not applicable for EEP projects.

Table 3-1. Description of Data Obtained by RTI

BMP Type	Number of Projects	Data Source
Riparian buffers	8	Provided by private-sector firms that constructed riparian buffers for the EEP. These projects were primarily located in the Piedmont and inner Coastal Plain regions of the state.
Stormwater wetlands	17	Provided by academics in North Carolina State University’s Water Quality and Stormwater Engineering Groups and engineers working for the city of Charlotte’s Storm Water Services. These projects were scattered across the state but were primarily located in the state’s Piedmont and Coastal Plain regions.
Large bioretention areas	12	Provided by academics in North Carolina State University’s Water Quality and Stormwater Engineering Groups as well as individuals working for the North Carolina Department of Transportation and the town of Garner. These projects were scattered across the state but were primarily located in the state’s Piedmont and Coastal Plain regions.
Wetponds	9	Provided by academics in North Carolina State University’s Water Quality and Stormwater Engineering Groups. These projects were scattered across the state but were primarily located in the state’s Piedmont and Coastal Plain regions.

First, RTI obtained construction cost estimates from the North Carolina Department of Transportation (DOT). Based on their experience with constructing “concrete wall” level spreaders, the DOT estimated that construction costs would average $60 per linear foot of level spreader. Second, based on discussions with the DOT, RTI estimated the cost of designing a level spreader by applying a standard design-to-cost ratio of 35%. This implies that level spreaders cost $21 per linear foot to design. Lastly, RTI interviewed several experts who estimated that properly maintaining a level spreader after construction would cost approximately $2 per linear foot per year.

Before we could use these data to adjust our original cost estimates, we then needed to 1) determine what portion of buffer projects would potentially require buffers and 2) approximately how long the average level spreader would be relative to the total length of the buffer.

To answer the first question, we assumed that agricultural land by its nature is relatively level and, hence, buffer projects on this land would not require level spreaders. Based on RTI’s buffer availability analysis (discussed in Section 4.2.2), a conservative estimate of the portion of land associated with agriculture practices is approximately 45%.

The remaining 55% of potential buffer land would therefore currently be used for other purposes (e.g., grassland, pasture). Because it is impossible to predict exactly where the EEP will be able to pursue most of their buffer projects, our analysis assumes that for 55% of future buffer projects level spreaders will be required.

The second question relates to the size (length) of level spreaders when needed. The length of any particular level spreader ultimately depends on the physical characteristics of the construction site. For example, a riparian buffer that is 4,000 feet long on hilly pastureland may require several level spreaders that sum to a total of 1,000 feet (25% of total length), while another site that is more amenable to diffuse water flow may only require several level spreaders that sum to a total of 400 feet (10% of total length). Because this is a prospective analysis, after discussions with experts, RTI made the conservative assumption that for future buffers requiring level spreaders, the total length of the spreaders would be 25 % of the project's total linear feet. The 25% level spreader assumption is used in the buffer cost estimate analysis throughout this report.

3.3.4 Total 30-Year Project Costs by BMP

Tables 3-2 and 3-3 summarize the average costs of installing different BMPs by cost category, as described in Section 3.2. To reflect the fact that land costs will differ by river basin, land and total costs are reported individually for the Neuse and Tar-Pamlico river basins. Values are expressed in both dollars per pound of nitrogen removed and dollars per pound of phosphorus removed.

Table 3-2. Mean Expenditures by BMP Cost Category for Nitrogen ($/lb-N per 30 year) in 2006 Dollars

BMP	Land Cost		Design Cost	Construction Cost	Present Value of 30-Year Maintenance Cost[a]	Total	
	Neuse	Tar-Pamlico				Neuse	Tar-Pamlico
Riparian buffers	$11.63[b]	$7.01	$1.95	$5.75	$2.04	$21.4	$16.8
Stormwater wetlands	$25.85[c]	$22.43	$14.38	$32.08	$9.68	$82.0	$78.6
Large bioretention areas	$71.18[c]	$61.77	$129.83	$329.69	$43.55	$574.3	$564.8
Wet Ponds	$43.94[c]	$38.13	$41.85	$130.79	$47.43	$264.0	$258.2

[a] Present value calculations use a discount rate of 5%.

[b] Based on average rural area land price. Prices are slightly higher in the Neuse compared with the Tar-Pamlico.

[c] Based on average low-density urban land price. Prices are slightly higher in the Neuse compared with the Tar-Pamlico.

Table 3-3. Mean Expenditures by BMP Cost Category for Phosphorus ($/0.10 lb-P per 30 year) in 2006 Dollars

BMP	Land Cost: Neuse	Land Cost: Tar-Pamlico	Design Cost	Construction Cost	Present Value of 30-Year Maintenance Cost[a]	Total: Neuse	Total: Tar-Pamlico
Riparian buffers	$18.06 [b]	$10.89	$3.03	$8.93	$3.17	$33.2	$26.0
Stormwater wetlands	$25.06 [c]	$21.75	$10.71	$20.98	$8.91	$65.7	$62.3
Large bioretention areas	$46.96 [c]	$40.75	$86.87	$221.30	$30.48	$385.6	$379.4
Wet Ponds	$23.29	$20.21	$28.12	$87.87	$26.08	$165.4	$162.3

[a] Present value calculations use a discount rate of 5%.

[b] Based on average rural area land price. Prices are slightly higher in the Neuse compared with the Tar-Pamlico.

[c] Based on average low-density urban land price. Prices are slightly higher in the Neuse compared with the Tar-Pamlico.

The total project cost for a BMP over 30 years is the sum of its one-time installation costs—which includes the purchase of the land as well as the design and construction of the BMP itself—and the present value of estimated maintenance costs over the next 30 years. Total project costs range from $21.4 per pound of nitrogen over 30 years for riparian buffers in the Neuse River Basin and $16.8 per pound of nitrogen in the Tar-Pamlico to $574 per pound of nitrogen over 30 years for large bioretention retrofits in the Neuse and $565 per pound of nitrogen over 30 years in the Tar-Pamlico. The differences in BMP costs across river basins are driven by differences in land prices.

Tables 3-4 and 3-5 report information on the mean, median, and range of total BMP project costs for each BMP type by river basin. These tables are intended to convey information on the distribution and variation of the cost information provided to RTI. As the tables indicate, the mean and median are very close for riparian buffers with relatively few extremes reported in its ranges for both river basins. This would indicate that there was not much variation in the information for riparian buffer costs. On the other hand, there are larger differences between the mean and the median costs for stormwater wetland, bioretention retrofits, and wetponds. The range of observations is also more spread out for these types of BMPs. This would indicate that there is a much greater degree of variability in the cost implementation.

Table 3-4. Distribution of Total 30-Year Project Costs by BMP for the Neuse River Basin in 2006 Dollars

BMP Category	Dollars per Pound of Nitrogen: Mean Total Project Cost (30-Year) ($/lb-N)	Median Total Project Cost (30-Year) ($/lb-N 30)	Range ($/lb-N 30)	Dollars per Pound of Phosphorus: Mean Total Project Cost (30-Year) ($/0.10 lb)	Median Total Project Cost (30 years) ($/0.10 lb)	Range ($/0.10 lb-P)
Riparian buffers	$21.4	$19.8	$16.8 to $30.9	$33.2	$30.7	$26.2 to $48.0
Stormwater wetlands	$82.0	$59.1	$26.0 to $155.1	$65.7	$37.0	$6.6 to $150.4
Large bioretention areas	$574.3	$514.6	$132.5 to $895.9	$385.6	$355.6	$87.4 to $591.0
Wetponds	$264.0	$240.90	$132.7 to $494.1	$165.4	$127.7	$70.3 to $261.9

Table 3-5. Distribution of Total 30-Year Project Costs by BMP for the Tar-Pamlico in 2006 Dollars

BMP Category	Dollars per Pound of Nitrogen: Mean Total Project Cost (30-Year) ($/lb-N)	Median Total Project Cost (30-Year) ($/lb-N)	Range ($/lb-N)	Dollars per Pound of Phosphorus: Mean Total Project Cost (30-Year) ($/0.10 lb-)	Median Total Project Cost (30 years) ($/0.10 lb-P)	Range ($/0.10 lb-P)
Riparian buffers	$16.8	$15.2	$12.2 to $26.3	$26.0	$23.6	$19.0 to $40.9
Stormwater wetland retrofit	$78.6	$59.1	$24.6 to $155.1	$62.3	$35.5	$5.3 to $150.4
Large bioretention retrofit	$564.8	$512.8	$132.5 to $881.0	$379.4	$355.6	$87.4 to $581.2
Wetponds	$258.2	$233.83	$125.6 to $491.4	$162.3	$124.0	$66.6 to $260.5

SECTION 4
FINANCIAL ANALYSIS (OBJECTIVES 1, 2, AND 3)

In this section, we discuss the financial analysis that underlies Objectives 1, 2, and 3 of the study. Because the type of offset projects pursued by the EEP in the future will significantly influence the financial analysis, we begin this section by defining three scenarios that are evaluated for each of the analysis Objectives 1, 2, and 3.

- ***Scenario A: All Buffers***. The EEP implements exclusively riparian buffers on land obtained primarily through conservation easements.
- ***Scenario B: Integrated Implementation***. In addition to buffers, the EEP pursues a number of stormwater wetland retrofit offset projects to target integrated environmental objectives. This would enables offset projects to be implemented closer in proximity (e.g., in local watersheds) to where development is occurring. This results in higher costs per pound of nitrogen and phosphorous.
- ***Scenario C: All Stormwater Wetlands.*** The EEP does not undertakes any buffer projects and instead installs all stormwater wetland projects. This implementation scenario is under consideration by the NCDWQ and would also increase the costs per pound of nitrogen and phosphorous.

Because of the prospective nature of the analysis, this section also defines and documents the trends used to adjust costs over time. These include

- forecasted demand for nutrient offsets,
- projected land costs and availability, and
- price indices for labor and materials.

This is followed by the financial calculations for Objectives 1, 2, and 3.

4.1 Implementation Scenarios

As shown in Tables 3-2 and 3-3 (Section 3.3), BMP costs vary greatly depending on the type of mitigation option employed. As a result, any analysis of program sustainability or offset payment formula design needs to be based on a detailed projection of the types of mitigation activities to be implemented.

To reflect the uncertainty in the types of mitigation options that may be implemented in the future, the financial analysis for this study was conducted relative to three different implementation scenarios that focus on buffers and stormwater wetlands. Based on the cost estimates presented in Tables 3-2 and 3-3, we assumed that large bioretention retrofits and wetponds are not viable options for BMPs because of their high cost. As a result, it is projected that the EEP will likely pursue some mixture of the lower-cost buffers and stormwater wetland BMPs to meet the NOFFP's program objectives.

The three implementation scenarios shown in Table 4-1 are increasing in the average cost per pound of nitrogen and phosphorous offset by the EEP. This increased cost is primarily driven by an increased use of nonriparian buffer offset projects that are implemented to meet varying environmental objectives put forth by the EEP and NCDWQ. The specific BMP share distributions for each scenario are speculative. They are selected to provide insights into the potential range of costs the EEP might bear under different mission statements they may pursue as part of the NOFPP.

Table 4-1. Distribution of BMPs and Expenditures Incurred by the EEP

Scenario/BMP	BMP Share	Land Cost	Design Cost	Construction Cost	Maintenance Cost
Scenario A: All Buffers					
Riparian buffers	100%	√	√	√	√
Scenario B: Integrated Implementation					
Riparian buffers	70%	√	√	√	√
Stormwater wetlands[a]	5%		√	√	
Stormwater wetlands	25%	√	√	√	√
Scenario C: All Stormwater Wetlands					
Stormwater wetlands[a]	5%		√	√	
Stormwater wetlands	95%	√	√	√	√

√ = EEP assumes full cost.

[a] Local municipalities donate land and assume maintenance costs.

4.1.1 All Buffers

The all-buffer scenario is the lowest-cost scenario modeled. This scenario could be considered the most cost-effective way to meet the objectives of reducing nitrogen and phosphorous in the river basin estuaries. As discussed in Section 4.2.2, an all-buffer scenario would require buffer restoration on approximately 7% of the available buffer land in the Neuse River Basin and 1% of available buffer land in the Tar-Pamlico River Basin. Specific assumptions for this scenario include the following:

- Riparian buffers are the sole source of nutrient offsets, accounting for 100% of the total offsets demanded.
- The riparian buffer projects are implemented on land acquired through conservation easements or purchased by the EEP.

- All buffer projects are maintained by the EEP; hence, the EEP incurs maintenance costs over the 30-year life expectancy of the mitigation project.

4.1.2 Integrated Implementation

The EEP indicated that the current mix of offset projects has been strongly influenced by funding constraints of the existing offset payment structure. Thus, the integrated implementation scenario is intended to reflect a less-constrained world under which the EEP is able to pursue a wider range of mitigation options (beyond buffers) to achieve integrated environmental watershed objectives. Integrating projects conducted under the NOFPP into an overall water quality strategy could provide benefits beyond reduced nutrient loads in river estuaries such as improving water quality in local streams and rivers. Specific assumptions for this scenario include the following:

- Riparian buffers account for 70% of nutrient offsets.
- As in Scenario A, the riparian buffer projects are implemented on land acquired through conservation easements or purchased by the EEP.
- Stormwater wetland projects account for the remaining 30% of the nutrient offsets.
- The first 5% of the stormwater wetland projects are conducted on donated land, and local municipalities accept future maintenance responsibilities. Thus, the EEP does not incur land costs or maintenance costs associated with these projects.
- For the remaining 25% of the stormwater wetland projects, land must be purchased, and the EEP is responsible for maintenance over the 30 years of the project life expectancy.

4.1.3 All Stormwater Wetlands

Several stakeholder groups we spoke with expressed interest in the EEP conducting more offset mitigation projects in the regional areas where development is taking place. This approach has the benefit of contributing to the water quality of individual river/stream segments affected by development, in addition to the river estuary. In addition, the NCDWQ said that buffers might not be eligible for the NOFPP in the future because of concerns about effectiveness and long-term maintenance. To reflect these concerns, we included an all stormwater wetlands scenario. Specific assumptions for this scenario include the following:

- Stormwater wetlands account for 100% of nutrient offsets.
- As in Scenario B, the first 5% of the stormwater wetland projects are conducted on donated land, and local municipalities accept future maintenance responsibilities. Thus, the EEP does not incur land costs or maintenance costs associated with these projects.

- For the remaining 95% of the stormwater wetland projects, land must be purchased, and the EEP is responsible for maintenance over the 30 years of the project life expectancy.

4.2 Additional Data Used in RTI's Financial Analysis

In this section, we discuss the secondary data RTI used in conjunction with the BMP cost data described in Section 3 to study the sustainability of the NOFPP under a variety of different fee structures. These additional data include historical demand for nutrient offsets, geographic information system (GIS) assessment of land available for riparian buffer projects, GIS assessment of land costs in both river basins, and annual growth forecasts for each BMP cost component.

4.2.1 Historical and Forecasted Demand for Nutrient Offsets

Based on data RTI received from the EEP, the NOFPP has collected $10,508,435 in fees ($11,495,323 in inflation-adjusted 2006 dollars) to offset 954,433 pounds of nitrogen in the Neuse River Basin since May 2001. When these data are compared with population growth estimates for counties inside the river basin, a clear pattern emerges.

Figure 4-1 illustrates that the number of excess pounds of nitrogen needing to be offset by the NOFPP is closely correlated with population growth. This makes intuitive sense because excess nutrient loading is primarily generated through new development (both residential and commercial), which is itself in large part driven by population growth. Between 2002 and 2006, every new person entering the Neuse River Basin was associated with an average of 3.9 new pounds of nitrogen needing to be offset.[3] Using this pound-per-person ratio, we can project nutrient offset demand based on government population growth projections.

Assuming that this simple ratio stays constant into the future and applies for both river basins, RTI forecasts future demand for nitrogen offsets in the Neuse and Tar-Pamlico basins by using county population forecasts out to the year 2020.[4] For example, counties in the Neuse River Basin had a combined population of 2,151,298 in 2006, which is forecasted to increase to 2,739,453 by the year 2020. This implies a compound annual growth rate of approximately 1.6%. Therefore, RTI estimates that 38,498 new individuals will enter the Neuse River Basin in 2007, which will be associated with 148,731 pounds of excess nitrogen from new development.

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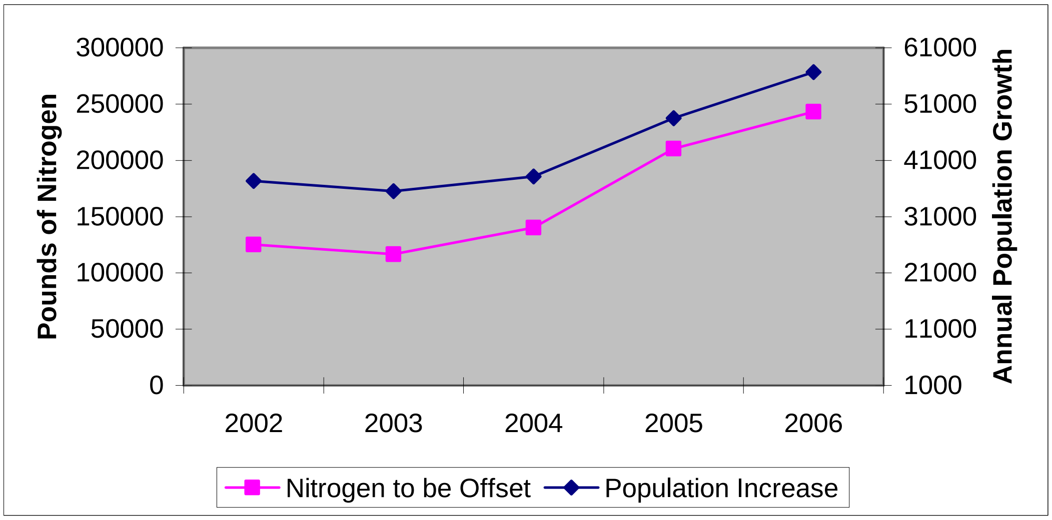
[3] Because historical data for offsets are not available for the Tar-Pamlico river basin, the factor of 3.9 pounds of nitrogen per person is also used when projecting demand for the Tar-Pamlico river basin.

[4] In these calculations, RTI only included counties that had more than 5% of their areas located in the Neuse or Tar-Pamlico river basins.

Figure 4-1. Number of Pounds for Which the EEP Has Collected Nutrient Offset Payments and Population Growth in the Neuse River Basin: 2002–2006



Similar calculations were made for each year and each river basin and are presented in Tables 4-2 and 4-3.

4.2.2 Land Available for Riparian Buffer Restoration

As discussed in Section 2.1, the vast majority of nutrient offsets have been provided through the restoration of riparian buffers along the Neuse River and its tributaries. However, there is only a finite amount of land available for pursuing riparian buffer projects. Therefore, addressing the question of how much land is available for buffer restoration is critically important for assessing the viability of pursuing buffer projects in the future.

To determine the amount of land available for buffer restoration, RTI used three data sets: a HUC8 (8-digit hydrologic unit code) coverage for the Tar-Pamlico and Neuse river basins developed by the United States Geological Service (USGS), the USGS 1:24k-scale National Hydrography Dataset (NHD) dataset, and the 2001 National Land Cover Dataset (NLCD).

RTI combined these data with the desktop GIS program ArcMap to identify the total amount of potential buffer land in the Neuse and the Tar-Pamlico river basins. This was done by first using the data and software to identify the amount of land specifically within 50 feet of the centerline of each waterway within the Neuse and Tar-Pamlico river basins (HUC8 and NHD datasets), then to estimate the total amount of land within those areas by cover type using the NLCD 2001 dataset. The results of this analysis are presented in Table 4-4.

Table 4-2. Forecast of Nutrient Offset Demand for the Neuse River Basin from 2007 to 2020

Year	Estimated Cumulative Population	Population Increase Over Previous Year	Pounds Needing Offsets
2006	2,151,298		
2007	2,186,241	34,943	134,999
2008	2,221,752	35,511	137,192
2009	2,257,840	36,088	139,421
2010	2,294,514	36,674	141,685
2011	2,331,784	37,270	143,987
2012	2,369,659	37,875	146,325
2013	2,408,149	38,490	148,702
2014	2,447,265	39,115	151,117
2015	2,487,016	39,751	153,572
2016	2,527,412	40,397	156,067
2017	2,568,465	41,053	158,602
2018	2,610,184	41,719	161,178
2019	2,652,582	42,397	163,796
2020	2,695,667	43,086	166,456

RTI estimated that there are approximately 85,500 acres of land associated with the 50-foot buffer area surrounding either side of the waterways in the Neuse River Basin and 76,700 acres of land in the Tar-Pamlico.

Note that these estimates are larger than those implied by earlier analysis conducted by the NCDWQ. For example, in the "1998 Basin Wide Water Quality Plan," it was estimated that 3,443 miles of stream existed in the Neuse River Basin. This implies an estimate of 41,733 acres of land within the 50-foot buffer region that exists on both sides of these streams (approximately half of RTI's estimate).[5] The difference stems from RTI using a more detailed data set that includes more miles of stream (more smaller streams) than the one NCDWQ used.

[5] To replicate this calculation, remember that there are 5,280 linear feet in a mile, which implies that 18,179,040 linear feet of stream are associated with 3,443 miles. Multiplying this number by 100 (the size of the 50-foot buffer on either side of each stream) gives an estimate of the square feet of land in the buffer zone. Because there are 43,560 square feet in an acre, this implies a total of 41,733 acres of land in the Neuse River's 50-foot buffer zone.

Table 4-3. Forecast of Nutrient Offset Demand for Tar-Pamlico River Basin from 2007 to 2020

Year	Estimated Cumulative Population	Population Increase Over Previous Year	Pounds Needing Offsets
2006	772,264		
2007	778,460	6,196	23,938
2008	784,706	6,246	24,130
2009	791,002	6,296	24,323
2010	797,348	6,346	24,519
2011	803,746	6,397	24,715
2012	810,194	6,449	24,914
2013	816,695	6,500	25,113
2014	823,247	6,553	25,315
2015	829,852	6,605	25,518
2016	836,510	6,658	25,723
2017	843,222	6,712	25,929
2018	849,987	6,765	26,137
2019	856,807	6,820	26,347
2020	863,681	6,874	26,558

Table 4-4. Distribution of Land within 50 foot Buffer, by River Basin

Description	Neuse Area (acres)	Tar-Pamlico Area (acres)
Open water	10,973	8,756
Developed	5,040	2,980
Barren	552	682
Forest cover	24,748	21,486
Grassland, shrub, and pasture	8,384	8,146
Cultivated crops	7,349	9,732
Wetlands	39,459	33,666
Acres of Land	85,533	76,695
Total Acres (including Open Water)	96,507	85,452

The next step in RTI's analysis was to determine the amount of land that could potentially be used for installing riparian buffer projects (i.e., land physically fit for nutrient offset for riparian buffers). Based on conversations with the EEP, RTI assumed that land identified as being developed, barren, occupied by wetlands, or already covered by forest should not be considered eligible for buffer projects because land in these categories would either not support a forested riparian buffer (barren land), would not achieve additional nutrient offsets (land covered in forest is already acting as a buffer), or would not be available because of federal restrictions (no net wetland loss policy).[6] When land currently devoted to these uses is excluded from our estimates, we are left with a total of 15,734 acres of land available to sustain buffer projects in the Neuse River Basin and 17,880 acres of land able to sustain buffer projects in the Tar-Pamlico River Basin.

However, the current number of acres that could potentially host a riparian buffer does not reflect the amount of land that will *actually* be available for NOFPP buffer projects in the future. We must also take into account other interests competing for this land, in particular, buffer land demanded for other EEP programs and/or for urban development.

In addition to the NOFPP, the EEP administers other programs that will compete for land within the buffer region, such as their stream mitigation program. Currently, the EEP has a target of 53,396 linear feet of stream mitigation in the Neuse and 986 linear feet in the Tar-Pamlico through the year 2013. Assuming that this implied annual activity remains constant over time, we can estimate the EEP's stream mitigation target through the year 2020 (116,000 feet of stream mitigation in the Neuse and 2,000 feet in the Tar-Pamlico). Assuming that these projects restore 50 feet of buffer as part of each foot of mitigation, we can estimate the amount of acreage that these projects will require.[7] Based on RTI's calculations, the EEP's stream mitigation program will require 266 acres of buffer land in the Neuse River Basin and 5 acres of buffer land in the Tar-Pamlico River Basin through 2020.

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[6] In 1996, Kristin Komines studied the land cover along streams within the Neuse River Basin. In this study, Komines classified land as either agricultural, developed, or forested. Based on her analysis, Komines determined that 81% of stream edges in her sample had forested buffer of at least 50 feet (Moreau et al., 2000). RTI's buffer analysis appears to be consistent with these findings. As illustrated in Table 4-4, RTI estimated that 75% of land in the 50-foot "buffer zone" of the Neuse River Basin is classified as either forest or wetland.

[7] To estimate the amount of buffer land that will be required for these mitigation projects, we multiply each linear foot by 100 (representing the 50 feet of buffer on either side of the stream that will be restored during the project). This calculation gives us the square-feet of buffer land that will be required for the stream mitigation program to reach its target; dividing this number by 43,560 (the number of square feet in a single acre) gives you the target in terms of acreage.

In addition to the EEP, developers will also be competing for land within the buffer strip as urbanization spreads through the Neuse River and Tar-Pamlico basins. According to the National Resource Inventory, from 1992 to 2003 the number of acres of cropland in North Carolina decreased from 5.96 million acres to 5.50 million acres (USDA, 2000 and 2007). This decrease of 446,000 acres over 11 years represents a 0.71% annual decrease in cropland due to cropland being converted into a variety of other uses, including urban development.

If we assume that this rate of loss reflecting urban development remains constant into the future and this rate of conversion applies for all land we have identified as viable for riparian buffers (not just cropland), we can estimate that 1,385 and 1,573 acres of current buffer land in the Neuse and Tar-Pamlico river basins will be converted to other land uses by the year 2020.[8]

When estimates of competing demand for buffer land are taken into account, we are left with approximately 14.7 thousand acres available for NOFPP buffer projects in the Neuse River Basin and 16.9 thousand acres in the Tar-Pamlico. Based on the nutrient loading projections presented in section 4.2.1, RTI predicts that 2.1 million pounds of nitrogen in the Neuse River Basin and 353 thousand pounds of nitrogen in the Tar-Pamlico will need to be offset through the year 2020. If all of this nutrient loading was offset with riparian buffer projects, RTI predicts (using EEP's estimate that one acre of buffer offsets 2,273 pounds of nitrogen on average) that this would require 925 acres of buffer in the Neuse and 155 acres of buffer in the Tar-Pamlico River Basins to be restored. This amounts to utilizing 7% of the total amount of buffer land in the Neuse River Basin and 1% of buffer land in the Tar-Pamlico River Basin that is potentially available for riparian buffer projects. These results are summarized in Table 4-5.

4.2.3 Land Costs

The land used by the EEP for constructing BMPs is frequently be obtained through conservation easements or purchased from current owners when public land is not available. To estimate the price per acre of land in the Neuse and Tar-Pamlico river basins, RTI obtained recent tax parcel GIS data from eight counties that made these data freely available through the Internet: Beaufort, Carteret, Craven, Dare, Edgecombe, Halifax, Johnston, and Wake counties. Tax assessment data were used for land costs because no actual sales data were available. In discussions with the Carolina Builders Association, they indicated that they were beginning to

[8] It should be noted that there are other competing interests that RTI was not able to quantify in their analysis, for example, buffer projects being pursued for the Department of Transportation. Another relevant point to keep in mind is that this some landowners may be unwilling to allow a buffer to be installed on their property. Therefore, the following analysis should be interpreted as an approximation of the amount of land available for riparian buffer projects.

Table 4-5. Summary of Available Buffer Analysis

	Neuse River Basin	Tar-Pamlico River Basin
Acres of land suitable for buffers	15,734	17,880
Acres required for EEP stream mitigation until 2020	266	5
Acres of agricultural land consumed by development	1,385	1,573
Acres of land potentially available for buffer	14,083	16,302
Buffer required by NOFPP	925	155
NOFPP percentage of available buffer land	7%	1%

create a North Carolina land cost database (because one did not exist), but that it would not be available for this study. In addition, several stakeholders indicated that tax assessment data were appropriate because it represented an average of conservation easements payment and purchased land costs.

These counties are divided by the U.S. Census Bureau into three distinct categories: high-density urban areas (such as cities), low-density urban areas (such as suburban areas), and rural areas (such as unincorporated areas). By dividing the total value of land in each category by the total number of acres in each category, RTI estimated a dollar per value for each category in each of the six counties.

RTI then applied this dollar per acre figure to other counties in the river basins, based on geographic characteristics. For example, Franklin County borders Wake County; therefore, it was assumed that it would have similar land values to other counties that border Wake such as Johnston County. Using this method, RTI calculated dollar per acre figures for all counties that had more than 5% of their land area in the Neuse or Tar-Pamlico River Basin. The results of this analysis are summarized in Table 4-6.

Table 4-6. Dollar per Acre Land Costs by Category and River Basin

Land Category	Neuse River Basin Dollars per Acre	Tar-Pamlico River Basin Dollars per Acre
High-density urban	$200,311	$123,961
Low-density urban	$145,498	$126,264
Rural areas	$19,139	$8,646

Rural area land costs are used to estimate costs for riparian buffers. Low-density urban land costs are used to estimate costs for stormwater wetlands.

4.2.4 Price Data Used in Forecasting Land, Design, Construction, and Maintenance Costs

In Section 3, costs were presented in 2006 dollars for three types of BMP projects (riparian buffers, stormwater wetlands, large bioretention areas and wet ponds) and broken down across four major cost categories (land, design, construction, and maintenance).

Although this information may reflect the current cost of doing these projects, it is likely that installation and maintenance costs will rise over time. We used secondary data to forecast how costs would change over the next 13 years for each cost category. The specific data sets used to determine growth rates for each cost component are discussed below.

- **Assessed Value of Locally Taxable Property in North Carolina.** Data were obtained from the N.C. Department of Revenue for the total assessed value of real property in unincorporated areas and municipalities of counties in the Neuse and Tar-Pamlico river basins for the years 1996 to 2005 (provided by the Policy Analysis and Statistics Division of the North Carolina Department of Revenue in April 2007). RTI computed a compound annual growth rate for unincorporated land of 3.6% in the Neuse River Basin and 3.5% in the Tar-Pamlico. RTI computed similar growth rates for the value of municipal land—3.9% in the Neuse River Basin and 3.7% in the Tar-Pamlico. RTI assumed that all riparian buffers would be constructed on land in unincorporated areas, while stormwater wetlands and bioretention areas would be constructed on land in municipalities. Therefore, RTI used both growth rates when projecting land costs into the future.
- **Producer Price Index for Architectural, Engineering and Other Related Services.** Data were obtained from the U.S. Bureau of Labor Statistics for the prices received by architectural and engineering firms for the services they performed (this does not include construction) from 1997 to 2006 (BLS, 2007). Because BMPs are typically designed by environmental engineering firms, RTI believed that this is the best index for estimating the speed at which design costs will rise over time. The average annual growth rate is approximately 2.1%.
- **Producer Price Index for Construction Machinery and Equipment**. Data were obtained from the U.S. Bureau of Labor Statistics for the prices charged by firms for the sale of construction machinery and equipment from 1977 to 2006 (BLS, 2007). Because construction of BMPs typically require the use of various types of machinery and equipment (particularly for stormwater wetlands), we believe that this price index is appropriate for forecasting BMP construction costs. The average annual growth rate is approximately 1.6%.
- **Employment Cost Index.** Data were obtained from the Federal Reserve Bank of St. Louis for the Employee Cost Index from 2001 to 2006 (FRED, 2007). After a BMP is installed, it must be maintained to ensure it remains useful through its potential life

time. It was RTI's understanding that the largest component of these maintenance costs was the time individual workers put in performing various maintenance tasks. Therefore, the employment cost index was used to adjust maintenance cost each year. The average annual growth rate is approximately 2.4%.

4.3 Objective 1: Program Sustainability at $11 per Pound of Nitrogen

To calculate the sustainability of the program at the current fixed fee of $11/lb of nitrogen, we generated a time series of offset fees (revenue) and mitigation project costs (expenses). As discussed in Section 4.2.1, annual offset fees increase over time in proportion to the projected growth in demand for nitrogen offsets.

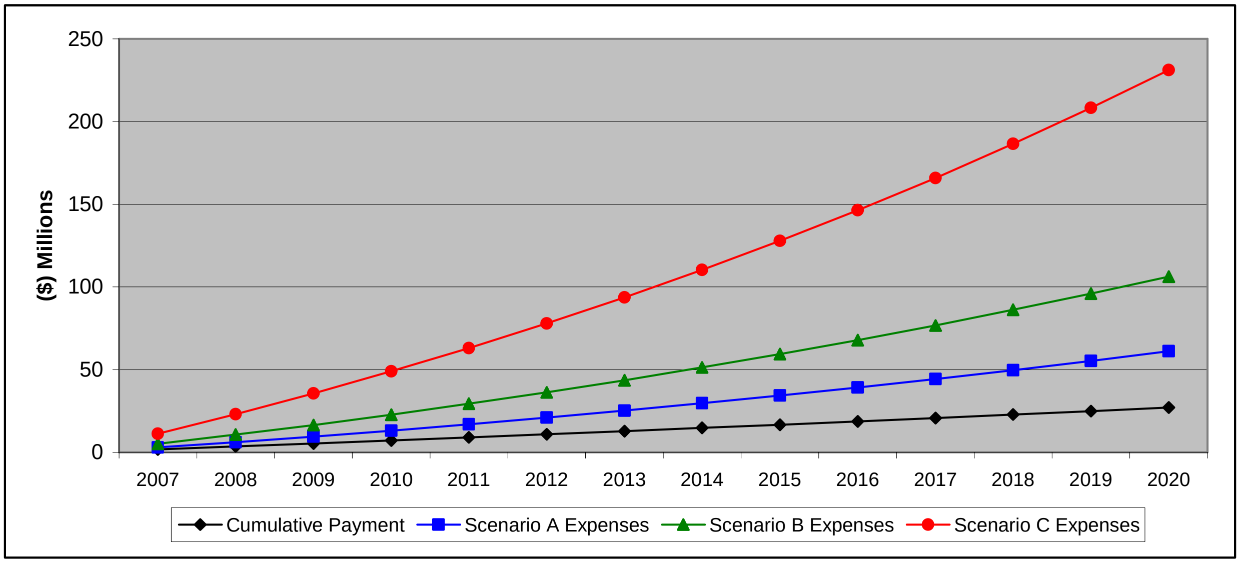
The analysis begins in 2007, and projects are assumed to be implemented in the same year as fees are paid. Thus, the program is always in balance in regard to offsets purchased and offsets implemented.

Table 4-7 and Figure 4-2 present the cumulative offset payment revenue stream and the cumulative NOFPP program expenses. Program expenses are presented for Scenarios A, B, and C. As the table and figure show, expenditures exceed revenue in the first year of the analysis for all three potential scenarios; and this deficit grows over time.

Table 4-7. Cumulative Offset Fee Revenue and NOFPP Mitigation Project Expenses

Year	Cumulative Payments	Scenario A Expenses	Scenario B Expenses	Scenario C Expenses
2007	$1,748,308	$2,962,207	$5,198,938	$11,210,910
2008	$3,522,850	$6,124,101	$10,715,511	$23,086,927
2009	$5,324,034	$9,496,141	$16,565,661	$35,661,105
2010	$7,152,275	$13,089,298	$22,766,084	$48,968,055
2011	$9,007,995	$16,915,072	$29,334,262	$63,044,017
2012	$10,891,623	$20,985,523	$36,288,503	$77,926,941
2013	$12,803,594	$25,244,846	$43,600,064	$93,656,559
2014	$14,744,350	$29,701,951	$51,285,976	$110,274,477
2015	$16,714,341	$34,366,176	$59,364,067	$127,824,257
2016	$18,714,024	$39,247,309	$67,853,001	$146,351,510
2017	$20,743,861	$44,355,611	$76,772,311	$165,903,993
2018	$22,804,325	$49,701,838	$86,142,450	$186,531,709
2019	$24,895,893	$55,297,267	$95,984,826	$208,287,012
2020	$27,019,052	$61,153,722	$106,321,851	$231,224,720

Figure 4-2. Cumulative Offset Fee Revenue and NOFPP Mitigation Project Expenses



In other words, given an $11/lb of nitrogen fee, the NOFPP program is currently unsustainable. This reflects the fact that the first-year costs (i.e., the sum of land, design, and construction) are more than $11/lb of nitrogen. The gap between revenue and average program expenditures only widens with time as maintenance costs are incurred for projects initiated in previous years. By year 2020, the program deficit for Scenario A is projected to be $61 million, the deficit for Scenario B is projected to be $106 million, and the deficit for Scenario C is projected to be $231 million.

4.4 Objective 2: Proposed Fee Based on Cost-Effectiveness

We define cost-effectiveness as the NOFPP being sustainable through the year 2020. That is to say, a cost-effective fee would be one that allows cumulative expenses to equal cumulative payments in the year 2020. This implies that the NOFPP will earn a surplus for several years, which will then be eaten up by deficits as maintenance costs from previously installed BMP projects accumulate. It is assumed that if the program can break even through 2020, at this point, the offset fee would be reassessed and adjusted. We looked at two fee structures for each river basin. The first is a fixed offset fee that does not change over time. The second is an offset fee that is tied to the construction price index and hence increases approximately 1% per year. Separate cost-effectiveness estimates for each of the three scenarios are provided for both the Neuse and Tar-Pamlico river basins.

4.4.1 Fixed Offset Fee

The cost-effective offset fee is determined by calculating the fee that will equate the cumulative fee revenue with program expenditures in the year 2020. The offset fees that yield a sustainable program through 2020 are presented by river basin in Tables 4-8 and 4-9. Figures 4-3 and 4-4 graph the time series of revenue and expenses. As discussed above, cumulative program expenses lag cumulative offset fee payments until they are equal in 2020.

Table 4-8. Cost-Effective Offset Fee for the Neuse River Basin

	Cost-Effective Offset Fee[a] ($/lb-30 N)	Cost-Effective Offset Fee[a] ($/0.10 lb-30 P)
Scenario A	$25.77	$33.19
Scenario B	$43.94	$41.23
Scenario C	$94.80	$62.91

[a] Offset fee that allows the program to be sustainable through 2020.

Figure 4-3. Cumulative Revenue and Expenses with Cost-Effective Nitrogen Offset Fees for the Neuse River Basin

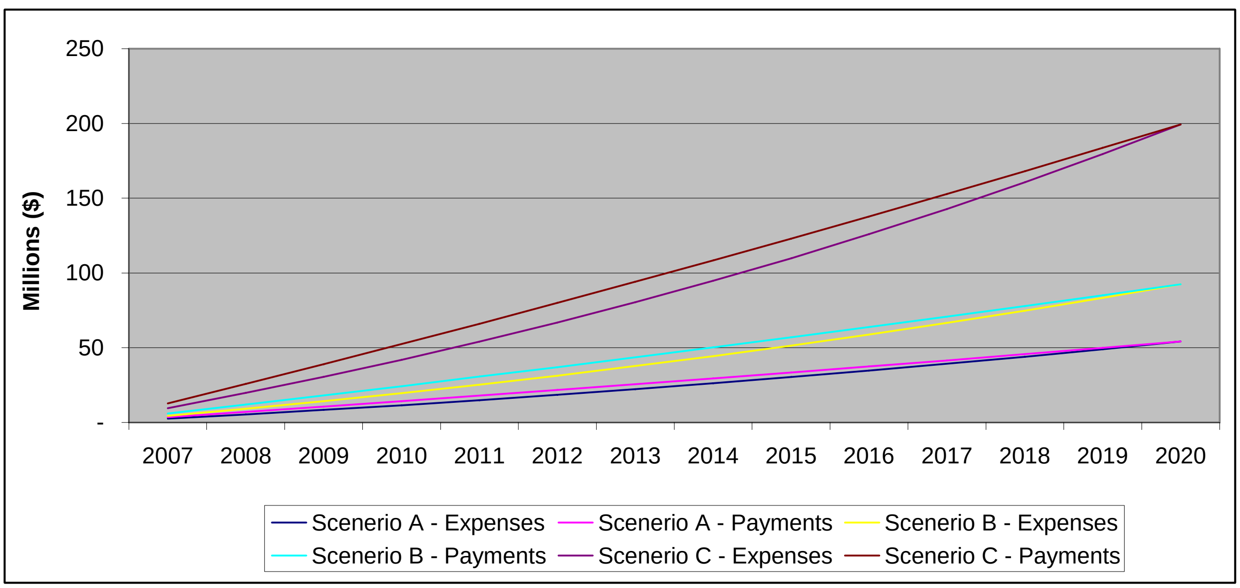
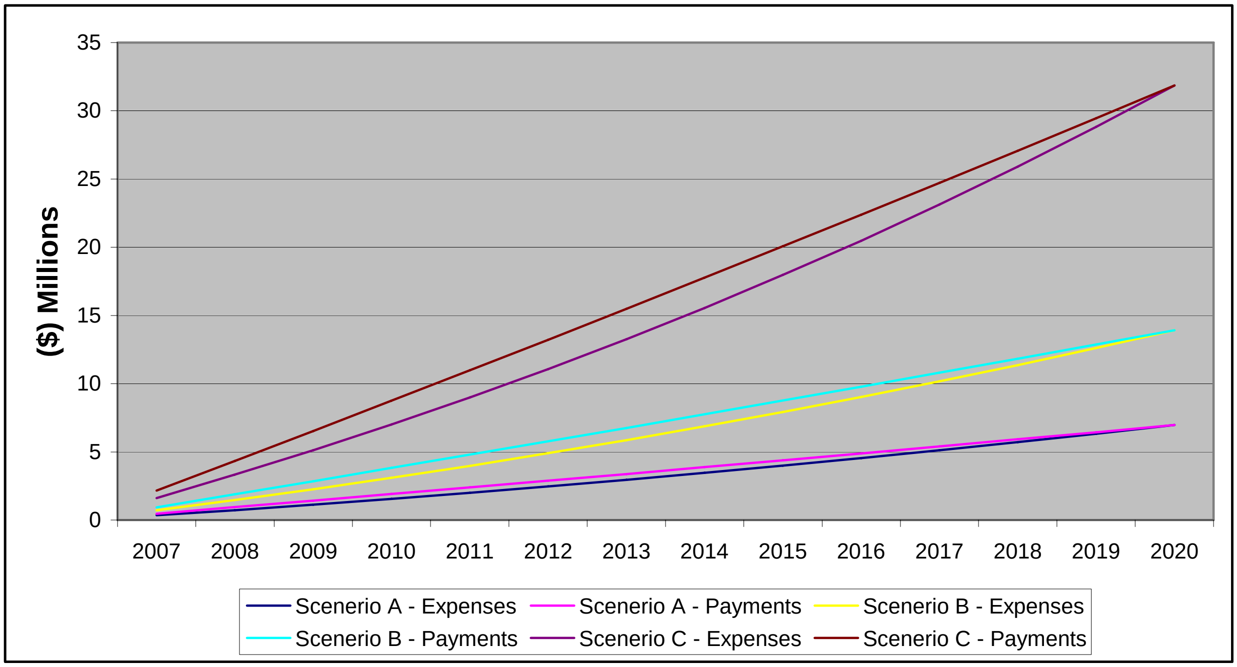


Table 4-9. Cost-Effective Offset Fee for the Tar-Pamlico River Basin

	Cost-Effective Offset Fee[a] ($/lb-30 N)	Cost-Effective Offset Fee[a] ($/0.10 lb-30 P)
Scenario A	$19.70	$26.02
Scenario B	$39.40	$35.38
Scenario C	$90.21	$59.77

[a] Offset fee that allows the program to be sustainable through 2020.

Figure 4-4. Cumulative Revenue and Expenses with Cost-Effective Nitrogen Offset Fees for the Tar-Pamlico River Basin



4.4.2 Offset Fee Program Administrative Costs

The offset fees collected to implement mitigation projects need to adequately cover not only the cost of designing and constructing a project but also the cost of administering the offset program itself. From the perspective of a mitigation project, program administration includes identifying and prioritizing potential mitigation projects and initiating those projects as offset fee payments are made. According to the proposed amendments discussed in Section 2, a 10% fee is added to each offset fee payment to cover the cost of administrating the offset fee program. This fee is intended to provide support for administrative (credit management, tracking payments, processing requests) and project delivery tasks (identifying sites, oversee implementation) similar to other mitigation programs. EEP staff estimate 6% to 7% of their total program costs are for program administration.

Table 4-10 presents information about the typical components of a stormwater retrofit program. It is recommended that the information presented in Table 4-10 be used to determine if the 10% fee is sufficient to fund the administration of a stormwater retrofit program.

Table 4-10. Administrative Components of a Retrofit Program

Component	Key Tasks
Retrofit scoping	• Define retrofitting objectives • Translate objectives into performance criteria • Define preferred retrofit practices
Comparative subwatershed analysis	• Identify subwatersheds with greatest restoration potential
Desktop retrofit analysis	• Secure GIS and other mapping data • Conduct desktop search for retrofit sites • Prepare base maps for site investigations
Retrofit reconnaissance investigation	• Advanced preparation • Investigate and evaluate individual sites
Compile retrofit inventory	• Develop concept designs • Assemble retrofit inventory (e.g., compile list of potential projects)
Retrofit evaluation and ranking	• Neighborhood consultation • Develop screening/ranking criteria • Create priority project list
Subwatershed treatment analysis	• Compute pollutant removal benefits • Compare to retrofitting objectives
Contract and project management	• Obtain landowner approval • Secure permits and easements • Complete engineering analysis • Assemble final design package • Project management and contract administration
Project tracking and monitoring	• As-built inspection • Regular maintenance • Project tracking and monitoring

4.4.3 Adjusted Offset Fee

The cost-effective offset fee is determined by calculating the fee that will equate the cumulative fee revenue with the program expenditures in the year 2020, while also incorporating a factor to account for rising costs each year. The offset fees that yield a sustainable program through 2020 are presented by river basin in Tables 4-11 and 4-12. Figures 4-5 and 4-6 graph the time series of revenue and expenses for both river basins.

Table 4-11. Adjusting Cost-Effective Offset Fee for the Neuse River Basin

	2007 Cost-Effective Offset Fee[a] ($/lb-N)	2020 Cost-Effective Offset Fee[a] ($/lb-N)
Scenario A	$23.13	$28.36
Scenario B	$39.44	$48.35
Scenario C	$85.10	$104.32

[a] Offset fee that allows the program to be sustainable through 2020.

Figure 4-5. Cumulative Revenue and Expenses with Adjusting Offset Fees for the Neuse River Basin

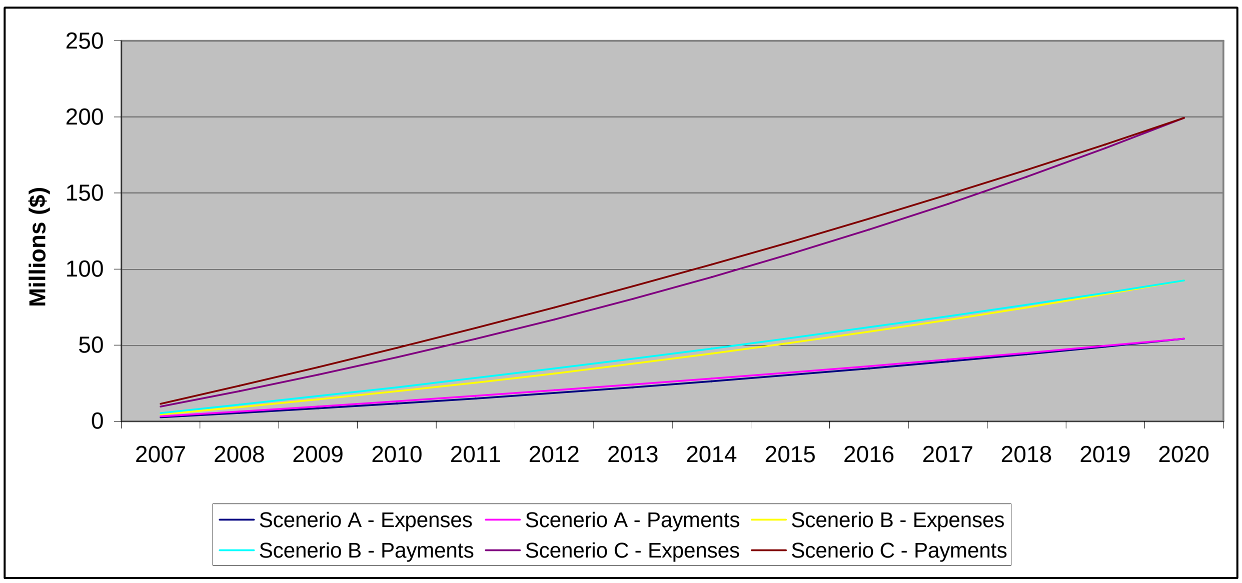
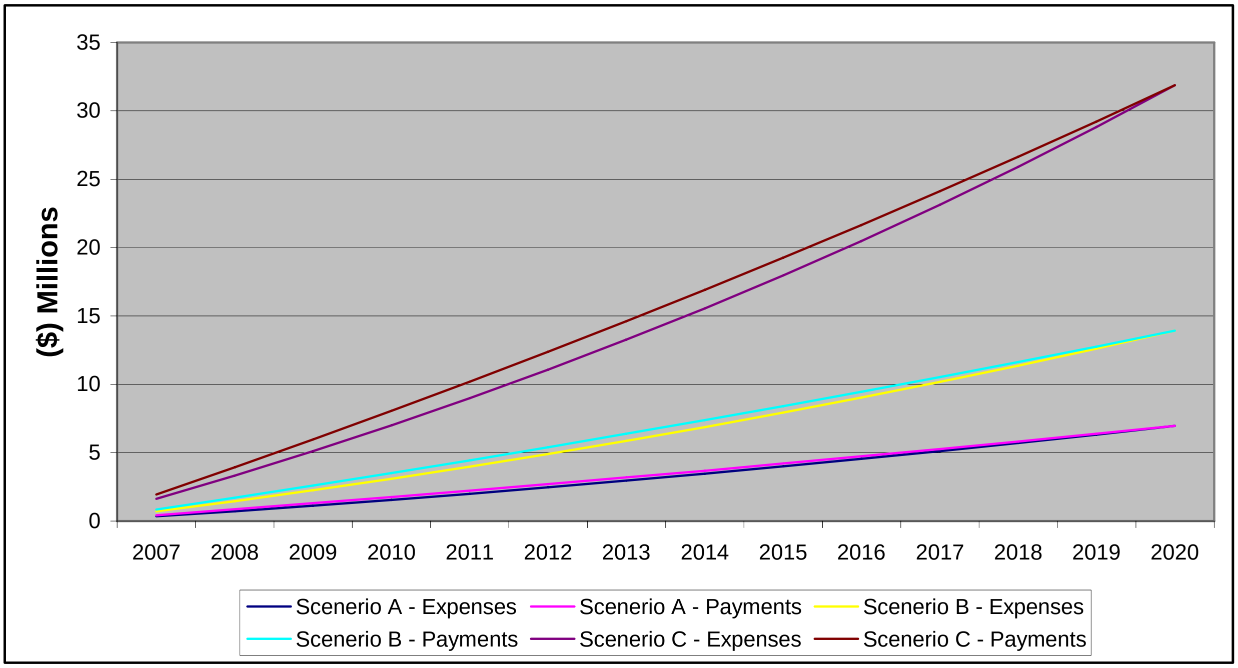


Table 4-12. Adjusting Cost-Effective Offset Fee for the Tar-Pamlico River Basin

	2007 Cost-Effective Offset Fee[a] ($/lb-N)	2020 Cost-Effective Offset Fee[a] ($/lb-N)
Scenario A	$17.72	$21.72
Scenario B	$35.44	$43.45
Scenario C	$81.15	$99.48

[a] Offset fee that allows the program to be sustainable through 2020.

Figure 4-6. Cumulative Revenue and Expenses with Adjusting Offset Fees for the Tar-Pamlico River Basin



The results are very similar to those of the fixed offset fee presented in Section 4.4.2. The only difference is that, with an inflation adjustment factor, payments track more closely with expenditures. However, it is unclear if the added complexity of an indexed offset fee is warranted because the differences between the fixed and adjusted offset fees are minimal.

4.5 Objective 3: Formula for Offset Payment Fee

The offset fee formula that has been used to date is a flat fee in terms of dollars per pound (30 year), with a 10% surcharge added to cover EEP administrative costs. Section 4.4.2 discusses the activities covered by the 10% administrative surcharge.

It seems logical that the formula for the offset payment fee could vary depending on the type of mitigation options pursued (Scenario A, B, or C) and on the underlying rationale for pursuing them. The issue is should the type of development project being offset factor into the payment fee. For example, the proposed payment formula presented in Section 1 contains a land cost component intended to help fund mitigation projects in the specific areas where the development is taking place. If this is the EEP's and the NOFPP's mission, then this formulation seems reasonable. However, if the mission is to simply offset nutrients affecting the estuary, incorporating land costs does not seem appropriate. Thus, we propose the following formulas for the three scenarios covered in this study.

Formula for Scenario A:

Neuse River Basin

Nitrogen Payment = ($25.77/lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)

Phosphorus Payment = ($33.19/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

Tar-Pamlico River Basin

Nitrogen Payment = ($19.70/lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)

Phosphorus Payment = ($26.02/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

Rationale: The only factor that directly affects the water quality in the estuaries is the number of pounds of nutrients needing to be offset. A simple formula incorporating the cost-effective $/lb for nitrogen and $/0.10 lb for phosphorus produces a revenue stream that would allow the EEP to meet its objective of protecting the estuary and be sustainable through 2020.

Formula for Scenario B:

Neuse River Basin

Nitrogen Payment = [($25.77/lb N)(#of lbs/year)(30 years)*
((Land Cost $ per acre/19,000)^(0.64))*(1.1 AdminCosts)

Phosphorus Payment = [($33.19/0.10 lb P)(#of 0.10 lbs/year)(30 years) *
((Land Cost $ per acre/19,000)^(0.31))*(1.1 AdminCosts)

Tar-Pamlico River Basin

Nitrogen Payment = [($19.70/lb N)(#of lbs/year)(30 years)*
((Land Cost $ per acre/9,000)^(0.58))*(1.1 AdminCosts)

Phosphorus Payment = [($26.02/0.10 lb P)(#of 0.10 lbs/year)(30 years) *
((Land Cost $ per acre/9,000)^(0.31))*(1.1 AdminCosts)

Rationale: Under this scenario, the intent is to provide sufficient funds so that mitigation projects can be placed close to the area of the development. This is accomplished by incorporating the land cost of the property being developed (in terms of dollars per acre) into the offset fee to generate sufficient funds to support flexibility when choosing mitigation options.

The land cost factor (Land Cost $ per acre/19,000)^(0.64)) is structured so that when development occurs in rural areas the offset fee matches the cost-effective fee for Scenario A (buffers).[9] For example, when the land cost per acre is about $19,000, the formula generates a fee of $25.77 for nitrogen payments in the Neuse River Basin.[10]

$$\$25.77 * (\$19{,}000/19{,}000)\verb|^|(0.64) = \$25.77$$

The exponent applied to the land cost formula (^(0.64)) is calibrated so that when development occurs in low-density urban areas the offset fee matches the effective fee for Scenario C (stormwater wetlands). For example, when the land cost per acre is about $145,000, the formula generates a fee of approximately $95 for nitrogen payments in the Neuse River Basin.

$$\$25.77 * (\$145{,}000/19{,}000)\verb|^|(0.64) = \$95$$

Again, the advantage of this formula specification is that it generates lower offset fees for development occurring in rural areas. The disadvantage of this formula specification is that actual revenue will be uncertain because fees are a function of where future development will take place. However, the EEP could adjust its mixture of BMPs over time to reflect this reality.

Formula for Scenario C:

Neuse River Basin

Nitrogen Payment = ($94.80) /lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)

Phosphorus Payment = ($62.91/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

Tar-Pamlico River Basin

Nitrogen Payment = ($90.21) /lb N)(#of lbs/year)(30 years)(1.1 AdminCosts)

Phosphorus Payment = ($59.77/0.10 lb P)(#of lbs/year)(30 years)(1.1 AdminCosts)

Rationale: Under this scenario stormwater wetlands are always implemented. Thus, the location of the development (or the land cost per acre) has little impact on the cost of the BMPs. As a result, we recommend a simple formula specification similar to the one for Scenario A.

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[9] Land costs as rounded off from Table 4-6.

[10] Note that when the land cost per acre is $19,000, the ratio becomes 1.0 and the exponent does not influence the calculation.

SECTION 5
PROGRAM IMPLEMENTATION (OBJECTIVES 4, 5, AND 6)

5.1 Objective 4

Any assessment of expanding nutrient offset payments to other parts of the state or to other nutrients needs to be based on a full cost-benefit assessment that weighs the economic costs of imposing environmental assessments of water quality issues. From an economic perspective, nutrient offset fees can distort regional development costs and, hence, lead to marginal shifts in development away from river basins that require fees to river basins that do not require them. However, estimating the magnitude of these economic impacts is beyond the scope of this study.

Therefore, in this analysis, we only consider the environmental impacts of excessive nutrient loading when assessing the need to expand nutrient offset payments to a particular water body. From this perspective, the environmental question that needs to be asked is whether nutrients are creating sufficient environmental damage to warrant regulation in the water body under consideration. We focus on describing the existing literature and published studies to provide insights on this issue.

5.1.1 The Chowan River Basin

Among the other water bodies in North Carolina that have experienced, and could be considered candidates for, geographic extension of the nutrient offset program is the Chowan River Basin (part of the Albemarle-Pamlico Estuarine system). The Chowan was the first basin in the state to be designated as NSW in 1979 because of the occurrence of nuisance algal blooms and fish kills. Forest and agriculture dominate the North Carolina portion of the Chowan River Basin. Management strategies have been adopted to reduce the discharge of nutrients from wastewater treatment plant (WWTP) dischargers and agricultural runoff. The latest basin-wide plan for the Chowan indicates that, although conditions have improved over the past several decades, eutrophiation remains a concern (NCDWQ, 2002b).

5.1.2 The New River Watershed

The New River watershed in Onslow County (part of the White Oak River Basin) is another potential candidate. The Upper New River watershed was designated as NSW in 1991 because of persistent algal blooms, fish kills, and low oxygen levels. The watershed above Jacksonville is used primarily for forestry and agriculture. At Jacksonville, the river widens into a broad, slow-moving tidal estuary. It eventually discharges to the Atlantic Ocean through a narrow opening called New River Inlet. The shallow depth and narrow inlet that restricts tidal exchange contribute to the long flushing time (ranging from 8 to 187 days) and semilagoonal nature of this system (Ensign et al., 2004). These physical properties make this system sensitive to excess nutrients. In the late 1990s, the City of Jacksonville removed its WWTP discharge from the upper New River Estuary, and Camp Lejeune consolidated seven of its discharges into one tertiary WWTP. Since the removal of these nutrient effluent sources, documented reduction of nitrogen and phosphorous, 57% and 71% decreases respectively, has occurred (Mallin et al., 2005). However, nutrient inputs from point and nonpoint sources remain a concern (NCDWQ, 2007a).

5.1.3 The Jordan and Falls of the Neuse Reservoirs

The Jordan and Falls of the Neuse reservoirs were both designated as NSW in the 1980s; nutrient Total Maximum Daily Load (TMDL) implementation remains an active process for both watersheds (NCDWQ, 2005c; NCDWQ, 2007b). Jordan Reservoir is located in the Cape Fear River Basin in Chatham County south of Chapel Hill and Durham. A nutrient management strategy and TMDL were developed to satisfy NSW requirements and a federally mandated TMDL. Both the NSW and TMDL programs include the development of a calibrated nutrient response model to support a management strategy to control nutrients and meet the state's chlorophyll a standard. This model determined that point sources discharge 36% of the nitrogen and 17% of the phosphorous load, and nonpoint sources discharge 64% of the nitrogen and 83% of the phosphorous load to Jordan reservoir. The NCDWQ has drafted new rules for the nutrient management strategy for Jordan Reservoir. In March, 2007 the EMC approved these rules to be released for public comments (expected summer 2007). These proposed rules follow the framework of previous nutrient strategies for the Neuse and Tar-Pamlico river basins, but these new rules include stormwater requirements for all local governments in the watershed, local implementation of buffer rules, and a rule requiring local governments to achieve nutrient loading reductions from existing developed lands. A separate rule outlining a trading framework to maximize options for achieving more cost-effective reductions is also planned (NCDWQ, 2007b).

Falls of the Neuse Reservoir (Falls Lake) is located within the headwaters of the Neuse River Basin in Durham and Wake counties. Approximately 61% of the watershed is forested, 16% is in agriculture, and 17% is suburban and urban development. Currently, Falls Lake is not classified as impaired, but several upstream tributaries are classified as impaired (NCDWQ, 2002c). In 2005, NCDWQ initiated a field study and modeling plan for the development of a nutrient management strategy for the lake. This study established 13 stations designed to monitor the water quality on Falls Lake. Results indicate a spatial trend with nutrients and chlorophyll a concentrations higher at the upstream stations and decreasing toward the dam (NCDWQ, 2007c).

5.1.4 High Rock Lake

High Rock Lake, located in Rowan and Davidson counties, is scheduled as the next large Piedmont reservoir for examination (Woolfolk, 2005,). Water quality concerns for High Rock Lake date back to the mid-1970s, and the need for nutrient reduction strategies to address problems due to accelerated eutrophication has been apparent since the mid-1990s. In the most recent assessment period (1999 to 2001), NCDWQ classified the lake as "impaired" based on high levels of nutrients, combined with chlorophyll a, turbidity, and percentage dissolved oxygen saturation in excess of state standards (NCDWQ 2003). A nutrient management strategy was implemented in 1998. In addition, new point sources are being restricted from certain portions of the lake, and TMDLs are being developed for some upstream tributaries. Strategies used to reduce concentrations in these watersheds will also help reduce nutrient and sediment loading to the upper portion of the basin and ultimately High Rock Lake. NCDWQ will continue to monitor the lake. Other large reservoirs in the Catawba and Yadkin basins, as well as other water supply reservoirs, could be considered as candidates for extending the nutrient offset program.

5.1.5 Streams and Rivers Experiencing Eutrophication

In addition to the lakes, reservoirs, and estuaries discussed previously; streams and rivers that experience excessive nutrients may also be targeted for the NOFPP if they become subject to nutrient loading limits. For example, the Rocky River in Chatham County downstream of the Rocky River Reservoir has been observed to have extensive algal mats during summer months at its confluence with the Deep River. Excessive nutrients from both agricultural and residential activities are thought to be potential sources of these algae (NCDWQ, 2005). If this is confirmed and nutrient loading limits are set, this river could be a potential candidate for extending the NOFPP.

However, more information on this and other streams needs to be gathered before it can be determined whether the NOFPP would be applicable in these waterbodies. An additional concern must also be stressed, that when we are looking at smaller rivers or streams, there may simply not be enough off-site mitigation opportunities to make the NOFPP a feasible or sustainable option.

5.2 Objective 5: Public versus Private Implementation

The EEP currently serves as the sole gateway for purchasing nutrient offsets in the Neuse and the Tar-Pamlico river basins. It receives payment for excess nutrients emitted by nonpoint sources, which it then uses to construct BMPs that will offset them (either through the use of the full delivery or design-bid-build processes described in Section 2). However, a wide range of alternative operational structures could be developed, such as a market-style nutrient trading system.

A market in nutrient credits would operate similarly to the way markets in other commodities operate. Both types of markets facilitate the exchange of desired goods between willing buyers and sellers. In the case of nutrient markets, individuals or companies that find it too expensive to meet mandated nutrient loading caps would be willing to purchase "credits" from other individuals or companies that have reduced nutrient loading elsewhere in the river basin beyond the capped amount. As a result, the excess nutrient loading of the credit purchaser is "offset" by the nutrient reductions of credit supplier.

Adopting a market structure to mitigate pollutants has a variety of advantages that have been well documented in the literature. Of particular interest to this study is the idea that the price paid by purchasers of nutrient credits could be determined by the interaction of market forces (supply and demand) that would ultimately ensure that the price was enough to cover the full cost of installing the BMP projects required. As a consequence, market-style structures will have great flexibility in the face of changes in supply (e.g., increasing costs of offsetting nutrients) and demand (e.g., an increase in development driven by population growth).

The same market forces that drive prices to balance supply and demand will also direct offset payments toward BMP projects that provide the greatest amount of nutrient reduction at the lowest cost. In the context of the NOFPP, this could mean that the majority of funds would be directed toward installing riparian buffer projects in rural areas of the two river basins. However, if the goal of the NOFPP is broader, and includes protecting water quality in individual watersheds, then regulations may be required that dictate that nutrient offsets must be supplied within a certain distance of environmental impact (King and Kuch, 2003).

Nutrient trading markets would still require continued government supervision to ensure they operate as intended. In particular, a key role for regulators would be to "certify" that each nutrient credit will offset the amount of nutrients it claims to offset. This can be a concern because the effectiveness of the BMPs generating nutrient offsets will vary based on site-specific factors, the quality of their construction, and the level of maintenance over time (King and Kuch, 2003).

Many states are developing market-style trading programs. Most recently, the Commonwealth of Pennsylvania began implementing a nutrient trading market to achieve the nutrient reduction goals laid out in the 2000 Chesapeake Bay Agreement (PADEP, 2007). This system allows individuals to buy and sell nutrient credits, which have been certified by the Pennsylvania Department of Environmental Protection, over an online market called NutrientNet (PADEP, 2007). This program is structurally similar to what has been discussed and could be used as a model for North Carolina, if policy makers considered pursuing a market-based solution.

Generally, the NOFPP seems well suited for market-style nutrient trading. A problem faced by other trading markets in the past has been an insufficient demand for nutrient offset, which led to a low volume of trades. However, the frequent purchase of nutrient offsets under the current system demonstrates that should not be an issue for the NOFPP. Also, the successful completion of eight full-delivery projects under the current program illustrates the fact that private entities have the capabilities to generate nutrient offset credits that they could provide to individual buyers. However, as mentioned previously, government regulation and oversight would be required to ensure that the market operates as intended. If such a market-style structure were pursued, the EEP would be among the best suited government entities for providing this oversight given its past experience in managing the current program.

Below, Section 5.2.1 provides an overview of other nutrient offset programs outside North Carolina, and Section 5.2.2 provides an overview of several high-profile, nonnutrient environmental trading programs that demonstrate the potential effectiveness of a market-style structure.

5.2.1 Similar Water Quality Offset Programs (from Table 5-1)

RTI spoke with program administrators of seven water quality offset programs identified in other states as being similar to the NOFPP in North Carolina. Appendix A describes these programs. Based on these conversations, we summarize in Table 5-1 eight major task areas associated with developing and maintaining a fee-based offset program. These task areas include the following:

- Offset program administration
  - rule making
  - environmental analysis
  - pollution monitoring
  - offset fee management (i.e., collection and disbursement)

- Offset project development
  - site selection
  - engineering design
  - offset project construction
  - offset project ongoing operation and maintenance

Governments' role typically included program setup, offset rule making, and development of a water quality management plan. These programs typically required development firms to submit water management plans to the program office. The program staff also reported that they were responsible for determining offset fees to be assessed. Offset fees are then typically used to develop new or improved existing water quality offset projects. The state and county program officers in many cases reported having environmental engineers on staff to conduct environmental assessments to inform emissions control policies.

Water quality offset programs were also responsible for offset project planning. These programs conduct offset project site selection. They typically contract the construction of offset projects to private construction firms, but long-term operation and maintenance is the responsibility of the program office.

The State of Maine Storm Water Compensation Fund is the only offset program interviewed that did not maintain direct control over offset projects. Although the program office was responsible for offset fee collection, they release an RFP for offset projects in selected regions. The offset project funds are then awarded as grants to nonprofit entities (e.g., a town council, an individual, an environmental group) that submit the most effective long-term offset project proposal. The grantees are then typically responsible for design, construction, and long-term operation and maintenance of the offset project. This year, the program is shifting away from single-site project awards toward awarding offset project grants that would designate regional responsibility for water quality offset projects.

5.2.2 Federal Environmental Trading Programs

Trading programs have been created to address compliance and create voluntary markets for the purchase of emission reduction credits (ERCs) to offset greenhouse gas (GHG) emissions.

Key elements to a successful GHG offsets (cap and trade) program include the following:

- market demand (i.e., cap) requires regulatory body enforcement
- clear rules surrounding the creation and use of offsets that will ensure the integrity of emission reductions

Table 5-1. Water Quality Offset Fees from Other Programs around the United States

Locality and Program	Contact	Fee	Costs Covered by Fee						
			Design	Engineering	Permitting	Construction	Land Acquisition	Program Administration	Maintenance
Arlington County, VA, Watershed Management Fund	Arlington County Department of Environmental Services 703-228-3612	$2.50/sq ft of impervious area requiring mitigation	✓	✓	✓	✓			✓
Austin, TX, Urban Watershed Structural Control Fund	Department of Watershed Protection and Development Review 512-974-2501	Fee based on impervious area base fee for first 0-1 ac $32,000	✓	✓	✓	✓	✓		✓
Baltimore, MD, Critical Area Program	Department of Planning 410 396-5902	$35,000/lb of phosphorous	✓	✓	✓	✓		✓	✓
Fairfax County, VA, Uniform Pro Rata Share Program	Department of Public Works and Environmental Services 703-324-1720	Determined on case-by-case basis and based on impervious area	✓	✓	✓	✓	✓	✓	✓
Gwinnett County, GA, Stream Buffer Mitigation Bank	Gwinnett County Water Resources 678-518-6150	$23,000 per water quality unit	✓	✓		✓			
Henrico County, VA, Environmental Fund	Henrico County Department of Public Works 804-501-4396	$8,000/lb of phosphorous	✓	✓	✓	✓			✓
State of Maine Stormwater Compensation Fund	Maine Department of Environmental Protection 207-287-2116	$10,000/lb of phosphorous for lake sheds $20,000/lb of phosphorous for severely blooming lake	✓	✓	✓	✓			✓
State of Maryland Critical Area 10% Rule	Maryland Critical Area Commission 410-260-3460	Equivalent cost: $38,400/lb of phosphorous retrofit cost: $22,500/lb of phosphorous	✓	✓	✓	✓		✓	✓

- clear rules and standardized processes for creating offsets that ensure validity and environmental integrity of projects
- clear rules regarding use of offsets to meet caps

Compliance trading programs typically result from government enforcement of air quality standards that cap direct emissions, limiting industries' allowable emissions. Offset regulators reduce uncertainty and risk to market participants by providing clear rules and standardized processes for creating and using ERCs.

Governments must recognize offsets as a valid emission reduction option. State or federal recognition of offsets is typically preceded by the validation of offset projects to ensure they are truly offsetting GHG emissions. Limitations in measurement and validation methodologies constrain the universe of reductions that can satisfy the rules for offset creation. The following are examples of trading programs.

The SO_2 Emission Allowance is a cap-and-trade program created by EPA's Acid Rain Program, which falls under Title IV of the 1990 Clean Air Act Amendments and was established to achieve significant reductions in the emissions of sulfur dioxide (SO_2) and nitrogen oxide (NO_x), the primary causes of acid rain.

EPA allocates emission allowances to utility units, based on their historic fuel consumption (1985–1987) and a specific emissions rate. Each allowance permits a unit to emit 1 ton of SO_2 annually. EPA's role in allowance trading is to record allowance transfers that are used for compliance and to ensure at the end of the year that a source's emissions do not exceed the number of allowances it holds. To accomplish this, EPA maintains an Allowance Management System (AMS). Each affected utility source, corporation, group, or individual holding allowances has an account in the AMS.

EPA outsources the majority of the day-to-day operations of the SO_2 trading program. The private company, ICF Consulting, has supported EPA's Clean Air Markets Division (CAMD) on all their market-based air emissions controls programs (4/03 to 4/07). The contract is cost plus fixed fee for $21.6 million.

Perrin Quarles Associates (PQA), under contract by CAMD, developed the Emissions and Allowance Tracking System (EATS), a generic software application to support regulatory agencies and countries who adopt emissions trading approach to reduce air pollution emissions.

The Regional Clean Air Incentives Market (RECLAIM) was created by the South Coast Air Quality Management District (SCAQMD) in California, which is responsible for operating the program. RECLAIM covers all of Los Angeles and Orange counties along with half of Riverside County. This program controls the amount of nitrogen oxide (NO_x) and sulfuric oxide (SO_x) released in a 1 credit-to-1 pound NO_x emitted ratio. RECLAIM trading credits, or RTCs, were issued at a zero-cost basis to all sources whose yearly emissions are greater than 4 tons (8,000 pounds) per year at the start of the program.

Brokerage firms have emerged from the private sector in response to facilities participating in the trading scheme that have credits to sell or that need to purchase credits. Brokerage companies provide a fee-based service to bring market participants together for effective trading.

The Chicago Carbon Exchange[11] (CCX) is a self-regulatory exchange that administers a voluntary, legally binding pilot program for reducing and trading GHG emissions in North America with participation from offset providers in Brazil.

The exchange comprises North American companies with direct GHG emissions from their facilities and companies with no direct emissions but that comply with CCX rules by offsetting emissions with a selection of business related activities.

CCX members with direct emissions have voluntarily agreed to reduce their emissions by 1% each year for 3 years beginning in 2003. The 1% is calculated relative to a 1998 to 2001 average. Members are expected to reduce net emissions to 4% below baseline levels by the end of 2006.

CCX offset projects include the following:

- methane destruction projects for landfills and livestock operations
- agricultural practices projects to implement alternative crop tilling practices and initiate grass cover planting in applicable regions
- forestry practices such as forestation and forest enrichment projects
- renewable energy projects through the displacement of carbon dioxide (CO_2) emissions by eligible renewable energy facilities

Auditing, verification, and market surveillance activities are outsourced to a financial regulatory service company, NASD, Inc. NASD conducts audits of member-company emissions and reviews offset project verification methodologies. CCX requires third-party verification of GHG offset project achievements by approved verification service providers.

[11] Information obtained from CCX Web site, www.chicagoclimatex.com.

SGS and EcoSecurities[12] are one example of a carbon offset verification service provider. They provide periodic monitoring of project implementation and verification and the quantification and certification of projected and achieved emission reductions.

Valid projects under the CCX are required to offset 12 million tons of carbon per year. Few offset projects of this size exist in the United States. As a result, private-sector aggregators have emerged to provide fee-based services to allow smaller incremental offset projects to be aggregated to a level that meets the CCX requirement for offset project status.

5.3 Objective 6: Mitigation Options Available

The final objective of this study was to conduct a comprehensive review of the types of potential nutrient mitigation projects available. To accomplish this, the Center for Watershed Protection compiled and analyzed national cost data for a variety of structural stormwater retrofit practices, including wet ponds, wetlands, bioretention areas, filtering practices, infiltration practices, and swales (Schueler et al., in press). This effort produced national average construction costs for a wide range of mitigation practices that were not available for projects based in North Carolina. Additional mitigation project identified include sand filters, underground sand filters, infiltration practices, and water quality swales.

Using North Carolina event-mean-concentrations (EMCs) obtained from the National Stormwater Quality Database (NSQD) and pollutant removal efficiencies listed in the North Carolina Department of Environment and Natural Resources' (NCDENR) Manual of Stormwater Best Management Practices, the average construction costs for stormwater retrofits are presented in Table 5-2. National cost data for the mitigation options included in the study scenarios are also included in Table 5-2 for comparison. The project costs presented in Table 5-2 include only the construction cost and associated design and engineering fees; however, as shown earlier, these are by far the largest components of structural stormwater mitigation projects.

[12] This link is an example of validation method but based in the UK—http://www.eci.ox.ac.uk/research/biodiversity/linkcarbon.php.

Table 5-2. Nutrient Mitigation Project Costs[a]

Stormwater Retrofit Practice	Median Cost ($/lb-30 N)[b]	Range ($/lb-30 N)[b]	Median Cost ($/0.10 lb-30 P)[c]	Range ($/0.10lb-30 P)[c]
Wet ponds	$177	$88 to $317	$93	$47 to $168
Wetlands	$110	$55 to $198	$107	$53 to $192
Large bioretention areas	$265	$188 to $433	$174	$125 to $286
Small bioretention areas	$755	$628 to $1,007	$498	$415 to $664
Sand filters	$503	$403 to $553	$332	$266 to $365
Underground sand filters	$1,637	$705 to $1,887	$1,079	$465 to $1,245
Infiltration practices	$240	$160 to $368	—[d]	—[d]
Water quality swales	$550	$308 to $968	$466	$262 to $822

[a] Assumes design and engineering fees at 32% of construction cost.
[b] Cost per pound of nitrogen removed per year, in 2006 dollars.
[c] Cost per pound of phosphorus removed per year, in 2006 dollars.
[d] Not computable; pollutant removal benefits not defined within NCDENR, 2005a.

SECTION 6
CAVEATS AND FUTURE RESEARCH

The primary objective of this study was to assemble nutrient mitigation cost data to support an evaluation of the offset fees collected as part of the NOFPP. As part of the study, we developed several mitigation scenarios the EEP could implement in the future and estimated the cost-effective offset fees needed to keep the program solvent through 2020 for each scenario.

It was not the purpose of this project to recommend which of the three scenarios (or alternative possible scenarios) the EEP should pursue. That is a public policy decision that requires a more extensive environmental and economic benefit-cost analysis. However, our findings should serve as valuable inputs into the decision-making process.

As part of this study's analysis, we encountered several issues that may warrant further research. These relate to pollutant removal efficiencies, and EMCs and land use loading rates. These factors are used in calculating the offsets required of developers and the nutrients mitigated by the EEP. They support an important process indirectly underlying the formula for payments evaluated in this study because it is essential that pounds "in" (generated) equal pounds "out" (offset) by the NOFPP. These issues are discussed briefly below and in greater detail in Appendix B and Appendix C.

6.1 Pollutant Removal Efficiencies

Pollutant removal efficiencies for the NOFPP were obtained from the NCDENR Stormwater BMP Manual. However, a number of additional BMP performance studies have been published since the NCDENR Stormwater BMP Manual was created. For example, pollutant removal efficiencies are also available from the National Pollutant Removal Performance Database (NPRPD). The national data from the NPRPD generally confirm the BMP pollutant removal efficiencies presented in the NCDENR manual. However, some discrepancies do exist between North Carolina studies extracted from the NPRPD and the removal efficiencies reported in the NCDENR manual. These discrepancies include the suspended solids for all BMP types and nitrogen for infiltration practices. Because of the limited amount of North Carolina BMP data, further research is recommended to develop state-specific pollutant removal efficiencies.

6.2 Event-Mean-Concentrations (EMCs) and Land Use Loading Rates

EMCs are used to calculate predevelopment pollutant loads and (estimated acceptable background unit area nutrient load) and postdevelopment pollutant load (estimated unit nitrogen and phosphorus loading rate per acre of impervious cover for new or existing development). The current North Carolina EMCs were based on early 1980s National Urban Runoff Program data and then updated in 2000 by CH2M Hill. We recommend considering adjusting current EMCs for total nitrogen (TN) and total phosphorus (TP) based on the more extensive National Stormwater Quality Database (NSQD) estimates. In North Carolina, there is a statistically significant difference between residential, nonresidential, and open space EMCs for TN. In comparison, for TP, no statistical difference exists between residential and nonresidential EMCs, but a significant difference does exist between these two land uses and open space. This provides justification for using different EMCs based on categories of land use.

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APPENDIX A
DESCRIPTION OF OTHER NUTRIENT OFFSET PROGRAMS

A.1 Arlington County, VA

Arlington County requires stormwater treatment for all projects over 2,500 square feet that are covered by Virginia's Chesapeake Bay Preservation Ordinance. To comply with stormwater requirements, an applicant calculates the overall pollutant removal requirements for the site using a Stormwater Requirements Worksheet. On-site stormwater treatment is required for any impervious surfaces with which vehicles come into contact on the site, including but not limited to: parking areas; streets and roadways; loading docks; equipment, material, and waste storage areas; and vehicle fueling, washing, storage, maintenance, and repair areas. If the total pollutant removal requirements for the site cannot be met solely with on-site stormwater treatment, compliance can be achieved through approved combinations of additional on-site stormwater treatment for roofs, plazas, and other areas of the development site; on-site stormwater treatment for off-site areas, or a contribution to the County's Watershed Management Fund.

The Watershed Management Fund provides applicants with the option to contribute a fee-in-lieu program to comply with treatment requirements for nonvehicular areas. The intent of the hybrid on-site stormwater treatment practice/fee-in-lieu program is to recognize that most of the watershed impacts in Arlington County are due to the existing development already in the County. The Watershed Management Fund is used to address existing impacts through larger-scale watershed protection projects such as stream restoration, regional BMP retrofits, monitoring, and outreach and education. The contribution rate of $2.50 per impervious square foot of impact area only covers 40 to 60% of the total opportunity cost of BMP design, installation, and maintenance and is discounted to reflect the increased cost-effectiveness of watershed-scale solutions and the regional water quality from infill development in urban areas like Arlington.

A.2 Austin, TX, Urban Watershed Structural Control Fund

The City of Austin, TX, requires that, for all levels of impervious cover, projects in the designated urban watersheds must provide water quality controls when the cumulative total of both new and redeveloped impervious cover exceeds 5,000 square feet. The City provides a fee-in-lieu-of option to land developers as an alternative to providing on-site water quality improvement facilities in these urban watersheds. The fees are referred to as Urban Watersheds Structural Control Fund (UWSCF) fees and are based on a set of formulas from Appendix T of the Environmental Criteria Manual. The UWSCF fee was first adopted in 1991 but has undergone several modifications since its inception. The goal of the fee is to approximate the cost of building a water quality control facility on a site including the cost of land that would be occupied by the facility.

The program works by having an applicant calculate the fees of three components of a site to come up with the final fee. The first component is the site impervious cover. The total impervious cover at a site, both redeveloped impervious cover and new impervious cover, is multiplied by a sliding scale of fees to calculate the total site impervious cover fee (Table A-1). The City then offers an incentive for redeveloping older properties by paying 75% of the fee for those areas of existing impervious cover on a site that is being redeveloped. The second component is a building fee based on the square footage and currently set at $0.10 per square foot. The third component is a site area fee that multiplies the site area in acres within the limits of construction of a project by $6,000 for commercial or multifamily development or $4,000 for single family and duplex development. Again, the City pays for 75% of this fee for those areas of existing impervious cover on a site that is being redeveloped. The City is currently reevaluating its redevelopment incentive and whether redevelopment should be treated just like new development.

Table A-1. Austin UWSCF Impervious Cover Charges

Area of Impervious Cover	Fee
0 to 1.00 acres	$32,000
1.01 to 2.00 acres	$18,000
2.01 to 10.00 acres	$11,000
10.01 to 20.00 acres	$8,000
20.01 acres or greater	$6,000

A.3 Baltimore, MD, Critical Area Program

The City of Baltimore is part of the larger Maryland Critical Area Program, and it developed their Critical Area Program with an associated offset fee program. The program actually has two offsets: a water quality offset fee with a current cost of $35,000/lb of phosphorous, and a buffer offset fee when stream buffer is removed that uses $2.50 a square foot as the current charge. Because of the highly urbanized nature of Baltimore, most of the offset fees are used for pavement removal or acquisition of parkland. The fee collected is allowed to be used outside of the 1,000 foot Critical Area boundary, with the preference being to use the money in areas as close to the project as possible. Administration of the program is covered in the fee charged and is estimated to take about 5 to 10% of the total cost.

A.4 Fairfax County, VA

Fairfax County's program is called the Uniform Pro Rata Share Program. Fees under this program are based on the increase in impervious area and vary by watershed. The total fee for each watershed is based on master planning studies that identified a number of regional ponds as well as other flood control improvements (e.g., improved stream crossings) and the total potential impervious cover for each of the 30 major watersheds in Fairfax County. The total fee was divided by the projected increase in impervious area to determine the pro rata share by watershed. Fees vary from $1,784 per increase in impervious acre to $22,153 per increase in impervious acre, with an average of $5,469 per increase in impervious acre. The fees collected are placed into a watershed account and can only be expended for the established stormwater capital improvement projects in that watershed. The fees are recalculated every 6 months to account for changes in project costs and for addition and removal of projects as needed. Once a project is constructed, it remains in the program for 12 years to ensure maintenance.

A.5 Gwinnett County, GA, Stream Buffer Mitigation Bank

The Gwinnett County, GA, Stream Buffer Mitigation Bank Fund was established to provide for fee-in-lieu of mitigation for project sites where on-site mitigation of impacts to an existing stream buffer protection zone is not practical. The goal is to fund stream repair and restoration projects in watersheds that have the highest amount of stream degradation. The amount of mitigation necessary is determined by a water quality value calculation based on the proposed action in the stream buffer. Mitigation requirements can be satisfied by purchasing water quality values from the Gwinnett County Stream Buffer Mitigation Bank Fund.

The fee is based on the estimated cost of stream buffer restoration, and the in-lieu fee is currently set at $23,000 per water quality value unit. The methodology for developing the fee uses a water quality factor to determine the water quality value of a restored or preserved stream. The factor represents the functional value of the restored buffer to provide water quality protection for the stream and habitat enhancement for the stream biological community. Anecdotal evidence suggests that the current fee may be too low and does not cover the true cost of stream restoration of planting projects.

A.6 Henrico County, VA

Henrico County has an Environmental Fund that was established to accept fee-in-lieu contributions in instances where compliance with stormwater pollutant removal requirements is unachievable. The Environmental Fund provides a funding source for the water quality projects conducted within the county in the James River and Chickahominy River watersheds. The county uses the fee-in-lieu contributions to finance projects such as streambank stabilization, stream restoration, removal of stream obstructions, buffer establishment, regional BMPs, and constructed wetlands. Contribution to the Fund is based on a project's impervious percentages and the Watershed Management Area designation where the project is located. The contribution is based on a cost of $8,000.00 per pound of pollutant removal required to be achieved by the project. Pollutant loading and removal calculations are done in accordance with the simple method described in the Henrico County Environmental Program Manual.

Contributions to the Fund are based on a prorata share of the annual cost of providing equivalent pollutant removal projects over a normal year of development activity within the county. The current $8,000.00 per pound of pollutant removal requirement was derived from the annual cost of providing an equivalent level of pollutant removal based on a previous "site-by-site" approach. The current $8,000.00 per pound cost is based on older information and in need of review and adjustment to reflect changes in inflation and construction costs. The fee requirements can be reduced by providing forested stream protection area and energy dissipaters.

A.7 State of Maine

Maine's Stormwater Management Law authorizes the Department of Environmental Protection to accept a compensation fee in lieu of some of the phosphorus reduction required from projects located in lake watersheds identified as most at risk for development. The allowable per-acre phosphorus allocation for each lake most at risk is based on current water quality, potential for internal recycling of phosphorus, potential as a cold-water fishery, volume and flushing rate, and projected growth in the watershed. This allocation is used to determine phosphorus allocations for a project. Each project is required to incorporate phosphorus control measures that provide at least a 50% reduction in projected phosphorus export in stormwater runoff from the project site and may then opt to pay a compensation fee to provide the remaining phosphorus reduction necessary to meet the site's phosphorus allocation. The current rate is set at $10,000 per pound of annual algal-available phosphorus export.

The projects funded through the compensation fee-in-lieu are designed to provide long-term elimination or reduction of chronic phosphorus sources. The compensation project must be located within the same lake watershed as the project for which the compensation fee is paid. Interviews suggest that the current fee does not fully cover retrofit construction costs, and they will be looking to revise the fee in the next year to be $20,000/lb of phosphorous. Interviews also suggest that a lesson learned is that it is better to have fees go directly to approved recipients at a more local level, rather than to a general state fund because it is difficult to dispense funds that come with greater levels of requirements for dispensing state-held funds.

A.8 State of Maryland Critical Area 10% Rule

The Maryland Chesapeake Bay Critical Area Protection Act (Critical Area Act) was enacted in 1984 to help reverse the deterioration of the Chesapeake Bay and the surrounding environment. The Act recognizes that the land immediately surrounding the Bays and their tributaries has the greatest potential to affect its water quality and wildlife habitats and designated all land within 1,000 feet of tidal waters or from the edge of tidal wetlands as "critical area." The criteria set forth in conjunction with the Critical Area Act require that any development or redevelopment within intensely developed areas (IDAs) be accompanied by practices to reduce water quality impacts associated with stormwater runoff to a level at least 10% below the load generated by the same site prior to development. IDAs are generally areas that were developed with residential, commercial, industrial, and institutional land uses at the time of the original critical area mapping and where relatively little natural habitat occurred. IDAs are also considered the preferred locations for future growth through redevelopment and/or new development.

When on-site treatment practices cannot meet the phosphorus load reductions in IDAs, then an offset fee can be paid as a last resort to meet requirements. The offset projects must be located within reasonable proximity to the Chesapeake Bay, Atlantic Coastal Bays, their tributaries and associated tidal wetlands, and preferably within the critical area itself. Funds are intended for use within the same watershed and to replace equivalent water quality improvement projects. In addition, any measure or practice that is used for an offset cannot be a measure that would have been required under existing laws, regulations, statutes, or permits. The current state guidance for calculating offset fees gives local municipalities two methodologies: an equivalent cost method for computing the cost of providing stormwater management on-site and a retrofit cost method that examines the cost to a local government to provide phosphorus treatment with a larger stormwater retrofit elsewhere in the community. The estimate using the equivalent cost method was done from a review of the actual costs of 73 stormwater treatment practices in the Mid-Atlantic region and was set at $38,400 including maintenance of the practice. The retrofit cost estimate was $22,500 including maintenance.

APPENDIX B
POLLUTANT REMOVAL EFFICIENCIES

Most stormwater management approaches rely heavily on the use of structural stormwater BMPs (e.g., structural stormwater controls) to mitigate the impacts of urbanization. This appendix reviews data on the ability of structural BMPs used in North Carolina to remove common stormwater pollutants.

B.1 Data Comparison

Table B-1 compares the pollutant removal efficiencies obtained from the NCDENR Stormwater BMP Manual with those obtained from the National Pollutant Removal Performance Database (NPRPD) (Winer, 2000). A number of additional BMP performance studies have been published since the NPRPD was created in 2000. As part of our research, we added these studies to the NPRPD and updated the pollutant removal efficiencies for each BMP (second column in Table B-1). North Carolina studies were then extracted from the NPRPD, and removal efficiencies were calculated (third column in Table B-1).

B.2 Findings

The updated national data from the NPRPD generally confirm the BMP pollutant removal efficiencies presented in the NCDENR manual. However, some discrepancies do exist between the North Carolina studies extracted from the NPRPD and the removal efficiencies reported in the NPRPD and NCDENR manual. These discrepancies include the suspended solids for all BMP types and nitrogen for infiltration practices (bolded numbers in the third column of Table B-1). For each North Carolina BMP type extracted from the NPRPD, the removal efficiencies are based on a small number of studies (fewer than five studies for each BMP type), and the reported removal rates are extremely variable (e.g., bioretention suspended solids and phosphorus removal range from –100% to 98% and –100% to 65%, respectively, while infiltration nitrogen removal ranges from 0% to 85%). This makes it difficult to draw any firm conclusions about the performance of these North Carolina BMPs and highlights the need for additional research.

Because of the limited amount of NC BMP data, further research is needed before state-specific pollutant removal efficiencies can be recommended. The current removal efficiencies in the NCDENR manual and the NPRDP are relatively comparable.

Table B-1. Comparison of North Carolina BMP Pollutant Removal Efficiencies to the Pollutant Removal Efficiencies Presented in the NCDENR Stormwater BMP Manual and the National Pollutant Removal Performance Database (NPRPD)

Pollutant	Stormwater BMP	NCDENR Manual (%)	National (%)	North Carolina (%)
Total suspended solids	Wet ponds	85	80	61[a]
	Dry ponds	50	49	**71**[a]
	Wetlands	85	72	N/A
	Filtering practices	85	86	N/A
	Bioretention	85	59[a]	**–100**[a]
	Infiltration practices	85	89[a]	**0**[a]
	Open channels	35	81	N/A
Total phosphorus	Wet ponds	40	52	41[a]
	Dry ponds	10	20	14[a]
	Wetlands	35	48	N/A
	Filtering practices	45	59	N/A
	Bioretention	45	5	2[a]
	Infiltration practices	N/A	65	33[a]
	Open channels	20	24	N/A
Total nitrogen	Wet ponds	25	31	26[a]
	Dry ponds	10	24	26[a]
	Wetlands	40	24	N/A
	Filtering practices	35	32	N/A
	Bioretention	35	46	40[a]
	Infiltration practices	40-70	42	**0**[a]
	Open channels	20	56	N/A

[a] Fewer than five studies

Note: Numbers in **bold** represent the BMP removal efficiencies that appear to be different in North Carolina compared with the national data.

APPENDIX C
EVENT MEAN CONCENTRATIONS AND LAND USE LOADING RATES

The National Stormwater Quality Database (NSQD) includes stormwater pollutant concentration and land use loading rates from over 3,770 separate storm events from 66 agencies and National Pollutant Discharge Elimination (NPDES) Municipal Separate Storm Sewer System (MS4) municipalities from 17 states collected by the University of Alabama and CWP. CWP analyzed the NSQD version 1.1 to compare North Carolina and national EMCs derived for total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS). Statistical trends were examined for the EMCs based on land use, including residential, nonresidential, and open space. There were no database entries for different physiographic regions (i.e., coastal vs. piedmont).

Table C-1 provides the current and NSQD derived EMCs for North Carolina and nationally for comparison. Current EMCs were obtained from the NCDENR Stormwater BMP Manual.

Table C-1. Current and NSQD Event-Mean Concentrations

Parameter	Region	Current North Carolina EMCs (mg/L)	NSQD EMCs (mg/L)
Total Nitrogen			
	National		1.90
	North Carolina		2.29
	Residential	1.50	2.14
	Nonresidential	2.70	2.54
	Open space	1.10	0.84
Total Phosphorus			
	National		0.28
	North Carolina		0.27
	Residential	0.20	0.26
	Nonresidential	0.35	0.30
	Open space	0.20	0.11
Total Suspended Solids			
	National		61
	North Carolina		41