NARRATIVE AND CALCULATIONS

COSTS IMPACTS FOR NEW DEVELOPMENT

FROM THE

PROPOSED JORDAN LAKE NUTRIENT MANAGEMENT RULES

IN

GUILFORD AND ALAMANCE COUNTIES

IN THE

HAW RIVER ARM OF THE JORDAN LAKE WATERSHED

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I. EXECUTIVE SUMMARY

The costs of impacts to new development from the proposed Jordan Lake Rules, in excess of those costs required to meet Phase II and/or existing watershed protection requirements, are ***understated by a factor on the order of 100*** in the Fiscal Analysis for the proposed rules.

From the calculations presented herein, we project the costs impact from the Jordan Lake Rules, in excess of those required by Phase II and/or existing watershed development rules, will exceed $22,000,000 per year for Alamance and Guilford Counties alone. Nitrogen export limits are even more stringent for the rapidly developing upper New Hope Arm of the Jordan Lake Basin, so overall impacts to new development from the proposed Jordan Lake Rules will be well in excess of $50,000,000 per year, as opposed to the estimates presented in the Fiscal Analysis of approximately just under $500,000 per year. And this does not account for the costs of secondary impacts of increased infrastructure costs associated with the encouragement of urban sprawl.

II. PURPOSE OF CALCULATIONS

An initial review of materials presented in the Fiscal Analysis raised concerns that the proposed cost impacts for new development activities were significantly underestimated. Examples of the items in the Fiscal Analysis that triggered these concerns include:

- Table 4.3 of the Fiscal Analysis notes a five-year (2009-2013) total of 646 BMP's to comply with the Jordan lake Rules, with a total capital cost for these 646 BMP's of $848,700, which computes to an average capital cost of $1,314 per BMP. In our opinion, this number is at least an order of magnitude lower than the cost that any complete BMP can be provided. And, the costs for BMP's presented in Table 4.9 of the Fiscal Analysis average nearly $50,000, as compared with this computed average of $1,314 per BMP to comply with the Jordan Lake Rules. We also believe the averages presented in Table 4.9 are low, and are skewed significantly by an inappropriate cost number associated with providing a level spreader and buffer as a BMP. The "install cost" for this BMP is given in the table as $178, not including land costs. This BMP will typically be used at the discharge point from another primary BMP. Construction of a level spreader includes the excavation of a forebay, and the provision of a weir of either concrete or some other material of such construction that the weir can be installed and permanently maintained nearly perfectly level. Average lengths of the weir will vary from one application to another, but will typically be somewhere between 25' minimum and 100' maximum in length. An average capital cost of $25,000 would likely be more realistic to meet current performance criteria, over 100 times the cost presented in Table 4.9 for this BMP. This particular element is of significance, because it is our opinion that a level spreader will be a very popular supplemental BMP for achieving additional nitrogen reduction for projects where a single BMP will not achieve the required nitrogen export threshold.

- In Table 4.8 of the Fiscal Analysis, an average of approximately 1,500 acres per year of new residential development is estimated for the five year period 2009 through 2013. Non-residential new development acreage is estimated in that table to be about 1,060 acres per year for that same five-year period. We ore of the opinion that these acreage estimates are significantly lower than what will actually occur. We further believe that even our acreage estimates are low, as are included in this package, at a combined total of 2,166 acres of new development just for Alamance and Guilford Counties. We do not have the actual acreages for these counties for recent years. However, we do have information from the City of Burlington that in their jurisdiction alone, there were 594 acres of new development in 2006. In terms of new housing counts for 2006 as are summarized on page 8 of this package, Burlington represented less than 10 percent of the total new homes in Alamance and Guilford Counties. If Burlington also represents less than 10 percent of the total new development acreage for these counties, then the total new development acreage per year for Alamance and Guilford Counties alone may be estimated to be on the order of 6,000 acres.
- From the methodology presented in the Fiscal Analysis, it appears that excess nitrogen was computed for the basin overall, and that the costs for handling excess nitrogen were based upon the basin-wide total. The reality is that much new development activity will meet the nitrogen removal rates with a single BMP, so much to the extent that for the less dense development projects, considerably greater nitrogen will be removed than is required. Using the methodology presented in the Fiscal Analysis, this would result in negative costs for many developments, which when averaged with the costs for developments with excess nitrogen produces a much lower average than using zero costs for those sites that can meet the nitrogen export limits with a single BMP.

III. ASSUMPTIONS MADE

Unfortunately, data is not readily available to quantify all existing development trends in recent years in order to accurately tie down each specific development project relative to numbers of residential units, gross acreages, percents of impervious coverage, etc. And, there are no financial resources available to undertake a study to accurately produce this data. Lacking this specific data, we have consulted with developers of both residential and commercial projects in the Triad region, and based upon their expertise, we have made the following assumptions:

- Residential projects vary from subdivisions of 2 acres or more average lot size to 20 units or more per acre in multifamily developments. But with current development regulations in the Triad region, and economic viability targets for the development community, it is assumed that a typical residential project consists of a project size of about 40 acres, with 7,000 square foot minimum lots. There are many projects in the Triad that follow this norm.
- Commercial projects vary from single-building retail outlets on lots of approximately 0.5 acres to major shopping centers or industrial sites of

over 100 acres. Impervious area coverage for these developments can be anywhere from 50 percent or less to in excess of 80 percent. And ratios of transportation-related impervious areas to non-transportation-related impervious areas can vary widely, as well. But we have achieved consensus among our commercial development experts that a typical non-residential project may be about 8 acres in size and have an impervious coverage of about 70 percent, with about 60 percent of the impervious area being in parking and/or vehicular access and storage.

- Almost every development site in excess of 5 acres will normally have at least one jurisdictional stream on the property. Some will have two or more streams, and a few will have none. We are assuming that for either the typical 40-acre residential development or the 8-acre non-residential development, there is on average a single stream on the property. We further assume that with the 30-foot buffers required by Phase II regulations, that approximately 10 percent of the total development site will be lost to streams and buffers. For the 8-acre non-residential site, we are assuming that development takes place just on one side of the stream, such that a single series of BMP's can be used. For the typical residential development, we are assuming that streams bisect the property, with development occurring on each side, requiring on average two sets of BMP's.
- Based upon input from local development officials, we are assuming the total development acreage to be about 2/3 residential and about 1/3 non-residential. The Fiscal Analysis projects a higher percentage of total acreage in non-residential, but the impact on costs associated with these differing assumptions should not be that significant. If we were to use the higher percentages for non-residential development that were used in the Fiscal Analysis, the costs for impacts from the Jordan Lake Rules would be increased from those presented herein.
- We have assumed an excess nitrogen offset payment of $28.35, and that offset payments will be computed as per 15A NCAC 02B .0240.
- All other assumptions are self-explanatory in the calculations.

IV. COMPUTATION OF RESIDENTIAL DEVELOPMENT COSTS

On page 9, the costs calculations for the Typical Residential Subdivision are presented. Calculations are presented first to generate the area percentages needed to complete the state's nutrient removal worksheet. The worksheet used for the Tar-Pamlico rules was modified to accommodate the proposed rules for the Jordan Lake Watershed. Wet detention ponds are assumed to be the primary BMP. Then, the removal percentages are computed using the state nutrient removal worksheet based upon the use of wet detention ponds as the primary BMP. For the typical residential project, the nitrogen export after wet detention pond treatment exceeds the threshold allowed by the proposed rules, so a second BMP has to be provided. A level spreader and buffer was assumed to be the most economical second BMP proposed for series operation with the wet detention pond. After entering the second BMP into the state nutrient removal worksheet, nitrogen and phosphorous exports are below the target rate. No nutrient offset payment is required. Costs of the BMP's are computed using the Wossink and Hunt 2003 study, with an inflation factor of 1.2 to develop 2007 costs. The Wossink and Hunt paper

did not provide a capital cost for a level spreader and buffer, and these costs were estimated by Anderson & Associates in conjunction with developer consultation. Total costs, and costs in excess of meeting Phase II requirements were computed on a per lot basis.

V. COMPUTATION OF NON-RESIDENTIAL DEVELOPMENT COSTS

Beginning on page 14, acreage calculations are developed for the typical commercial project to allow entry into the state nutrient removal worksheet. As with the typical residential project, wet detention was assumed for the primary BMP. On first run of the nutrient removal worksheet, the nitrogen export exceeds the allowable threshold for non-residential projects using just a wet pond. Constructed wetlands were assumed to be the most economical means for incorporation of a second BMP in series with a wet pond. After incorporating nutrient removal from the constructed wetlands, the nitrogen export is below the allowable threshold, but still exceeds the target export rate. Nutrient offset payments are required. The total costs of BMP's and nutrient offset payments are computed, and the costs in excess of those for Phase II compliance are also computed.

VI. DISCUSSION OF RELATED COSTS

There are two other cost categories presented in the Fiscal Analysis under the New Development section that we are of the opinion are significantly underestimated, i.e., planning costs and regulatory costs.

In Table 4.3 of the Fiscal Analysis, planning costs for the five-year period 2009 through 2013 are presented as totaling $83,188. There are a corresponding number of BMP's of 646, for a computed planning cost of $129 per BMP. It is assumed that planning costs include engineering design costs. It is our experience that current design of a wet pond BMP costs on the order of $5,000, and that additional BMP's cost on the order of $2,000 each to design and document. At a design cost of $2,000 per BMP required in excess of those needed to meet Phase II requirements, for 646 BMP's the total planning costs would be on the order of $1.3 million.

Similarly, a number of under $50,000 is given as the total regulatory costs for the entire basin for the 5-year period. These regulatory costs are assumed to include increased permitting fees and additional staff review costs. While we cannot readily estimate what these costs might be, we are of the opinion that these will be at least an order of magnitude higher than the estimates given in the Fiscal Analysis.

In addition, the imposition of the Jordan Lake Rules will require less dense development. Demand for residential and non-residential new development will dictate a certain number of new projects each year, and in order to meet this demand, developers will have to further encroach into our rural environment. This "urban sprawl" will mean increased infrastructure costs to accommodate these new developments, and the costs of this secondary impact is not included in the Fiscal Analysis.

VII. CONCLUSIONS

From the calculations presented herein, we project the costs impact from the Jordan Lake Rules, in excess of those required by Phase II and/or existing watershed development rules, will exceed $22,000,000 per year for Alamance and Guilford Counties alone. Nitrogen export limits are even more stringent for the

rapidly developing upper New Hope Arm of the Jordan Lake Basin, so overall impacts to new development from the proposed Jordan Lake Rules will be well in excess of $50,000,000 per year, as opposed to the estimates presented in the Fiscal Analysis of approximately just under $500,000 per year. This is a factor of 100! And this does not account for the costs of secondary impacts of increased infrastructure costs associated with the encouragement of urban sprawl.

Summaries of Costs From Residential and Commercial Worksheets for Guilford and Alamance Counties Only

Number of New Dwelling Units (2006):

Alamance County	1,021	
Burlington	778	
Graham	170	
Greensboro	2,831	
Guilford County	1,336	
Total Units	6,136	
Total Cost per Dwelling Unit for Jordan lake Rules	$2,812	
Total Residential Costs for Jordan Lake Rules	**$17,253,880**	**per year**
Total Cost per Dwelling Unit for Phase II	$2,038	
Costs per Unit in Excess of Phase II	$774	
Total Residential Costs in Excess of Phase II	**$4,748,712**	**per year**

According to area planning officials, new development gross acreage is approximately 2/3 residential, and 1/3 commercial.

Using the typical 40-acre subdivision for which the costs were developed with 170 lots yield:

Number of Subdivisions = Total Units/170 Units per Subdivision =	36	
Estimated Total Residential Acreage = # Subdv. * 40 Ac./Subdv. =	1444	Acres
Estimated Commercial Acreage = 50% of Residential =	722	Acres
Number of Commercial Developments at 8.0 Ac. Avg. =	90	
Cost of Jordan Lake Rules per Commercial Development =	$393,797	
Total Commercial Costs of Jordan Lake Rules	**$35,534,388**	**per year**
Total Cost per Commercial Development for Phase II (Wet Pond only) =	$196,827	
Total Commercial Costs of Phase II	$17,760,742	per year
Total Commercial Costs in Excess of Phase II	**$17,773,646**	**per year**
TOTAL NEW DEVELOPMENT COSTS FOR JORDAN LAKE RULES*	**$52,788,268**	**PER YEAR**
TOTAL NEW DEVELOPMENT COSTS IN EXCESS OF PHASE II*	**$22,522,358**	**PER YEAR**

***GUILFORD AND ALAMANCE COUNTIES ALONE**

Assumed Typical Subdivision (See Narrative)
Greensboro, NC

Assume Zoning = R-7
Assumed Typical Toatal Acreage = 40 Acres
Assume property is transected by a single stream. Therefore, two primary BMP's required.
Assume property division by stream is 1/3 and 2/3.
Assumed Total Primary BMP area (0.5 ac. Ea.) = 1 acre

Assumed area in stream buffers = 10% 4 Acres

Net Buildable Acreage = 35 Acres

Typical Lot Size = 60' x 120' = 7200 s.f. = 0.1653 acres

Assumed R/W Width = 50 feet

Typical Direct Street R/W per Lot = 25' x 60' 1560 s.f.

Layout inefficiency multiplier for Street R/W per lot = 1.15

Gross Street R/W per lot = 1794 s.f.

Ratio of Street R/W to Building Lot = 0.25

Lot Yield = Net Ac./ (Lot Size * (1 + R/W Ratio)) 170 lots

Total Road R/W = Lots X Gross R/W/ per lot = 304,106 s.f. = 6.98 Acres

Transportation Impervious:		**1/3 of Site**	**2/3 of Site**
Roadway 30' / 50' x Total Road R/W	4.19 Acres	1.38 Acres	2.81 Acres
Driveways, (20' X 25' X No. Lots) / 43560	1.95 Acres	0.64 Acres	1.30 Acres
Total Transportation Impervious =	**6.13 Acres**	**2.02 Acres**	**4.11 Acres**

Roof and Non-Transportation Impervious:		**1/3 of Site**	**2/3 of Site**
Building Footprints = (40' X 50' x No. Lots) / 43560	7.78 Acres	2.57 Acres	5.21 Acres
Patios = (10' X 12' X No. Lots)/43560	0.47 Acres	0.15 Acres	0.31 Acres
Lot Walks = (4' X 30' X No. Lots) / 43560	0.47 Acres	0.15 Acres	0.31 Acres
R/W/ Walks = (5'/50') * Total Road R/W	0.70 Acres	0.23 Acres	0.47 Acres
Total Non-Transportation Impervious =	**9.42 Acres**	**3.11 Acres**	**6.31 Acres**
Total Gross Area =	**40.00 Acres**	**13.20 Acres**	**26.80 Acres**
Wooded Pervious = Stream Buffers =	**-4.00 Acres**	**-1.32 Acres**	**-2.68 Acres**
Area in BMP =	**-1.00 Acres**	**-0.33 Acres**	**-0.67 Acres**
Total Impervious =	**-15.55 Acres**	**-5.13 Acres**	**-10.42 Acres**
Net Managed Pervious Area =	**19.45 Acres**	**6.42 Acres**	**13.03 Acres**

GO TO AND RETURN FROM NUTRIENT CALCULATION SPREADHEET

First run of nutrient spreadsheet with Wet Ponds resulted in Nitrogen export of 4.64 and 4.70 #/ac/year.
Threshold for single Family Projects is 4.0 #/acre/year. Have to add 2nd BMP.
From practical standpoint, add vegetated filter strip with level spreader to each pond.
Results in Nitrogen exports of 3.71 and 3.76 #/acre/year.
Note, phoshorous limits were well met with wet pond alone.

From Wossink and Hunt, 2003, (w/ inflation 5%/year for 4 years = 120%):

	Single BMP	Multiple BMP's		
		1/3 of Site	2/3 of Site	Total Site
Wet Pond Constr. Cost = 1.2*13,909*Ac^0.672 =	$199,096	$94,515	$152,119	$246,635
20-year Maintenance Cost = 1.2*9,202*Ac^0.269 =	$29,786	$22,105	$26,744	$48,850
Land Opportunity Cost = AC in BMP * $50,000 =	$50,000	$16,500	$33,500	$50,000
Total Wet Pond BMP Cost =	$278,882	$133,121	$212,363	$345,484
Level Spreader Construction Cost (Rough Estimate)	$50,000	$27,500	$27,500	$55,000
Total BMP's Construction Costs	$328,882	$160,621	$239,863	$400,484
BMP Cost / Lot =	$1,940 /lot			$2,363 /lot
Level Spreader Buffer Opportunity Cost ($50,000*30*100)/43560 =	$3,444			$3,444
Stream Buffer Opportunity Cost ($50,000*Buffer AC*(40/110) =	$72,727			$72,727
Total Buffer Opportunity Costs	$76,171			$76,171
Buffer Opportunity Cost per Lot	$449 /lot			$449 /lot
Total BMP and Nutrient Offset Cost per Lot =	**$2,390 /lot**			**$2,812 /lot**
Excess Costs over Phase II for Jordan lake Rules*	**$744 /lot**			**$774 /lot**

*Includes Level Spreader Cost and Stream Buffer Opportunity Cost

Haw River (Taken from Piedmont of the Tar-Pamlico River Basin):

BMP Removal Calculation Worksheet (Automated)

Project Name: ***7,000 s.f. Residential Single Family Subdivision (See Development Spreadsheet)***
Date: ***9/10/2007***
By: ***James R. Billups, PE*** Checked By:

Directions:

> It may be advantageous to split the development into separate catchments to be handled by separate BMPs. The tables below allow the development to be split into as many as three catchments, and can be copied for greater than three. NOTE: Unless runoff flowing onto the development from offsite is routed separately around or through the site, the offsite catchment area draining in must be included in the acreage values of the appropriate land use(s) and treated.

> **Above each table:** Enter the catchment acreage in the top green blank. Based on a comparison of the post-development TN and TP export coefficients you calculated above to the rule requirements of 3.8 lb/ac/yr TN and 1.43 lb/ac/yr TP, select BMP(s) from the list for treating the catchment runoff. Enter the chosen BMP(s) nutrient removal rates in the green blanks. If more than one BMP is to be used in series, the combined removal rates will be calculated automatically in the blue blanks.

> **Catchment Tables:** Enter the acres of each type of land cover in the green boxes. The spreadsheet will calculate all of the light blue boxes. NOTE: Compare the Total Catchment Acreage for the Development (final table) to the value you established in the pre-BMP worksheet tables, and also to the site plans, for consistency. All of these values need to be the same

BMP Nutrient Removal Rates

	TN	TP	Design Standard
Wet Detention Pond	25	40	NC BMP Manual
Stormwater Wetland	40	35	NC BMP Manual
Sand Filter	35	45	NC BMP Manual
Bioretention	35	45	NC BMP Manual
Grass Swale	20	20	NC BMP Manual
Vegetated Filter Strip w/ Level Spreader	20	35	NC BMP Manual
Dry Detention	10	10	NC BMP Manual

Catchment 1:

Total acreage of catchment 1 =	13.37 ac		
First BMP's TN removal rate =	25 %	First BMP's TP removal rate =	40 %
Second BMP's TN removal rate =	20 %	Second BMP's TP removal rate =	35 %
Third BMP's TN removal rate =	%	Third BMP's TP removal rate =	%
TOTAL TN REMOVAL RATE =	40 %	TOTAL TP REMOVAL RATE =	61 %

(1) Type of Land Cover	(2) Catchment Acreage	(3) S.M. Formula (0.46 + 8.3I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious	2.02	3.65	2.60	19.16	0.19	1.40
Roof impervious	3.11	3.65	1.95	22.13	0.11	1.25
Managed pervious	6.42	3.65	1.42	33.26	0.28	6.56
Wooded pervious	1.32	3.65	0.94	4.53	0.14	0.67
Area taken up by BMP	0.50	3.65	1.95	3.56	0.11	0.20
Fraction Impervious (I) =	0.38		Pre-BMP TN Load (lb/yr) =	82.63	Pre-BMP TP Load (lb/yr) =	10.08
Total Area of Development =	13.37		Pre-BMP TN Export (lb/ac/yr) =	6.18	Pre-BMP TP Export (lb/ac/yr) =	0.75
			Post-BMP TN Load (lb/yr) =	49.58	Post-BMP TP Load (lb/yr) =	3.93
			Post-BMP TN Export (lb/ac/yr) =	3.71	Post-BMP TP Export (lb/ac/yr) =	0.29

Catchment 2:

Total acreage of catchment 2 =	26.63	ac			
First BMP's TN removal rate =	25	%	First BMP's TP removal rate =	40	%
Second BMP's TN removal rate =	20	%	Second BMP's TP removal rate =	35	%
Third BMP's TN removal rate =		%	Third BMP's TP removal rate =		%
TOTAL TN REMOVAL RATE =	40	%	TOTAL TP REMOVAL RATE =	61	%

(1) Type of Land Cover	(2) Catchment Acreage	(3) S.M. Formula (0.46 + 8.3I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious	4.11	3.71	2.60	39.66	0.19	2.90
Roof impervious	6.31	3.71	1.95	45.67	0.11	2.58
Managed pervious	13.03	3.71	1.42	68.67	0.28	13.54
Wooded pervious	2.68	3.71	0.94	9.35	0.14	1.39
Area taken up by BMP	0.50	3.71	1.95	3.62	0.11	0.20
Fraction Impervious (I) =	0.39		Pre-BMP TN Load (lb/yr) =	166.98	Pre-BMP TP Load (lb/yr) =	20.61
Total Area of Development =	26.63		Pre-BMP TN Export (lb/ac/yr) =	6.27	Pre-BMP TP Export (lb/ac/yr) =	0.77
			Post-BMP TN Load (lb/yr) =	100.19	Post-BMP TP Load (lb/yr) =	8.04
			Post-BMP TN Export (lb/ac/yr) =	3.76	Post-BMP TP Export (lb/ac/yr) =	0.30

Assumed Typical Commercial Project
Greensboro, NC

Assumed Typical Toatal Acreage =	8	Acres
Assumed Primary BMP area (Smallest practical area with access easements) =	0.5	Acre
Assumed area in stream buffers = 10%	0.8	Acres
Net Buildable Acreage =	6.7	Acres
Built Upon Area (70% of Gross)	5.6	Acres
Under Roof (40% of BUA)	2.24	Acres
Transportation Impervious (60% of BUA)	3.36	Acres
Wooded Pervious = Stream Buffers =	**-0.80**	**Acres**
Area in BMP =	**-0.50**	**Acres**
Net Managed Pervious Area =	**1.10**	**Acres**

GO TO AND RETURN FROM NUTRIENT CALCULATION SPREADHEET
After Wet Pond, Nitrogen Export = 9.65#/acre/year. Threshold is 8#/acre/year.
Have to provide second BMP. Use Constructed Wetland.

Nutrient Offset Payments computed per 15A NCAC 02B .0240
Using $28.35 per # of Nitrogen, $220,000/acre land cost per Wossink & Hunt (2003)
Assumes 20% Construction Cost Inflation 2003 to 2007 (1.2 Factor)

Using State Nutrient Spreadsheet, Nitrogen Export =	5.79	#/ac./year
Target Nitrogen Export =	-3.80	#/ac./year
Nitrogen Nutrient Offset Unit Quantity =	1.99	#/ac./year
Total Nitrogen in # / year =	15.92	#/year
Total Nitrogen, 30 Years, in #	478	#
Mitigation cost (using Tar-Pam Costs) / #	$28.35	/#
Sub-total Nitrogen Payment	**$13,540**	
Land Cost of Development	$220,000	/acre
Sub-total Land payment = (Cost/ac)*(no. ac)/35	**$50,286**	
Total Offset Payment = 1.1*(Nitrogen+Land) =	**$70,208**	

BEST MANAGEMENT PRACTICES:

WET POND:

Wet Pond Constr. Cost = 1.2*13,909*Ac^0.672 =	$67,508	
20-year Maintenance Cost = 1.2*9,202*Ac^0.269 =	$19,319	
Land Opportunity Cost = AC in BMP * $220,000 =	$110,000	
Total Wet Pond Cost =	**$196,827**	

STORMWATER WETLANDS:

Wetlands Construction Cost = 1.2*3852*Ac^0.484 =	$12,646	
20-year Maintenance Cost = 4,502*Ac^0.153 =	$6,188	
Land Area = 0.02*Ac =	0.16	Acres
Land Opportunity Cost = AC in BMP*$220,000	$35,200	
Total Wetlands Cost	**$54,035**	
Buffer Opportunity Cost ($50,000*Buffer AC*(40/110))	**$72,727**	
Total BMP's, Buffers and Nutrient Offset Costs =	**$393,797**	

Haw River (Taken from Piedmont of the Tar-Pamlico River Basin):

BMP Removal Calculation Worksheet (Automated)

Project Name: ***Typical Commercial Development***
Date: ***9/12/2007***
By: ***James R. Billups, PE*** Checked By: _____

Directions:

> It may be advantageous to split the development into separate catchments to be handled by separate BMPs. The tables below allow the development to be split into as many as three catchments, and can be copied for greater than three. NOTE: Unless runoff flowing onto the development from offsite is routed separately around or through the site, the offsite catchment area draining in must be included in the acreage values of the appropriate land use(s) and treated.

> **Above each table:** Enter the catchment acreage in the top green blank. Based on a comparison of the post-development TN and TP export coefficients you calculated above to the rule requirements of 3.8 lb/ac/yr TN and 1.43 lb/ac/yr TP, select BMP(s) from the list for treating the catchment runoff. Enter the chosen BMP(s) nutrient removal rates in the green blanks. If more than one BMP is to be used in series, the combined removal rates will be calculated automatically in the blue blanks.

> **Catchment Tables:** Enter the acres of each type of land cover in the green boxes. The spreadsheet will calculate all of the light blue boxes. NOTE: Compare the Total Catchment Acreage for the Development (final table) to the value you established in the pre-BMP worksheet tables, and also to the site plans, for consistency. All of these values need to be the same

BMP Nutrient Removal Rates

	TN	TP	Design Standard
Wet Detention Pond	25	40	NC BMP Manual
Stormwater Wetland	40	35	NC BMP Manual
Sand Filter	35	45	NC BMP Manual
Bioretention	35	45	NC BMP Manual
Grass Swale	20	20	NC BMP Manual
Vegetated Filter Strip w/ Level Spreader	20	35	NC BMP Manual
Dry Detention	10	10	NC BMP Manual

Catchment 1:

Total acreage of catchment 1 =	40 ac		
First BMP's TN removal rate =	25 %	First BMP's TP removal rate =	40 %
Second BMP's TN removal rate =	40 %	Second BMP's TP removal rate =	35 %
Third BMP's TN removal rate =	%	Third BMP's TP removal rate =	%
TOTAL TN REMOVAL RATE =	55 %	TOTAL TP REMOVAL RATE =	61 %

(1) Type of Land Cover	(2) Catchment Acreage	(3) S.M. Formula (0.46 + 8.3I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious	3.36	6.28	2.60	54.84	0.19	4.01
Roof impervious	2.24	6.28	1.95	27.42	0.11	1.55
Managed pervious	1.10	6.28	1.42	9.80	0.28	1.93
Wooded pervious	0.80	6.28	0.94	4.72	0.14	0.70
Area taken up by BMP	0.50	6.28	1.95	6.12	0.11	0.35
Fraction Impervious (I) =	0.70		Pre-BMP TN Load (lb/yr) =	102.90	Pre-BMP TP Load (lb/yr) =	8.54
Total Area of Development =	8.00		Pre-BMP TN Export (lb/ac/yr) =	12.86	Pre-BMP TP Export (lb/ac/yr) =	1.07
			Post-BMP TN Load (lb/yr) =	46.30	Post-BMP TP Load (lb/yr) =	3.33
			Post-BMP TN Export (lb/ac/yr) =	5.79	Post-BMP TP Export (lb/ac/yr) =	0.42