Estimated Pollutant Removal for Proposed Conover Station Stormwater Control Measures

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NORTH CAROLINA PROFESSIONAL SEAL 14113 ENGINEER CYNTHIA C. LANCASTER

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JEWELL
ENGINEERING CONSULTANTS, PC
311 S. Main Street
Kernersville, NC 27284

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JEWELL Engineering Consultants has been retained by the City of Conover to design appropriate stormwater control measures (SCM) for the site to maximize pollutant capture from runoff on and through the site. The initial intent was to develop an online wetland of about 3.2 acres on the southern portion of the site. However, regulators with the Corps of Engineers and NC Department of Environment and Natural Resources view the proposed wetland as an impact to a perennial stream that would require 1:1 mitigation. Thus, the City has been forced to re-evaluate a more economical and appropriate way to manage pollution.

In developing a revised conceptual plan, JEWELL Engineering performed an extensive investigation of the watershed and onsite stormwater infrastructure and determined that the area that would drain through an online stormwater wetland is 50.4 acres, instead of the 70 acres estimated by the previous engineer based on contour mapping. JEWELL has also performed more detailed analysis of the impervious cover within the drainage area to determine that existing impervious cover in the watershed is about 80% transportation and 20% roof. In the Tar-Pam spreadsheet analysis of nutrient removal computed for the grant application, all impervious cover was assumed to be “transportation” and pervious areas were not included in the nutrient loading estimates. In order to compare estimated pollutant removal for the revised conceptual plan against the originally planned online wetland, JEWELL Engineering updated/corrected the application spreadsheet in the following manner:

1. Drainage area changed from 70 acres to 50.4 acres.
2. Impervious cover total changed from 39 acres to 27.51 acres, with 20% as roof and 80% as transportation (instead of 100% transportation). The planned development on the north portion of the Conover Station site is assumed as 100% impervious.
3. The managed pervious and BMP areas were added to the loading estimates.

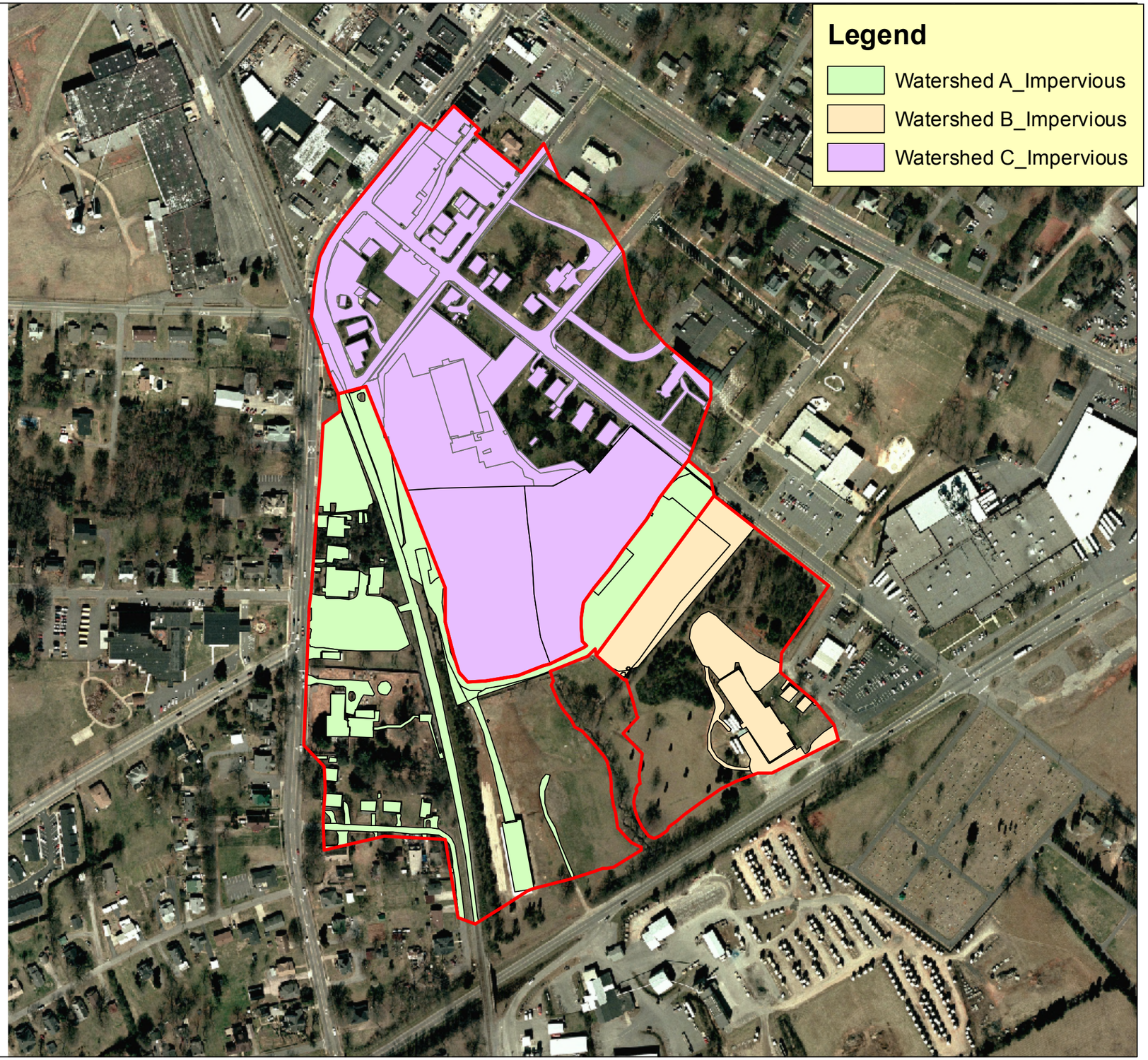
The computations for the revised concept plan required subdividing the watershed according to which areas are routed to which SCM’s. Attached is a map (Exhibit A) corresponding to drainage areas A to C in the Tar-Pam spreadsheet file titled N-PCalcsheetPiedProtected11-05_JEWELL.xls. Area A drains directly to the proposed offline stormwater wetland west of the stream, which is undersized by about 25%. The estimated pollutant reduction is estimated at 75% of the levels for a wetland sized according to the BMP manual. Area B drains through the proposed grassed swales and pocket wetland east of the stream, with removal estimates scaled down to reflect the small size of the wetland. Area C drains through the proposed grassed swale north of the road crossing and then through the larger proposed western wetland area. The table below lists the estimated nitrogen and phosphorus loads and reductions computed for the original grant application, the corrected and updated loads and reductions for the originally proposed 3.2 acre online wetland, and the loads and reductions projected for the revised plan.

Note that the North Carolina BMP Manual phosphorus removal rate for a stormwater wetland has been increased from 30% to 40% since the original grant application was prepared. The calculations for the "Online Wetland – Updated" and the "Proposed SCM Plan" both reflect this change.

Table 1. Nutrient Removal Estimates for Conover Station Stormwater Control Measures

	Pre-SCM TN (lb/yr)	Pre-SCM TP (lb/yr)	Post-SCM TN (lb/yr)	Post-SCM TP (lb/yr)	TN Reduction (lb/yr)	TP Reduction (lb/yr)
Grant Application	889.28	64.99	533.57	42.24	355.72	22.75
Online Wetland – Updated Information	510.37	53.22	306.22	31.93	204.15	21.29
Proposed SCM Plan	521.13	52.12	319.84	32.38	201.19	19.74

We conclude on the basis of these calculations that the treatment train of stormwater control measures proposed in lieu of the originally proposed online stormwater wetland will provide comparable nutrient reductions.



Conover Station Drainage Areas for Stormwater Control Measures

N

Feet
0 150 300 600

Exhibit A

June 2011

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Appendix A

Calculations for Previous Online Wetland

Designed by Others

BMP Removal Calculation Worksheet (Automated)

Project Name: *Conover Station Park*
Date: *6/1/2011*
By: *Nick Cook* Checked By: Cindy Lancaster, P.E.

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 4.0 lb/ac/yr TN and 0.4 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 =	50.4	ac			
First BMP's TN removal rate =	40	%	First BMP's TP removal rate =	40	%
Second BMP's TN removal rate =	0	%	Second BMP's TP removal rate =	0	%
Third BMP's TN removal rate =	0	%	Third BMP's TP removal rate =	0	%
TOTAL TN REMOVAL RATE =	40	%	TOTAL TP REMOVAL RATE =	40	%

(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	22.02	5.00	2.60	286.02	0.19	20.90
Roof impervious	5.49	5.00	1.95	53.48	0.11	3.02
Managed pervious	19.69	5.00	1.42	139.68	0.28	27.54
Wooded pervious		5.00	0.94	0.00	0.14	0.00
Area taken up by BMP	3.20	5.00	1.95	31.17	0.11	1.76
Fraction Impervious (I) =	0.55		Pre-BMP TN Load (lb/yr) =	510.37	Pre-BMP TP Load (lb/yr) =	53.22
Total Area of Development =	50.40		Pre-BMP TN Export (lb/ac/yr) =	10.13	Pre-BMP TP Export (lb/ac/yr) =	1.06
			Post-BMP TN Load (lb/yr) =	306.22	Post-BMP TP Load (lb/yr) =	31.93
			Post-BMP TN Export (lb/ac/yr) =	6.08	Post-BMP TP Export (lb/ac/yr) =	0.63

Catchment 2:

Total acreage of catchment 2 = ac

First BMP's TN removal rate = %
Second BMP's TN removal rate = %
Third BMP's TN removal rate = %
TOTAL TN REMOVAL RATE = 0 %

First BMP's TP removal rate = %
Second BMP's TP removal rate = %
Third BMP's TP removal rate = %
TOTAL TP REMOVAL RATE = 0 %

(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			2.60		0.19	
Roof impervious			1.95		0.11	
Managed pervious			1.42		0.28	
Wooded pervious			0.94		0.14	
Area taken up by BMP			1.95		0.11	
Fraction Impervious (I) =			Pre-BMP TN Load (lb/yr) =		Pre-BMP TP Load (lb/yr) =	
Total Area of Development =			Pre-BMP TN Export (lb/ac/yr) =		Pre-BMP TP Export (lb/ac/yr) =	
			Post-BMP TN Load (lb/yr) =		Post-BMP TP Load (lb/yr) =	
			Post-BMP TN Export (lb/ac/yr) =		Post-BMP TP Export (lb/ac/yr) =	

Catchment 3:

Total acreage of catchment 3 = ac

First BMP's TN removal rate = %
Second BMP's TN removal rate = %
Third BMP's TN removal rate = %
TOTAL TN REMOVAL RATE = 0 %

First BMP's TP removal rate = %
Second BMP's TP removal rate = %
Third BMP's TP removal rate = %
TOTAL TP REMOVAL RATE = 0 %

(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			2.60		0.19	
Roof impervious			1.95		0.11	
Managed pervious			1.42		0.28	
Wooded pervious			0.94		0.14	
Area taken up by BMP			1.95		0.11	
Fraction Impervious (I) =			Pre-BMP TN Load (lb/yr) =		Pre-BMP TP Load (lb/yr) =	
Total Area of Development =			Pre-BMP TN Export (lb/ac/yr) =		Pre-BMP TP Export (lb/ac/yr) =	
			Post-BMP TN Load (lb/yr) =		Post-BMP TP Load (lb/yr) =	
			Post-BMP TN Export (lb/ac/yr) =		Post-BMP TP Export (lb/ac/yr) =	

Weighted Average of Nutrient Loadings from the Catchments:

	Catchment Acreage	Post-BMP TN Loading (lb/ac/yr)	Post-BMP TP Loading (lb/ac/yr)
Catchment 1	**50.40**	**6.08**	**0.63**
Catchment 2	**0.00**	**0.00**	**0.00**
Catchment 3	**0.00**	**0.00**	**0.00**
TOTAL FOR DEVELOPMENT	**50.40**	**6.08**	**0.63**

Note: The nutrient loading goals are 4.0 lb/ac/yr for TN and 0.4 lb/ac/yr for TP. If the post-development nutrient loading is below these levels, then the BMPs planned are adequate. Otherwise, additional BMPs and/or modifications in development plans are required.

Appendix B

Calculations for Structural Control Measures

Designed by JEWELL Engineering

BMP Removal Calculation Worksheet (Automated)

Project Name: *Conover Station Park*
Date: *6/1/2011*
By: *Nick Cook* Checked By: Cynthia Lancaster, P.E.

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 4.0 lb/ac/yr TN and 0.4 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	40	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	30	35	NC BMP Manual
Dry Detention	10	10	NC BMP Manual

Catchment 1 (WATERSHED A):

Total acreage of catchment 1 =	16.72	ac			
First BMP's TN removal rate =	30	%	First BMP's TP removal rate =	30	%
Second BMP's TN removal rate =		%	Second BMP's TP removal rate =		%
Third BMP's TN removal rate =		%	Third BMP's TP removal rate =		%
TOTAL TN REMOVAL RATE =	30	%	TOTAL TP REMOVAL RATE =	30	%

(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	5.82	4.07	2.60	61.64	0.19	4.50
Roof impervious	1.45	4.07	1.95	11.52	0.11	0.65
Managed pervious	7.99	4.07	1.42	46.21	0.28	9.11
Wooded pervious		4.07	0.94	0.00	0.14	0.00
Area taken up by BMP	1.46	4.07	1.95	11.60	0.11	0.65
Fraction Impervious (I) =	0.43		Pre-BMP TN Load (lb/yr) =	130.96	Pre-BMP TP Load (lb/yr) =	14.92
Total Area of Development =	16.72		Pre-BMP TN Export (lb/ac/yr) =	7.83	Pre-BMP TP Export (lb/ac/yr) =	0.89
			Post-BMP TN Load (lb/yr) =	91.68	Post-BMP TP Load (lb/yr) =	10.44
			Post-BMP TN Export (lb/ac/yr) =	5.48	Post-BMP TP Export (lb/ac/yr) =	0.62

Catchment 2 (WATERSHED B):

Total acreage of catchment 2 =	8.27	ac			
First BMP's TN removal rate =	20	%	First BMP's TP removal rate =	20	%
Second BMP's TN removal rate =	9	%	Second BMP's TP removal rate =	9	%
Third BMP's TN removal rate =		%	Third BMP's TP removal rate =		%
TOTAL TN REMOVAL RATE =	27.2	%	TOTAL TP REMOVAL RATE =	27.2	%

(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	2.58	3.70	2.60	24.79	0.19	1.81
Roof impervious	0.64	3.70	1.95	4.61	0.11	0.26
Managed pervious	3.91	3.70	1.42	20.52	0.28	4.05
Wooded pervious		3.70	0.94	0.00	0.14	0.00
Area taken up by BMP	1.14	3.70	1.95	8.22	0.11	0.46
Fraction Impervious (I) =	0.39		Pre-BMP TN Load (lb/yr) =	58.14	Pre-BMP TP Load (lb/yr) =	6.58
Total Area of Development =	8.27		Pre-BMP TN Export (lb/ac/yr) =	7.03	Pre-BMP TP Export (lb/ac/yr) =	0.80
			Post-BMP TN Load (lb/yr) =	42.32	Post-BMP TP Load (lb/yr) =	4.79
			Post-BMP TN Export (lb/ac/yr) =	5.12	Post-BMP TP Export (lb/ac/yr) =	0.58

Catchment 3 (WATERSHED C):

Total acreage of catchment 3 =	23.98	ac			
First BMP's TN removal rate =	20	%	First BMP's TP removal rate =	20	%
Second BMP's TN removal rate =	30	%	Second BMP's TP removal rate =	30	%
Third BMP's TN removal rate =		%	Third BMP's TP removal rate =		%
TOTAL TN REMOVAL RATE =	44	%	TOTAL TP REMOVAL RATE =	44	%

(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	13.62	6.36	2.60	225.15	0.19	16.45
Roof impervious	3.40	6.36	1.95	42.15	0.11	2.38
Managed pervious	6.40	6.36	1.42	57.78	0.28	11.39
Wooded pervious		6.36	0.94	0.00	0.14	0.00
Area taken up by BMP	0.56	6.36	1.95	6.94	0.11	0.39
Fraction Impervious (I) =	0.71		Pre-BMP TN Load (lb/yr) =	332.03	Pre-BMP TP Load (lb/yr) =	30.62
Total Area of Development =	23.98		Pre-BMP TN Export (lb/ac/yr) =	13.85	Pre-BMP TP Export (lb/ac/yr) =	1.28
			Post-BMP TN Load (lb/yr) =	185.94	Post-BMP TP Load (lb/yr) =	17.15
			Post-BMP TN Export (lb/ac/yr) =	7.75	Post-BMP TP Export (lb/ac/yr) =	0.71

Weighted Average of Nutrient Loadings from the Catchments:

	Catchment Acreage	Post-BMP TN Loading (lb/ac/yr)	Post-BMP TP Loading (lb/ac/yr)
Catchment 1	**16.72**	**5.48**	**0.62**
Catchment 2	**8.27**	**5.12**	**0.58**
Catchment 3	**23.98**	**7.75**	**0.71**
TOTAL FOR DEVELOPMENT	**48.97**	**6.53**	**0.66**

Note: The nutrient loading goals are 4.0 lb/ac/yr for TN and 0.4 lb/ac/yr for TP. If the post-development nutrient loading is below these levels, then the BMPs planned are adequate. Otherwise, additional BMPs and/or modifications in development plans are required.

	Total Acreage	TN Loading (lb/yr)	TP Loading (lb/yr)
TOTALS	**48.97**	**521.13**	**52.12**

	Total Acreage	Post-BMP TN Loading (lb/yr)	Post-BMP TP Loading (lb/yr)
TOTALS	**48.97**	**319.94**	**32.38**
Reductions		201.20	19.74