Edgecombe County
Stormwater Management
Program for Nutrient Control

County of Edgecombe
North Carolina

September 13, 2004

Edgecombe County
201 St. Andrew Street
P.O. Box 10
Tarboro, NC 27886
Table of Contents

1. Introduction
   1-A Purpose of the Tar-Pamlico Stormwater Rule
   1-B Requirements of the Tar-Pamlico Stormwater Rule

2. New Development
   2-A Requirements in the Rule
   2-B Protecting Riparian Areas on New Development
   2-C Calculating Nutrient Export from New Development
   2-D BMPs for Reducing Nitrogen and Phosphorus
   2-E Calculating Peak Runoff
   2-F Offsite Partial Offset Option
   2-G Regional or Jurisdiction-Wide Approaches
   2-H BMP Maintenance
   2-I Land Use Planning Provisions

3. Illegal Discharges
   3-A Requirements in the Rule
   3-B What is an Illegal Discharge / Connection?
   3-C Establishing Legal Authority
   3-D Collecting Jurisdiction-Wide Information
   3-E Mapping and Field Screening in High Priority Areas
   3-F Identifying and Removing illegal Discharges / Connections
   3-G Preventing Discharges / Connections and Establishing a Hotline
   3-H Implementation Schedule

4. Retrofit Locations
   4-A Requirements in the Rule
   4-B Approach for Meeting Requirements
   4-C Data Collection and Notification
   4-D Mapping Requirements

5. Public Education
   5-A Requirements in the Rule
   5-B Public Education Action Plan

6. Reporting Requirements
   6-A New Development Review/Approval
   6-B Illegal Discharges
   6-C Retrofit Locations
   6-D Public Education

Edgecombe County
Stormwater Management Program for Nutrient Control
Figure / Tables

Table 2  
BMP Types, TN and TP Removal Rates, and Design Standards 8

Table 2f  
Tar River Basin Classified Surface Waters 14

Table 3a  
Allowable Discharges to the Stormwater Collection System 21

Table 3b  
Discharges Not Allowed to the Stormwater Collection System 21

Figure 3  
Field Screening Process 24

Table 3c  
Field Screening Report Information 25

Table 3d  
Implementation Schedule for Addressing Illegal Discharges 27

Table 4  
Retrofit Opportunity Table for the County of Edgecombe, NC. 29

Table 6  
Annual Reporting Requirements for Illegal Discharges 32

Appendices

Appendix A  
15A NCAC 2B .0258 Tar-Pamlico River Basin - Nutrient Sensitive Waters

Appendix B  
Export Calculation Worksheets and Supporting Information

Appendix C  
Land Use Planning and Design Techniques

Appendix D  
Example Stormwater Maintenance Agreement and Covenants

Appendix E  
Illicit Discharge Screening Report Forms

Appendix F  
Public Education Action Report and Plan
1. Introduction

In accordance with stormwater rule 15A NCAC 2B .0258 Tar-Pamlico River Basin-Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements, hereafter referred to as the "Rule", the County of Edgecombe is required to develop a local stormwater program to comply with the substantive requirements of the Rule. This document is intended to satisfy the substantive requirements of the Rule along with some additional requirements of the National Pollution Discharge Elimination System (NPDES) Phase II Stormwater Rule.

This Program includes all technical requirements to satisfy the Rules, and works together with the Edgecombe County Unified Development Ordinance. Within the Unified Development Ordinance, Section 12-3 regulates Stormwater Management, and references this Stormwater Management Program for Nutrient Control, making this document fully enforceable as if it were wholly contained within the Unified Development Ordinance.

This Program will be implemented and enforced through the cooperation of several County Departments, including:
Planning & Inspections (lead role)............... contact # 252-641-7803
Soil & Water Conservation ....................... contact # 252-641-7900
North Carolina Cooperative Extension.......... contact # 252-641-7815

1-A. Purpose of the Tar-Pamlico Stormwater Rule

The Tar-Pamlico River Basin begins in Piedmont North Carolina and extends approximately 180 miles through the Coastal Plain to Pamlico Sound. Together, Pamlico Sound and neighboring Albemarle Sound constitute one of the most productive estuarine systems in the country. The 5,400 square mile Tar-Pamlico basin is comprised primarily of agricultural and forest land, and many smaller municipalities. Despite the rural character of the basin, in the mid-1970's the Pamlico River estuary began to see increasing frequencies of harmful algal blooms, fish kills, and other nutrient-related problems.

By the mid-1980's, the state began to consider actions to control nutrient inputs to the estuary. Those actions have included the following:

Phase I: In 1989, the North Carolina Environmental Management Commission, hereafter referred to as "the Commission" or "EMC", designated the entire basin "Nutrient Sensitive Waters". The first phase of management through 1994 focused primarily on point sources, establishing an annually decreasing nutrient loading cap for an association of dischargers, and an innovative "trading" program that allowed dischargers to achieve reductions in nutrient loading more cost-effectively.

PCS Recycling: In 1992, a phosphate mining company then known as Texas Gulf, which is located on the Pamlico River estuary, instituted a wastewater recycling system that reduced its phosphorus discharges to the estuary by 93%.

Phase II: Modeling of estuary conditions showed that despite the gains made to that point, significant reductions in nitrogen and phosphorus loading were still needed to restore water quality standards and
minimize the recurrence of harmful algal blooms. The second phase of the nutrient strategy, which runs through 2004, established a biologically based goal of 30 percent reduction in nitrogen loading from 1991 levels and holding phosphorus loading at 1991 levels. Load reductions were apportioned among point sources and the major nonpoint sources. The point sources were given steady annual nitrogen and phosphorus loading caps. A program was designed with the nonpoint sources to achieve the goals through voluntary measures. After two years of voluntary implementation, the Commission found insufficient progress and called for rules for nonpoint sources.

**Rules:** Beginning in 1998, DWQ (the North Carolina Department of Environment and Natural Resources, Division of Water Quality) staff, hereafter referred to as "the Division" or "DWQ", conducted a lengthy public input process to evaluate source categories and develop rules where needed. Over the course of 2000, the Commission adopted rules for agriculture, fertilizer application across all land uses, urban stormwater, and rules to protect the nutrient removal functions of existing riparian buffers. These rules were modeled after a similar set of rules recently adopted in the adjacent Neuse River Basin. The Neuse rules were given extensive public review and modification, and the Tar-Pamlico rules similarly received extensive scrutiny. The resulting rules provide increased flexibility for the regulated community while maintaining the focus of the nutrient reduction goals.

1-B. Requirements of the Tar-Pamlico Stormwater Rule

The Tar-Pamlico Stormwater Rule applies to the local governments with the greatest likelihood of contributing significant nutrient loads to the Pamlico estuary. The Commission may designate additional local governments in the future through rule amendment based on criteria given in the Rule.

The affected local governments are:

**Municipalities** | **Counties**
--- | ---
Greenville | Beaufort
Henderson | Edgecombe
Oxford | Franklin
Rocky Mount | Nash
Tarboro | Pitt
Washington

Edgecombe County will implement this Program throughout the County’s jurisdiction, as established in the Edgecombe County Unified Development Ordinance, Section 1-4.

The Rule establishes a broad set of objectives for limiting nutrient runoff from urban areas. It then lays out a set of specific elements, described below, that the affected local governments must include in their programs. Timeframes for implementation of the Rule are as follows:

**April 1, 2001:** Effective date of the Rule.
**February 13, 2003:** Target date for approval of the Model Stormwater Program by the Environmental Management Commission (modified through EMC approval from the date of April 1, 2002 established in the Rule).
**February 13, 2004:** Deadline for submittal of local Stormwater Programs (including ordinances) to the EMC (modified as above).
**September 13, 2004:** Edgecombe County local Stormwater Program Implementation Date (modified during review process).
Following implementation in September 2004, the County of Edgecombe, hereafter referred to as the "County", will provide annual progress reports to the EMC that will include nitrogen and phosphorus loading reduction estimates.

The elements included in the County's stormwater management program are:

1. **New Development Review/Approval**
   New development is required to meet the 30% reduction goal through site planning and best management practices. The Rule imposes a 4.0 pounds per acre per year (lb/ac/yr) nitrogen loading limit and a 0.4 lb/ac/yr phosphorus loading limit on new development. Proposals that exceed these performance standards may partially offset their load increases by treating existing developed areas offsite that drain to the same stream.

   New development must also avoid causing erosion of surface water conveyances. At minimum, post-development peak flows leaving the site may not exceed pre-development for the 1-year, 24-hour storm event. The County may consider using regional stormwater facilities to help meet nutrient loading and attenuation requirements under certain circumstances.

2. **Illegal Discharges**
   Illegal discharges are substances deposited in storm sewers (that lead to streams) that should instead be handled as wastewater discharges. Illegal discharges may contain nitrogen. The County will implement a program to identify and remove existing illegal discharges and to prevent future illegal discharges.

3. **Retrofit Locations**
   There are a number of funding sources available for water quality retrofit projects, such as the Clean Water Management Trust Fund and the Wetland Restoration Program that the NC General Assembly has recently established. To assist technical experts, the County will identify sites and opportunities for retrofitting existing development to reduce total nitrogen and phosphorus loads.

4. **Public Education**
   Citizens can reduce the nitrogen pollution coming from their lawns and septic systems if they understand the impacts of their actions and respond with appropriate management measures. The County will develop and implement public and developer education programs for its jurisdictional area. To satisfy requirements of the NPDES Phase II Stormwater Rule, the County's public education program will include a public involvement and participation component; and a pollution prevention program for County operations, including an employee training component, will be developed and implemented.
2. New Development Review/Approval

2-A. Requirements in the Rule

The Tar-Pamlico Stormwater Rule (15A NCAC 2B .0258) has the following requirements (see the Rule in Appendix A for complete language) for new development located within the planning and zoning jurisdiction of the County:

- The nitrogen load contributed by new development activities is held at 4.0 pounds per acre per year. This is equivalent to 70 percent of the estimated average nitrogen load contributed by non-urban areas in the Tar-Pamlico River basin (as defined using 1995 LANDSAT data). Similarly, the phosphorus load contributed by new development activities is held at 0.4 pounds per acre per year, which is equivalent to the estimated average phosphorus load contributed by non-urban areas in the basin. The Environmental Management Commission may periodically update these performance standards based on the availability of new scientific information.

- Property owners shall have the option of partially offsetting projected nitrogen loads by providing treatment of existing developed areas off-site that drain to the same stream. However, the total nitrogen loading rate cannot exceed 6.0 pounds per acre per year for residential development or 10 pounds per acre per year for non-residential development.

- There is no net increase in peak flow leaving the developed site from the predevelopment conditions for the 1-year, 24-hour storm.

- The County will review new development plans to assure compliance with requirements for protecting and maintaining riparian areas as specified in 15A NCAC 2B .0259.

The County will consider regional stormwater facilities in its program to provide for partial nutrient and flow control. Such facilities may not degrade surface waters.

2-B. Protecting Riparian Areas on New Development

The Tar-Pamlico Riparian Buffer Protection Rule, 15A NCAC 2B .0259, requires the County to ensure that riparian areas on new developments are protected in accordance with the buffer rule's provisions. The buffer rule requires that 50-foot riparian buffers be maintained on all sides of intermittent and perennial streams, ponds, lakes and estuarine waters in the basin. The buffer rule provides for certain "allowable" uses within the buffer with DWQ approval, such as road and utility crossings.

The County will disapprove any new development activity proposed within the first 50 feet adjacent to a waterbody that is shown on either the USGS 7.5 minute topographic map or the Natural Resources Conservation Services Soil Survey map unless the owner can show that the activity has been approved by DWQ. DWQ approval may consist of the following:
• An on-site determination that surface waters are not present.
• An Authorization Certificate from DWQ for an "allowable" use such as a road crossing or utility line, or for a use that is "allowable with mitigation" along with a Division-approved mitigation plan. A table delineating such uses is included in the buffer rule.
• An opinion from DWQ that vested rights have been established for the proposed development activity.
• A letter from DWQ documenting that a variance has been approved for the proposed development activity.

2-C. Calculating N and P Export from New Development

New Development Described: For the purposes of this program, new development shall be described to include the following:

• Any activity that disturbs greater than one acre of land to establish, expand, or replace a single family or duplex residential development or recreational facility. For individual single family residential lots of record that are not part of a larger common plan of development or sale, the activity must also result in greater than ten percent built-upon area.

• Any activity that disturbs greater than one-half an acre of land to establish, expand, or replace a multifamily residential development or a commercial, industrial or institutional facility.

• Projects meeting the above criteria that replace or expand existing structures or improvements and that do not result in a net increase in built-upon area shall not be required to meet the basinwide average non-urban loading levels.

• Projects meeting the above criteria that replace or expand existing structures or improvements and that result in a net increase in built-upon area shall achieve a 30 percent reduction in nitrogen loading and no increase in phosphorus loading relative to the previous development. Such projects may achieve these loads through onsite or offsite measures or some combination thereof.

Multi-family residential, commercial, industrial, and institutional projects may choose to achieve all of this reduction by providing treatment of off-site developed areas, or by permanently conserving land from future development in conformance with the County's approved land conservation plan, as described in Section 2-G.

• Built-upon area means that portion of a development project that is covered by impervious or partially impervious cover including buildings, pavement, and gravel area. Slatted wooden decks and the water surface area of pools shall be considered pervious.

• Land disturbance is defined as grubbing, stump removal, grading, or removal of structures.

New development shall not include agriculture (including intensive livestock operations), mining, or forestry activities.

Vesting: All new development projects that have received approval from the County for a site-specific or phased development plan by September 13, 2004, and that have implemented that development in accordance with the County's vesting provisions shall be exempt from these requirements. Any plats associated with such development must be recorded within a maximum of five years from the date of development approval. All new development projects that have not
received such approval by September 13, 2004 or recorded any plats associated with such development within five years of the development's approval shall be subject to the requirements of the Rule.

Projects that require a state permit, such as landfills, NPDES wastewater discharges, land application of residuals and road construction activities shall be considered exempt if a state permit was issued prior to the effective date of the County's stormwater program.

**Calculating N and P Export:** The nitrogen and phosphorus export from each new development must be calculated. The developer shall submit calculations signed and sealed by a qualified professional. This export will be calculated in pounds per acre per year (lbs/ac/yr). A methodology that may be used to make this calculation is described here. Worksheets to carry out this method are provided in Appendix B.

It is expected that some values provided in the methodology will be refined over time. The Division plans to provide those refinements to the County on a periodic basis as they are established. For example, additional research may lead to refined export values for the various urban land covers, particularly rooftop and transportation impervious surface. Also, stormwater management practices are typically in various stages of refinement around the country. Several nutrient reducing BMPs are being applied and studied around North Carolina toward better designs and more accurate knowledge of long-term nutrient removal efficiencies. The County will incorporate these refinements into its program from time to time as they are substantiated by the Division.

For a given project, the methodology calculates a weighted annual load export for both nitrogen and phosphorus based on event mean concentrations of runoff from different urban land covers and user-supplied acreages for those land covers. The user chooses BMPs that reduce the export to Rule mandated levels. The "Piedmont" version of the export calculation spreadsheet developed by the Division shall be utilized for export calculations within the County.

A residential worksheet is also provided in Appendix B to calculate acreages dedicated to different land covers in residential developments where impervious footprints are not shown. One situation not addressed by the methodology is a non-residential subdivision where the impervious surfaces are not shown on the plans at the time of submittal. In this case, the property owner will be required to use the worst-case scenario based on zoning restrictions for the areas of impervious surface and managed open space for the type of development specified and then apply the methodology.

**2-D. BMPs for Reducing Nitrogen and Phosphorus**

The Rule requires that all new developments achieve a nitrogen export of less than or equal to 4.0 (and a phosphorus export of less than or equal to 0.4) pounds per acre per year. If the development contributes greater than 4.0 pounds nitrogen (or 0.4 pounds phosphorus), then the following options exist.

For residential (or commercial or industrial) development:

- If the computed nitrogen export is greater than 6.0 (or 10.0) lb Mc/yr, then the owner must either use on-site BMPs or take part in an approved regional or jurisdiction-wide stormwater strategy or some combination of these to lower the nitrogen export to at least 6.0 (or 10.0) lb
N/ac/yr. The owner may then use one of the following two options to reduce nitrogen from 6.0 (or 10.0) to 4.0 lb N/ac/yr.

- If the computed nitrogen export is greater than 4.0 lb/ac/yr but less than 6.0 (or 10.0) lb N/ac/yr, then the owner may either:
  1) Install BMPs onsite or take part in an approved regional or jurisdiction-wide stormwater strategy or some combination of these to remove nitrogen down to 4.0 lb N/ac/yr; or
  2) Provide treatment of an offsite developed area that drains to the same stream to achieve the same nitrogen mass loading reduction that would have occurred onsite.

- The owner must install BMPs that also achieve a phosphorus export of less than or equal to 0.4 lb P/ac/yr, but may do so through any combination of on-site and offsite measures. Any and all BMPs must be designed and installed under the supervision of a qualified professional.

- County review of applications that require BMPs, and review of the design of BMPs, will be overseen by a qualified professional.

As with most resource impacts, an ounce of stormwater prevention is worth a pound of cure. A sound site planning process first considers the ability to achieve the needed reductions using site design measures that avoid or minimize runoff to begin with. The accounting method in Section 2-C provides credit for site planning practices that reduce nutrient loadings in this manner. These planning measures include reducing, disconnecting, and rerouting impervious surfaces, maximizing time of concentration for stormwater, and protecting open spaces for infiltration and evapotranspiration. More detail on planning measures that reduce hydrologic and nutrient loading is given in Appendix C.

Often, structural management practices cannot be avoided. BMP selection is an important and challenging craft. Available data indicate that most BMPs remove only 20 to 40 percent of total nitrogen or phosphorus on a consistent basis. There are a number of issues to consider to ensure this sustained performance. It is crucial to consider the issues of aesthetics, long-term maintenance, safety and reliability in BMP design. All BMPs require regular maintenance and some have varying performance depending on soil type and season. The efficiencies provided in Table 2 and in the load calculation worksheets in Appendix B assume correct sizing and other design per the referenced manuals, and optimum performance based on regular, effective maintenance as well as proper siting of the practices.

The BMPs available for nutrient reduction and their removal rates based on current literature studies are provided in Table 2. These median values are based on a literature review conducted by a contractor that updated Neuse nitrogen efficiencies and established phosphorus values. Provided in the table are the design standards to be adhered to in permitting BMP design.

The North Carolina Department of Environment and Natural Resources, Division of Water Quality, Water Quality Section, Stormwater Best Management Practices Manual, 1999, and all amendments thereto, is hereby adopted by reference as fully as though set forth herein. If any standard, requirement, or procedure as set forth in the manual is in conflict with any standard, requirement, or procedure as set forth in this program, then the most stringent shall prevail. A copy of this manual shall be available for public review in the office of the Stormwater Administrator.

The design of best management practices that remove nitrogen and phosphorus from stormwater is a developing field. Researchers throughout the country, particularly in the Southeast, are conducting
studies to identify and refine effective means of controlling nitrogen and phosphorus. As stated in Section 2-C, the Division plans to provide refinements in the stated BMP removal efficiencies to the County on a periodic basis as they are substantiated.

Table 2: BMP Types, TN and TP Removal Rates, and Design Standards

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>TN Removal Rate per Literature Review</th>
<th>TP Removal Rate per Literature Review</th>
<th>Appropriate Design Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet detention ponds</td>
<td>25%</td>
<td>40%</td>
<td>NC Design Manual</td>
</tr>
<tr>
<td>Constructed wetlands</td>
<td>40%</td>
<td>35%</td>
<td>NC Design Manual</td>
</tr>
<tr>
<td>50' Restored riparian buffers with level spreader</td>
<td>30%</td>
<td>30%</td>
<td>NC Design Manual, Tar-Pamlico Riparian Buffer Rule (15A NCAC 2B .0259)</td>
</tr>
<tr>
<td>Grass Swales</td>
<td>20%</td>
<td>20%</td>
<td>NC Design Manual</td>
</tr>
<tr>
<td>Vegetated filter strips20 with level spreader</td>
<td>%</td>
<td>35%</td>
<td>NC Design Manual and other literature information</td>
</tr>
<tr>
<td>Bioretention (rain gardens)</td>
<td>35% o</td>
<td>45% d</td>
<td>NC Design Manual</td>
</tr>
<tr>
<td>Sand Filters</td>
<td>35%</td>
<td>45%</td>
<td>NC Design Manual</td>
</tr>
<tr>
<td>Dry Detention '</td>
<td>10%</td>
<td>10%</td>
<td>NC Design Manual</td>
</tr>
<tr>
<td>Proprietary BMPs</td>
<td>Varies</td>
<td>Varies</td>
<td>Per manufacturer Subject to DWQ approval</td>
</tr>
<tr>
<td>Other BMPs</td>
<td>Varies</td>
<td>Varies</td>
<td>Subject to DWQ approval</td>
</tr>
</tbody>
</table>

• As established in an August 28, 2001 memorandum from DWQ Stormwater Unit to Neuse local governments, existing riparian buffers are not eligible for nutrient credit, while restored riparian buffers meeting buffer rule specifications and with level spreaders may receive credit. Use of and credit for a restored riparian buffer would depend on a degraded prior land use condition and would require site-specific approval by DWQ staff.

• The NC BMP Manual establishes vegetated filter strips as a managed riparian practice, located adjacent to streams or other waterbodies. Since Neuse and Tar-Pamlico buffer rules require 50-foot buffers adjacent to surface waters in new developments, vegetated filter strips under Neuse and Tar-Pamlico stormwater rules would be located adjacent to and landward of these protected buffers. Nitrogen and phosphorus removal efficiencies are assigned based on that assumption.

An additional design requirement beyond the specifications given in Stormwater Best Management Practices, NCDENR, Division of Water Quality, Water Quality Section, April 1999, to achieve the nutrient efficiency listed here is the use of fill soils with an infiltration rate of between one and three inches per hour, and the use of mulch on the surface.

• An additional design requirement beyond the specifications given in Stormwater Best Management Practices, NCDENR, Division of Water Quality, Water Quality Section, April 1999, to achieve the nutrient efficiency listed here is the testing of soils to meet a phosphorus index value of less than 50. Visit http://www.agr.state.nc.us/agronomi/sthome.htm for soil testing information.

• Dry detention is considered primarily an adjunct practice that can provide volume attenuation to help meet site attenuation requirements. The practice could be employed for this purpose preceding a grassed swale or Bioretention area, or preceding a level spreader above a vegetated filter strip or riparian buffer. Available data indicate that it can provide only limited nutrient removal, as reflected in the efficiencies listed. Additional research data may result in adjustment of these values in the future.
The North Carolina BMP Design Manual can be accessed and downloaded from the DWQ Stormwater Unit’s web page at [http://h2o.enr.state.nc.us/su/stormwater.html](http://h2o.enr.state.nc.us/su/stormwater.html) or obtained by contacting the Stormwater Unit at 919-733-5083 ext. 545.

**Multiple BMPs:** The worksheet provides calculation space for the case where more than one BMP is installed in series on a development. It determines the removal rate through serial rather than additive calculations. This is important to understand in projects where the automated worksheet is not used to estimate the effect of multiple BMPs.

As an example, if a wet detention pond discharges through a restored riparian buffer, then the removal rate shall be estimated to be 47.5 percent, determined as follows. The pond removes 25 percent of the influent nitrogen mass and discharges 75 percent to the buffer. The buffer then removes 30 percent of the remaining 75 percent of the original nitrogen amount that discharged from the pond, or 22.5 percent of the original influent amount. The sum of 25 and 22.5 is 47.5. The removal rate is NOT 25 percent plus 30 percent.

**Assigning Values to Pervious Cover:** Large-lot residential development may involve substantial open space that, at least initially, may remain in an undisturbed wooded or reforesting condition. While it may seem logical to enter this acreage as wooded pervious, without conservation easements or some other mechanism for ensuring protection of these areas, the County has no control over their eventual condition. Thus, unless specific protection instruments, such as conservation easements, are established and provided in the development application or by the County, lot areas shall be assigned the lawn/landscape managed pervious export rate. The worksheet will do this automatically.

Riparian buffers protected under the Tar-Pamlico Riparian Buffer Protection rule, 15A NCAC 2B .0259, are divided into two zones, moving landward from the surface water, that are afforded different levels of protection. Zone 1, the first 30 feet, is to remain essentially undisturbed, while zone 2, the outer 20 feet, must be vegetated but may be managed in certain ways. The user shall enter the acreage in zone 1 into the worksheet as wooded pervious, while zone 2 acreage shall be entered as managed pervious (lawn/landscape).

**2-E. Calculating Peak Runoff**

The Tar-Pamlico Stormwater Rule requires that new development not cause erosion of surface water conveyances. At a minimum, new development shall not result in a net increase in peak flow leaving the site from pre-development conditions for the 1-year, 24-hour storm event. The developer shall submit calculations signed and sealed by a qualified professional. A number of Neuse local governments sought to use the 2-year rather than the 1-year storm as the design storm for peak flow control given that the 2-year storm is more consistent with current hydrologic modeling methodologies.

The main reason that the Rule requires a 1-year design storm for peak flow control is to protect stream channels from erosion. Development on land causes many changes in stormwater hydrology. One of the major causes of streambank erosion in urban streams is the increase in the frequency of the bankfull-flooding event. The bankfull-flooding event generally occurs at approximately a 1.5-year frequency. The Tar-Pamlico Stormwater Rule requires control of the 1-year storm to predevelopment levels to insure that the rate of release will be below bankfull and therefore less erosive to the stream.
channel. Releasing the 2-year storm at predevelopment levels would likely have the effect of increasing the frequency of a storm that is just a bit larger than the most erosive storm.

Protecting streambanks from erosion is a crucial part of the overall Tar-Pamlico Nutrient Sensitive Waters Management Strategy. Riparian buffers are protected under this program because in most situations they are effective at removing nitrogen resulting from nonpoint source pollution. The use of nitrogen reducing BMPs on new development does not obviate the need to maintain valuable riparian buffers.

In the Neuse process, DWQ staff devised a strategy, which is incorporated here, to allow use of the 2-year design storm while also providing a similar level of protection for streambanks as the use of the 1-year design storm. The strategy gives the County the option of using the 2-year storm as the design storm for peak flow control; however, requiring that it be controlled to the pre-development levels of the 1-year storm. This can be done by computing the peak flow associated with the 2-year storm for pre-development conditions and then reducing it by an appropriate percentage to reflect the difference between the 1-year and 2-year storm peak flows. The County will allow either of the following two options to calculate the peak runoff.

**Option 1: Use the 1-year Design Storm**

The US Weather Bureau (Technical Paper 40) published maps of rainfall depths for the 1-year storm of duration 30 minutes to 24 hours. The 1-year, 24-hour precipitation, as given in this atlas, varies along the Tar-Pamlico River Basin. For Edgecombe County, the rainfall depth for the 1-year, 24-hour storm is 3.2 inches.

The Rational Method is an acceptable method for estimating peak discharge in the design of stormwater facilities for relatively small watersheds (up to 50 acres). The basic equation is:

\[ Q = CIA \]

Where:
- \( Q \) is the peak flow for the design storm in cubic feet per second
- \( C \) is the coefficient of runoff based on land cover (dimensionless)
- \( I \) is the rainfall intensity in inches per hour for the designated return period storm and the time of concentration, \( T_c \)
- \( A \) is the drainage area in acres
- \( T_c \) is defined as the longest time of flow from a point on the watershed ridge to the outlet of the watershed. \( T_c \) may be calculated different ways. One way is the Kirpich Equation:

\[ 7: = \frac{\text{L} \text{H}}{128} \]

in which:
- \( L \) = hydraulic length of the watershed in feet = the length of the longest flow path from the most remote point on the watershed ridge to the outlet
- \( H \) = the elevation difference, or fall, in feet along the hydraulic length
Another acceptable method is that given by Soil Conservation Service (SCS, 1986) which is based on the length of flow and the average velocity for the given watercourse hydraulic characteristics.

The Rational Method is based upon the assumption that rainfall is uniformly distributed over the entire drainage area at a steady rate, causing the flow to reach a maximum at the outlet of the watershed at a time to peak, $T_p$. The method typically gives a conservative estimate of runoff.

In order to use the Rational Method to determine peak flows, it is necessary to compute the storm intensity in inches per hour for the 1-year storm. The intensity is computed by the formula:

$$\frac{I}{g} = \frac{h + T}{T}$$

Where:
- $I$ is the rainfall intensity in inches per hour
- $g$ and $h$ are empirically derived constants
- $T$ is the duration in minutes set equal to the time of concentration

The appropriate values for $g$ and $h$ were estimated by graphing the 2, 5, 10, 25, 50 and 100-year values of $g$ and $h$ for Wilson County as a function of return period on a log-normal scale and determining the y-intercept of the best-fit line. For Edgecombe County, the resulting values for $g$ and $h$ for the 1-year storm are 112 and 20, respectively.

**Option 2: Use the 2-year Design Storm, but Control it to 1-year Design Storm Predevelopment Levels**

This option involves the following three steps:

1) Compute the peak flows (both pre- and post-development) from the drainage area based on the 2-year design storm using one of the acceptable methodologies listed below. Note for the County, the values of $g$ and $h$ for the 2-year storm are 144 and 20, respectively.

2) Estimate the 1-year predevelopment peak flow by multiplying the 2-year predevelopment peak flow by 80%.

3) Design a BMP that will control the 2-year post-development peak flow to 1-year pre-development peak flow levels (estimated by the second step).

**Exceptions to the Peak Flow Requirement**

Peak flow control is not required for developments that meet one or more of the following requirements:

1) The increase in peak flow between pre- and post-development conditions does not exceed ten percent (note that this exemption makes it easier to conduct redevelopment activities).

2) The proposed new development meets all of the following criteria: overall impervious surface is less than fifteen percent, and the remaining pervious portions of the site are utilized to the maximum extent practical to convey and control the stormwater runoff.

3) The development occurs in a part of a drainage basin where stormwater detention can aggravate local flooding problems as determined by the County.
Acceptable Methodologies for Computing Peak Flow

Acceptable methodologies for computing the pre- and post-development conditions for the design storm include:

- The Rational Method
- Dr. Rooney Malcom, P.E., Small Watershed Method
- NRCS Methodologies applied through the Corps of Engineers BEC-1 Program
- The Peak Discharge Method as described in USDA Soil Conservation Service's Technical Release Number 55 (TR-55)
- The Putnam Method

The same method must be used for both the pre- and post-development conditions.

2-F. Offsite Partial Offset Option

The Tar-Pamlico stormwater rule provides the option to partially offset nitrogen load increases from new development by providing treatment of offsite developed areas. The offsite area must drain to the same classified surface water as the new development, as defined in the schedule of Classifications, 15A NCAC 2B .0316 and listed in Table 2f of this chapter. The developer must also provide appropriate legal measures to ensure that the offsite area achieves and maintains the credited nutrient reduction for as long as the new development exists, including through changes of ownership on either property.

In order to take advantage of the partial offset option, the development plan must meet the following conditions:

- The offsite facility must drain to the same classified surface water as the new development.
- The new development must first reduce nitrogen export from the site to at least 6 lb N/ac-yr for residential and 10 lb N/ac-yr for other types of development. The balance of the nitrogen removal must be made by the offsite facility.
- The net phosphorus loading for the project must be reduced to 0.4 lb/ac/yr. Some or all of the reduction may be obtained through the offsite BMPs.
- The offsite facility may only be used to address the nutrient requirements, unless the development proposal demonstrates that meeting some or all attenuation requirements offsite will not result in degradation of surface waters to which the new development site discharges.
- The offsite BMP may serve multiple projects provided the facility is appropriately sized and a tracking system to allocate nutrient removal is in place and the off-site facility has been approved as a regional BMP.
- Both the development owner and the owner of the offsite facility must agree in a documented, enforceable manner that offsite facilities are dedicated to achieving the specified nutrient and flow reductions for the life of the new development. The responsibility for maintaining these reductions as well as the provisions of any required conservation easements and operation and maintenance agreements shall run with the land and be binding upon subsequent owners of both the development project and the off-site BMP.
- The operation and maintenance plan shall require an annual inspection by a licensed professional and shall ensure that Edgecombe County has the authority to inspect the stormwater facilities and make any necessary corrections if the owner fails to complete the required inspection or complete any required improvements. Any costs associated with this work, including administrative costs and fines, will be charge to the owner or party legally responsible for maintenance of the facility.
The developer shall submit the following information:

- The type and design of the proposed stormwater facility.
- The location, extent, type of use, and built-upon areas on the existing development site that will be treated by the stormwater facility.
- A maintenance agreement and plan for the offsite facility that meets all of the requirements of this plan.
- A binding legal instrument to be recorded at the Edgecombe County Register of Deeds prior to the release of a certificate of occupancy for the new development site that:
  - Permits the applicant to construct and maintain the offsite facility on the property of the existing development;
  - Clearly describes the responsibilities and limitations of all parties;
  - Holds all owners and parties in interest in the existing development and the proposed new development corporately and separately liable to the county for the ongoing maintenance of the facility;
  - Clearly states that the offsite facility is dedicated to achieving the specified nutrient and flow reductions for the life of the new development;
  - Attaches to both properties and is automatically transferable to any and all new owners, parties in interest, future successors and assigns;
  - Will remain in full force and effect unless and until the county shall approve the closure of the offsite facility;
  - Clearly indicates by numerical standard(s) the nutrient reduction and, if applicable, stormwater attenuation ability of the facility(ies);
  - Acknowledges that as long as the agreement is in effect, future change of use or land disturbing activity of either site shall be reviewed for its impact on the ability of the offsite facility to meet the nutrient and, if applicable, attenuation requirements of this plan and shall not be approved if the requirements cannot be maintained; and
  - Acknowledges the intent of the county to insure through any and all inspection and enforcement authorities it has that the offsite facility is maintained in perpetuity.

An as-built survey of the existing development site along with the location and extent of the proposed offsite facility and clear indication of the area the facility is treating shall be required to be submitted, approved, and recorded prior to the release of a certificate of occupancy for the new development site. Such survey shall show on its face the following note signed by all owners:

NOTE: The stormwater facility(ies) shown on this site are provided as an offsite offset facility for the property known as <Subdivision / development name> located at <physical address / location> with Tax Identification Number(s) <#1444 #441444>. This (these) facility(ies) and such property(ies) are legally bound by a <name of binding legal instrument> recorded at the Edgecombe County Register of Deeds <reference number>.

This note shall also be shown on the face of the recorded site plan and/or subdivision plat of the new development site, signed by all owners of that property, and shall appear along with the owner’s signature on all future subdivision maps and/or documents of both properties as long as the agreement is in effect.

Prior to approval of any subsequent change of use or land development activity on either site, the applicant shall demonstrate that offsite property nutrient loading reductions and, if applicable, attenuation as required by this plan shall be maintained.
The classified surface waters in Edgecombe County include the following: Table 2f: Tar River Basin Classified Surface Waters

<table>
<thead>
<tr>
<th>Name of Stream</th>
<th>Description</th>
<th>Current Class</th>
<th>Stream Index #</th>
<th>Water Quality Issues</th>
<th>Notes</th>
</tr>
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<tbody>
<tr>
<td>Tar River</td>
<td>From dam at Rocky Mount Mills to a point 0.9 mile downstream of Buck Swamp</td>
<td>C;NSW</td>
<td>28-(69)</td>
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<tr>
<td>Cowlick Branch</td>
<td>From source to Tar River</td>
<td>C;NSW</td>
<td>28-71</td>
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<tr>
<td>Compass Creek</td>
<td>From source to Tar River</td>
<td>C;NSW</td>
<td>28-72</td>
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<tr>
<td>Horn Beam Swamp</td>
<td>From source to Compass Creek</td>
<td>C;NSW</td>
<td>28-72-1</td>
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<tr>
<td>Gay Branch</td>
<td>From source to Tar River</td>
<td>C;NSW</td>
<td>28-72.5</td>
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<tr>
<td>Buck Swamp</td>
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<td>C;NSW</td>
<td>28-73</td>
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<tr>
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<td>From a point 0.9 mile downstream of Buck Swamp to a point 0.5 mile upstream of Tarboro Water Supply Intake</td>
<td>WS-IV;NSW</td>
<td>28-(74)</td>
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<td>Beech Branch</td>
<td>From U.S. Hwy 301 to Falling Run</td>
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<td>Falling Run</td>
<td>From source to Beech Branch</td>
<td>C;NSW</td>
<td>28-75-3</td>
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<td></td>
</tr>
<tr>
<td>Beech Branch</td>
<td>From Falling Run to Tar River</td>
<td>WS-IV;NSW</td>
<td>28-75-(4)</td>
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<tr>
<td>Walnut Creek</td>
<td>From source to Tar River</td>
<td>WS-IV;NSW</td>
<td>28-76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key Branch</td>
<td>From source to Tar River</td>
<td>WS-IV;NSW</td>
<td>28-7.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penders Mill Run (Harts Mill Run)</td>
<td>From source to Tar River</td>
<td>WS-IV;NSW</td>
<td>28-77</td>
<td></td>
<td></td>
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<tr>
<td>Racoon Branch (Hatcher Swamp)</td>
<td>From source to Harts Mill Run</td>
<td>WS-IV;NSW</td>
<td>28-77-1</td>
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<tr>
<td>Swift Creek</td>
<td>From Nash County SR 1003 to a point 1.4 miles upstream of Edgecombe County SR 1409</td>
<td>C;NSW</td>
<td>28-78-(2.5)</td>
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<tr>
<td>Moccasin Creek</td>
<td>From source to Swift Creek</td>
<td>C;NSW</td>
<td>28-78-6</td>
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<tr>
<td>Swift Creek</td>
<td>From a point 1.4 miles upstream of Edgecombe County SR 1409 to Tar River</td>
<td>WS-IV;NSW</td>
<td>28-78-(6.5)</td>
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<td></td>
</tr>
<tr>
<td>Whiteoak Swamp</td>
<td>From source to a point 1.8 miles upstream of Edgecombe County SR 1428</td>
<td>C;NSW</td>
<td>28-78-7-(1)</td>
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<tr>
<td>Whiteoak Swamp</td>
<td>From a point 1.8 miles upstream of Edgecombe County SR 1428 to Swift Crk.</td>
<td>WS-TV;NSW</td>
<td>28-78-7-(2)</td>
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<tr>
<td>Fishing Creek</td>
<td>From Enfield Raw Water Supply Intake to a point 1.7 miles downstream of Beech Swamp</td>
<td>C;NSW</td>
<td>28-79-(29)</td>
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<td>Turbidity</td>
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</tbody>
</table>

Edgecombe County
Stormwater Management Program for Nutrient Control

Page 14
<table>
<thead>
<tr>
<th>Stream Name</th>
<th>Description</th>
<th>Impaired Cause</th>
<th>Impact Parameter</th>
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<tbody>
<tr>
<td>Fishing Creek</td>
<td>From a point 1.7 miles downstream of Beech Swamp to Tar River</td>
<td>Impaired</td>
<td>28-79-(30.5)</td>
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<tr>
<td>Maple Swamp</td>
<td>From source to Edgecombe County SR 1426</td>
<td>Source Unknown</td>
<td>28-79-31-(0.3)</td>
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<tr>
<td>Maple Swamp</td>
<td>From Edgecombe County SR 1426 to Fishing Creek</td>
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<td>28-79-31-(0.7)</td>
</tr>
<tr>
<td>Moore Swamp</td>
<td>From source to Maple Swamp</td>
<td>Impaired</td>
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<tr>
<td>Deep Creek</td>
<td>From a point 1/3 miles upstream of N.C. Hwy 97 to Fishing Creek</td>
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<td>28-79-32-(1.5)</td>
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<tr>
<td>Marsh Swamp</td>
<td>From source to Deep Creek</td>
<td></td>
<td>28-79-32-2</td>
</tr>
<tr>
<td>Indian Branch</td>
<td>From source to Deep Creek</td>
<td></td>
<td>28-79-32-3</td>
</tr>
<tr>
<td>Savage Mill Run</td>
<td>From source to Deep Creek</td>
<td></td>
<td>28-79-32-4</td>
</tr>
<tr>
<td>Long Branch</td>
<td>From source to Deep Creek</td>
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<td>28-79-32-5</td>
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<tr>
<td>Tar River</td>
<td>From a point 0.5 mile upstream of tarboro Water Supply Intake to Tarboro Water Supply Intake</td>
<td>Impaired</td>
<td>28-(79.5)</td>
</tr>
<tr>
<td>Tar River</td>
<td>From Tarboro Raw Water Supply Intake to Suggs Creek</td>
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<td>28-(80)</td>
</tr>
<tr>
<td>Hendricks Creek</td>
<td>From source to Tar River</td>
<td>Source Unknown</td>
<td>28-81</td>
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<tr>
<td>Holly Creek</td>
<td>From source to Hendricks Creek</td>
<td></td>
<td>28-81-1</td>
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<tr>
<td>Cromwell Canal &amp;</td>
<td>Connecting Canals</td>
<td></td>
<td>28-82</td>
</tr>
<tr>
<td>Jerrys Creek</td>
<td>From source to Tar River</td>
<td></td>
<td>28-82.5</td>
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<tr>
<td>Town Creek</td>
<td>From source to Tar River</td>
<td></td>
<td>28-83</td>
</tr>
<tr>
<td>Williamson Branch</td>
<td>From source to Tar River</td>
<td></td>
<td>28-83-2</td>
</tr>
<tr>
<td>Corn Creek</td>
<td>From source to Town Creek</td>
<td></td>
<td>28-83-2.5</td>
</tr>
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<td>Cokey Swamp</td>
<td>From source to Town Creek</td>
<td>Impaired</td>
<td>28-83-3</td>
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<tr>
<td>Little Cokey</td>
<td>From source to Cokey Swamp</td>
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<td>28-83-3-1</td>
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<td>Swamp</td>
<td>Parker Branch</td>
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<td>Dickson Branch</td>
<td>From source to Cokey Swamp</td>
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<td>28-83-3-1.7</td>
</tr>
<tr>
<td>DeLoach Branch</td>
<td>From source to Cokey Swamp</td>
<td></td>
<td>28-83-3-2</td>
</tr>
<tr>
<td>Cabin Branch</td>
<td>From source to Cokey Swamp</td>
<td></td>
<td>28-83-3-2.3</td>
</tr>
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<td>Millpond Branch</td>
<td>From source to Cokey Swamp</td>
<td></td>
<td>28-83-3-2.5</td>
</tr>
<tr>
<td>Beaverdam Branch</td>
<td>From source to Cokey Swamp</td>
<td></td>
<td>28-83-3-2.7</td>
</tr>
<tr>
<td>Sasnett Mill Branch</td>
<td>From source to Cokey Swamp</td>
<td></td>
<td>28-83-3-3</td>
</tr>
<tr>
<td>Bynums Mill</td>
<td>From source to Town Creek</td>
<td>Impaired</td>
<td>28-83-4</td>
</tr>
<tr>
<td>Creek</td>
<td>Bynums Mill Creek</td>
<td></td>
<td>Source Unknown</td>
</tr>
<tr>
<td>Stream Name</td>
<td>Source to Destination</td>
<td>Code</td>
<td>Date</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-------------------------------------------------------------</td>
<td>------</td>
<td>----------</td>
</tr>
<tr>
<td>Bynums Mill Run</td>
<td>From source to Bynums Mill Creek</td>
<td>C;NSW</td>
<td>28-83-4-1</td>
</tr>
<tr>
<td>Briery Branch</td>
<td>From source to Bynums Mill Creek</td>
<td>C;NSW</td>
<td>28-83-4-1-1</td>
</tr>
<tr>
<td>Tar River</td>
<td>From Suggs Creek to Johnsons Mill Creek</td>
<td>WS-W;NSW</td>
<td>28-(84)</td>
</tr>
<tr>
<td>Suggs Creek (Cheek Creek)</td>
<td>From source to Tar River</td>
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<td>28-86-(0.3)</td>
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<td>Kitten Creek</td>
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<td>C;NSW</td>
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<tr>
<td>Conetoe Creek</td>
<td>From source to Pitt County SR 1404</td>
<td>C;NSW</td>
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<td>Fountain Fork Creek</td>
<td>From source to Conetoe Creek</td>
<td>C;NSW</td>
<td>28-87-0.7</td>
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<td>Crisp Creek</td>
<td>From source to Conetoe Creek</td>
<td>C;NSW</td>
<td>28-87-1</td>
</tr>
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<td>Ballahack Canal</td>
<td>From source to Conetoe Creek</td>
<td>C;NSW</td>
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<td>Mitchell Swamp Canal</td>
<td>From source to Conetoe Creek</td>
<td>C;NSW</td>
<td>28-87-3</td>
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<tr>
<td>Knight Canal</td>
<td>From source to Michell Swamp Canal</td>
<td>C;NSW</td>
<td>28-87-3-1</td>
</tr>
<tr>
<td>Swift Creek</td>
<td>From source to a point 1.4 miles upstream of Edgecombe County SR 1409</td>
<td>C;NSW</td>
<td>28-78-(0.5)</td>
</tr>
</tbody>
</table>
2-G. Regional or Jurisdiction-Wide Approaches

The Tar-Pamlico stormwater rule provides the option for local governments to develop regional or jurisdiction-wide stormwater facilities in their programs as an alternative means for developers to address nutrient or flow control requirements. Should Edgecombe County identify viable regional or jurisdiction-wide projects, it will demonstrate that such measures will not contribute to degradation of surface waters and quantify nutrient and flow reductions and provide for tracking and administration of the use of such facilities to DWQ.

**Regional Facilities:** Within the context of this plan, regional facility means a stormwater facility that serves a large developed area and serves more than one development draining to the same classified water. Examples of regional facilities may include but are not limited to wet detention ponds or constructed wetlands.

The regional system option will be evaluated by the County through a series of basin master plans or as specific opportunities are identified through other processes. The regional option would be pursued to provide greater flexibility to development in the impacted area by constructing stormwater management facilities on a larger scale. Two basic types of regional facilities may be described as off-stream and in-stream. While the County may pursue in-stream regional facilities, in-stream facilities involve a more complicated set of issues associated with protection of surface waters. They are potentially suitable to a relatively small set of circumstances.

Regional facilities provided for in this plan would serve more than one development project. They may be publicly or privately owned, but would be proposed to DWQ with the support of the County. Basic elements of regional system proposals, to be permitted by DWQ, and other "shared-facility" individual projects permitted by local governments would be the same, and are described below.

As mandated by the rule, such strategies would demonstrate that any proposed measures will not contribute to degradation of surface water quality, degradation of aquatic or wetland habitat or biota or destabilization of conveyance structure of involved surface waters.

**Jurisdiction-Wide Approach:** Within the context of the rule and this plan, means generally a nutrient-reducing management measure or strategy implemented under the authority of the County to offset one or more increases that may take place in the same or a separate watershed within the jurisdiction. An offsite offset project (see Section 2-F) that is implemented under the authority of the County to serve projects in multiple watersheds would be a specific type of jurisdiction-wide approach. Examples of nutrient reducing measures may include but are not limited to conventional stormwater facilities, constructed wetlands, or land conservation.

Edgecombe County controls a significant amount of land that may be suitable for conservation easements and reforestation and will likely consider development of specific proposals for land conservation offsets in the future. When developing a land conservation proposal for DWQ review, the County will consider the following criteria:

- Conserved land would need to achieve the net nutrient reductions not achieved by new development that conservation is credited with offsetting. Proposals would need to quantify those reductions, including a measure of uncertainty. Land conservation would need to occur as part of some activity that would allow the conservation to achieve nutrient reductions. Examples include:
Conservation of a portion of a new development site to receive and treat the runoff from the development.

Conservation of a portion of some other, concurrent new development site to receive and treat runoff from that other site.

Restoration of the buffering functions of undeveloped land adjacent to existing or new development, e.g. converting pipe or ditch flow to dispersed sheetflow through forested land.

Obtaining and retiring agricultural land to forest land.

- The conserved land should be no further from the estuary than the new development and within the same jurisdiction. Proposals to establish interlocal agreements that would provide for development and offsetting conservation in different jurisdictions shall provide adequate assurance of enforceability between jurisdictions, as well as cross-jurisdictional tracking and monitoring procedures, in addition to the proposal information called for below.

- Adjacent new development could not claim credit for conserved lands that are being credited to other new development (no double counting)

- Lands whose nutrient removal functions are established and protected through other regulatory programs, such as wetlands and riparian buffers, would not be eligible for conservation credit.

- Conserved land could be used to offset flow attenuation requirements if adequate measures are provided to ensure diffuse flow and no hydrologic degradation of the conserved features or surface waters.

- The conserved land would be established within the context of a long-term regulating plan for development in the local government's comprehensive plan.

- It should be secured in a permanent conservation easement or equivalent legal mechanism whose provisions prohibit both farming and unapproved logging practices. This conservation land should be tracked on a GIS system and recorded on the plat or deed.

Proposal Information: Regional or jurisdiction-wide approaches will be undertaken on a project by project basis and will be incorporated into the County's comprehensive stormwater management program as they are developed provided there is appropriate supporting information to show how they will achieve the nitrogen and phosphorus loading reduction requirements applicable to new development. Whether a regional or jurisdiction-wide approach is designed, implemented, and maintained by a developer or the local government, the County will provide the following information to DWQ for any proposed regional facility.

- System location and design information, including:
  - land uses in the contributing area
  - type of facility — treatment, attenuation, both, treatment method, expected nitrogen and phosphorus removal efficiency
  - worst-case percent impervious of the contributing area at build out
  - assumptions for on-lot treatment and attenuation
  - calculations on nitrogen and phosphorus reduction needed, demonstration that facility meets needs
  - demonstration that any proposed measures will not contribute to degradation of surface water quality, degradation of aquatic or wetland habitat or biota, or destabilization of conveyance structure of involved surface waters.

- Process for tracking expenditure of treatment and attenuation capacity.
Facility protection provisions - an easement, restricted to storm water management and containing adequate access, dedicated to the public or public entity through a platted and recorded map.

Operation and maintenance provisions:
- An agreement that demonstrates that (a) the developer, (b) a local government, or (c) a private for-profit or non-profit company will operate and maintain the facilities. An example maintenance agreement is provided in Appendix D.
- Financial guarantees for maintenance of continued performance in the event that the local government must assume maintenance.
- An adopted ordinance providing for fines and penalties to ensure maintenance of the stormwater facilities.

2-H. BMP Maintenance

If BMPs are implemented to achieve the nitrogen and phosphorus loading and flow attenuation requirements for a development, then the County will require an operation and maintenance plan for the BMPs at the time of construction to ensure long term maintenance of the facility. For projects under its jurisdiction, the County will ensure BMP maintenance through the following method:

- The County Unified Development Ordinance requires the formation of a property owners association, as needed, and a legal recorded agreement with the owner or owners association for maintenance of the BMP. The provisions of the agreement will be required to run with the land. Minimum requirements are as stated in the example stormwater maintenance agreement in Appendix D. The County shall notify the owner by Certified Mail upon finding that maintenance is needed on a BMP. If the owner does not complete the maintenance himself within 30 days of notification, then the County can contract out the maintenance itself and recover costs in the manner it determines most appropriate. The County will undertake an annual inventory of BMPs to ensure that the required inspections and maintenance activities have been completed. If the owner does not complete the required inspections by a qualified professional or required maintenance in a timely manner, the County will pursue enforcement actions consistent with the provisions of the agreement and current code enforcement provisions.

- The County requires the landowner, its successors and assigns, to have each BMP inspected annually by a Qualified Professional. A certified inspection report for each BMP inspected shall be submitted to the County by September 15th of each year, along with a report of any and all maintenance, failures, and/or repairs. The County will maintain an inventory of BMPs and their locations to assist in the inspection process. Edgecombe County shall have the authority to inspect the stormwater facilities and make any necessary corrections if the owner fails to complete the required inspection or complete any required improvements. Any costs associated with this work, including administrative costs and fines, will be charge to the owner or party legally responsible for maintenance of the facility.

- The County will annually conduct inspections on at least 10% of permitted systems to determine compliance with permitted design and shall take appropriate follow-up action necessary to achieve compliance.
. Land Use Planning Provisions

The State's model program is intended to provide the flexibility and incentives for the County to improve their growth management practices and for developers to use impact-reducing site design techniques that will reduce nitrogen and phosphorus loading from their developments. As discussed previously, one such measure, reducing impervious surfaces, reduces the need for BMPs to control nitrogen and peak stormwater flows and also reduces associated BMP maintenance concerns.

The County may consider the following planning techniques and the general advantages and disadvantages of incorporating these approaches to reduce impervious surfaces.

- Reducing road widths
- Reducing minimum parking requirements
- Minimizing use of curb and gutter
- Cluster or open-space developments
- Traditional neighborhood developments
- Mixed-use developments
- Low Impact Development principles
- Other impact-reducing approaches

Descriptions of these techniques are provided in Appendix C.
3. Illegal Discharges / Connections

3-A Requirements in the Rule

The Tar-Pamlico Stormwater Rule requires that the County establish a program to prevent, identify and remove illegal discharges / connections. Illegal discharges are flows in the stormwater collection system that are not associated with stormwater runoff or an allowable discharge. Illegal connections are pipes or drains that form connections to the stormwater system that may allow for an illegal discharge.

3-B What is an Illegal Discharge / Connection?

Stormwater collection systems are vulnerable to receiving illegal discharges (even though the person responsible for the discharge may be unaware that it is illegal). Depending on their source, illegal discharges may convey pollutants such as nutrients, phenols, and metals to receiving waters. Table 3a identifies some potential flows to the stormwater collection system that may be allowable. Table 3b identifies some discharges that are not allowed.

<table>
<thead>
<tr>
<th>Table 3a: Allowable Discharges to the Stormwater Collection System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waterline Flushing</td>
</tr>
<tr>
<td>Uncontaminated Rising Ground Water</td>
</tr>
<tr>
<td>Infiltration to stormwater collection system</td>
</tr>
<tr>
<td>Discharges from potable water sources</td>
</tr>
<tr>
<td>Irrigation Water</td>
</tr>
<tr>
<td>Footing Drains</td>
</tr>
<tr>
<td>Flows from Riparian Habitats and Wetlands</td>
</tr>
<tr>
<td>Fire Fighting Emergency Activities</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3b: Discharges Not Allowed to the Stormwater Collection System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dumping of oil, anti-freeze, paint, cleaning fluids</td>
</tr>
<tr>
<td>Contaminated Foundation Drains</td>
</tr>
<tr>
<td>Sanitary Sewer Discharges</td>
</tr>
<tr>
<td>Chlorinated backwash and draining associated with swimming pools</td>
</tr>
</tbody>
</table>
3-C. Establishing Legal Authority

One of the first steps that the County is required to take is establishing the legal authority to control illegal discharges / connections. Edgecombe County Unified Development Ordinance, Sections 1-5 and 12-3.5, establishes the County's legal authority to do the following:

- Control the contribution of illegal pollutants identified in Table 3b to the stormwater collection system.
- Prohibit illegal discharges / connections to the stormwater collection system.
- Prohibit discharge of spills and disposal of materials other than stormwater to the stormwater collection system.
- Determine compliance and non-compliance.
- Require compliance and undertake enforcement measures in cases of non-compliance.

3-D. Collecting Jurisdiction-Wide Information

The County will collect geographic information at three increasing levels of detail:

1) Cursory level information shall be collected for the entire County's jurisdiction. The associated requirements are discussed in this section.

2) A more detailed screening for high priority areas within the County's jurisdiction. The associated requirements are discussed in Section 3-E.

3) A detailed investigation shall be done upon the discovery of an illegal discharge. The associated requirements are discussed in Section 3-F.

The purpose of collecting jurisdiction-wide information is to assist with identifying potential illegal discharge sources and characterizing illegal discharges after they are discovered. The County will compile maps at a scale no greater than 1:24,000 that show the following:

- Location of sanitary sewers in areas of the major stormwater collection systems and the location of areas that are not served by sanitary sewers.
- Waters that appear on the USDA — Natural Resources Conservation Service Soil Survey Maps and the U.S. Geological Survey 1:24,000 scale topographic maps.
- Land uses. Categories, at a minimum, will include undeveloped, residential, commercial, agriculture, industrial, institutional, publicly owned open space and others.
- Currently operating and known closed municipal landfills and other treatment, storage, and disposal facilities, including for hazardous materials.
- Major stormwater structural controls.
- Known NPDES permitted discharges to the stormwater collection system (this list can be obtained from the Division of Water Quality).
Written descriptions will be provided for the map components as follows:

- A summary table of municipal waste facilities that includes the names of the facilities, the status (open/closed), the types, and addresses.
- A summary table of the NPDES permitted dischargers that includes the name of the permit holder, the address of the facility and permit number.
- A summary table of the major structural stormwater control structures that shows the type of structure, area served, party responsible for maintaining, and age of structure.
- A summary table of publicly owned open space that identifies size, location, and primary function of each open area.

The County will complete this collection of jurisdiction-wide information by the time the second annual report is due.

3-E. Mapping and Field Screening in High Priority Areas

Beginning in the third year after implementation of the local stormwater program, the County will identify a high priority area of its jurisdiction for more detailed mapping and field screening. This high priority area will comprise at least ten percent of the County's jurisdictional area. This requirement will begin in the third year after implementation. Each subsequent year, the County will select and screen another high priority area that comprises at least ten percent of its jurisdiction.

"High priority" means the areas within a jurisdiction where it is most likely to locate illegal discharges. The most likely locations for identifying illegal discharges are areas with older development. Each year, the County will explain their basis for selection of the high priority areas.

The first part of the screening process for the selected high priority area is mapping the stormwater system. At a minimum, the map that is produced will include the following:

- Locations of the outfalls, or the points of discharge, of any pipes from non-industrial areas that are greater than or equal to 36 inches.
- Locations of the outfalls of any pipes from industrial areas that are greater than or equal to 12 inches.
- Locations of the outfalls of drainage ditches that drain more than 50 acres of non-industrial lands.
- Locations of the outfalls of drainage ditches that drain more than 2 acres of industrial land.
- An accompanying summary table listing the outfalls that meet the above criteria that includes outfall ID numbers, location, primary and supplemental classification of receiving water, and use-support of receiving water.

The second part of the screening process for the selected high priority area is conducting a dry weather field screening of all outfalls that meet the above criteria to detect illegal discharges. The dry weather field screening will not be conducted during or within 72 hours following a rain event of 0.1 inches or greater.
Figure 3 illustrates a suggested process for conducting field screening sampling activities and following up with any findings of dry weather flow. The County will generally use this process for field screening. As shown in the figure, if the field screening shows that an outfall is dry, then the outfall shall be checked for intermittent flow at a later date.

If the field screening shows that an outfall has a dry weather flow, then the County will complete a screening report for the outfall. The information that will be contained in the screening report is outlined in Table 3c. Screening reports will be kept on file for a minimum of five years. Example illicit discharge screening report forms are provided in Appendix E.

Figure 3: Field Screening Process

Screen outfall in high priority area

No flow

Check for signs of intermittent flow

Flow

Inspect and sample flow

Flow found

Outfall OK

Investigate source of flow, considering the following:
- Jurisdiction-wide information collected
- Field investigation of drainage area of outfall
- Sampling data
- Qualitative observations -- sheen, odor, turbidity, etc.

Remove illegal discharge

Checking for intermittent flow includes rechecking outfall at a later date as well as visual observations for evidence of intermittent flow.

Analytical monitoring is required only if an obvious source of the dry weather flow cannot be determined through an investigation of the upstream stormwater collection system.
Table 3c: Field Screening Report Information

<table>
<thead>
<tr>
<th>General Information</th>
<th>Sheet Number</th>
<th>Outfall ID Number</th>
<th>Date</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field Site Description</td>
<td>Location</td>
<td>Type of Outfall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant Watershed Land Use(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual Observations</td>
<td>Photograph</td>
<td>Deposits/Stains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Odor</td>
<td></td>
<td>Vegetation Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td></td>
<td>Structural Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarity</td>
<td></td>
<td>Biological</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floatables</td>
<td></td>
<td>Flow Estimation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sampling Analysis'</td>
<td>Temperature</td>
<td>Nitrogen-Nitrate/Nitrite</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>Fluoride or Chlorine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen-Ammonia</td>
<td></td>
<td>Total Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ortho-Phosphate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Analytical monitoring is required only if an obvious source of the dry weather flow cannot be determined through an investigation of the upstream stormwater collection system.

Outfalls with flow will be screened again within 24 hours for the above parameters. The tests for ammonia and nitrate/nitrite that are purchased will be sensitive for 0.1 to 10 mg/L.

The purpose of the field screening is to provide clues as to the source of the illegal discharge. The characterization will be used in conjunction with the jurisdiction-wide information and a field investigation to identify the source of the illegal discharge. The process of identifying and removing illegal discharges is discussed in the next section.

3-F. Identifying and Removing Illegal Discharges / Connections

After the field screening is complete, the County will take measures to identify and remove illegal discharges / connections. Identifying illegal discharges / connections may require a combination of office and field work. After the field screening, the County will consult the jurisdiction-wide information they have compiled (see Section 3-D) to obtain information about the land uses, infrastructure, industries, potential sources and types of pollution that exist in the drainage area of the outfall.

After potential sources have been identified in the office, a systematic field investigation should be planned that minimizes the amount of resources required to identify the source. Several field methods may be used to identify illegal discharges / connections. The County will use a simple approach if that will suffice. Listed below are several approaches that may be used, not all inclusive, starting with simple approaches and moving to more complex ones:
• Site Investigation
• Additional Chemical Analysis (recommend testing for fecal coliform if the ammonia concentration was found to exceed 1.0 mg/L)
• Flow Monitoring (recommended to use multiple site visits rather than a depth indicator)
• Dye Testing (fluorescent dye is recommended)
• Smoke Testing
• Television Inspection

Documentation of the results of the office and field investigations will be kept on file for at least five years with the screening report.

After the County identifies the source of an illegal discharge, or finds an illegal connection, it will take enforcement action to have the source / connection removed as outlined in the County's Unified Development Ordinance. Enforcement will include requiring the person responsible for the discharge / connection to remove or redirect it to the sanitary sewer. Non-compliance will result in a violation and ultimately a civil penalty. Records of all compliance actions will be kept for a minimum of five years with the screening report.

In addition to keeping all screening reports on file, the County will maintain a map that includes the following:
• Points of identified illegal discharges / connections.
• Watershed boundaries of the outfalls where illegal discharges / connections have been identified.
• An accompanying table that summarizes the illegal discharges that have been identified that includes location, a description of pollutant(s) identified, and removal status.

3-G. Preventing Discharges and Establishing a Hotline

The County will contact persons who are responsible for establishments that are likely sources of illegal discharges, Some of these sources include automotive sales, rental, repair and detailing establishments, lawn care companies, cleaners and certain types of contractors. Previous experience has shown that many illegal discharges are actually unintentional.

The County will establish a hotline. The hotline will include a recording advising citizens what to do if they call during non-business hours. There will be another number given in cases where the illegal discharge is perceived to be an emergency.
3-H. Implementation Schedule

In keeping with the State's model program, the County will follow a phased implementation schedule for illegal discharges / connections (Table 3d). The schedule allows for collecting jurisdiction-wide information during the first year of implementation and then screening the high priority areas during future years. The County will evaluate and make improvements to its programs as it progresses through high priority areas.

Table 3d: Implementation Schedule for Addressing Illegal Discharges / Connections

<table>
<thead>
<tr>
<th>Year</th>
<th>Implementation Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>By August 2004</td>
<td>• Establish legal authority to address illegal discharges / connections</td>
</tr>
<tr>
<td>By October 2006</td>
<td>• Collect jurisdiction-wide information.</td>
</tr>
<tr>
<td></td>
<td>• Select high priority area for additional screening.</td>
</tr>
<tr>
<td></td>
<td>• Initiate illegal discharge hotline.</td>
</tr>
<tr>
<td>Each subsequent year after 2006</td>
<td>• Complete mapping and field screening for high priority area.</td>
</tr>
<tr>
<td></td>
<td>• Select next high priority area.</td>
</tr>
<tr>
<td></td>
<td>• Identify and remove Illegal discharges / connections as encountered.</td>
</tr>
<tr>
<td></td>
<td>• Continue operating illegal discharge hotline.</td>
</tr>
</tbody>
</table>
4. Retrofit Locations

4-A Requirements in the Rule

The Rule requires the County to establish a program to identify and prioritize places within existing developed areas that are suitable for retrofits.

4-B Approach for Meeting the Requirements

The County will identify at least two (2) retrofit opportunities each year. Sites may be carried over to meet the minimum requirements for up to two subsequent years provided that BMPs/retrofits have not been implemented and the site continues to meet the criteria below on an annual basis.

Retrofit opportunities will be considered acceptable if all of the following conditions are met:

- The retrofit, if implemented, clearly has the potential to reduce nitrogen or phosphorus loading to the receiving water.
- The watershed is clearly contributing nitrogen or phosphorus loading above background levels.
- The landowner where the retrofit is proposed is preliminarily willing to have the retrofit installed on his property.
- There is adequate space and access for the retrofit.
- It is technically practical to install a retrofit at that location.

4-C. Data Collection and Notification

Each retrofit opportunity that is identified shall be accompanied by information to describe the location of the retrofit, the type of retrofit being proposed, the property owner, as well as basic information about the watershed and the receiving water. Table 4 may be used for presenting this information for each retrofit opportunity.

The County will submit retrofit opportunities to the Division of Water Quality by October 30 of each year beginning in the year 2005 as part of the annual report.

4-D Mapping Requirements

The County will provide maps that show the locations of retrofit opportunities. Using an adequate scale, the map(s) will identify the following required parameters:
- Drainage area to retrofit opportunity site.
- Land uses within the drainage area.
- Location of retrofit opportunity.
- Property boundaries in the vicinity of the retrofit opportunity.
- Significant hydrography (as depicted on U.S.G.S. topographic maps and USDA-NRCS Soil Survey maps).
- Roads.
- Environmentally sensitive areas (steep slopes, wetlands, riparian buffers, endangered/threatened species habitat — where available).
- Publicly owned parks, recreational areas, and other open lands. Table

4: Retrofit Opportunity Table for the County of Edgecombe NC

<table>
<thead>
<tr>
<th>Location description, including directions from a major highway</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and description of retrofit opportunity</td>
<td></td>
</tr>
<tr>
<td>Current property owner</td>
<td></td>
</tr>
<tr>
<td>Is the property owner willing to cooperate?</td>
<td></td>
</tr>
<tr>
<td>Land area available for retrofit (sq. ft)</td>
<td></td>
</tr>
<tr>
<td>Accessibility to retrofit site</td>
<td></td>
</tr>
<tr>
<td>Drainage area size (acres)</td>
<td></td>
</tr>
<tr>
<td>Land use in drainage area (percent of each type of land use)</td>
<td></td>
</tr>
<tr>
<td>Average slope in drainage area (%)</td>
<td></td>
</tr>
<tr>
<td>Environmentally sensitive areas in drainage area (steep slopes, wetlands, riparian buffers, endangered/threatened species habitat)</td>
<td></td>
</tr>
<tr>
<td>Approximate annual nitrogen and phosphorus loading from drainage area (lbs/acre/year) (^1)</td>
<td>Nitrogen = Phosphorus =</td>
</tr>
<tr>
<td>Potential nitrogen reduction (lbs/ac/yr) (^1)</td>
<td></td>
</tr>
<tr>
<td>Potential phosphorus reduction</td>
<td></td>
</tr>
<tr>
<td>Estimated cost of retrofit</td>
<td>$</td>
</tr>
<tr>
<td>Receiving water</td>
<td></td>
</tr>
<tr>
<td>DWQ classification of receiving water</td>
<td></td>
</tr>
<tr>
<td>Use support rating for receiving water</td>
<td></td>
</tr>
<tr>
<td>Other important information</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Suggested methodology: Use the methodology provided in Appendix B to compute nitrogen export from the drainage area based on the amount of impervious surface, landscaped area and forested area in the watershed.
5-A Requirements in the Rule
The Tar-Pamlico Stormwater Rule requires the County to develop a locally administered environmental education program to address nitrogen & phosphorous loading issues with the public and developers, and to address peak stormwater flow issues with developers.

5-B Public Education Action Report and Plan
The ultimate goal of the public education program is to educate the general public, County staff, the development community, and elected officials. The County will develop a Public Education Action Report and Plan. The Action Report and Plan will outline the proposed education activities for the upcoming year, identifying target audiences and anticipated and actual costs of the program. The County will submit an annual Action Report and Plan to DWQ for approval in its October annual report each year. The Public Education Action Report and Plan format can be found in Appendix F.

The Action Plan template in Appendix F identifies point values for each type of education activity that may be used by the County. The County shall conduct activities that sum to at least 15 points each year. Ongoing activities, such as continuing program for pet waste, receive credit for each year that they are continued.

During the first year of program implementation, the County will conduct two (2) technical workshops. One shall be designed to educate local government officials and staff and the other for the development community, including: engineers, developers, architects, contractors, surveyors, planners, and realtors. These two workshops will receive point credit toward the annual total. During subsequent years, technical workshops are considered an optional activity. The County’s complete education program for the first year is shown in the Public Education Action Report and Plan in Appendix F.

The County shall develop a public involvement and participation component as a part of the public education program. The County shall also develop an operations and maintenance program for the County operations, including training for County staff, to prevent or reduce pollutant runoff from those operations.
6. Reporting Requirements
Annual Tar-Pamlico River Basin stormwater program reports must be submitted to the Division of Water Quality by October 30 of each year beginning in 2005. All reports shall contain the following information.

6-A. New Development Review/Approval
The County shall be responsible for submitting the following information as part of the annual reporting requirement;

- Acres of new development and impervious surface based on plan approvals.
- Acres of new development and impervious surface based on certificates of occupancy.
- Summary of BMPs implemented and use of offsite options.
- Computed baseline and net change in nitrogen and phosphorus export from new development that year.
- Summary of maintenance activities conducted on BMPs.
- Summary of any BMP failures and how they were handled.
- Summary of results from any applicable jurisdictional review of planning issues.
- Status of compliance with implementation timeline.
- Program administrative changes and updates.
- Summary of development approvals granted, construction compliance, Operation and Maintenance Inspections, and enforcement actions.
6-B. Illegal Discharges

Table 6 outlines the annual reporting requirements for illegal discharges.

Table 6: Annual Reporting Requirements for Illegal Discharges

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual Report Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>By August 2004</td>
<td>• Submit report identifying established legal authority to meet requirements.</td>
</tr>
<tr>
<td>By October 2006</td>
<td>• Report on completion of jurisdiction-wide information collection.</td>
</tr>
<tr>
<td></td>
<td>• Submit map of high priority areas and reason for selection.</td>
</tr>
<tr>
<td></td>
<td>• Report on initiation of illegal discharge hotline.</td>
</tr>
<tr>
<td>Each subsequent year after 2006</td>
<td>• Submit map of stormwater collection system in high priority area upon request by DWQ.</td>
</tr>
<tr>
<td></td>
<td>• Document illegal discharges found and resulting action.</td>
</tr>
<tr>
<td></td>
<td>• Report on hotline usage and actions taken.</td>
</tr>
<tr>
<td></td>
<td>• Submit map of next high priority area and reason for selection.</td>
</tr>
</tbody>
</table>

6-C. Retrofit Locations

The Report shall include information on retrofit locations as follows:

- Data on each retrofit opportunity (Table 4 or other equivalent format).
- Maps of potential retrofit sites as specified in Section 4-D.
- The status of any retrofit efforts that have been undertaken within the County's jurisdiction.

6-D. Public Education

The Report will summarize the next year's Action Plan and evaluate the implementation of the previous year's Action Plan (if applicable). The Report shall include goals, activities completed, realized education program costs, explanation of experienced shortfalls and a plan as to how the County will address shortfalls.
APPENDICES
to the
Edgecombe County
Stormwater Management
Program for Nutrient Control

County of Edgecombe
North Carolina

September 13, 2004

Edgecombe County
201 St. Andrew Street
P.O. Box 10
Tarboro, NC 27886
Appendix A
15A NCAC 2B .0258 Tar-Pamlico River Basin - Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements

(a) PURPOSE. The purposes of this Rule are as follows.

(1) To achieve and maintain a reduction in nitrogen loading to the Pamlico estuary from lands in the Tar-Pamlico River Basin on which new development occurs. The goal of this Rule is to achieve a 30 percent reduction relative to pre-development levels;

(2) To limit phosphorus loading from these lands to the estuary. The goal of this Rule is to limit phosphorus loading to pre-development levels;

(3) To provide control for peak stormwater flows from new development lands to ensure that the nutrient processing functions of existing riparian buffers and streams are not compromised by channel erosion; and

(4) To minimize, to the greatest extent practicable, nitrogen and phosphorus loading to the estuary from existing developed areas in the basin.

(b) APPLICABILITY. This Rule shall apply to local governments in the Tar-Pamlico basin according to the following criteria.

(1) This Rule shall apply to the following municipal areas:
   (A) Greenville
   (B) Henderson
   (C) Oxford
   (D) Rocky Mount
   (E) Tarboro
   (F) Washington

(2) This Rule shall apply to the following counties:
   (A) Beaufort
   (B) Edgecombe
   (C) Franklin
   (D) Nash
   (E) Pitt

(3) The Environmental Management Commission may designate additional local governments as subject to this Rule by amending this Rule based on the potential of those jurisdictions to contribute significant nutrient loads to the Tar-Pamlico River. At a minimum, the Commission shall review the need for additional designations as part of the Basinwide process for the Tar-Pamlico River Basin. The Commission shall consider, at a minimum, the following criteria related to local governments: population within the basin, population density, past and projected growth rates, proximity to the estuary, and the designation status of municipalities within candidate counties.
(c) REQUIREMENTS. All local governments subject to this Rule shall develop stormwater management programs for submission to and approval by the Commission according to the following minimum standards:

(1) A requirement that developers submit a stormwater management plan for all new developments proposed within their jurisdictions. These stormwater plans shall not be approved by the subject local governments unless the following criteria are met:

(A) The nitrogen load contributed by the proposed new development activity shall not exceed 70 percent of the average nitrogen load contributed by the non-urban areas in the Tar-Pamlico River basin based on land use data and nitrogen export research data. Based on 1995 land use data and available research, the nitrogen load value shall be 4.0 pounds per acre per year;

(B) The phosphorus load contributed by the proposed new development activity shall not exceed the average phosphorus load contributed by the non-urban areas in the Tar-Pamlico River basin based on land use data and phosphorus export research data. Based on 1995 land use data and available research, the phosphorus load value shall be 0.4 pounds per acre per year;

(C) The new development shall not cause erosion of surface water conveyances. At a minimum, the new development shall not result in a net increase in peak flow leaving the site from pre-development conditions for the 1-year, 24-hour storm event; and

(D) Developers shall have the option of partially offsetting their nitrogen and phosphorus loads by providing treatment of off-site developed areas. The off-site area must drain to the same classified surface water, as defined in the Schedule of Classifications, 15A NCAC 2B .0316, that the development site drains to most directly. The developer must provide legal assurance of the dedicated use of the off-site area for the purposes described here, including achievement of specified nutrient load reductions and provision for regular operation and maintenance activities, in perpetuity. The legal assurance shall include an instrument, such as a conservation easement, that maintains this restriction upon change of ownership or modification of the off-site property. Before using off-site treatment, the new development must attain a maximum nitrogen export of six pounds/acre/year for residential development and 10 pounds/acre/year for commercial or industrial development.

(2) A public education program to inform citizens of how to reduce nutrient pollution and to inform developers about the nutrient and flow control requirements set forth in Part (c)(1).

(3) A mapping program that includes major components of the municipal separate storm sewer system, waters of the State, land use types, and location of sanitary sewers.

(4) A program to identify and remove illegal discharges.

(5) A program to identify and prioritize opportunities to achieve nutrient reductions from existing developed areas.
(6) A program to ensure maintenance of BMPs implemented as a result of the provisions in Subparagraphs (c)(1) and (c)(5).

(7) A program to ensure enforcement and compliance with the provisions in Subparagraph (c)(1).

(8) Local governments may include regional or jurisdiction-wide strategies within their stormwater programs as alternative means of achieving partial nutrient removal or flow control. At a minimum, such strategies shall include demonstration that any proposed measures will not contribute to degradation of surface water quality, degradation of aquatic or wetland habitat or biota, or destabilization of conveyance structure of involved surface waters. Such local governments shall also be responsible for including appropriate supporting information to quantify nutrient and flow reductions provided by these measures and describing the administrative process for implementing such strategies.

(d) TIMEFRAME FOR IMPLEMENTATION. The timeframe for implementing the stormwater management program shall be as follows:

(1) Within 12 months of the effective date of this Rule, the Division shall submit a model local stormwater program that embodies the minimum criteria described in Paragraph (c) of this Rule to the Commission for approval. The Division shall work in cooperation with subject local governments in developing this model program.

(2) Within 12 months of the Commission's approval of the model local stormwater program or within 12 months of a local government's later designation pursuant to Subparagraph (b)(3), subject local governments shall submit their local stormwater management programs to the Commission for review and approval. These local programs shall meet or exceed the requirements in Paragraph (c) of this Rule.

(3) Within 18 months of the Commission's approval of the model local stormwater program or within 18 months of a local government's later designation pursuant to Subparagraph (b)(3), subject local governments shall adopt and implement their approved local stormwater management program.

(4) Local governments administering a stormwater management program shall submit annual reports to the Division documenting their progress and net changes to nitrogen load by October 30 of each year.

(e) COMPLIANCE. A local government that fails to submit an acceptable local stormwater management program within the timeframe established in this Rule or fails to implement an approved program shall be in violation of this Rule. In this case, the stormwater management requirements for its jurisdiction shall be administered through the NPDES municipal stormwater permitting program per 15A NCAC 2H .0126. Any local government that is subject to an NPDES municipal stormwater permit pursuant to this Rule shall:
(1) Develop and implement comprehensive stormwater management program to reduce nutrients from both existing and new development. This stormwater management program shall meet the requirements of Paragraph (c) of this Rule for new and existing development.

(2) Be subject to the NPDES permit for at least one permitting cycle (five years) before it is eligible to submit a local stormwater management program to the Commission for consideration and approval.

*Histoty Note: Authority G.S. 143-214.1; 143-214.7; 143-215.3(a)(1); 143-215.6A; 143-215.6B; 143-215.6C; 143-282(d); Eff. April 1, 2001.*
Appendix B
Export Calculation Worksheets & Supporting Information

This appendix contains a set of manual worksheets for Piedmont Communities for estimating nitrogen and phosphorus export from a development project prior to and following development, and following the installation of best management practices (BMPs) on the development. The worksheets are followed by supporting information that details the basis for the design of the worksheets and the values and formulas included in them.

An automated version of the worksheets is also available. Excel files containing the automated version may be downloaded from the Division of Water Quality's Tar-Pamlico web page at http://112o.enr.state.ne.uships/tarpam.htm. The files may also be obtained from the County Planning Office in hardcopy form.

- The worksheets in this appendix and the automated version of the worksheets both contain the following elements:
  1. Definitions of Land Use Terms Used in Spreadsheets (B.2)
  2. Residential Worksheet when Footprints are not Shown (B.3)
  3. Export Calculation Worksheet for Piedmont Communities (B.4)
  4. BMP Removal Calculation Worksheet for Piedmont Communities (13.5-7)

- The remainder of this appendix is a report describing the development of the nutrient export model, provided by contractors with North Carolina State University (B.8-17).
**Definitions of Land Use Terms Used in Spreadsheets**

**Transportation impervious:** The portion of the development that is taken up by roads, driveways, parking areas, wash pads or any other facility designed for vehicular use, maintenance or storage. Transportation impervious includes areas covered in pavement, gravel, pavers and dirt.

**Roof impervious:** The portion of the development that consists of roofs of buildings and other structures. Commercial parking garages shall be considered as transportation impervious.

**Managed pervious:** The portion of the development that consists of vegetated areas that the landowner could manage by mowing, clearing, applying fertilizer, etc. Although residential development may include pervious areas that are initially undisturbed, these areas must be considered as managed pervious (instead of wooded pervious) unless they have conservation easements or another mechanism to insure they will not be managed. Also, the land in Zone 2 (the outer 20 feet) of a protected riparian buffer must be considered as managed pervious area unless it is protected by a conservation mechanism.

**Wooded pervious:** The portion of the development that consists of forested areas that are permanently protected by a conservation easement or other binding conservation mechanism. Also, wetlands and the land in Zone 1 of a protected riparian buffer (the first 30 feet adjacent to a stream) may be considered as wooded pervious area.
Residential Worksheet when Footprints are not Shown

Use this worksheet when building footprints are not known to determine the acreage in each of the four categories - transportation impervious, roof impervious, managed pervious, and wooded pervious - in the development. You will need these acreages for both the "Export before BMPs" and "Export after BMPs" worksheets. For the "Export after BMPs" worksheet, you will need to subtract the acreage occupied by BMPs from the managed pervious acreage produced by this worksheet. Also for the "Export after BMPs" worksheet, if the development contains more than one catchment, use this worksheet for each catchment.

**Directions:**

1. In the two blanks in the box below, enter the average lot size and the percent of the right-of-way that is impervious within the development.

2. Column (2): Determine the total area of the development that will be in lots and enter it in the top box. Next, multiply 0.089*total acreage in lots*average lot size to get transportation impervious - enter this in the second box. Then, multiply 0.059*total acreage in lots*average lot size to get rooftop impervious - enter this in the third box. In the bottom box (wooded pervious), enter any lot area that is wetlands or permanently protected by a conservation easement or the Tar-Pamlico buffer rule (enter “0” if there is none). Next, subtract the sum of the two impervious types and wooded pervious from the total lot area to get managed pervious acreage, the remaining box. NOTE: If lots are drawn to exclude protected lands that are part of the total development acreage, enter the acreage of those protected lands as wooded pervious within "Community Areas", column (4).

3. Column (3): Enter the total acreage in the development that will be in right-of-way in the first box. Then, multiply this value by the percentage of right-of-way that is impervious from the blank below, and enter the result in the second box (Transportation Impervious in ROW). Subtract this value from the total right-of-way area and enter this in the third unshaded box (Managed Pervious in ROW).

4. Column (4): Enter the total acreage of any community areas in the development (eg., parks, community centers) in the top box. In the next four boxes, distribute the total acreage among each type of land use.

5. Column (5): Total each row. NOTE: Make sure that the total area in the top box accurately reflects the total area of the development and that the three lower boxes add up to the top box. If not, there is an error that must be corrected. You may then want to see if the component acreages in each column add to the top TOTAL value.

<table>
<thead>
<tr>
<th>Average lot size</th>
<th>% impervious in right-of-way</th>
<th>Must show building footprints if lot size &lt; 0.13 ac.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Type of Land Cover</td>
<td>Lot area (ac)</td>
<td>Right of way Area (ac)</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation impervious</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof impervious</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managed pervious</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wooded pervious</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B.3
Piedmont of the Tar-Pamlico River Basin:
Includes Oxford, Henderson, Rocky Mount and Tarboro as well as Franklin, Nash and Edgecombe Counties

Nitrogen and Phosphorus Load Calculation Worksheet (Manual)

<table>
<thead>
<tr>
<th>Pre-development:</th>
<th>Post-development:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Type of Land Cover</td>
<td>(1) Type of Land Cover</td>
</tr>
<tr>
<td>(2) Area (acres)</td>
<td>(2) Area (acres)</td>
</tr>
<tr>
<td>(3) S.M. Formula (0.46 + 8.3*I)</td>
<td>(3) S.M. Formula (0.46 + 8.3*I)</td>
</tr>
<tr>
<td>(4) Average EMC of TN (mg/L)</td>
<td>(4) Average EMC of TN (mg/L)</td>
</tr>
<tr>
<td>(5) Column (2) * (3) * (4)</td>
<td>(5) Column (2) * (3) * (4)</td>
</tr>
<tr>
<td>(6) Average EMC of TP (mg/L)</td>
<td>(6) Average EMC of TP (mg/L)</td>
</tr>
<tr>
<td>(7) Column (2) * (3) * (6)</td>
<td>(7) Column (2) * (3) * (6)</td>
</tr>
</tbody>
</table>

| Transportation impervious | 2.60 | 0.40 |
| Roof impervious | 1.95 | 0.15 |
| Managed pervious (lawn/landscaped) | 1.42 | 0.31 |
| Managed pervious (cropland) | 4.23 | 1.23 |
| Managed pervious (pasture) | 2.04 | 0.62 |
| Wooded pervious | 0.94 | 0.14 |

Fraction Impervious (I) =

Total Area of Development =

| Transportation impervious | TN Loading (lb/yr) = | TP Loading (lb/yr) = |
| Roof impervious | 1.95 | 0.15 |
| Managed pervious | 1.42 | 0.31 |
| Wooded pervious | 0.94 | 0.14 |

Fraction Impervious (I) =

Total Area of Development =

| Transportation impervious | TN Loading (lb/ac/yr) = | TP Loading (lb/ac/yr) = |
| Roof impervious | 1.95 | 0.15 |
| Managed pervious | 1.42 | 0.31 |
| Wooded pervious | 0.94 | 0.14 |

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 no BMP is necessary. Otherwise, the next worksheet calculates post-development TN and TP loadings after BMPs are installed.
### BMP Removal Calculation Worksheet (Manual)

<table>
<thead>
<tr>
<th>BMP Nutrient Removal Efficiencies</th>
<th>TN</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wet Detention Pond</td>
<td>25</td>
<td>40</td>
</tr>
<tr>
<td>Stormwater Wetland</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Sand Filter</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>Bioretention</td>
<td>40</td>
<td>35</td>
</tr>
<tr>
<td>Grass Swales</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Vegetated Filter Strip w/ Level Spreader</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

**Directions for the following pages (same for all catchments in the development):**

- It may be advantageous to split the development into separate catchments to be handled by separate BMPs. This table allows for the development to be split into up to three catchments, and can be copied for greater than three. Unless runoff into the development from offsite is routed separately around or through the site, offsite catchment area running 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 blank. Next, 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 a BMP or BMPs from the table above for treating the catchment runoff. Enter the chosen BMP(s) nutrient removal rates in the blanks. If a second BMP is to be used in series, determine the TOTAL TN and TP removal rates for the series through the following equation:
  \[
  \text{removal rate}_1 + \text{removal rate}_2 = \left(\text{removal rate}_1 \times \text{removal rate}_2\right) / 100
  \]

- **Column (2):** Enter the acres in each land use in the first five boxes. Add to get the total acres of development and enter it in the sixth box. Divide impervious area by total development area and enter it in the seventh box.

- **Column (3):** Compute 0.46 + 8.3 *I (I = fraction impervious from column 2) and enter this number in all five boxes (each box will have the same number in it).

- **Column (4):** TN land use coefficients are already entered for each land use.

- **Column (5):** In each of the first five boxes, multiply the entries for Columns (2), (3) and (4). Determine the pre-BMP TN loading in the sixth box by adding the first five boxes. Determine the pre-BMP TN export coefficient in the seventh box by dividing the TN load by the total acreage of the catchment. Determine the post-BMP TN loading in the next-to-last box by the following equation: pre-BMP TN loading * (100 - TOTAL TN REMOVAL RATE)/100. Determine the post-BMP export coefficient in the bottom box by dividing the post-BMP TN loading by the total acreage of the catchment.

- **Column (6):** TP land use coefficients are already entered for each land use.

- **Column (7):** In each of the first five boxes, multiply the entries for Columns (2), (3) and (6). Determine the pre-BMP TP loading in the sixth box by adding the first five boxes. Determine the pre-BMP TP export coefficient in the seventh box by dividing the TP load by the total acreage of the catchment. Determine the post-BMP TP loading in the next-to-last box by the following equation: pre-BMP TP loading * (100 - TOTAL TP REMOVAL RATE)/100. Determine the post-BMP export coefficient in the bottom box by dividing the post-BMP TP loading by the total acreage of the catchment.
### Catchment 1:

<table>
<thead>
<tr>
<th>Type of Land Cover</th>
<th>Area (acres)</th>
<th>S.M. Formula (0.46 + 8.3*I)</th>
<th>Average EMC of TN (mg/L)</th>
<th>Column (2) * (3) * (4)</th>
<th>Average EMC of TP (mg/L)</th>
<th>Column (2) * (3) * (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation impervious</td>
<td>2.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof impervious</td>
<td>1.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managed pervious</td>
<td>1.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wooded pervious</td>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Area taken up by BMP

Fraction Impervious (I) =

Total Area of Development ---

Pre-BMP TN Load (lb/yr) =

Pre-BMP TP Load (lb/yr) =

Pre-BMP TN Export (lb/ac/yr) =

Pre-BMP TP Export (lb/ac/yr) =

### Catchment 2:

<table>
<thead>
<tr>
<th>Type of Land Cover</th>
<th>Area (acres)</th>
<th>S.M. Formula (0.46 + 8.3*I)</th>
<th>Average EMC of TN (mg/L)</th>
<th>Column (2) * (3) * (4)</th>
<th>Average EMC of TP (mg/L)</th>
<th>Column (2) * (3) * (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation impervious</td>
<td>2.60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof impervious</td>
<td>1.95</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managed pervious</td>
<td>1.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wooded pervious</td>
<td>0.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Area taken up by BMP

Fraction Impervious (I) =

Total Area of Development ---

Pre-BMP TN Load (lb/yr) =

Pre-BMP TP Load (lb/yr) =

Pre-BMP TN Export (lb/ac/yr) =

Pre-BMP TP Export (lb/ac/yr) =
### Catchment 3:

<table>
<thead>
<tr>
<th>Type of Land Cover</th>
<th>Area (acres)</th>
<th>S.M. Formula</th>
<th>Average EMC of TN (mg/L)</th>
<th>Column (2) * (3) * (4)</th>
<th>Average EMC of TP (mg/L)</th>
<th>Column (2) * (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td></td>
<td></td>
<td>2.60</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof impervious</td>
<td></td>
<td></td>
<td>1.95</td>
<td></td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>Managed pervious</td>
<td></td>
<td></td>
<td>1.42</td>
<td></td>
<td></td>
<td>0.31</td>
</tr>
<tr>
<td>Wooded pervious</td>
<td></td>
<td></td>
<td>0.94</td>
<td></td>
<td></td>
<td>0.14</td>
</tr>
<tr>
<td>Area taken up by BMP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.95</td>
</tr>
<tr>
<td>Fraction Impervious (I)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>Total Area of Development</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-BMP TN Load (lb/yr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-BMP TP Load (lb/yr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-BMP TN Load (lb/yr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-BMP TP Export (lb/ac/yr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Weighted Average of Nutrient Loadings from the Catchments:**

**Directions:** Enter data on TN and TP export coefficients for each catchment (based on calculations above.) Do a weighted average of TN and TP loads for the entire development and enter it in the shaded cells below. The weighted average equals: \([(\text{catchment area}_1 \times \text{export coeff}_1) + (\text{catchment area}_2 \times \text{export coeff}_2) + (\text{catchment area}_3 \times \text{export coeff}_3)]/\text{total area of development}.  

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Area (ac)</th>
<th>Post-BMP TN Export Coeff. (lb/ac/yr)</th>
<th>Post-BMP TP Export Coeff. (lb/ac/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catchment 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catchment 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catchment 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL FOR DEVELOPMENT</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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. Modifications in development plans are required. 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.
Development of a Nutrient Export Model for New Developments in the Tar-Pamlico River Basin

A study completed by
NC State University, Biological & Agricultural Engineering
Bill Hunt, PE, and Annette Lucas

For
The North Carolina Department of Environment & Natural Resources, Tar-Pamlico Stormwater Group

April 11, 2003
The Nutrient Export Model for New Developments

The Tar-Pamlico Stormwater Team worked with North Carolina State University to establish a nutrient export model for new developments. The purpose of this model is to estimate the total nitrogen (TN) and total phosphorous (TP) loadings from development sites before development, after development and after installation of BMPs. This model was constructed to allow developers and local governments to determine if proposed new development projects are in compliance with the required TN and TP loading limits of 4.0 and 0.4 pounds/acre/year, respectively.

The experience with nitrogen loading calculations in the Neuse River basin provided the foundation for the Tar-Pamlico nutrient loading model. The City of Durham made some significant improvements to the model given in the Neuse Model Stormwater Plan. In addition, new data on nutrient loadings from various types of development have become available recently. The Tar-Pamlico Nutrient Loading Model built on this new information.

Application of the Simple Method

Both the Neuse and Tar-Pamlico models are based on the "Simple Method," a model developed by the Metropolitan Washington Council of Governments during the 1980s. The Simple Method is extremely useful because it inputs event mean concentrations (EMCs) measured during storm events in mg/L and converts them to export coefficients in pounds/acre/year.

The Simple Method formula is as follows:

\[ L = P * P_i * R_y * C * 0.227 \]

Where:
- \( L \) is the nutrient load in lbs/ac/yr.
- \( P \) is the average annual rainfall (45 in/yr - Piedmont, 50 in/yr - Coastal Plain).
- \( P_i \) is a correction factor for storms with no runoff (0.9).
- \( R_y \) is the runoff coefficient equal to 0.05 + 0.91 (I - fraction impervious from 0 to 1).
- \( C \) is the flow-weighted event mean concentration in lbs/ac/yr.

(The Piedmont includes Oxford, Henderson, Rocky Mount and Tarboro as well as Franklin, Nash and Edgecombe Counties. The Coastal Plain includes Greenville and Washington as well as Pitt and Beaufort Counties. This delineation was made based on rainfall data).

The Simple Method becomes even simpler after realizing that \( P \) and \( P_i \) are known variables. \( R \) can be determined by determining \( I \), the percentage of the development that is impervious. So, the only real "variable" in the equation is \( C \), the flow-weighted event mean concentration. The majority of effort in developing the model methodology was spent determining appropriate \( C \) values (more on that later).

In order to apply the Simple Method to new developments in the Tar-Pamlico basin, the method was applied to each of the four major land use categories within a development site:
1. **Transportation impervious:** The portion of the development that is taken up by roads, driveways, parking areas, wash pads or any other facility designed for vehicular use, maintenance or storage. Transportation impervious includes areas covered in pavement, gravel, pavers and dirt.

2. **Roof impervious:** The portion of the development that consists of roofs of buildings and other structures that serve single-family homes. Commercial parking garages shall be considered as transportation impervious.

3. **Managed pervious:** The portion of the development that consists of vegetated areas that the landowner could manage by mowing, clearing, applying fertilizer, etc. Although residential development may include pervious areas that are initially undisturbed, these areas must be considered as managed pervious (instead of wooded pervious) unless they have conservation easements or another mechanism to insure they will not be managed. Also, the land in Zone 2 (the outer 20 feet) of a protected riparian buffer must be considered as managed pervious area unless it is protected by a conservation mechanism.

4. **Wooded pervious:** The portion of the development that consists of forested areas that are permanently protected by a conservation easement or other binding conservation mechanism. Also, wetlands and the land in Zone 1 of a protected riparian buffer (the first 30 feet adjacent to a stream) may be considered as wooded pervious area.

The Simple Method formulas for each land use category are as follows:

\[
\begin{align*}
L_{\text{transportation}} & = P \times P_i \times R_s \times C_{\text{transportation}} \times 0.227 \\
L_{\text{roof}} & = P \times P_i \times R_s \times C_{\text{roof}} \times 0.227 \\
L_{\text{managed}} & = P \times P_i \times R_v \times C_{\text{managed}} \times 0.227 \\
L_{\text{wooded}} & = P \times P_i \times P \times C_{\text{wooded}} \times 0.227
\end{align*}
\]

Figure 1 below is an excerpt from the Piedmont nutrient loading model. The arrows explain which part of the Simple Method formula each column represents. The Coastal Plain nutrient loading model is identical to the Piedmont except that the input for rainfall is 50 inches/year in the Coastal Plain instead of 45 inches/year used in the Piedmont (based on state climatologic data). This results in a Simple Method formula in column(3) of 0.51 + 9.1*I for the Coastal Plain, where 0.46 + 8.3*I applies to the Piedmont.
Figure 1. The Application of the Simple Method to the Nutrient Loading Model

\[
= P \times \text{Pi} \times \text{r}^\text{v} \times 0.227 = C \text{ (for TN)} \quad = C \text{ (for TP)}
\]
\[
= 45 \times 0.9 \times (0.05 + 0.9 \times I) \times 0.227 = 0.46 + 8.3 \times I
\]

<table>
<thead>
<tr>
<th>(1) Type of Land Cover</th>
<th>(2) Area (acres)</th>
<th>(3) S.M. Formula (0.46 + 8.3I)</th>
<th>(4) Average EMC of TN (m - .)</th>
<th>Column (2) • (3) • (4)</th>
<th>(5) Average EMC of TP (mg/L)</th>
<th>Column (2) • (3) • (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation impervious</td>
<td>2.60</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof impervious</td>
<td>1.95</td>
<td>0.15</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managed pervious</td>
<td>1.42</td>
<td>0.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wooded pervious</td>
<td>0.95</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fraction Impervious (I) = TN Loading (lb/yr) = TP Loading (lb/yr) =

Total Area of Development = TN Exp. Coeff. (lb/ac/yr) = TP Exp. Coeff. (lb/ac/yr) =

Determining Appropriate EMCs for the Land Uses

The concentrations for the land uses given above were determined based on water quality monitoring data from Durham, Fayetteville, Raleigh and Chesapeake, VA. These cities were selected for two reasons:

1. All are required to monitor different types of watersheds under their federal NPDES (National Pollutant Discharge Elimination System) stormwater permits. All of the data were collected recently using consistent EPA methodology.
2. All of these cities are geographically close to the Tar-Pamlico river basin and, in a sense, bracket it.

The data collected by these cities is summarized and graphed below. As Table 1 shows, data were sorted according to whether the pervious surfaces in the watershed were "managed" or "unmanaged" (wooded). The decision on whether to classify each site as having managed or unmanaged pervious surfaces was based on each local government's best judgments about the characteristics of the watersheds being monitored. Table 1 summarizes the monitoring data that were used to support model development.
The researchers analyzed the monitoring data listed above to determine appropriate EMCs for TN and TP for impervious, managed pervious and unmanaged pervious using this process:

1. First, the monitoring data were plotted with percentage impervious on the x-axis and nutrient concentrations on the y-axis. The managed pervious sites were considered separately from the unmanaged pervious sites.

2. Then, the researchers determined the best-fit points for 100% impervious, 100% managed pervious and 100% unmanaged pervious. (Note: 100% managed pervious on the graph is equivalent to 0% impervious for the managed sites. Likewise, 100% unmanaged pervious on the graph is equivalent to 0% impervious for the unmanaged sites). The best-fit points were determined through trial and error by testing different values in the graph and determining which points resulted in the highest r-squared values.

Figure 2 shows the graphs and illustrates how the EMCs were determined.
Figure 2. Graphs of the TN and TP EMCs from the Monitoring Sites

**TN EMCs from Developments**

- Developments with Managed Pervious:
  \[ y = 0.0118x + 1.42 \]
  \[ R^2 = 0.50 \]

- Developments with Unmanaged Pervious:
  \[ y = 0.0166x + 0.94 \]
  \[ R^2 = 0.69 \]

**TP EMCs from Developments**

- Developments with Managed Pervious:
  \[ y = 0.0009x + 0.31 \]
  \[ R^2 = 0.15 \]

- Developments with Unmanaged Pervious:
  \[ y = 0.0026x + 0.14 \]
  \[ R^2 = 0.49 \]
The graphs in Figure 2 above show a much higher correlation within the TN data than within the TP data. The researchers think this difference may be attributable to the greater influence of landscape maintenance on TP concentrations than TN concentrations. That is, developments with similar percentages of impervious surfaces will show greater variations in TP than TN concentrations if one is managed with healthy, abundant vegetation and the other has sparse vegetation and erosion problems.

In addition to the concentrations for impervious, managed pervious and wooded pervious developed as shown above, the model also splits the "impervious" category into transportation impervious and roof impervious. For TP, this decision was based on research conducted by Waschbusch et al. (1999). This research showed that the TP concentration of rooftop runoff is only 37% of the TP concentration in runoff from roads (Waschbusch et al., 1999). Unfortunately, these researchers did not collect data on TN concentrations. Therefore, researchers at NCSU used their best professional judgment to estimate that TN concentration of rooftop runoff is 75% of the TN concentration of roadway runoff. The TN "discount" was awarded based on the fact that roads receive a greater amount of organic nitrogen (leaf litter, etc.) and fertilizer than roofs. However, the majority of TN from impervious surfaces is likely to originate from deposition of NOx, which is likely to be similar for both roofs and roads. Table 2 summarizes how this information is applied to the EMC values for the various land uses.

### Table 2. Summary of the EMC Values and Information Sources

<table>
<thead>
<tr>
<th>Land Use</th>
<th>TN EMC (mg/L)</th>
<th>TP EMC (mg/L)</th>
<th>Source of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation impervious</td>
<td>2.60</td>
<td>0.40</td>
<td>Best-fit points for the TN and TP graphs for managed and unmanaged pervious surfaces for the 100% impervious value of x.</td>
</tr>
<tr>
<td>Roof impervious</td>
<td>1.95</td>
<td>0.15</td>
<td>75% of the transportation impervious EMC (based on best professional judgment)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>37% of the transportation impervious EMC (based on research by Waschbusch et al., 1999)</td>
</tr>
<tr>
<td>Managed pervious</td>
<td>1.42</td>
<td>0.31</td>
<td>y-intercept of graphs of TN and TP concentrations for managed pervious surfaces</td>
</tr>
<tr>
<td>Woodyed pervious</td>
<td>0.94</td>
<td>0.14</td>
<td>y-intercept of graphs of TN and TP concentrations for managed pervious surfaces</td>
</tr>
</tbody>
</table>

**Development of the Residential Worksheet**

In order to use the Simple Method effectively, it is necessary to know how much of the development lies in each of the land uses given in the table above. This is a simple exercise when the footprints of all buildings, parking lots, roads, lawns, landscaped areas, etc. are shown on the plans. This is nearly always the case for commercial, industrial and higher-density residential development. However, for larger-lot residential developments, plans are often show only lot and right-of-way boundaries. The Tar-Pamlico model includes a "Residential Worksheet" that allows the user to input known information and determines the acreage in each of the four major land uses. The worksheet calculations are based on data developed by the City of Raleigh on the relationship between lot size and impervious area.
The information that is required in the Residential Worksheet should be fairly simple for the developer to determine based on the development plans:
- Average lot size in acres,
- Percentage of right-of-way that is impervious,
- Total acres in lots,
- Total acres in protected stream buffer area,
- Total acres in rights-of-way,
- Total acres in community space (and the land use break-down of that space), and
- Lot acreage in buffer or wetland.

The City of Raleigh has done a study of its various zoning categories (in dwelling units per acre) and the corresponding levels of imperviousness that would be expected per lot. For the purpose of this model, the dwelling units per acre were converted to average lot size in acres and graphed with lot size on the x-axis and percentage lot area in impervious surface on the y-axis (see Figure 3 below). The equation of the best-fit line was:

\[ \text{Percentage impervious} = 0.148 \times \text{(average lot size)}^{-0.48} \]

**Table 3. City of Raleigh’s Data on Lot Size Versus Lot Imperviousness**

<table>
<thead>
<tr>
<th>Dwelling Units per acre</th>
<th>Size of lot (acres)</th>
<th>Lot area in impervious surface (percent)</th>
<th>Lot area in managed pervious (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.00</td>
<td>0.14</td>
<td>0.86</td>
</tr>
<tr>
<td>2</td>
<td>0.50</td>
<td>0.22</td>
<td>0.78</td>
</tr>
<tr>
<td>4</td>
<td>0.25</td>
<td>0.30</td>
<td>0.70</td>
</tr>
<tr>
<td>6</td>
<td>0.17</td>
<td>0.35</td>
<td>0.65</td>
</tr>
<tr>
<td>8</td>
<td>0.13</td>
<td>0.38</td>
<td>0.62</td>
</tr>
</tbody>
</table>

**Figure 3. Graph of Lot Size Versus Percentage Impervious**
ased on Schueler's Site Planning Manual (1995), researchers estimated that 60% of lot imperviousness is for transportation (driveways, parking) and 40% is for roofs. This yields the following two equations:

\[
\text{Transportation impervious} = 0.089 \times (\text{average lot size})^{-0.48}
\]
\[
\text{Roof impervious} = 0.059 \times (\text{average lot size})^{-0.48}
\]

The above equations are used in the Residential Worksheet to directly compute transportation and rooftop impervious areas based on values provided by the user for average lot size and total acreage in lots. The user also enters as "Wooded Pervious" the acreage of any protected buffers or wetlands within lots. The spreadsheet calculates the acreage of managed pervious areas as the total development acreage minus the sum of the impervious and the wooded pervious values.

In addition to computing the pre- and post-development TN and TP export coefficients, the Tar-Pamlico model also computes export coefficients from developments after BMP installation. A review of the efficiencies follows in the next section.

\section*{Summary of Improvements to Export Calculation Method}

The Tar-Pamlico model is an improvement over the Neuse model for the following reasons:

1. The model is more accurate than the Neuse model, which actually overestimates TN loading, especially for developments in the 40 to 60 percent impervious range. Figure 4 below shows the export coefficients found by the Tar-Pamlico model as a solid line and the Neuse model as a dashed line.

2. The model has an automated version for easier use by developers and local governments.

3. The model calculates TP loads and nutrient reductions resulting from BMP installation.

4. The model separates rooftop and transportation imperviousness rather than considering them as a single entity as in the Neuse model.

5. The model has separate versions for the Piedmont and Coastal Plain that consider their differing climatologic data.

\begin{figure}
\centering
\caption{Results of Neuse Versus Tar-Pamlico Nutrient Export Models}
\end{figure}
REFERENCES


City of Chesapeake, VA. April 2001. Wet Weather Sampling Results.


Davis, A. P. (2002) Personal Communication. Director, Maryland Water Resources Research Center and Professor, Department Civil and Environmental Engineering, University of Maryland, College Park, MD.


Appendix C
Land Use Planning and Design Techniques

Reducing Road Widths

In many instances, road widths are required to be wider than needed to safely convey traffic through residential and commercial areas. Although these wide widths are often adopted to increase safety for automobiles, they often increase speeds through residential areas and, in so doing, may decrease safety for pedestrians and cyclists. Also, some jurisdictions require curb and gutter for aesthetic reasons where it is not actually necessary to control stormwater runoff. This can result in increased flooding and also eliminates the potential for stormwater runoff control and treatment that can occurs in properly designed and maintained roadside swales.

Most local governments model their residential street design standards after state and/or federal highway criteria, although the traffic capacity and function of their street system is considerably different from highways. Very few communities recognize any local road categories that are different from established state and federal street categories. Many local traffic engineers have simply accepted the notion that wider streets adequately address these concerns and that wide streets are safe streets (Schueler 1995).

Narrower road widths can reduce the road surface area by up to 35 percent. A number of communities have implemented standards that promote narrower residential streets and have concluded this to be an attractive, safe and environmentally beneficial alternative.

Communities should also review their standards for turnarounds to reduce the need or unnecessary road surface. One of the most common types of turnaround is a cul-de-sac that may have a diameter of 80 to 100 feet or more (Schueler 1995). Some communities are recognizing that this is excessive and are choosing alternatives that create less impervious cover, such as T-shapes. A 60-foot by 30-foot T-shaped turnaround creates only about 36% as much impervious area as an 80-foot diameter cul-de-sac and is more than adequate for most vehicles.

Local governments should: (1) examine community regulations governing road width and turnaround size; (2) evaluate if the specified widths are necessary; and (3) where feasible, make changes to reduce unnecessary road surfaces.

Reducing Minimum Parking Requirements

Parking lots are often designed to accommodate parking needs on the busiest days of the year. For example, shopping center parking areas are often big enough to handle the busy holiday times, but then sit vacant for much of the rest of the year. This can result in increased nitrogen load (as opposed to maintaining open space).

Some management strategies that would contribute to a reduction in urban nitrogen from parking lots:
• Use angles and smaller parking spaces.
• Use more pervious construction materials in seldom-used parking areas (Land of Sky 1995).
• Provide public transportation to shopping centers during the peak holiday times and encourage people to use it.
• Design parking areas to drain in sheet flow into stable vegetated areas. **Minimizing Use of Curb and Gutter**

Runoff is conveyed along streets and parking areas in one of two ways, either (a) in an open drainage channel located in the right of way, or (b) in an enclosed storm drain located under the street or right of way. The use of an open channel or storm drain in a particular street is determined by a number of factors, such as drainage area, slope, length, housing density, and street type. Open channels can be used on smaller streets, but at some point runoff velocities become too erosive to be adequately handled in an earthen channel and they must be enclosed in a storm drain. This erosive velocity is typically around 4 feet per second. A channel's maximum velocity is generally defined and computed using the peak discharge rate under the two year design storm event.

Open vegetated channels can have many water resource protection benefits. For example, a portion of stormwater pollutants may be removed through grass and soil as they pass through the channel. Performance monitoring has shown that open channels only realize these benefits under ideal conditions (e.g., low slope, sandy soils, dense grass cover, etc.). When these conditions are not met, drainage channels can have a low or even negative removal capability for many pollutants.

Only recently have engineers recognized the value of designing open channels explicitly for pollutant removal during small and moderate-sized storm events. Depending on the depth to the water table, they are known as either grass channels, dry swales or wet swales. Checkdams, underdrains, stone inlets, prepared soil mixes and landscaping are also used to enhance the pollutant removal capability of swales. The use of grass channels or swales along residential streets can be an economical and effective element of a BMP system, as long as the critical erosive velocity is not exceeded. In addition, open channels must be designed to prevent standing water, to ensure that mowing is convenient, and to avoid odors, mosquitoes, or other nuisances associated with standing water.

Even the moderate vertical break of a curb shelters airborne pollutants that blow in by the wind. Thus, dust, pollen, leaves, grass clippings, and other nitrogen-rich organic matter can be trapped by the curb, where they remain until they are washed into the storm drain system.

Some management strategies that may contribute to a reduction in urban nitrogen from roadside drainage systems are:

• Minimize the use of curb and gutter and maximize the use of vegetated swales where feasible.
- If curb and gutter is necessary, consider frequent curb cuts to divert manageable quantities of runoff into stable vegetated areas for infiltration. (Land of Sky 1995).

- Develop a site/landscaping plan that uses landscaped areas for infiltration or detention/retention areas (bioretention).

- Instead of grass that requires chemical applications, use trees, shrubs, ground cover, mulch or other materials that require little or no chemical applications.

**Allowing Cluster or Open-Space Developments**

Cluster or open-space developments rearrange density on each development tract so that a lower percentage of the tract is covered by impervious surfaces. This results in more land being retained in a natural state.

This approach respects private property rights and the ability of developers to create new homes for the expanding population. Such developments are "density-neutral" since the overall number of dwellings allowed is not less than it would be in a conventional development. This lessens the adverse impact on the remaining natural areas and cultural resources that make our communities such special places to live, work, and recreate.

The most important step in designing an "open space subdivision" is to identify the land to preserve. "Primary Conservation Areas" include unbuildable wetlands, waterbodies, floodplains, and steep slopes. "Secondary Conservation Areas" include mature woodlands, upland buffers around wetlands and waterbodies, prime farmland, natural meadows, critical wildlife habitats, and sites of historic, cultural or archeological significance.

Cluster developments can reduce road lengths by 50 to 70 percent (Arendt 1993). At an average cost of over $100 to construct a linear foot of road, such reductions are extremely cost-effective. The reduction in road length may also reduce the overall capital costs for stormwater controls. The developer may realize a significant savings in the reduced need for storm drain pipes and best management practices. It has been reported that in some cases the overall reduction in capital costs associated with these developments can be 10 to 33 percent (Schueler 1995).

Property owners can realize indirect economic benefits from reduced impervious cover. While a host of factors influence future residential property values, some evidence indicates that homes located adjacent to well designed and maintained open or green space do appreciate at a faster rate than traditional subdivision properties. This premium has been found to range from 5 to 32 percent, according to Land Ethics (1994). Another study in Massachusetts indicated that homes in cluster subdivisions with open space appreciated 13% more in value than similar homes in conventional subdivisions over a 21-year period (Arendt 1993).

For local governments, it is typically more expensive to provide public services on large residential lot developments compared to smaller ones. Clustered developments can greatly reduce the length of water and sewer pipes and roads that local governments have to construct and maintain.