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Tar-Pamlico River Basin: Model Stormwater Program for Nutrient Control

September 12, 2003*

*Changes to Model
Subsequent to 2/13/03 NC EMC Approval of Model

Date	Section	Type of Change	Explanation
6/4/03	2-D	Clarification	Table 2c, BMP Efficiencies - Corrections for consistency with worksheets. Added grass swales line. Corrected vegetated filter strip efficiencies from 20% to 30%.
9/12/03	2-D	Content Correction	BMPs - Added web links to NC and MD BMP manuals for design information.

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Appendices

1. Introduction

The Tar-Pamlico stormwater rule, 15A NCAC 2B .0258, requires that staff of the Division of Water Quality work with local governments affected by the rule to develop a model local stormwater program. This document and an associated set of appendices are to serve as the Tar-Pamlico model local stormwater program. It is intended to guide the local governments as they develop their individual stormwater programs to comply with the substantive requirements of the rule.

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 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 staff 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 EMC 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	

For these local governments, only their geographic areas that fall within the Tar-Pamlico River Basin are subject to the rule. In subject counties, applicable areas are those under the direct jurisdiction of the counties, which would not include incorporated cities, towns, or villages within county jurisdictional limits. Cities and counties are encouraged to coordinate to establish implementation responsibilities within municipal extraterritorial jurisdictions. Counties administering development regulations by interlocal agreement on behalf of municipalities would implement the rule within only those municipalities that are subject to the rule. The activities of state entities within subject local governments would be subject to the rule.

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 local governments shall include in their programs. It also sets up a process by which DWQ will work with the affected local governments to develop a model stormwater program for meeting the objectives. 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).
August 13, 2004:	Deadline for local governments to begin implementing local Stormwater Programs (modified as above).

Following implementation in August 2004, local governments are required to make annual progress reports to the EMC that will include nitrogen and phosphorus loading reduction estimates.

The elements that must be included in local stormwater management programs 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 rule also provides local government with the option of 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. Local governments must identify and remove 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, local governments are required to 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 local governments will develop and implement public and developer education programs for the Tar-Pamlico basin.

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 B for complete language) for new development located within the planning and zoning jurisdictions of the 11 local governments subject to these rules:

- 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.

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

Local governments may include regional stormwater facilities in their programs 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 local governments that are subject to the stormwater rule 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.

Each jurisdiction has the following choices for ensuring that riparian buffers are protected on new developments:

1. Obtain delegated authority to implement a local riparian buffer protection program pursuant to the buffer delegation rule, 15A NCAC 2B .0261, and implement all applicable provisions of the buffer rule within its jurisdiction, or

2. 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 NRCS 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 the Tar-Pamlico Stormwater 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 local government's approved land conservation plan, as described in Section 2-G.
  - Alternatively, any project that is subject to the above loading requirements and that is located within an area that a local government has established for redevelopment, as characterized here, in a pattern conducive to the goals of the Tar-Pamlico nutrient strategy, may not be required to achieve those nutrient reductions if the project meets certain conditions that are established for that area as follows. The local government shall have established a strategy, as represented in land development codes, for reinvestment in historic community centers (including crossroads communities), traditional central business districts, historical districts, educational centers, or other existing developed areas. The strategy for any of these existing developed areas shall contain provisions that address the following criteria:

    - A "fix it first" policy that reserves public funds for repair of existing infrastructure in these areas before investing in new infrastructure of the same type in new growth areas.
    - Mixed use/mixed density zoning provisions.
    - Retrofits are consistent with NCDOT definitions for pedestrian scale in traditional neighborhood developments (e.g., 80% of users are within a ¼ mile walk from schools, libraries, and recreational/athletic facilities, 60% of students and 50% of teachers are within ½ mile walk from schools, and 40% of congregants are within ¼ mile of churches).
    - Parking maximums or shared parking ratios.
    - Residential density bonuses where parking maximums, pedestrian scale, or "fix it first" are proposed.

- 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 an affected local government for a site-specific or phased development plan by September 1, 2004, and that have implemented that development in accordance with local vesting provisions shall be exempt from the requirements of the Tar-Pamlico stormwater rule. 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 1, 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 local stormwater program.

Calculating N and P Export: The nitrogen and phosphorus export from each new development must be calculated. 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 H, along with a description of their development.

Local governments may propose alternative load calculation approaches or adapt the process to be more applicable to their jurisdictions where they demonstrate such modifications to be equivalent. Any changes to the method should be adequately explained and supported with appropriate technical information.

It is expected that some values provided in the methodology will be refined over time. The Division plans to provide those refinements to the jurisdictions 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 Division will ask the jurisdictions to incorporate these refinements into their programs from time to time as they are substantiated.

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. Two versions of the spreadsheet were developed based on rainfall differences; one (the "Piedmont" version) for the jurisdictions of Oxford, Henderson, Rocky Mount, and Tarboro, and the counties of Franklin, Nash, and Edgecombe, and the other (the "Coastal Plain" version) for the remaining communities.

A residential worksheet is also provided in Appendix H 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 local government could require that the property owner specify the areas of rooftop and transportation impervious surface, undisturbed open space and managed open space on the property in a restrictive covenant or other legal, enforceable mechanism. Then, the methodology could be applied. An alternative is for the local government to determine a worst-case scenario 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 N/ac/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:
  - 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.
  - 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.

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 L.

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 below and in the load calculation worksheets in Appendix H 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 2c below. These median values are based on a literature review conducted by a contractor that updated Neuse nitrogen efficiencies and established phosphorus values. A summary of these literature studies is given in Appendix I. Also provided in the table are the design standards to be adhered to in permitting BMP design.

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 jurisdictions on a periodic basis as they are substantiated.

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

BMP Type	TN Removal Rate per Literature Review	TP Removal Rate per Literature Review	Appropriate Design Standards
Wet detention ponds	25%	40%	NC and MD Design Manuals
Constructed wetlands	40%	35%	NC and MD Design Manuals
Restored riparian buffers	30%	30%	Tar-Pamlico Riparian Buffer Rule (15A NCAC 2B .0259)
Grass Swales	20%	20%	NC and MD Design Manuals
Vegetated filter strips with level spreader	30%	30%	NC and MD Design Manuals and other literature information
Bioretention (rain gardens)	40%	35%	NC and MD Design Manuals
Sand Filters	35%	45%	NC and MD Design Manuals
Proprietary BMPs	Varies	Varies	Per manufacturer subject to DWQ approval
Other BMPs	Varies	Varies	Subject to DWQ approval

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 or obtained by contacting the Stormwater Unit at 919-733-5083 ext. 545.

The Maryland BMP Design Manual can be downloaded section by section from the Maryland Dept. of the Environment Stormwater Management Program's web pages at:
http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/home/index.asp
or purchased from their publications page at:
http://www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/home/index.asp

or by contacting the program at 1-800-633-6101 or 410-537-3000, or by mail at: Stormwater Management Program, MDE, 1800 Washington Blvd, Baltimore, MD 21230.

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 local government 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 local government, 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 acrage shall be entered as managed pervious (lawn/landscape).

2-E. Calculating Peak Runoff Volume

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. 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 is to give local governments 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. More discussion on each of the options follows below.

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 as illustrated in Table 2b below.

Table 2d: Rainfall depths for the 1-year, 24-hour storm (from US Weather Bureau Technical Paper 40)

Municipality	1yr – 24hr depth (inches)	County	1yr – 24hr depth (inches)
Oxford	2.9		
Henderson	2.9	Franklin	3.0
Rocky Mount	3.2	Nash	3.1
Tarboro	3.3	Edgecombe	3.2
Greenville	3.4	Pitt	3.4
Washington	3.5	Beaufort	3.5

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 storm intensity in inches per hour
A is the drainage area in acres

The rational equation 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, Tp. The Rational 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:

$$I = g/(h+T)$$

Where: I is the storm intensity in inches per hour
g and h are empirically derived constants
T is the duration in minutes (or $(L^3/H)^{0.385}$)/128)

The values for constants g and h for the one-year storm are not presently available. 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 Wake and Wilson Counties as a function of return period on a log-normal scale and determining the y-intercept of the best-fit line (see Appendix J). The resulting values for g and h are directly applicable in the Tar-Pamlico River basin as follows:

Table 2c: Values of g and h for the One-Year Storm

Values From	Applicable Location in Tar-Pamlico Basin	Value of g	Value of h
Wake County	Oxford, Henderson, and Franklin County	104	18
Wilson County	Rocky Mount, Tarboro, and Greenville Nash, Edgecombe, and Pitt Counties	112	20
Craven County	Washington and Beaufort County	127	22

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

This option involves the following three steps:

- First, compute the peak flows (both pre- and post-development) from the drainage area based on the 2-year design storm using one of the methodologies listed below.
- Second, estimate the 1-year predevelopment peak flow by multiplying the 2-year predevelopment peak flow by 80%. Details on how the 80% was computed can be found in Appendix K.
- Third, 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).

Local governments that are part of the Tar-Pamlico Stormwater Program should inform DWQ staff about which of the two options they would like to follow for developments within their jurisdictions.

Exceptions to the Peak Flow Requirement

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

- 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).
- 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.
- The development occurs in a part of a drainage basin where stormwater detention can aggravate local flooding problems. Communities will need to tailor requirements or provide exemptions to those specific locations.

Acceptable Methodologies for Computing Peak Flow

Each jurisdiction affected by the rule may specify the methodology(ies) that shall used when determining peak flows from new development activities.

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 HEC-1 Program
- The Peak Discharge Method as described in USDA Soil Conservation Service's Technical Release Number 55 (TR-55).
- The Putnam Method.
- Other methods proposed by local governments and approved by the Environmental Management Commission.

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. The developer must 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.

Typical features of such an offsite offset project that distinguish it from regional systems (described in section 2-G) include the following:

- The new development site does not typically drain into the offsite treatment facility.
- The offsite facility is retrofitted to treat an existing developed property.

- The offsite facility may address only the nutrient requirements, unless a 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 new development site must reduce nitrogen export to at least 6 lb N/ac-yr for residential and 10 lb N/ac-yr for other types of development.

Offsite offset projects may be similar to regional system projects in certain ways:
- The offsite facility may be public or private.
- The offsite facility may serve multiple projects provided the local government tracks its use and the new development owner performs maintenance.

To make this option workable for new developments in their jurisdictions, local stormwater programs will need to adequately address a series of objectives. Local programs shall address the following objectives and shall include supporting ordinance changes where necessary:
- Establish appropriate processes, mechanisms, legal instruments, etc that developers will use to demonstrate that:
  - Projects reduce nitrogen load onsite to 6 lb/ac/yr for residential, 10 lb/ac/yr for commercial, industrial
  - Projects achieve remaining nitrogen reductions offsite
  - Projects reduce phosphorus loading to 0.4 lb/ac/yr between onsite and offsite BMPs
  - Projects meet the flow attenuation requirements of the rule
  - The offsite property drains to the same stream as the new development
  - Both current owners 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
  - All future owners of both properties will undestand and accept these restrictions at the time of purchase
  - Current and future owners of the new development will maintain stormwater facilities on both the new development and the offsite property

- Establish appropriate tracking processes, mechanisms, legal instruments, etc for the following purposes:
  - To ensure, after development approval, that the new development and offsite property are linked for operation and maintenance purposes.
  - To ensure that the local government will maintain stormwater facilities if the owner fails.
  - To ensure, when a change of use is proposed on either site, that the local government will maintain the offsite property nutrient loading reductions through the change of use.

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. Local governments are required to demonstrate that such measures will not contribute to degradation of surface waters. The rule also requires local governments to quantify nutrient and flow reductions and provide for tracking and administration of the use of such facilities.

Regional Facilities: Within the context of the rule, the Group interprets the concept of a regional facility to mean generally a stormwater facility that serves more than one development project, each of which drains to the facility for treatment or attenuation. Inflows to regional facilities may already be partially treated or attenuated. Examples of regional facilities may include wet detention ponds or constructed wetlands.

The regional system option is intended to provide greater flexibility to development in affected communities than would strict onsite controls by giving local governments the opportunity to include stormwater management on a larger scale. Two basic types of regional facilities may be described as offstream and instream. While local governments may pursue instream regional facilities, instream 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, and federal approval must be sought on a case-by-case basis and may be difficult to obtain.

Many individual developments include stormwater designs that could be interpreted as "regional" under the broadest of definitions, but which are not intended for the type of review and approval process described here. Projects such as phased developments or commercial projects with outparcels may propose using shared stormwater facilities that receive runoff from more than one lot and that would be accessed by lots under different ownership at different points in time. However, shared facilities that are permitted under single projects are intended for permitting by the local governments.

Regional facilities provided for in the rule would serve more than one development project. They could be publicly or privately owned, but would be proposed to DWQ by local governments. 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.

The rule mandates certain limitations on regional facilities. A regional facility would have to be implemented in conjunction with on-site controls to locally protect against water quality degradation and flooding. The Tar-Pamlico buffer requirements may impact the feasibility of using certain regional stormwater approaches.

Jurisdiction-Wide Approach: Within the context of the rule, the Group interprets the concept of a jurisdiction-wide approach to mean generally a nutrient-reducing management measure implemented under the authority of a local government 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 a local government 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.

Local governments interested in developing a land conservation proposal for DWQ review should 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. An example conservation easement is provided in Appendix O.

Proposal Information: Regional or jurisdiction-wide approaches may be incorporated into an individual local government's model program if 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 local government will need to provide in its program submittal or amendment to DWQ the following information for any proposed regional facility. Local governments should also refer to the offsite offset criteria for guidance on administrative elements to consider in a regional or jurisdiction-wide approach.

- 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 buildout
  - 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. ***Design standards have not yet been established for these criteria. The Group recommends that DWQ develop these standards with significant input from a diversity of interests and technical experts. Local governments are encouraged to work with DWQ on individual projects.***

- 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. An example conservation easement is provided in Appendix O for projects where such an instrument would be appropriate.

- 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. Example maintenance agreements are provided in Appendix N.
  - 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. An example ordinance is provided in Appendix M.

2-H. BMP Maintenance

If BMPs are implemented to achieve the nitrogen and phosphorus loading and flow attenuation requirements for a development, then the local governments must require a maintenance plan for the BMPs. The stormwater management plan must describe the local

government's selected approach for assuring BMP maintenance. Possible options to be considered include, but are not limited to, the following:

- The jurisdiction can charge a stormwater maintenance fee and assume the responsibility of maintaining the stormwater BMP itself, including providing annual inspection.

- The jurisdiction can notify the owner upon finding that maintenance is needed on a BMP. If the owner does not complete the maintenance himself in a timely manner, then the jurisdiction can contract out the maintenance itself and recover costs in the manner it determines most appropriate.

- The jurisdiction can require that escrow accounts be set up to provide sufficient resources to completely replace the BMP in the event of failure.

- The jurisdiction can require a legal maintenance agreement for the BMP with the owner.

An example of a stormwater maintenance program is given in Appendix M.

Regardless of the option selected, the jurisdiction should inspect all BMPs on an annual basis. The resources needed for this may be recovered through an inspection fee or other funding source(s) determined appropriate and necessary by the local government (currently, some Neuse local governments are charging annual inspection fees for stormwater BMPs that range from $105 to $150). Jurisdictions should keep a list (database recommended) of BMPs and their locations to assist in the inspection process.

2-I. Land Use Planning Provisions

This model program is intended to provide the flexibility and incentives for local governments 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.

Under the model stormwater program, affected jurisdictions are encouraged to review their local ordinances with regard to the following topics and show that they have provided adequate flexibility for developers to utilize planning measures to reduce impervious surfaces. This review is intended to look for opportunities where these measures could be allowed, or where obstacles to their use could be removed.

Each jurisdiction should show that they have reviewed and considered the following planning techniques and the general advantages and disadvantages of incorporating these approaches.

- 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 L.

2-J. References

Arendt, R. Open Space Design Guidebook: Albermarle-Pamlico Estuarine Region. 1993. Prepared for the NC Association of County Commissioners. National Lands Trust. Media, PA. 259 pp.

Environmental Protection Agency. Office of Water. November 1994. Section 319 Success Stories.

Environmental Protection Agency. Office of Water. Jan. 1993. Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. Washington, DC.

Land of Sky Regional Council. 1995. Stormwater Fact Sheet Number 8: Plan Early for Stormwater in Your New Development. Asheville, NC. 4 pp.

Schueler, T. S. Dec. 1995. Site Planning for Urban Stream Protection. Metropolitan Washington Council of Governments. Silver Spring, MD 231 pp.

Stimmel Associates. 1993. Traditional Neighborhood Development Design Guidelines. Chapel Hill, NC.

3. Illegal Discharges

3-A. Requirements in the Rule

The Tar-Pamlico Stormwater Rule requires that all municipalities establish a program to prevent, identify and remove illegal discharges. Illegal discharges are flows in the stormwater collection system that are not associated with stormwater runoff or an allowable discharge.

3-B. What is an Illegal Discharge?

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 3a: Discharges that may be allowable to the stormwater collection system

Waterline Flushing	Landscape Irrigation	Diverted Stream Flows
Uncontaminated Rising Ground Water	Uncontaminated Ground Water Infiltration to stormwater collection system	Uncontaminated Pumped Ground Water
Discharges from potable water sources	Foundation Drains	Uncontaminated Air Conditioning Condensation
Irrigation Water	Springs	Water from Crawl Space Pumps
Footing Drains	Lawn Watering	Non-commercial Car Washing
Flows from Riparian Habitats and Wetlands	NPDES permitted discharges	Street wash water
Fire Fighting Emergency Activities	Wash Water from the Cleaning of Buildings	Dechlorinated backwash and draining associated with swimming pools

Table 3b: Types of Discharges that are not allowed to stormwater collection system

Dumping of oil, anti-freeze, paint, cleaning fluids	Commercial Car Wash	Industrial Discharges
Contaminated Foundation Drains	Cooling water unless no chemicals added and has NPDES permit	Washwaters from commercial / industrial activities
Sanitary Sewer Discharges	Septic Tank Discharges	Washing Machine Discharges
Chlorinated backwash and draining associated with swimming pools		

3-C. Establishing Legal Authority

One of the first steps that each local government is required to take is establishing the legal authority to control illegal discharges. According to the policies of each individual local government, this legal authority may be carried out through ordinances, policies, city codes or charters.

By August 2004, each local government is required to show that it has established the legal authority to do the following:

- Control the contribution of illegal pollutants identified in Table 3b to the stormwater collection system.
- Prohibit illegal discharges 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.

Raleigh and Durham have established legal authority in the above areas. Examples of these ordinances are provided in Appendix P. Communities may want to request that councils of government compile other examples.

3-D. Collecting Jurisdiction-Wide Information

Under the Model Program for Illegal Discharges, each jurisdiction is required to collect geographic information at three increasing levels of detail:

- The first, most cursory level is information that shall be collected for the entire jurisdiction. The associated requirements are discussed in this section.

- The second level is a more detailed screening for high priority areas within the jurisdiction. The associated requirements are discussed in Section 3-E.

- The third level is a very detailed investigation that 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 are to assist with identifying potential illegal discharge sources and characterizing illegal discharges after they are discovered.

Each local government shall compile maps that show the following information. It is not necessary that all of this information be shown on a single map. The maps shall be at a scale that is most useful to the jurisdiction; however, no scale may be greater than 1:24,000.

- 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, should 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 should 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 local governments shall complete this collection of jurisdiction-wide information by the time the second annual report is due (October 2006).

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

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

The method for determining the high priority area will vary from jurisdiction to jurisdiction. "High priority" means the areas within a jurisdiction where it is most likely to locate illegal

discharges. Based on the experiences of Raleigh and Durham, the most likely locations for identifying illegal discharges are areas with older development. Each year, the local governments should 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 should 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 shall not be conducted during or within 72 hours following a rain event of 0.1 inches or greater. In residential areas, it is recommended to conduct the field screening either before 9:00 am or after 5:00 pm, since these are the hours that citizens are most likely to be home and thus any illegal discharges are more likely to be evident.

Figure 3a illustrates a suggested process for conducting field screening sampling activities and following up with any findings of dry weather flow. As shown in the figure, if the field screening shows that an outfall is dry, then the outfall should be checked for intermittent flow at a later date.

If the field screening shows that an outfall has a dry weather flow, then the local government is required to complete a screening report for the outfall. The information that should be contained in the screening report is outlined in Table 3c. Screening reports shall be kept on file for a minimum of five years. Example screening report forms are provided in Appendix Q.

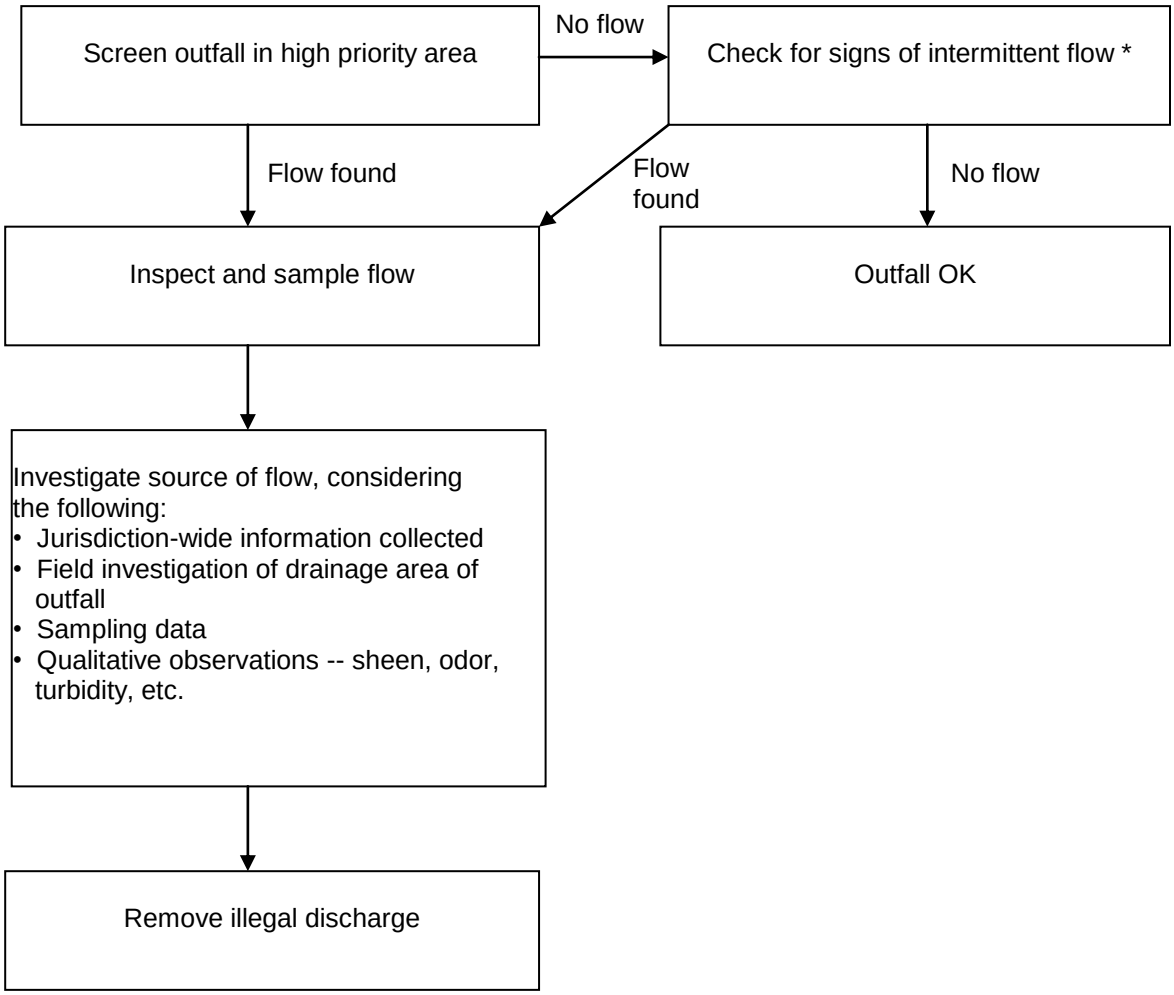
Table 3c: Field Screening Report Information

General Information	Sheet Number Outfall ID Number Date Time Date, Time and Quantity of Last Rainfall Event	
Field Site Description	Location Type of Outfall Dominant Watershed Land Use(s)	
Visual Observations	Photograph Odor Color Clarity Floatables	Deposits/Stains Vegetation Condition Structural Condition Biological Flow Estimation
Sampling Analysis *	Temperature pH Nitrogen-Ammonia	Nitrogen-Nitrate/Nitrite Fluoride or Chlorine Total Phosphorus Ortho-Phosphate

* 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/nitrate that are purchased should be sensitive for 0.1 to 10 mg/L. The cities of Raleigh and Durham can be contacted for guidance on test kit information.

Figure 3a: Field Screening Process



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

Note: 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.

The purpose of the field screening is to provide clues as to the source of the illegal discharge. The characterization should 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.

As part of the review process for field screening activities, the Team recognized that there were some training needs associated with performing these activities. The Education Program (outlined in Section 5) should look at the development of training materials and opportunities to assist local governments in preparing to implement these measures.

3-F. Identifying and Removing Illegal Discharges

After the field screening is complete, local governments are required to take measures to identify and remove illegal discharges. Identifying illegal discharges may require a combination of office and field work. After the field screening, local government staff should 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. It is recommended that local governments use a simple approach if that will suffice. Listed below are several approaches that are recommended by Raleigh and Durham, 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

One tip on identifying illegal discharges is that outfalls that do not have flow during wet weather are likely to originate from floor drains.

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

After a local government identifies the source of an illegal discharge, it is required to take enforcement action to have the source removed. The legal authority that was established for the illegal discharge program shall provide the means to accomplish this requirement. Enforcement should include requiring the person responsible for the discharge to remove or redirect it to the sanitary sewer. There should also be remedies to deal with cases of non-compliance. Records of all compliance actions shall be kept for five years with the screening report.

In addition to keeping all screening reports on file, each jurisdiction shall maintain a map that includes the following:

- Points of identified illegal discharges.
- Watershed boundaries of the outfalls where illegal discharges 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

Local governments are required to 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. A sample letter to inform owners and operators about the requirements of the illegal discharge program is included in Appendix R.

The experiences of Raleigh and Durham have shown that an illegal discharge hotline is a cost-effective way to identify illegal discharges. Part of the public education program (discussed in Chapter 5) will be to educate citizens about what types of discharges should not go to the stormwater collection system and make them aware of the hotline.

Local governments are responsible for establishing a hotline. The hotline will require them to either designate a new phone number or use an existing service. The hotline should include a recording advising citizens what to do if they call during non-business hours. There should be another number given in cases where the illegal discharge is perceived to be an emergency.

3-H. Implementation Schedule

In keeping with their goal of having an efficient and cost-effective program, the Tar-Pamlico Stormwater Model Group has created a phased implementation schedule for illegal discharges (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. This phased schedule is also intended to allow communities to evaluate and make improvements to their programs as they progress through high priority areas.

Table 3d: Implementation Schedule and Annual Reporting Requirements

Year	Implementation Requirements	Annual Report Requirements
By August 2004	• Establish legal authority to address illegal discharges	• Submit report identifying established legal authority to meet requirements.
By October 2006	• Collect jurisdiction-wide information. • Select high priority area for additional screening. • Initiate illegal discharge hotline.	• Report on completion of jurisdiction-wide information collection. • Submit map of high priority areas and reason for selection. • Report on initiation of illegal discharge hotline.
Each subsequent year after 2006	• Complete mapping and field screening for high priority area. • Select next high priority area. • Identify and remove Illegal discharges as encountered. • Continue operating illegal discharge hotline.	• Submit map of stormwater collection system in high priority area upon request by DWQ. • Document illegal discharges found and resulting action. • Report on hotline usage and actions taken. • Submit map of next high priority area and reason for selection.

3-J. References

Debo, Thomas N. and Reese, Andrew J., Municipal Stormwater Management, CRC Press, Inc. 1995

U.S. Environmental Protection Agency (EPA). 1992. Manual of Practice – Identification of Illicit Connections. EPA 833/R-90-100

U.S. Environmental Protection Agency (EPA). 1993. Investigation of Inappropriate Pollutant Entries into Storm Drainage Systems – A User's Guide. EPA 600/R-92-238.

U.S. Environmental Protection Agency (EPA). 1991. Guidance Manual for the Preparation of Part 1 of the NPDES Permit Applications for Discharges from Municipal Separate Storm Sewer Systems. EPA 505/8-91-003A.

4. Retrofit Locations

4-A. Requirements in the Rule

The rule requires that all affected local governments establish a program to identify and prioritize places within existing developed areas that are suitable for retrofits.

4-B. Approach for Meeting the Requirements

Retrofit opportunities will be considered acceptable if all of the following conditions have been investigated:

- 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 willing to have the retrofit installed on his property. Securing the landowner's cooperation is one of the most important tasks for the local government, as this is often the most difficult aspect of implementing a retrofit.
- There is adequate space and access for the retrofit.
- It is technically practical to install a retrofit at that location.

The minimum number of retrofit opportunities that each local government is required to identify is based on a sliding scale according to the population of the government. For those communities that are not completely located within the Tar-Pamlico River Basin, the number of retrofits can be based on the estimated population within the Tar-Pamlico River Basin. The local government will have to provide the data to support this population. Table 4a shows the minimum requirements for identifying retrofit opportunities for each affected jurisdiction. 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 above on an annual basis.

Table 4a: Minimum Number of Retrofit Opportunities that Each Local Government Must Identify on an Annual Basis

Population Category	Local Government	Estimated 2001 Basin Population	Minimum Number of Retrofit Sites to be Identified
Less than 15,000	Tarboro Oxford Washington	11,200 8,500 9,700	1
Between 15,000 and 30,000	Edgecombe County Henderson Nash County	22,400 16,300* 29,000	2
Between 30,000 and 60,000	Beaufort County Franklin County Greenville Pitt County Rocky Mount	30,600 38,500 41,700 31,800 56,000	3
Over 60,000			4

* Represents total municipal population; portion within Basin not determined.

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 4b shows a suggested format for presenting this information for each retrofit opportunity.

The tables shall be submitted to the Division of Water Quality on October 30 of each year beginning in the year 2005 as part of the annual report.

The Division will take the responsibility for posting these retrofit opportunities on its Web Page and also for notifying, at a minimum, the following organizations of the opportunities for retrofitting within existing developed areas:

- Clean Water Management Trust Fund
- N.C. State University Cooperative Extension Service
- Kerr-Tar Regional Council of Governments
- Upper Coastal Plain Council of Governments
- Mid-East Commission
- Environmental programs at NCSU, Duke University, UNC, ECU and others
- N.C. Sea Grant
- USDA – Natural Resources Conservation Service
- Tar-Pamlico Basin Association
- N.C. Wetlands Restoration Program

4-D. Mapping Requirements

Affected local governments are required to provide maps that show the locations of retrofit opportunities. Mapping may be accomplished by using computers or with existing hard copy maps. The scale of the map should be large enough to adequately 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 4b: Retrofit Opportunity Table

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

* Suggested methodology: Use the methodology provided in Appendix H to compute nitrogen export from the drainage area based on the amount of impervious surface, landscaped area and forested area in the watershed.

5. Public Education

5-A. Requirements in the Rule

The Tar-Pamlico Stormwater Rule requires each of the affected jurisdictions in the Tar-Pamlico River Basin 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, affected county and municipal staff, the development community, and elected officials. Each local government affected by the rule is required to develop a Public Education Action Report and Plan. The purpose of the Action Report and Plan is to provide local governments a platform to design their own locally unique public education effort and to maintain it on an ongoing basis. 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. Each affected community shall submit an annual Action Report and Plan to DWQ for approval in its October annual report each year. An example Action Report and Plan format can be found in Appendix S.

The Action Report and Plan shall consist of various types of activities. Innovative public education activities not included in this list are encouraged, and will be considered for approval on a case-by-case basis. All activities must be designed to raise awareness and educate the audience about water quality, nonpoint source pollution, and the effects of everyday activities on water quality and nutrient loading.

The Action Plan template in Appendix S identifies point values for each type of education activity that may be contemplated by a community. All affected local governments are required to conduct activities that sum to at least 15 points each year. Ongoing activities, such as continuing programs for pet waste or storm drain marking, receive credit for each year that they are continued.

During the first year of program implementation, affected communities are required to 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. Communities are encouraged to work jointly to develop and conduct the workshops, if feasible. A Sample workshop agenda, including recommended resources, is located in Appendix U.

5-C. Flexibility of Implementation / Alternative Programs

Communities may develop a locally unique program designed to meet their needs as long as the activities meet or exceed the minimum requirements set forth above. While it is not a requirement, communities are encouraged to work with each other to make use of existing resources and stormwater education efforts in their areas to meet the requirements. Working together will provide a more consistent education effort for communities of all sizes, will be an efficient use of resources and will reduce duplication of efforts.

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

Under the model program for new development review/approval, local governments are 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.

6-B. Illegal Discharges

Table 6a outlines the annual reporting requirements for illegal discharges.

Table 6a: Implementation Schedule and Annual Reporting Requirements

Year	Implementation Requirements	Annual Report Requirements
By August 2004	• Establish legal authority to address illegal discharges	• Submit report identifying established legal authority to meet requirements.
By October 2006	• Collect jurisdiction-wide information. • Select high priority area for additional screening. • Initiate illegal discharge hotline.	• Report on completion of jurisdiction-wide information collection. • Submit map of high priority areas and reason for selection. • Report on initiation of illegal discharge hotline.
Each subsequent year after 2006	• Complete mapping and field screening for high priority area. • Select next high priority area. • Identify and remove Illegal discharges as encountered. • Continue operating illegal discharge hotline.	• Submit map of stormwater collection system in high priority area upon request by DWQ. • Document illegal discharges found and resulting action. • Report on hotline usage and actions taken. • Submit map of next high priority area and reason for selection.

6-C. Retrofit Locations

- Data on each retrofit opportunity (Table 4b or other equivalent format),
- Maps of potential retrofit sites as specified in Section 4-D, and
- The status of any retrofit efforts that have been undertaken within the 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 should include goals, activities completed, realized education program costs, explanation of experienced shortfalls and a plan as to how the locality will address shortfalls.

APPENDICES TO THE TAR-PAMLICO RIVER BASIN MODEL STORMWATER PROGRAM FOR NUTRIENT CONTROL

June 4, 2003*

*Changes to Appendices
Subsequent to 2/13/03 NC EMC Approval of Model

Date	Appen-dix	Type of Change	Explanation
6/4/03	A	Format correction	Program Submittal Checklist - Reduced embedded Excel spreadsheet so that entire text appears on page (last lines calling for reporting items had been cropped off).
6/4/03	H	Content Correction	Worksheets - Added wetlands to wooded pervious definition in Definitions sheet.
6/4/03	H	Clarification	Worksheets - Added introductory explanation to Residential Worksheet.
6/4/03	H	Clarification	Reorganized, clarified, added notes to Residential Worksheet and BMP worksheet directions.
6/4/03	H	Content finalization	Installed contractor's final worksheets.
6/4/03	H	Content finalization	Added contractor's report detailing how worksheets were developed.
6/4/03	L	Content finalization	BMP Literature Summary - Moved Appendix L to I, replaced Neuse BMP Literature Summary with contractor's report describing BMPs, development of efficiency values, and literature references.

Appendices

Appendix A. Local Program Submittal Checklist

PROGRAM SUBMITTAL CHECKLIST FOR LOCAL GOVERNMENT STORMWATER PROGRAM FOR NUTRIENT CONTROL IN THE TAR - PAMLICO RIVER BASIN

Prior to submitting the proposed local stormwater program for nutrient control to the Environmental Management Commission, the local government should make sure the proposal addresses the Tar-Pamlico stormwater program requirements listed below.

	Component Description	Ordinance Provisions	Monitoring/ Enforcement
New Development Nutrient Control Program Components			
Provisions for Protecting Riparian Areas in New Developments	☐	☐	☐
Program for Calculating/Controlling TN & TP Export From New Development	☐	☐	☐
Program for Calculating/Attenuating Flow From New Development	☐	☐	☐
Program to Assure Long-Term Maintenance of BMPs	☐	☐	☐
Approach for Considering Land Use Planning/Design Techniques	☐	☐	☐
Description of Proposed Regional/Jurisdiction-Wide Approach (not required)	☐	☐	☐
Illegal Discharges Program Components			
Approach to Collecting Jurisdiction-Wide Information	☐	☐	☐
Approach to Mapping and Field Screening in High Priority Areas	☐		
Program for Identifying and Removing Illegal Discharges	☐	☐	☐
Program for Preventing Illegal Discharges and Establishing a Hotline	☐	☐	☐
Description of Proposed Regional/Jurisdiction-Wide Approach (not required)	☐	☐	☐
Retrofit Program Components			
Approach to Data Collection and Notification	☐		
Approach for Complying With Mapping Requirements	☐		
Description of Proposed Regional/Jurisdiction-Wide Approach (not required)	☐		
Public Education Program Components			
Description of Public Education Program	☐		
Description of Proposed Regional/Jurisdiction-Wide Approach (not required)	☐		
Reporting Requirements			
Description of Proposed Report Contents/Format	☐		
Description of Proposed Regional/Jurisdiction-Wide Approach (not required)	☐	☐	☐

Appendix B. 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.

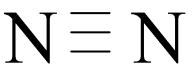
(2) Be subject to the NPDES permit for at least one permitting cycle (five years) before it is eligible to submit a local stormwater management program to the Commission for consideration and approval.

History 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 C. The Nitrogen Cycle

Forms of Nitrogen

Although nitrogen is the major pollutant of concern for the Tar-Pamlico River Estuary, it is also a nutrient that is essential for life. The majority of nitrogen on the planet exists as N_2 gas in the atmosphere. In fact, 78% of the volume of the air we breathe is nitrogen. Nitrogen is not a natural constituent of rocks or minerals.



The N_2 molecule has a triple bond, which is the most stable bond known to science. Plants obtain all of the oxygen and carbon they need from the air. However, it is very difficult for a plant to obtain nitrogen from the atmosphere because N_2 gas is so non-reactive.

Very special circumstances are required to break the triple bond in N_2 gas and to convert the nitrogen into forms that most plants can use, as described in the next section. The majority of plants obtain nitrogen from the soil as either nitrate (NO_3) or ammonium (NH_4).

Once in the plant, ammonium can be used directly but nitrate is transformed to the ammonium form using energy derived from photosynthesis. The plant uses nitrogen to form proteins that act primarily to control plant growth processes. A good supply of nitrogen is associated with vigorous growth and a deep green color. Plants deficient in nitrogen become stunted and yellow in appearance.

Nitrogen in plant-available forms is generally scarce under natural conditions. In other words, under natural conditions, nitrogen is a limiting growth factor. Only recently have humans upset the balance by the addition of nitrogen fertilizers and NO_X emissions and by artificially concentrating nitrogen sources such as human and livestock wastes.

Nitrogen is classified as either inorganic or organic nitrogen. At any given time, most of the nitrogen in the soil is in the organic form. Inorganic nitrogen compounds are unstable and nitrogen is constantly returning to the atmosphere in gaseous forms.

Inorganic Forms of Nitrogen

N2: Inert nitrogen gas found in the atmosphere
NO2: Nitrous oxides, is found in the atmosphere and is a component of automobile exhaust and industrial processes
NH3: Ammonia is a volatile gas and often is lost from soil applied ammonium fertilizer and animal manure into the atmosphere
NH4+: Ammonium, is a positively charge cation found in the soil
NO2-: Nitrite, is a negatively charge anion found in the soil

NO3-: Nitrate, is a negatively charge anion found in the soil and at times in the atmosphere

Organic Forms of Nitrogen

Organic sources of nitrogen include proteins and other complex compounds found in living, dead, or decomposing plants and animals.

The Nitrogen Cycle

The conversion of N2 to N compounds and from nitrogen compounds back to N2 is the nitrogen cycle. It has been estimated that it takes from 44 to 220 million years for all nitrogen to pass through the cycle. In 1982, it was estimated that human activities have caused an imbalance in the nitrogen cycle that causes an accumulation of nine million metric tons per year. This accumulated nitrogen can cause pollution problems.

Figure C1 shows a simplified nitrogen cycle in an undisturbed, forested area. In an urban area, human activities add sources of nitrogen other than the ones shown here. Modified nitrogen cycles are shown in Chapter 4 for each of the appropriate nitrogen sources.

Losses of Nitrogen

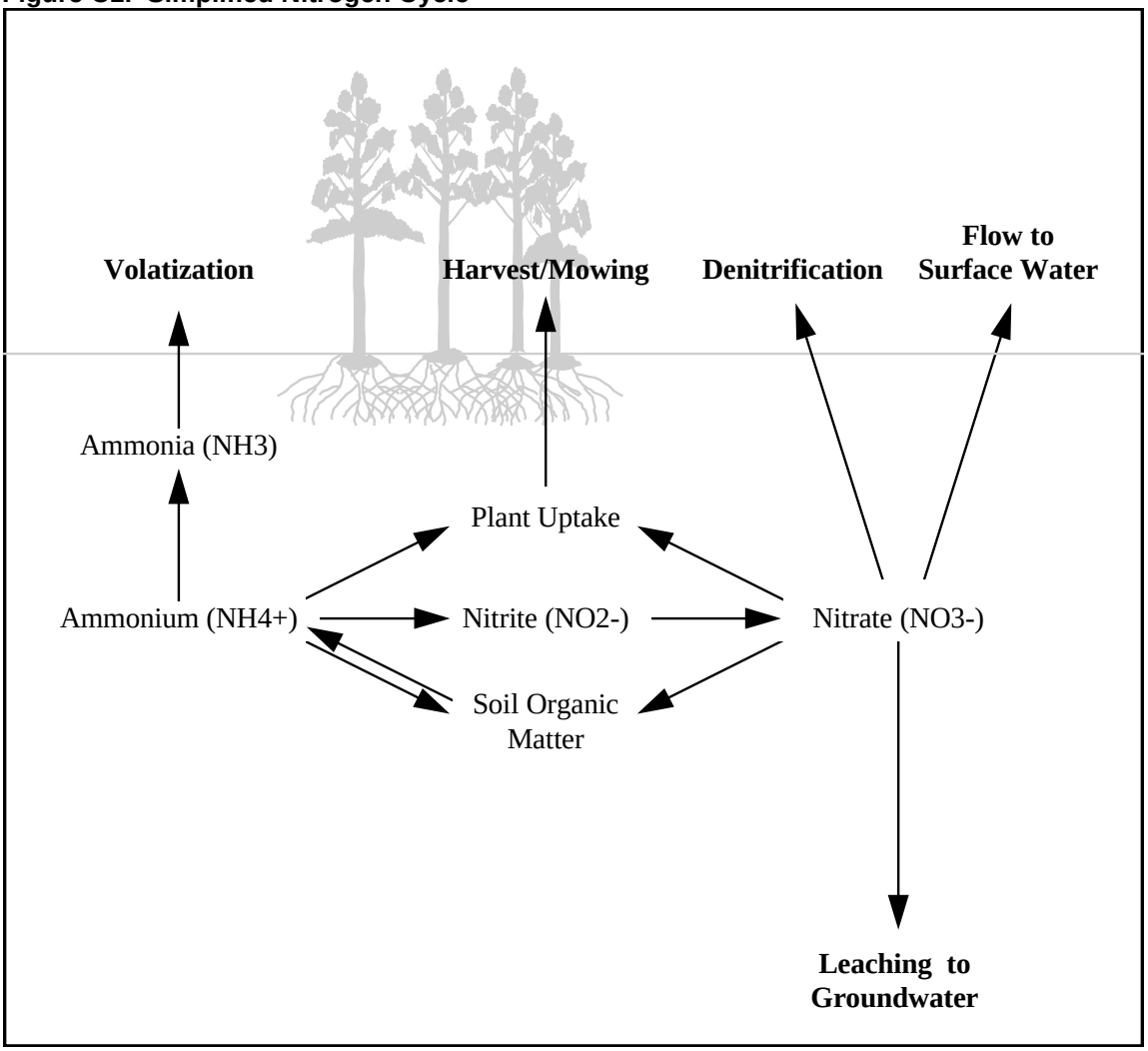
Nitrogen can be easily lost into the environment by various pathways. Those pathways include volatilization, leaching and runoff, and crop removal.

Volatilization, or the gaseous loss of ammonia, may occur under certain conditions with ammonia fertilizers. In situations where the soil is pH alkaline, or where limestone has recently been applied on acid soils, applications of ammonium fertilizer may result in the transformation of ammonium (NH4) to ammonia (NH3) which may be lost to the atmosphere. Urea fertilizers are particularly likely to volatilize. This situation can be avoided by incorporating these fertilizers into the soil in the case of soils with alkaline pH or waiting at least one month after limestone applications to surface apply ammonium fertilizers.

Leaching and Runoff are other important sources of nitrogen loss. Leaching occurs when inorganic forms of nitrogen, particularly nitrite (NO2) and nitrate (NO3) are solubilized and carried with water through the soil profile or with surface waters. Factors that contribute to nitrite and nitrate leaching or runoff include the following:

- Heavy, one-time applications of N fertilizers on sandy textured soils.
- Over applications of manure or sludge to land.
- Improperly timed applications of N fertilizer.
- Poorly designed or nonexistent soil conservation measures.
- Periods of exceptionally heavy rain.

Figure C1. Simplified Nitrogen Cycle



Harvest and Mowing are very important ways that nitrogen is lost. If crops are harvested and removed, there is a net loss to the farm's balance sheet for nitrogen. However, if crop residues or lawn clippings are saved and returned to the soil, some of the nitrogen will be recycled.

References

National Research Council. 1993. Soil and Water Quality: An Agenda for Agriculture. National Academy Press. Washington, DC.

NC Cooperative Extension Service. NCSU Nutrient Management Manual. Chapter 3. Raleigh, NC.

Appendix D. Sources of Nitrogen in Developed Areas

Water quality data from large municipalities in North Carolina clearly show that nitrogen loading is a problem in streams with entirely urban watersheds. Therefore, it is necessary and equitable for urban areas to address their nonpoint sources of nitrogen. An additional benefit of implementing practices to control nitrogen is that these practices are effective for a wide range of other pollutants, such as sediment, heavy metals, oil and grease, and bacteria.

Based on the present research, it appears that there are four major sources of nitrogen contributed by urban areas. These sources are:

- Atmospheric deposition
- Fertilizer
- Human waste
- Animal waste

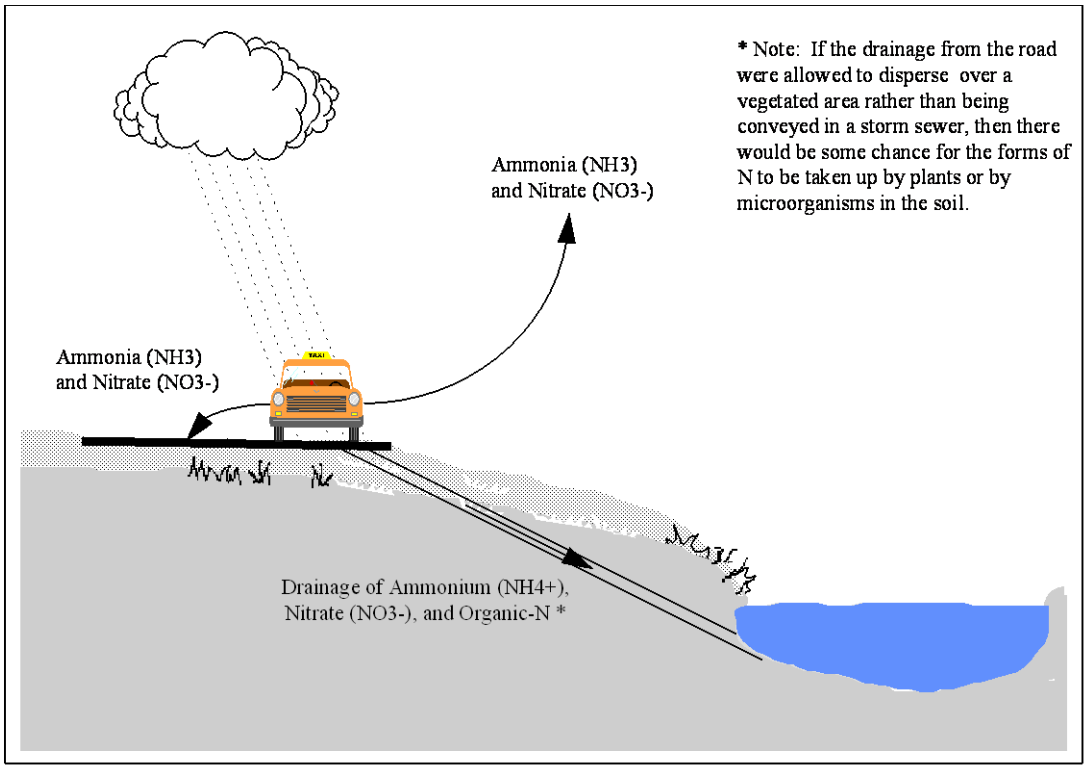
Atmospheric Deposition

Scientific evidence shows that atmospheric deposition is a significant source of nitrogen loading in urban areas. In fact, researchers in the Metropolitan Washington area believe that have shown that washoff of nitrate deposited on impervious surfaces from the atmosphere account for the *majority* of nitrogen in urban streams (MWCOG 1983).

Although atmospheric deposition occurs on all types of land areas, nitrogen deposited on urban areas is more likely to enter surface waters than nitrogen deposited on forests and farms. Urban areas contain impervious surfaces such as roofs, driveways and roads that quickly channel runoff and associated pollutants directly to surface waters with no opportunity for interception or uptake. Impervious surfaces that are drained by storm sewer systems generally have pollutants carried directly into surface waters. Urban roads also have a greater number of local emissions sources, resulting in greater deposition on them than on the landscape as a whole. Figure D1 illustrates nitrogen pathways for impervious areas drained by curb and gutter.

Another reason why atmospheric deposition is a more significant source of nitrogen in urban areas is that urban soils are often heavily compacted and thus can function almost as an impervious surface themselves. Information on how to maintain urban soils and lawns is offered in the next section.

Figure D1. Nitrogen Pathways for Impervious Areas Drained by Curb and Gutter



Impervious areas associated with transportation, such as driveways, roads, and parking lots are usually greater sources of nitrogen than rooftops. Rooftop runoff, particularly in residential areas, is usually spread out over pervious yards that are not directly connected to the storm drain system. During smaller storms, rooftop runoff can infiltrate into the soil, and less runoff and pollutants are delivered to the stream.

Scientists from the Center for Watershed Protection estimate that the annual TN load from a parking lot is 15.4 lb/ac/yr (Schueler 1995). It is likely that roads with curb and gutter have similar export coefficients. According to recent DWQ estimates, the overall annual TN load from urban areas is 6.7 lb/ac/yr (1996). DWQ's estimated annual TN load includes not only contributions from parking lots and roads, but also nitrogen from construction areas, onsite wastewater treatment, and solid waste disposal (DWQ 1996). The large difference between the estimated loads suggests that transportation-related imperviousness is a significant source of nitrogen.

There is also evidence that nitrogen loads increase as average daily traffic volume increases. Runoff monitoring by the Federal Highway Administration (1990) indicates that highways with average daily traffic volume below 30,000 were found to have a 40% lower concentration of nitrate-N than highways with average daily traffic volume exceeding 30,000.

In summary, the available data indicate that:

- The transport of atmospheric nitrogen from land to surface waters is a major contributor of nitrogen to urban streams, and
- Reducing transport-related imperviousness in urban areas is likely to play a important role in reducing the deposited nitrogen that moves from urban land to surface waters.
- Minimizing the use of curb and gutter with storm sewer will also reduce the deposited nitrogen that moves from urban land to surface waters, and
- Reducing vehicle use in urban areas will reduce the amount of deposited nitrate nitrogen that could possibly be transported to surface waters.

In addition to reducing the amount of nitrogen moving into surface waters, reducing transportation-related imperviousness, minimizing curb and gutter, and reducing vehicle use all save money. For example, the cost of providing residential infrastructure such as roads, sidewalks, driveways, and parking spaces, generally constitutes about half of the cost of residential subdivision (Schueler 1995).

Reducing road widths, parking lot sizes, and the use of curb and gutter are important steps to reduce the contribution of nitrogen from atmospheric deposition. In addition, these measures will reduce loadings of many other pollutants, including phosphorous, bacteria, oxygen-demanding substances, and heavy metals. The next chapter on new approaches for planning development describes steps that can be taken on a larger scale to reduce overall impervious area.

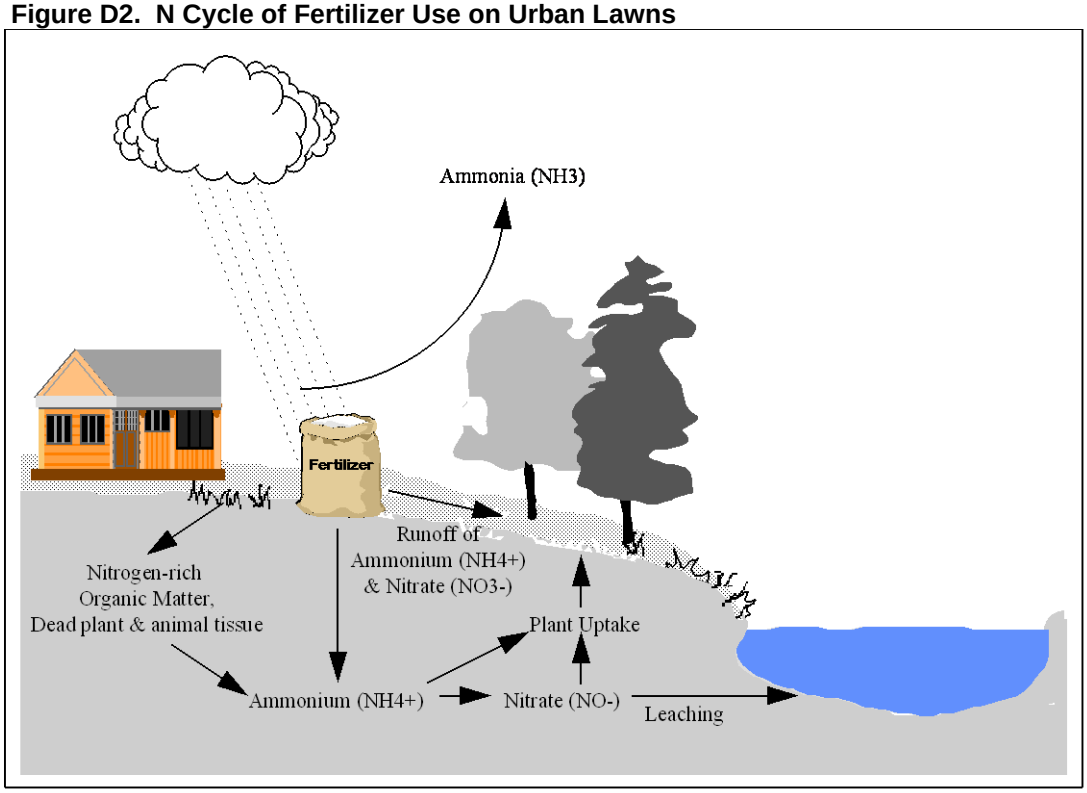
Fertilizers

Well-managed lawns and landscaped areas help protect water quality in urban areas by reducing soil erosion, moderating air temperatures, and filtering pollutants. However, the fertilizers used to maintain these natural areas can pollute urban waters. An important component of improving fertilizer and pesticide use in urban areas is public awareness and education.

Studies suggest that a large number of lawn acres are regularly fertilized without determining the need for nutrient addition. A study found that 79% of Virginia homeowners use fertilizers, but less than 20% of them had their soil tested (Aveni 1994). This study found that product labels are the number one information source for homeowners, while the Cooperative Extension Service ranked last. While all labels indicate how many square feet the label should cover, each takes a different approach on how often the product should be applied. Most label instructions do not mention soil testing.

The nitrogen cycle of fertilizer used on urban lawns is diagrammed in Figure D2.

Figure D2. N Cycle of Fertilizer Use on Urban Lawns



Considering privately and publicly managed lawns, Schueler estimates that about a third of all vegetated areas in the urban landscape can be classified as "high input," meaning that they receive high rates of irrigation and fertilizer application (1995).

Based on studies by the Center for Watershed Protection (Barth 1995):

- homeowners fertilizing their own lawns apply 44-261 pounds/acre/year of nitrogen
- home lawn companies apply 194-258 pounds/acre/year of nitrogen.

Although many homeowners are applying fertilizers with incomplete information, lawn care companies appear to be applying an equal or greater amount of fertilizer. Lawn care companies usually offer service plans that consist of five or more visits per year. Unless a customer specifically requests a soil test or a special application rate, most lawn companies give every lawn serviced the same rate of fertilization (Morton 1988).

The travel distance between lawns and impervious areas can be short. Lawns with compacted soil, bare spots, steep slopes, and channelized areas have increased flow of fertilizer off the lawn. Leaching can also be a significant source of nitrogen in areas with sandy soils where lawns are overwatered and overfertilized (Cohen et al. 1990). In areas where soils are highly compacted, fertilizer can run off lawns easily. Also, lawns in urban areas are frequently interlaced with driveways, roads, and parking lots, which increase the chance for fertilizer to enter into storm sewers.

A review of three nitrate-leaching studies by turfgrass researchers generally shows that grass, when managed properly, can retain nitrogen fertilizer at the soil surface or within the root zone and thus prevent soluble nitrates from percolating downward into the environment. All soils were sandy or silty loam. The results of the study are given in Table D1. This research strongly suggests that efforts to educate homeowners about lawn care should stress the critical connection between fertilization and overwatering. The concept that careless watering can flush nitrogen throughout the soil and away from the grass should be strongly emphasized on both economic and environmental grounds.

Another important factor that affects fertilizer use is soils. Development usually involves grading the entire site, removing topsoil, erosion during construction, compaction by heavy equipment, and filling of depressions. Thus, urban soils tend to be highly compacted, poor in structure, and low in permeability. As a result, urban areas often produce more runoff than before they were disturbed and thus have more potential to lose fertilizer. A good lawn care program should also address soil building.

Some management strategies that would contribute to a reduction in urban nitrogen from fertilizer use are:

- Use fertilizers that are composed of slow-release sources of nitrogen. Products containing slow-release sources of nitrogen are usually called one or more of the following terms: water-insoluble, slow-release, controlled-release, or slowly-available water soluble.

- Lightly water after fertilizer application to allow penetration and reduce the potential for runoff.

- Use drop (gravity) type spreaders rather than centrifugal (rotary) type spreaders so that fertilizer will not be deposited on impervious surfaces.

- Aerate lawns to reduce surface runoff. Also, aeration results in a healthier lawn that does not require as many nutrient inputs. Aerating the soil can reduce the potential for nitrogen export when the soil is compacted or the lawn is on a slope or in a natural drainage area.

- Select the appropriate grass species to reduce the need to add nitrogen to the lawn.

- Water lawns only when they need it. When lawns are very thirsty, grass will lie flat and leave footprints when walked on, shrubs will droop or drop leaves and look wilted. Watering less often actually promotes deeper, more tolerant root systems (Alliance for the Chesapeake Bay 1994).

- Do not fill fertilizer applicators over a hard surface. Make sure that the spreader is off when passing over driveway, sidewalk, patio, etc. Clean up any spills immediately.

- Expansive lawn areas can be replace with equally attractive, efficient landscape alternatives, such as appropriate shrubs or ground covers that require less maintenance (Alliance for the Chesapeake Bay 1994).

- Involve the public and golf community in decisions that affect water quality. Perhaps they would be willing to accept a few brown patches in exchange for knowing that the course is not harming water quality.

Table D1. Nitrate Levels in Soil Water Depending on Turf Management Strategies (from Schueler 1994)

Grass type	Irrigation	Management	N applied (lbs/ac/yr)	N conc. (mg/l)	Researcher
Tall Fescue/ Bluegrass	not watered	Clippings removed	none	0.33	Gross et al. 1990 Maryland
Bluegrass	overwatered	Clippings left	none	0.36	Morton et al. 1988 Rhode Island
Bluegrass	slightly watered	Clippings left	none	0.51	Morton et al. 1988 Rhode Island
Tall Fescue/ Bluegrass	not watered	Granular fert. Clippings removed	196	0.85	Gross et al. 1990 Maryland
Bluegrass	slightly watered	Clippings left	86	0.87	Morton et al. 1988 Rhode Island
Tall Fescue/ Bluegrass	not watered	Liquid fert. Clippings removed	196	1.02	Gross et al. 1990 Maryland
Kentucky bluegrass	watered	Seeded clippings left	194	1.09	Geron et al. 1993 Ohio
Bluegrass	slightly watered	Clippings left	217	1.24	Morton et al. 1988 Rhode Island
Bluegrass	overwatered	Clippings left	86	1.77	Morton et al. 1988 Rhode Island
Kentucky bluegrass	watered	slow release clippings left	194	1.84	Geron et al. 1993 Ohio
Kentucky	watered	early season	194	2.27	Geron et al.

bluegrass		fert. Clippings left			1993 Ohio
Kentucky bluegrass	watered	late season fert. Clippings left	194	2.30	Geron et al. 1993 Ohio
Kentucky bluegrass	watered	fast release clippings left	194	2.74	Geron et al. 1993 Ohio
Kentucky bluegrass	watered	Sodded clippings left	194	3.50	Geron et al. 1993 Ohio
Bluegrass	overwatered	Clippings left	217	4.02	Morton et al. 1988 Rhode Island

Human Waste

Conventional septic systems are comprised of a septic tank, a distribution system, and a soil absorption system. In the septic tank, anaerobic bacteria digest organic matter, solids settle to the bottom, and low-density compounds such as oil and grease float to the water surface. Partially-treated wastewater then leaves the septic tank and enters the distribution box, where it is discharged into the soil absorption systems, also know as the drainage field.

In the drainage field, effluent percolates through the soil and remaining pollutants -- nutrients, suspended solids, bacteria, viruses, and organic/inorganic compounds -- are removed by filtration, adsorption, and microbial degradation (AGWT 990). The absorption system consists of a network of perforated pipes located in shallow trenches covered with backfill. Gravel usually surrounds the piped to encourage even distribution of the effluent into soil.

Even properly functioning septic systems can deliver significant pollutant loads to groundwater. The most common shortcoming of conventional septic systems is their inability to remove much nitrogen. It is not uncommon for the effluent leaving a typical system to have a total nitrogen concentration of 40 to 60 mg/l, primarily in the form of ammonia and organic nitrogen (CBO 1992). Once in the drainage field, organic nitrogen forms are easily converted into nitrates, which are quite soluble and easily mobilized, thus increasing the potential for ground and surface water contamination.

Some problems with septic system performance are related to what goes into them. Household chemicals entering a septic tank can kill organic-consuming bacteria or cause sludge and scum to be flushed out into the drainfield. Such chemicals can include various readily available septic system additives, which ironically are advertised as having the ability to improve system performance. Not only are some household chemicals detrimental to the septic system itself, but they often reach ground or surface waters where they cause toxicity problems.

Normal amounts of detergents, bleaches, drain cleansers, and toilet bowl deodorizers, however, can be used without causing harm to bacterial action in the septic tank (AGWT 1990). Properly operating septic systems must be located in a way to ensure both lateral distance between surface waters and vertical separation to groundwater. Also, drainfield areas must become larger when soils are not permeable or slopes are steep. Larger volumes of wastewater require larger drainfields.

Unfortunately, many conventional septic systems have been constructed in areas poorly suited for their proper operation. Many were installed before the need for separation distance was understood or because no other wastewater treatment option was available. Septic systems are suspected of contributing nutrients through subsurface flow. Malfunctioning systems may increase the nutrient loading beyond the assimilative capacity of the site soils and vegetation. This may result in excess nutrients being conveyed to surface waters via groundwater and subsurface flow of infiltrated stormwater.

While alternative systems have some benefits over conventional septic systems, it is important to recognize that no system can simply be installed and forgotten. Regular inspection and maintenance is a necessity. For example, septic tanks should be periodically pumped out, since solids and sludge tend to accumulate over time. North Carolina does not require regular pumpouts of conventional septic systems.

Alternative on-site wastewater treatment designs are attractive because of their decreased reliance on site conditions and their ability to remove pollutants that cannot be removed by conventional systems. Two options that are particularly promising for nitrogen removal are recirculating sand filters and constructed wetlands.

Table D2. Pollutant loadings from Septic Systems (Schueler, 1995)

On-site wastewater treatment system	TN (%)	TSS (%)	BOD (%)	Pathogens (Logs)	Capital ($/house)	Maint. ($/house/yr)
Conventional septic system	28	72	45	3.5	$4,500	$70
Recirculating sand filter	64	90	92	2.9	$3,900	$145
Constructed wetlands	90	80	81	4.0	$710	$25

To reduce the contribution of nitrogen from septic systems, the following measures are recommended:

- Homeowners should not use garbage disposals or pour grease down the drain.

- Septic systems should be inspected at least once every two years and pumped as needed (time interval varies with size, use, and operation).

- DWQ, DEH, and local health departments should increase educational efforts for homeowners to properly operate and maintain septic systems and other on-site wastewater treatment systems.
- DWQ, DEH, and local health departments should encourage installation of innovative on-site wastewater treatment systems where they are appropriate and where there is a commitment to ongoing care and maintenance.

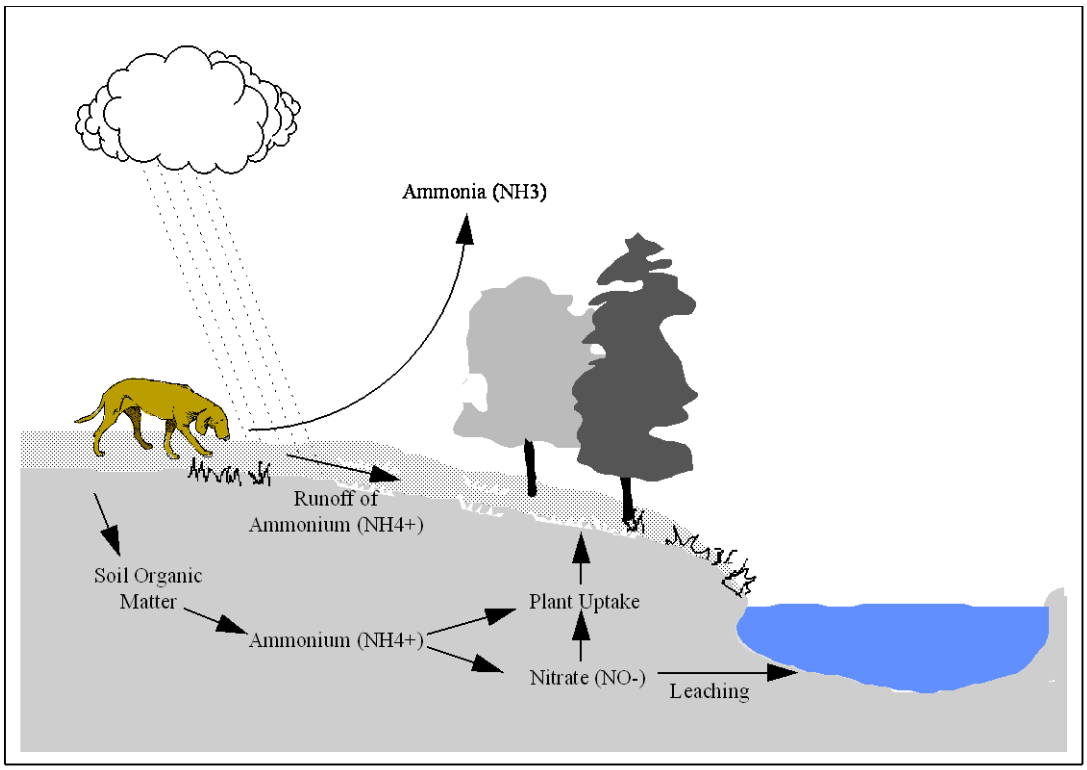
- DWQ, DEH, local health departments, and community groups should increase surveillance of their local streams to help to identify areas where on-site wastewater treatment systems are failing.

Another source of nitrogen from human waste is overflowing sanitary sewers. Often, maintaining infrastructure such as sanitary sewers does not receive a high priority for funding. Sometimes flow data at wastewater treatment plants indicates that there is a problem with leaking sewer lines, however it is extremely difficult to pinpoint the sources of the problem. It is recommended that this issue be addressed in this model program by educating citizens about how to detect and report an overflowing sanitary sewer line
.

Animal Waste

Like human wastes, pet wastes also present a concentrated source of nutrients, bacteria, and oxygen-demanding substances. If these wastes are not disposed of properly, they often enter storm sewers without any treatment. In fact, some pet owners actually deposit their pet's waste into storm drains. Figure D3 shows the nitrogen cycle of pet wastes in urban areas.

Figure D3. N Cycle of Pet Waste in Urban Areas



To reduce the contribution of nitrogen from pet wastes, the following measures are recommended:

- Pet owners should use proper disposal methods such as putting waste in the trash (some landfills prohibit animal wastes) or burying waste in the yard or using a pre-fabricated pet waste disposal unit (this may relocate the contribution from surface to subsurface nutrient loading).

- The public should be educated about proper methods of disposing of pet wastes.

- Storm drain stenciling can remind citizens that storm drains go directly to streams.

- Local ordinances should require proper pet waste disposal.

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Appendix E. The Phosphorus Cycle

(Text to be included at a later date)

Appendix F. Sources of Phosphorus in Developed Areas

(Text to be included at a later date)

Appendix G. Process of Developing the Model Stormwater Program

The Tar-Pamlico Stormwater Group has played a key role in developing the model program for controlling nutrients from urban stormwater in the Tar-Pamlico basin. Local governments have worked in cooperation with DWQ staff to create a model program that is technically sound and implementable. In February 2003, this program, along with the Group's recommendation, will be submitted to the Environmental Management Commission for their approval. Once approved, the program will serve as a model for all municipalities and counties in the Tar-Pamlico River basin that are required to develop a local stormwater program for nitrogen and phosphorus control.

Because of staffing shortages, DWQ was unable to initiate the Stormwater Group's meeting process in a timely manner. Staff convened the first meeting of the Group in February 2002. To provide adequate time for the Group to carry out its charge, staff sought and received approval from the Water Quality Committee of the EMC to return with a model program in early 2003 instead of April 2002.

The Stormwater Group met at least once a month, usually on the third Thursday, between February 2002 and January 2003 to develop the model program. In addition, in most months the New Development Subgroup met again separately, between full Group meetings, to provide sufficient time to deal with the large number of issues found in that part of the model. Meetings were typically held in the Nash County Office Building, a central location in the basin.

To help the Group meet its timeframes, DWQ obtained a Section 319 grant to hire a contractor to develop phosphorus export values, to update nitrogen export values, to summarize BMP phosphorus efficiencies, and to modify the project export calculation methodology accordingly. The contractor began work in October, brought initial results to the Group in November, and provided final model additions in December.

Steve Smutko, Director of the Natural Resources Leadership Institute at North Carolina State University, gave a presentation at an early meeting that provided the Group with tools to more effectively achieve results that would be acceptable to all. Using Section 319 funds, staff contracted a facilitator, Bill Sanford, through NRLI to aid the Group's process. Bill participated full-time beginning in November, and helped the Group through the latter stages of agreement seeking.

Group members divided themselves into three subgroups as follows:

- New Development Review/Approval
- Public Education
- Stormwater Retrofits/Illegal Discharges

The majority of the work involved in gathering information and formulating proposals occurred in the three subgroups. Each of the subgroups designated a chair who was responsible for keeping discussions running smoothly and on task. The subgroups were largely responsible for setting their agendas and priorities. However, they also had input from the full Group.

All approval decisions about the model stormwater program were ultimately made in a forum that included the full Group. All decisions about the model program were made by consensus.

The participants agreed to the following responsibilities as team members:

1. Follow-through on commitments to the Stormwater Group, including completing background reading, preparing information and reviewing Group proposals.
2. Report back to the jurisdiction/group they are representing on the progress of the Stormwater Group and bring feedback back to the team.
3. Provide constructive input into the strategies that are developed by the Stormwater Group.
4. Work within their appropriate realm of influence to contribute to the successful implementation of the local stormwater program developed by the Stormwater Group.

The deliverable of the Tar-Pamlico Stormwater Group is this model stormwater management program, which consists of the following:

1. A model program for evaluating new developments to determine if they meet nutrient control standards.

2. Model criteria for identifying appropriate retrofit sites.

3. Guidance for implementing an illegal discharges program.

4. A model educational program to reduce nutrients in urban stormwater.

The Stormwater Group will plan to continue to meet at a minimum of once a year in August (before the annual reports are due). The team may meet more often if it so chooses.

Approach for Meeting the New Development Review/Approval Requirements

Early in the process, the Group reviewed and approved a charter of operation that described the nature of the final product. The model would attempt to assemble supporting technical information needed to address each rule element, and would identify

technically sound and implementable options for technical methods and programmatic and legal issues.

To its great advantage, the Group had a template to work from in the form of the Neuse model stormwater program. Stakeholders in the adjacent Neuse River Basin had conducted a similar effort during 1998-1999 to comply with the provisions of the Neuse stormwater rule, which was the progenitor of the Tar-Pamlico stormwater rule.

While the two rules were the same in many regards, the Tar-Pamlico rule incorporated several unique provisions in an effort to learn from the Neuse experience and to address strategy-specific issues. These unique provisions required the Group to develop new elements in the model.
Two unique provisions in the Tar-Pamlico rule were intended to provide greater flexibility to achieve nutrient reductions by allowing use of offsite options. One was the option for local governments to develop regional facilities or jurisdiction-wide strategies within their programs to give developers more options. The other option allows projects to achieve partial offsite loading reduction by retrofitting existing developed sites. These options were included in part because Neuse local governments had expressed a desire late in their model development process to be given greater flexibility in complying with the rule than strict onsite controls would allow.

Another unique provision in the Tar-Pamlico rule stemmed from the explicit requirement in the Tar-Pamlico nutrient strategy to hold phosphorus loading at baseline, 1991, levels. This provision was embodied in the rule as a numeric phosphorus-loading requirement in addition to the nitrogen requirement for new development. This provision required the collection and synthesis of research data applicable to basin conditions on phosphorus export from different land uses and on phosphorus removal efficiencies by various BMPs. At the same time, the nitrogen export and BMP efficiency information was in need of update.

Given the breadth of issues the Group faced, the Division chose to contract development of the phosphorus and nitrogen data and export calculation methodology to stormwater professionals at North Carolina State University. The contractor's staff included Annette Lucas, who had led the Neuse model development process for the Division, and who was familiar with the various challenges involved in designing a methodology for nutrient export.

The contractor synthesized event mean concentration values for phosphorus export from different land covers, updated the nitrogen concentration values, and applied them to Schueler's Simple Method, as done in the Neuse model, to allow determination of annual mass loading values for development projects. Concentration values were synthesized from the urban areas of Raleigh, Durham, Fayetteville, and Norfolk VA. These concentration data were chosen because they were required under NPDES Phase I permits, used a consistent EPA collection methodology, were close to the Tar-Pamlico Basin, were recent, and provided fairly large datasets characterizing various urban land covers.

The contractor collected data on available nutrient reducing BMPs based on studies conducted in similar climatic conditions in the Southeast (states of MD, VA, NC, SC, TX and FL). The credit given for nitrogen and phosphorus removal reflects median values of removals found in the chosen set of studies. As the charts in Section 5-E show, the removal rates found for similar BMPs vary widely in different studies.

The Group also discussed maintenance of BMPs. There was consensus that maintenance of BMPs is vital to their ongoing performance and that this will not be accomplished without appropriate policies in place.

Approach for Meeting the Illegal Discharge Requirements

In crafting the model program for Illegal Discharges, the Tar-Pamlico Stormwater Group reviewed and accepted the Neuse guidance with only minor modifications. The Neuse guidance relied heavily on the experiences of the communities that have already been implementing Illegal Discharge programs under their Phase I NPDES Municipal Stormwater Permits (Raleigh and Durham). The main goal of the team was to find the most cost-effective and efficient means of preventing, identifying and removing Illegal Discharges.

The team's goal for a cost-effective and efficient program is reflected in the following aspects of the model Illegal Discharges program:

- Local governments are not being asked to create new maps of their jurisdictions showing locations of infrastructure, land uses, surface waters, etc. Instead, they are required to compile existing information so it can be consulted efficiently when needed.
- Each year, local governments are required to select a high priority area (consisting of at least ten percent of their jurisdictions) where they will focus their mapping and field screening efforts. The stormwater collection system mapping and field screening will be done only in the high priority areas, not across the entire jurisdiction. This approach also attempts to build in equitability in that the size of the high priority area will be proportional to the size of the overall jurisdiction.
- Local governments are required to establish an Illegal Discharges Hotline. This effort requires minimal resources but, based on the experiences of Raleigh and Durham, is effective at identifying illegal discharges. When the discharge is of an episodic nature, it may be the only way to identify an illegal discharge.

Appendix H. Export Calculation Worksheets and Supporting Information

This appendix contains a set of manual worksheets 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. Supporting information on the development of BMP efficiencies is found in Appendix I.

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://h2o.enr.state.nc.us/nps/tarpam.htm. The files may also be obtained from the DWQ staff contact for the Tar-Pamlico nutrient strategy.

- 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 (1 pg.)
  2. Residential Worksheet when Footprints are not Shown (1 pg.)
  3. Export Calculation Worksheet for Coastal Plain Communities (1 pg.)
  4. BMP Removal Calculation Worksheet for Coastal Plain Communities (3 pp.)
  5. Export Calculation Worksheet for Piedmont Communities (1 pg.)
  6. BMP Removal Calculation Worksheet for Piedmont Communities (3 pp.)

- The remainder of this appendix is a report describing the development of the nutrient export model, provided by contractors with North Carolina State University.

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.

Project Name: _____

Date: _____

By: _____

Directions:

- 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.

- **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$^{-0.48}$ to get transportation impervious - enter this in the second box. Then, multiply 0.059*total acreage in lots*average lot size$^{-0.48}$ 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).

- **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).

- **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.

- **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.

Average lot size = _____ ac (Must show building footprints if lot size < 0.13 ac.)

% impervious in right-of-way = _____ %

(1)	(2)	(3)	(4)	(5)
Type of Land Cover	**Lot area (ac)**	**Right-of-way area (ac)**	**Community areas (ac)**	**Sum of Columns (2), (3), and (4)**
TOTAL				
Transportation impervious				
Roof impervious				
Managed pervious				
Wooded pervious				

Coastal Plain of the Tar-Pamlico River Basin:

Includes Greenville and Washington as well as Pitt and Beaufort Counties

Nitrogen and Phosphorus Load Calculation Worksheet (Manual)

Project Name: _____

Date: _____

By: _____ Checked By: _____

Directions (same for pre-development and post-development tables):

- **Column (2):** Enter the acres in each land use in all but the bottom two boxes. Add entries to get Total Area of Development (bottom box). Divide Impervious total (Transport. + Roof) by Total Area of Development; enter in Fraction Impervious box.
- **Column (3):** Compute 0.51 + 9.1*I and enter this number in all unshaded 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 box except the bottom two, enter the product of Columns (2), (3) and (4) in that row. Determine TN loading in the next-to-last box by adding the boxes above. Divide the result by the total area of development from column (2) to determine the TN export coefficient for the bottom box.
- **Column (6):** TP land use coefficients are already entered for each land use.
- **Column (7):** In each box except the bottom two, enter the product of Columns (2), (3) and (6) in that row. Determine TP loading in the next-to-last box by adding the boxes above. Divide the result by the total area of development from column (2) to determine the TP export coefficient for the bottom box.

Pre-development:

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.51 + 9.1 I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious			**2.60**		**0.40**	
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) =			**TN Loading (lb/yr) =**		**TP Loading (lb/yr) =**	
Total Area of Development =			**TN Exp. Coeff. (lb/ac/yr) =**		**TP Exp. Coeff. (lb/ac/yr) =**	

Post-development:

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.51 + 9.1 I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
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) =**	

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.

Coastal Plain of the Tar-Pamlico River Basin:

Includes Greenville and Washington as well as Pitt and Beaufort Counties

BMP Removal Calculation Worksheet (Manual)

Project Name: _____

Date: _____

By: _____ Checked By: _____

BMP Nutrient Removal Efficiencies

	TN	TP
Wet Detention Pond	**25**	**40**
Stormwater Wetland	**40**	**35**
Sand Filter	**35**	**45**
Bioretention	**40**	**35**
Grass Swales	**20**	**20**
Vegetated Filter Strip w/ Level Spreader	**30**	**30**

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:

  $$\text{removal rate}_1 + \text{removal rate}_2 - (\text{removal rate}_1 * \text{removal rate}_2)/100.$$

- **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 seventh box. Divide impervious area by total development area and enter it in the sixth box.
- **Column (3):** Compute 0.51 + 9.1*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:

Total acreage of catchment 1 = _____ ac

First BMP's TN removal rate = _____ %

Second BMP's TN removal rate = _____ %

TOTAL TN REMOVAL RATE = _____ %

First BMP's TP removal rate = _____ %

Second BMP's TP removal rate = _____ %

TOTAL TP REMOVAL RATE = _____ %

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.51 + 9.1 I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
Area taken up by BMP			**1.95**		**0.15**	
Fraction Impervious (I) =			**Pre-BMP TN Load (lb/yr) =**		**Pre-BMP TP Load (lb/yr) =**	
Total Area of Development =			**Pre-BMP TN Export (lb/ac/yr) =**		**Pre-BMP TP Export (lb/ac/yr) =**	
			Post-BMP TN Load (lb/yr) =		**Post-BMP TP Load (lb/yr) =**	
			Post-BMP TN Export (lb/ac/yr) =		**Post-BMP TP Export (lb/ac/yr) =**	

Catchment 2:

Total acreage of catchment 2 = _____ ac

First BMP's TN removal rate = _____ %

Second BMP's TN removal rate = _____ %

TOTAL TN REMOVAL RATE = _____ %

First BMP's TP removal rate = _____ %

Second BMP's TP removal rate = _____ %

TOTAL TP REMOVAL RATE = _____ %

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.51 + 9.1 I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
Area taken up by BMP			**1.95**		**0.15**	
Fraction Impervious (I) =			**Pre-BMP TN Load (lb/yr) =**		**Pre-BMP TP Load (lb/yr) =**	
Total Area of Development =			**Pre-BMP TN Export (lb/ac/yr) =**		**Pre-BMP TP Export (lb/ac/yr) =**	
			Post-BMP TN Load (lb/yr) =		**Post-BMP TP Load (lb/yr) =**	
			Post-BMP TN Export (lb/ac/yr) =		**Post-BMP TP Export (lb/ac/yr) =**	

Catchment 3:

Total acreage of catchment 3 = _____ ac

First BMP's TN removal rate = _____ %

Second BMP's TN removal rate = _____ %

TOTAL TN REMOVAL RATE = _____ %

First BMP's TP removal rate = _____ %

Second BMP's TP removal rate = _____ %

TOTAL TP REMOVAL RATE = _____ %

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.51 + 9.1 I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
Area taken up by BMP			**1.95**		**0.15**	
Fraction Impervious (I) =			**Pre-BMP TN Load (lb/yr) =**		**Pre-BMP TP Load (lb/yr) =**	
Total Area of Development =			**Pre-BMP TN Export (lb/ac/yr) =**		**Pre-BMP TP Export (lb/ac/yr) =**	
			Post-BMP TN Load (lb/yr) =		**Post-BMP TP Load (lb/yr) =**	
			Post-BMP TN Export (lb/ac/yr) =		**Post-BMP TP Export (lb/ac/yr) =**	

Weighted Average of Nutrient Loadings from the Catchments:

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:
[(catchment area$_1$ * export coeff.$_1$) + (catchment area$_2$ * export coeff.$_2$) + (catchment area$_3$ * export coeff.$_3$)]/(total area of development).

	Area (ac)	Post-BMP TN Export Coeff. (lb/ac/yr)	Post-BMP TP Export Coeff. (lb/ac/yr)
Catchment 1			
Catchment 2			
Catchment 3			
TOTAL FOR DEVELOPMENT			

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

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)

Project Name: _____

Date: _____

By: _____ Checked By: _____

Directions (same for pre-development and post-development tables):

- **Column (2):** Enter the acres in each land use in all but the bottom two boxes. Add entries to get Total Area of Development (bottom box). Divide Impervious total (Transport. + Roof) by Total Area of Development; enter in Fraction Impervious box.
- **Column (3):** Compute 0.46 + 8.3*I and enter this number in all unshaded 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 box except the bottom two, enter the product of Columns (2), (3) and (4) in that row. Determine TN loading in the next-to-last box by adding the boxes above. Divide the result by the total area of development from column (2) to determine the TN export coefficient for the bottom box.
- **Column (6):** TP land use coefficients are already entered for each land use.
- **Column (7):** In each box except the bottom two, enter the product of Columns (2), (3) and (6) in that row. Determine TP loading in the next-to-last box by adding the boxes above. Divide the result by the total area of development from column (2) to determine the TP export coefficient for the bottom box.

Pre-development:

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.46 + 8.3*I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious			**2.60**		**0.40**	
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) =			**TN Loading (lb/yr) =**		**TP Loading (lb/yr) =**	
Total Area of Development =			**TN Exp. Coeff. (lb/ac/yr) =**		**TP Exp. Coeff. (lb/ac/yr) =**	

Post-development:

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.46 + 8.3*I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
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) =**	

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.

Piedmont of the Tar-Pamlico River Basin:

Includes Oxford, Henderson, Rocky Mount and Tarboro as well as Franklin, Nash and Edgecombe Counties

BMP Removal Calculation Worksheet (Manual)

Project Name: _____

Date: _____

By: _____ Checked By: _____

BMP Nutrient Removal Efficiencies

	TN	TP
Wet Detention Pond	**25**	**40**
Stormwater Wetland	**40**	**35**
Sand Filter	**35**	**45**
Bioretention	**40**	**35**
Grass Swales	**20**	**20**
Vegetated Filter Strip w/ Level Spreader	**30**	**30**

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:

  $$\text{removal rate}_1 + \text{removal rate}_2 - (\text{removal rate}_1 * \text{removal rate}_2)/100.$$

- **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 seventh box. Divide impervious area by total development area and enter it in the sixth 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:

Total acreage of catchment 1 = _____ ac

First BMP's TN removal rate = _____ %

Second BMP's TN removal rate = _____ %

TOTAL TN REMOVAL RATE = _____ %

First BMP's TP removal rate = _____ %

Second BMP's TP removal rate = _____ %

TOTAL TP REMOVAL RATE = _____ %

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.46 + 8.3*I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
Area taken up by BMP			**1.95**		**0.15**	
Fraction Impervious (I) =			**Pre-BMP TN Load (lb/yr) =**		**Pre-BMP TP Load (lb/yr) =**	
Total Area of Development =			**Pre-BMP TN Export (lb/ac/yr) =**		**Pre-BMP TP Export (lb/ac/yr) =**	
			Post-BMP TN Load (lb/yr) =		**Post-BMP TP Load (lb/yr) =**	
			Post-BMP TN Export (lb/ac/yr) =		**Post-BMP TP Export (lb/ac/yr) =**	

Catchment 2:

Total acreage of catchment 2 = _____ ac

First BMP's TN removal rate = _____ %

Second BMP's TN removal rate = _____ %

TOTAL TN REMOVAL RATE = _____ %

First BMP's TP removal rate = _____ %

Second BMP's TP removal rate = _____ %

TOTAL TP REMOVAL RATE = _____ %

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.46 + 8.3*I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
Area taken up by BMP			**1.95**		**0.15**	
Fraction Impervious (I) =			**Pre-BMP TN Load (lb/yr) =**		**Pre-BMP TP Load (lb/yr) =**	
Total Area of Development =			**Pre-BMP TN Export (lb/ac/yr) =**		**Pre-BMP TP Export (lb/ac/yr) =**	
			Post-BMP TN Load (lb/yr) =		**Post-BMP TP Load (lb/yr) =**	
			Post-BMP TN Export (lb/ac/yr) =		**Post-BMP TP Export (lb/ac/yr) =**	

Catchment 3:

Total acreage of catchment 3 = _____ ac

First BMP's TN removal rate = _____ %

Second BMP's TN removal rate = _____ %

TOTAL TN REMOVAL RATE = _____ %

First BMP's TP removal rate = _____ %

Second BMP's TP removal rate = _____ %

TOTAL TP REMOVAL RATE = _____ %

(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.46 + 8.3*I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6
Transportation impervious			**2.60**		**0.40**	
Roof impervious			**1.95**		**0.15**	
Managed pervious			**1.42**		**0.31**	
Wooded pervious			**0.94**		**0.14**	
Area taken up by BMP			**1.95**		**0.15**	
Fraction Impervious (I) =			**Pre-BMP TN Load (lb/yr) =**		**Pre-BMP TP Load (lb/yr) =**	
Total Area of Development =			**Pre-BMP TN Export (lb/ac/yr) =**		**Pre-BMP TP Export (lb/ac/yr) =**	
			Post-BMP TN Load (lb/yr) =		**Post-BMP TP Load (lb/yr) =**	
			Post-BMP TN Export (lb/ac/yr) =		**Post-BMP TP Export (lb/ac/yr) =**	

Weighted Average of Nutrient Loadings from the Catchments:

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:
[(catchment area$_1$ * export coeff.$_1$) + (catchment area$_2$ * export coeff.$_2$) + (catchment area$_3$ * export coeff.$_3$)]/(total area of development).

	Area (ac)	Post-BMP TN Export Coeff. (lb/ac/yr)	Post-BMP TP Export Coeff. (lb/ac/yr)
Catchment 1			
Catchment 2			
Catchment 3			
TOTAL FOR DEVELOPMENT			

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

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:

$$\mathbf{L = P * P_i * R_v * C * 0.227}$$

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).
$\mathbf{P_i}$ is a correction factor for storms with no runoff (0.9).
$\mathbf{R_v}$ is the runoff coefficient equal to 0.05 + 0.9I (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_v 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.

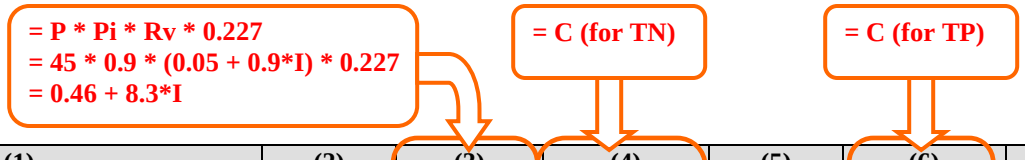
4. **Wooded pervious:** The portion of the development that consists of forested areas that are permanently protected by a conservation easement or other binding conservation mechanism. Also, wetlands and the land in Zone 1 of a protected riparian buffer (the first 30 feet adjacent to a stream) may be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

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

$$L_{transportation} = P * P_i * R_v * C_{transportation} * 0.227$$
$$L_{roof} = P * P_i * R_v * C_{roof} * 0.227$$
$$L_{managed} = P * P_i * R_v * C_{managed} * 0.227$$
$$L_{wooded} = P * P_i * R_v * C_{wooded} * 0.227$$

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



(1) Type of Land Cover	(2) Area (acres)	(3) S.M. Formula (0.46 + 8.3I)	(4) Average EMC of TN (mg/L)	(5) Column (2) * (3) * (4)	(6) Average EMC of TP (mg/L)	(7) Column (2) * (3) * (6)
Transportation impervious			2.60		0.40	
Roof impervious			1.95		0.15	
Managed pervious			1.42		0.31	
Wooded pervious			0.95		0.14	
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.

Table 1. Summary of Water Quality Data Collected to Support the Model

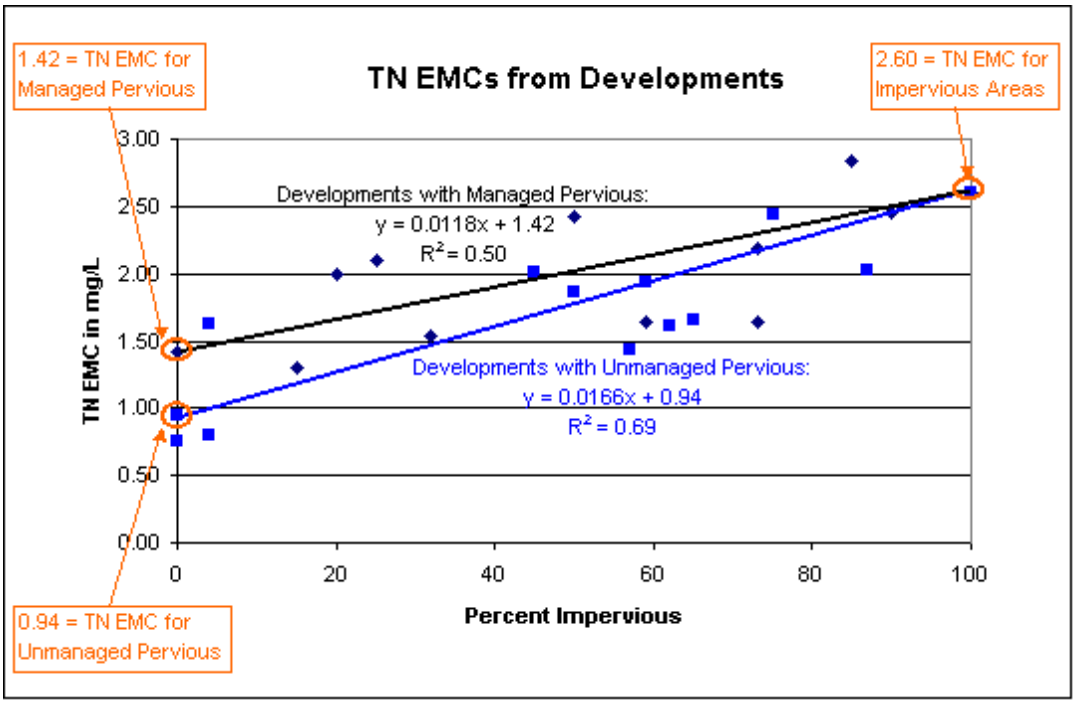
City	Managed or Unmanaged?	Outfall Name	Land Use	Imperv-ious (%)	TN EMC (mg/L)	TP EMC (mg/L)
Durham	managed	Chateau	Low Residential	15	1.30	0.32
Fayetteville	managed	clea	Low Residential	20	1.99	0.19
Chesapeake	managed	999	Med Residential	25	2.09	0.25
Durham	managed	Northgate	Med Residential	32	1.53	0.50
Chesapeake	managed	002	Med Residential	50	2.43	0.37
Raleigh	managed	7	Mixed	59	1.64	0.46
Raleigh	managed	4	Commercial	73	1.64	0.46
Durham	managed	Wortham	Commercial	73	2.18	0.39
Chesapeake	managed	007	Commercial	85	2.83	0.26
Fayetteville	managed	elms	Commercial	90	2.46	0.42
Best-fit point for 0% imperviousness:				0	1.42	0.31
Best-fit point for 100% imperviousness:				100	2.60	0.40
Fayetteville	unmanaged	strk	Open	0	0.75	0.10
Durham	unmanaged	Maplewood	Open	4	0.80	0.13
Raleigh	unmanaged	1	Open	4	1.62	0.28
Fayetteville	unmanaged	71st	Insitutional	45	2.02	0.23
Fayetteville	unmanaged	rose	Mixed	50	1.86	0.20
Chesapeake	unmanaged	008	Industrial	57	1.43	0.20
Durham	unmanaged	Academy I	High Residential	62	1.61	0.24
Durham	unmanaged	Maxwell	Industrial	65	1.66	0.31
Durham	unmanaged	Academy II	Mixed	59	1.94	0.49
Fayetteville	unmanaged	wins	Industrial	75	2.44	0.25
Raleigh	unmanaged	5	Light Industry	87	2.03	0.40
Best-fit point for 0% imperviousness:				0	0.94	0.14
Best-fit point for 100% imperviousness:				100	2.60	0.40

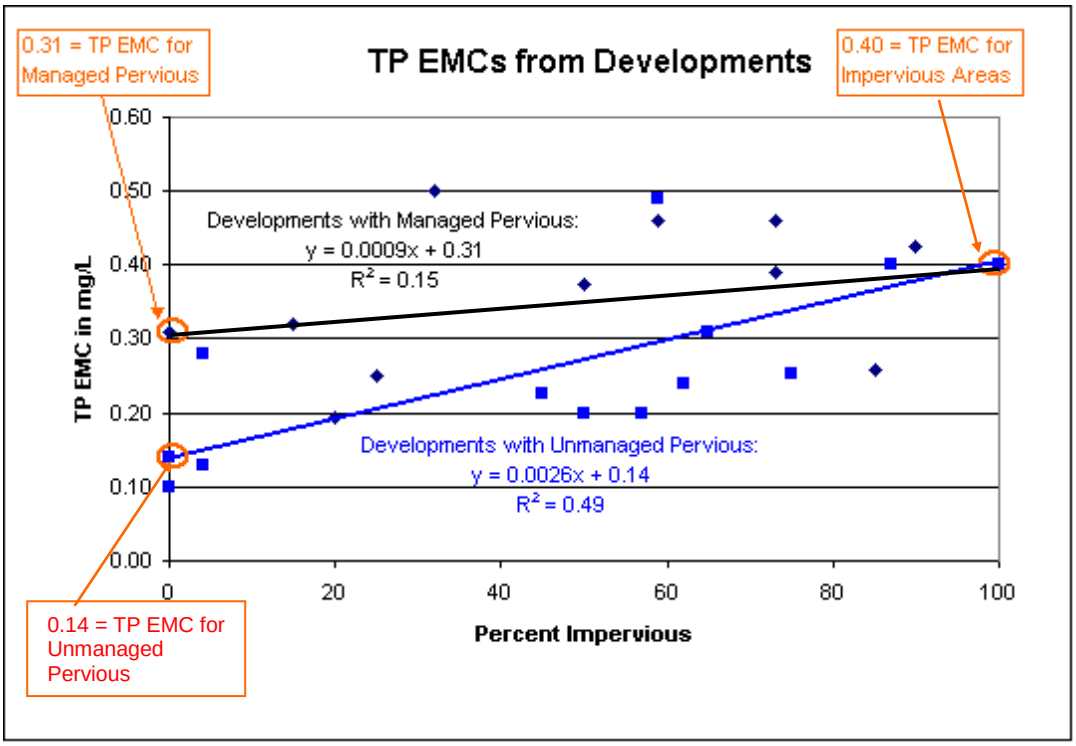
The researchers analyzed the monitoring data listed above to determine appropriate EMCs for TN and TP for impervious, managed pervious and unmanaged pervious using this process:

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 below shows the graphs and illustrates how the EMCs were determined.

Figure 2. Graphs of the TN and TP EMCs from the Monitoring Sites





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

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

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.

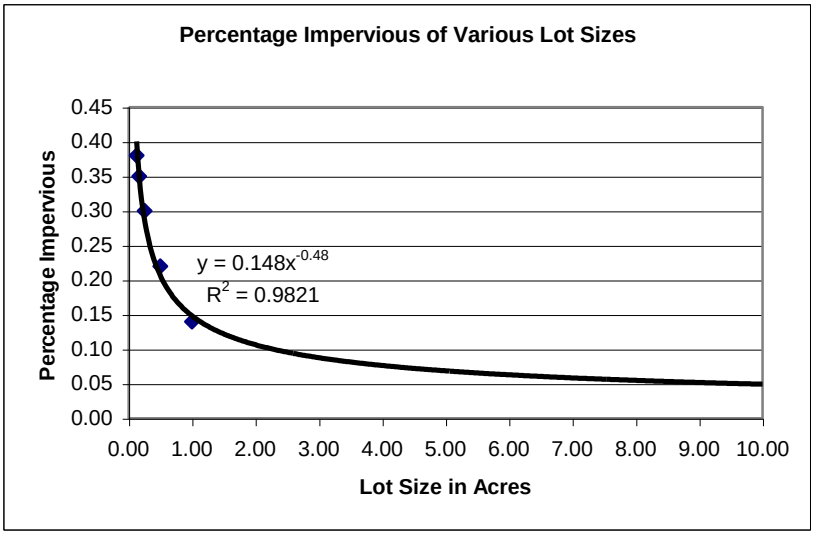
The City of Raleigh has done a study of its various zoning categories (in dwelling units per acre) and the corresponding levels of imperviousness that would be expected per lot. For the purpose of this model, the dwelling units per acre were converted to average lot size in acres and graphed with lot 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:

Percentage impervious = 0.148 * (average lot size)$^{-0.48}$

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

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

Figure 3. Graph of Lot Size Versus Percentage Impervious



Based 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:

$$\textbf{Transportation impervious} = 0.089 * (\text{average lot size})^{-0.48}$$
$$\textbf{Roof impervious} = 0.059 * (\text{average lot size})^{-0.48}$$

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.

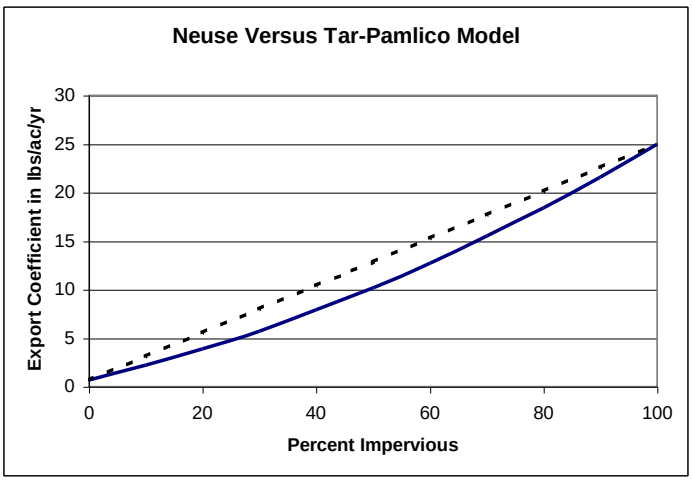
In addition to computing the pre- and post-development TN and TP export coefficients, the Tar-Pamlico model also computes export coefficients from developments after BMP installation. A review of the efficiencies follows in the next section.

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.

Figure 4. Results of Neuse Versus Tar-Pamlico Nutrient Export Models



References: Please see the references section at the end of Appendix I.

Appendix I. Summary of BMP Literature Studies

Establishment of Nutrient Removal Rates for Stormwater BMPs 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

Assigning Removal Efficiencies to Five Stormwater BMPs

The construction of pavement and buildings, and the clearing of land, increase the volume and speed of stormwater runoff. When impervious or disturbed areas are created by urban construction activities, and stormwater is not adequately managed, the environment may be adversely affected by: (1) changes in volume, timing, and location of the stormwater discharges, and (2) the movement of pollutants from the site to waterbodies such as tributaries reaching the Tar-Pamlico River System and the Pamlico Sound and estuarine system. This contributes to flooding and damage to property and habitat (stormwater quantity impacts). It also contributes to lowering of water quality, by increasing the flow of human pollutants such as oil, fertilizers and pesticides, and the flow of natural elements such as nitrogen, phosphorus and sediment into the water (stormwater quality impacts). Degradation of lakes, streams and wetlands due to urban stormwater reduces property values, raises bills from public water utilities and reduces tourism and related business income.

The following sections will examine several stormwater Best Management Practices (BMPs) and present a model for estimating BMP removal efficiencies. This model is intended to serve the Tar-Pamlico basin, and as such only a limited amount of data is used to estimate pollutant removal efficiencies. Only BMPs from sites with relatively similar weather to that of Central and Eastern North Carolina are included in the study. Because of this, there are some differences in pollutant removal rates reported herein and those from national studies that do not make adjustments for weather regimes. Furthermore, even when only examining studies from the Southeastern and Mid-Atlantic states, there is evidenced a very wide range of removal efficiencies within a practice type. This is due to site specific factors such as soil type, monitoring period (a wet year or a dry year), or type of sample (grab or composite). Only data from sites that are within certain standards are used to compute removal efficiencies, with data from known North Carolina studies given the most weight. Finally, as more and more data is found regarding the effectiveness of stormwater best management practices, such as bio-retention, the removal rates will be expected to change. This report illustrates this point with respect to bio-retention cells. The removal rate has been adjusted from that of the Neuse Stormwater plan due to the influx of data from new studies. The study of stormwater BMPs is dynamic and perhaps the State of North Carolina should consider annual or bi-annual updates of removal efficiencies.

Structural Stormwater BMPs

An urban stormwater BMP is believed to be a 'best' way of treating or limiting pollutants in stormwater runoff. Certain BMPs are better under certain conditions than others. The size of the watershed, the imperviousness of the watershed, and the amount of available land for the structure all influence the selection of a BMP. The stormwater treatment practices investigated in this study are solely structural devices and include wet ponds, stormwater wetlands, bio-retention areas, grassy swales and sand filters.

Wet Ponds, also called wet detention ponds or facilities, have been used in North Carolina longer than any other stormwater BMP. Wet Ponds are runoff-holding facilities that have standing water in them constantly. Storm flows are held in the pond temporarily and then released to minimize large scale flooding. Wet ponds are characterized by larger excavation volumes and have forebays located where the inflow enters the BMP. The primary removal mechanism is settling while stormwater runoff resides in the pool. Nutrient uptake also occurs through biological activity in the pond. Wet ponds can be designed to have vegetated fringes or zones (as in Figure 5), and the plant roots hold sediment and use the nutrients that are often contained in urban runoff. Developers can design the wet ponds to look like natural lakes and enhance the value of surrounding property. Mosquito larvae-eating fish live in the pond to keep mosquito problems to a minimum. Wet ponds can be used for any size of drainage area. In North Carolina, wet ponds treat watersheds as small as 0.75 acres and as large as several hundred acres. Wet ponds may cause community concerns regarding safety; there is an increased liability due to drowning risk because of their relative depth. Additionally, wet pond effluent is often warmer than base stream water, causing thermal pollution and potentially damaging downstream aquatic habitats.

Figure 5. Wet Pond with Aquatic Fringe

Stormwater Wetlands,[1] also called constructed wetlands, are comparable to wet ponds but are much shallower and more heavily vegetated with wetland plants. In many stormwater wetlands the average depth of water is approximately 1-1.5 feet. They serve as a natural filter for urban runoff and also help to slow the flow of water to the receiving waters and replenish ground water. As stormwater runoff flows through the wetland, pollutant removal is achieved by settling, adsorption and biological uptake within the practice. Wetlands are effective stormwater practices in terms of pollutant removal and also offer aesthetic value. When properly designed (Figure 6), stormwater wetlands have excellent wildlife habitat potential (MWCOG, 1992). In North Carolina, constructed stormwater wetlands have been located on watersheds as small as four to five acres, but they are most commonly used for larger drainage areas and typically serve watersheds ranging from 15 acres to over 100 acres. Thanks to its vegetative cover, wetland effluent is typically cooler than that of wet ponds, minimizing the impacts of thermal pollution.

Figure 6. Stormwater Wetlands can be designed to incorporate diverse vegetative species.

[1] For regulatory purposes under the Clean Water Act, the term wetlands means "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

There are also some limitations to stormwater wetlands. Wetlands consume a relatively large amount of space making them an impractical option on sites where surface land area is constrained or land prices are high. They have, therefore, limited applicability in highly urbanized settings. There can also be a public perception that wetlands are a mosquito source, although design features can minimize the potential of wetlands becoming a breeding area for mosquitoes (McLean, 2000).

Wetlands and Wet Ponds: When choose which?

Wetlands and Wet Ponds are similar practices in that each tends to treat larger watersheds, have standing water year round, and are sited in roughly the same types of locations. There are advantages to each that lead a designer to select one over the other. These selection guidelines are summarized below:

1. Wet Ponds are substantially deeper than stormwater wetlands. A four feet difference in average depth can lead to a 50% increase in construction cost. If land costs are relatively low, a stormwater wetland will be a less expensive stormwater BMP to construct, even though wetlands do have the added cost of vegetation purchase and planting.
2. Stormwater wetlands typically occupy more land than wet ponds. This is due to the fact that the height of water rise over normal pool (the elevation at which the water is typically) is much higher in a wet pond than a wetland. This relates to a wet pond's surface area only approaching 60-70% of that of a stormwater wetland. In areas where land costs are relatively higher, the opportunity cost of using extra land may easily offset the increased cost of constructing a wet pond, making the wet pond a more economically viable option.
3. Contrary to initial estimation, wet ponds do not cost less than wetlands to maintain. This is due to the nature of each BMP. A standard wet pond used as an amenity is often well-manicured, with the surrounding lawn mowed to the banks and all vegetation along the side (wetland plants) being killed by direct herbicide application. The wetland's plants are designed to maintain a natural state; that is, there is very little cosmetic maintenance to a wetland when compared to many wet ponds. Other maintenance needs such as outlet inspection and forebay cleaning are the same for each practice. Long term maintenance needs for a stormwater wetland do potentially include plant harvesting, but a recent study by Wossink and Hunt (2003) suggests that wet pond maintenance in the long run is substantially higher than that of stormwater wetlands.
4. Liability issues are present for each practice. Ponds tend to be much deeper so the risk of drowning is higher for wet ponds than it is for wetlands. However, wetlands are excellent environments for animals such as frogs and snakes, with the latter potentially being an issue of concern, if there is easy and uncontrolled access to the stormwater wetland by young children.
5. Aesthetics can be a determining factor in BMP selection. If an open water surface is desired for aesthetic reasons, then a wet pond will be more appropriate than a stormwater wetland. To many, a stormwater wetland is still viewed as a "swamp" and has unfavorable connotations to some.
6. The state of North Carolina counts a stormwater wetland to be a riparian buffer, but the state does not view a wet pond to be the same. This is important when a new development is required to install buffers around all blue-line (from a USGS topographic map) bodies of water. If a pond is constructed in a watershed with buffer requirements

(such as the Tar-Pamlico basin), it would then need to have a 50' buffer established around its perimeter. This land would need to be dedicated apart from a developed activity in addition to the surface area of the wet pond. A wetland, since it is vegetated already, does not need a buffer to be established in addition to itself.

7. Pollutant removal rates perhaps provide the biggest incentive to choose one practice over the other. If a stormwater wetland is credited with a better pollutant removal rate, say, for phosphorus, than a wet pond, a developer can just barely meet the nutrient reduction requirement by installing a stormwater wetland in lieu of a wet pond, then the former BMP will be selected.

Three other practices are used to treat smaller watersheds. Each of the three is reviewed below.

Sand filters are usually two-chambered stormwater treatment practices; the first chamber is for settling, and the second is a filter bed filled with sand or another filtering media. As stormwater flows into the first chamber, large particles settle out, and the finer particles and other pollutants are removed as stormwater flows through filtering media. At the bottom of the sand layer, an underdrain pipe typically connects the treated water with the existing drainage network. Sand filters, in general, are good options for relatively small drainage areas in ultra-urban environments where space is limited and original soils have been disturbed (as in Figure 7).

Figure 7. Sand filters can be designed to sustain vehicular traffic or not as is the case at this site in Durham.

Moreover, sand filters are particularly well suited to treat runoff from stormwater hotspots[2] common in ultra urban areas because stormwater treated by sand filters has no interaction with, and thus no potential to contaminate groundwater.

Sand filters are best applied on small sites and can be used on sites with up to about 6% slopes. It is difficult to use sand filters in extremely flat terrain, as they require a significant drop in elevation (ranging from two to five feet) to allow runoff flow through the filter. There are several modifications of the basic sand filter design, including the surface sand filter, underground sand filter and the perimeter sand filter. All of these filtering practices operate on the same basic principle. Underground and perimeter sand filters are particularly well suited for ultra-urban watersheds as they consume no surface space. The perimeter sand filter can be applied with as little as 2 feet of drop in elevation. In this report we address the economics of the latter type of sand filter specifically. The first sand filter in North Carolina was installed in the early mid-1990's. Their use is currently not widespread due to the costs of construction. Sand filters are designed

[2] Stormwater hotspots are land uses or activities that generate highly contaminated runoff and include: commercial parking lots, fueling stations, industrial rooftops, outdoor container storage of liquids and loading/unloading facilities and vehicle/equipment service, maintenance/washing/steam cleaning areas.

for impervious watershed in particular, and typically one sandfilter treats a drainage catchment of less than a few acres.

Bioretention/rain gardens in many respects are landscaped and vegetated filters for storm water runoff. Surface runoff is directed into shallow, landscaped depressions (Figure 8). These depressions are designed to incorporate many of the pollutant removal mechanisms that operate in forested ecosystems and are strikingly similar in vegetation types to the poccosins of eastern North Carolina . Trees and shrubs are planted in bedding material consisting of a high percentage of sand, and lesser amounts of silt, clay and organic matter. During rain events, stormwater ponds above the mulch and soil in the system. Runoff from larger storms is generally diverted past the facility to the storm drain system. The remaining runoff filters through the mulch and prepared soil mix. Typically, in clay soil sites, the filtered runoff is collected in a perforated underdrain and returned to the storm drain system. Bioretention systems are generally applied to small sites and in a highly urbanized setting. Bioretention facilities are ideally suited to many ultra-urban areas as they can be fit into existing parking lot islands or other landscaped areas.

Figure 8. This Rain Garden in Kinston was the first one constructed in Eastern North Carolina. The site located at the Neuseway Education Center serves aesthetic, water quality and educational purposes.

Because bioretention can potentially fulfill two purposes, (1) water quality control and (2) landscaping requirements, their use is expected to increase. For example, in 1997 there were no bioretention areas in North Carolina; whereas today, it is the secondly most common planned practice in Greensboro, the state's third largest city (Bryant, 2001). Bio-retention areas typically serve small watersheds such as (portions of) parking lots, or residential run off areas. In North Carolina, the majority of bioretention areas served watersheds ranging from one to two acres. Their use is poised to grow further, pending several studies conducted by N.C. State University and other universities, particularly if the research shows that this BMP works to remove pollutants at a rate as high as is currently anticipated.

Grassy Swales are the simplest and most prevalent stormwater BMPs in North Carolina. Their use is typically limited by overwhelming amounts of runoff which cause erosion of swales. There are some ways to mitigate this erosion by including changing the slope of the swale or incorporating turf reinforcement matting to strengthen the grass lining (see Figure 9). Swales are often triangular in shape and are constructed by using relatively simple equipment. The use of grassy swales is very limited in ultra-urban areas, but swales are often easily installed in residential environments. Maintenance of wet swales can be particularly important in neighborhoods. It is essential that grassy swales don't become collectors of nutrient rich grass clippings, as this nutrient source is easily transported to adjoining water bodies by water flowing through the swale.

Figure 9. Turf reinforcement mats increase allowable velocities for grassy swales, making swale use more possible.

Table 4. Summary of the five structural stormwater BMPs by relative size of the associated drainage area.

BMP	Relative size of commercial/residential drainage area	
	Large	**Small**
Wet Pond	X	X
Stormwater Wetland	X	
Sandfilter*		X
Bioretention/Raingarden**		X
Grassy Swales		X
*Only effective with a significant drop in elevation (for perimeter sandfilter at least two feet). ** In clay soils a significant drop in elevation (4 feet) is typically required.		

Above, several structural options were described for achieving water quality improvements in stormwater runoff, all of which have various technical characteristics (design requirements and site constraints[3]), ecological characteristics (i.e. capabilities regarding pollution control) and economic characteristics (maintenance requirements and construction costs).

While each may be constructed based upon design constraints, the different BMPs are shown to remove nutrients at varying efficiencies. The next section will summarize pollutant removal abilities for TN and TP for each of the five stormwater practices discussed.

[3] BMPs should only be used in areas where the physical site characteristics are suitable. Some of the important physical site characteristics are soil type, watershed area, water table, depth to bedrock, site size and topography. If these conditions are not suitable, a BMP can loose effectiveness, require excessive maintenance or stop working.

Pollutant Removal Effectiveness

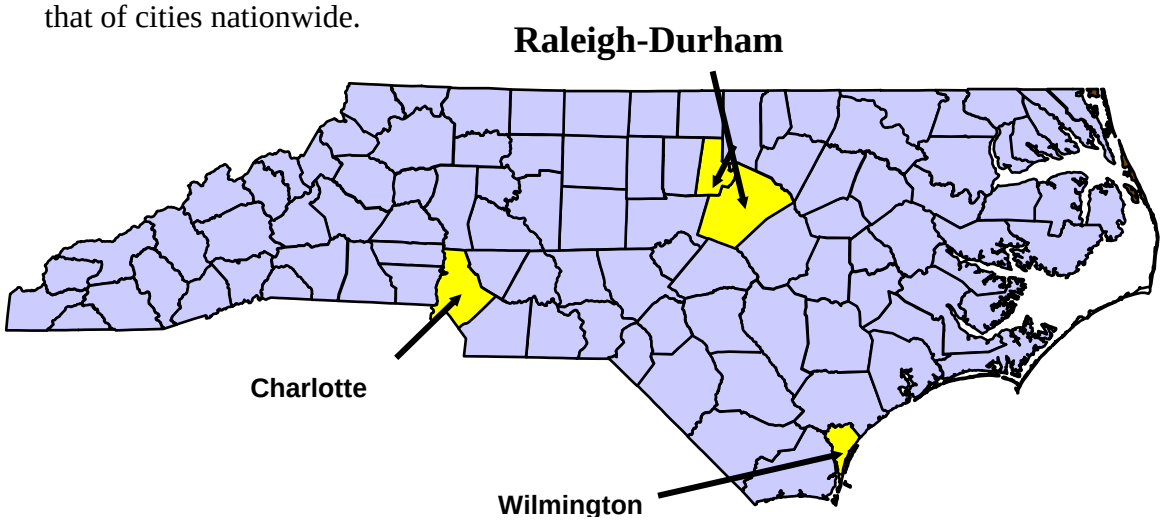
Climatologic Screening

A large body of national research data was available on the removal effectiveness of the four types of BMPs. Particularly there was a considerable amount of data for the following cities: Austin TX; Baltimore, MD; Chicago, IL; Minneapolis, MN; Seattle, WA and Tampa, FL. However, North Carolina's climate is substantially different from many other parts of the U.S. with respect to temperature and precipitation. Because of this, a screening procedure was used to decide which data to use.

The out-of-state cities' weather was compared to the weather of three cities in North Carolina: Charlotte, Raleigh-Durham and Wilmington (Figure 10). These three cities represent the weather conditions found in eastern and central North Carolina, and may best approximate weather in the Tar-Pamlico River Basin.

Temperature and rainfall data over the period of 1990 -2000 was collected for the six out-of state and the three in-state cities using both the Midwestern Climate Information System (MICIS, 2000) and the Southeastern Regional Climate Center's CIRRUS system (CIRRUSweb, 2000). Average monthly mean temperature and average monthly precipitation level were assessed for each city and statistically analyzed for significant differences.

Figure 10. Location of cities in North Carolina whose weather was compared to that of cities nationwide.



Seattle, WA; Minneapolis, MN, and Chicago, IL, were shown to have either drastically different rainfall distribution and amounts or temperatures or both. This is detailed graphically in Appendix I-1. The temperatures and precipitation levels of the remaining three cities: Austin TX, Baltimore, MD, and Tampa, FL, where similar to the climate of at least one of the three cities in North Carolina. Comparisons show that Austin and Charlotte had similar temperatures, though Charlotte was somewhat cooler in the winter. Except for the month of June, the difference in the average monthly rainfall in Charlotte and Austin, TX, was less than 1". Raleigh-Durham and Baltimore, MD were quite similar both with respect to temperature and rainfall, with Raleigh-Durham being slightly wetter and warmer. Again differences in rainfall were within 1" on a per-month basis. Finally, Wilmington, NC and Tampa, FL, were surprisingly similar. Precipitation

levels for each city were high in late summer and early fall, reflecting tropical activity at both locations. The rainfall amounts for July-September were 7-8" for both cities. Tampa was warmer in the winter but the difference with Wilmington was within 10ºF. Therefore pollution removal data collected from the Austin, TX, region, the Baltimore-Washington metropolitan area, and the northern two-thirds of Florida were all included in the analysis and were added to what had been collected in North Carolina and Virginia. Appendix I-1 provides a graphical presentation of each comparison made.

Assigning Pollution Removal Efficiencies

The two principal sources of best management practice effectiveness were (1) the ASCE/EPA joint venture National BMP pollutant removal database (found at http://www.bmpdatabase.com), and (2) The Center for Watershed Protection's National Pollutant Removal Performance Database (2000 version). Each is a collection of studies reported by either research agencies (such as universities or water management districts), or governments (state, county, or municipal). Research deemed unacceptable by the governing bodies of each database is not included in either database, making these two resources the most credible sources of this type of information in America. Other sources, particularly research projects from NC State and other regional land-grant schools, were used as noted. Appendix I-2 provides an overview of all the data sources used to assess the pollutant removal efficiencies.

Based on the data sources described above, the effectiveness of each of the five BMPs in the Southeast and Mid-Atlantic was determined. For each BMP the data on removal of total phosphorus (TP) and total nitrogen (TN) were analyzed for scale effects by relating the removal effectiveness to the size of the watershed. Linear regression was used for this purpose. Based on the results of this statistical analysis, each practice was assigned a single removal rate (the median removal efficiency) in the cost-effectiveness analysis. That is, assuming the practice is designed properly, it will work comparably well whether it serves a 10-acre watershed or a 50-acre watershed. The median pollutant removal efficiencies for each of the practices are reported in Table 5 on the following page.

There was a wide range of scatter in the data with respect to pollutant removal efficiencies. No significant relationship could be assessed between removal efficiency and watershed size (note Figures 11 and 12) and therefore median pollutant removal efficiencies were used for this report. This is certainly an area for future research and adaptation. Median efficiencies were chosen in lieu of mean efficiencies because the former discounts the impact of skewing data. Outliers, such as negative pollutant removal efficiencies have a more pronounced effect on the results. As such, median removal rates better represent the pollutant removal to expect.

Ideally, a relationship could be developed relating removal efficiency with the ratio of BMP practice size to contributing watershed size. It is generally assumed that the smaller the ratio is, i.e., a small relatively BMP with a large drainage area, the poorer the practice's performance at removing pollution. The opposite is suspected to hold true if the ratio is larger. However, there is very little data to support this assumption and the data is very widely scattered (as shown in an example of Figure 13). Because of a lack of supporting data, the BMP efficiency model can not at this time factor in practice size to watershed size with respect to pollutant removal. Perhaps a later version of the model can incorporate this relationship as new findings are added to the BMP database.

Table 5. Removal Efficiencies assigned to each of the stormwater BMPs to be utilized in the Tar-Pamlico Basin. These numbers account for prior standards, new research, and anticipated maintenance.

BMP Type	TP		TN	
	Removal Efficiency (%)	Number of Sites	Removal Efficiency (%)	Number of Sites
Wet Ponds	40	28	25	27
ormwater Vetlands	35	14	25	14
Sand Filters	45	11	35	12
Bio-retention	35	8	40	4
Grassy Swales	20	16	20	11

The TN results displayed in Table 5 vary slightly from those presented by the Neuse Stormwater Team. This is due to the increased amount of data that has been collected since the Neuse Team completed its work in early 2001. Most striking is the change associated with bio-retention. Since 2001, the number of field studies has quadrupled (from 1 to 4), giving a much firmer, though still not firm enough, idea of how well bio-retention devices work to remove both TP and TN.

Explanation of Efficiencies by BMP

Wet Ponds. A total of 28 studies contained data regarding pollutant removal from wet ponds, which is by far the most of any practice studied, reflecting the relative abundance of wet ponds throughout the Mid-Atlantic and Southeastern states. TP removal rates varied from -50 (meaning the wet pond *added* TP to the receiving stream) to 88%. TN removal rates ranged from -1 to 55%.

Stormwater Wetlands. Fourteen studies chronicled the effectiveness of stormwater wetlands. TP rates ranged from -61 to 75%. TN removal rates were lower than is nationally accepted, ranging from -12 to 55%. The median removal rate of about 25% is 15% less than what the Neuse Stormwater rules stated. These median removal rates are generally higher for appropriately sized stormwater wetlands.

Sand Filters. Twelve studies documented the efficiencies of sand filters. Removal rates for this practice are almost always initially higher due, with the rates dropping when the required maintenance is not performed. TP removal rates ranged from 10 to 80%. TN rates varied from 8 to 71%. The form of nitrogen that sand filters release into the environment is NO_3-N, which is very difficult to remove, once in the water column. It will be imperative that the practice is maintained on a regular basis to maintain such high removal efficiencies.

Bio-retention. Only eight studies (4 of them in the laboratory) document the effectiveness of bio-retention areas to remove TP. Fewer still (four) research this BMP's ability to remove TN. All of the latter are field studies. There is a significant chance these removal efficiencies will continue

to change. Several NC DENR funded demonstration research projects are studying the effectiveness of bio-retention areas and will be completed in 2003 and 2004. TP removal rates vary from -3% to 87%, while TN removal efficiencies vary from 33% to 65%. A conservative removal rate of 40% is being suggested for the latter due to the lack of studies documenting bio-retention removal efficiency. The rate is, however, 15% higher than what is given in the Neuse Stormwater report.

Grass Swales. Without a doubt grass swales have the highest variability of removal efficiencies. Swales that are maintained and from which grass clippings are removed can have relatively high removal rates for TP and TN. Those swales, however, which are unmanaged or managed poorly, will add substantial amounts of TP and TN to the environment. A total of 16 studies document swale efficiencies. TP and TN removal efficiencies both range from -100 to 99%.

Figure 11. TSS Removal Efficiency - Stormwater Wetlands

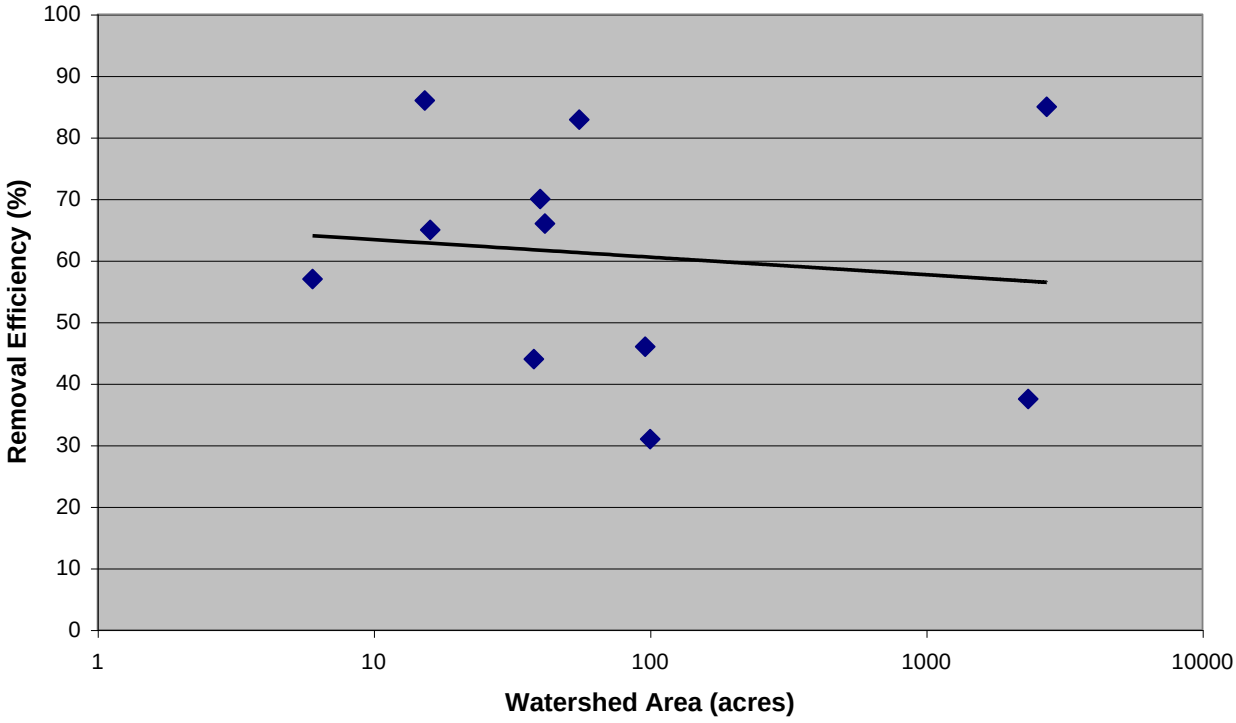


Figure 12. TP Removal Efficiency - Wet Ponds

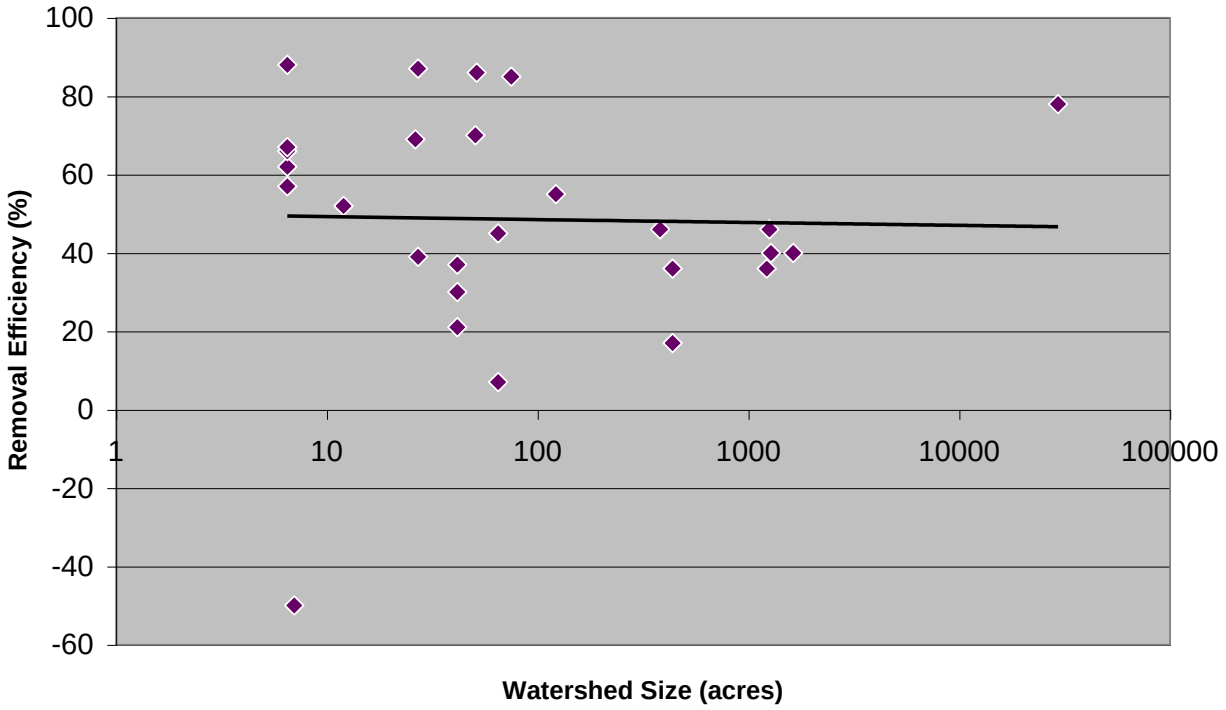
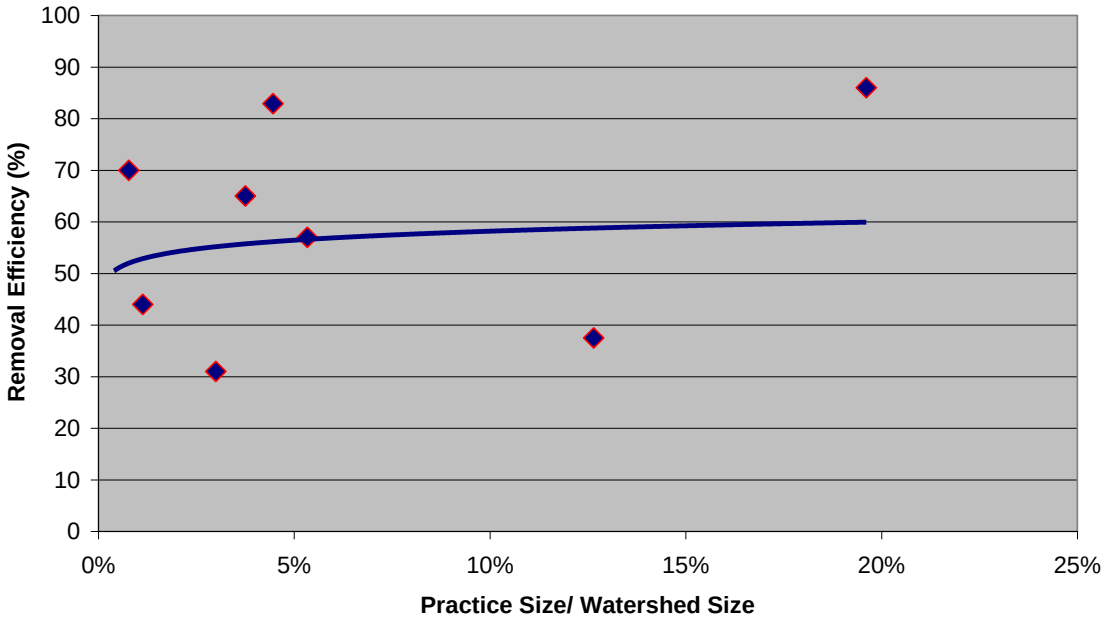


Figure 13. TSS Removal as a Function of Practice Size to Watershed Size Ratio



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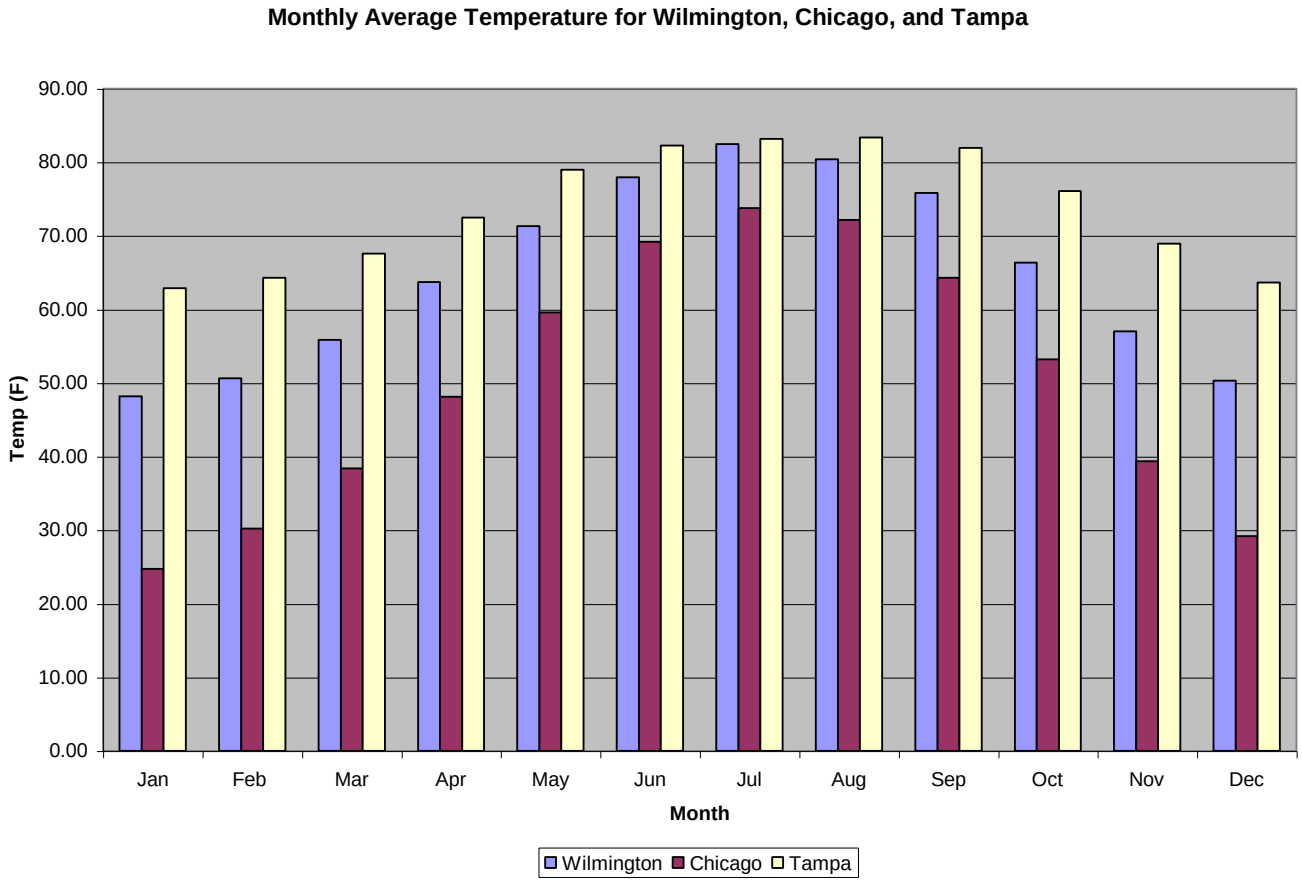
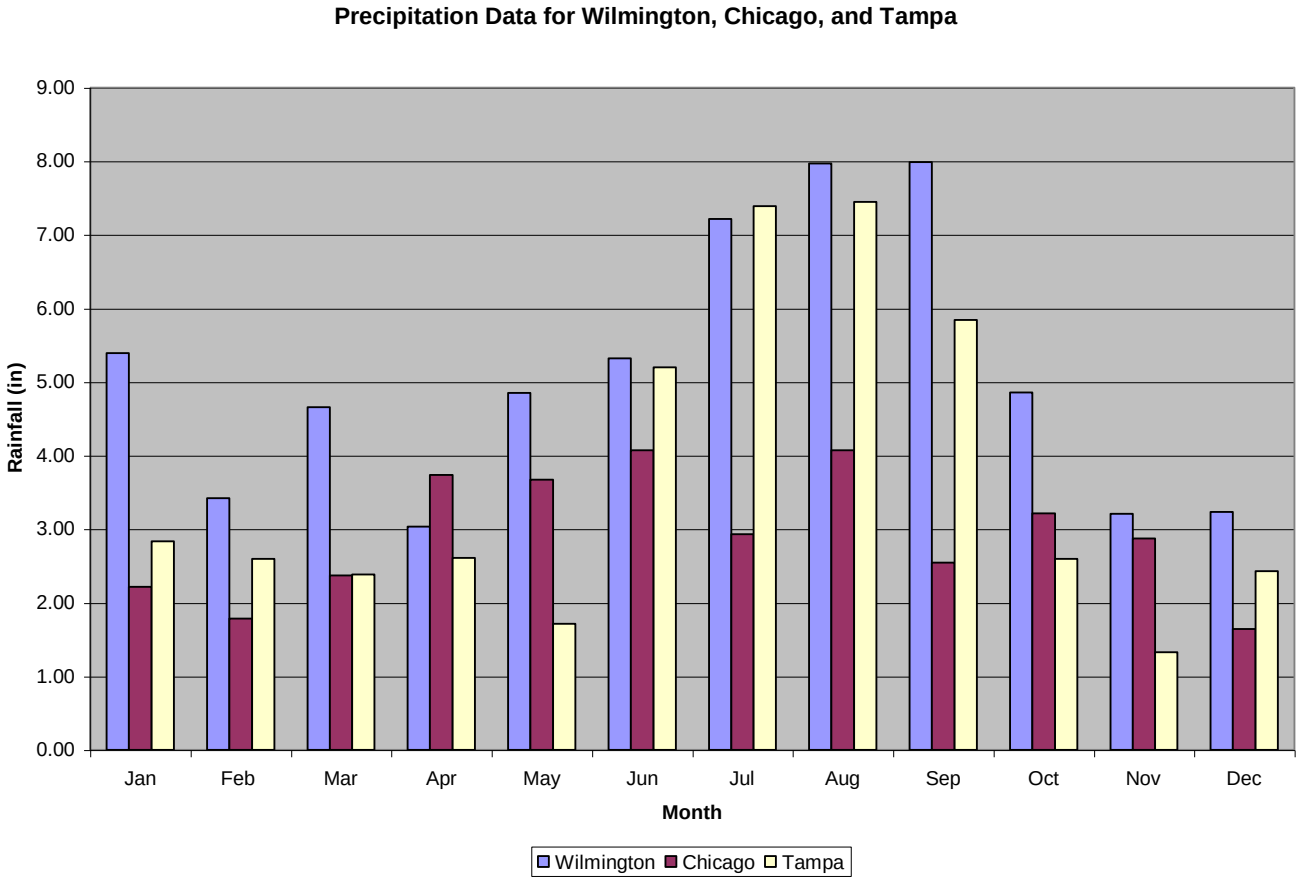
Appendix I-1. Precipitation and Temperature Comparison of Six U.S. cities with three cities in North Carolina.

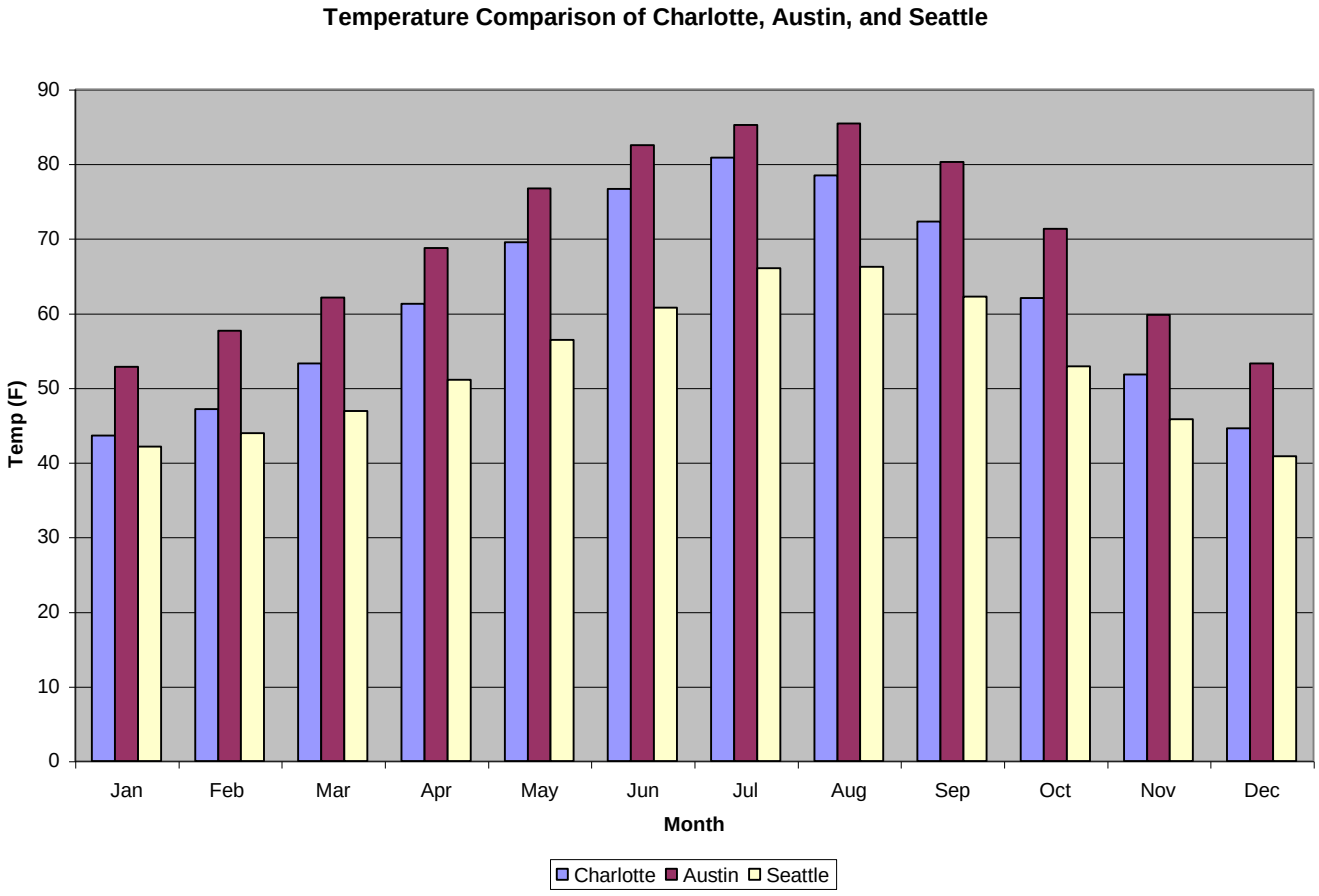
Wilmington and Tampa are shown to have very similar temperature plots (typically within 10°F of each other). Neither city has an average temperature approaching biological zero. However, Chicago's temperatures are much colder and remain either below or within biological zero (accepted around 5°C) for five of twelve months of the year. It is not reasonable to accept data from the upper Midwest as similar to that of Central and Eastern North Carolina due to this temperature discrepancy.



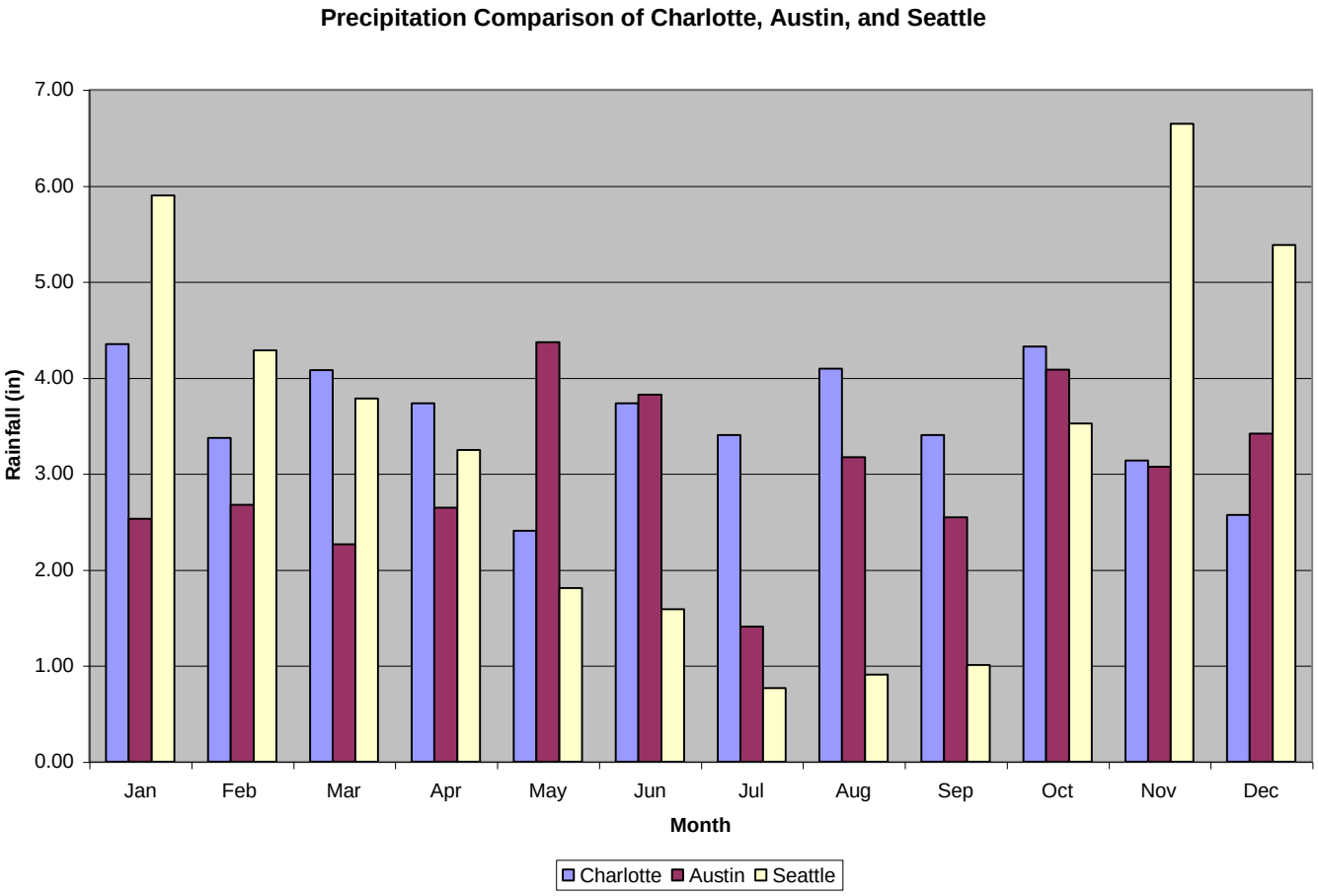
A comparison of precipitation amounts from Wilmington and Tampa show that each city received high amounts of rainfall at approximately the same times of the year, with Wilmington being slightly wetter. The relationship is particularly close during the summer and fall months reflecting tropical activity. This is particularly important because large storm events are often blamed for BMP "release" of pollutants, due to large quantities of water flushing nutrients from the system. Because Wilmington and Tampa are so similar in this regard, they are deemed to be good "paired" cities. However, as expected, Chicago's rainfall does not reflect any high monthly rainfall totals and are substantially lower than that of both Wilmington and Tampa in most months.



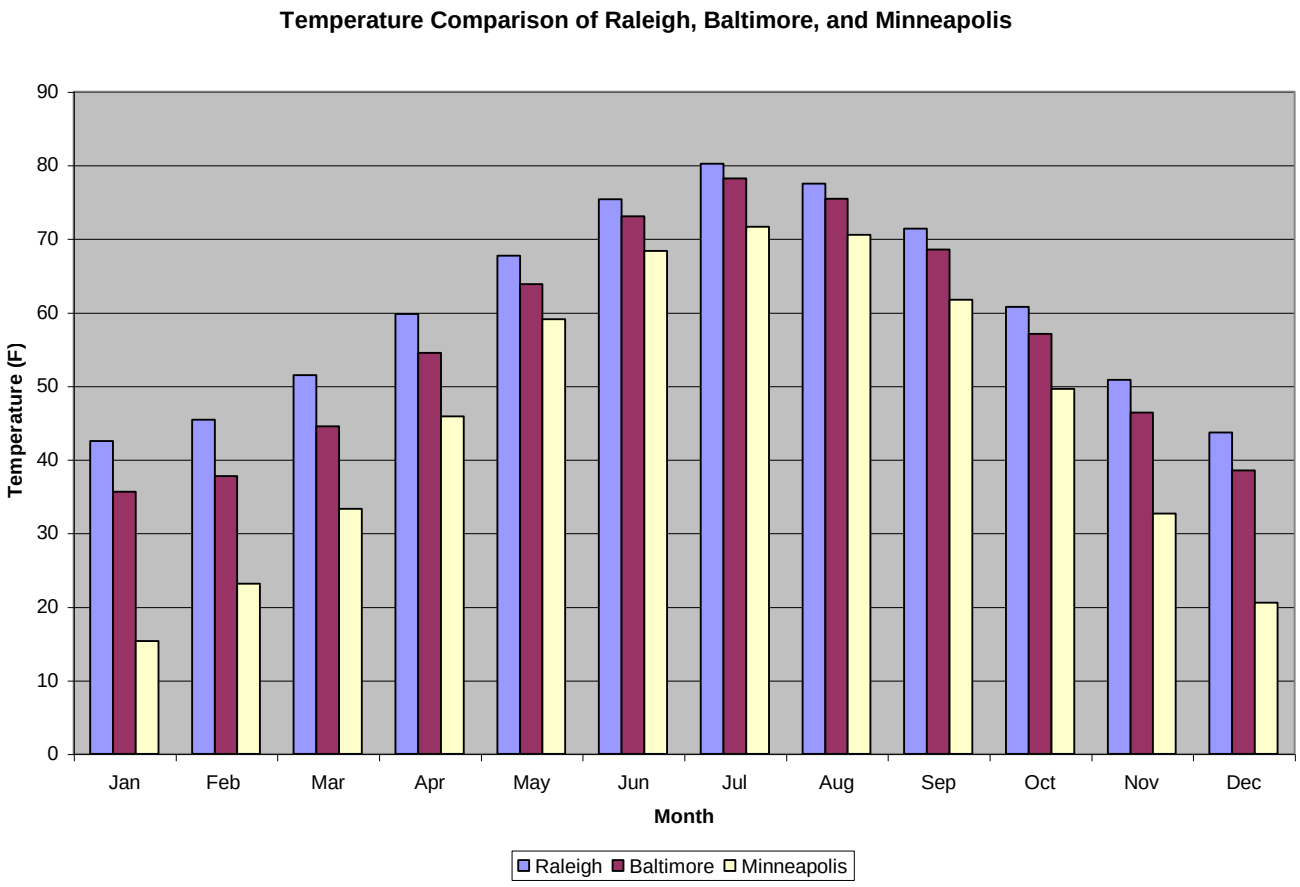
Charlotte and Austin are shown to be very similar in temperature on a monthly basis, with Austin being slightly warmer (but always within 10°F). Both cities remain at or above biological zero (5°C). Seattle, too, remains at or above biological zero, and does reflect similar temperatures to Charlotte during the late fall through early spring. However, Seattle has a much more moderate summer temperature, with differences near 15°F. Temperature alone may not cause Seattle's data to be rejected, but it does not support the use of Pacific Northwest BMP removal efficiencies, either. An examination of rainfall is necessary.



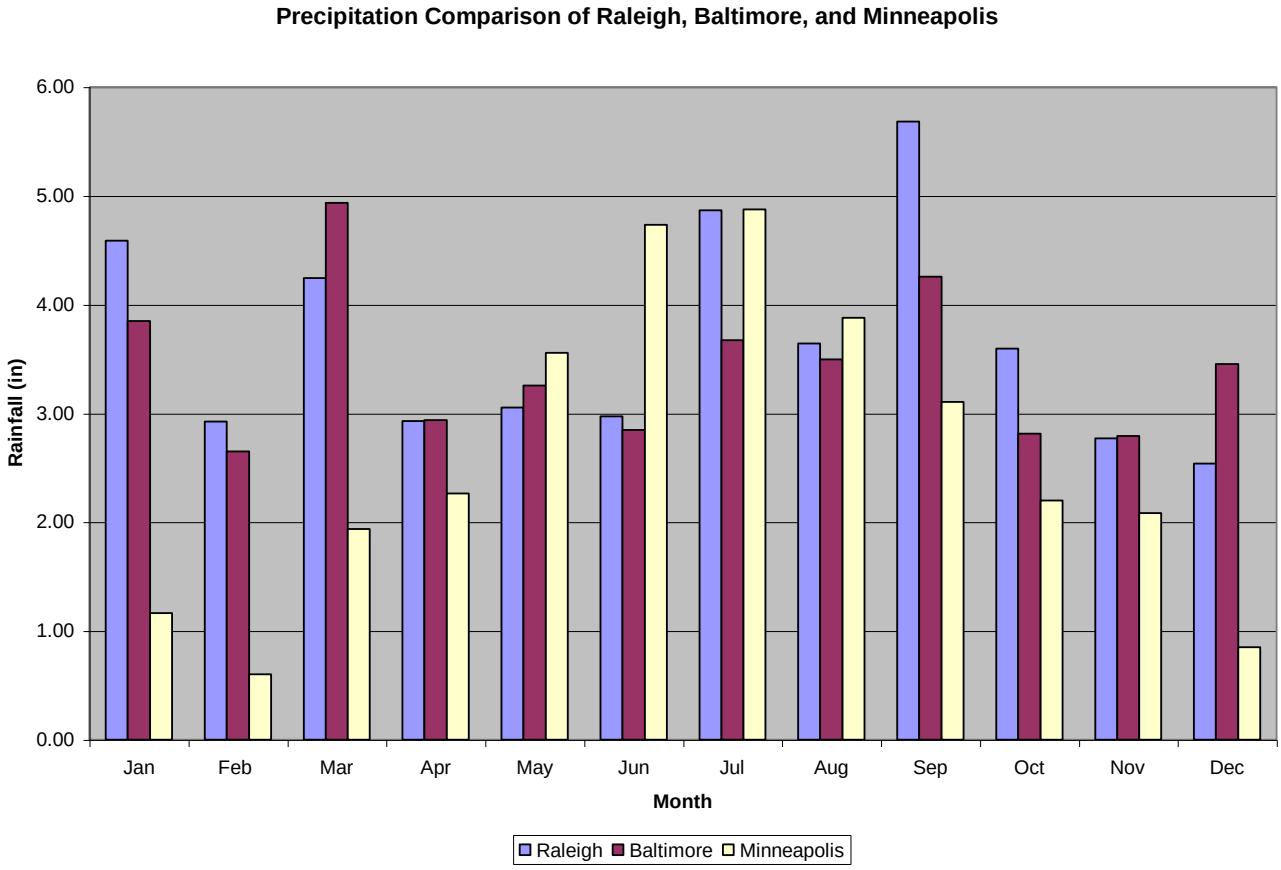
Seattle has a much different monthly rainfall distribution to that of Charlotte. While Charlotte's rainfall distribution is relatively evenly distributed throughout the year, Seattle receives the vast majority of precipitation from late fall through early spring. Rainfall differences are over two inches for much of the summer and fall. Contrastingly, Austin and Charlotte are within one inch more most of the year and only exhibit a two inch difference in March when Austin receives more rainfall. Charlotte does receive slightly more rainfall on an annual basis than Austin.



Baltimore and Raleigh have very similar temperatures, never exceeding 6°F. The temperature difference, however, between Minneapolis and Raleigh are substantially different (over 20°F) in much of the winter, as the average temperature in the latter city is below biological zero from November through March.



Raleigh and Baltimore have similar rainfall totals, often within 0.20" on a monthly basis with occasional exceptions reaching over 1 inch. Minneapolis is substantially direr in the winter, with over two inch differences in December through March. These differences coupled with substantial temperature differences prohibit the use of stormwater BMP effectiveness data from studies from states of the upper Great Plains when proposing efficiencies for North Carolina.



Appendix I-2. Sources of information for BMP Pollutant Removal Effectiveness.

Practice Type	State	Researcher(s) or Agency	Reference
Stormwater Wetlands	FL	Rushton and Dye	CWP
Stormwater Wetlands	NC	Tweedy and Broome	Personal Communication
Stormwater Wetlands	VA	Northern VA Soil & Water District	NBMPD
Stormwater Wetlands	FL	FL DOT/ USGS	NBMPD
Stormwater Wetlands	MD	Baltimore City Water Quality Management Offic	NBMPD
Stormwater Wetlands	FL	EPA/ Florida DER	NBMPD
Stormwater Wetlands	VA	Yu	Personal Communication
Stormwater Wetlands	MD	Althanus and Stevenson	CWP
Stormwater Wetlands	MD	MD Center for Environment & Estuarine Studies	NBMPD
Stormwater Wetlands	VA	Yu	Personal Communication
Stormwater Wetlands	VA	Yu	Personal Communication
Stormwater Wetlands	FL	Carr and Rushton	CWP
Stormwater Wetlands	FL	Harper, Wanileista, Fries, and Baker	CWP
Stormwater Wetlands	NC	Bass	Personal Communication
Stormwater Wetlands	FL	Blackburn, Pimentel, and French	CWP
Stormwater Wetlands	VA	Yu	Personal Communication
Sand Filter	TX	City of Austin	CWP
Sand Filter	TX	Barton Springs/ Edwards Aquifer Conservation District	CWP
Sand Filter	TX	Tenney, Barrett, Malina, Charbeneau, Ward	CWP
Sand Filter	TX	City of Austin	CWP
Sand Filter	VA	Bell, Stokes, Gavin, and Nguyen	CWP
Sand Filter	NC	Hunt	Unpublished Data
Sand Filter	TX	City of Austin	CWP
Sand Filter	TX	City of Austin	CWP
Sand Filter	TX	City of Austin	CWP
Sand Filter	TX	Welborn and Veenhuis	CWP
Sand Filter	TX	Barrett, Keblin, Malina, Charbeneau	CWP
Sand Filter	FL	EPA/ Florida DER	NBMPD
Bio-Retention	MD	Davis	Personal Communication
Bio-Retention	MD	Davis	Personal Communication
Practice Type	**State**	**Researcher(s) or Agency**	**Reference**

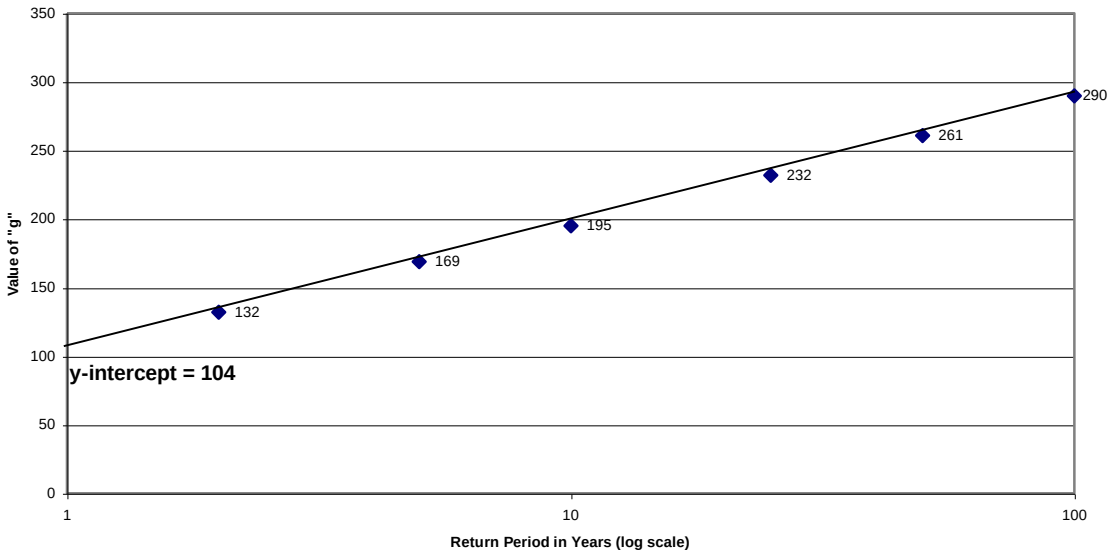
Bio-Retention	MD	Davis, Shokouhian, Sharma, Miniami	Water Environment Research
Bio-Retention	MD	Davis, Shokouhian, Sharma, Miniami	Water Environment Research
Bio-Retention	VA	Yu	Personal Communication
Bio-Retention	NC	Hunt	Unpublished data- Greensboro
Bio-Retention	NC	Hunt	Unpublished data- Chapel Hill
Bio-Retention	PA	Hunt, Jarrett, Smith	ASAE Conference Proceedings, 2002
Wet Detention Pond	FL	FL DOT/ USGS	NBMPD
Wet Detention Pond	FL	Dormman, Hartigan, Steg, Quasebarth	CWP
Wet Detention Pond	VA	Occoquan Watershed Monitoring Laboratory	CWP
Wet Detention Pond	FL	Gain	CWP
Wet Detention Pond	FL	Martin	CWP
Wet Detention Pond	FL	Florida DOT / USGS	NBMPD
Wet Detention Pond	NC	Wu	CWP
Wet Detention Pond	NC	WRRI / UNCC	NBMPD
Wet Detention Pond	TX	City of Austin	CWP
Wet Detention Pond	NC	Wu	CWP
Wet Detention Pond	NC	Borden, Dorn, Stillman, Liehr	CWP
Wet Detention Pond	FL	USGS	NBMPD
Wet Detention Pond	TX	Lower Colorado River Authority	CWP
Wet Detention Pond	TX	City of Austin	CWP
Wet Detention Pond	FL	Environmental Research and Design, Inc / St. John's River Water Mngmt. District	NBMPD
Wet Detention Pond	VA	Yu	Personal Communication
Wet Detention Pond	FL	Holler	CWP
Wet Detention Pond	VA	Yu	Personal Communication
Wet Detention Pond	FL	Rushton, Miller, Hull	CWP
Wet Detention Pond	FL	Rushton, Miller, Hull	CWP
Wet Detention Pond	VA	Occoquan Watershed Monitoring Laboratory	CWP
Wet Detention Pond	FL	Cullum	CWP
Wet Detention Pond	NC	Borden, Dorn, Stillman, Liehr	CWP

Practice Type	State	Researcher(s) or Agency	Reference
Wet Detention Pond	FL	Kantrowitz and Woodham	CWP
Wet Detention Pond	FL	Northwest FL Water Management District	NBMPD
Grassy Swale	FL	Dorman, Hartigan, Steg, Quasebarth	CWP
Grassy Swale	FL	Harper	CWP
Grassy Swale	FL	Kercher, Landon, Massarelli	CWP
Grassy Swale	FL	Harper	CWP
Grassy Swale	VA	Dorman, Hartigan, Steg, Quasebarth	CWP
Grassy Swale	MD	Occoquan Watershed Monitoring Laboratory	CWP
Grassy Swale	MD	Occoquan Watershed Monitoring Laboratory	CWP
Grassy Swale	VA	Occoquan Watershed Monitoring Laboratory	CWP
Grassy Swale	TX	Walsh, Barrett, Malina, Charbeneau, Ward	CWP
Grassy Swale	TX	Walsh, Barrett, Malina, Charbeneau, Ward	CWP
Grassy Swale	TX	Welborn, Veenhuis	CWP

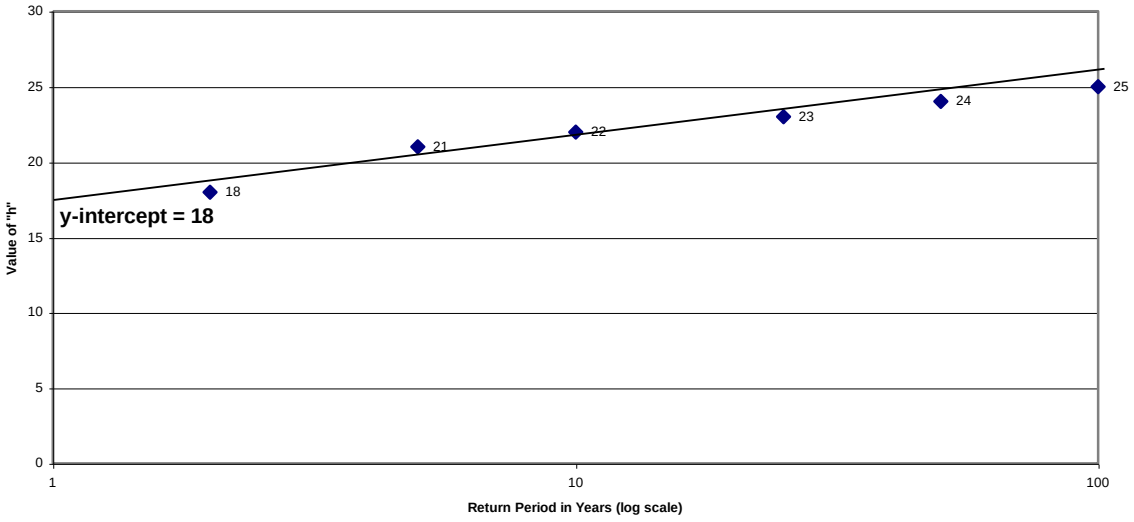
References noted:
CWP – Center for Watershed Protection's National Pollutant Removal Performance Database. 2000
NBMPD – National Best Management Practice Database (http://www.bmpdatabase.com)
Much of Dr. Shaw Yu's data (from the University of Virginia) is going to be described in the National BMP pollutant database.

Appendix J. Computing the Intensity-Duration Variable for the One-Year Storm in Wake, Wilson and Craven Counties

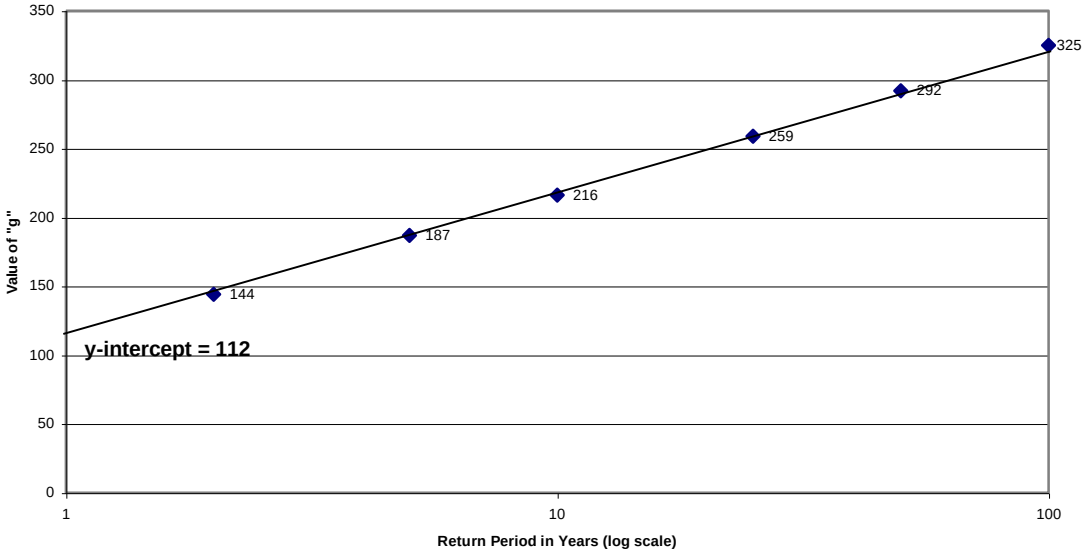
Computation of the Variable "g" for Wake County



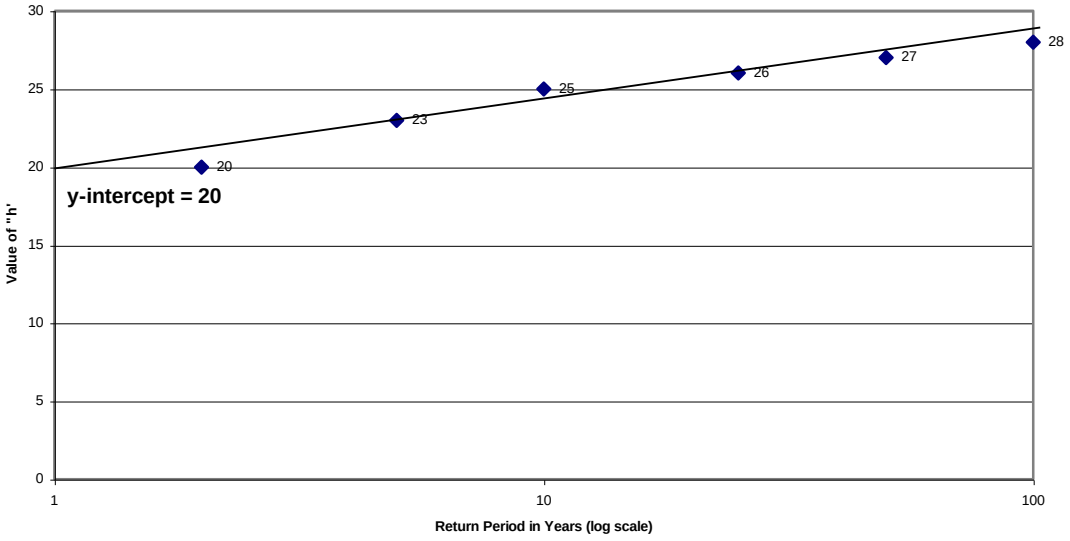
Computation of the Variable "h" for Wake County



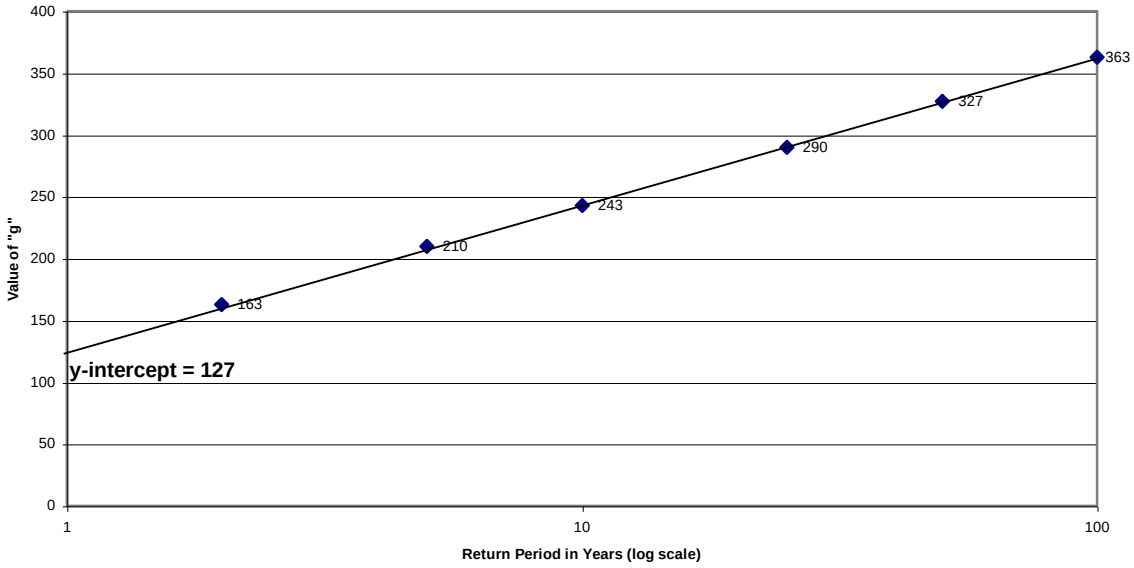
Computation of the Variable "g" for Wilson County



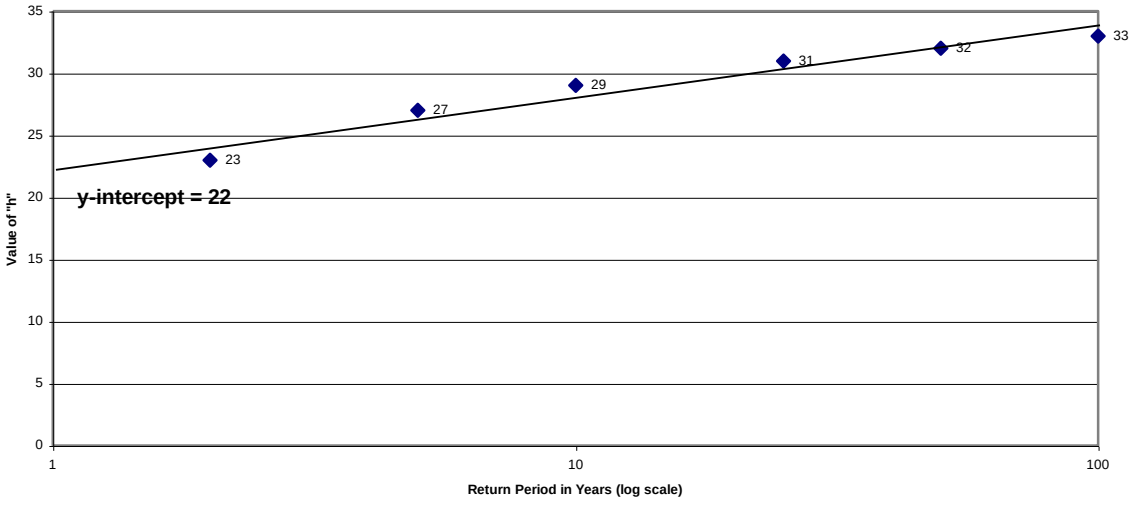
Computation of the Variable "h" for Wilson County



Computation of the Variable "g" for Craven County



Computation of the Variable "h" for Craven County



Appendix K. Comparing the 1-year and 2-year storms in Wake, Wilson, and Craven Counties

The flows resulting from the 1-year and the 2-year storms differ by a certain factor (i.e., the 1-year storm flow will be a certain percentage lower than the 2-year storm flow). A local government may decide to use the 2-year storm rather than the 1-year storm for peak flow control. However, the local government will have to require its developers to control the 2-year storm to the 1-year storm predevelopment levels. This will involve computing the 2-year storm flow and then reducing it by the appropriate percentage, which was determined to be 80% for the Neuse Basin. This appendix explains how the 80% figure was determined.

DWQ staff used the Rational Method to make the comparison between the 1-year and 2-year storms. The factor of difference between the two storms was simply called "**X**." DWQ staff solved the equations for **X**.

$Q_{1\text{-yr}} = (CIA)_{1\text{-yr}} = \mathbf{X}*(CIA)_{2\text{-yr}}$

For any given watershed, the following will hold true:

$C_{1\text{-yr}} = C_{2\text{-yr}}$

$A_{1\text{-yr}} = A_{2\text{-yr}}$

$T_{1\text{-yr}} = T_{2\text{-yr}}$ ***Note:*** The time of concentration does not vary based on storm size.

Canceling these factors from the equations leaves us with:

$I_{1\text{-yr}} = \mathbf{X} * I_{2\text{-yr}}$ OR $\mathbf{X} = (I_{1\text{-yr}})/(I_{2\text{-yr}})$ ***Note:*** Remember that I = g/(h+T).

Now, solve this equation for each county:

- ***Wake County:***

For the 1-yr storm, g = 104, h = 18.
For the 2-yr storm, g = 132, h = 18.

$\mathbf{X} = [104/(18+T)]/[132/(18+T)]$
$=104/132$
$= 0.79$

- ***Wilson County:***

For the 1-yr storm, g = 112, h = 20.
For the 2-yr storm, g = 144, h = 20.

$\mathbf{X} = [112/(20+T)]/[144/(20+T)]$
$=112/144$
$= 0.78$

- ***Craven County:***

  For the 1-yr storm, g = 127, h = 22.
  For the 2-yr storm, g = 163, h = 23.

  X = [127/(22+T)]/[163/(23+T)]
  =127(23+T)/163(22+T)

If T is varied between 5 and 120 minutes, the following results are obtained for X:

T	**X**
5	0.81
10	0.80
15	0.80
20	0.80
25	0.80
30	0.79
35	0.79
40	0.79
45	0.79
50	0.79
55	0.79
60	0.79
65	0.79
70	0.79
75	0.79
80	0.79
85	0.79
90	0.79
95	0.79
100	0.79
105	0.79
110	0.79
115	0.78
120	0.78
average =	0.79

The average value obtained for **X** is 0.79.

To reflect the precision of the methods used, the factor of **X** for all three counties will be rounded to 0.8, or 80%.

Appendix L. 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.

Allowing Traditional Neighborhood Developments

Traditional neighborhood developments (TNDs) are designed so that dwellings, shops, and workplaces are in close proximity. They typically follow a rectilinear pattern of streets and blocks arranged to provide interesting routes of travel that also accommodate and promote pedestrian travel and bicycle travel rather than automobile travel. These developments also include greenways, landscaped streets, churches, stores, schools, and parks woven into the neighborhood for social activity, recreation, aesthetics, and environmental enhancement. See Figure G1 for a diagram of a TND.

One of the most important features of TNDs that affects water quality is their compactness. As these developments expand, they maintain their compact, rectilinear layout and their accessibility. Another environmental advantage offered by TNDs is that they may reduce automobile traffic and promote increased use of alternative forms of transportation, such as mass transit.

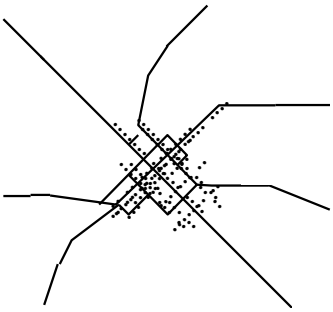
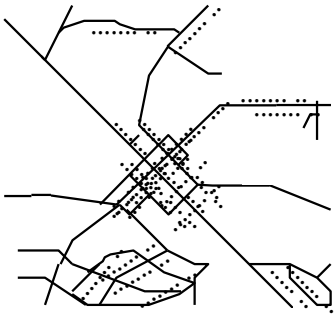
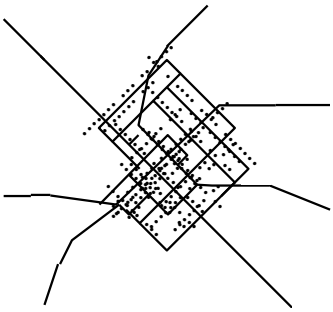
Environmental impacts of TNDs are affected by site conditions and the development intensity and design. Those TNDs that offer environmental benefits may also offer economic benefits. The increased value of real estate in a traditional development is illustrated in Raleigh. The "inside the beltline" neighborhoods in Raleigh that have city blocks, greenways, and accessibility to shopping areas, on the average, sell for 40 percent more per square foot than homes in North Raleigh subdivisions (pers. comm. Marilyn Marks, Simpson and Underwood Realtors, 1997).

Other Techniques

In many instances, subdivision codes contain rigid requirements that govern setbacks from the property lines. These requirements increase the length of driveways, roads, and sidewalks and thus increase the proportion of impervious cover to housing units. These requirements can inadvertently increase impervious surfaces and cause expense for developers and homeowners.

Large-lot zoning also impacts overall imperviousness. Although large-lot zoning reduces rooftop impervious cover in a watershed and spreads development over a wider geographic area, it can increase transport-related impervious cover because of longer road networks. Although large-lot zoning may be wise for individual sensitive watersheds, it is probably not practical as a uniform standard. An alternative is forming more compact neighborhoods in order to decrease impervious surfaces associated with transportation, a factor that has long been overlooked. Another advantage to compact neighborhoods is that they decrease automobile use by allowing better accessibility for walkers and cyclists and facilitating public transportation.

Figure G1. Maytown Before and After (adapted from Stimmel Associates, 1993)

A. Maytown in 1900	B. Maytown today.	C. Maytown as it could have been.
		
A. Maytown developed around a central square with a grid street pattern. Development was compact and there was a distinct separation between the village and the surrounding countryside.	B. The development that has occurred over the past 30 years is not compatible with the original village. Curvilinear street and cul-de-sacs have replaced the traditional grid street pattern. The separation between the village and the surrounding countryside have been lost.	C. The same amound of development could have been accommodated in a pattern that complements the original village. All residents could have been within walking distance of the center square, community facilities, and parks.

Appendix M. Example of a Stormwater Maintenance Program

CITY OF RALEIGH
CHAPTER 6. HEALTH, SANITATION AND PUBLIC NUISANCES*

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*Editor's note: Former Ch. 5 of Part 7 was renumbered as Ch. 6 of Part 12 by §51 of Ord. No. 1983-245-TC-205, adopted Dec. 6, 1983. Subsequently, Ord. No. 1995-785, §1, adopted Nov. 21, 1995, set out a new Ch. 6 and repealed the old Ch. 6, §§12-6001--12-6004, which had pertained to similar subject matter and derived from Code 1959, §§12-1--12-3; Ord. No. 1977-511, §§1--12, adopted May 3, 1977; Ord. No. 1985-577-TC-232, §34, adopted March 5, 1985; Ord. No. 1991-747, §§2, 3, adopted March 19, 1991; and Ord. No. 1995-573, §1, adopted March 7, 1995.

Sec. 12-6001.
ENFORCEMENT BY INSPECTION DEPARTMENT.

The Department of Inspections is charged with the duty of full enforcement of this chapter and any inspector thereof is clothed with full power and authority imposed by this chapter and is hereby authorized and directed to proceed to carry out its provisions; provided that the identification of nuisances and the required abatement as described in §12-6002(r) shall be the responsibility of the transportation director or his designee.

(Ord. No. 1995-785, §1, 11-21-95)

Sec. 12-6002.
NUISANCES PROHIBITED; ENUMERATION.

The following enumerated and described conditions are hereby found, deemed and declared to constitute a detriment, danger and hazard to the health, safety, morals, and general welfare of the inhabitants of the City and are found, deemed and declared to be public nuisances wherever the same may exist and the creation, maintenance, or failure to abate any nuisances is hereby declared unlawful.

(a) Any condition which is a breeding ground or harbor for mosquitoes or a breeding ground or harbor for rats or other pests, or

(b) Is a place of heavy growth of weeds or grasses over eight (8) inches in height which lie less than one hundred (100) feet from any abutting open street or which lie less than one hundred (100) feet from any adjoining property line which contains a structure; or is a place of heavy growth of weeds or grasses over eight (8) inches in

height which lies within fifty (50) feet of any occupied dwelling; provided that the nuisance defined by this subsection (b) shall be cleared and cut not less than three (3) inches in height, or

(c) Is a place of vines, shrubs, or other vegetation over eight (8) inches in height when:

(1) Such vines or vegetation lie less than one hundred (100) feet from any adjoining property line and when such conditions are not located within a floodplain or not located on any slope that is steeper than three (3) to one (1) (horizontal to vertical), which has ground cover planted specifically for erosion purposes, and when such condition is causing a breeding ground for rodents and a hazard detrimental to public health, or

(2) Such vines, shrubs, or vegetation are a focal point for any other nuisance enumerated in this code; provided that the nuisance herein defined by this subsection (c)(2) shall be cleared and cut only when it is necessary to abate any other nuisance described in this section, or

(d) Is a place of growth of poison sumac (Rhus vernix), poison ivy (Rhus radicans), or poison oak (Rhus toxicodendron) and other noxious vegetation; or

(e) Is an open place of collection of stagnant water where insects tend to breed; or

(f) Any concentration of combustible items such as mattresses, boxes, paper, automobile tires and tubes, garbage, trash, refuse, brush, old clothes, rags, or any other combustible materials or objects of a like nature; or

(g) Any concentration of building materials including concrete, steel or masonry which are not suitable for building construction, alterations or repairs, and which are in open places; or

(h) Is an open place of collection of garbage, food waste, animal waste, or any other rotten or put rescible matter of any kind; however, nothing in this subsection shall be construed to prevent the generally accepted use of a properly maintained compost pile or storage of animal manure being used as fertilizer for lawns and gardens and for other agricultural or horticultural purposes; or

(i) Privies; or

(j) Hides, dried or green; provided the same may be kept for sale in the City when thoroughly cured and odorless; or

(k) Any household or office furniture, appliances, or other metal products of any kind or kept in open places; or

(l) Any products which have jagged edges of metal or glass or areas of confinement which are kept in open places; or

(m) Any open place of concentration of discarded bottles, cans or medical supplies; or

(n) Any improper or inadequate drainage on private property which causes flooding, interferes with the use of, or endangers in any way the streets, sidewalks, parks or other City owned property of any kind; provided, the notices required and powers conferred by this chapter by and on the Department of Inspections in abating the nuisances defined by this subsection (n) shall be given and exercised by the Director of Transportation; or

(o) Any condition which blocks, hinders or obstructs, in any way the natural flow of branches, streams, creeks, surface waters, ditches or drains; or

(p) Any collection of water for which no adequate natural drainage is provided and which is or is likely to

become a nuisance and a menace to health; or

(q) Any stormwater retention or impoundment device which is operating improperly; or

(r) Any condition whereby any person owning or having the legal control of any land within the corporate limits of the City maintains or permits upon any such land any fence, sign, billboard, shrubbery, bush, tree, mailbox, or other object or combination of objects which obstructs the view of motorists using any street, private driveway, or approach to any street intersection adjacent to and abutting such land so as to constitute a traffic hazard as a condition dangerous to public safety upon any such street, private driveway, or at any such street intersection; or

(s) Any other condition specifically declared to be a danger to the public health, safety, morals, and general welfare of inhabitants of the City and public nuisance by the Council; which proceeding may be initiated by the Department of Inspections before the Council after giving written notice in conformity with §12-6003(a) hereof, which notice will state the condition existing, the location, and that the Council will be requested on a day certain, after a public hearing at which the person notified may appear and be heard, to declare that the conditions existing constitute a danger to the public health, safety, morals, and general welfare of the inhabitants of the City and a public nuisance, and that after such declaration by the Council in the form of an ordinance the condition will be abated as provided for in §12-6003(b) hereof; provided no appeal shall lie from a proceeding initiated by the Department of Inspections before the Council of the City as provided in this subsection.

(Ord. No. 1995-785, §1, 11-21-95; Ord. No. 1998-454, §19, 11-4-98)

Sec. 12-6003.
NUISANCE ABATEMENT PROCEDURES.

When any public nuisance as set out in §12-6002 is found to exist on any property, including rights-of-way and easements within the City and one (1) mile beyond the City limits, the following procedures shall be followed:

(a) The Department of Inspections of the City shall notify the owner of the premises where the nuisance is located that conditions exist which constitute a public nuisance and unless the condition is abated within fifteen (15) days from the mailing of the notice which shall be sent by registered mail, return receipt requested, the conditions constituting a nuisance will be abated and the cost of abatement, including an administrative fee of one hundred twenty-five dollars ($125.00), also including the cost, if any to reseed areas which were formerly a nuisance, shall constitute a lien against the premises. Provided, the costs of abating nuisances so declared by §12-6002(o) and (p) under the condition described in subsection (d) hereof shall be limited to the amounts indicated therein.

(b) The Department of Inspections is hereby given full power and authority to enter upon the premises involved for the purpose of abating the nuisance found to exist as herein set out. Within the fifteen-day period mentioned in subsection (a) hereof the owner of the property where the nuisance exists may appeal the findings of the Department of Inspections made pursuant to subsection (a) hereof to the Council by giving written notice of appeal to the Department of Inspections, the appeal to stay the abatement of the nuisances by the Department of Inspections until a final determination by the Council. In the event no appeal is taken, the Department of Inspections may proceed to abate the nuisance.

(c) The Council in the event an appeal is taken as provided in subsection (b) hereof may, after hearing all interested persons and reviewing the findings of the Department of Inspections, reverse the finding made pursuant to subsection (a) hereof; but if the Council shall determine that the findings of the Department of Inspections made pursuant to said subsection is correct and proper it shall adopt an ordinance specifically declaring the condition existing on the property to be a danger and hazard to the health, safety, morals, and general welfare of the inhabitants of the City and a public nuisance and directing the Department of Inspections to cause the conditions to

be abated.

(d) After the abatement of the nuisance as provided in subsection (a), (b) or (c) hereof the cost of such abatement shall become a lien against the premises upon confirmation of the cost thereof by the Council, which said confirmation shall take place only after ten (10) days' written notice to the owner of the premises where the nuisance existed of the proposed confirmation. Provided, when a nuisance, described and declared by §12-6002(o) and (p) results from the present inadequacy, due to subsequent development, of a storm drainage pipe, which was adequate when installed and which is directly connected to a public facility owned and maintained by the City, the materials portion of the confirmed cost of abating the nuisance by replacing the inadequate pipe with an adequate one shall not exceed the difference between the replacement cost of a pipe the size of the existing one and the new cost of a larger pipe thirty-six (36) inches in diameter. The full labor costs of the project shall also be assessed. Upon confirmation the cost of abatement shall be a lien against the premises from which the nuisance was abated the same to be recorded as provided in G.S. 160A-216 et seq. and to be collected as unpaid taxes.

(Ord. No. 1995-785, §1, 11-21-95)

Sec. 12-6004. NUISANCES PROHIBITED; ENUMERATION; ABATEMENT IN GREENWAY PROPERTIES.

(a) Greenway properties shall mean any interest in real property owned by the City, leased to the City, or any dedicated greenway easement to the City which:

(1) Is actually used as a linear park network and is primarily left in its natural state except for the introduction of a connector system of trails for use by pedestrians and bicyclists; and

(2) Appears on the Council approved Greenway Plan which is on file in the office of the City Clerk and Treasurer.

(b) The following enumerated and described conditions are hereby found, deemed, and declared to constitute a detriment, danger, and hazard to the health, safety, morals, and general welfare of the inhabitants of the City and are found, deemed, and declared to be public nuisances wherever the same may exist and the creation, maintenance, or failure to abate said nuisances is hereby declared unlawful.

(1) Any concentration of combustible items such as mattresses, boxes, paper, automobile tires, and tubes, garbage, trash, refuse, old clothes, rags, or any other combustible materials or objects of a like nature in open places;

(2) Any concentration of building materials including concrete, steel or masonry which are not suitable for building construction, alterations or repairs and which are in open places; or

(3) An open place of collection of garbage, food waste, animal waste, or any other rotten or putrescible matter of any kind; however, nothing in this subsection shall be construed to prevent the generally accepted use of a properly maintained compost pile or storage of animal manure being used as fertilizer for lawns and gardens and for other agricultural or horticultural purposes; or

(4) Privies;

(5) Hides, dried or green; provided the same may be kept for sale in the City when horoughly cured and odorless;

(6) Any household or office furniture, appliances, or other metal products of any kind or nature kept in open places;

(7) Any products which have jagged edges of metal or glass or areas of confinement which are openly kept in places including porches and carports; or

(8) Any open place of concentration of discarded bottles, cans or medical supplies; or

(9) Any improper or inadequate drainage which causes flooding on private property, interferes with the use of or endangers in any way City-owned streets, sidewalks; provided, the notices required and powers conferred by this chapter by and on the Department of Inspections for abating the nuisances defined in this subsection (9) shall be given and exercised by the Director of Transportation; or

(10) Any other condition specifically declared to be a danger to the public health, safety, morals, and general welfare of inhabitants of the City and a public nuisance by the governing body of the City which proceeding may be initiated by the Department of Inspections before the Council after giving written notice in conformity with subsection (c) hereof, which notice will state the condition existing, the location, and that the City Council will be requested on a day certain, after a public hearing at which the person notified may appear and be heard, to declare that the conditions existing constitute a danger to the public health, safety, morals, and general welfare of the inhabitants of the City and a public nuisance, and that after such declaration by the Council in the form of an ordinance the condition will be abated as provided in subsection (d) hereof; provided no appeal shall lie from a proceeding initiated by the Department of Inspections before the Council of the City as provided in this subsection.

(c) When any public nuisance as set out in subsection (b) hereof is found to exist on any property including rights-of-way and easements within the City and one (1) mile beyond the City limits, the Department of Inspections of the City shall notify the owner of the premises where the nuisance is located that conditions exist which constitute a public nuisance and unless the condition is abated within fifteen (15) days from the mailing of the notice, which shall be sent by registered mail, return receipt requested, or certified mail, the conditions constituting a nuisance will be abated and the cost of abatement including an administrative fee of one hundred twenty-five dollars ($125.00), also including the cost, if any, to reseed areas which were formally a nuisance shall constitute a lien against the premises.

(d) The Department of Inspections is hereby given full power and authority to enter upon the premises involved for the purpose of abating the nuisance found to exist as herein set out. Within the fifteen-day period mentioned in subsection (c) hereof the owner of the property where the nuisance exists may appeal the findings of the Department of Inspections made pursuant to subsection (b) hereof to the Council by giving written notice of appeal to the Department of Inspections, said appeal to stay the abatement of the nuisances by the Department of Inspections until a final determination by the Council. In the event no appeal is taken, the Department of Inspections may proceed to abate the nuisance.

(e) The Council in the event an appeal is taken as provided in subsection (d) hereof may after hearing all interested persons and reviewing the findings of the Department of Inspections, reverse the finding made pursuant to subsection (b) hereof; but if the Council shall determine that the findings of the Department of Inspections made pursuant to said subsection are correct and proper, it shall adopt an ordinance specifically declaring the condition existing on the property to be a danger and hazard to the health, safety, morals, and general welfare of the inhabitants of the City and a public nuisance and directing the Department of Inspections to cause said conditions to be abated.

(f) After the abatement of the nuisance as provided in subsection (c), (d), or (e) hereof the cost of such abatement shall become a lien against the premises upon confirmation of the cost thereof by the Council, which confirmation shall take place only after ten (10) days' written notice to the owner of the premises where the nuisance existed of the proposed confirmation. Upon confirmation, the cost of abatement shall be a lien against the premises from which the nuisance was abated, the same to be recorded as provided in Article 10 of Chapter 160A of the General

Statutes and to be collected as unpaid taxes.

(Ord. No. 1995-785, §1, 11-21-95; Ord. No. 1998-454, §19, 11-4-98)

Sec. 12-6005. CIVIL PENALTY.

Any owner of a property whose property shall be declared a public nuisance as provided in §§12-6001 through 12-6004 of this Code shall, on the third offense occurring within one (1) calendar year, and for each additional offense in the calendar year, be subject to a civil penalty of three hundred dollars ($300.00). If a person fails to pay the civil penalty within thirty (30) days after being notified of the amount due, the City may recover the penalty together with all costs by filing a civil action in the general court of justice in the nature of a suit to collect a debt.

(Ord. No. 1995-785, §1, 11-21-95)

Appendix N. Example Stormwater Maintenance Agreements

Several examples of stormwater maintenance agreements are provided on the following pages. Another source of additional examples is a website maintained by the Center for Watershed Protection at http://www.stormwatercenter.net/. The Tar-Pamlico model program development group did not review the following examples for the extent of their applicability. Local governments are encouraged to consider these examples in light of their individual program needs.

NORTH CAROLINA
NASH COUNTY

STORM WATER FACILITY OPERATION AND MAINTENANCE AGREEMENT

THIS AGREEMENT, made and entered into this _____day of October, 2002, by and between Robert Carlton Davis, and wife, Gay L. Davis, herein "Permittee" and Nash County, a political subdivision of North Carolina (the "County");

W I T N E S S E T H:

WHEREAS, the County has adopted certain storm water management regulations applicable to the property of Permittee located in the County of Nash, Nash County, North Carolina, and more particularly described in the Nash County Unified Development Ordinance; and

WHEREAS, such regulations require the Permittee to operate and maintain an engineered storm water control facility as part of the development of the Property; and

WHEREAS, Permittee has constructed a private on-site engineered storm water control facility (the "Facility") to satisfy the requirements of such regulations, the boundaries of such Facility being described in Appendix 1 attached hereto and incorporated herein by reference; and

WHEREAS, a deed vesting title to the real estate on which the Facility is located in Permittee has been recorded in the Nash County Registry; and

WHEREAS, as a condition of the development of the Property, Permittee is required to enter into an operation and maintenance agreement providing for the continued operation and maintenance of the Facility.

NOW, THEREFORE, for and in consideration of the premises and the approval by the County of the development activities on the Property, the Permittee does hereby covenant and agree with the County that the Facility shall be held, operated, maintained, and encumbered pursuant to the covenants and conditions hereinafter set forth;

1. Operation and Maintenance Plan. Permittee has prepared and submitted to the County an Operation and Maintenance Plan for the Facility which has been approved by the County. Permittee shall operate, maintain, repair, and, if necessary, reconstruct the Facility in accordance with the Operation and Maintenance Plan.
2. Inspection and Maintenance of Facility. In addition to the maintenance provided for in the Operation and Maintenance Plan, Permittee shall undertake and provide the following inspection, repair, and maintenance of the Facility:
   a. Grassing around the Facility shall be maintained to prevent the erosion of these areas. The areas shall be periodically mowed to maintain the aesthetic quality of the site and to prevent a reduction in capacity of the stormwater system. Grass should not exceed a height of 15 inches. All eroded areas shall be repaired and planted with grass.
   b. Open ditches shall be kept free of undesirable growth and mowed or maintained to the design cross-section and area as shown on the construction plans approved by the Nash County and on file in the Office of the Planning Director. Growth on the slopes and bottom should not exceed a height of 8 inches.
   c. Landscaping of the area around the Facility shall not reduce the capacity or hinder operation and maintenance of the Facility. Landscaping shall be maintained to ensure that landscape materials live and prosper. Re-vegetation of areas may be required by the Planning Director or designee.
   d. The Facility shall be routinely checked as directed by the Planning Director for, and cleared of, all accumulation of debris and the Facility's outlet structure cleared of any blockage that is present.
   e. Storm drainage pipes and culverts shall be periodically inspected on a schedule established by the Planning Director for debris and sand build-up. They shall be cleaned as necessary to provide for the free conveyance of stormwater as designed.
   f. The Facility shall be maintained at the design depth as shown on the construction plans approved by the Planning Director and on file in the office of the Planning Director. The pond shall be inspected and maintained by the Permittee on a regular basis. Debris and sedimentation

shall be removed by the Permittee when:

1. The primary outlet capacity is impaired and/or;
2. The depth of the Facility has been reduced by more than one foot from the original depth or the Facility volume is reduced by 20% of the design impoundment volume. Sediment bays and forebays shall be kept clean of any sediment.

g. The Facility shall be maintained in a manner to control insects, odors and algae as determined necessary by the Planning Director.
h. Any fencing or other security measures shall be maintained in good condition. If no fencing or security measures are included with the original construction, they shall be added at the Permittee's expense at such time as the Planning Director determines that unauthorized persons are disturbing the Facility and that security measures will help prevent such unauthorized activity.

3. Right of Inspection by County. The Permittee hereby grants the County the right, privilege and easement over and cross the Property lying between any public street or right of way and the Facility for the purpose of inspecting, correcting, repairing, replacing or maintaining the Facility as provided in this Agreement. This right, privilege and easement is appurtenant to and shall run with the Property.

4. Remedies for Violations of this Agreement.

   a. If the Permittee shall fail to maintain or repair the Facility as set forth herein, or otherwise violates this Agreement, the County may order the Permittee to undertake the necessary repair or maintenance or to correct such violation. If the Permittee shall fail to comply with such order within thirty (30) days from the date thereof, the County may enter the Property and perform all necessary work to place the Facility in proper working condition. The full cost of performing the work shall be a lien on the property as provided in G.S. 160A-193.
   b. The County shall have the right to bring an action and recover all sums due, including damages and its attorney fees, seek injunctive relief, and/or such other and further relief as may be just and appropriate.
   c. The remedies provided by this paragraph are cumulative; and are in addition to any other remedies provided by law.

5. No Waiver of Breach. In the event of a breach of any term of this Agreement, any delay or failure on the part of the County to exercise any rights, powers, or remedies herein provided shall not be construed as a waiver thereof or acquiescence of such breach or any future breach.
6. Amendments. This Agreement may be amended, revised or modified only by a written document signed by the parties.
7. Binding Effect. The conditions and restrictions set forth herein with regard to the Facility shall run with the land and shall bind the Permittee and its, heirs, successors and assigns and all parties claiming by, through, or under them shall be taken to hold, agree, and covenant with the County, its successors and assigns, and with each of them to conform to, comply with and observe said conditions and restrictions. The County shall be deemed a beneficiary of the conditions and restrictions set forth herein and such conditions and restrictions shall run with the land in favor of the County.
8. Warranties of Title. The Permittee covenants and warrants that it is lawfully seized and possessed of the Facility and real estate described in Appendix 1, that it has good right and lawful authority to enter into this Agreement for the purposes herein expressed, and that no consent or waiver by the holder of any mortgage, deed of trust, or other security instrument, or any other person, firm, or corporation is required prior to entering into this Agreement.
9. Interpretation. Use of the masculine gender herein includes the feminine and neuter, and the singular number used herein shall equally include the plural. The captions preceding the various provisions of this Agreement are for the convenience of reference only, and shall not be used as an aid in interpretation or construction of this Agreement.
10. Severability. Invalidation of any one of these covenants or conditions by judgment or order of any court shall in no way affect any of the other provisions, which shall remain in full force and effect.

IN WITNESS WHEREOF, the parties have hereunto set their hands and seals this the day and year first above written.

_____ _____

Robert Carlton Davis Gay L. Davis

Address: P. O. Box 8356, Greenville, South Carolina 29604

_____
Planning Director, County of Nash

STATE OF SOUTH CAROLINA
COUNTY OF _____

I, _____, a notary public in and for said county and state, certify that Robert Carlton Davis and wife, Gay L. Davis personally appeared before me this date and acknowledged the execution of the foregoing instrument with the County of Nash.

This the _____ day of _____, 20___.

_____
Notary Public
My Commission Expires: _____

STATE OF NORTH CAROLINA
COUNTY OF _____

I, _____, a notary public in and for said county and state, certify that _____ personally appeared before me this day, stated that he or she is the Planning Director of the County of Nash, a political subdivision of the State of North Carolina, and that by authority duly given may act on behalf of the County.

This the _____ day of _____, 20___.

_____
Notary Public
My Commission Expires: _____

(SEAL)

APPROVED AS TO FORM:

_____
County Attorney

STORMWATER MANAGEMENT/ BMP FACILITIES AGREEMENT

Albemarle County, VA

Water Resources Management

(804) 296 – 5861

Revised 8 January 1997

Prepared by County of Albemarle Department of Engineering & Public Works

STORMWATER MANAGEMENT/BMP FACILITIES MAINTENANCE AGREEMENT

THIS AGREEMENT, made and entered into this ___ day of _____, 19___, by and between

_____ hereinafter called the "Landowner", and the
(Insert Full Name of Owner)
Board of Supervisors of Albemarle County, Virginia, hereinafter called the "County".

WITNESSETH, that

WHEREAS, the Landowner is the owner of certain real property described as

_____ as recorded by deed in the land records of Albemarle County,
(Albemarle County tax Map/Parcel Identification Number)

Virginia, Deed Book _____ Page _____, hereinafter called the "Property".

WHEREAS, the Landowner is proceeding to build on and develop the property; and

WHEREAS, the Site Plan/Subdivision Plan known as _____, hereinafter
(Name of Plan/Development)
called the "Plan", which is expressly made a part hereof, as approved or to be approved by the County, provides for detention of stormwater within the confines of the property; and

WHEREAS, the County and the Landowner, its successors and assigns, including any homeowners association, agree that the health, safety, and welfare of the residents of Albemarle County, Virginia, require that on-site stormwater management/BMP facilities be constructed and maintained on the Property; and

WHEREAS, the County requires that on-site stormwater management/BMP facilities as shown on the Plan be constructed and adequately maintained by the Landowner, its successors and assigns, including any homeowners association.

NOW, THEREFORE, in consideration of the foregoing premises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The on-site stormwater management/BMP facilities shall be constructed by the Landowner, its successors and assigns, in accordance with the plans and specifications identified in the Plan.

2. The Landowner, its successors and assigns, including any homeowners association, shall adequately maintain the stormwater management/BMP facilities. This includes all pipes and channels built to convey stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater. Adequate maintenance is herein defined as good working condition so that these facilities are performing their design functions. The Annual Inspection Report form dated 6/2/92 (or latest date form available) is to be used to establish what good working condition is acceptable to the County.

3. The Landowner, its successors and assigns, shall inspect the stormwater management/BMP facility and submit an inspection report annually. The purpose of the inspection is to assure safe and proper functioning of the facilities. The inspection shall cover the entire facilities, berms, outlet structure, pond areas, access roads, etc. Deficiencies shall be noted in the inspection report.

4. The Landowner, its successors and assigns, hereby grant permission to the County, its authorized agents and employees, to enter upon the Property and to inspect the stormwater management/BMP facilities whenever the County deems necessary. The purpose of inspection is to follow-up on reported deficiencies and/or to respond to citizen complaints. The County shall provide the Landowner, its successors and assigns, copies of the inspection findings and a directive to commence with the repairs if necessary.

5. In the event the Landowner, its successors and assigns, fails to maintain the stormwater management/BMP facilities in good working condition acceptable to the County, the County may enter upon the Property and take whatever steps necessary to correct deficiencies identified in the inspection report and to charge the costs of such repairs to the Landowner, its successors and assigns. This provision shall not be construed to allow the County to erect any structure of permanent nature on the land of the Landowner outside of the easement for the stormwater management/BMP facilities. It is expressly understood and agreed that the County is under no obligation to routinely maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the County.

6. The Landowner, its successors and assigns, will perform the work necessary to keep these facilities in good working order as appropriate. In the event a maintenance schedule for the stormwater management/BMP facilities (including sediment removal) is outlined on the approved plans, the schedule will be followed.

7. In the event the County pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner, its successors and assigns, shall reimburse the County upon demand, within thirty (30) days of receipt thereof for all actual costs incurred by the County hereunder.

8. This Agreement imposes no liability of any kind whatsoever on the County and the Landowner agrees to hold the County harmless from any liability in the event the stormwater management/BMP facilities fail to operate properly.

9. This Agreement shall be recorded among the land records of Albemarle County, Virginia, and shall constitute a covenant running with the land, and shall be binding on the Landowner, its administrators, executors, assigns, heirs and any other successors in interests, including any homeowners association.

WITNESS the following signatures and seals:

_____

Company/Corporation/Partnership Name (Seal)

By: _____

_____

(Type Name)

_____

(Type Title)

STATE OF _____

COUNTY OF _____

The foregoing Agreement was acknowledged before me this ____ day of _____, 19___, by _____.

_____

NOTARY PUBLIC

My Commission Expires: _____

COUNTY OF ALBEMARLE, VIRGINIA

By: _____

_____

(Type Name)

_____

(Type Title)

STATE OF _____

COUNTY OF _____

The foregoing Agreement was acknowledged before me this ____ day of _____, 19___, by _____.

_____

NOTARY PUBLIC

My Commission Expires: _____

Approved as to Form:

_____ _____

County Attorney Date

WET [WETLAND] DETENTION BASIN OPERATION AND MAINTENANCE AGREEMENT
[Wetland maintenance wording is bracketed. Please modify the document as appropriate.]

The wet [wetland] detention basin system is defined as the wet [wetland] detention basin, pretreatment including forebays and the vegetated filter if one is provided.

Maintenance activities shall be performed as follows:

1. After every significant runoff producing rainfall event and at least monthly:

   a. Inspect the wet [wetland] detention basin system for sediment accumulation, erosion, trash accumulation, vegetated cover, and general condition.

   b. Check and clear the orifice of any obstructions such that drawdown of the temporary pool occurs within 2 to 5 days as designed.

2. Repair eroded areas immediately, re-seed as necessary to maintain good vegetative cover, mow vegetative cover to maintain a maximum height of six inches, and remove trash as needed.

3. Inspect and repair the collection system (i.e. catch basins, piping, swales, riprap, etc.) quarterly to maintain proper functioning.

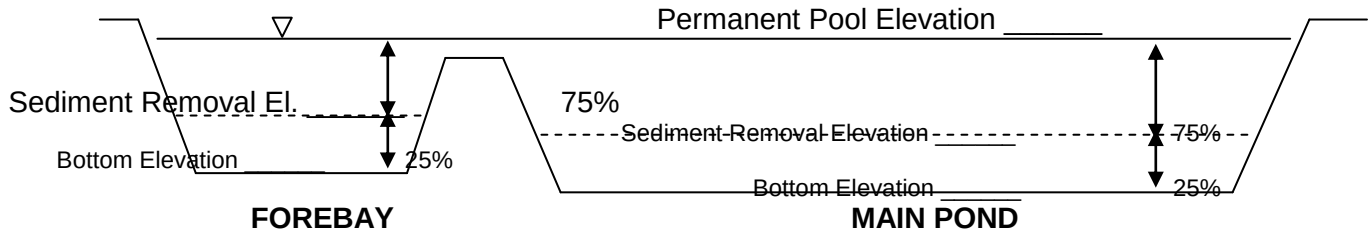
4. Remove accumulated sediment from the wet [wetland] detention basin system semi-annually or when depth is reduced to 75% of the original design depth (see diagram below). Removed sediment shall be disposed of in an appropriate manner and shall be handled in a manner that will not adversely impact water quality (i.e. stockpiling near a wet [wetland] detention basin or stream, etc.).

   The measuring device used to determine the sediment elevation shall be such that it will give an accurate depth reading and not readily penetrate into accumulated sediments.

   When the permanent pool depth reads _____ feet in the main pond, the sediment shall be removed.
   [For stormwater wetlands: If the elevation of the marsh areas exceed the permanent pool elevation, the sediment should be removed to design levels. This shall be performed by removing the upper 6 inches of soil and stockpiling it. Then the marsh area shall be excavated six inches below design elevations. Afterwards the stockpiled soil should be spread over the marsh surface. The soil should not be stockpiled for more than two weeks.]

   When the permanent pool depth reads _____ feet in the forebay [and micro-pool], the sediment shall be removed.

BASIN DIAGRAM *(fill in the blanks)*



5. Remove cattails and other indigenous wetland plants when they cover 50% of the basin surface. These plants shall be encouraged to grow along the vegetated shelf and forebay berm.

   [For wetlands: Wetland planting densities in the marsh areas should be maintained by replanting bare areas as needed. Wetland plants should be encouraged to grow in the marsh areas.]

6. If the basin must be drained for an emergency or to perform maintenance, the flushing of sediment through the emergency drain shall be minimized to the maximum extent practical.

7. All components of the wet [wetland] detention basin system shall be maintained in good working order.

8. Level spreaders or other structures that provide diffuse flow shall be maintained every six months. All accumulated sediment and debris shall be removed from the structure, and a level elevation shall be maintained across the entire flow spreading structure. Any down gradient erosion must be repaired and/or replanted as necessary.

I acknowledge and agree by my signature below that I am responsible for the performance of the seven maintenance procedures listed above. I agree to notify DWQ of any problems with the system or prior to any changes to the system or responsible party.

Print name:_____

Title:_____

Address:_____

Phone:_____

Signature:_____

Date:_____

Note: The legally responsible party should not be a homeowners association unless more than 50% of the lots have been sold and a resident of the subdivision has been named the president.

I, _____, a Notary Public for the State of

_____, County of _____, do hereby certify that

_____ personally appeared before me this ___ day of

_____, _____, and acknowledge the due execution of the forgoing wet [wetland] detention basin maintenance requirements. Witness my hand and official seal,

SEAL

My commission expires_____

Appendix O. Example Conservation Easement

This appendix provides an example conservation easement. All conservation easements are case-specific documents. This example suggests elements that drafters of a conservation easement may wish to consider. This example was taken from the Clean Water Management Trust Fund. It is designed as an agreement between the state and a county to place a conservation easement on a riparian buffer for specific purposes. It would require modification for use between a developer and a local government for land conservation, and greater modification to conserve the functions of a stormwater facility.

DRAFT

Tax Parcel ID #_____

STATE OF NORTH CAROLINA
COUNTY OF _____

CONSERVATION EASEMENT
Property name

THIS [CWD31]CONSERVATION EASEMENT ("Conservation Easement") is made on this _____ day of _____, 2001, by and between _____, with an address at ___ ("Grantor") and the STATE OF NORTH CAROLINA, with its address c/o State Property Office, 1321 Mail Service Center, Raleigh, NC 27699-1321 ("State" or "Grantee"), acting solely through the North Carolina Clean Water Management Trust Fund, with its address at 1651 Mail Service Center, Raleigh, NC 27699-1651 ("Fund").

RECITALS & CONSERVATION PURPOSES

A. Grantor is the sole owner in fee simple of the property being approximately _____ acres in _____ County, State of North Carolina and being all of that certain tract as more particularly described in Exhibit A attached hereto and by this reference incorporated herein ("Property"); and

B. The State of North Carolina will be the Grantee and holder of this Conservation easement; and,

C. Fund is authorized by Article 13A, Chapter 113 of the General Statutes of North Carolina ("N.C.G.S.") to finance projects and to acquire land and interests in land, including conservation easements for riparian buffers for the purposes of providing environmental protection for surface waters and urban drinking water supplies and establishing a network of riparian greenways for environmental, educational, and recreational uses; and

D. The Grantor has received a grant from the Fund for acquisition of the Property in consideration of which Grantor has agreed that it will be conserved and managed in a manner that will

protect the quality of the waters of _____ and otherwise promote the public purposes authorized by Article 13A, Chapter 113 of the N.C.G.S; and,

E. The parties hereto recognize the conservation and water quality values of the Property in its present state as a riparian shoreline and intend that said conservation values of the Property be preserved and maintained.

F. The characteristics of the Property, its current use and state of improvement are described in Exhibit A, which is the appropriate basis for monitoring compliance with the objectives of preserving the conservation and water quality values; the Exhibit A is not intended to preclude the use of other evidence (e.g. surveys, appraisals) to establish the present condition of the Property if there is a controversy over its use.

NOW, THEREFORE, in consideration of the premises and the mutual benefits recited herein, together with other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged by the parties hereto, the Grantor hereby unconditionally and irrevocably gives, grants and conveys forever and in perpetuity to the Grantee, its successors and assigns, and the Grantee hereby accepts, a Deed of Conservation Easement of the nature and character and to the extent hereinafter set forth in, over, through and across the Property, together with the right to preserve and protect the conservation values thereof as described in the Recitals herein.

The purposes of this Conservation Easement are to provide environmental protection for surface waters and to protect the wildlife and natural heritage values and it shall be so held, maintained, and used therefore. It is the further purpose of this Easement to prevent any use of the Property that will significantly impair or interfere with the preservation of said conservation values. Grantor intends that this easement will restrict use of the Property to such activities as are consistent with the purposes of conservation.

ARTICLE I. DURATION OF EASEMENT

This Conservation Easement shall be perpetual. It is an easement in gross, runs with the land, and is enforceable by Grantee against Grantor, its representatives, successors, assigns, lessees, agents and licensees.

ARTICLE II. RIGHTS RESERVED TO GRANTOR

Grantor reserves certain rights accruing from ownership of the Property, including the right to engage in or permit others to engage in uses of the Property that are not inconsistent with the purpose(s) of this Easement. All rights reserved by Grantors are reserved for Grantors, their representatives, successors, and assigns, and are considered to be consistent with the conservation purposes of this Conservation Easement. The following rights are expressly reserved:

What is appropriate? Perhaps the following?

A. To engage in passive recreational uses of the Property (requiring no surface alteration of the land and posing no threat to conservation values), including, without limitation, walking, fishing, or animal and plant observation; and,

B. To allow public access to the property for the purpose of conducting educational tours, scientific study, maintenance of the Property and any other purpose consistent with maintaining the conservation value.

Notwithstanding the foregoing, Grantor and Grantee have no right to agree to any activity that would result in the termination of this Conservation Easement.

ARTICLE III. PROHIBITED AND RESTRICTED ACTIVITIES

Any activity on, or use of, the Property inconsistent with the purposes of this Conservation Easement is prohibited. The Property shall be maintained in its natural, scenic, wooded and open condition and restricted from any development or use that would impair or interfere with the conservation purposes of this Conservation Easement set forth above.

Without limiting the generality of the foregoing, the following activities and uses are expressly prohibited or restricted.

A. Industrial and Commercial Use. Industrial and commercial activities and any right of passage for such purposes are prohibited on the Property within the 300 foot corridor.

B. Agricultural, Timber Harvesting, Grazing and Horticultural Use. Agricultural, timber harvesting, grazing, horticultural and animal husbandry operations are prohibited on the Property within the 300 foot corridor.

C. Disturbance of Natural Features, Plants and Animals. There shall be no cutting or removal of trees, or the disturbance of other natural features within the 300 foot corridor except for the following: (1) as incidental to boundary marking, fencing, signage, construction and maintenance of nature trails and public access allowed hereunder; (2) selective cutting and prescribed burning or clearing of vegetation and the application of mutually approved pesticides for fire containment and protection, disease control, restoration of hydrology, wetlands enhancement and/or control of non-native plants; subject however, to the prior approval of Fund, and (3) hunting and fishing pursuant to applicable rules and regulations.

D. Construction of Buildings and Recreational Use. There shall be no constructing or placing of any building, mobile home, asphalt or concrete pavement, billboard or other advertising display, antenna, utility pole, tower, conduit, line, pier landing, dock or any other temporary or permanent structure or facility on or above the Property except for the following: placing and display of no trespassing signs, local, state or federal traffic or similar informational signs, for sale or lease signs, fencing, signs identifying the conservation values of the Property, and/or signs identifying the Grantor as owner of the Property and State as holders of this Conservation Easement and as the source of funding for the acquisition of this Property, educational and interpretative signs, identification labels or any other similar temporary or permanent signs, reasonably satisfactory to the Fund.

E. Mineral Use, Excavation, Dredging. There shall be no filling, excavation, dredging, mining or drilling; no removal of topsoil, sand, gravel, rock, peat, minerals or other materials, and no change in the topography of the land in any manner except as necessary for the purpose of combating erosion or incidental to any conservation management activities otherwise permitted in this Conservation Easement.

F. Wetlands and Water Quality. There shall be no pollution or alteration of water bodies and no activities that would be detrimental to water purity or that would alter natural water levels, drainage, sedimentation and/or flow in or over the Property or into any surface waters, or cause soil degradation or erosion nor diking, dredging, alteration, draining, filling or removal of wetlands, except activities to restore natural hydrology or wetlands enhancement as permitted by state and any other appropriate authorities.

G. Dumping. Dumping of soil, trash, ashes, garbage, waste, abandoned vehicles, appliances, or machinery, or other materials on the Property is prohibited.

H. Conveyance and Subdivision. The Property may not be subdivided, partitioned nor conveyed, except in its current configuration as an entity or block of property.

ARTICLE IV. ENFORCEMENT AND REMEDIES

A. Enforcement. To accomplish the purposes of this Easement, Grantee is allowed to prevent any activity on or use of the Property that is inconsistent with the purposes of this Easement and to require the restoration of such areas or features of the Property that may have been damaged by such activity or use. Upon any breach of the terms of this Conservation Easement by Grantor that comes to the attention of the Grantee, the Grantee shall, except as provided below, notify the Grantor in writing of such breach. The Grantor shall have ninety (90) days after receipt of such notice to correct the conditions constituting such breach. If the breach remains uncured after ninety (90) days, the Grantee may enforce this Conservation Easement by appropriate legal proceedings including damages, injunctive and other relief. The Grantee shall also have the power and authority, consistent with its statutory authority: (a) to prevent any impairment of the Property by acts which may be unlawful or in violation of this Conservation Easement; (b) to otherwise preserve or protect its interest in the Property; or (c) to seek damages from any appropriate person or entity. Notwithstanding the foregoing, the Grantee reserves the immediate right, without notice, to obtain a temporary restraining order, injunctive or other appropriate relief if the breach of the term of this Conservation Easement is or would irreversibly or otherwise materially impair the benefits to be derived from this Conservation Easement. The Grantor and Grantee acknowledge that under such circumstances damage to the Grantee would be irreparable and remedies at law will be inadequate. The rights and remedies of the Grantee provided hereunder shall be in addition to, and not in lieu of, all other rights and remedies available to Grantee in connection with this Conservation Easement, including, without limitation, those set forth in the Grant Agreement under which this Conservation Easement was obtained.

B. Inspection. Grantee, its employees and agents and its successors and assigns, have the right, with reasonable notice, to enter the Property at reasonable times for the purpose of inspecting the Property to determine whether the Grantor, Grantor's representatives, or assigns are complying with the terms, conditions and restrictions of this Conservation Easement.

C. Acts Beyond Grantor's Control. Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury or change in the Property caused by third parties, resulting from causes beyond the Grantor's control, including, without limitation, fire, flood, storm, and earth movement, or from any prudent action taken in good faith by the Grantor under emergency conditions to prevent, abate, or mitigate significant injury to life, damage to property or harm to the Property resulting from such causes.

D. Costs of Enforcement. Any costs incurred by Grantee in enforcing the terms of this Conservation Easement against Grantor, including, without limitation, any costs of restoration necessitated by Grantor's acts or omissions in violation of the terms of this Conservation Easement, shall be borne by Grantor.

E. No Waiver. Enforcement of this Easement shall be at the discretion of the Grantee and any forbearance by Grantee to exercise its rights hereunder in the event of any breach of any term set forth herein shall not be deemed or construed to be a waiver by Grantee of such term or of any subsequent breach of the same or of any other term of this easement or of Grantee's rights. No delay or omission by Grantee in exercise of any right or remedy shall impair such right or remedy or be construed as a waiver.

ARTICLE V. DOCUMENTATION AND TITLE

A. Property Condition. The parties acknowledge that the Property is currently undeveloped land, with no improvements other than as described in Exhibit A and easements and rights of way of record.

B. Title. The Grantor covenants and represents that the Grantor is the sole owner and is seized of the Property in fee simple and has good right to grant and convey the aforesaid Conservation Easement; that there is legal access to the Property, that the Property is free and clear of any and all encumbrances, except easements of record, none of which would nullify, impair or limit in any way the terms or effect of this Conservation Easement; Grantor shall defend its title against the claims of all persons whomsoever, and Grantor covenants that the Grantee shall have the use of and enjoy all of the benefits derived from and arising out of the aforesaid Conservation Easement.

ARTICLE VI. MISCELLANEOUS

A. Subsequent Transfers. Grantor hereby covenants and agrees, that in the event it transfers or assigns the Property, the transferee of the Property will be a qualified organization as that term is defined in Section 170(h)(3) of the Internal Revenue Code of 1986, as amended, or any successor section, and the regulations promulgated thereunder (the Internal Revenue Code"), which is organized or operated primarily for one of the conservation purposes specified in Section 170 (h)(4)(A) of the Internal Revenue Code. Grantor agrees for itself, its successors and assigns, to notify Grantee in writing of the names and addresses of any party to whom the Property, or any part thereof, is to be transferred at or prior to the time said transfer is consummated. Grantor, for itself, its successors and assigns, further agrees to make specific reference to this Conservation Easement in a separate paragraph of any subsequent lease, deed or other legal instrument by which any interest in the Property is conveyed.

B. Conservation Purpose.

(1) Grantee, for itself, its successors and assigns, agrees that this Conservation Easement shall be held exclusively for conservation purposes.

(2) The parties hereto recognize and agree that the benefits of this Conservation Easement are in gross and assignable, provided, however that the Grantee hereby covenants and agrees, that in the event it transfers or assigns this Conservation Easement, the organization receiving the interest will be a qualified organization as that term is defined in Section 170(h)(3) of the Internal Revenue Code, which is organized or operated primarily for one of the conservation purposes specified in Section 170 (h)(4)(A) of the Internal Revenue Code, and Grantee further covenants and agrees that the terms of the transfer or assignment will be such that the transferee or assignee will be required to continue to carry out in perpetuity the conservation purposes that the contribution was originally intended to advance, set forth in the Recitals herein.

(3) Unless otherwise specifically set forth in this Conservation Easement, nothing herein shall convey to or establish for the public a right of access over the Property.

C. Construction of Terms. This Conservation Easement shall be construed to promote the purposes of the North Carolina enabling statute set forth in N.C.G.S. 121-34 et. seq. which authorizes the creation of Conservation Easements for purposes including those set forth in the Recitals herein, and the conservation purposes of this Conservation Easement, including such purposes as are defined in Section 170(h)(4)(A) of the Internal Revenue Code.

D. Recording. State shall record this instrument and any amendment hereto in timely fashion in the official records of _____ County, North Carolina, and may re-record it at any time as may be required to preserve its rights.

E. Notices. All notices, requests or other communications permitted or required by this Agreement shall be sent by registered or certified mail, return receipt requested, addressed to the parties as set forth above, or to such other addresses such party may establish in writing to the other. All such items shall be deemed given or made three (3) days after being placed in the United States mail as herein provided. In any case where the terms of this Conservation Easement require the consent of any party, such consent shall be requested by written notice. Such consent shall be deemed denied unless, within ninety (90) days after receipt of notice, a written notice of approval and the reason therefore has been mailed to the party requesting consent.

F. Amendments. Grantor and Grantee are free to jointly amend this Conservation Easement to meet changing conditions, provided that no amendment will be allowed that is inconsistent with the purposes of this Conservation Easement or affects the perpetual duration of this Conservation Easement. Such amendment(s) require the written consent of both Grantor and Grantee and shall be effective upon recording in the public records of ____ County, North Carolina.

G. Environmental Condition of Property. The Grantor warrants, represents and covenants to the Grantee that to the best of its knowledge after appropriate inquiry and investigation that: (a) the Property described herein is and at all times hereafter will continue to be in full compliance with all

federal, state and local environmental laws and regulations, and (b) as of the date hereof there are no hazardous materials, substances, wastes, or environmentally regulated substances (including, without limitation, any materials containing asbestos) located on, in or under the Property or used in connection therewith, and that there is no environmental condition existing on the Property that may prohibit or impede use of the Property for the purposes set forth in the Recitals and the Grantor will not allow such uses or conditions.

H. Entire Agreement. This instrument sets forth the entire agreement of the parties with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings or agreements relating to the Conservation Easement. If any provision is found to be invalid, the remainder of the provisions of this Conservation Easement, and the application of such provision to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby. The party(ies) hereto intend this document to be an instrument executed under seal. If any party is an individual, partnership or limited liability company, such party hereby adopts the word "SEAL" following his/her signature and the name of the partnership or limited liability company as his/her/its legal seal. The Recitals set forth above and the Exhibits attached hereto are incorporated herein by reference.

I. Indemnity. The Grantors agree to the fullest extent permitted by law, to defend, protect, indemnify and hold harmless the State from and against all claims, actions, liabilities, damages, fines, penalties, costs and expenses suffered as a direct or indirect result of any violation of any federal, state, or local environmental or land use law or regulation or of the use or presence of any hazardous substance, waste or other regulated material in, on or under the property.

J. Interpretation. This Conservation Easement shall be construed and interpreted under the laws of the State of North Carolina, and any ambiguities herein shall be resolved so as to give maximum effect to the conservation purposes sought to be protected herein.

K. Parties. Every provision of this Conservation easement that applies to the Grantors or to the Grantee shall likewise apply to their respective heirs, executors, administrators, assigns, and grantees, and all other successors in interest herein.

L. Merger. The parties agree that the terms of this Conservation Easement shall survive any merger of the fee and easement interest in the Property.

M. Subsequent Liens. No provisions of this Conservation Easement shall be construed as impairing the ability of Grantors to use this Property for collateral for borrowing purposes, provided that any mortgage or lien arising therefrom shall be subordinated to this Easement.

TO HAVE AND TO HOLD unto THE STATE OF NORTH CAROLINA, its successors and assigns, forever. The covenants agreed to and the terms, conditions, restrictions and purposes imposed as aforesaid shall be binding upon Grantor, Grantor's representatives, successors and assigns, and shall continue as a servitude running in perpetuity with the Property.

IN WITNESS WHEREOF, Grantor, by authority duly given, has hereunto caused these presents to be executed by its officers and its seal affixed, to be effective the day and year first above written.

GRANTOR:

By: Don’t sign this version, it is a draft document
Title:_____

ATTEST:

_____
Title:_____

[SEAL]

STATE OF _____
COUNTY OF _____

I, _____, Notary Public, do hereby certify that _____ personally came before me this day and acknowledged that he/she is _____of _____, a _____, and that by authority duly given and as the act of the _____, the foregoing instrument was signed in its name by its _____, sealed with its _____ seal, and attested by him/herself as its _____.

Witness my hand and notarial seal, this the ____ day of _____, 2000.

_____
Notary Public
My commission expires:_____

STATE OF NORTH CAROLINA
_____ COUNTY

The foregoing certificate of _____, Notary Public, is certified to be correct. This _____day of _____, 2000.

_____
Register of Deeds

This instrument prepared by and should be returned to: _____

EXHIBIT A

[Add legal description of Property along with description of property condition, improvements, structures, and major features]

[CWD31]Comment 1 Issues in co-holding:
Grantee(s), its/theirs/them
State as Primary Grantee, others as local Grantees
Only Primary Grantee can pursue legal enforcement
Identify who monitors compliance, who is chief liason w/Grantor
Article IV – Paragraph A – The Primary Grantee shall have the right to prevent and correct violations of the terms of this easement. The Local Grantee(s) will monitor the Property and communicate with the Grantor regarding any potential or perceived breach of the easement …attention of (add) any Grantee, such Grantee shall immediately notify the other Grantees, and the Local Grantee shall, except as provided below, notify the Grantor in writing of such breach.

Appendix P. Examples of Ordinances to Establish Legal Authority for Illegal Discharge Programs

RALEIGH CITY CODES
CHAPTER 5.
OFFENSES AGAINST THE ENVIRONMENT*

*State law references: G.S. Chapter 113A Article 4 (Pollution Control Act); G.S. Chapter 143 Article 21 (Water and Air Resources); Emission of pollutants and contaminants, G.S. 160A-185; Raleigh City Charter §2.14(50); 1989 Session Law, Chapter 1043 (Authorizes City of Raleigh to regulate stormwater).

Section 13-5001
TITLE

This chapter shall be known and may be cited as the City of Raleigh's "Illicit Discharge Ordinance."
(Ordinance. No. 1995-573, §2, 3-7-95)

Section 13-5002
PURPOSES

(a) This chapter is adopted for the purposes of:

(1) Protecting the public health, safety and welfare by controlling the discharge of pollutants into the stormwater conveyance system;

(2) Promoting activities directed toward the maintenance and improvement of surface and ground water quality;

(3) Satisfying the requirements imposed upon the City of Raleigh under its National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) discharge permit issued by the State; and

(4) Establishing administration and enforcement procedures through which these purposes can be fulfilled.

(b) The provisions of this regulation are supplemental to regulations administered by Federal and State governments.
(Ordinance. No. 1995-573, §2, 3-7-95)

Section 13-5003

ACRONYMS

DEHNR: North Carolina Department of Environment Health and Natural Resources.
DEM: North Carolina Division of Environmental Management.
MS4: Municipal Separate Storm Sewer System.
NPDES: National Pollutant Discharge Elimination System.
(Ordinance No. 1995-573, §2, 3-7-95)

Section 13-5004 DEFINITIONS

As used in this chapter, unless the context clearly indicates otherwise, the following definitions apply:
Illicit Connection -. Any unlawful connection which allows the discharge of non-stormwater to the stormwater conveyance system or waters of the State in violation of this chapter.
Illicit Discharge - Any unlawful disposal, placement, emptying, dumping, spillage, leakage, pumping, pouring, emission, or other discharge of any substance other than stormwater into a stormwater conveyance, the waters of the State, or upon the land in such proximity to the same, such that the substance is likely to reach a stormwater conveyance or the waters of the State.
Municipal Separate Storm Sewer System (MS4) - A stormwater conveyance or unified stormwater conveyance system (including without limitation: roads with drainage systems, municipal streets, catch basins, stormwater detention facilities, curbs, gutters, ditches, natural or man-made channels, or storm drains), that:

(1) Is located within the corporate limits of Raleigh, North Carolina; and
(2) Is owned or operated by the State, County, the City, or other public body; and
(3) Discharges to waters of the State, excluding publicly owned treatment works, and lawful connections thereto, which in turn discharge into the waters of the State.

National Pollutant Discharge Elimination System - A permitting system established pursuant to §402 of the Clean Water Act et seq.
Federal law reference: National Pollutant Discharge Elimination System Permits, 33 USC §1342.
Pollution - Man-made or man-induced alteration of the chemical, physical, biological, thermal, and/or radiological integrity of water.
Stormwater - Any flow resulting from, and occurring during or following, any form of natural precipitation.
Stormwater Conveyance or Stormwater Conveyance System - Any feature, natural or man-made, that collects and transports stormwater, including but not limited to roads with drainage systems, streets, catch basins, curbs, gutters, ditches, man-made and natural channels, pipes, culverts, and storm drains, and any other natural or man-made feature or structure designed or used for collecting or conveying stormwater.
Waters of the State - Surface waters within or flowing through the boundaries of the State including the following: any intermittent or perennial stream, river, creek, brook, swamp, lake, sound, tidal estuary, bay, reservoir, wetland, or any other surface water or any portion thereof that is mapped as solid or dashed blue lines on United States Department of the Interior Geological Survey 7.5 minute series topographic maps. Treatment systems, consisting of man-made bodies of water, which were not originally created in waters of the State and which are not the result of impoundment of waters of the State, are not waters of the State.

(Ordinance No. 1995-573, §2, 3-7-95)

Section 13-5005 SCOPE AND EXCLUSIONS

This chapter shall apply within the territorial jurisdiction of the City, with the following exclusions:

(1) Federal, State, and local governments, including their agencies, unless intergovernmental agreements have been established giving the City enforcement authority.

(Ordinance No. 1995-573, §2, 3-7-95)

Section 13-5006
OBJECTIVES

The objectives of this chapter are to:

(1) Regulate the discharge of substances which may contaminate or cause pollution of stormwater, stormwater conveyances, or waters of the State;
(2) Regulate connections to the stormwater conveyance system;
(3) Provide for the proper handling of spills; and
(4) Provide for the enforcement of same.

(Ordinance No. 1995-573, §2, 3-7-95)

Section 13-5007
NON-STORMWATER DISCHARGE CONTROLS

(a) ***Illicit Discharge***

No person shall cause or allow the discharge, emission, disposal, pouring, or pumping directly or indirectly to any stormwater conveyance, the waters of the State, or upon the land in such proximity to the same (such that the substance is likely to reach a stormwater conveyance or the waters of the State), any fluid, solid, gas, or other substance, other than stormwater; provided that non-stormwater discharges associated with the following activities are allowed provided that they
do not significantly impact water quality:

(1) Filter backwash and draining associated with swimming pools;
(2) Filter backwash and draining associated with raw water intake screening and filtering devices;
(3) Condensate from residential or commercial air conditioning;
(4) Residential vehicle washing;
(5) Flushing and hydrostatic testing water associated with utility distribution systems;
(6) Discharges associated with emergency removal and treatment activities, for hazardous materials, authorized by the federal, State, or local government on-scene coordinator;
(7) Uncontaminated ground water [including the collection or pumping of springs, wells, or rising ground water and ground water generated by well construction or other construction activities];
(8) Collected infiltrated stormwater from foundation or footing drains;
(9) Collected ground water and infiltrated stormwater from basement or crawl space pumps;
(10) Irrigation water;
(11) Street wash water;
(12) Flows from fire fighting;
(13) Discharges from the pumping or draining of natural watercourses or waterbodies;
(14) Flushing and cleaning of stormwater conveyances with unmodified potable water;
(15) Wash water from the cleaning of the exterior of buildings, including gutters, provided that the discharge does not pose an environmental or health threat; and
(16) Other non-stormwater discharges for which a valid NPDES discharge permit has been approved and issued by DEM, and provided that any such discharges to the municipal separate storm sewer system shall be authorized by the City.

Prohibited substances include but are not limited to: oil, anti-freeze, chemicals, animal waste, paints, garbage, and litter.

State law references: Emission of pollutants and contaminants, G.S. 160A-185, Raleigh City Charter §2.14(50), and 1989 Session Laws, Chapter 1043.

Cross reference: Discharge onto City streets, sidewalks, or gutters, §12-1032 and depositing waste on land in the City, §7-3005(c)(2), (3).

(b) ***Illicit Connections***

(1) Connections to a stormwater conveyance or stormwater conveyance system which allow the discharge of non-stormwater, other than the exclusions described in section (a) above, are unlawful. Prohibited connections include, but are not limited to: floor drains, waste water from washing machines or sanitary sewers, wash water from commercial vehicle washing or steam cleaning, and waste water from septic systems.

(2) Where such connections exist in violation of §13-5007 and said connections were made prior to the adoption of this provision or any other ordinance prohibiting such connections, the property owner or the person using said connection shall remove the connection within one (1) year following application of this regulation; provided that, this grace period shall not apply to connections which may result in the discharge of hazardous materials or other discharges which pose an immediate threat to health and safety, or are likely to result in immediate injury and harm to real or personal property, natural resources, wildlife, or habitat.

(3) Where it is determined that said connection:

a. May result in the discharge of hazardous materials or may pose an immediate threat to health and safety, or is likely to result in immediate injury and harm to real or personal property, natural resources, wildlife, or habitat, or

b. Was made in violation of any applicable regulation or ordinance,

the City Manager or his designee shall designate the time within which the connection shall be removed. In setting the time limit for compliance, the City shall take into consideration:

a. The quantity and complexity of the work,
b. The consequences of delay,
c. The potential harm to the environment, to the public health, and to public and private property, and
d. The cost of remedying the damage.

Editor's note: This regulation first became applicable on March 12, 1995.

Permits are issued by the Inspections Department for connection to or modification of storm sewers located in City owned rights-of-way.

State law reference: Emission of pollutants and contaminants, G.S. 160A-185.

(c) ***Spills***

Spills or leaks of polluting substances discharged to, or having the potential to be indirectly transported to the stormwater conveyance system, shall be contained, controlled, collected, and removed promptly. All affected areas shall be restored to their preexisting condition.

Persons associated with the spill or leak shall immediately notify the City of Raleigh Fire Chief or his designee of all spills or leaks of polluting substances. Notification shall not relieve any person of any expenses related to the restoration, loss, damage, or any other liability which may be incurred as a result of said spill or leak, nor shall such notification relieve any person from other liability which may be imposed by State or other law.

(Ordinance No. 1995-573, §2, 3-7-95)

Section 13-5008 ENFORCEMENT

(a) **Authority to Enter**

Any authorized City personnel shall be permitted to enter upon public or private property for the purposes of observation, inspection, sampling, monitoring, testing, surveying, and measuring compliance. Should the owner or occupant of any property refuse to permit such reasonable access, the City Manager or his designee shall proceed to obtain an administrative search warrant pursuant to G.S. 15-27.2 or its successor.

No person shall obstruct, hamper or interfere with any such representative while carrying out his official duties.

(b) **Civil Penalties**

(1) ***Illicit Discharges***

Any designer, engineer, contractor, agent, or any other person who allows, acts in concert, participates, directs, or assists directly or indirectly in the creation of a violation of this chapter shall be subject to civil penalties as follows:

a. For first time offenders, if the quantity of the discharge is equal to or less than five (5) gallons and consists of domestic or household products in quantities considered ordinary for household purposes, said person shall be assessed a civil penalty not to exceed one hundred dollars ($100.00) per violation or per day for any continuing violation, and if the quantity of the discharge is greater than five (5) gallons or contains non-domestic substances, including but not limited to process waste water, or if said person cannot provide clear and convincing evidence of the volume and nature of the substance discharged, said person shall be assessed a civil penalty not to exceed one thousand dollars ($1,000.00) per violation or per day for any continuing violation.

b. For repeat offenders, the amount of the penalty shall be double the amount assessed for the previous penalty, not to exceed ten thousand dollars ($10,000.00) per violation or per day for any continuing violation.

c. In determining the amount of the penalty, the City Manager or his designee shall consider:

1. The degree and extent of harm to the environment, the public health, and public and private property;
2. The cost of remedying the damage;
3. The duration of the violation;
4. Whether the violation was willful;
5. The prior record of the person responsible for the violation in complying or failing to comply with this chapter;
6. The costs of enforcement to the public; and
7. The amount of money saved by the violator through his, her, or its noncompliance.

(2) ***Illicit Connection.***

Any person found with an illicit connection in violation of this chapter and any designer, engineer, contractor, agent, or any other person who allows, acts in concert, participates, directs, or assists directly or indirectly in the establishment of an illicit connection in violation of this chapter, shall be subject to civil penalties as follows:

a. First time offenders shall be subject to a civil penalty not to exceed five hundred dollars ($500.00) per day of continuing violation.

b. Repeat violators shall be subject to a civil penalty not to exceed one thousand dollars ($1,000.00) per day of continuing violation.

c. In determining the amount of the penalty, the City Manager or his designee shall consider:

1. The degree and extent of harm to the environment, the public health, and public and private property;
2. The cost of remedying the damage;
3. The duration of the violation;
4. Whether the violation was willful;
5. The prior record of the person responsible for the violation in complying or failing to comply with this chapter;
6. The costs of enforcement to the public; and
7. The amount of money saved by the violator through his, her, or its noncompliance.

d. Procedures for assessing penalties pursuant to Illicit Connections.

Said penalties shall be assessed by the City Manager or his designee. No penalty shall be assessed until the person alleged to be in violation is served written notice of the violation by registered mail, certified mail-return receipt requested, or personal service. Refusal to accept the notice shall not relieve the violator of the obligation to pay the penalty. The notice shall describe the violation with particularity and specify the measures needed to come into compliance. The notice shall designate the time within which such measures must be completed. In setting the time limit for compliance, the City shall take into consideration:

1. The quantity and complexity of the work;
2. The consequences of delay;

3. The potential harm to the environment, the public health, and public and private property; and
4. The cost of remedying the damage.

The notice shall warn that failure to correct the violation within the specified time period will result in the assessment of a civil penalty and/or other enforcement action. If after the allotted time period has expired, and the violation has not been corrected, the penalty shall be assessed from the date of receipt of notice of violation and each day of continuing violation thereafter shall constitute a separate violation under this section.

(3) ***Other Violations***

Any person found in violation of other provisions of this chapter, not specifically enumerated elsewhere, shall be subject to a civil penalty not to exceed one hundred dollars ($100.00) per violation or per day for any continuing violation.

(4) ***Payment/Collection Procedures***

Penalties shall be assessed by the City Manager or his designee. No penalty shall be assessed until the person alleged to be in violation is served written notice of the violation by registered mail, certified mail-return receipt requested, or personal service. Refusal to accept the notice shall not relieve the violator of the obligation to pay the penalty. The City Manager or his designee shall make written demand for payment upon the person in violation. If the payment is not received or equitable settlement reached within thirty (30) days after demand for payment is made, the matter shall be referred to the City Attorney for institution of a civil action in the name of the City, in the appropriate division of the general court of justice in Wake County for recovering the penalty.

(c) **Injunctive Relief**

(1) Whenever the City Council has a reasonable cause to believe that any person is violating or threatening to violate this chapter, rule, regulation, order duly adopted or issued pursuant to this chapter or making a connection to a stormwater conveyance or stormwater conveyance system other than in accordance with the terms, conditions, and provisions of approval, the City may, either before or after the institution of any other action or proceeding authorized by the Code, institute a civil action in the name of the City for injunctive relief to restrain and abate the violation or threatened violation.

(2) The institution of an action for injunctive relief under subsection (c) shall not relieve any party to such proceeding from any further civil or criminal penalty prescribed for violations of this Code.

(d) **Criminal Penalties**

Any person who knowingly or willfully violates any provision of this chapter, rule, regulation, order duly adopted or issued pursuant to this chapter shall be guilty of a misdemeanor, punishable by a fine not to exceed five hundred dollars ($500.00) or imprisonment for not longer than thirty (30)days. Each violation shall be a separate offense.

(Ordinance No. 1995-573, §2, 3-7-95)
Cross reference: Declaration of public nuisance, §12-6002(p

Appendix Q. Example Illicit Discharge Screening Report Forms

This appendix contains several forms developed by the City of Durham for routine use in its illicit discharge detection and elimination program. The Stormwater Services Section agreed to provide these forms for Tar-Pamlico local governments to draw from. Subject local governments are encouraged to adapt the forms as appropriate to address their specific program needs. The following forms are provided:

1. Outfall Identification and Flow Analysis Record
2. Water Quality Complaint/Inspection Record
3. Industrial Inspections Report

Also include is a recent progress report on Durham's illicit discharge program, which offers insights into the issues that may be faced by any local government implementing such a program.

City of Durham
Stormwater Services Division

Outfall Identification and Flow Analysis Record

Field ID: _____ *(AB)*
Ogden ID:_____
ADC Map #: _____ *(##L-##)*
Sheet No.:_____
GIS ID:_____

Land Use in Drainage Area:
☐ Res ☐ Com
☐ Ind ☐ Ag
☐ Forest ☐ Open

☐ Little River
☐ Eno River
☐ Ellerbe Cr
☐ Panther Cr

☐ Ltl Lick Cr
☐ Lick Cr.
☐ New Hope Cr.
☐ Sandy Cr
☐ Third Fork Cr
☐ Crooked Cr
☐ Little Cr (OC)
☐ Northeast Cr
☐ Stirrup Iron Cr

Weather:
Air Temp: _____ °C
☐ Rain w/in 72 hrs?
☐ Ground wet?

Sky
☐ Clear
☐ P. Cloudy
☐ Cloudy
☐ Overcast

Flow:
☐ dry ☐ Moderate
☐ stand. H_2O ☐ High Flo
☐ Trickle

Outfall Information
Size: _____ ☐ in/ ☐ ft
(diameter or width x height)

Nearest St. address
_____
Specific Location **(direction & distance of fall from above address & nearby landmarks)**
_____
_____
_____

Investigation
Date: _____
Time: _____ *(24 hr clock)*
Team:
☐ CO ☐ GP
☐ MF ☐ BH
☐ FL ☐ MR
☐ PW ☐ JC

Outfall Type *(check one)*:
☐ Corrugated Metal Pipe
☐ Box culvert
☐ Concrete pipe
☐ Cast Iron
☐ Earthen Ditch
☐ RipRap/Concrete Chan.
☐ Other: _____

Physical Observations:

Odor:
·☐ none
·☐ musty
·☐ sewage
·☐ sulfide
·☐ fuel oil
·☐ gasoline
·☐ other: _____

Floatables:
☐ none
☐ petrol sheen
☐ sewage
☐ foam
☐ other _____

Turbidity:
·☐ clear
·☐ cloudy
·☐ opaque
☐ particles
☐ black floc

Deposits/stains:
☐ none
☐ oily
☐ algae
☐ other _____

Damage to Outfall Structure: ☐ N/A
☐ none ☐ paint peeling
☐ concrete cracking/spalling ☐ metal corrosion
☐ concrete erosion ☐ other: _____
☐ Outlet capacity significantly reduced by sediment
☐ Outlet area significantly eroded

Comments, description: _____
_____
Vegetation condition: _____

Field Analysis:
Field Instrument ☐ **Pens** ☐ **YSI**

Sample 1 Location: _____ Date: _____ Time: _____

Temp: _____ °C	DO: _____ %	Chlorine: _____mg/L	☐	Phosphate: _____mg/L	☐
pH: _____	DO: _____ mg/L	Copper: _____mg/L	☐	Ammonia: _____mg/L	☐
TDS: _____ g/L	Turbid.: _____ NTU	Phenols: _____mg/L	☐	Nitrate: _____mg/L	☐
Sp Cnd: _____ µs/cm	_____ _____ ____	detergent: _____mg/L	☐	_____ _____ _____	

Sample 2 Location: _____ Date: _____ Time: _____

Temp: _____ °C	DO: _____ %	Chlorine: _____mg/L	☐	Phosphate: _____mg/L	☐
pH: _____	DO: _____ mg/L	Copper: _____mg/L	☐	Ammonia: _____mg/L	☐
TDS: _____ g/L	Turbid.: _____ NTU	Phenols: _____mg/L	☐	Nitrate: _____mg/L	☐
Sp Cnd: _____ µs/cm	_____ _____ ____	detergent: _____mg/L	☐	_____ _____ _____	

Rate likelihood that water is contaminated (scale of 1 to 6)
☐ No Flow ☐ Some possibility
☐ Very unlikely ☐ Likely
☐ Unlikely ☐ Very Likely

☐ Investigate?
☐ Revisit?
Investigation Number: ____SI _____
Photo? ☐ File Name: _____

Office:

By: _____ (Staff initials)
Form: Outfall&DryScreen Form Printed: 9/15/11

(over for more)

Outfall Identification and Flow Analysis Record, cont.

Additional Field Analysis:

Sample 3 Location: _____ Date: _____ Time: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐
pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐
TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐
Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ _____

Sample 4 Location: _____ Date: _____ Time: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐
pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐
TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐
Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ _____

Sample 5 Location: _____ Date: _____ Time: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐
pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐
TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐
Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ _____

Sample 6 Location: _____ Date: _____ Time: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐
pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐
TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐
Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ _____

Sample 7 Location: _____ Date: _____ Time: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐
pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐
TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐
Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ _____

Comments: _____

City of Durham
Stormwater Services Division

WATER QUALITY COMPLAINT / INSPECTION RECORD for 2003

Note: Shaded areas should be filled in before going out to field

CR File Number: _____ *(97CR999)*

ADC Map #: _____ *(####L-##)*

Complainant's Description of Problem and Location:
Description: _____
Location: _____

Complaint from:
Name: _____
Address: _____
_____
Home Phone #: _____
Work Phone #: _____
Other: _____ *(pager, e-mail, etc.)*

***Complaint Date and Source*:**
Call date: _____
Time: _____
☐ Hotline ☐ SW Staff Initiatd
☐ Walk-In ☐ Emerg. Mgt.
☐ Call In ☐ Health Dept.
☐ WWW ☐ Erosion Ctrl.
☐ Other City employee
☐ Other _____

First Callback:
Date: _____
Time: _____

Results Callback:
Date: _____
☐ Phone
☐ Letter
☐ In Person

vestigation
Date: _____
Time: _____
Duration: _____

Team (initials of staff):
☐ CO ☐ BL
☐ MF ☐ BH
☐ PW ☐ JC
☐ other _____

Field Observations ***(if different):***
Investigator's Description: _____
Street Address (Nearest): _____

Property Type
☐ Public ☐ Commercial
☐ Residential ☐ Industrial
☐ Unimproved

Observations:
☐ Sheen . . . . . _____
☐ Odor . . . . . _____
☐ Floatables . . _____

Drainage Basin
Crk _____
Sub-Basin _____
☐ Flow reached storm drain?
☐ Flow reached creek?

Probable Source of Water Quality Problem *(check main items that apply)*:

Construction Erosion & Sed:
☐ Controls not provided
☐ Controls not maintained
☐ Sediment in drainage system

On-site sewage treatment:
☐ Discharging sand filter system
☐ Failing septic leachfield
☐ Piping failure, leak, etc (on-site only)
☐ Laundry discharge (household)

Private Connection to City System:
☐ Sewer lateral (house/duplex)
☐ Sewer lateral (apart/commercial)

City Sanitary Sewer System:
☐ Overflow
☐ Leak (small flow)
☐ Break (large flow)
☐ Other _____
Sub: _____ Basin: _____
Manhole: Up-MH: _____
Down-MH: _____

☐ Illicit Connection
☐ Contaminated Groundwater
☐ Petroleum spill/release
☐ Paint spill/release/dumping
☐ Grease/Cooking oil/food wastes
☐ Improper Housekeeping
☐ Trash/Garbage in Channel
☐ Yard wastes/leaves
☐ Source Unknown
☐ Water Leak
☐ Other WQ Prob (see details)
☐ No WQ Problem Found
☐ Drainage Problem _____

Details, Sample Locations, Findings, Actions:

Continue on back, if necessary

☐ Need NOV? Date Sent _____

Tax Map #:
_____

NOV Sent to (usu. Prpty Owner):
_____

Mailing Address:
_____

☐ Health Dept. ☐ Land Qual
☐ W&S Maint.. ☐ DOT
☐ W&S Eng. ☐ Other : _____

Photo File Name: _____

Respond to Complainant By:
(date)_____
☐Phone ☐ Letter ☐In Person

☐ Entered In Database ? By: _____(staff initials)

Water Quality Complaint / Inspection Record, Cont.

Additional Details, Sample Locations, Findings, Actions:

Sample 1 Location: _____ Date: _____ Time: _____

Details: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐

pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐

TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐

Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ ____

Sample 2 Location: _____ Date: _____ Time: _____

Details: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐

pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐

TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐

Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ ____

Sample 3 Location: _____ Date: _____ Time: _____

Details: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐

pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐

TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐

Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ ____

Sample 4 Location: _____ Date: _____ Time: _____

Details: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐

pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐

TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐

Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ ____

Sample 5 Location: _____ Date: _____ Time: _____

Details: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐

pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐

TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐

Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ ____

Sample 6 Location: _____ Date: _____ Time: _____

Details: _____

Temp: _____ °C DO: _____ % Chlorine: _____mg/L ☐ Phosphate: _____mg/L ☐

pH: _____ DO: _____ mg/L Copper: _____mg/L ☐ Ammonia: _____mg/L ☐

TDS: _____ g/L Turbid.: _____ NTU Phenols: _____mg/L ☐ Nitrate: _____mg/L ☐

Sp Cnd: _____ µs/cm _____ _____ ____ detergent: _____mg/L ☐ _____ _____ ____

Additional Details, Sample Locations, Findings, Actions:

City of Durham
Storm Water Services
Industrial Inspections
Report
(560-4326)

Date _____
Time _____
Inspector _____
Account # _____

(Office Only)
ADC Map # _____
Basin _____
Sub-Basin _____

Industry Information

Site Name _____
(Business/industry name and identification of site)

Street Address_____

Contact _____ Phone _____
(name)

Mailing _____

Address _____

Field Observations ☐ Inspection N/A?

☐ **Material Waste (M/W) Storage Areas** ***(Petroleum products and hazardous materials/wastes)***

No.	Material or Waste	Storage	Containment?	Concerns?	Description of Concern (spill, leak, etc.)
1			☐ Secondary	☐ Yes	
2			☐ Secondary	☐ Yes	
3			☐ Secondary	☐ Yes	
4			☐ Secondary	☐ Yes	

M/W Drainage_____

☐ **Material Transfer Areas**

☐ Loading Dock ☐ Conveyor

☐ Pipe nozzles ☐ Loader

☐ Other_____ ☐ Spill Containment?

☐ Evidence of spills/leaks? What material? _____

MT Drainage _____

☐ **Manufacturing Areas**

☐ Spill Containment?

☐ Evidence of spills/leaks (Mfgr. Area)?

If so, what material spilled? _____

☐ Floor Drains

FD Locations _____

Housekeeping Comments _____

☐ **Vehicle Maintenance Area**

☐ Spill Containment?

☐ Evidence of spills/leaks (Maint.)?

If so, what material spilled? _____

☐ **Vehicle Fueling**

Drainage _____

_____

Storm Drainage System

☐ Stormwater drainage system accessible?

☐ Current Precipitation or Precipitation Within 72 Hours?

Stormwater Flow
☐ Dry, no flow
☐ Standing Water
☐ Dry Weather Flow
☐ Wet Weather Flow
☐ Other _____

Water Characteristics
☐ Color
☐ Odor
☐ Stains
☐ Foam

Storm Drainage System Condition
☐ Erosion
☐ Sedimentation
☐ Corrosion

Comments _____

_____

F: dbases/Strmwtr/Quality/Forms/Fd-form3 9/15/2011

☐ Follow up needed? _____ *(date completed)* ☐ Entered in D-Base? _____ *(initials)*

City of Durham
Field Screening
Program Progress

Field screening is a component of the City's dry weather monitoring program to identify and eliminate illicit discharges and improper disposal. The dry weather monitoring program is an integrated outfall field survey program that incorporates outfall identification, inspection and inventory; field screening; and preliminary follow-up field investigation. Additional investigation and follow-up may be required to accomplish the elimination of an illicit discharge or improper disposal practice.

The Part II Application identified approximately 850 stormwater outfalls within the City of Durham municipal stormwater system. Each of these outfalls will be located and inspected in the field survey program. Furthermore, the field survey program will identify and inspect additional stormwater outfalls located in the field.

When precipitation has occurred within 72 hours, outfalls would be located or identified, and inspected. Later, during dry weather, the field team would return to any outfall having evidence of flow to determine whether the outfall had a dry weather flow, and, for those dry weather flows, to conduct field screening.

When precipitation has not occurred within 72 hours, the outfall identification, inspection and inventory step will be followed immediately by field screening of any dry weather flows that were observed.

Field Screening Parameters and Methodology

The field screening conducted under the Part 1 permit application included physical observations at the selected field screening points, and grab sampling and field analysis of dry weather flows. Where dry weather flows were observed, a second follow-up grab sample was collected and field analyzed within the ensuing 24 hour period.

Field analysis evaluated pH, total chlorine, total soluble copper, phenols, and detergents (anionic surfactants) using the CHEMetrics M-1000 Stormwater Discharge Kit, using visual evaluation of colormetric results using color comparators.

The current field screening program incorporates the methodology and parameters used in the Part 1 permit application, with some minor modifications. One change is that the current methodology allows outfall identification and inspection to occur during periods that do not meet dry weather criteria, provided there is subsequent follow up during dry weather to determine whether a dry weather flows exist. In the 'old industrial areas' of the pilot basin, field investigators have found a number of pipes that terminate at the open channel and that were not identified in the stormwater outfall inventory. Some of these pipes appear to be abandoned, while others appeared to be floor drain or yard drain discharges. Where such pipes exist, performing the identification and investigation work during wet weather can help to establish whether the pipe is currently used to discharge stormwater. Furthermore, during wet weather it is easier to identify stormwater outfalls that may be overgrown and obscured by vegetation.

Unknown pipes terminating in stormwater channels are expected to be very rare outside of the 'old industrial areas' identified in the Part 2 permit application. In most other areas in the City, it is expected that outfall identification and inspection work will be accomplished during dry weather and will coincide with field analytical chemistry testing, as indicated in the Part II permit application.

Another modification to the field screening program is the availability of two additional monitoring parameters for field screening. Field investigators will carry CHEMetrics colormetric test kits for ammonia and phosphates. Existing data on water quality of urban streams within the City indicates three sites periodically have some combination of high fecal coliform bacteria, high BOD, or low dissolved oxygen. In addition, ongoing discussions with Public Health personnel indicate that there are numerous failing on-site, non-discharge systems within the city. In drainage basins where fecal contamination is suspected, the availability of an ammonia test to the field screening parameters will be useful in identifying and isolating cross-connections, as well as flows originating from failing septic systems. Similarly, the availability of a phosphate test will be useful upstream of ponds that have been impacted by heavy growth of algae.

When deemed appropriate for follow-up investigations, field investigators will have the capability of measuring the additional parameters of dissolved oxygen and total dissolved solids in the field.

Copies of the field form for outfall identification and inspection and the field form for flow inspection and field analysis are attached. Note that the flow inspection form can also be used, when appropriate, for investigation of water quality complaints referred to the city by Citizen's or other agencies.

The screening methodology has been developed into a set of standard operating procedures (SOPs). These SOPs provide both general guidance and, where appropriate, detailed, step-by-step instructions for field investigators in order to promote safety, consistency and quality in data collection and field analysis. The procedures cover:

- checklists,
- personal protective equipment,
- instrument calibrations and maintenance,
- equipment maintenance
- observations and record keeping
- field analysis, and
- preliminary evaluation of field data.

The field SOPs for the dry weather program have been tested and refined. Additional refinements will be made as necessary.

Scheduling

A schedule has been established for completing the field screening within the permit period. This schedule is based on conducting field screening on approximately 35 outfalls per month. It is anticipated that the field screening would be substantially complete by the time a permit renewal application would be submitted.

The Part II application identified priority areas within the City, generally following land use patterns, with "old industrial areas" having the highest priority, followed by industrial/
commercial areas, and then by older residential areas. The high priority 'old industrial areas' generally follow along the railroad tracks which run diagonally (southeast to northwest) through the City.

Initial priority for the field screening program is based on completing field screening of the pilot basin selected in the Part II permit application. The upper end of Goose Creek drains an 'old industrial area' and was selected as the pilot basin.

Our next priority will be to complete an evaluation of the 'old industrial areas' through the central part of the city. To help prioritize selection of additional basins an evaluation of recent water quality data collected at thirteen urban stream sites problem areas was used to identify three problem areas: Goose Creek, an unnamed tributary of South Ellerbe Creek, and an unnamed tributary of Rocky Creek in the Third Fork Creek basin. The Goose Creek priority area is being addressed within the pilot study.

The South Ellerbe and Rocky River priority areas are basins in the Neuse River and Cape Fear River basins, respectively. Surveying these two areas concurrently follows our general intent of working in both the northern and southern halves of the city.

Training

A training program has been developed for field investigators. Initial training has been provided, but training is an on-going activity within the field screening component.

Classroom training has been provided on the overall intent of the program, the specific components of the outfall identification and inspection, and flow inspection and analysis tasks. Field investigators have received First Responder

training in dealing with hazardous materials spills, and have had classroom training in field safety, including a review of all MSDS sheets for chemicals being used in the program.

Hands-on training has been provided in the use and maintenance of field instruments, the use of the CHEMetrics field analytical chemistry kits, and the use of field data collection forms. Field practice sessions have been conducted using all tests and measurements.

Detailed standard operating procedures have been developed for the field outfall survey work covering: record keeping; safety and use of personal protective equipment; receipt and use of chemicals; use, calibration and maintenance of field analytical equipment; sample collection; field analysis; and dye testing to identify/locate illicit drains. These procedures also provide guidance in making a preliminary evaluation of field results to assist timely information collection for follow-up investigation. The SOPs also serve as a training resource for field personnel.

Databases and Geographic Information Systems

Microsoft Access relational database software has been selected to maintain database information for the program as an interim measure. A database has been developed for the field screening component containing separate (but related) tables for:

- outfall identification and inspection, and
- dry weather flow inspection and analysis.

In addition, a table has been developed for water quality data from urban stream sampling, and one is planned for data from wet weather sampling.

A database on potential sources of contamination has also been developed incorporating tables for:

- NCDWQ Incident Management Contamination Sites
- Emergency Management spills reports
- NCDWQ General Stormwater Permits
- NCDWQ NPDES Permits
- NCDWQ Non-discharge Permits
- Fire Department Inspection Reports (inspections of industrial and related facilities)

A third database on potential sources of contamination contains information on hazardous substances reported pursuant to SARA Title III tier II reporting requirements.

The sources databases will be utilized to identify likely sources of illicit discharge and improper disposal, or of any other source of contamination encountered.

Reports are currently being developed to allow some data analysis and reporting within MS Access. For greater flexibility, data can be exported from MS Access to a MS Excel spreadsheet for analysis.

A grid system has been developed for tracking field screening and sources databases in MS Access, and is currently being implemented in all the appropriate source database tables. The grid is based on a commercially available map and breaks the City of Durham into approximately 1,850 cells. Software is planned that will allow the sources tables to be queried to find all sources in a given cell, and optionally all sources that are upstream or upgradient of that cell. When fully implemented, this capability will assist in relating water quality data in a given cell both to sources in that cell, and to sources that are upstream of that cell.

Once the GIS system has been developed for the pilot facilities inventory program, and existing facilities have been inventoried, it is planned that the field screening and sources databases will be imported into the GIS system to facilitate more accurate and more detailed geographic evaluation of data.

Appendix R. Example Letter to Prevent Illegal Discharges

This space intentionally left blank

(This document to be provided at a later date)

Appendix S. Sample Public Education Action Report and Plan

	Public Education Action Report and Plan							
	Jurisdiction:_____Date Submitted:_____							
	Activity	Point Value	# Done Last Yr (7/__ - 6/__)	Points	Cost	# Planned Next Yr (7/__ - 6/__)	Points Anticipated	Anticipated Cost
1	Demonstration Sites (for BMPs)	4 each						
2	Local Newspaper Article	2 each						
3	Technical Workshop (1st year, 2 required)	4 each						
4	Environmental Contest / Field Day	4 each						
5	Arrange Speakers For Civic Organizations	1 each						
6	Clean Water Proclamation, with Newspaper Article	2						
7	Web Page / Web Site Links	2 / year						
8	Pet Waste Ordinance	5 / year						
9	Factsheets/Brochures/Flyers/Enviro freebies (public places)	2 / year						
10	Utility Bill Inserts or Messages on Bills	3 / year						
11	Close-out Packages / Info for New Homeowners	3 / year						
12	Storm Drain Marking (24 minimum per year)	2 / year						
13	Sponsor new/expand Adopt-A-(Street-or-Stream) Program	4 / year						
14	Recognition Program (environmentally friendly participants)	1 / year						
15	Toll Free Environmental Hotline (1-800 or Local)	3 / year						
16	VWIN Monitoring Force (Water Quality Reporting)	6 / year						
17	Other Water Quality Reporting Program	3 / year						
18	Major Media Advertising	6 / year						
19	Local Access TV or Radio Spots	3 / year						
			Total Points Reported:			Total Points Planned:		
	Please attach copies of articles, flyers, photographs, etc. documenting your activities, labeled for each type of activity.							
	Note: Ongoing Activities will continue to receive the education points for each year that they are in effect.							
	Note: If your locality has put together an exceptional effort for any of the above activities, you may be entitled to additional points for that activity. Please attach a description of the activity, a merit rationale, and a point proposal.							
	Submitted By:		Title:					
			Date:					
			Signature:					

Detail of Reported Activities				
Brief Description of Activity	Targeted Audience	Date	Cost	Comments / Attachments
Detail of Planned Activities				
Brief Description of Activity	Targeted Audience	Date Planned	Anticipated Cost	Comments / Attachments

Appendix T. List of Education Resources

Education Activity Options for Tar-Pamlico Local Programs

VWIN Water Quality Monitoring Program

This is a Volunteer Water Information Network, a program which allows volunteers to collect water samples, and send them to the lab for certified laboratory analysis. The cost of the program is $4500 per year, for a 10 site program plus about $300 - $500 per year for 2-day shipment of samples.

Contact: UNC-Asheville, Asheville, NC 28804
Dr. Rick Maas, EQI Research Director
(828) 251-6366 maas@unca.edu
Marilyn Westphal, VWIN Coordinator
(828) 251-6823 mwestphal@unca.edu

Home*A*Syst

Homeowner self-assessments developed by the Cooperative Extension Service for a variety of home activities, including protecting your water quality and your septic system.

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www.soil.ncsu.edu/assist

- a local government can link their website to this website, and receive educational points for each year that the link is in effect
- a local government could use a Home*A*Syst presentation in their workshops
- a local government could have publications available for the public, and / or distribute packages to new homeowners.

Adopt-A Stream

www.adopt-a-stream.org

Funding Resources

NOAA Grants

www.rdc.noaa.gov/~grants/index.html

North Carolina '319' Nonpoint Source Grant Program

Funds innovative BMP demonstration and education efforts, as well as watershed restoration projects.

http://h2o.enr.state.nc.us/nps/Section_319_Grant_Program.htm

NC Clean Water Management Trust Fund

http://www.cwmtf.net/

State Stormwater Programs under NC Department of Environment & Natural Resources

- **Tar-Pamlico Nutrient Strategy**
  The NC Division of Water Quality web site for the Tar-Pamlico nutrient strategy. Includes a history and status of the strategy and its elements, both point and nonpoint source, as well as links to rules and supporting information. This model and appendices are also available on the site.
  http://h2o.enr.state.nc.us/nps/tarpam.htm

- **Neuse Local Stormwater Programs**
  - Town of Cary
    www.townofcary.org/depts/dsdept/engineering/engproj/stormwater/stormwatermain.htm
  - Orange County
    www.co.orange.nc.us/planning/erosion.htm

- **Division of Water Quality Stormwater and General Permits Unit**
  Includes links to the Neuse stormwater model and Neuse local programs, information on Phase I and II NPDES Stormwater programs, the State Stormwater Management Program (coastal, ORW, and HQW), stormwater manuals and other resources, and useful links.
  h2o.enr.state.nc.us/su/stormwater.html

- **Division of Water Quality, Nonpoint Source Management Program**
  Includes Tar-Pamlico and Neuse nutrient strategies, the NC Coastal Nonpoint Source Program, the Section 319 grant program, information about nonpoint source pollution, other programs and links.
  h2o.enr.state.nc.us/nps/

- **NC Water Supply Watershed Program**
  The oversight program for local water supply ordinances. Includes links to local programs, model ordinances, forms, and fact sheets, the Streamlines newsletter that details program options and discusses salient issues, and other information.
  h2o.enr.state.nc.us/wswp/index.html

- **Office of Environmental Education**
  www.ee.enr.state.nc.us/Index.htm

- **Division of Water Resources,**
  Includes links to Stream Watch & Project Wet, and a slide presentation on BMPs
  www.dwr.ehnr.state.nc.us
  www.dwr.ehnr.state.nc.us/Reports_and_Publications/Stream_Watch/bmps.pdf

- **Albemarle-Pamlico National Estuary Program (APNEP)**
  Includes information on the Citizen's Water Quality Monitoring Program (CWQMP)
  h20.enr.state.nc.us/nep/

Low Impact Development

Maryland Stormwater Management Program

Home page explains impacts of runoff and steps individuals can take to help. It also has links to homeowner and other materials including a model stormwater ordinance and technical manuals, including the Maryland Stormwater Design Manual

www.mde.state.md.us/Programs/WaterPrograms/SedimentandStomwater/home.index.asp

Low Impact Development Program, Prince George's County, Maryland

The originators of LID. Includes links to their LID manuals and bioretention info.

www.co.pg.md.us/Government/AgencyIndex/DER/PPD/lid.asp?h=20&s=&n=50&n1=160

Low Impact Development Center, Inc.

Non-Profit whose mission is to "provide information to individuals and organizations dedicated to protecting the environment and our water resources through proper site design techniques that replicate pre-existing hydrologic site conditions".

www.lowimpactdevelopment.org

Stormwater Strategies: Community Responses to Runoff Pollution

This Natural Resources Defense Council report, originally published in 1999, was updated in 2001 with a chapter on Low Impact Development.

www.nrdc.org/water/pollution/storm/stoinx.asp

Smart Growth

NOAA Smart Coastal Growth

Includes links to smart growth documents and organizations

www.csc.noaa.gov/themes/communities

Smart Growth America

A nationwide coalition of over 80 national and local organizations promoting a better way to grow: one that protects farmland and open space, revitalizes neighborhoods, keeps housing affordable, and provides more transportation choices.

www.smartgrowthamerica.com

USEPA Office of Smart Growth

Information including initiatives, events, publications, and helpful links.

www.epa.gov/smartgrowth/index.htm

Congress for the New Urbanism

www.cnu.org

Smart Growth Network

In 1996, the US EPA joined with several non-profit and government organizations to form the Smart Growth Network (SGN). The Network was formed in response to increasing community concerns about the need for new ways to grow that boost the economy, protect the environment, and enhance community vitality. The Network's partners include environmental groups, historic preservation organizations, professional organizations, developers, real estate interests, local and state government entities.

www.smartgrowth.org/default.asp

Broad Stormwater Information

Storm Water Strategies

To help communities implement better storm water controls, the Natural Resources Defense Council (NRDC) recently released a CD-ROM version of its 1999 report, Storm Water Strategies: Community Responses to Run-off Pollution. The new CD-ROM is very user-friendly and includes updated case studies on storm water management issues (including new information on Low Impact Development), and web site links to storm water leaders across the country. For more information:

www.nrdc.org/ publications
212-727-2700.

NCSU Stormwater Education

The web site of North Carolina State University stormwater specialist and Biological and Agricultural Engineering faculty member Bill Hunt that includes:

- general and specific stormwater management training,
- upcoming stormwater education events,
- online and regular university courses,
- stormwater publications.

www.bae.ncsu.edu/people/faculty/hunt

NCSU Water Quality Group

Exclusively focused on nonpoint source pollution, this site includes a wealth of information on the subject, including a searchable, annotated bibliography of NPS literature, a watershed management decision support system, an education component with extensive information on BMPs for different NPS categories, and extensive links.

www.bae.ncsu.edu/programs/extension/wqg/index.html

NCSU Water Quality Program

A web site with information and links on all aspects of water quality protection and management.

www.water.ncsu.edu

USEPA Office of Water – Urban Stormwater page

Urban Stormwater Runoff Program includes model ordinances, economic benefits of prevention, and program development guides.

www.epa.gov/owow/nps/urban.html

Army Corps of Engineers

Includes information on Navigation, Flood Damage Reduction, Environmental Missions, Wetlands and Waterways Regulation and Permitting, Water Supply and Public Services.

www.usace.army.mil/
www.usace.army.mil/public.html#Navigation

Center for Watershed Protection
A non-profit stormwater education organization out of Maryland. Site offers an abundance of information on the management of stormwater, including "The Importance of Imperviousness" and "The Peculiarities of Imperviousness" by Tom Schueler, and links to other reports.

www.cwp.org

Stormwater Center Website
Supported by the Center for Watershed Protection, the site offers information about watershed and stormwater planning, including free example stormwater maintenance agreements and slideshows for viewing and purchase.

http://www.stormwatercenter.net/

NC Cooperative Extension Service
Centered at North Carolina State University, the NC Cooperative Extension Service offers a variety of educational information useful to local governments, industry, businesses and homeowners. The site includes links to county Extension offices across the state.

www.ces.ncsu.edu

Stormwater Magazine
Includes information from Stormwater Publications, including a search feature allowing the reader to search for articles of interest

www.stormh2o.com

Pamlico Tar River Foundation
The Pamlico-Tar River Foundation was founded in 1981. It is a private, non-profit organization dedicated to protecting, preserving and promoting the environmental quality of the Tar-Pamlico River and its watershed. PTRF is a grassroots organization, supported by nearly 1,500 citizen members -- "River Givers." PTRF achieves its mission through education, advocacy, and research.

www.ptrf.org

Appendix U. Sample Technical Workshop Agenda

Sample Technical Workshop Agenda

Purpose:

a. Review of State Model Stormwater Management Program
b. Implementation of the Local Stormwater Management Program
c. Presentation of Stormwater Guidebook
d. Planning and Designing for Stormwater
e. Structural BMPs

The following is an outline of a recommended Introductory Staff Workshop Agenda:

Session	Time	Resources
Session 1	**3 ¼ hours**	
I) Problems & Effects of Urbanization	15 minutes	CES, COG, DWQ
II) Why Do We Need a Stormwater Program	15 minutes	CES, COG, DWQ
III) Review Stormwater Guidance Documant	1 hour	DWQ
New Development		
Illegal Discharge / Retrofit		
Education		
Enforcement		
IV) How To Handle Rules Locally	1 hour	CES
V) Responsibilities of State and Localities	30 minutes	DWQ
VI) Implementation Timeline of Rules	15 minutes	DWQ
Session 2	**3 hours**	
VII) Presentation of Guidebook	15 minutes	DWQ
VIII) Planning & Design BMPs	45 minutes	CES, DWQ
IX) Structural BMPs	1 hour	CES, DWQ
X) Homeowner Technical Assistance	15 minutes	CES, DWQ
XI) Local Implementation	15 minutes	DWQ, local staff
XII) General Question & Answer Session	30 minutes	All Presenters

DWQ = Division of Water Quality COG = Council of Governments

CES = Cooperative Extension Service

Appendix V. Local Government Codes and Ordinances Worksheet

Codes and Ordinances Worksheet
A Self-Assessment Tool

1. Street Width

a. What is the minimum pavement width allowed for streets in low density residential developments that have less than 500 average daily trips (ADT)?

*If the answer is between **18-22 feet**, award **4** points* ☐

b. At higher densities are parking lanes allowed to also serve as traffic lanes (i.e., queuing streets)?

*If the answer is **YES**, award **3** points* ☐

2. Street Length

a. Do street standards promote the most efficient street layouts that reduce overall street length?

*If the answer is **YES**, award **1** point* ☐

3. Right-of-Way Width

a. What is the minimum right-of-way (ROW) width for a residential street?

*If the answer is **less than 45 feet**, award **3** points* ☐

b. Does the code allow utilities to be placed under the paved section of the ROW?

*If the answer is **YES**, award **1** point* ☐

4. Cul-de-Sacs

a. What is the minimum radius allowed for cul-de-sacs?

*If the answer is **less than 35 feet**, award **3** points* ☐

*If the answer is **36 feet to 45 feet**, award **1** point* ☐

b. Can a landscaped island be created within the cul-de-sac?

*If the answer is **YES**, award **1** point* ☐

c. Are alternative turn arounds such as "hammerheads" allowed on short streets in low density residential developments?

*If the answer is **YES**, award **1** point* ☐

5. Vegetated Open Channels

a. Are curb and gutters required for most residential street sections?

*If the answer is **NO**, award **2** points*

b. Are there established design criteria for swales that can provide stormwater quality treatment (i.e., dry swales, biofilters, or grass swales)?

*If the answer is **YES**, award **2** points*

6. Parking Ratios

a. What is the minimum parking ratio for a professional office building (per 1000 ft^2 of gross floor area)?

*If the answer is **less than 3.0 spaces**, award **1** point*

b. What is the minimum required parking ratio for shopping centers (per 1,000 ft^2 gross floor area)?

*If the answer is **4.5 spaces or less**, award **1** point*

c. What is the minimum required parking ratio for single family homes (per home)?

*If the answer is **less than or equal to 2.0 spaces**, award **1** point*

d. Are the parking requirements set as maximum or median (rather than minimum) requirements?

*If the answer is **YES**, award **2** points*

7. Parking Codes

a. Is the use of shared parking arrangements promoted?

*If the answer is **YES**, award **1** point*

b. Are model shared parking agreements provided?

*If the answer is **YES**, award **1** point*

c. Are parking ratios reduced if shared parking arrangements are in place?

*If the answer is **YES**, award **1** point*

d. If mass transit is provided nearby, is the parking ratio reduced?

*If the answer is **YES**, award **1** point*

8. Parking Lots

a. What is the minimum stall width for a standard parking space?

*If the answer is **9 feet or less**, award **1** point*

b. What is the minimum stall length for a standard parking space?

*If the answer is **18 feet or less**, award **1** point* ☐

c. Are at least 30% of the spaces at larger commercial parking lots required to have smaller dimensions for compact cars?

*If the answer is **YES**, award **1** point* ☐

d. Can pervious materials be used for spillover parking areas?

*If the answer is **YES**, award **2** points* ☐

9. Structured Parking

a. Are there any incentives to developers to provide parking within garages rather than surface parking lots?

*If the answer is **YES**, award **1** point* ☐

10. Parking Lot Runoff

a. Is a minimum percentage of a parking lot required to be landscaped?

*If the answer is **YES**, award **2** points* ☐

b. Is the use of bioretention islands and other stormwater practices within landscaped areas or setbacks allowed?

*If the answer is **YES**, award **2** points* ☐

11. Open Space Design

a. Are open space or cluster development designs allowed in the community?

*If the answer is **YES**, award **3** points* ☐

*If the answer is **NO**, skip to question No. 12* ☐

b. Is land conservation or impervious cover reduction a major goal or objective of the open space design ordinance?

*If the answer is **YES**, award **1** point* ☐

c. Are the submittal or review requirements for open space design greater than those for conventional development?

*If the answer is **NO**, award **1** point* ☐

d. Is open space or cluster design a by-right form of development?

*If the answer is **YES**, award **1** point* ☐

e. Are flexible site design criteria available for developers that utilize open space or cluster design options (e.g, setbacks, road widths, lot sizes)

*If the answer is **YES**, award **2** points* ☐

12. Setbacks and Frontages

a. Are irregular lot shapes (e.g., pie-shaped, flag lots) allowed in the community?

*If the answer is **YES**, award **1** point*

b. What is the minimum requirement for front setbacks for a **one half (½) acre** residential lot?

*If the answer is **20 feet or less**, award **1** point*

c. What is the minimum requirement for rear setbacks for a **one half (½) acre** residential lot?

*If the answer is **25 feet or less**, award **1** point*

d. What is the minimum requirement for side setbacks for a **one half (½) acre** residential lot?

*If the answer is **8 feet or less**, award **1** points*

e. What is the minimum frontage distance for a **one half (½) acre** residential lot?

*If the answer is **less than 80 feet**, award **2** points*

13. Sidewalks

a. What is the minimum sidewalk width allowed in the community?

*If the answer is **4 feet or less**, award **2** points*

b. Are sidewalks always required on both sides of residential streets?

*If the answer is **NO**, award **2** points*

c. Are sidewalks generally sloped so they drain to the front yard rather than the street?

*If the answer is **YES**, award **1** point*

d. Can alternate pedestrian networks be substituted for sidewalks (e.g., trails through common areas)?

*If the answer is **YES**, award **1** point*

14. Driveways

a. What is the minimum driveway width specified in the community?

*If the answer is **9 feet or less (one lane) or 18 feet (two lanes)**, award **2** points*

b. Can pervious materials be used for single family home driveways (e.g., grass, gravel, porous pavers, etc)?

*If the answer is **YES**, award **2** points*

c. Can a "two track" design be used at single family driveways?

*If the answer is **YES**, award **1** point*

d. Are shared driveways permitted in residential developments?

*If the answer is **YES**, award **1** point* ☐

15. Open Space Management

a. Does the community have enforceable requirements to establish associations that can effectively manage open space?

*If the answer is **YES**, award **2** points* ☐

b. Are open space areas required to be consolidated into larger units?

*If the answer is **YES**, award **1** point* ☐

c. Does a minimum percentage of open space have to be managed in a natural condition?

*If the answer is **YES**, award **1** point* ☐

d. Are allowable and unallowable uses for open space in residential developments defined?

*If the answer is **YES**, award **1** point* ☐

e. Can open space be managed by a third party using land trusts or conservation easements?

*If the answer is **YES**, award **1** point* ☐

16. Rooftop Runoff

a. Can rooftop runoff be discharged to yard areas?

*If the answer is **YES**, award **2** points* ☐

b. Do current grading or drainage requirements allow for temporary ponding of stormwater on front yards or rooftops?

*If the answer is **YES**, award **2** points* ☐

17. Buffer Systems

a. Is there a stream buffer ordinance in the community?

*If the answer is **YES**, award **2** points* ☐

b. If so, what is the minimum buffer width?

*If the answer is **75 feet or more**, award **1** point* ☐

c. Is expansion of the buffer to include freshwater wetlands, steep slopes or the 100-year floodplain required?

*If the answer is **YES**, award **1** point* ☐

18. Buffer Maintenance

a. Does the stream buffer ordinance specify that at least part of the stream buffer be maintained with native vegetation?

*If the answer is **YES**, award **2** points* ☐

b. Does the stream buffer ordinance outline allowable uses?

*If the answer is **YES**, award **1** point* ☐

c. Does the ordinance specify enforcement and education mechanisms?

*If the answer is **YES**, award **1** point* ☐

19. Clearing and Grading

a. Is there any ordinance that requires or encourages the preservation of natural vegetation at residential development sites?

*If the answer is **YES**, award **2** points* ☐

b. Do reserve septic field areas need to be cleared of trees at the time of development?

*If the answer is **NO**, award **1** point* ☐

20. Tree Conservation

a. If forests or specimen trees are present at residential development sites, does some of the stand have to be preserved?

*If the answer is **YES**, award **2** points* ☐

b. Are the limits of disturbance shown on construction plans adequate for preventing clearing of natural vegetative cover during construction?

*If the answer is **YES**, award **1** point* ☐

21. Land Conservation Incentives

a. Are there any incentives to developers or landowners to conserve non-regulated land (open space design, density bonuses, stormwater credits or lower property tax rates)?

*If the answer is **YES**, award **2** points* ☐

b. Is flexibility to meet regulatory or conservation restrictions (density compensation, buffer averaging, transferable development rights, off-site mitigation) offered to developers?

*If the answer is **YES**, award **2** points* ☐

22. Stormwater Outfalls

a. Is stormwater required to be treated for quality before it is discharged?

*If the answer is **YES**, award **2** points*

b. Are there effective design criteria for stormwater best management practices (BMPs)?

*If the answer is **YES**, award **1** point*

c. Can stormwater be directly discharged into a jurisdictional wetland without pretreatment?

*If the answer is **NO**, award **1** point*

d. Does a floodplain management ordinance that restricts or prohibits development within the 100 year floodplain exist?

*If the answer is **YES**, award **2** points*

Total

Scoring

90 - 100 Community has above-average provisions that promote the protection of streams, lakes and estuaries.

80 - 89 Local development rules are good, but could use minor adjustments or revisions in some areas.

70 - 79 Opportunities exist to improve development rules. Consider creating a site planning roundtable.

60 - 69 Development rules are likely inadequate to protect local aquatic resources. A site planning roundtable would be very useful.

less than 60 Development rules are definitely not environmentally friendly. Serious reform is needed.