Tar-Pamlico River Basin: Stormwater Program for Nutrient Control

City of Oxford
Oxford, North Carolina

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ACRONYMS AND ABBREVIATIONS

BMP	Best Management Practice
COE	US Army Corps of Engineers
DENR	North Carolina Department of Environment and Natural Resources
DWQ	Division of Water Quality, DENR
EMC	North Carolina Environmental Management Commission
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System
NCWRP	North Carolina Wetlands Restoration Program
NPDES	National Pollutant Discharge Elimination System
SSO	Sewer System Overflow
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USGS	US Geological Survey
303(d) List	List of waters not meeting water quality standards and uses. The list is published by DWQ as per requirements in section 303(d) of the federal Clean Water Act.

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EXECUTIVE SUMMARY

The City of Oxford is subject to State of North Carolina water quality-related stormwater regulations which became effective in April 2001. Commonly referred to as the Tar-Pamlico stormwater rules, these regulations require the City to develop a comprehensive stormwater program designed to improve the water quality of Oxford's streams and reduce the amount of pollutants which eventually reach the Tar-Pamlico estuary downstream.

The eleven local governments affected by these state regulations were required to submit a copy of their proposed stormwater program to the NC Environmental Management Commission (EMC) by February 13, 2004 for approval. Implementation of the City's approved program is required to begin September 27, 2004. This document describes the City's program and includes a variety of supporting documentation, including the Oxford's Stormwater Management Ordinance which can be found in Appendix A.

Below is a brief outline of the major components of the City of Oxford's stormwater management requirements:

- Oxford has a program to review and approve new development to ensure that post construction stormwater runoff is properly managed. Typically, this will mean that new development will be required to include on-site stormwater treatment facilities. More information can be found in Part 2 of this document.

- Oxford has a program to detect and eliminate illicit discharges into the stormwater conveyance system. Article 700 of the Stormwater Management Ordinance defines what types of discharges and connections are allowable and what types on not. More information on this topic can be found in Part 3 of this document.

- Oxford has a program to identify and prioritize opportunities to reduce pollutant loadings from existing developed areas. Typically, this will involve identifying properties where stormwater treatment facilities could be constructed to manage runoff from existing developed areas. More information on this topic can be found in Part 4 of this document.

- Oxford has a locally administered environmental education program to address pollutant loading issues with the public and developers, and to address peak stormwater flow issues with developers. More information on this topic can be found in Part 5 of this document.

- Oxford will submit annual reports to the NC Division of Water Quality (DWQ) which documents and quantifies progress towards reducing pollution associated with stormwater runoff. More information on this topic can be found in Part 6 of this document.

The components of the stormwater management requirements are further defined in the City of Oxford Stormwater Management Ordinance. The ordinance includes articles on definitions, protecting riparian buffers, permits, stormwater management and plans, stormwater BMP

inspection and maintenance requirements, illicit discharge and connections, and violations and enforcement.

The stormwater management requirements are applicable to the City of Oxford's corporate limits and extraterritorial jurisdiction (ETJ) planning limits. See Appendix K for a map.

The stormwater management requirements will be administered by:

City of Oxford Engineering Department
Contact: Stormwater Administrator
919-603-1100

City of Oxford Planning Department
Contact: Planning Director
919-603-1100

The stormwater management requirements will be implemented based on the following schedule:

August 9, 2004	Second Revised Draft Stormwater Program Submitted to DWQ
_____	EMC to approve Oxford Stormwater Program
September 27, 2004	Stormwater Program Approved by Oxford Board of Commissioners
September 27, 2004	Stormwater Program Anticipated Effective Date
October 30, 2005	Oxford to submit to DWQ Retrofit Locations Information on Data Collection, Notification, and Maintenance. Additional information required each subsequent year after 2005.
October 30, 2005	Oxford to submit to DWQ Annual Action Report and Plan. Subsequent reports and plans required each subsequent year after 2005.
October 30, 2006	Oxford to submit the DWQ Jurisdiction-Wide Information on Illegal Discharges. Additional information required each subsequent year after 2006.

Part 1
INTRODUCTION

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 (EMC) designated the entire basin "Nutrient Sensitive Waters". The first phase of management through 1994 focused primarily on point sources, establishing an annually decreasing nutrient loading cap for an association of dischargers, and an innovative "trading" program that allowed dischargers to achieve reductions in nutrient loading more cost-effectively.

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

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

The rule established 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:	Date of 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, local governments are required to make annual progress reports to the EMC that will include nitrogen and phosphorus loading reduction estimates.

The general elements that are included in the City of Oxford's Stormwater Management Program are:

1. New Development Review/Approval

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

New development must also avoid causing erosion of surface water conveyances. At minimum, post-development peak flows leaving the site may not exceed pre-development for the 1-year, 24-hour storm event.

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. Oxford is required under this rule to 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 Ecosystem Enhancement Program that the NC General Assembly has recently established. To assist technical experts, Oxford is 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. Oxford will develop and implement public and developer education programs for the Tar-Pamlico basin.

Part 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 Oxford's jurisdiction:

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

In addition, the City of Oxford will not approve the start of new development until copies of necessary permits, under jurisdiction of others, are provided the City. Such permits include DWQ 401 Water Quality Clarification, US Army Corps of Engineers 404 Dredge Fill Permit, and Land Quality Section Erosion and Sedimentation Permit.

2-B. Protecting Riparian Areas on New Development

The Tar-Pamlico Riparian Buffer Protection Rule, 15A NCAC 2B .0259, requires the City of Oxford 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. In addition, stormwater management plans shall demonstrate maintenance of diffuse flow to protected buffers.

Oxford must 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.
- 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.

Vested rights: New development projects that have received approval from the City for a site-specific or phased development plan by September 27, 2004, shall be exempt from the nutrient

management stormwater management requirements of Part 2 of this document. 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 27, 2004 or recorded any plats associated with such development within five years of the development's approval, shall be subject to the requirements of Part 2 of this document. 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, such as for landfills, NPDES wastewater discharges, land application of residuals, and road construction activities, was issued prior to September 27, 2004.

Calculating N and P Export: The nitrogen and phosphorus export from each new development shall be calculated by the owner. 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 I, along with a description of their development.

It is expected that some values provided in the methodology will be refined over time. The DWQ 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 DWQ 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.

A residential worksheet is also provided in Appendix I 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, Oxford 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 City 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. The exact methodology to be used will be determined by the City of Oxford during the review process.

2-D. Redevelopment within the Central Business District (B-1 Zoning District)

Through the concerted efforts of its elected officials, City staff, concerned citizens, and local business people, the City of Oxford enjoys a vibrant Central Business District. In this age of "big box" type development, which has driven retail businesses away from traditional downtown areas in many small North Carolina towns, Oxford's Central Business District has defied the trend, and remains the heart of the community and an important part of the local economy.

Uniquely distinguished by its B-1 zoning district designation, the Central Business District defines downtown Oxford and provides a diverse blend of locally owned businesses, restaurants, shops, and historic buildings. Downtown Oxford has long served as a traditional business center for the City and the Granville County area at large. Downtown Oxford was listed as a Historic District on April 28th, 1988 in the National Register of Historic Places. The National Register of Historic Places is the nation's official list of buildings, structures, objects, sites, and districts worthy of preservation for their significance in American history, architecture, archaeology, and culture. The National Register was established by the National Historic Preservation Act of 1966. *"The purpose of the Act is to ensure that as a matter of public policy, properties significant in national, state, and local history are considered in the planning of federal undertakings, and to encourage historic preservation initiatives by state and local governments and the private sector."*

Oxford's downtown Central Business District is zoned to allow a diversity of mixed uses ranging from residential dwellings and restaurants to a variety of commercial and retail businesses. Businesses share parking and sidewalks encourage pedestrian travel between establishments.

In support of its commitment to the vitality of its downtown, Oxford participates in the North Carolina Main Street Program. This program administered by the NC Division of Community Assistance within the Department of Commerce, is a human and technical reference center which works to stimulate economic development within the context of historic preservation. Since its inception in 1980, the NC Main Street Program has focused its efforts on preserving and revitalizing the downtown areas of small North Carolina communities.

The continuing investment and broad support for the Central Business District is reflected by Oxford's citizens and city officials in several additional ways:

- ✓ The Central Business District has its own unique zoning designation (B-1) specifically crafted to encourage diverse mixed uses within an efficiently concentrated area to encourage a pedestrian oriented setting.[1]
- ✓ The City employs a full time staff person specifically charged with developing revitalization strategies, organizing, and overseeing initiatives to ensure the long term vitality of the downtown area. This person holds the title of Director of the

[1] Article 300 – District Regulations - of the City's Zoning ordinance provides a definition of the purpose of the B-1 Central Business District and a table of permitted uses.

Oxford Downtown Economic Development Corporation, which is a public/private partnership for achieving community goals in the downtown area.

- ✓ Revitalization initiatives include giving the downtown area priority consideration when allocating resources for the repair of existing infrastructure.
- ✓ Between 1998 and 2003 there has been a total of over $5.1M in new public/private investment in the Central Business District. Within this period there has been a net increase of 63 jobs in the downtown area.

Exemption from phosphorus nutrient reduction performance standards: The NC Division of Water Quality's model stormwater program, approved by the EMC on February 13, 2003, allows for an exemption from the Tar-Pamlico phosphorus nutrient reduction performance standards for redevelopment projects within traditional central business districts. Local governments may take advantage of this exemption as long as they develop a management strategy for the central business district which is consistent with the spirit and goals of the State's Tar-Pamlico nutrient reduction strategy. The local management strategy must include a commitment to maintaining existing infrastructure, allowing mixed use/mixed density development within a pedestrian friendly environment, shared parking, and other smart growth-type development criteria. Oxford meets these criteria through a combination of its B-1 zoning code, City policies, and a demonstrated commitment to preserve the integrity, vitality, and historic character of the downtown area.

In addition to the downtown management strategy presented in this section, the City is committed to exploring additional stormwater BMP opportunities appropriate for ultra urban situations. The BMP application pictured above is a proprietary bioretention filtration system designed to remove nutrients and other pollutants from street runoff. This application might also help the City meet some of its landscaping goals for the downtown area.

In addition to these smart growth development policies, Oxford has the following stormwater management strategy for the B-1 Central Business District which is designed to provide a measure of nutrient load reduction conducive to the goals of the Tar-Pamlico basinwide nutrient strategy:

- ❑ Projects that replace or expand existing structures within the B-1 Central Business District, and that result in a net increase in the built upon area, shall have the option of using on-site BMPs to reduce nitrogen loads by an amount equal to the amount contributed by the net increase in built upon area. Phosphorus treatment is exempt.
- ❑ Alternatively, the developer may have the option of purchasing credits from the City, if credits are available for purchase, to offset the nutrient load from the net increase in built upon area. The cost of nutrient offset credits for a given project shall be determined by the Stormwater Administrator based on the cost to the City of constructing and maintaining a stormwater retrofit BMP which has been designated as a source of nutrient offset credits for developers. The City shall not be allowed to sell nutrient offset credits for retrofit BMPs which have not yet been constructed, or for retrofit BMPs whose credits have already been allocated.

- Projects that replace or expand existing structures within the B-1 Central Business District and do not increase the built upon area may take advantage of the aforementioned exemption and do not have to meet the four (4.0) pounds of nitrogen per acre per year and four tenths (0.4) of a pound of phosphorus per acre per year performance standards referenced in Section 501 of the City's stormwater management ordinance, provided that these projects facilitate shared parking with the surrounding businesses and other permitted uses.
- New development projects in the B-1 Central Business Districts which do not involve the replacement or expansion of existing structures or impervious area do not qualify for this exemption from the nutrient loading control requirements.
- Applicants for new development within the B-1 Central Business District which require BMPs should meet with the City of Oxford Stormwater Administer early in the development process. BMPs shall be compatible with the overall character of the Central Business District. Compatible features could include underground systems such as sand filters and low impact features such as bioretention. BMPs shall be selected on a case by case basis and shall meet State design requirements.

2-E. BMPs for Reducing Nitrogen and Phosphorus

All new developments shall 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 shall 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.

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 I assume correct sizing and other design per the referenced manuals, and optimum performance based on regular, effective maintenance as well as proper siting of the practices.***

The BMPs available for nutrient reduction and their removal rates based on current literature studies are provided in Table 2.1 below. A summary of these literature studies is given in Appendix J. 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 DWQ plans to provide refinements in the stated BMP removal efficiencies to the jurisdictions on a periodic basis as they are substantiated.

Table 2.1 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.

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

The Maryland Department of Environment Stormwater Management Program BMP Design Manual and all amendments thereto, is hereby adopted by reference as fully as though set forth herein. If any standard, requirement, or procedure as set forth in the manual is in conflict with any standard, requirement, or procedure as set forth in this ordinance then the most stringent shall prevail. A copy of this manual shall be available for public review in the office of the Stormwater Administrator.

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 City of Oxford 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 acreage shall be entered as wooded previous or managed pervious (lawn/landscape), as applicable.

2-F. 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.

Protecting stream banks 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.

Use of 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, is provided in Table 2.2 below.

Table 2.2 Rainfall depths for the 1-year, 24-hour storm (from US Weather Bureau Technical Paper 40)

Municipalities	1yr – 24hr depth (inches)
Oxford	2.9

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 H). The resulting values for g and h are directly applicable in the Tar-Pamlico River basin as follows:

Table 2.3 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	104	18

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.

Acceptable Methodologies for Computing Peak Flow

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

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

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

2-G. 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 owner 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- H) 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 City of Oxford tracks its use and the new development owner performs maintenance.

The City generally discourages the use of offsite partial offsets. However, the City will review offsets on a case-by-case basis and approve those which are in the best interest of the City.

The owner shall provide acceptable documentation to Oxford demonstrating:

- 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 understand 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

2-H. Regional or Jurisdiction-Wide Approaches

The Tar-Pamlico stormwater rule provides the option for Oxford to develop regional or jurisdiction-wide stormwater facilities in their programs as an alternative means for owners to address nutrient or flow control requirements. Oxford will demonstrate that such measures will not contribute to degradation of surface waters. Oxford will quantify nutrient and flow reductions and provide for tracking and administration of the use of such facilities.

The City generally discourages the use of regional facilities and jurisdiction-wide approaches. However, the City will review regional facilities and jurisdictional-wide approaches on a case-by-case basis and approve those which are in the best interest of the City.

Regional facilities and jurisdiction-wide approaches require two levels of approval. Regional facilities and jurisdiction-wide approaches must be approved first by the City and then by DWQ. If initially approved by the City, the approval shall be contingent on DWQ approval. The applicant shall be responsible for preparing any documents required and gaining DWQ approval.

Regional Facilities: Within the context of the rule, the concept of a regional facility generally refers to 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 the City the opportunity to include stormwater management on a larger scale. Two basic types of regional facilities may be described as offstream and instream. While Oxford 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 City of Oxford.

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 concept of a jurisdiction-wide approach generally refers to a nutrient-reducing management measure implemented under the authority of Oxford 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-G) that is implemented under the authority of Oxford 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.

Proposal Information: Regional or jurisdiction-wide approaches may be incorporated into Oxford's 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 City, Oxford will need to provide an amendment to DWQ which describes the following information for any proposed regional facility and 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. Note that DWQ has not as of May 2004 established design standards for these criteria.
- Process for tracking expenditure of treatment and attenuation capacity.
- Facility protection provisions - an easement, restricted to stormwater management and containing adequate access, dedicated to the public or public entity through a platted and recorded map.
- Operation and maintenance provisions:
  - An agreement that demonstrates that (a) the developer, (b) City of Oxford, or (c) a private for-profit or non-profit company will operate and maintain the facilities.
  - Financial guarantees for maintenance of continued performance in the event that the City of Oxford must assume maintenance.
  - An adopted ordinance providing for fines and penalties to ensure maintenance of the stormwater facilities.

2-I. BMP Maintenance

The City of Oxford requires the BMP owner to maintain the BMPs at all times. The City of Oxford requires a maintenance plan for all BMPs. The City of Oxford requires the maintenance plan to be recorded and escrow account be established by the owner for most BMPs. Wherever a BMP serves more than one (1) lot, will be maintained through a homeowners or property owners association or is for multi-family residential, commercial, industrial, or institutional facility, prior

to receiving a stormwater permit, a maintenance plan, shall be recorded in the Granville County Register of Deeds. The maintenance plan shall be submitted for review and approval by the City during the permitting process. The BMP maintenance plan shall include the following elements at a minimum:

- A description of the property of which the device is located and all easement from the site to the device;
- A sketch which identifies the size and configuration of the device;
- A statement that properties which will be served by the device are granted rights to construct, use, reconstruct, repair, maintain, access to the device;
- A statement that each lot served is jointly or severally responsible for repairs and maintenance of the device, and unpaid ad valorem taxes, and public assessments for improvements.
- Identify and describe maintenance/monitoring operations.
- Provide inspection forms and checklists.
- Provide construction cost estimate for device.
- Provide escrow account calculations.
- Certification statement to be used annually. Certification statement will include wording that BMP continues to function as required to meet the stormwater management requirements and Oxford's Stormwater Management Ordinance.

The BMP maintenance plan shall at least meet the minimum standards of the North Carolina Department of Environment and Natural Resources, Division of Water Quality, Water Quality Section, Stormwater Best Management Practices Manual, 1999, and all amendment thereto. The BMP maintenance plan shall be designed to insure that the BMP continues to function as required to meet the stormwater management requirements included in this program and the City of Oxford Stormwater Ordinance.

Oxford shall inspect all BMPs on an annual basis. Oxford will typically inspect the BMPs after receipt of the BMP owner's annual report.

Refer to Appendix A for additional information.

2-J. Land Use Planning Provisions

Oxford's Stormwater Management Program is intended to provide the flexibility and incentives to improve 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.

Part 3

ILLEGAL DISCHARGES

3-A. Requirements in the Rule

The Tar-Pamlico Stormwater Rule requires that Oxford 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 3.1 identifies some potential flows to the stormwater collection system that may be allowable. Table 3.2 identifies some discharges that are not allowed.

Table 3.1 Discharges that may be allowable to the stormwater collection system

Waterline flushing	Landscape irrigation water	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
Springs	Water from crawl space pumps	Non-commercial car washing
Footing drains	Lawn watering	Street wash water
Flows from riparian habitats and wetlands	NPDES permitted stormwater discharges	Dechlorinated backwash and draining associated with swimming pools
Emergency fire fighting activities	Wash water from the cleaning of buildings, provided that the discharge does not pose a threat to the environment	

Table 3.2 Types of Discharges that are not allowed to stormwater collection system

Dumping of oil, anti-freeze, paint, cleaning fluids	Commercial car wash washwaters	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	Domestic wastewater discharges	Runoff from roof drains

3-C. Establishing Legal Authority

By September 27, 2004, Oxford will show that it has established the legal authority to do the following:

- Control the contribution of illegal pollutants identified in Table 3.2 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.

3-D. Collecting Jurisdiction-Wide Information

Oxford will 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 is to assist with identifying potential illegal discharge sources and characterizing illegal discharges after they are discovered.

Oxford will compile maps that show the following information.

- 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, or 1:24,000 scale digital hydrography GIS layers obtained from the NC Center for Geographic and Information Analysis (CGIA).
- 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 obtained from the Division of Water Quality.

All of this information will not be shown on a single map. The maps shall be at a scale that is most useful to the City; however, no scale will be greater than 1:24,000.

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.

Oxford will 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 City's stormwater program, Oxford will identify a high priority area of its jurisdiction for more detailed mapping and field screening. "High priority" means the areas most likely to contain illegal discharges. 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, Oxford is responsible for selecting and screening another high priority area that comprises at least ten percent of its jurisdiction. Each year, the City will explain our basis for selection of the high priority areas.

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

- 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.

Figure 3.1 illustrates the Oxford 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.

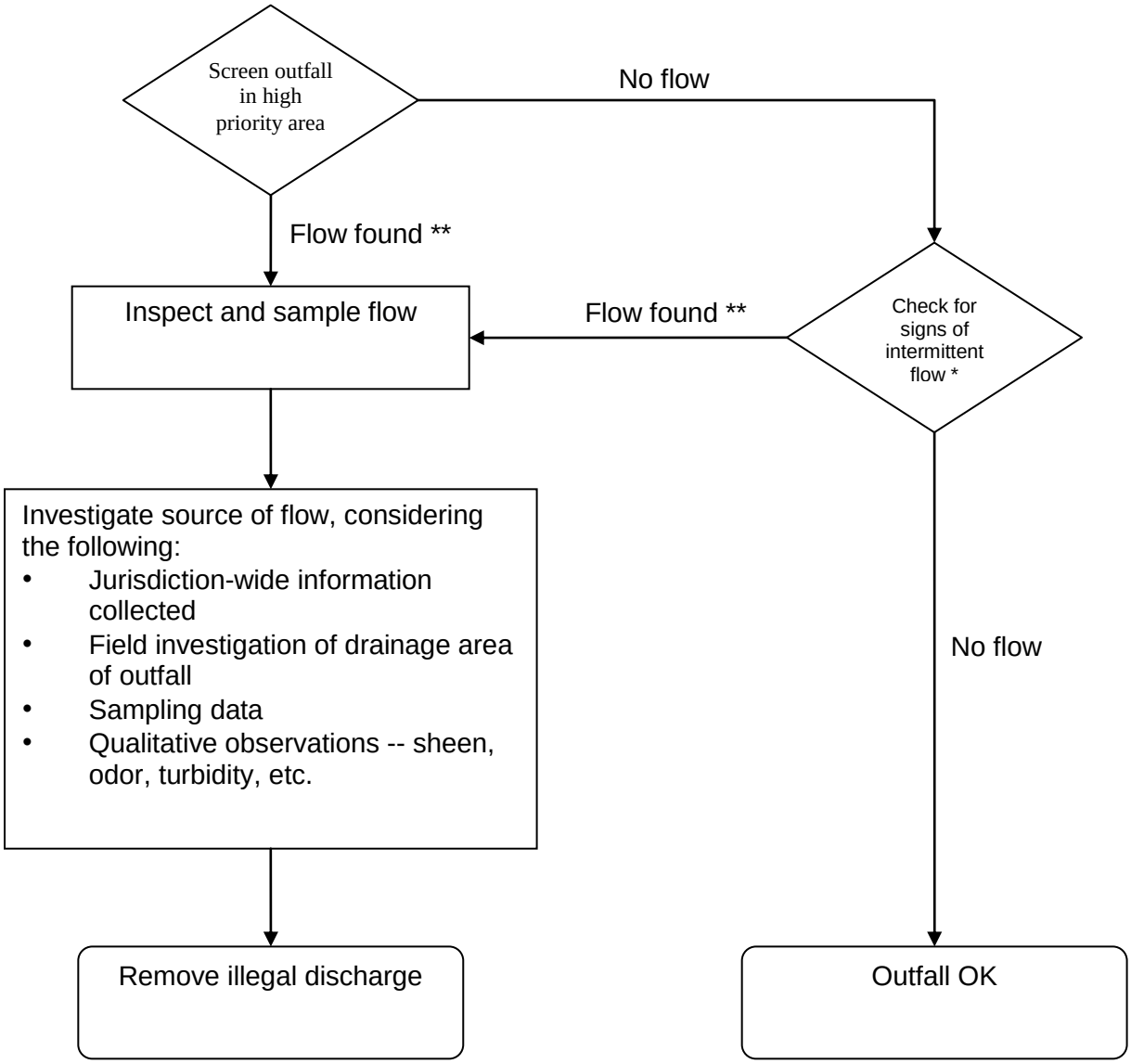
If the field screening shows that an outfall has a dry weather flow, then Oxford is required to complete a screening report for the outfall. The information will, as appropriate, be contained in the screening report is outlined in Table 3.3. Screening reports will be kept on file for a minimum of five years.

Table 3.3 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.

Figure 3.1: Field Screening Process



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

** Evaluate if flow is groundwater infiltrating into the stormwater conveyance system

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

3-F. Identifying and Removing Illegal Discharges

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

After potential sources have been identified in the office, a systematic field investigation will be planned that minimizes the amount of resources required to identify the source. Several field methods may be used to identify illegal discharges. Listed below are several approaches which will be considered, starting with simple approaches and moving to more complex ones:

- Site Investigation
- Additional Chemical Analysis (recommend testing for fecal coliform if the ammonia concentration was found to exceed 1.0 mg/L)
- Flow Monitoring (recommended to use multiple site visits rather than a depth indicator)
- Dye Testing (fluorescent dye is recommended)
- Smoke Testing
- Television Inspection

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

After the source of an illegal discharge is identified, the City will take enforcement action to have the source removed. Enforcement will include requiring the person responsible for the discharge to remove or redirect it to the sanitary sewer. Records of all compliance actions will be kept for five years with the screening report.

In addition to keeping all screening reports on file, the City will 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

Oxford will establish a hot line which citizens can call to report an illicit discharge or connection. The hot line number will be advertised as part of the public education program to educate citizens about what types of discharges should not go to the stormwater collection system. The hotline will include a recording advertising citizens what to do if they call during non-business hours. There will be an emergency number given on the recording in cases where the illicit discharge is perceived to be an emergency.

3-H. Implementation Schedule

The illicit discharge detection and elimination program will be implemented on a phased schedule as follows:

Table 3.4 Implementation Schedule and Annual Reporting Requirements

Year	Implementation Requirements	Annual Report Requirements
By September 27, 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.

Part 4
RETROFIT LOCATIONS

4-A. Requirements in the Rule

The rule requires that Oxford establish a program to identify and prioritize one (1) place per year within existing developed areas that are suitable for retrofits. A retrofit BMP refers to a structural best management practice designed to manage stormwater runoff from an existing developed area typically not already served by a stormwater management facility.

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.
- There is adequate space and access for the retrofit.
- It is technically practical to install a retrofit at that location.

4-C. Data Collection, Notification, and Maintenance

Each retrofit opportunity that is identified will be accompanied by information to describe the location of the retrofit, the type of retrofit being proposed, the property owner, as well as basic information about the watershed and the receiving water. Table 4.1 shows a format which will be considered for presenting this information for each retrofit opportunity.

The tables will 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.

DWQ 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. Ecosystem Enhancement Program

The City of Oxford intends to work in a spirit of cooperation with all parties involved to identify high quality retrofit opportunities within its jurisdiction. However, unless a retrofit opportunity is identified for location on city property, the City does not intend to take over ownership of the stormwater treatment facility. In accordance with this policy, the City will not take responsibility for the long term maintenance of the facility.

4-D. Mapping Requirements

The City will 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 will, be at a scale that is most useful to the City; however, no scale will be greater than 1:24,000 and the scale will be such that the City can 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 4.1 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 I to compute nitrogen export from the drainage area based on the amount of impervious surface, landscaped area and forested area in the watershed.

Part 5
PUBLIC EDUCATION

5-A. Requirements in the Rule

The Tar-Pamlico Stormwater Rule requires Oxford 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. Oxford is required to develop a Public Education Action Report and Plan. The purpose of the Action Report and Plan is to provide a platform to design 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. Per the Tar-Pamlico Stormwater Rule Oxford will submit an annual Action Report and Plan to DWQ for approval in its October annual report each year.

The Action Report and Plan shall consist of various types of activities. Innovative public education activities not included in this list may be proposed for review by DWQ on a case-by-case basis. All activities will 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 City will conduct activities that sum to at least 15 points each year. The City will identify and conduct activities throughout the 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, the City will conduct two (2) technical workshops. One will 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 may be considered as an optional activity.

Part 6
REPORTING REQUIREMENTS

As required by the Tar-Pamlico Stormwater Rule, annual Tar-Pamlico River Basin stormwater program reports will 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

Oxford will submit the following information regarding new development as part of the annual reporting requirement:

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

6-B. Illegal Discharges

Table 6.1 outlines the annual reporting requirements for illegal discharges.

Table 6.1 Implementation Schedule and Annual Reporting Requirements

Year	Implementation Requirements	Annual Report Requirements
By September 27, 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 4.1 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 city.

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 City will address shortfalls.

Appendices to the

Tar-Pamlico River Basin: Stormwater Program for Nutrient Control

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APPENDIX A

CITY OF OXFORD PROPOSED STORMWATER MANAGEMENT ORDINANCE

Chapter XX STORMWATER MANAGEMENT

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ARTICLE 100 – PURPOSE

101 Title

This ordinance shall be known and may be cited as the "City of Oxford Stormwater Management Ordinance", except as referred to herein, where it shall be known as "this Ordinance".

102 Purpose

The purpose of this ordinance is to establish minimum criteria to control and minimize quantitative and qualitative impacts of stormwater runoff from development within the City of Oxford, in accordance with 15A NCAC 2B .0258 Tar-Pamlico River Basin Nutrient Sensitive Waters Management Strategy: Basinwide Stormwater Requirements.

Further, prudent site planning should include special consideration for the purposes of preserving natural drainage ways, maximizing infiltration, and slowing stormwater runoff from individual sites in route to streams and rivers by use of effective runoff management, structural and non-structural best management practices, drainage structures, and stormwater facilities.

103 Jurisdiction

The provisions of this Ordinance shall apply to all territory within the City of Oxford corporate limits and the City of Oxford extraterritorial jurisdiction (ETJ) planning limits.

104 Exceptions to jurisdiction

The provisions of this Chapter shall not apply to:

(A) Developers/property owners that can demonstrate that they have vested rights shall be exempt from the nutrient loading control requirements.

(B) Exemption from the riparian buffer protection requirements: Existing and ongoing uses within the riparian buffer, if present as of January 1, 2000, may be exempt from the riparian buffer protection requirements according to the provisions outlined in 15A NCAC 02B .0259. On-site determinations as to the applicability of the riparian buffer protection requirements fall under the jurisdiction of the NC Department of Environment and Natural Resources. Proposed developments which have received City approval, but have not been constructed as of January 1, 2000, may not claim an exemption to the riparian buffer protection requirements.

(C) Exemption from the nutrient loading control requirements: Projects 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 nutrient loading control requirements contained within this Chapter.

(D) Exemption from the nutrient loading control requirements for individual single family residential lots of record that are not part of a larger common plan of development: such projects which disturb greater than one acre of land to establish, expand, or replace a single family home, but which result in less than ten percent (10%) built-upon area, shall be exempt from the nutrient loading control requirements contained within this Chapter.

(E) Exemption from the phosphorus loading control requirements for projects within the B-1 Central Business District: Projects that replace or expand existing structures within the B-1 Central Business District, and that result in a net increase in the built upon area. Alternatively, the developer may have the option of purchasing credits from the City, if credits are available for purchase, to offset the nutrient load from the net increase in built upon area. The cost of nutrient offset credits for a given project shall be determined by the Stormwater Administrator based on the cost to the City of constructing and maintaining a stormwater retrofit BMP which has been designated as a source of nutrient offset credits for developers. The City shall not be allowed to sell nutrient offset credits for retrofit BMPs which have not yet been constructed, or for retrofit BMPs whose credits have already been allocated.

(F) Exemption from the peak flow attenuation requirement: Peak flow control is not required for developments that meet one or more of the following requirements:

1. The increase in peak flow between pre- and post-development conditions does not exceed ten percent (10%).

2. The proposed new development meets all of the following criteria:

a) Overall impervious surface is less than fifteen percent (15%); and
b) The remaining pervious portions of the site are utilized to the maximum extent practical to convey and control stormwater runoff.

105 Interpretation

In interpreting and applying this Chapter, the requirements are intended to be minimum requirements, which are imposed and are to be conformed to, and are in addition to, and not in lieu of, all other legal requirements.

This Chapter shall not be deemed to interfere with or annul or otherwise affect in any manner whatsoever any ordinance, rules, regulations, permits, or easements, covenants, or other agreements between parties, provided, however, that where this Chapter imposes greater restrictions and controls with respect to stormwater management, the provisions of this Chapter shall prevail.

106 Administration of the Stormwater Management Ordinance

The City Engineer of the City of Oxford, or his designee, is hereby appointed to serve as Stormwater Administrator and it shall be his or her duty to administrator and enforce the provisions of this Ordinance. Appeal from a decision by the Stormwater Administrator may be made to the Board of Commissioners.

ARTICLE 200 - DEFINITIONS

For the purpose of this Chapter, the following terms, phrases and words, and their derivatives, shall have the meaning herein:

201.1 *Applicant* means an owner or developer of a site who executes the stormwater permit application pursuant to this Chapter.

201.2 *Best management practices (BMPs)* means a wide range of practices that have been demonstrated to effectively manage the quality and/or quantity of stormwater runoff and which are compatible with the planned land use.

201.3 *Built upon area (BUA)* 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 swimming pools are considered pervious.

201.4 *Channel bank* means the location of the upper edge of the active channel above which the water spreads into the overbanks on either side of the channel or the elevation of the two-year frequency storm. Where the channel bank is not well defined, the channel bank shall be considered the edge of the waterline.

201.5 *Design storm* means the specific frequency and, if necessary, duration of the rainfall event to be used in design to meet the criteria established in the City of Oxford's Tar-Pamlico River Basin: Stormwater Program for Nutrient Control. The design storm for peak flow attenuation described in this Chapter shall be the 1 year, 24 hour storm.

201.6 *Development* means any of the following actions taken by a public or private individual or entity:

(A) The division of a lot, tract or parcel of land into two (2) or more lots, plots, sites, tracts, parcels or other divisions by plat or deed, or

(B) Any land change, including, without limitation, clearing, tree removal, grubbing, stripping, dredging, grading, excavating, transporting and filling of land.

201.7 *Drainage structures* shall include swales, channels, storm sewers, curb inlets, yard inlets, culverts and other structures designed to convey stormwater.

201.8 *Existing development* means an individual non-residential site with site plan approval by the planning department or a non-residential or residential subdivision with preliminary subdivision approval from the planning board.

201.9 *Illicit discharges* means any unlawful disposal, placement, emptying, dumping, spillage, leakage, pumping, pouring, or other discharge of any substance other than stormwater into a stormwater conveyance system, the waters of the State or upon the land such that the substance is likely to reach a stormwater conveyance system or waters of the State.

201.10 *Impervious surface* means a surface composed of any material that impedes or prevents natural infiltration of water into the soil. Gravel areas shall be considered impervious.

201.11 *Land disturbance* means removal of topsoil, grubbing, stump removal and/or grading.

201.12 *Natural drainage way* shall mean a channel with a defined channel bed and banks that are part of the natural topography. Construction channels such as drainage ditches shall not be considered a natural drainage way unless the constructed channel was a natural drainage way that has been relocated, widened, or otherwise improved.

201.13 *New development* shall be defined as:

(A) Any activity that disturbs greater than one acre of land in order to establish, expand, replace, or modify 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.

(B) Any activity that disturbs greater than one-half (1/2) acre of land in order to establish, expand, replace, or modify a multi-family residential development or a commercial, industrial, or institutional facility.

(C) New development shall not include mining, agricultural or forestry activities.

201.14 *Nutrient(s)* means nitrogen and phosphorus, which if present in excessive amounts within a water body, can lead to large growths of algae, low dissolved oxygen concentrations, and other water quality problems.

201.15 *Retrofit BMP* refers to a structural best management practice (BMP) designed to manage stormwater runoff from an existing developed area typically not already served by a stormwater management facility.

201.16 *Riparian buffer* means an area of trees, shrubs, or other forest vegetation, that is adjacent to surface waters. For purposes of this Chapter, surface water shall be present if the feature is approximately shown on either the most recent version of the Granville County soil survey report prepared by the Natural Resources Conservation Service or the most recent version of the 1:24,000 scale (7.5 min.) quadrangle topographic maps prepared by the United States Geological Survey. Riparian buffers adjacent to surface waters that do not appear on either of these maps shall not be subject to this Chapter, except areas designated by the Stormwater Administrator to be environmentally sensitive.

201.17 *Stormwater* means flow resulting from and occurring after any form of precipitation.

201.18 *Stormwater Administrator* means the City Engineer or his designee, who has the designated authority to review and approve stormwater permits and stormwater management plans.

201.19 *Stormwater conveyance system or structure* means any feature, natural or man-made, that collects and transports stormwater, including but not limited to roadways with collection systems, catch basins, man-made and natural channels, streams, pipes and culverts, and any other structure or system designed to transport runoff.

201.20 *Stormwater Program for Nutrient Control* means the manual of design, performance, and review criteria adopted by the City of Oxford Board of Commissioners for the administration of the stormwater program. The manual will be maintained and revised as needed by the Stormwater Administrator with the approval of the Board of Commissioners.

201.21 *Qualified Professional* shall mean a professional licensed and/or registered in the State of North Carolina performing services only in their area(s) of competence.

201.22 *Vegetative buffer* means an area that has a dense ground cover of herbaceous or woody species, which provides for diffusion and infiltration of runoff and filtering of pollutants.

201.23 *Vested rights* means new development projects that have received approval from the City for a site-specific or phased development plan by September 27, 2004, shall be exempt from the nutrient management stormwater management requirements of Part 2 of this Document. 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 27, 2004 or recorded any plats associated with such development within five years of the development's approval, shall be subject to the requirements of Part 2 of this Document. 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, such as for landfills, NPDES wastewater discharges, land application of residuals, and road construction activities, was issued prior to September 27, 2004.

201.24 *Water dependent* structures means those structures that require the access or proximity to, or sitting within surface waters to fulfill its basic purpose, such as boat ramps, boathouses, docks, and bulkheads. Ancillary facilities such as restaurants, outlets for boat supplies, parking lots, and commercial boat storage areas are not considered water-dependent structures.

ARTICLE 300 - PROTECTING RIPARIAN BUFFERS

301 Protection of buffer

As required by 15A NCAC 02B .0259 (Tar-Pamlico River Basin: Nutrient Sensitive Waters Management Strategy: Protection and Maintenance of Existing Riparian Buffers), a fifty-foot (50') wide riparian buffer shall be maintained directly adjacent to all perennial and intermittent streams, including lakes, ponds, and other bodies of water, excluding wetlands, as indicated on the most recent version of the 1:24,000 scale (7.5 minutes) quadrangle topographic maps prepared by the United States Geological Survey (USGS) and all other surface waters as indicated by the most recent version of the Soil Survey of Granville County, North Carolina. Where obvious conflicts exists between actual field conditions and USGS and county soil survey maps, appeals may be made to the NC Department of Environment and Natural Resources.

302 Delineation of buffer zones

In all developments, a riparian buffer of minimum width of fifty (50) feet is hereby established along each subject body of water. The width of each riparian buffer, measured perpendicular to the banks of the stream, shall be equal to fifty (50) feet on each side of the stream.

There are hereby established two (2) zones of the riparian buffer as follows:

(A) Zone 1 (A distance of thirty (30) feet that begins at most landward limit of the top of bank or the rooted herbaceous vegetation and extends landward on all sides of the surface water)

(B) Zone 2 (Twenty (20) feet landward adjacent to Zone 1)

303 Activity within buffer

Activity may take place within any riparian buffer zone as defined by 15A NCAC 02B .0259. As per 15A NCAC 02B .0259, Zone 1 is to remain essentially undisturbed, whereas Zone 2 is to be vegetated but with some uses permitted.

Development activity within Zone 1 and Zone 2 of a riparian buffer may take place provided that the landowner has one of the following:

(A) An authorization certificate that documents that the NC Department of Environment and Natural Resources has approved an allowable use.

(B) An opinion from the NC Department of Environment and Natural Resources that vested rights has been established for that activity.

(C) A letter from the NC Department of Environment and Natural Resources documenting that a variance has been granted for the proposed activity.

304 Description of buffers on development plans

Riparian buffers shall be shown on the maps submitted for stormwater management plan approval, and on all approved site plans, subdivision plans, and recorded plats.

ARTICLE 400 - PERMITS

401 Stormwater permit application process

Except where provided elsewhere, land-disturbing activities subject to the provisions of this Chapter shall not commence without obtaining a stormwater permit.

The stormwater permit application shall be made by, or on behalf of the owner(s) or developer(s) of the site for which the permit is sought. The application shall be filed with the City on a form supplied by the City and shall be accompanied with the information identified in the Stormwater Program for Nutrient Control.

A stormwater permit shall not be issued until all of the following conditions are met:

(A) Approval of the stormwater management plan by the Stormwater Administrator.

(B) Submission and approval of any required easements on a map to be recorded.

(C) Submission and approval of any required inspection and maintenance agreement and/or escrow account or other legal instrument established to ensure long-term maintenance of BMPs.

(D) Payment of all fees.

If the development requires State approval of an erosion and sediment control plan, the stormwater permit will be conditional upon the owner receiving such approval from the NC Department of Environment and Natural Resources.

The stormwater permit must be maintained for the life of the development or until significant changes in the development are made that change the intent of the permit. Significant changes may include, but are not limited to, increases in the amount of impervious coverage or major changes to the stormwater conveyance system. The Stormwater Administrator shall determine if such changes warrant re-opening the permit. If significant changes are made, the original stormwater permit shall not be valid, and a new permit shall be required.

Conveyance of the property shall not terminate the original developer's obligations under this Chapter until such time as a replacement permit is approved by the Stormwater Administrator. The original developer shall include in the deed conveying the property notice of the existence of the stormwater control measures and the purchaser's obligations to maintain and inspect them and to obtain a permit and otherwise comply with the terms of this Chapter.

402 Fees

A list of fees associated with this section, and approved by the Board of Commissioners, is available at the Finance Department in the Oxford Town Hall.

ARTICLE 500 - STORMWATER MANAGEMENT AND PLANS

501 In general

Stormwater shall be conveyed from developments in an adequately designed drainage system of natural drainage ways, grass swales, storm sewers, culverts, inlets, and channels. Drainage systems shall be designed, constructed, and maintained to encourage natural infiltration, control velocity, control flooding, and extend the time of concentration of stormwater runoff. The Stormwater Administrator shall determine adequacy of the stormwater drainage system.

The post-development peak flow runoff rate for the 1-year, 24 hour storm event shall be attenuated to the pre-development peak flow runoff rate for the 1-year, 24 hour storm according to the provisions described in the Stormwater Program for Nutrient Control. The rainfall depth for the 1-year, 24-hour storm for Oxford is 2.9 inches. Acceptable methods for computing peak flow 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 55 (TR55), and The Putnam Method. The Rational Method values for g and h for Oxford are 104 and 18, respectively. Exceptions to the peak flow requirements are the increase in the peak flow between pre- and post-developed conditions does not exceed ten percent and if the 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 nitrogen loading contributed by new development shall be restricted to four (4.0) pounds of nitrogen per acre per year. Methodologies for determining nitrogen loading are outlined in the Stormwater Program for Nutrient Control.

The phosphorus loading contributed by new development shall be restricted to four tenths (0.4) of a pound of phosphorus per acre per year. Methodologies for determining phosphorus loading are outlined in the Stormwater Program for Nutrient Control.

Applicants shall make every reasonable effort to achieve the required nitrogen and phosphorus load reductions using on-site BMPs. If the full nutrient load reductions cannot be achieved using on-site BMPs exclusively, then the applicant may request in writing, permission from the Stormwater Administrator to exercise the option of partially offsetting their nitrogen and phosphorus loads by providing treatment of off-site developed areas as outlined in the Stormwater Program for Nutrient Control. The off-site area must drain to the same classified surface water, as defined in the NC Schedule of Classifications, 15A NCAC 2B .0316, that the development site drains to most directly.

The applicant must provide legal assurance of the dedicated use of the off-site area for the purposes described in this Chapter, including achievement of specified nutrient load reductions and provision for regular operation and maintenance activities, in perpetuity. The legal assurance shall include an instrument that maintains this restriction upon change of ownership or modification of the off-site property.

Before off-site treatment can be considered as an option, the new development must reduce nitrogen export from the site to no greater than six (6) pounds/acre/year for residential development, or no greater than ten (10) pounds/acre/year for commercial or industrial development, through the use of on-site BMPs. The applicant must demonstrate that achieving the full nitrogen and phosphorus loading reductions is not feasible using on-site BMPs solely, before making a request for the use of off-site treatment.

The North Carolina Department of Environment and Natural Resources, Division of Water Quality, Water Quality Section, Stormwater Best Management Practices Manual, 1999, and all amendments thereto, is hereby adopted by reference as fully as though set forth herein. If any

standard, requirement, or procedure as set forth in the manual is in conflict with any standard, requirement, or procedure as set forth in this ordinance then the most stringent shall prevail. A copy of this manual shall be available for public review in the office of the Stormwater Administrator.

502 Stormwater management plans

A stormwater management plan shall be prepared by the applicant for all land disturbing activities subject to this Chapter. Stormwater management plans shall:

(A) Include drawings, maps, supporting calculations, specifications, and summaries as outlined in the Stormwater Program for Nutrient Control.

(B) Application Requirements.

1. Any person desiring a stormwater permit shall submit a permit application to the Stormwater Administrator on a form provided by the City for that purpose.

2. Unless otherwise excepted by this Ordinance, a permit application must be accompanied by the following in order for the permit application to be considered:

(a) Two copies of a stormwater management plan, and

(b) Two copies of maintenance plan.

(C) Application Procedure.

1. Applications for a stormwater permit may be filed with the Stormwater Administrator during regular business hours.

2. An application for a stormwater permit may be filed simultaneously with an application for a building permit, grading permit or other land development permit issued by the City.

3. Any applicant claiming a variance to one or more requirements of this ordinance shall submit evidence of valid approval of such variance at the time of permit application.

(D) Stormwater Management Plan Requirements.

1. All plans shall be prepared and sealed by a qualified professional who also certifies under seal that the plan, including engineering detail, conforms to the minimum requirements established by this Ordinance.

2. All plans shall include a site plan, which at a minimum, clearly indicates the following features unless the Stormwater Administrator determines that certain elements are not appropriate or are unnecessary for a particular application:

   (a) Ownership and use of the proposed site and all surrounding properties;

   (b) The entire area of development and existing built-upon area on the site;

   (c) Existing and proposed structures and impervious surfaces;

   (d) The location of any watercourses or surface water bodies;

   (e) The location, extent and dimensions of all existing and proposed stormwater conveyences on and immediately adjacent to the development site;

   (f) Existing and proposed buffer areas;

   (g) Existing and proposed open space;

   (h) Existing and proposed topography using two foot contours;

   (i) Existing and proposed structural BMPs;

   (j) The extent of existing vegetation;

   (k) Acreages of the various proposed land covers (e.g. pervious, impervious, managed open space, etc.);

   (l) Maintenance Plan; and

   (m) Any other information that the Stormwater Administrator needs in order to determine compliance with these regulations.

3. All plans shall clearly demonstrate of protection of and diffuse flow to buffer areas as established in Article 300.

4. All plans shall include nutrient calculation worksheets and peak flow calculations. Forms and formulas for calculating nutrient load and peak flow are available at the office of the Stormwater Administrator.

5. All plans shall include data, site plans, and information necessary to support a proposed offsite approach, if applicable.

6. All plans shall include a landscaping plan which clearly shows the extent of undisturbed vegetation and the location, species, number, and planting characteristics (including height at time of planting, spacing, etc.) of proposed vegetation. The plan must also describe the vegetative stabilization and management techniques to be used at the site after construction is completed, who

will be responsible for the maintenance of vegetation, and what practices will be employed to ensure that adequate vegetative cover is preserved.

7. All plans shall include engineering detail for each structural BMP, including calculations, sufficient to determine compliance with this Ordinance.

8. All plans shall include Memorandum of Maintenance Agreement. The Agreement shall be recorded by the Owner at the time of issuance of the permit and will be recorded in the Register of Deeds. The Agreement shall include the names of the owners, the identity of the parcel and the fact that the parcel is subject to the agreement and stormwater ordinance. The Agreement shall incorporate and related documents by reference and indicate that the provisions of the Agreement are appurtenant to and run with the land of the Owner.

(E) Permit Review and Approval Procedure.

1. The Stormwater Administrator shall approve, approve with conditions, or deny the permit application within thirty (30) days of receipt.

2. If the permit application is denied, the Stormwater Administrator shall provide written comments to the applicant explaining the reason(s) for denial.

3. If the permit application is approved by the Stormwater Administrator, a stormwater permit shall be issued.

4. A previously denied permit application may not be resubmitted for consideration unless the Stormwater Administrator determines that material facts, either in the ordinance or the application, have changed significantly enough to warrant reconsideration.

(F) Permit Duration.

Permits issued under this section shall be valid for a period of six months from the date of issuance. If after six months the permitted activity has not begun the stormwater permit shall expire.

(G) Permit Amendments.

Once an applicant has received a stormwater permit, any minor change or alteration to the site, as determined by the Stormwater Administrator, that is inconsistent with the approved permit shall require an amendment to the approved permit. Any major change or alteration to the site, as determined by the Stormwater Administrator, shall require the owner to submit a new stormwater permit application to the Stormwater Administrator for review and approval. Until such amendment or new permit has been approved, no work inconsistent with the original permit shall be commenced.

(H) Document through accepted engineering practices the impacts of the proposed development. At a minimum, documented impacts of the design storm for the proposed development shall include:

1. Effects on existing upstream and/or downstream drainage systems and property;

2. Ability of the natural drainage way to handle additional stormwater runoff; and;

3. Site-specific criteria supporting the analysis of any impacts noted in (B)(1) and (B)(2) above.

(I) Demonstrate through accepted engineering practices that stormwater runoff is adequately conveyed through the development in a drainage system designed to meet the criteria described in the Stormwater Program for Nutrient Control.

(J) Demonstrate through accepted engineering practices that stormwater facilities required to control the impacts, including pre- and post-development run off rates, of the development are designed to meet the criteria described in the Stormwater Program for Nutrient Control.

(K) Using the methodologies set forth in the Stormwater Program for Nutrient Control, demonstrate that the nitrogen and phosphorus loading from the new development does not exceed the limits set forth in Section 501 (In General) above.

(L) If the BMP serves more than one (1) lot, and will be maintained through a homeowners or property owners association, or serves any development except single family detached residential maintenance plan, together with a maintenance budget, shall be provided by the initial developer as noted in Section 601.

(M) Demonstrate through accepted engineering practices that stormwater facilities maintain diffuse flow to protected buffers.

(N) Stormwater management plans shall be prepared and sealed by a qualified professional who certifies under seal that the plan, including engineering detail, conforms to the minimum requirements established by this ordinance.

(O) One copy of the approved stormwater management plan shall be kept on file at the job site during construction.

503 Certification of Completion and Compliance

For new construction, prior to the issuance of a certificate of occupancy, a qualified professional shall certify that the constructed BMP is in substantial compliance with the approved construction documents.

ARTICLE 600 - STORMWATER BMP INSPECTION AND MAINTENANCE REQUIREMENTS

601 Maintenance Policy

Unless otherwise approved, ownership of BMPs established pursuant to this Chapter shall remain with the property owner. The property owner shall be responsible for proper maintenance and performance of BMPs.

Whenever a BMP serves more than one (1) lot, will be maintained through a homeowners or property owners association or is for multi-family residential, commercial, industrial, or institutional facility, prior to receiving a stormwater permit, a maintenance plan, shall be received by the City, approved by the City, recorded in the Granville County Register of Deeds by the applicant.

If an association is delegated these responsibilities, then membership into the association shall be mandatory for each parcel served by the device and any successive owner. The association shall have the power to levy assessments for these obligations, and that all unpaid assessments levied by the association shall become a lien on the individual parcel. Maintenance plan, together with a budget, shall be provided by the initial developer. The plan shall indicate what operation and maintenance actions are needed, and what specific quantitative criteria will be used to determine when those actions are to be undertaken. The plan must indicate the steps that will be taken to restore a stormwater system to design specifications if a failure occurs. The budget shall include both annual costs, such as maintenance and taxes, and a sinking fund for structural replacement, periodic sediment removal, major repairs, and reconstruction. These required documents shall be attached to the property association declaration as an exhibit.

The City shall perform inspections of all BMPs at least annually to verify that the property owner or association is following the maintenance agreement approved by the city attorney and Stormwater Administrator. In conducting such inspections, the City shall verbally notify the property owner or association representative of any deficiencies and establish an acceptable time for a follow-up inspection. If the follow-up inspection reveals that maintenance is still required, the City will notify the property owner or association representative in writing and establish a reasonable deadline for the maintenance to be performed.

The property owner or association shall pay a fee for each inspection performed by the City. A list of fees associated with this Section, and approved by the Board of Commissioners, is available at the Finance Department in the Oxford Town Hall. Payment of fees shall be made within thirty (30) days of the date the City performed the inspection. A separate invoice shall be generated for each fee.

602 Maintenance Plan

A written maintenance plan shall be provided prior to receiving a stormwater permit. The agreement shall:

(A) Include a description of the property on which the device is located and all easements from the site to the device;

(B) Include a sketch which identifies the size and configuration of the device;

(C) Include a statement that properties which will be served by the device are granted rights to construct, use, reconstruct, repair, maintain, access to the device;

(D) Include a statement that each lot served by the device is jointly or severally responsible for:

- repairs and maintenance of the device;
- any unpaid ad valorem taxes; and
- public assessments for improvements, and;

(E) Bind the parties thereto and all subsequent owners, successors, and assigns to operation, maintenance and inspection of the system or structure.

(F) Identify and describe the maintenance/monitoring operations required to maintain the proper function of the BMPs. The description of maintenance/monitoring operations shall be specific to each of the BMPs on the site. Such maintenance/monitoring operations may include as appropriate, but are not limited to, the following:

1. Routine maintenance measures such as grass mowing, trash removal, and other general measures.

2. Checking of grass cover and seeding exposed areas.

3. Checking sediment forebay and removal of sediment when 50% of the sediment volume is reached.

4. Checking outlet protection for erosion or debris blockage and performing repairs.

5. Checking outlet structure, removing any debris blockage, or repairing any damage.

6. Checking a BMP after large storm events for structural damage or erosion.

7. Checking underdrain for proper drainage.

8. Checking vegetation required that provide nutrient removal and identifying when vegetation should be harvested, cut, or replanted to maintain a healthy stand.

(G) State the frequency which the property owner shall have the BMP inspected by a qualified professional to certify their safety, maintenance, and continued proper function. Qualified professional shall mean a professional licensed and/or registered in the State of North Carolina performing services only in their area(s) of competence. An inspection report shall be submitted to the Stormwater Administrator on or before January 15th of each year.

(H) Require the establishment of an escrow account which can be spent solely for routine maintenance, sediment removal, structural, biological or vegetative replacement, major repair, or reconstruction of the BMP. Provide construction cost estimate for BMP. Provide escrow account calculations.

(I) Identify the percentage of developer contribution and lengths of time to fund the escrow account, in the event the BMP is, or will subsequently be, owned and maintained by a property owners association, home owners association, or similar entity.

(J) State that if the City directs the correction, repair, replacement, or maintenance of the system or structure in writing and the actions are not satisfactorily performed within a reasonable time (but not greater than one hundred twenty (120) days), the City (or its contractors) may, after reasonable notice, enter the land and perform all the necessary work and may assess the owner(s) of the facility with the cost of the work performed plus reasonable administrative costs, and the City can seize all or part of the escrow set aside by the applicant for perpetual maintenance.

The owner(s) served by the facility shall be jointly responsible to the City for the maintenance of the facility and liable for any costs incurred by the City pursuant to the said agreement. All properties are jointly subject to the imposition of the liens for said costs.

(K) The maintenance plan shall be recorded in the Granville County Register of Deeds at the expense of the applicant.

(L) The BMP maintenance plan shall be a form acceptable to the City.

(M) The BMP maintenance plan shall at least meet the minimum standards of the North Carolina Department of Environment and Natural Resources, Division of Water Quality, Water Quality Section, Stormwater Best Management Practices Manual, 1999, and all amendments thereto. The BMP maintenance plan shall be designed to insure that the BMP continues to function as required to meet the Stormwater Management Requirements include in this Program and the City of Oxford Stormwater Ordinance.

(N) The BMP maintenance plan shall stipulate that parties responsible for the operation and maintenance of a stormwater management facility shall make and keep records of the installation and of all maintenance and repairs, and shall retain the records indefinitely. Whenever the party(ies) responsible for the operation and maintenance of a facility cease

to exist, such records shall be transferred to City. As long as records are maintained privately, they shall be made available to City or its agents during inspection of the facility and at other reasonable times upon request.

(O) An escrow account shall be provided solely for the routine maintenance, repair, restoration, reconstruction, removal, and/or replacement of a required BMP. In the case of multiple BMPs covered by an escrow account, the specifics for each BMP covered by the account shall be included. The agreement shall include the following:

1. The amount of the escrow fund.

2. A statement that if the City issues a notice of violation ordering the correction, repair, replacement, or maintenance of the system or structure and the owner fails to take all necessary actions to remove the violation or initiate an appeal within the time prescribed, the City may have full access to the property to complete any action necessary to correct the violation.

3. A statement that the City may, upon order or other official action of the Board of Commissioners, seize all or part of the escrowed funds to pay for all costs associated with the correction of the violation including administrative costs borne by the City.

4. A statement that all owners of the BMP shall jointly and severally responsible to the City for the proper maintenance and function of the structure, for the required annual maintenance inspection report, for any enforcement action taken by the county, and for any costs incurred by the county to correct a violation not covered by the amount or scope of the escrow account.

(P). Financial Sureties Required.

1. To provide reasonable assurance that BMPs are completed per permit specification, a cash bond, letter of credit or other acceptable financial surety shall be required from the applicant to be help by the City until all constructed BMPs have received final approval by the City unless no other construction or land disturbing activity occurs on the site prior to the approval of the completed BMP(s) by the City.

2. To provide reasonable assurance that BMPs function as permitted and required by this ordinance, a performance bond shall be required from the applicant prior to release of the certificate of occupancy. Such bond shall be held for a minimum of 12 months to insure that the BMP continues proper function through at least one full year of weather.

603 Easements

Easements for stormwater BMPs shall include the area of the BMP, area of ponded water, and enough area for access and maintenance from a public right-of-way. The easement shall be recorded in the Granville County Register of Deeds at the expense of the applicant and shall be depicted on the final plat or recorded map.

ARTICLE 700 - ILLICIT DISCHARGE AND CONNECTIONS

701 Illicit discharges

No person shall cause or allow the discharge, disposal, pouring or pumping directly or indirectly to any stormwater conveyance structure, stormwater conveyance system, stream, lake, pond, wetland or other body of water, or upon the land in proximity to the same, any fluid, solid or other substance (other than stormwater). Prohibited substances include, but are not limited to oil, anti-freeze, chemicals, animal waste, paints, grass clippings, yard waste, garbage, and litter.

Examples of illicit discharges are:

(A) Dumping of oil, anti-freeze, paint or cleaning fluids;
(B) Commercial car wash washwater;
(C) Industrial discharges;
(D) Contaminated foundation drains;
(E) Cooling waters, unless no chemicals added and has valid NPDES permit;
(F) Washwaters from commercial and industrial activities;
(G) Chlorinated backwash and draining associated with swimming pools;
(H) Domestic wastewater;
(I) Septic system effluent;
(J) Washing machine discharges;
(K) Sanitary sewer discharges.

702 Allowable discharges

Allowable discharges into the stormwater system or surface waters within the jurisdiction of or owned by the City of Oxford shall be determined by the Stormwater Administrator. Such allowable discharges shall include but shall not be limited to:

(A) Waterline flushing;
(B) Uncontaminated rising groundwater;
(C) Discharges from potable water sources;
(D) Landscape irrigation water;
(E) Footing drains;
(F) Flows from riparian habitats and wetlands;
(G) Emergency fire fighting activities;

(H) Uncontaminated groundwater infiltration into stormwater collection system;
(I) Foundation drains;
(J) Springs;
(K) Lawn watering;
(L) NPDES permitted stormwater discharges;
(M) Washwater from the cleaning of the exterior of buildings, including gutters, provided that the discharge does not pose an environmental or health threat;
(N) Diverted stream flows;
(O) Uncontaminated pumped groundwater;
(P) Uncontaminated air conditioning condensation;
(Q) Water from crawl space pumps;
(R) Noncommercial car washing;
(S) Street washwater;
(T) Dechlorinated backwash and draining associated with swimming pools.

703 Illicit connections

Connections to a stormwater conveyance system or structure that allow the discharge(s) of non-stormwater are unlawful. Prohibited connections include but are not limited to:

(A) Floor drains;
(B) Wastewater from washing machines or sanitary sewers;
(C) Washwater from commercial vehicle washing or steam cleaning;
(D) Wastewater from septic systems.

704 Determination of connection

Upon notification by the City that said connection exists in violation of Section 703 and said connections were made prior to the adoption of this Chapter 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.

Where it is determined that said connection 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 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 the quantity and complexity of the work; the consequences of delay; the potential harm to the environment, to the public health, and to public and private property; and the cost of remedying the damage.

705 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 Director of Public Works 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.

ARTICLE 800 - VIOLATIONS AND ENFORCEMENT

801 Violations

Whenever, by the provisions of this section, the performance of any act is required, or the performance of any act is prohibited, or whenever any regulation or limitation is imposed on the use of any land, or on the erection, alteration, or the use or change of use of a structure, a failure to comply with such provisions shall constitute a violation of this Ordinance. The owner, tenant, or occupant of any land or structure, or part thereof, and any architect, engineer, builder, contractor, agent, or other person who participates in, assists, directs, creates, or maintains any situation that is contrary to the requirements of this section may be held responsible for the violation and be subject to the penalties and remedies provided herein. Failure to follow an approved stormwater management plan or permit shall constitute a violation of this section and subject the appropriate parties to the penalties and remedies provided herein.

Any of the following shall be a violation of this Ordinance and shall be subject to the enforcement remedies and penalties provided by this Article and by state law.

801.1 Development Without Permit

A “development without a stormwater permit” violation means to engage in any development, use, construction, external remodeling, or other activities of any nature upon the land or improvements thereon subject to the jurisdiction of this Ordinance without required permits, maintenance agreements, or other forms of authorization as set forth in this Ordinance.

801.2 Development Inconsistent With Permit

A “development inconsistent with a stormwater permit” violation means to engage in any development, use, construction, external remodeling, or other activity of any nature in

any way inconsistent with any approved plan, permit, certificate, or other form of authorization granted for such activity.

801.3 Violation by Act or Omission

A "violation by act or omission" means to violate, by act or omission, any term, variance or waiver, condition, or qualification placed by the Stormwater Administrator, Board of Commissioners or its authorized boards, upon any required permit, certificate or other form of authorization for the use, development, or other activity upon land or improvements thereon.

801.4 Use in Violation

A "use in violation" means to erect, construct, reconstruct, alter, repair, convert, maintain or use any building or structure or to use any land in violation or contravention of this Ordinance, or any other regulation made under the authority conferred thereby.

801.5 Continue a Violation

Each day's violation of any provision of this Ordinance is a separate and distinct offense.

802 Authority to enter

Any City personnel, or contractors for the City shall be permitted to enter upon public or private property for the purposes of inspection, sampling, monitoring, testing, or otherwise verifying compliance. Should the City personnel, or contractor for the town, be denied reasonable access to any property, the City Manager or his designee may obtain an administrative search warrant.

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

803 Procedures upon discovery of violations

Procedures upon discovery of violations shall be as follows:

Upon determination that any provision of this section is being violated, the Stormwater Administrator or his designee shall deliver a written notice by first class mail, to the person(s) responsible for such violation, indicating the nature of the violation, ordering the action necessary to correct it, and outlining the timeframe for gaining compliance. Additional written notices may be sent by registered or certified mail, return receipt requested, at the Stormwater Administrator's discretion.

The final written notice may also be the initial notice. The City shall state the enforcement action the City intends to take if the violation is not corrected, and shall advise that the

Stormwater Administrator's order may be appealed to the City of Oxford Board of Commissioners.

In cases when delay would seriously threaten the effective enforcement of this Chapter or pose a danger to the public health, safety or general welfare, the Stormwater Administrator may seek enforcement without prior written notice by invoking any of the penalties or remedies contained herein.

804 Penalties and remedies

Penalties and remedies shall be as described below. Each day that any violation continues after receipt of the final written notice, such violation shall constitute a separate violation and a separate offense for purposes of the penalties and remedies specified herein. In addition to the penalties and remedies below, the City shall institute any appropriate action or proceedings to prevent, restrain, correct, or abate a violation of this Chapter.

(A) Determination of civil penalties. The City Manager or his designee, after consultation with the Stormwater Administrator and City Attorney, shall take into consideration the following factors, as applicable, when determining the amount of the civil penalty:

1. The willfulness of the violation;
2. The degree and extent of harm to the environment, public health, and property;
3. The duration of the violation;
4. The cost of remedying the damage;
5. The violator’s prior record in complying or failing to comply with this Chapter;
6. The amount of money saved by the violator by noncompliance;
7. The costs of enforcement to the public.

(B) Waiver of civil penalties for first time offenders. At the discretion of the City Manager, civil penalties for first time offenders shall be waived provided that the offender demonstrates a good faith effort to correct the violation in a timely manner.

(C) Penalties for development without a stormwater management permit. Development pursuant to this Chapter, that begins land-disturbing activities prior to obtaining a stormwater management permit shall be subject to a one-time one thousand dollar ($1,000.00) penalty.

(D) Penalties for development inconsistent with the stormwater management permit. Any *Development Inconsistent with Permit*, or any *Violation by Act or Omission*, or any *Use in Violation* as described in Section 801, shall subject the violator to a penalty ranging from fifty dollars ($50.00) to five hundred dollars ($500.00).

(E) Penalties for illicit discharges. Any designer, engineer, consultant, contractor or person that allows, acts in concert, participates, directs or assists directly or indirectly in an illegal discharge shall be subject to civil penalties as follows:

1. 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, said person may be assessed a civil penalty ranging from ten dollars ($10.00) to one hundred dollars ($100.00) per violation or day for any continuing violation. If the quantity of the discharge is greater than five (5) gallons or contains non-domestic substances or if the person cannot provide clear and convincing evidence of the volume and nature of the substance discharged, said person may be assessed a civil penalty ranging from one hundred dollars ($100.00) to one thousand dollars ($1,000.00) per violation or per day for continuing violation.

2. 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. If a waiver was given for the previous penalty, the City Manager shall determine the amount of the penalty pursuant to Section 804(A).

(F) Penalties for illicit connections. 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:

1. First time offenders may be subject to a civil penalty ranging from ten dollars ($10.00) to five hundred dollars ($500.00) per day of continuing violation.

2. Repeat violators shall be subject to a civil penalty ranging from one hundred dollars ($100.00) to one thousand dollars ($1,000.00) per day of continuing violation.

(G) 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 first class mail, or 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.

805 Enforcement intent and appeals

It is the intention of this Ordinance, unless otherwise provided, that all questions arising in connection with the enforcement of this Ordinance shall be presented first to the Stormwater Administrator, and that such questions shall be presented to the City of Oxford Board of Commissioners only on appeal from the Stormwater Administrator's decision. The Board of Commissioners shall hold a quasi-judicial hearing and may affirm, increase, reduce or remit the penalty initially assessed by the Stormwater Administrator. An appeal from the decision of the Board of Commissioners shall be by proceedings in the nature of certiorari to the Superior Court as provided by law and must be filed with the Granville County Clerk of Court within thirty (30) days of the Board's decision.

(A) Penalties. An offender shall pay the penalty within ten (10) days of receiving final written notice of violation unless within that period he/she submits to the Stormwater Administrator a written notice of intent to appeal to the Board of Commissioners. The offender must appeal to the Board of Commissioners within thirty (30) days of receiving the final written notice of violation, or at such later time as the parties mutually agree.

(B) Plan and permit denials. The disapproval or modification of any proposed stormwater management plan, or the refusal to issue a stormwater permit by the Stormwater Administrator, or their designee, shall entitle the person submitting the plan, or applying for the permit, to a hearing before the City Engineer if such person submits written demand to the City Engineer for a hearing within fifteen (15) days after receipt of written notice of disapproval or modifications. This appeal shall specify the factual and/or legal grounds underlying their demand and only such specified grounds may be argued at the hearing. Such hearing will be held within twenty-one (21) days after the date of the demand for a hearing, or at such later time as the parties mutually agree. The City Engineer shall provide the applicant with a written decision from the hearing within fifteen (15) days of the date of the hearing. The applicant may appeal the City Engineer's decision to the City Manager within fifteen (15) days of the date of the City Engineer's written decision, or at such later time as the parties mutually agree. The City Manager will provide the applicant with a written decision on the appeal within thirty (30) days, or at his discretion refer the matter to the Board of Commissioners for further consideration.

(C) Appeals

1. The Board of Commissioners shall hear and decide appeals from any order, requirement, decision, or determination made by the City Manager pertaining to this ordinance.

2. An appeal may be taken by any person aggrieved by any order, requirement, decision or determination made by the City Manager. An appeal to the Board of Commissioners shall be made within ten days of the order, requirement, decision, or determination made by City Manager.

3. An appeal, specifying the grounds thereof, shall be filled with the City Manager on a form provided by the City Manager. Once an appeal is filed, the City Manager shall forthwith transmit all papers with reference to the case to the Board of Commissioners.

4. The Board of Commissioners may reverse or affirm, in whole or in part, or may modify the order, requirement, decision, or determination with reference to the appeal.

(D) Variances

1. When practical difficulties or unnecessary hardships would result from carrying out the strict letter of this ordinance, the Board of Commissioners shall have the power to vary or modify any of the regulations or provisions of this ordinance so the spirit of the ordinance shall be observed, public safety and welfare secured, and substantial justice done.

2. Anyone requesting a variance shall file such with the Stormwater Administrator on a form provided by the Stormwater Administrator. Applications shall be filed at least ten days prior to the Board of Commissioners meeting at which it will be heard. After filing, the request shall be heard at the next available Board of Commissioners meeting.

3. The Board of Commissioners, in considering an application for a variance, shall not consider the following as grounds for granting a variance:

   a) The use of land or structures in the county that are not in compliance with the requirements of this ordinance.

   b) The fact that property may be used more profitably.

4. The Board of Commissioners, before granting a variance, shall make all of the following findings:

   a) There are practical difficulties or unnecessary hardships in the way of carrying out the strict letter of the ordinance. This shall be construed to mean:

i. If the property owner complies with the provisions of this ordinance, he can secure no reasonable return from, nor make reasonable use of, his property;

ii. The hardship results from the application of the requirements of this ordinance;

iii. The hardship is suffered by the applicant's property;

iv. The hardship is not the result of the applicant's own actions;

v. The hardship is peculiar to the applicant's property.

b) That the variance is in harmony with the general purpose and intent of the ordinance and preserves its spirit.

c) That in granting of the variance, the public safety and welfare have been assured a substantial justice has been done.

d) That the reasons set forth in the application justify the granting of a variance, and that the variance is the minimum one that will make possible the reasonable use of land or structures.

5. The Board of Commissioners, in granting a variance, may prescribe appropriate conditions and safeguards in conformity with this ordinance. Violation of such conditions and safe guards, when made a part of the terms under which a variance is granted, shall be deemed a violation of this ordinance.

(E) Amendments

1. Authority. The Board of Commissioners shall have the authority to amend the text of this ordinance. However, under no circumstances shall the City amend, supplement or change these regulations so as to cause them to violate 15A NCAC 2B .0258, as adopted and amended by the N.C. Environmental Management Commission.

2. Initiation. Any amendment to the text may be initiated by the Board of Commissioners, the staff, and any citizen or agent thereof upon filing an official petition including a complete application.

3. Application. A petition for amendment to the text of this ordinance shall consist of:

a) A completed application form.

b) A written justification for the requested amendment including consistency of the proposal with the state rule.

c) All appropriate fees.

d) Any other information deemed necessary by the Stormwater Administrator.

4. Hearing. The Board of Commissioners may refuse to call for a public hearing on any petition for amendment to the text for any reason or no reason. Notice of public hearings required under these regulations shall be in accordance with the North Carolina General Statutes. The hearing shall be conducted in accordance with rules and procedures established by the Board of Commissioners.

5. Decision. The Board of Commissions may modify any proposed text amendment upon adoption of an adoption of an ordinance enacting the amendment, without the withdrawal or modification of the petition or further public hearings, when, in the opinion of the board, such a change would not require a separate public hearing.

6. NC DWQ Review and Approval. All text amendments shall be submitted to NC DWQ for formal review and approval. The effective date of any amendment to this ordinance shall not be set earlier than the date such amendment to this ordinance shall not be set earlier than the date such amendment is approved by NC DWQ.

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

15A NCAC 02B .0259 TAR-PAMLICO RIVER BASIN: NUTRIENT SENSITIVE WATERS MANAGEMENT STRATEGY: PROTECTION AND MAINTENANCE OF EXISTING RIPARIAN BUFFERS

The following is the management strategy for maintaining and protecting existing riparian buffers in the Tar-Pamlico River Basin.

(1) PURPOSE. The purpose of this Rule shall be to protect and preserve existing riparian buffers to maintain their nutrient removal functions, in the entire Tar-Pamlico River Basin, whose surface waters are described in the Schedule of Classifications, 15A NCAC 2B .0316.

(2) DEFINITIONS. For the purpose of this Rule, these terms shall be defined as follows:

(a) 'Channel' means a natural water-carrying trough cut vertically into low areas of the land surface by erosive action of concentrated flowing water or a ditch or canal excavated for the flow of water. (current definition in Forest Practice Guidelines Related to Water Quality, 15A NCAC 1I .0102)

(b) 'DBH' means Diameter at Breast Height of a tree, which is measured at 4.5 feet above ground surface level.

(c) 'Ditch or canal' means a man-made channel other than a modified natural stream constructed for drainage purposes that is typically dug through inter-stream divide areas. A ditch or canal may have flows that are perennial, intermittent, or ephemeral and may exhibit hydrological and biological characteristics similar to perennial or intermittent streams.

(d) 'Ephemeral (stormwater) stream' means a feature that carries only stormwater in direct response to precipitation with water flowing only during and shortly after large precipitation events. An ephemeral stream may or may not have a well-defined channel, the aquatic bed is always above the water table, and stormwater runoff is the primary source of water. An ephemeral stream typically lacks the biological, hydrological, and physical characteristics commonly associated with the continuous or intermittent conveyance of water.

(e) 'Forest plantation' means an area of planted trees that may be conifers (pines) or hardwoods. On a plantation, the intended crop trees are planted rather than naturally regenerated from seed on the site, coppice (sprouting), or seed that is blown or carried into the site.

(f) 'High Value Tree' means a tree that meets or exceeds the following standards: for pine species, 14-inch DBH or greater or 18-inch or greater stump diameter; and, for hardwoods and wetland species, 16-inch DBH or greater or 24-inch or greater stump diameter.

(g) 'Intermittent stream' means a well-defined channel that contains water for only part of the year, typically during winter and spring when the aquatic bed is below the water table. The flow may be heavily supplemented by stormwater runoff. An intermittent stream often lacks the biological and hydrological characteristics commonly associated with the conveyance of water.

(h) 'Modified natural stream' means an on-site channelization or relocation of a stream channel and subsequent relocation of the intermittent or perennial flow as evidenced by topographic alterations in the immediate watershed. A modified natural stream must have the typical biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water.

(i) 'Perennial stream' means a well-defined channel that contains water year round during a year of normal rainfall with the aquatic bed located below the water table for most of the year. Groundwater is the primary source of water for a perennial stream, but it also carries stormwater runoff. A perennial stream exhibits the typical biological, hydrological, and physical characteristics commonly associated with the continuous conveyance of water.

(j) 'Perennial waterbody' means a natural or man-made basin that stores surface water permanently at depths sufficient to preclude growth of rooted plants, including lakes, ponds, sounds, non-stream estuaries and ocean. For the purpose of the State's riparian buffer protection program, the waterbody must be part of a natural drainageway (i.e., connected by surface flow to a stream).

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(k) 'Stream' means a body of concentrated flowing water in a natural low area or natural channel on the land surface.

(l) 'Surface waters' means all waters of the state as defined in G.S. 143-212 except underground waters.

(m) 'Tree' means a woody plant with a DBH equal to or exceeding five inches.

(3) APPLICABILITY. This Rule shall apply to 50-foot wide riparian buffers directly adjacent to surface waters in the Tar-Pamlico River Basin (intermittent streams, perennial streams, lakes, ponds, and estuaries), excluding wetlands. Except as described in (4)(a)(iii), wetlands adjacent to surface waters or within 50 feet of surface waters shall be considered as part of the riparian buffer but are regulated pursuant to 15A NCAC 2H .0506. The riparian buffers protected by this Rule shall be measured pursuant to Item (4) of this Paragraph. For the purpose of this Rule, a surface water shall be present if the feature is approximately shown on either the most recent version of the soil survey map prepared by the Natural Resources Conservation Service of the United States Department of Agriculture or the most recent version of the 1:24,000 scale (7.5 minute) quadrangle topographic maps prepared by the United States Geologic Survey (USGS). Riparian buffers adjacent to surface waters that do not appear on either of the maps shall not be subject to this Rule. Riparian buffers adjacent to surface waters that appear on the maps shall be subject to this Rule unless one of the following applies.

(a) EXEMPTION WHEN AN ON-SITE DETERMINATION SHOWS THAT SURFACE WATERS ARE NOT PRESENT. When a landowner or other affected party believes that the maps have inaccurately depicted surface waters, he or she shall consult the Division or the appropriate delegated local authority. Upon request, the Division or delegated local authority shall make on-site determinations. Any disputes over on-site determinations shall be referred to the Director in writing. A determination of the Director as to the accuracy or application of the maps is subject to review as provided in Articles 3 and 4 of G. S. 150B. Surface waters that appear on the maps shall not be subject to this Rule if an on-site determination shows that they fall into one of the following categories.

(i) Ditches and manmade conveyances other than modified natural streams unless constructed for navigation or boat access.

(ii) Manmade ponds and lakes that are located outside natural drainage ways.

(iii) Ephemeral (stormwater) streams.

(b) EXEMPTION WHEN EXISTING USES ARE PRESENT AND ONGOING. This Rule shall not apply to portions of the riparian buffer where a use is existing and ongoing according to the following:

(i) A use shall be considered existing if it was present within the riparian buffer as of January 1, 2000. Existing uses shall include, but not be limited to, agriculture, buildings, industrial facilities, commercial areas, transportation facilities, maintained lawns, utility lines and on-site sanitary sewage systems. Only the portion of the riparian buffer that contains the footprint of the existing use is exempt from this Rule. Activities necessary to maintain uses are allowed provided that no additional vegetation is removed from Zone 1, except that grazed or trampled by livestock, and existing diffuse flow is maintained. Grading and revegetating Zone 2 is allowed provided that the health of the vegetation in Zone 1 is not compromised, the ground is stabilized and existing diffuse flow is maintained.

(ii) At the time an existing use is proposed to be converted to another use, this Rule shall apply. An existing use shall be considered to be converted to another use if any of the following applies:

(A) Impervious surface is added to the riparian buffer in locations where it did not exist previously.

(B) An agricultural operation within the riparian buffer is converted to a non-agricultural use.

(C) A lawn within the riparian buffer ceases to be maintained.

(4) ZONES OF THE RIPARIAN BUFFER. The protected riparian buffer shall have two zones as follows:

(a) Zone 1 shall consist of a vegetated area that is undisturbed except for uses provided for in Item (6) of this Paragraph. The location of Zone 1 shall be as follows:

(i) For intermittent and perennial streams, Zone 1 shall begin at the most landward limit of the top of bank or the rooted herbaceous vegetation and extend landward a distance of 30 feet on all sides of the surface water, measured horizontally on a line perpendicular to the surface water.

(ii) For ponds, lakes and reservoirs located within a natural drainage way, Zone 1 shall begin at the most landward limit of the normal water level or the rooted herbaceous vegetation and extend landward a distance of 30 feet, measured horizontally on a line perpendicular to the surface water.

(iii) For surface waters within the 20 Coastal Counties (defined in 15A NCAC 2B .0202) within the jurisdiction of the Division of Coastal Management, Zone 1 shall begin at the most landward limit of:

(a) the normal high water level;

(b) the normal water level; or

(c) the landward limit of coastal wetlands as defined by the Division of Coastal Management;

and extend landward a distance of 30 feet, measured horizontally on a line perpendicular to the surface water, whichever is more restrictive.

(b) Zone 2 shall consist of a stable, vegetated area that is undisturbed except for activities and uses provided for in Item (6) of this Paragraph. Grading and revegetating Zone 2 is allowed provided that the health of the vegetation in Zone 1 is not compromised. Zone 2 shall begin at the outer edge of Zone 1 and extend landward 20 feet as measured horizontally on a line perpendicular to the surface water. The combined width of Zones 1 and 2 shall be 50 feet on all sides of the surface water.

(5) DIFFUSE FLOW REQUIREMENT. Diffuse flow of runoff shall be maintained in the riparian buffer by dispersing concentrated flow and reestablishing vegetation.

(a) Concentrated runoff from new ditches or manmade conveyances shall be converted to diffuse flow before the runoff enters Zone 2 of the riparian buffer.

(b) Periodic corrective action to restore diffuse flow shall be taken if necessary to impede the formation of erosion gullies.

(6) TABLE OF USES. The following chart sets out the uses and their designation under this Rule as exempt, allowable, allowable with mitigation, or prohibited. The requirements for each category are given in Item (7) of this Paragraph.

	Exempt	Allowable	Allowable with Mitigation	Prohibited
Airport facilities: • Airport facilities that impact equal to or less than 150 linear feet or one-third of an acre of riparian buffer • Airport facilities that impact greater than 150 linear feet or one-third of an acre of riparian buffer		X	X	
Archaeological activities	X			
Bridges		X		
Dam maintenance activities	X			

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	Exempt	Allowable	Allowable with Mitigation	Prohibited
Drainage ditches, roadside ditches and stormwater outfalls through riparian buffers:				
• Existing drainage ditches, roadside ditches, and stormwater outfalls provided that they are managed to minimize the sediment, nutrients and other pollution that convey to waterbodies	X			
• New drainage ditches, roadside ditches and stormwater outfalls provided that a stormwater management facility is installed to control nitrogen and attenuate flow before the conveyance discharges through the riparian buffer		X		
• New drainage ditches, roadside ditches and stormwater outfalls that do not provide control for nitrogen before discharging through the riparian buffer				X
• Excavation of the streambed in order to bring it to the same elevation as the invert of a ditch				X
Drainage of a pond in a natural drainage way provided that a new riparian buffer that meets the requirements of Items (4) and (5) is established adjacent to the new channel	X			
Driveway crossings of streams and other surface waters subject to this Rule:				
• Driveway crossings on single family residential lots that disturb equal to or less than 25 linear feet or 2,500 square feet of riparian buffer	X			
• Driveway crossings on single family residential lots that disturb greater than 25 linear feet or 2,500 square feet of riparian buffer		X		
• In a subdivision that cumulatively disturb equal to or less than 150 linear feet or one-third of an acre of riparian buffer		X		
• In a subdivision that cumulatively disturb greater than 150 linear feet or one-third of an acre of riparian buffer			X	
Fences provided that disturbance is minimized and installation does not result in removal of forest vegetation	X			
Forest harvesting - see Item (11) of this Rule				
Fertilizer application:				
• One-time fertilizer application to establish replanted vegetation	X			
• Ongoing fertilizer application				X
Grading and revegetation in Zone 2 only provided that diffuse flow and the health of existing vegetation in Zone 1 is not compromised and disturbed areas are stabilized	X			
Greenway / hiking trails		X		
Historic preservation	X			
Landfills as defined by G.S 130A-290.				X

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	Exempt	Allowable	Allowable with Mitigation	Prohibited
Mining activities:				
• Mining activities that are covered by the Mining Act provided that new riparian buffers that meet the requirements of Items (4) and (5) are established adjacent to the relocated channels		X		
• Mining activities that are not covered by the Mining Act OR where new riparian buffers that meet the requirements or Items (4) and (5) are not established adjacent to the relocated channels			X	
• Wastewater or mining dewatering wells with approved NPDES permit	X			
Non-electric utility lines:				
• Impacts other than perpendicular crossings in Zone 2 only[3]		X		
• Impacts other than perpendicular crossings in Zone 1[3]			X	
Non-electric utility line perpendicular crossings of streams and other surface waters subject to this Rule[3]:				
• Perpendicular crossings that disturb equal to or less than 40 linear feet of riparian buffer with a maintenance corridor equal to or less than 10 feet in width	X			
• Perpendicular crossings that disturb equal to or less than 40 linear feet of riparian buffer with a maintenance corridor greater than 10 feet in width		X		
• Perpendicular crossings that disturb greater than 40 linear feet but equal to or less than 150 linear feet of riparian buffer with a maintenance corridor equal to or less than 10 feet in width		X		
• Perpendicular crossings that disturb greater than 40 linear feet but equal to or less than 150 linear feet of riparian buffer with a maintenance corridor greater than 10 feet in width			X	
• Perpendicular crossings that disturb greater than 150 linear feet of riparian buffer			X	
On-site sanitary sewage systems - new ones that use ground absorption				X
Overhead electric utility lines:				
• Impacts other than perpendicular crossings in Zone 2 only[3]	X			
• Impacts other than perpendicular crossings in Zone 1 [1,2,3]	X			

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	Exempt	Allowable	Allowable with Mitigation	Prohibited
Overhead electric utility line perpendicular crossings of streams and other surface waters subject to this Rule[3]: • Perpendicular crossings that disturb equal to or less than 150 linear feet of riparian buffer[1] • Perpendicular crossings that disturb greater than 150 linear feet of riparian buffer [1, 2]	X	X		
Periodic maintenance of modified natural streams such as canals and a grassed travelway on one side of the surface water when alternative forms of maintenance access are not practical		X		
Playground equipment: • Playground equipment on single family lots provided that installation and use does not result in removal of vegetation • Playground equipment installed on lands other than single-family lots or that requires removal of vegetation	X	X		
Ponds in natural drainage ways, excluding dry ponds: • New ponds provided that a riparian buffer that meets the requirements of Items (4) and (5) is established adjacent to the pond • New ponds where a riparian buffer that meets the requirements of Items (4) and (5) is NOT established adjacent to the pond		X	X	
Protection of existing structures, facilities and streambanks when this requires additional disturbance of the riparian buffer or the stream channel		X		
Railroad impacts other than crossings of streams and other surface waters subject to this Rule.			X	
Railroad crossings of streams and other surface waters subject to this Rule: • Railroad crossings that impact equal to or less than 40 linear feet of riparian buffer • Railroad crossings that impact greater than 40 linear feet but equal to or less than 150 linear feet or one-third of an acre of riparian buffer • Railroad crossings that impact greater than 150 linear feet or one-third of an acre of riparian buffer	X	X	X	
Removal of previous fill or debris provided that diffuse flow is maintained and any vegetation removed is restored	X			
Road impacts other than crossings of streams and other surface waters subject to this Rule			X	

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	Exempt	Allowable	Allowable with Mitigation	Prohibited
Road crossings of streams and other surface waters subject to this Rule:				
• Road crossings that impact equal to or less than 40 linear feet of riparian buffer	X			
• Road crossings that impact greater than 40 linear feet but equal to or less than 150 linear feet or one-third of an acre of riparian buffer		X		
• Road crossings that impact greater than 150 linear feet or one-third of an acre of riparian buffer			X	
Scientific studies and stream gauging	X			
Stormwater management ponds excluding dry ponds:				
• New stormwater management ponds provided that a riparian buffer that meets the requirements of Items (4) and (5) is established adjacent to the pond		X		
• New stormwater management ponds where a riparian buffer that meets the requirements of Items (4) and (5) is NOT established adjacent to the pond			X	
Stream restoration	X			
Streambank stabilization		X		
Temporary roads:				
• Temporary roads that disturb less than or equal to 2,500 square feet provided that vegetation is restored within six months of initial disturbance	X			
• Temporary roads that disturb greater than 2,500 square feet provided that vegetation is restored within six months of initial disturbance		X		
• Temporary roads used for bridge construction or replacement provided that restoration activities, such as soil stabilization and revegetation, occur immediately after construction		X		
Temporary sediment and erosion control devices:				
• In Zone 2 only provided that the vegetation in Zone 1 is not compromised and that discharge is released as diffuse flow in accordance with Item (5)	X			
• In Zones 1 and 2 to control impacts associated with uses approved by the Division or that have received a variance provided that sediment and erosion control for upland areas is addressed to the maximum extent practical outside the buffer		X		
• In-stream temporary erosion and sediment control measures for work within a stream channel	X			
Underground electric utility lines:				
• Impacts other than perpendicular crossings in Zone 2 only	X			
• Impacts other than perpendicular crossings in Zone 1[4]	X			

	Exempt	Allowable	Allowable with Mitigation	Prohibited
Underground electric utility line perpendicular crossings of streams and other surface waters subject to this Rule:				
• Perpendicular crossings that disturb less than or equal to 40 linear feet of riparian buffer[3, 4]	X			
• Perpendicular crossings that disturb greater than 40 linear feet of riparian buffer[3, 4]		X		
Vegetation management:				
• Emergency fire control measures provided that topography is restored	X			
• Periodic mowing and harvesting of plant products in Zone 2 only	X			
• Planting vegetation to enhance the riparian buffer	X			
• Pruning forest vegetation provided that the health and function of the forest vegetation is not compromised	X			
• Removal of individual trees which are in danger of causing damage to dwellings, other structures or human life	X			
• Removal of poison ivy	X			
• Removal of understory nuisance vegetation as defined in: Smith, Cherri L. 1998. Exotic Plant Guidelines. Dept. of Environment and Natural Resources. Division of Parks and Recreation. Raleigh, NC. Guideline #30	X			
Water dependent structures as defined in 15A NCAC 2B .0202		X		
Water supply reservoirs:				
• New reservoirs provided that a riparian buffer that meets the requirements of Items (4) and (5) is established adjacent to the reservoir		X		
• New reservoirs where a riparian buffer that meets the requirements of Items (4) and (5) is NOT established adjacent to the reservoir			X	
Water wells	X			
Wetland restoration	X			

[1] Provided that, in Zone 1, all of the following BMPs for overhead utility lines are used. If all of these BMPs are not used, then the overhead utility lines shall require a no practical alternative evaluation by the Division.

- A minimum zone of 10 feet wide immediately adjacent to the water body shall be managed such that only vegetation that poses a hazard or has the potential to grow tall enough to interfere with the line is removed.
- Woody vegetation shall be cleared by hand. No land grubbing or grading is allowed.
- Vegetative root systems shall be left intact to maintain the integrity of the soil. Stumps shall remain where trees are cut.
- Riprap shall not be used unless it is necessary to stabilize a tower.
- No fertilizer shall be used other than a one-time application to re-establish vegetation.
- Construction activities shall minimize the removal of woody vegetation, the extent of the disturbed area, and the time in which areas remain in a disturbed state.
- Active measures shall be taken after construction and during routine maintenance to ensure diffuse flow of stormwater through the buffer.
- In wetlands, mats shall be utilized to minimize soil disturbance.

[2] Provided that poles or towers shall not be installed within 10 feet of a water body unless the Division completes a no practical alternative evaluation.

[3] Perpendicular crossings are those that intersect the surface water at an angle between 75° and 105°.

[4] Provided that, in Zone 1, all of the following BMPs for underground utility lines are used. If all of these BMPs are not used, then the underground utility line shall require a no practical alternative evaluation by the Division.

- Woody vegetation shall be cleared by hand. No land grubbing or grading is allowed.
- Vegetative root systems shall be left intact to maintain the integrity of the soil. Stumps shall remain, except in the trench, where trees are cut.
- Underground cables shall be installed by vibratory plow or trenching.
- The trench shall be backfilled with the excavated soil material immediately following cable installation.
- No fertilizer shall be used other than a one-time application to re-establish vegetation.
- Construction activities shall minimize the removal of woody vegetation, the extent of the disturbed area, and the time in which areas remain in a disturbed state.
- Active measures shall be taken after construction and during routine maintenance to ensure diffuse flow of stormwater through the buffer.
- In wetlands, mats shall be utilized to minimize soil disturbance.

(7) REQUIREMENTS FOR CATEGORIES OF USES. Uses designated as exempt, allowable, allowable with mitigation and prohibited in Item (6) of this Paragraph shall have the following requirements:

(a) EXEMPT. Uses designated as exempt are allowed within the riparian buffer. Exempt uses shall be designed, constructed and maintained to minimize soil disturbance and to provide the maximum water quality protection practicable. In addition, exempt uses shall meet requirements listed in Item (6) of this Paragraph for the specific use.

(b) ALLOWABLE. Uses designated as allowable may proceed within the riparian buffer provided that there are no practical alternatives to the requested use pursuant to Item (8) of this Paragraph. These uses require written authorization from the Division or the delegated local authority.

(c) ALLOWABLE WITH MITIGATION. Uses designated as allowable with mitigation may proceed within the riparian buffer provided that there are no practical alternatives to the requested use pursuant to Item (8) of this Paragraph and an appropriate mitigation strategy has been approved pursuant to Item (10) of this Paragraph. These uses require written authorization from the Division or the delegated local authority.

(d) PROHIBITED. Uses designated as prohibited may not proceed within the riparian buffer unless a variance is granted pursuant to Item (9) of this Paragraph. Mitigation may be required as one condition of a variance approval.

(8) DETERMINATION OF "NO PRACTICAL ALTERNATIVES." Persons who wish to undertake uses designated as allowable or allowable with mitigation shall submit a request for a "no practical alternatives" determination to the Division or to the delegated local authority. The applicant shall certify that the criteria identified in Sub-Item (8)(a) of this Paragraph are met. The Division or the delegated local authority shall grant an Authorization Certificate upon a "no practical alternatives" determination. The procedure for making an Authorization Certificate shall be as follows:

(a) For any request for an Authorization Certificate, the Division or the delegated local authority shall review the entire project and make a finding of fact as to whether the following requirements have been met in support of a "no practical alternatives" determination:

(i) The basic project purpose cannot be practically accomplished in a manner that would better minimize disturbance, preserve aquatic life and habitat, and protect water quality.

(ii) The use cannot practically be reduced in size or density, reconfigured or redesigned to better minimize disturbance, preserve aquatic life and habitat, and protect water quality.

(iii) Best management practices shall be used if necessary to minimize disturbance, preserve aquatic life and habitat, and protect water quality.

(b) Requests for an Authorization Certificate shall be reviewed and either approved or denied within 60 days of receipt of a complete submission based on the criteria in Sub-Item (8)(a) of this Paragraph by either the Division or the delegated local authority. Failure to issue an approval or denial within 60 days shall constitute that the applicant has demonstrated "no practical alternatives." The Division or the delegated local authority may attach conditions to the Authorization Certificate that support the purpose, spirit and intent of the riparian buffer protection program. Complete submissions shall include the following:

(i) The name, address and phone number of the applicant;

(ii) The nature of the activity to be conducted by the applicant;

(iii) The location of the activity, including the jurisdiction;

(iv) A map of sufficient detail to accurately delineate the boundaries of the land to be utilized in carrying out the activity, the location and dimensions of any disturbance in riparian buffers associated with the activity, and the extent of riparian buffers on the land;

(v) An explanation of why this plan for the activity cannot be practically accomplished, reduced or reconfigured to better minimize disturbance to the riparian buffer, preserve aquatic life and habitat and protect water quality; and

(vi) Plans for any best management practices proposed to be used to control the impacts associated with the activity.

(c) Any disputes over determinations regarding Authorization Certificates shall be referred to the Director for a decision. The Director's decision is subject to review as provided in Articles 3 and 4 of G. S. 150B.

(9) VARIANCES. Persons who wish to undertake uses designated as prohibited may pursue a variance. The Division or the appropriate delegated local authority may grant minor variances. The variance request procedure shall be as follows:

(a) For any variance request, the Division or the delegated local authority shall make a finding of fact as to whether the following requirements have been met:

(i) There are practical difficulties or unnecessary hardships that prevent compliance with the strict letter of the riparian buffer protection requirements. Practical difficulties or unnecessary hardships shall be evaluated in accordance with the following:

(A) If the applicant complies with the provisions of this Rule, he/she can secure no reasonable return from, nor make reasonable use of, his/her property. Merely proving that the variance would permit a greater profit from the property shall not be considered adequate justification for a variance. Moreover, the Division or delegated local authority shall consider whether the variance is the minimum possible deviation from the terms of this Rule that shall make reasonable use of the property possible.

(B) The hardship results from application of this Rule to the property rather than from other factors such as deed restrictions or other hardship.

(C) The hardship is due to the physical nature of the applicant's property, such as its size, shape, or topography, which is different from that of neighboring property.

(D) The applicant did not cause the hardship by knowingly or unknowingly violating this Rule.

(E) The applicant did not purchase the property after the effective date of this Rule, and then request an appeal.

(F) The hardship is unique to the applicant's property, rather than the result of conditions that are widespread. If other properties are equally subject to the hardship created in the restriction, then granting a variance would be a special privilege denied to others, and would not promote equal justice.

(ii) The variance is in harmony with the general purpose and intent of the State's riparian buffer protection requirements and preserves its spirit; and

(iii) In granting the variance, the public safety and welfare have been assured, water quality has been protected, and substantial justice has been done.

(b) MINOR VARIANCES. A minor variance request pertains to activities that are proposed only to impact any portion of Zone 2 of the riparian buffer. Minor variance requests shall be reviewed and approved based on the criteria in Sub-Item (9)(a) of this Paragraph by the either the Division or the delegated local authority pursuant to G.S. 153A-Article 18, or G.S. 160A-Article 19. The Division or the delegated local authority may attach conditions to the variance approval that support the purpose, spirit and intent of the riparian buffer protection program. Requests for appeals of decisions made by the Division shall be made to the Office of Administrative Hearings. Request for appeals made by the delegated local authority shall be made to the appropriate Board of Adjustment under G.S. 160A-388 or G.S. 153A-345.

(c) MAJOR VARIANCES. A major variance request pertains to activities that are proposed to impact any portion of Zone 1 or any portion of both Zones 1 and 2 of the riparian buffer. If the Division or the delegated local authority has determined that a major variance request meets the requirements in Sub-Item (9)(a) of this Paragraph, then it shall prepare a preliminary finding and submit it to the Commission. Preliminary findings on major variance requests shall be reviewed by the Commission within 90 days after receipt by the Director. Requests for appeals of determinations that the requirements of Sub-Item (9)(a) of this Paragraph have not been met shall be made to the Office of Administrative Hearings for determinations made by the Division or the appropriate Board of Adjustments under G.S. 160A-388 or G.S. 153A-345 for determinations made by the delegated local authority. The purpose of the Commission's review is to determine if it agrees that the requirements in Sub-Item (9)(a) of this Paragraph have been met. Requests for appeals of decisions made by the Commission shall be made to the Office of Administrative Hearings. The following actions shall be taken depending on the Commission's decision on the major variance request:

(i) Upon the Commission's approval, the Division or the delegated local authority shall issue a final decision granting the major variance.

(ii) Upon the Commission's approval with conditions or stipulations, the Division or the delegated local authority shall issue a final decision, which includes these conditions or stipulations.

(iii) Upon the Commission's denial, the Division or the delegated local authority shall issue a final decision denying the major variance.

(10) MITIGATION. Persons who wish to undertake uses designated as allowable with mitigation shall meet the following requirements in order to proceed with their proposed use.

(a) Obtain a determination of "no practical alternatives" to the proposed use pursuant to Item (8) of this Paragraph.

(b) Obtain approval for a mitigation proposal pursuant to 15A NCAC 2B .0260.

(11) REQUIREMENTS SPECIFIC TO FOREST HARVESTING. The following requirements shall apply for forest harvesting operations and practices.

(a) The following measures shall apply in the entire riparian buffer:

(i) Logging decks and sawmill sites shall not be placed in the riparian buffer.

(ii) Access roads and skid trails shall be prohibited except for temporary and permanent stream crossings established in accordance with 15A NCAC 1I .0203. Temporary stream crossings shall be permanently stabilized after any site disturbing activity is completed.

(iii) Timber felling shall be directed away from the stream or water body.

(iv) Skidding shall be directed away from the stream or water body and shall be done in a manner that minimizes soil disturbance and prevents the creation of channels or ruts.

(v) Individual trees may be treated to maintain or improve their health, form or vigor.

(vi) Harvesting of dead or infected trees or application of pesticides necessary to prevent or control extensive tree pest and disease infestation shall be allowed. These

practices must be approved by the Division of Forest Resources for a specific site. The Division of Forest Resources must notify the Division of all approvals.

(vii) Removal of individual trees that are in danger of causing damage to structures or human life shall be allowed.

(viii) Natural regeneration of forest vegetation and planting of trees, shrubs, or ground cover plants to enhance the riparian buffer shall be allowed provided that soil disturbance is minimized. Plantings shall consist primarily of native species.

(ix) High intensity prescribed burns shall not be allowed.

(x) Application of fertilizer shall not be allowed except as necessary for permanent stabilization. Broadcast application of fertilizer or herbicides to the adjacent forest stand shall be conducted so that the chemicals are not applied directly to or allowed to drift into the riparian buffer.

(b) In Zone 1, forest vegetation shall be protected and maintained. Selective harvest as provided for below is allowed on forest lands that have a deferment for use value under forestry in accordance with G.S. 105-277.2 through 277.6 or on forest lands that have a forest management plan prepared or approved by a registered professional forester. Copies of either the approval of the deferment for use value under forestry or the forest management plan shall be produced upon request. For such forest lands, selective harvest is allowed in accordance with the following:

(i) Tracked or wheeled vehicles are not permitted except at stream crossings designed, constructed and maintained in accordance with 15A NCAC 1I .0203.

(ii) Soil disturbing site preparation activities are not allowed.

(iii) Trees shall be removed with the minimum disturbance to the soil and residual vegetation.

(iv) The following provisions for selective harvesting shall be met:

(A) The first 10 feet of Zone 1 directly adjacent to the stream or waterbody shall be undisturbed except for the removal of individual high value trees as defined provided that no trees with exposed primary roots visible in the streambank be cut.

(B) In the outer 20 feet of Zone 1, a maximum of 50 percent of the trees greater than five inches dbh may be cut and removed. The reentry time for harvest shall be no more frequent than every 15 years, except on forest plantations where the reentry time shall be no more frequent than every five years. In either case, the trees remaining after harvest shall be as evenly spaced as possible.

(C) In Zone 2, harvesting and regeneration of the forest stand shall be allowed provided that sufficient ground cover is maintained to provide for diffusion and infiltration of surface runoff.

(12) REQUIREMENTS SPECIFIC TO LOCAL GOVERNMENTS WITH STORMWATER PROGRAMS FOR NITROGEN CONTROL. Local governments in the Tar-Pamlico River Basin that are required to have local stormwater programs to control nitrogen loading shall have two options for ensuring protection of riparian buffers on new developments within their jurisdictions as follows.

(a) Obtain authority to implement a local riparian buffer protection program pursuant to 15A NCAC 2B .0261.

(b) Refrain from issuing local approvals for new development projects unless either:

(i) The person requesting the approval does not propose to impact the riparian buffer of a surface water that appears on either the most recent versions of the soil survey maps prepared by the Natural Resources Conservation Service of the United States Department of Agriculture or the most recent versions of the 1:24,000 scale (7.5 minute quadrangle) topographic maps prepared by the United States Geologic Survey (USGS).

(ii) The person requesting the approval proposes to impact the riparian buffer of a surface water that appears on the maps described in Sub-Item (12)(b)(i) of this Paragraph and either:

(A) Has received an on-site determination from the Division pursuant to Sub-Item (3)(a) of this Paragraph that surface waters are not present;

(B) Has received an Authorization Certificate from the Division pursuant to Item (8) of this Paragraph for uses designated as Allowable under this Rule;

(C) Has received an Authorization Certificate from the Division pursuant to Item (8) of this Paragraph and obtained the Division's approval on a mitigation plan pursuant to Item (10) of this Paragraph for uses designated as Allowable with Mitigation under this Rule; or

(D) Has received a variance from the Commission pursuant to Item (9) of this Paragraph.

(13) OTHER LAWS, REGULATIONS AND PERMITS. In all cases, compliance with this Rule does not preclude the requirement to comply with all federal, state and local regulations and laws.

History Note: *Authority 143-214.1; 143-214.7; 143-215.3(a)(1); 143-215.6A; 143-215.6B; 143-215.6C; 143B-282(d); S.L. 1999-329, s. 7.1.*
Temporary Adoption Eff. January 1, 2000.
Eff. August 1, 2000.

APPENDIX D

North Carolina
Department of Environment and Natural Resources
Division of Water Quality
Nonpoint Source Management Program

Riparian Buffer Protection Rules for the Neuse and Tar-Pamlico River Basins

On Dec. 9, 1999, the North Carolina Environmental Management Commission adopted rules to protect 50-foot wide riparian, or waterside, buffers along waterways in the Neuse and Tar-Pamlico River Basins. These buffers remove nitrogen, phosphorus, and other pollutants from rainwater that flows into the basins' waterways, protecting the waterways from surrounding land uses. The rules are part of larger nutrient reduction strategies for each basin. In the **Neuse River basin,** the rules have been effective as temporary rules since **July 22, 1997**. In the **Tar-Pamlico basin**, temporary rules took effect on **Jan. 1, 2000**.

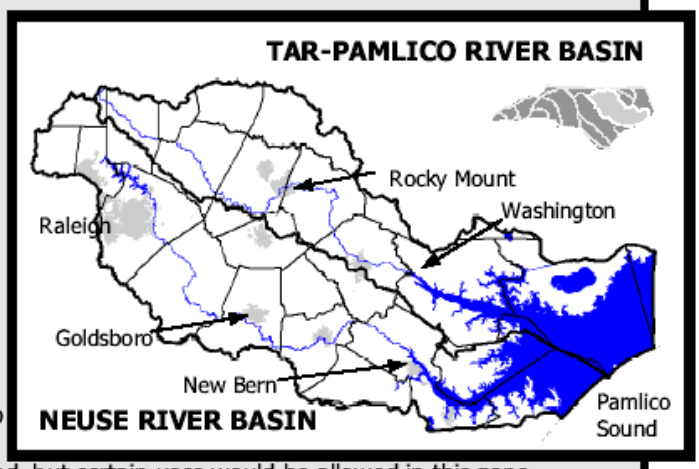
In both basins, the rules will be effective as permanent rules on Aug. 1, 2000, pending review by the General Assembly during the summer.

The main rule, referred to as the buffer *protection* rule, requires that up to 50 feet of riparian area be protected and maintained on the banks of waterways in the basin. **This rule does not require establishment of new buffers unless the existing use of the buffer changes.** Diffuse flow of stormwater that runs into the buffer must be maintained.

Here are some frequently asked questions followed by answers that further explain the rules.

Q: What waters in the basins require buffers?
A: Intermittent and perennial streams, lakes, ponds and estuarine waters that are shown on the most recent version of either a county soil survey map prepared by the Natural Resources Conservation Service or a 1:24,000 scale topographic map prepared by the U.S. Geologic Survey, and that exist on the ground.

Q: Are there any waters that don't have to be buffered?
A: Yes. The rule does not apply to the following waters: ditches and manmade conveyances other than modified natural streams unless they are constructed for navigation and/or boat access; manmade ponds and lakes located outside natural drainageways; and ephemeral (stormwater) streams.



Q: What does it mean to protect the buffer?
A: The first 30 feet (zone 1) of the buffer is to remain essentially undisturbed. The landward 20 feet (zone 2) is to be vegetated, but certain uses would be allowed in this zone.

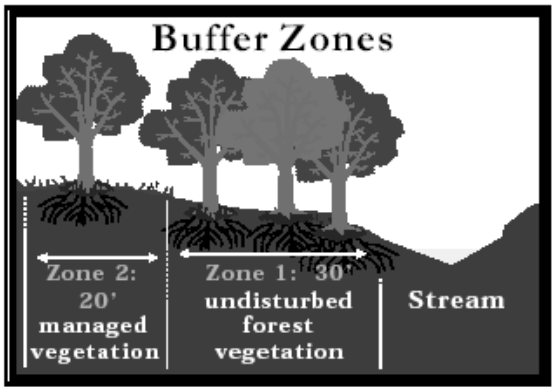
Q: Are existing activities within 50 feet of waterways exempt from the rules?
A: Yes. The footprint of existing, ongoing uses is exempt. These uses include, but are not limited to: agriculture; buildings; industrial, commercial, and transportation facilities; maintained lawns; utility lines; and on-site wastewater systems.

Q: What activities are allowed in the buffer?

A: The rule includes a table of uses. In it, specific activities are listed as *exempt*, *allowable*, *allowable with mitigation*, or *prohibited*. *Exempt* activities require no prior approval. *Allowable* and *allowable with mitigation* mean that approval must be obtained from the Division of Water Quality beforehand. The approval process will require a showing of no practical alternatives to the impact, and that the impact will be minimized. If it is *allowable with mitigation*, a greater amount of buffer must be established elsewhere to offset impacts. A separate buffer **mitigation rule** establishes requirements for activities that are *allowable with mitigation*. *Prohibited* activities are not allowed, however, a variance may be sought if one thinks that complying with the rule will cause practical difficulties or unnecessary hardships. If an activity is not listed in the table, then it is prohibited.

Q: What are some common activities listed in the table of uses?

A: The following are brief explanations of only some activities listed in the table - you will want to read and understand the rule before you begin any activity in a buffer:



- Driveway crossings on single-family residential lots that disturb less than 25 feet along the buffer are *exempt*.
- Maintenance of existing ditches through the buffer is *exempt* provided that water quality impacts are minimized.
- Grading and revegetation in zone 2 only is *exempt* if disturbed areas are stabilized, the health of vegetation in zone 1 is not compromised, and diffuse flow is reestablished.
- Road intrusions into the buffer are *allowable with mitigation*.
- Road crossings of a waterbody that impact less than 40 feet of the buffer are *exempt*. Wider crossings that are less than 150 feet wide are *allowable*, and those over 150 feet wide are *allowable with mitigation*.
- New ponds in drainageways are *allowable* if a 50-foot buffer is established around the new ponds, or *allowable with mitigation* if a new buffer is not established.
- Fertilizer application is *prohibited*, except for one-time application to establish replanted vegetation.
- Some management of vegetation is *exempt*, such as periodic mowing and harvesting of plant products in zone 2 only, planting to enhance the buffer, pruning provided that the health and function of the vegetation is not compromised, removal of understory nuisance vegetation as defined in the rule, and removal of individual trees that endanger structures or human life.
- Water dependent structures as defined in the rules are *allowable*.
- Utilities vary from *exempt* to *allowable with mitigation*, depending on type, size, and location.

The public is encouraged to read and understand the buffer rules before beginning any activities within buffers in the Basin. For more information or to obtain a copy of the rules, please contact Division of Water Quality staff at a Regional Office (see below). The rules can also be viewed or downloaded from the DWQ web site at http://h2o.enr.state.nc.us/nps/tarp.htm.

DENR Washington Regional Office (252) 946-6481
Location and mail address: 943 Washington Square Mall, Washington, NC 27889

DENR Raleigh Regional Office (919) 571-4700
Location: 3800 Barrett Drive, Suite 101, Raleigh, NC
Mail address: 1628 Mail Service Center, Raleigh, NC 27699-1628

NCDENR

DIVISION OF WATER QUALITY DWQ

APPENDIX E

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.

$$N \equiv N$$

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 E.1 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.

Losses of Nitrogen

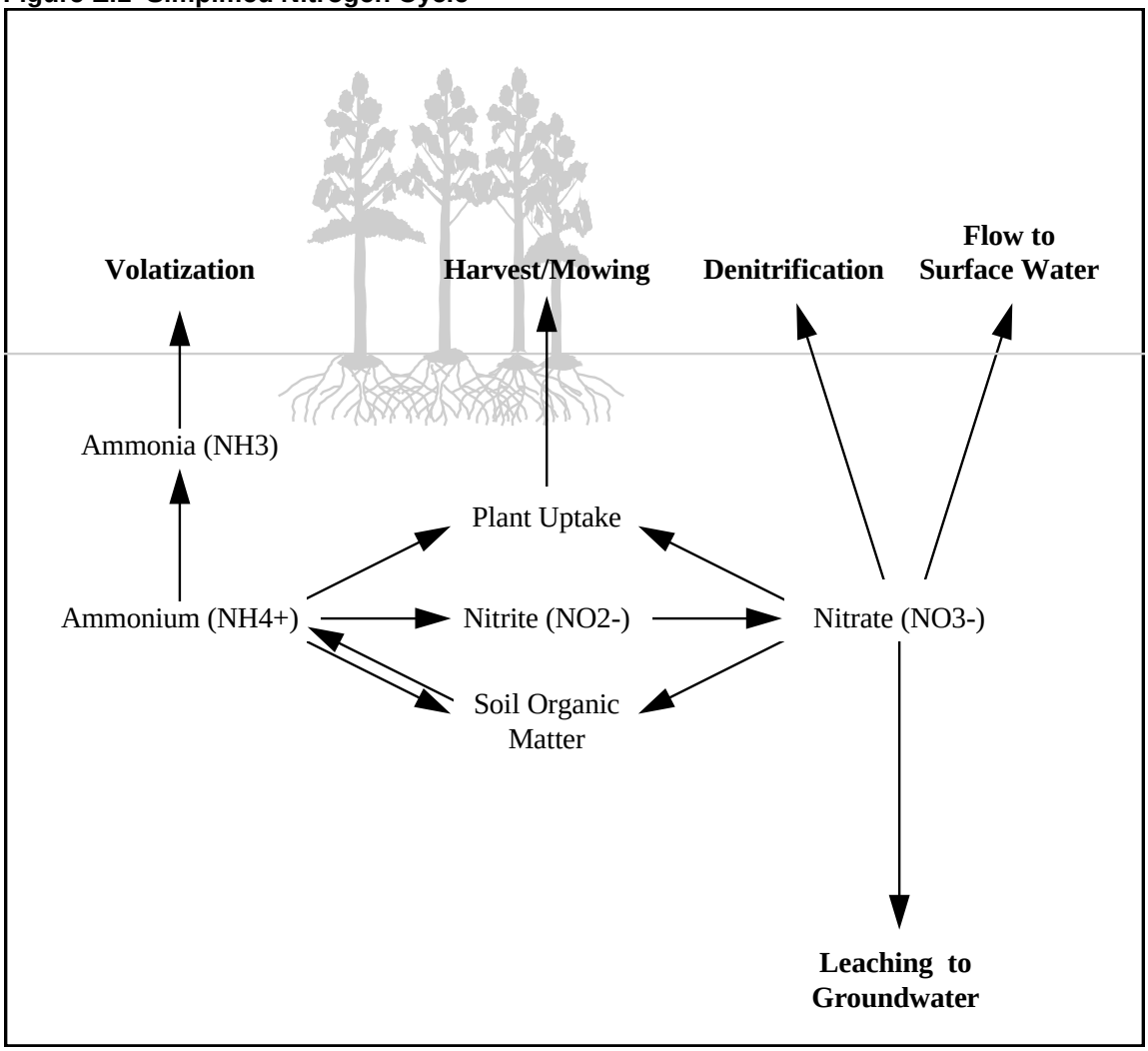
Nitrogen can be easily lost into the environment by various pathways. Those pathways include volatilization, leaching and runoff, and crop removal.

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 E.1 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.

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APPENDIX F

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

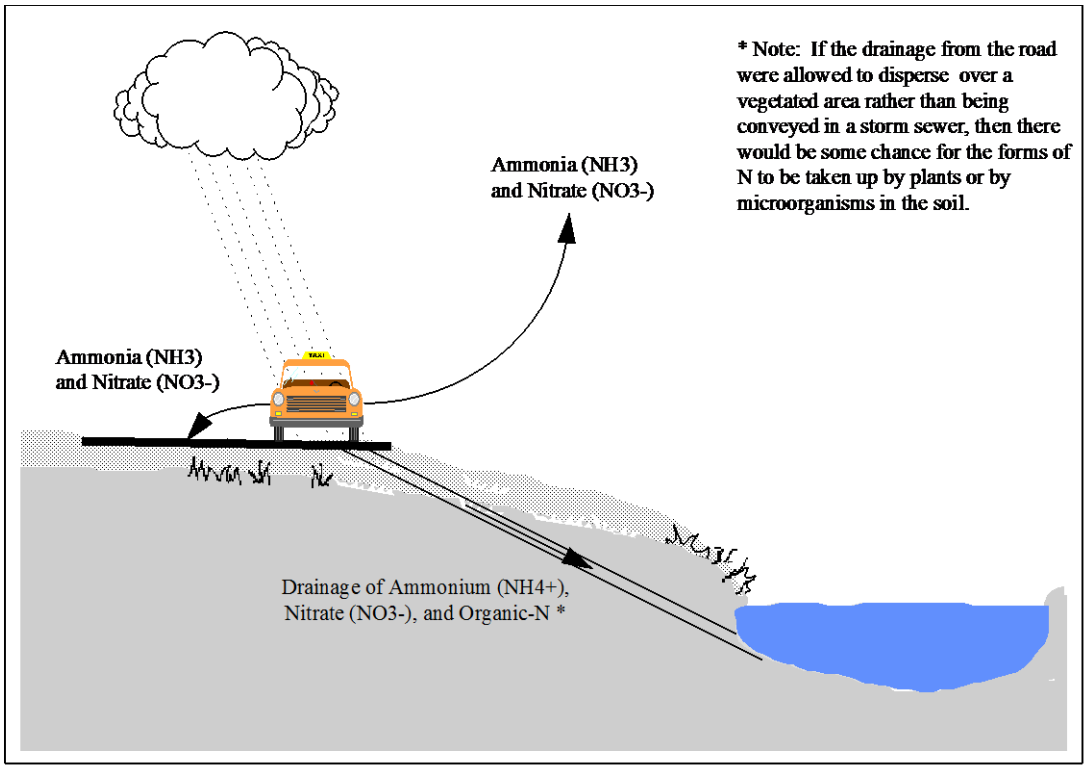
Atmospheric Deposition

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 F.1 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 F.1 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.

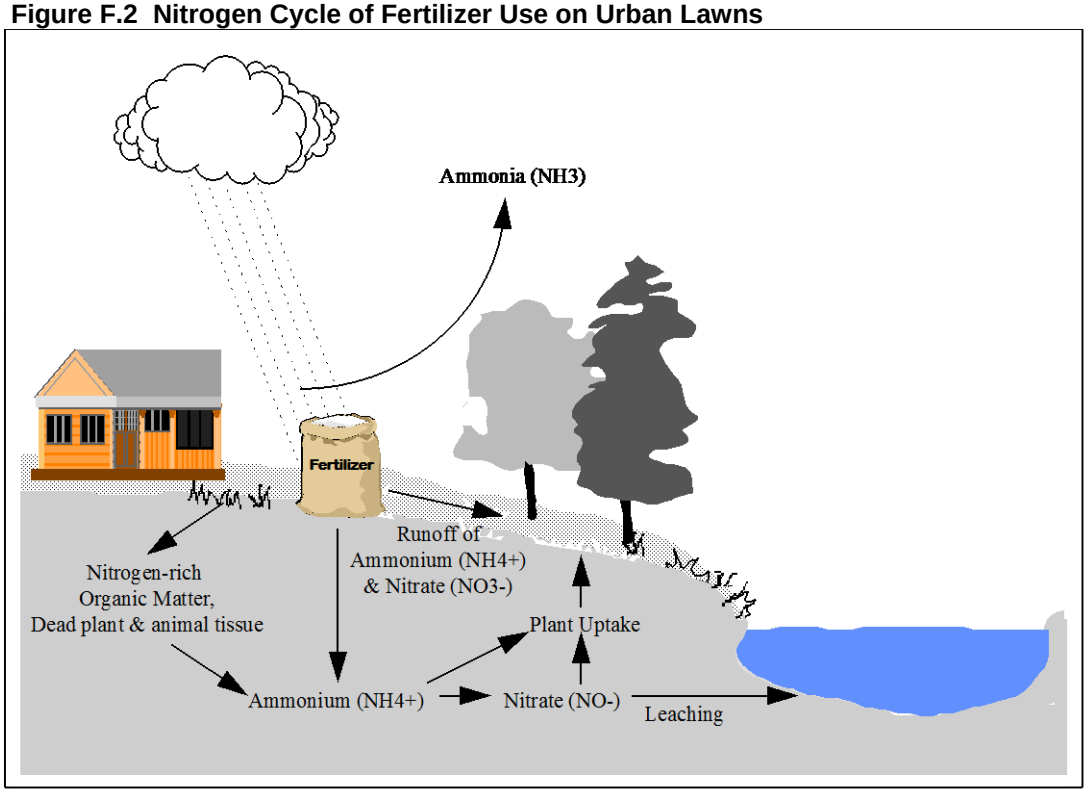
Fertilizers

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 F.2.

Figure F.2 Nitrogen 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 over watered and over fertilized (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 turf grass 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 F.1. This research strongly suggests that efforts to educate homeowners about lawn care should stress the critical connection between fertilization and over watering. 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 F.1 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 bluegrass	watered	early season fert. Clippings left	194	2.27	Geron et al. 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 drain field. 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, drain field areas must become larger when soils are not permeable or slopes are steep. Larger volumes of wastewater require larger drain fields.

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 F.2 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:

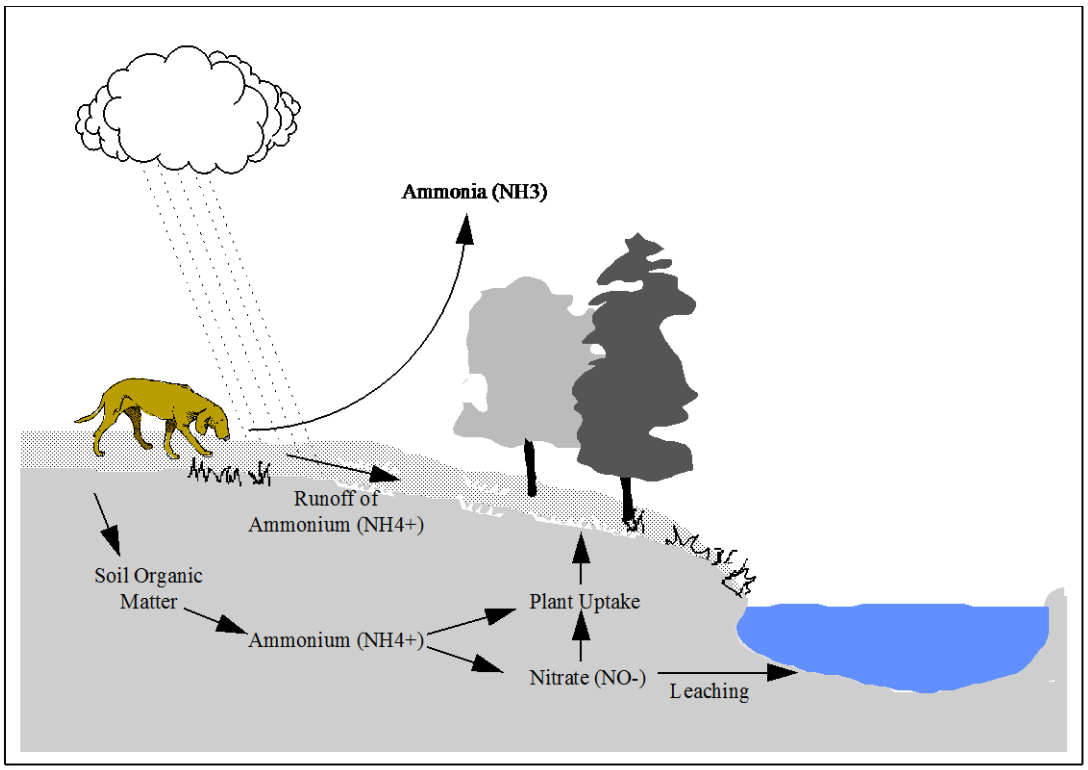
- Homeowners should not use garbage disposals or pour grease down the drain.
- Septic systems should be inspected at least once every two years and pumped as needed (time interval varies with size, use, and operation).
- DWQ, DEH, and local health departments should increase educational efforts for homeowners 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 F.3 shows the nitrogen cycle of pet wastes in urban areas.

Figure F.3 Nitrogen 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 G

The Phosphorus Cycle

(Text to be provide by DENR and included at a later date)

APPENDIX H

SOURCES OF PHOSPHORUS IN DEVELOPED AREAS

(Text to be provide by DENR and included at a later date)

APPENDIX I

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 J.

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 City of Oxford Stormwater Administrator.

- 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
  2. Residential Worksheet when Footprints are not Shown
  3. Export Calculation Worksheet for Piedmont Communities
  4. BMP Removal Calculation Worksheet for Piedmont Communities
- 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				

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 I.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 I.1 The Application of the Simple Method to the Nutrient Loading Model

= P * Pi * Rv * 0.227
= 45 * 0.9 * (0.05 + 0.9*I) * 0.227
= 0.46 + 8.3*I

= C (for TN)

= C (for TP)

(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 I.1 summarizes the monitoring data that were used to support model development.

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

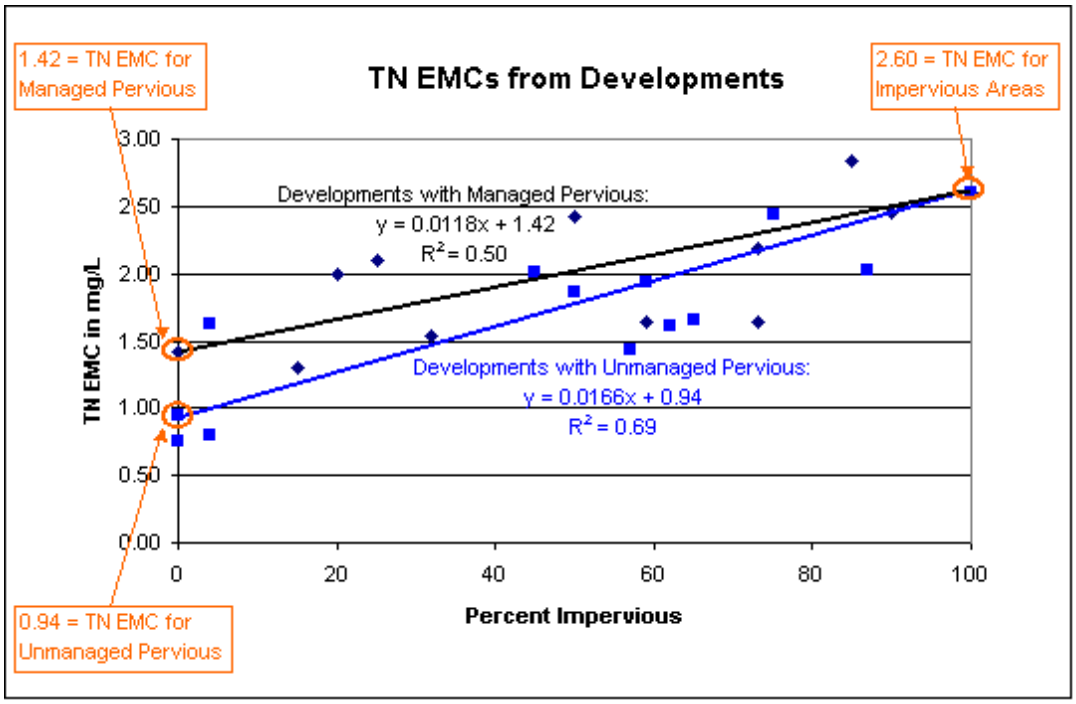
City	Managed or Unmanaged?	Outfall Name	Land Use	Imperv-ious (%)	TN EMC (mg/L)	TP EMC (mg/L)
Durham	managed	Chateau	Low Residential	15	1.30	0.32
Fayetteville	managed	clea	Low Residential	20	1.99	0.19
Chesapeake	managed	999	Med Residential	25	2.09	0.25
Durham	managed	Northgate	Med Residential	32	1.53	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	Institutional	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

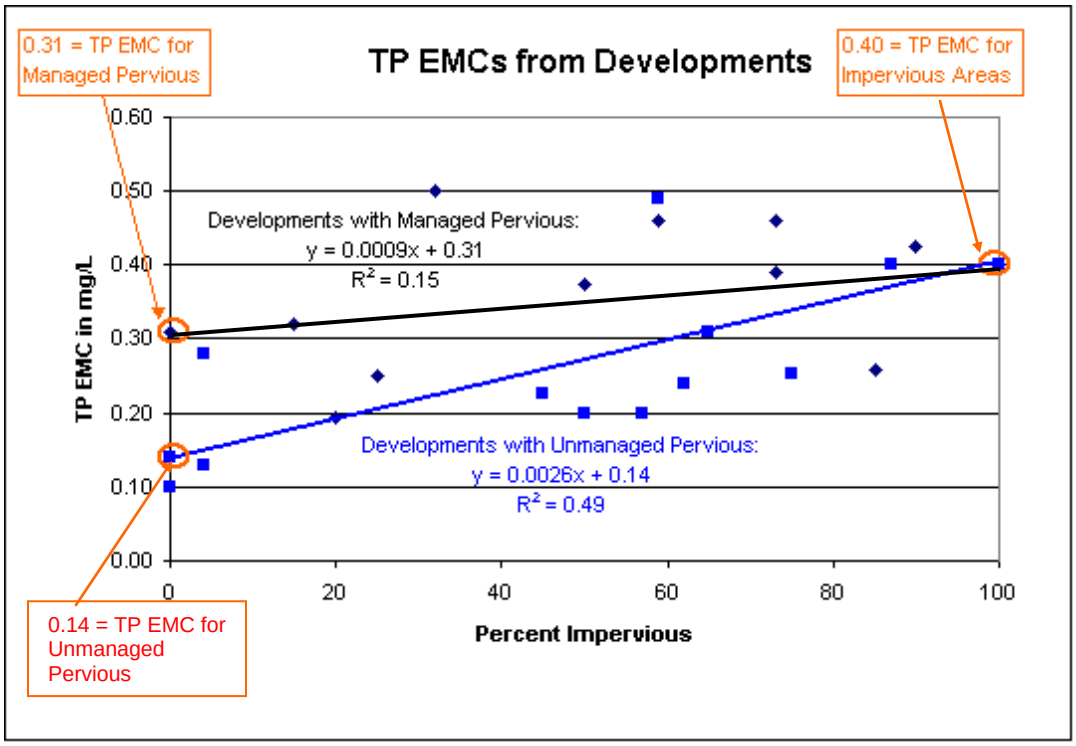
The researchers analyzed the monitoring data listed above to determine appropriate EMCs for TN and TP for impervious, managed pervious and unmanaged pervious using this process:

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 I.2 below shows the graphs and illustrates how the EMCs were determined.

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





The graphs in Figure I.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 I.2 summarizes how this information is applied to the EMC values for the various land uses.

Table I.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.

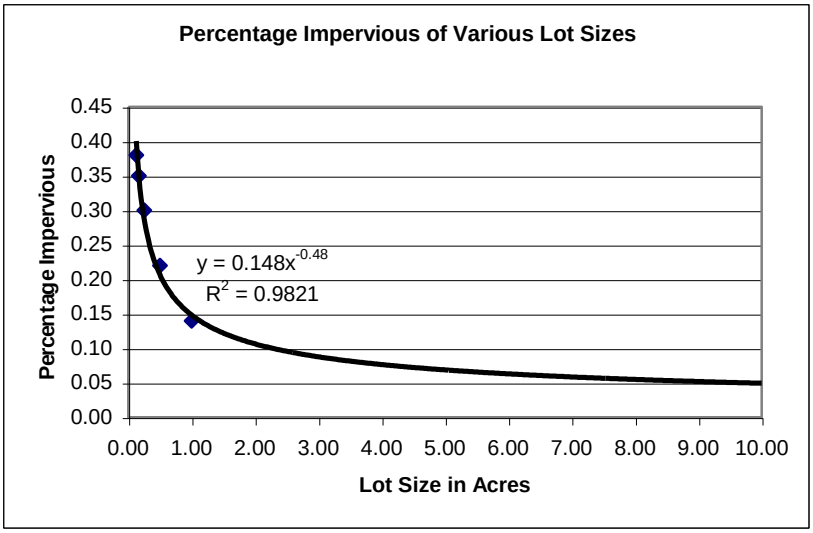
The City of Raleigh has done a study of its various zoning categories (in dwelling units per acre) and the corresponding levels of imperviousness that would be expected per lot. For the purpose of this model, the dwelling units per acre were converted to average lot size in acres and graphed with lot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

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

Table I.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 I.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:

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

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.

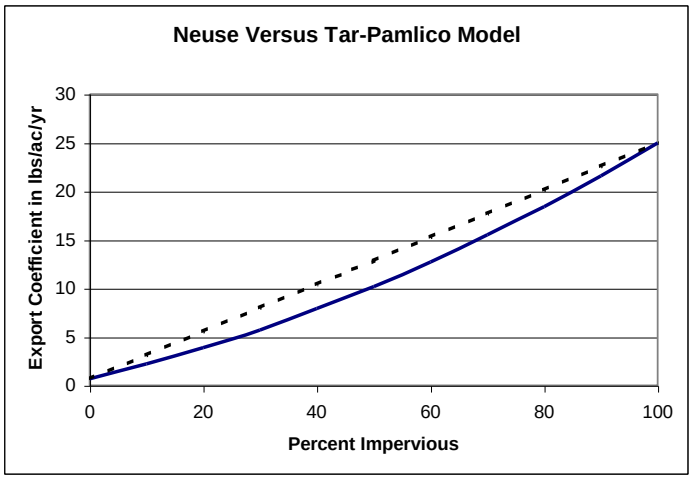
In addition to computing the pre- and post-development TN and TP export coefficients, the Tar-Pamlico model also computes export coefficients from developments after BMP installation. A review of the efficiencies follows in the next section.

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



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

APPENDIX J

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 J.1), 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 J.1 Wet Pond with Aquatic Fringe

Stormwater Wetlands,[2] 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 J.2), 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

Figure J.2 Stormwater Wetlands can be designed to incorporate diverse vegetative species.

[2] 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.

its vegetative cover, wetland effluent is typically cooler than that of wet ponds, minimizing the impacts of thermal pollution.
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 J.3).

Figure J.3 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[3] 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-

[3] 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.

1990's. Their use is currently not widespread due to the costs of construction. Sand filters are designed 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 J.4). 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 J.4 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.

Figure J.5 Turf reinforcement mats increase allowable velocities for grassy swales, making swale use more possible.

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 J.5). 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.

Table J.1 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[4]), 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.

Pollutant Removal Effectiveness

Climatologic Screening

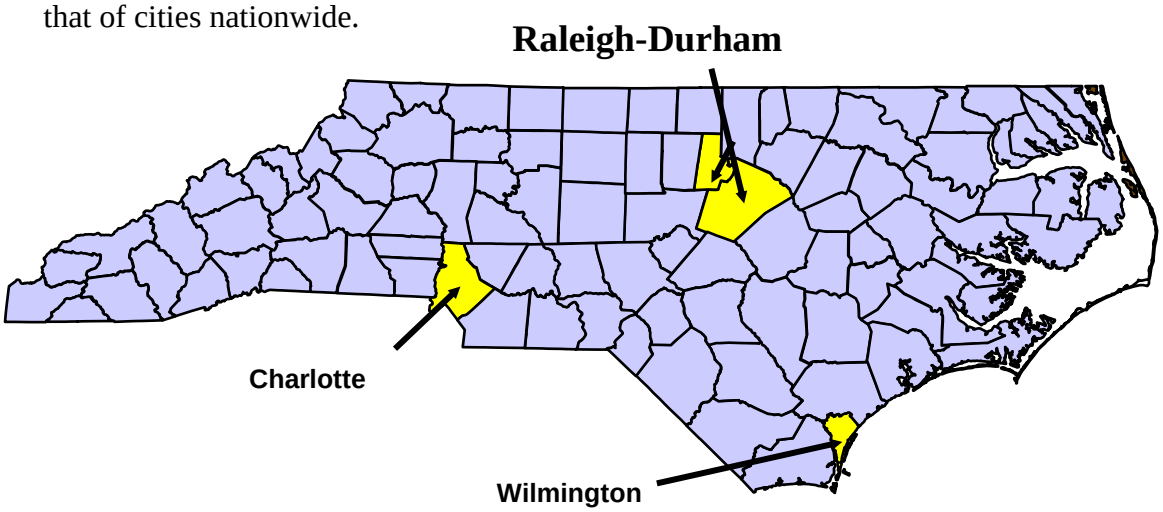
A large body of national research data was available on the removal effectiveness of the four types of BMPs. Particularly there was a considerable amount of data for the following cities: Austin TX; Baltimore, MD; Chicago, IL; Minneapolis, MN; Seattle, WA and Tampa, FL. However, North Carolina's climate 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.

[4] 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.

The out-of-state cities' weather was compared to the weather of three cities in North Carolina: Charlotte, Raleigh-Durham and Wilmington (Figure J.6). 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 J.6 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 J-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 J-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 J.2 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 J.7 and J.8) 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 J.9). 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 J.2 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 etlands	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 J.2 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 J.7 TSS Removal Efficiency – Stormwater Wetlands

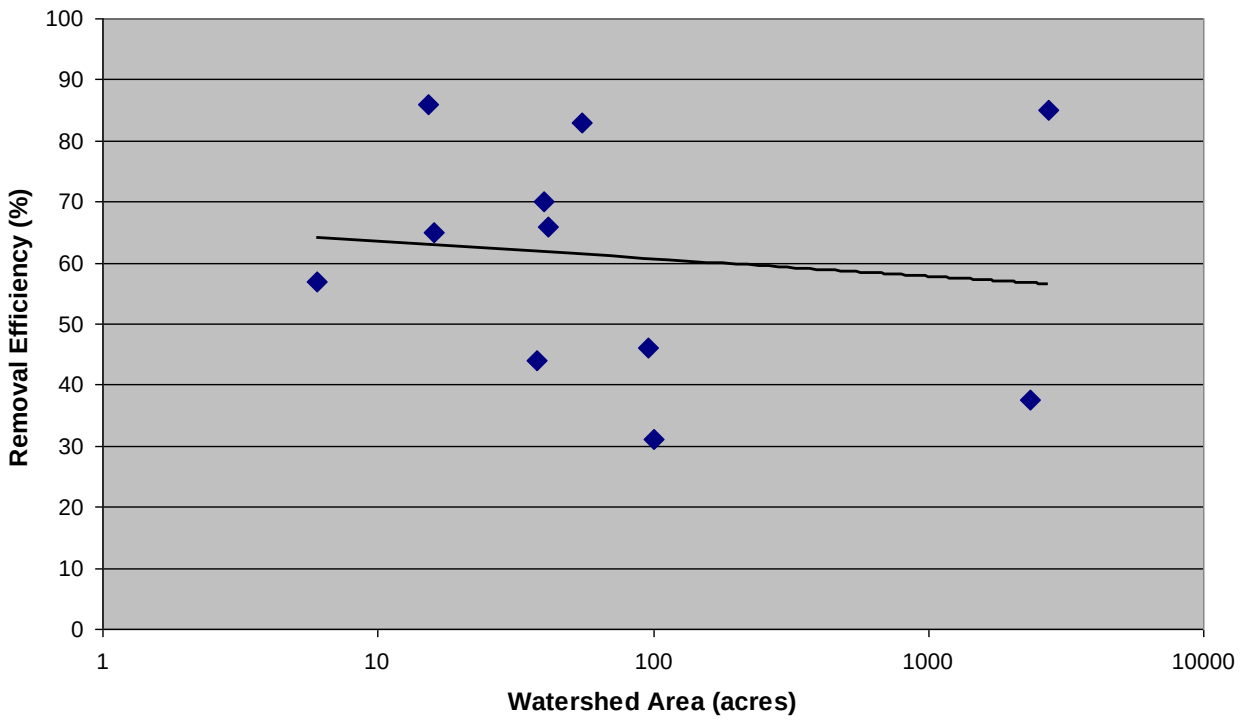


Figure J.8 TP Removal Efficiency – Wet Ponds

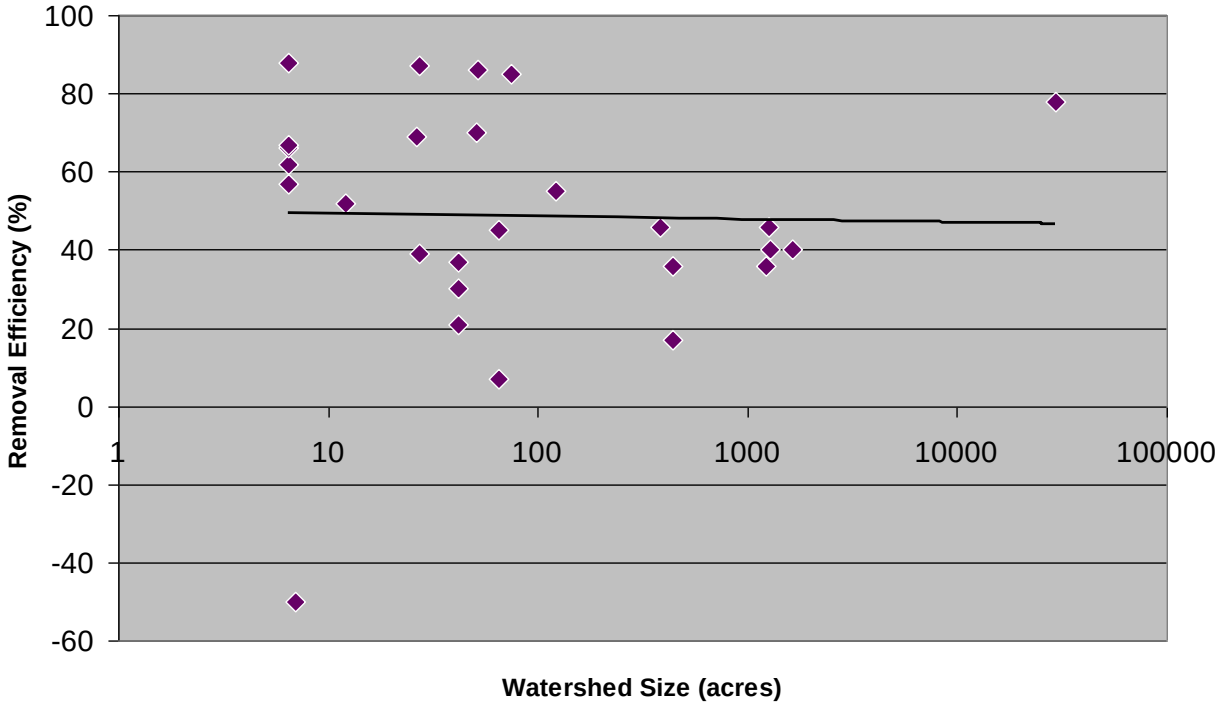
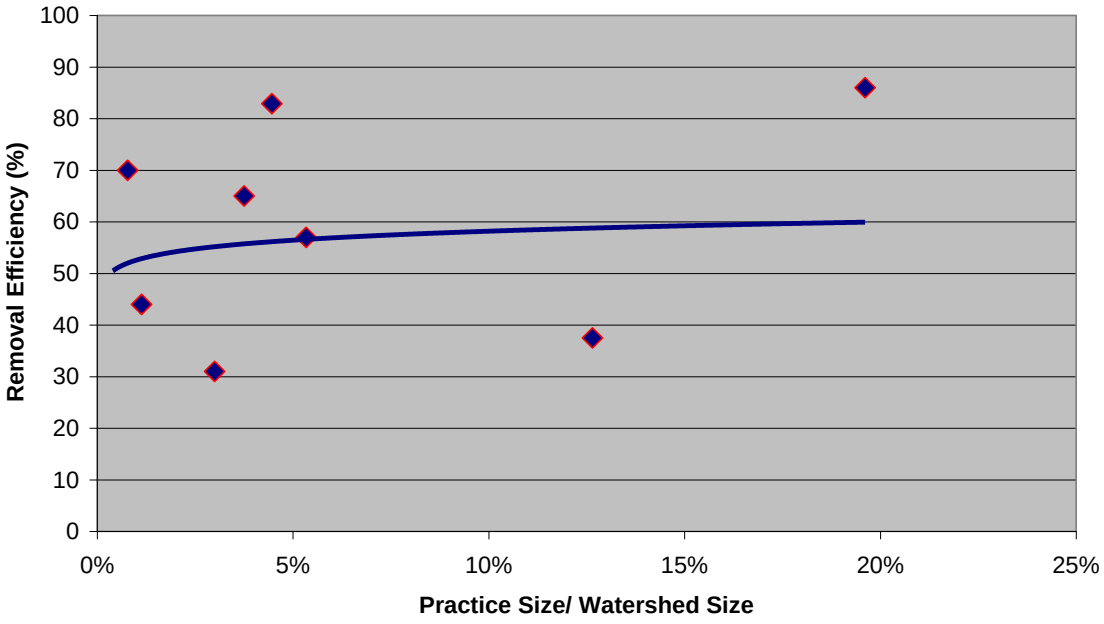


Figure J.9 TSS Removal as a Function of Practice Size to Watershed Size Ratio



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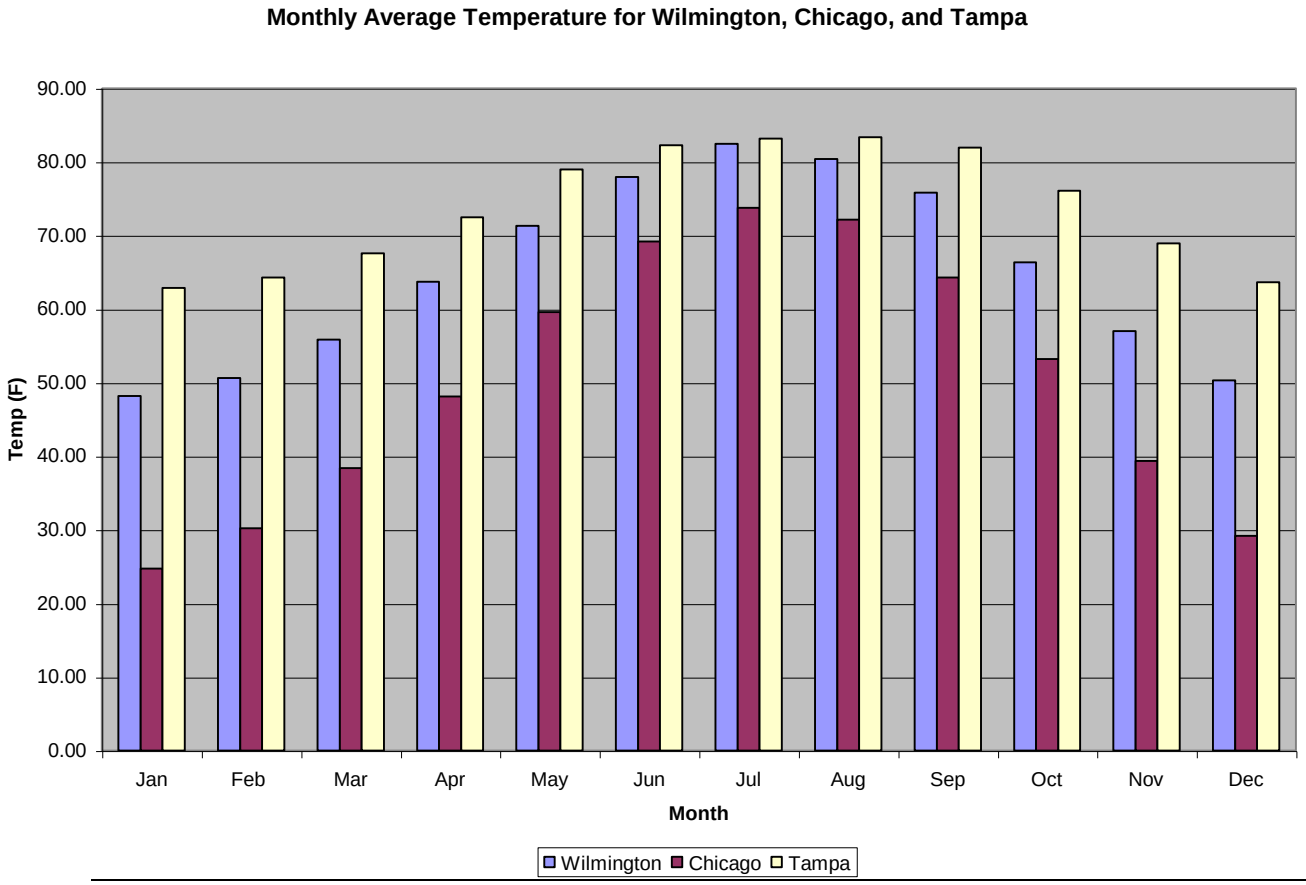
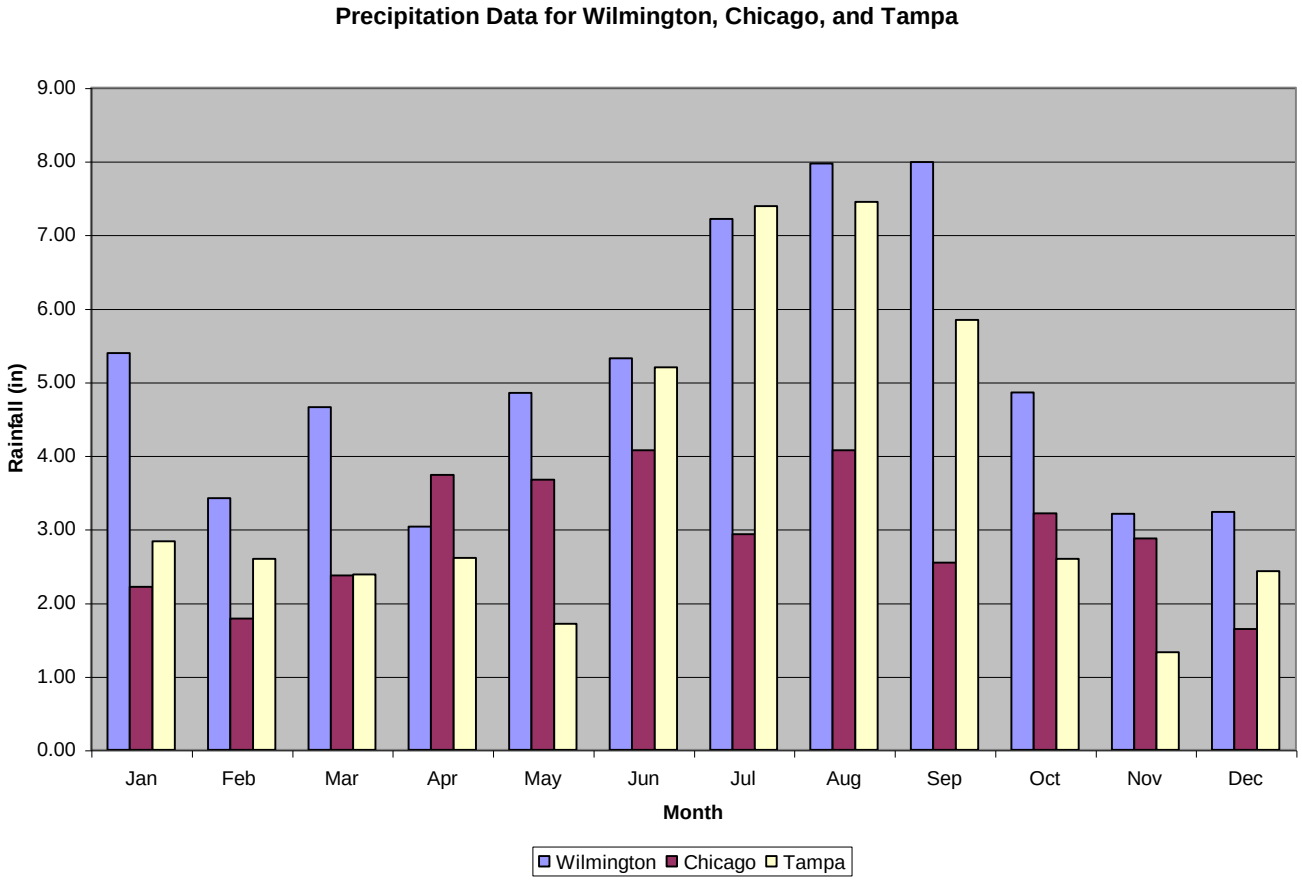
APPENDIX J-1

PRECIPITATION AND TEMPERATURE COMPARISON OF SIX U.S. CITIES WITH THREE CITIES IN NORTH CAROLINA

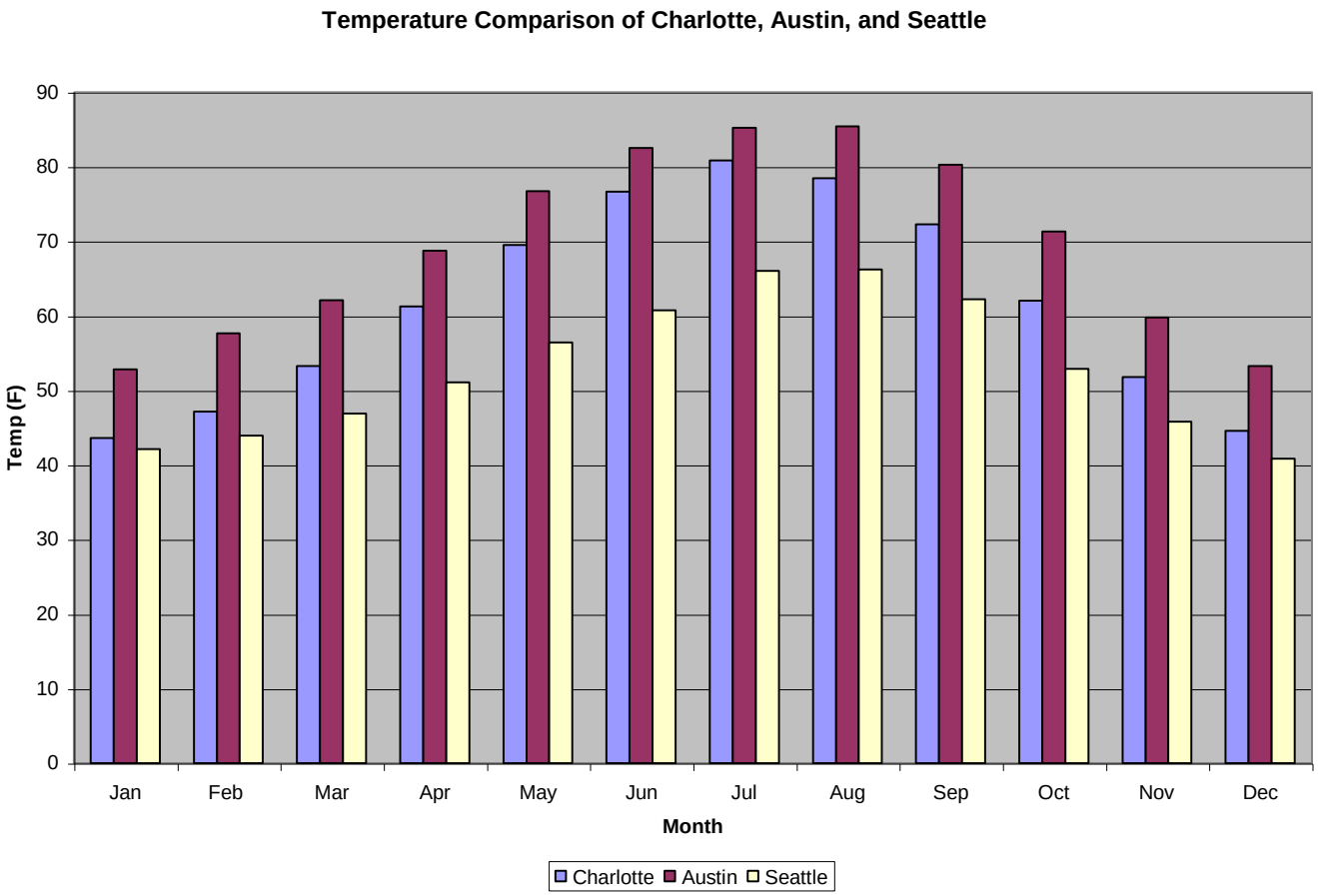
Wilmington and Tampa are shown to have very similar temperature plots (typically within 10°F of each other). Neither city has an average temperature approaching biological zero. However, Chicago's temperatures are much colder and remain either below or within biological zero (accepted around 5°C) for 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.



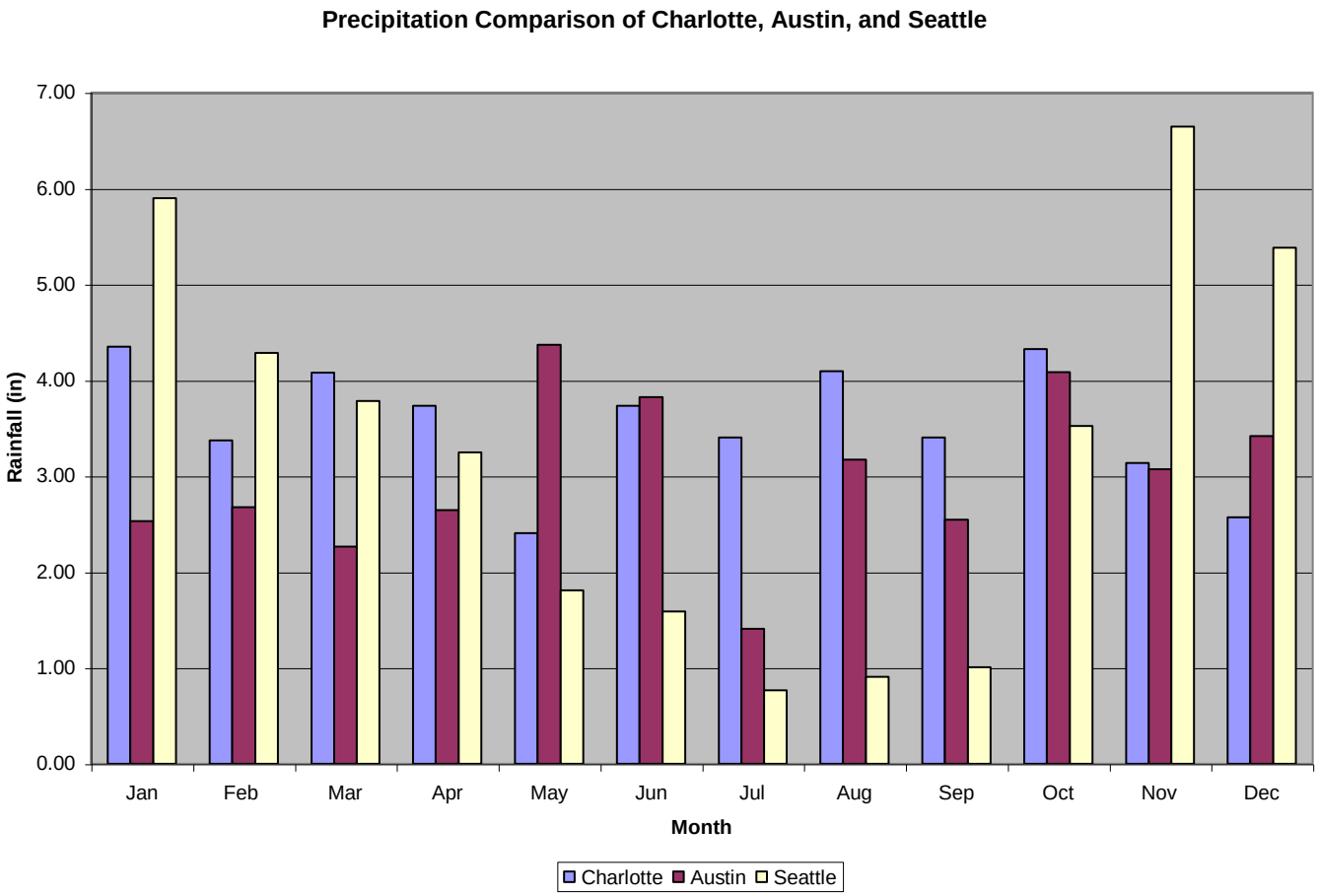
A comparison of precipitation amounts from Wilmington and Tampa show that each city received high amounts of rainfall at approximately the same times of the year, with Wilmington being slightly wetter. The relationship is particularly close during the summer and fall months reflecting tropical activity. 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.



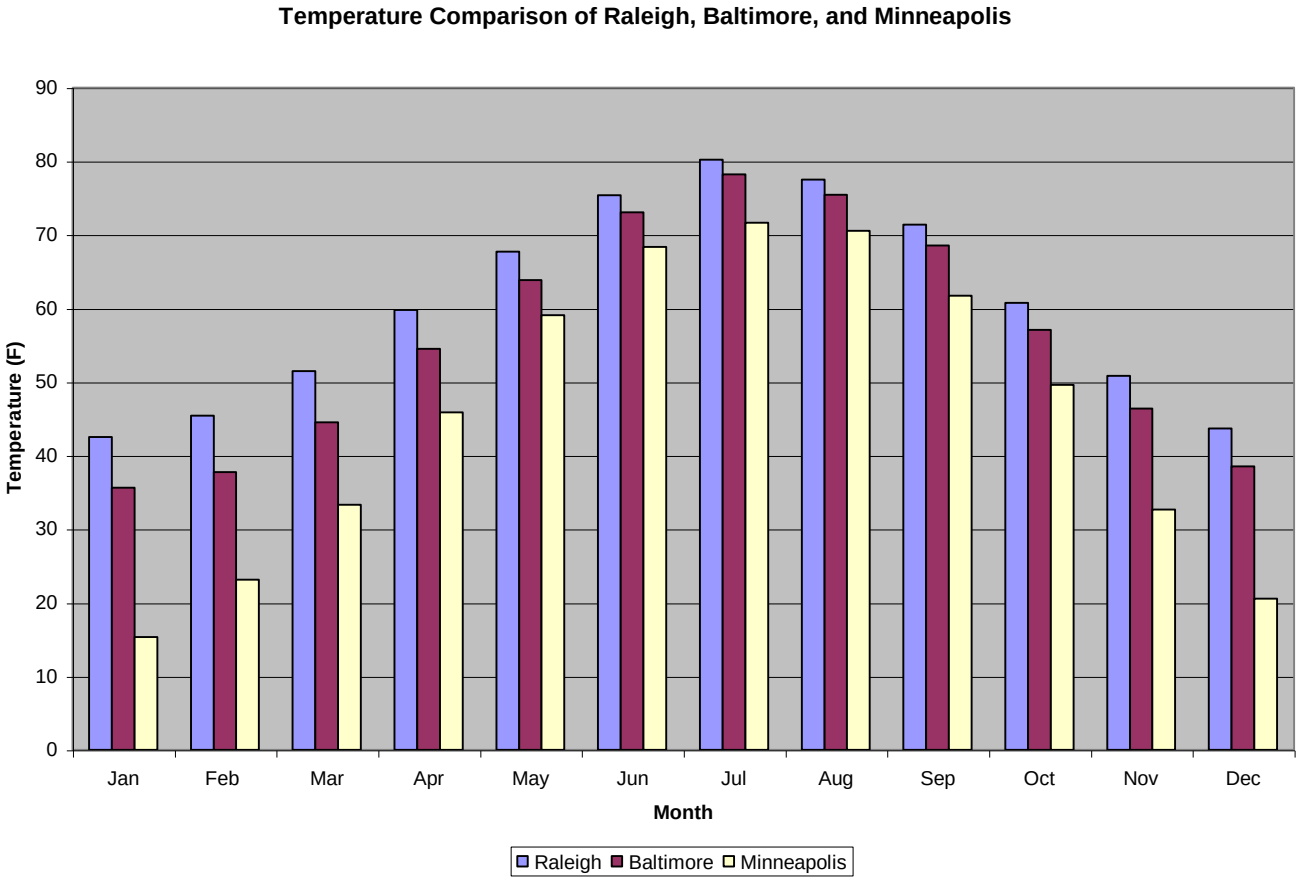
Charlotte and Austin are shown to be very similar in temperature on a monthly basis, with Austin being slightly warmer (but always within 10°F). Both cities remain at or above biological zero (5°C). Seattle, too, remains at or above biological zero, and does reflect similar temperatures to Charlotte 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.



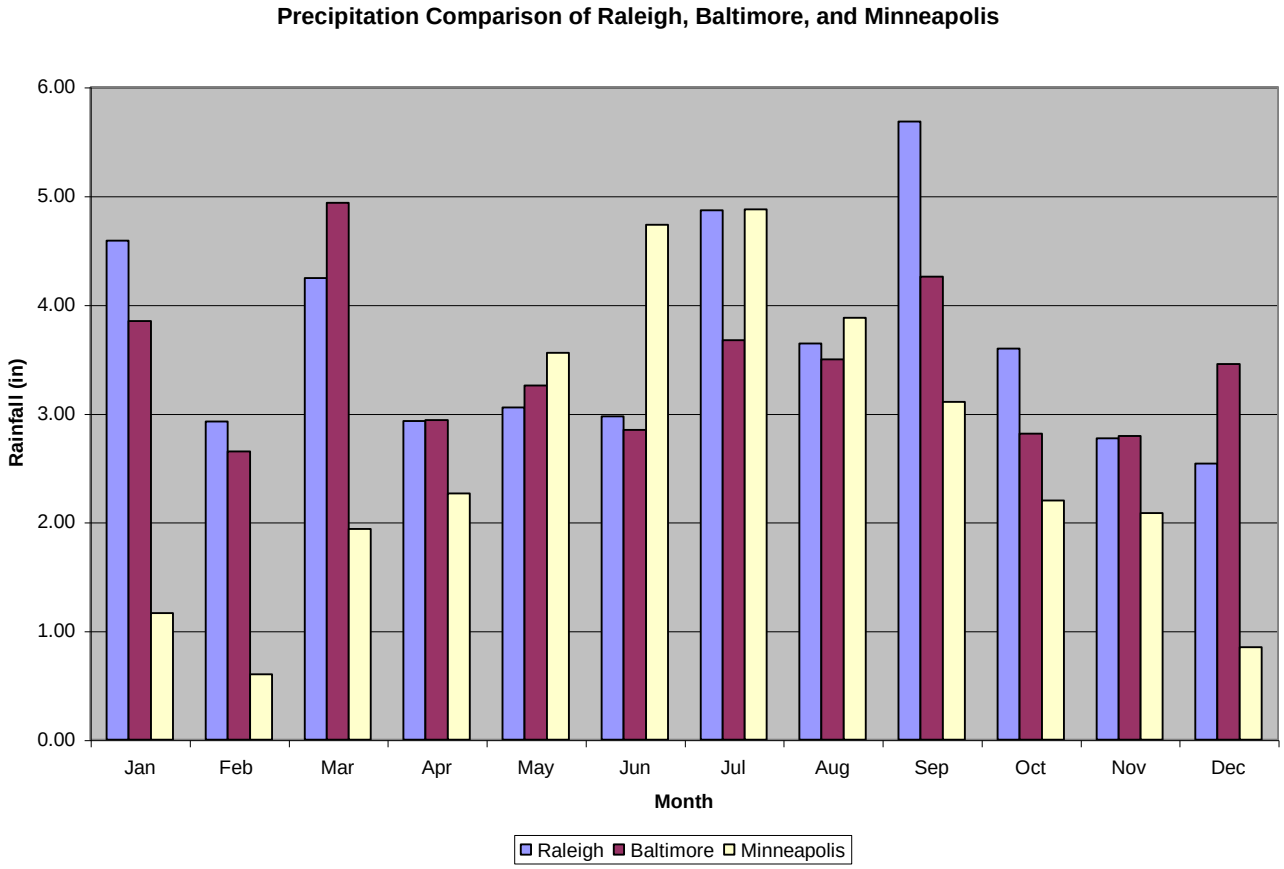
Seattle has a much different monthly rainfall distribution to that of Charlotte. While Charlotte's rainfall distribution is relatively evenly distributed throughout the year, Seattle receives the vast majority of precipitation from late fall through early spring. Rainfall differences are over two inches 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 J-2

SOURCES OF INFORMATION FOR BMP POLLUTANT REMOVAL EFFECTIVENESS

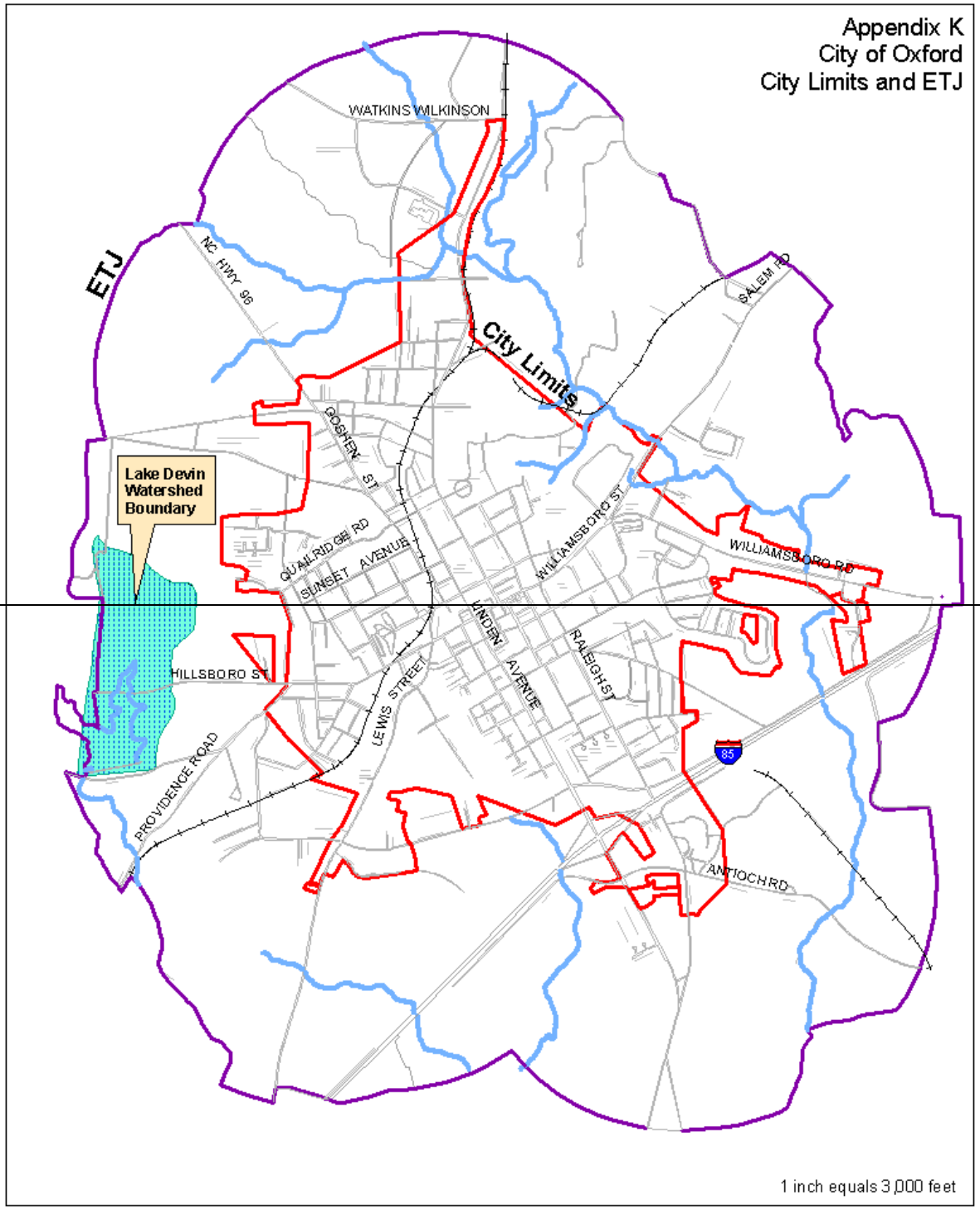
Practice Type	State	Researcher(s) or Agency	Reference
Stormwater Wetlands	FL	Rushton and Dye	CWP
Stormwater Wetlands	NC	Tweedy and Broome	Personal Communication
Stormwater Wetlands	VA	Northern VA Soil & Water District	NBMPD
Stormwater Wetlands	FL	FL DOT/ USGS	NBMPD
Stormwater Wetlands	MD	Baltimore City 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
Practice Type	**State**	**Researcher(s) or Agency**	**Reference**
Bio-Retention	MD	Davis	Personal Communication
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 K
City of Oxford
City Limits and ETJ
ETJ
City Limits
Lake Devin Watershed Boundary
WATKINS WILKINSON
NC HWY 96
SALEM RD
GOSHEN ST
QUAILRID GE RD
SUNSET AVENUE
WILLIAMSBORO ST
WILLIAMSBORO RD
LINDEN AVENUE
RALEIGH ST
LEWIS STREET
HILLSBORO ST
PROVIDENCE ROAD
85
ANTIOCH RD
1 inch equals 3,000 feet