NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

NCDOT Highway Stormwater PROGRAM

STORMWATER MANAGEMENT PROGRAM
for New and Existing Development in the Falls Lake Watershed

Version 1.0 | January 2014

GREEN
N.C. DEPARTMENT OF TRANSPORTATION
Guided Reduction of Excess Environmental Nutrients

Prepared for:

NC Department of Transportation
1590 Mail Service Center
Raleigh, NC 27699-1590
919.707.6700

Prepared by:

URS
1600 Perimeter Park Drive
Suite 400
Morrisville, NC 27560
919.461.1100

Stormwater Management Program

for New and Existing Development in the **Falls Lake** Watershed

TABLE OF CONTENTS

1.0 Background	1
2.0 Introducing GREEN	3
3.0 New Development Program	5
4.0 Existing Development Program	12
5.0 Nutrient Management Education Program	19
6.0 Annual Reporting	19
7.0 Contacts	20
8.0 References	21
9.0 Acronyms and Abbreviations	22

TABLE OF APPEDICIES

Appendix A. NCDOT Roads in the Falls Lake Watershed

Appendix B. NCDOT Inspection and Maintenance Program

Appendix C. NPDES Certification Statement

Appendix D. Baseline Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed

Appendix E. Interim Development Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed

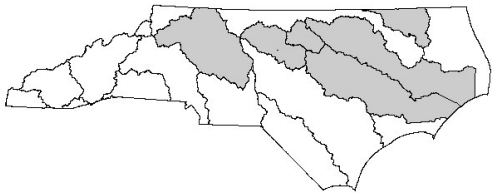
1.0 Background

In 2010, the North Carolina Environmental Management Commission (EMC) approved the Falls Lake Water Supply Nutrient Rules (Falls Lake Rules or Rules) (NCDENR, 2010), which established a nutrient management strategy for Falls Lake designed to reduce algal growth in the lake. As part of these rules, contributors of nutrients to Falls Lake, including the North Carolina Department of Transportation (NCDOT), are required to reduce their loading of total nitrogen and total phosphorous in order to meet percent reduction goals to restore water quality standards in the lake. The Falls Lake nutrient management strategy requires NCDOT to develop and implement a Stormwater Management Program for all **new development** and **existing development** activities. This document describes NCDOT's Stormwater Management Program for New and Existing Development, which addresses nutrient runoff from new and widened roads, new non-road development, and existing road and non-road development. Table 1 presents NCDOT's implementation schedule for these activities.

Table 1. NCDOT Falls Lake Rule implementation start date

New and widening road program	January 2014
New non-road development program	January 2014
Existing development program	January 2014
Nutrient management education program	January 2014
Riparian buffer protection program	2000

1.1 Nutrient Management in North Carolina

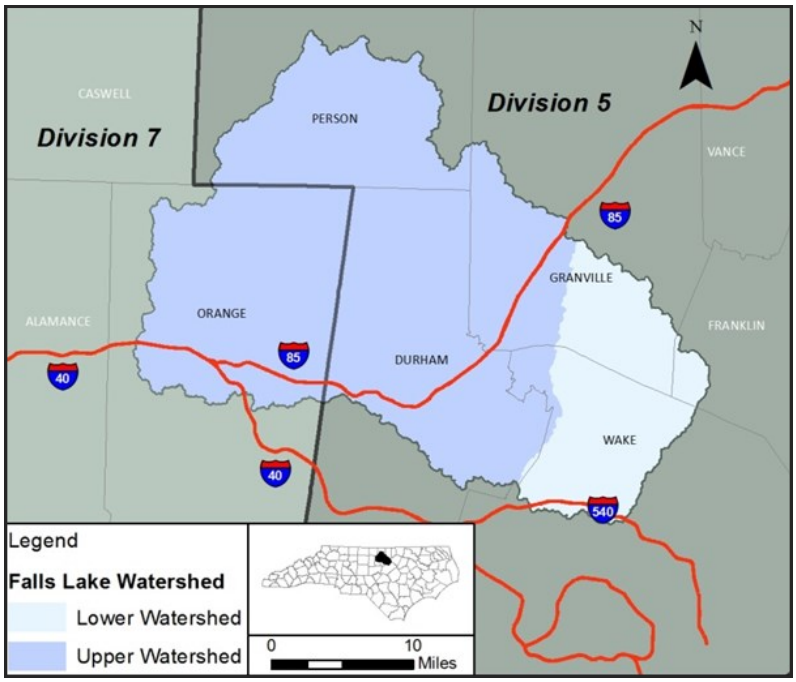


Selected North Carolina watersheds with eutrophication concerns

Management of excessive nutrient loading to receiving streams has been, and continues to be, a widespread effort in North Carolina. Prevalent eutrophication and algal blooms in the mid-1970s to 1980s and publicized fish kills in the mid-1990s have elevated the issue of nutrient management to the forefront of environmental programs in North Carolina. The EMC first began addressing nutrient issues in the Chowan River Basin in 1979 when the occurrence of nuisance algal blooms led to its designation as a Nutrient Sensitive Water (NSW). Since that time, similar water quality concerns have emerged in the Neuse River and Tar-Pamlico River Basins and the Jordan Lake, Falls Lake, and High Rock Lake watersheds. As the monitoring efforts of the North Carolina Department of Environment and Natural Resources (NCDENR) have expanded and the collective understanding of nutrient issues has improved, the EMC has increasingly directed resources to managing nutrient loads into North Carolina rivers, lakes, and estuaries.

1.2 NCDOT's Approach to Nutrient Management

NCDOT's response to nutrient management is focused on proactive compliance that is fair, reasonable, and proportionate to its contribution. NCDOT has managed nutrients in the highway environment through riparian area compliance, National Pollutant Discharge Elimination System (NPDES) stormwater requirements, scientific research, and taking active roles in state technical advisory committees. The Falls Lake Rules apply to all existing and new development, as defined in 15A North Carolina Administrative Code (NCAC) 02B .0276, that lies within or partially within the Falls Lake watershed. The affected area includes portions of NCDOT Highway Divisions 5 and 7 as shown in the adjacent figure.



Falls Lake watershed and NCDOT Divisions

2.0 Introducing GREEN

NCDOT directs, plans, constructs, maintains, and operates one of the largest state-maintained roadway system in the nation. The size, diversity, and geographic extent of this transportation network is reflected in NCDOT's numerous and unique stormwater management initiatives. In 1998, NCDOT established the Highway Stormwater Program to manage its NPDES stormwater permit requirements as well as other state stormwater programs. The Highway Stormwater Program is an NCDOT-wide initiative to manage and minimize the effects of stormwater runoff from NCDOT facilities.

Given NCDOT's responsibility for more than 1,800 miles of roadway in the Falls Lake watershed (see figure in Appendix A), a cost effective nutrient management strategy tailored to transportation is necessary. In order to address existing and future nutrient management needs, NCDOT initiated the **G**uided **R**eduction of **E**xcess **E**nvironmental **N**utrients (**GREEN**) Program to integrate and enhance NCDOT's stormwater and nutrient management practices and to support NCDOT's compliance with the Falls Lake Rules. The GREEN Program functions in collaboration with NCDOT's existing NPDES and state stormwater management activities and is designed to achieve the following objectives (also depicted on page 4):

1. Maintain compliance and accountability.
2. Increase NCDOT staff awareness of nutrient-related water quality issues.
3. Leverage and optimize existing environmental programs for nutrient management.

Highway NC-50 bridge over Falls Lake

4. Collect and document scientific research related to nutrient loading from NCDOT roadways and industrial areas.
5. Facilitate communication with resource agencies and the public.

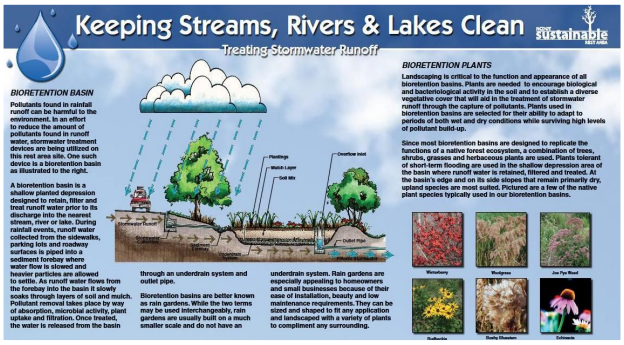
The GREEN Program encompasses requirements for both new and existing development as described in this document.

*In order to address near term and future nutrient management needs, NCDOT has initiated the **G**uided **R**eduction of **E**xcess **E**nvironmental **N**utrients (**GREEN**) Program to integrate and enhance NCDOT's stormwater and nutrient management practices and to support NCDOT's compliance with the Falls Lake Rules.*

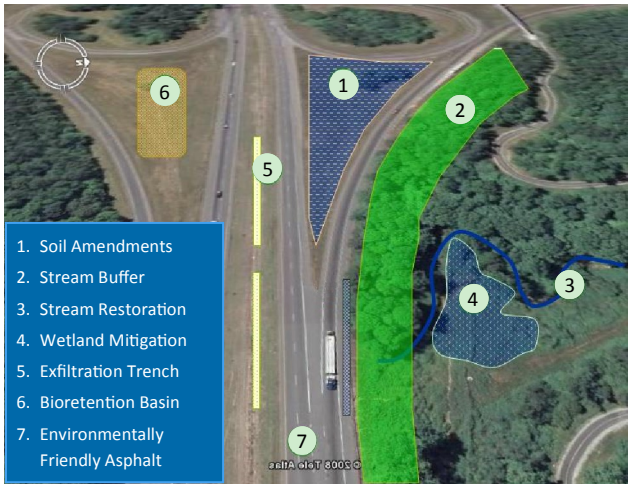
GREEN
Guided Reduction of Excess Environmental Nutrients

GREEN PROGRAM OBJECTIVES

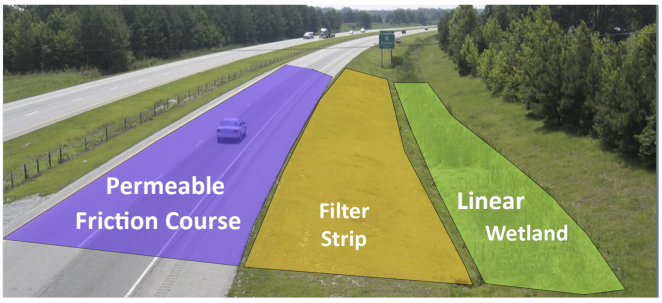
1 Maintain compliance and accountability



2 Increase NCDOT staff awareness of nutrient-related water quality issues



3 Leverage and optimize existing environmental programs for nutrient management



4 Collect and document scientific research related to nutrient loading from NCDOT roadways and industrial areas

5 Facilitate communication with resource agencies and the public

3.0 New Development Program

In keeping with the GREEN Program's mission and objectives, NCDOT crafted a new development post-construction stormwater runoff control program for nutrient management (hereafter referred to as the New Development Program). Under 15A NCAC 02B .0281 (9)(c), NCDOT is required to:

> *Establish a program for post-construction stormwater runoff control for new development, including new and widening NCDOT roads and facilities. The program shall establish a process by which the Division [of Water Quality] shall review and approve stormwater designs for new NCDOT development projects. The program shall delineate the scope of vested projects that would be considered as existing development, and shall define lower thresholds of significance for activities considered new development.*

To facilitate implementation of the new development program, project categories have been defined as **new road development** (see Table 2 for examples) and **new non-road development** (see Table 3 for examples).

For the purposes of compliance with the Falls Lake Rules, new road development is defined as any new road construction, road widening, road upgrade, or other activity resulting in net new built upon area occurring within the NCDOT right-of-way (ROW) or easement, with the exception of projects listed in Table 3 on page 6. The new road development category encompasses projects such as interchange modifications, roadway widening, addition of acceleration and deceleration lanes, median crossovers, new and widened hydraulic structures for stream crossings (e.g., bridges and culverts), and installation of structures for safety and signage. Projects involving permanent new built-upon area added within the NCDOT ROW or easement that supports pedestrian mobility associated with a new or existing roadway corridor, such as bus shelters and sidewalks, are also considered new road development projects. Examples of new road development projects are provided in Table 2.

Primary road in the Falls Lake watershed

Table 2. New road development project examples[1]
New location roadways
Roadway widening
New acceleration/deceleration lanes
Interchange modifications
New bridges or culverts
Bridge or culvert replacements
Median crossovers
Sidewalks within NCDOT ROW
Bus shelters within NCDOT ROW
Greenway Trails within the NCDOT ROW
Weigh stations
Borrow and waste sites associated with NCDOT road construction[2]

[1] This table provides examples of new road development projects and is not intended to be an exhaustive list.

[2] Borrow and waste sites may be operated by contractors and may be outside the NCDOT ROW.

New non-road development is defined as any new NCDOT facility or any modification to an existing facility that increases the net built-upon area and that does not otherwise qualify as new road development. Typically, new non-road development projects are not within the NCDOT ROW. These projects can include construction of new or upgrades to existing maintenance yards, rest areas, office buildings, training facilities, parking lots, or other non-road development. Examples of new non-road development projects are provided in Table 3.

Road and non-road projects that result in no net increase in built-upon area are deemed as existing development projects and are not subject to the New Development Program. When it is uncertain as to which category a new development project belongs, NCDOT staff and the regional NCDENR Division of Water Resources (NCDWR) representative will coordinate to determine proper project category based on the definitions and examples provided in this section.

Sections 3.1 and 3.2 provide a discussion of the proposed compliance process for new road and new non-road development projects based on the unique requirements associated with each project category. Vested projects considered existing development are defined for both new road and new non-road development projects. In addition, projects that are considered to be insignificant for nutrient loading are defined through specific project examples. The proposed process for review and approval of stormwater designs, including compliance with the riparian buffer protection requirements in 15A NCAC 02B .0233 and .0242, is also outlined in the following two sections for each project category.

Table 3. New non-road development project examples[1]
Rest areas
Maintenance yards
Office buildings
Training facilities
Parking lots
Railroad facilities
Material testing laboratories
Material storage facilities

[1] This table provides examples of new non-road development projects and is not intended to be an exhaustive list. Project examples assume a net increase of new built-upon area.

Permeable pavers installed at the McDowell County Interstate 40 Rest Area

3.1 New Development Program - New and Widening Road Projects

The new development program for new and widening road projects must meet the purposes defined in Rule 15A NCAC 02B .0281 (1) applicable to roads which includes achieving the highest practicable level of treatment; ensuring that the integrity and nutrient processing functions of receiving waters and associated riparian buffers are not compromised by erosive flows; and protecting the water supply uses within the watershed. Achieving these goals will be implemented through use of the nutrient removal capabilities of vegetated riparian buffers. Rules .0281 (9)(c)(i) and .0281 (9)(f) define the criteria for compliance with these goals. Rules .0233 and .0242 define the buffers that are protected and activities inside and outside the protected buffers which are regulated. Additionally requirements for the maintenance of diffuse flow through riparian buffers are set forth in Rule .0233 (5) and .0242 (9). Rule .0242 provides requirements for mitigation of unavoidable impacts to riparian buffers.

3.1.1 Review and Approval Process

15 NCAC 02B .0281

(9)(c)(i) For new and widening roads, weigh stations, and replacement of existing bridges, compliance with the riparian buffer protection requirements of Rules 15A NCAC 02B .0233 and .0242 shall be deemed as compliance with the purposes of this Rule;

(9)(f) Address compliance with the riparian buffer protection requirements of 15A NCAC 02B .0233 and .0242 through a Division approval process.

Rules 15A NCAC 02B .0281 (9)(c), and (9)(f) require that NCDOT "establish a process by which the Division [of Water Quality] shall review and approve storm-water designs for new NCDOT development projects" and "address compliance with the riparian buffer protection requirements of 15A NCAC 02B .0233 and .0242 through a Division [of Water Quality] approval process." For many years, riparian buffer protection requirements have been in place across North Carolina in selected water-sheds, including the Neuse River Basin, the Tar-Pamlico River Basin, the Randleman Lake watershed, and along the main stem of the Catawba River. To address these requirements, staff from NCDOT and NCDWR regional offices have collaborated over the years to develop project review and approval processes to facilitate accountability and compliance. New location roadway projects typically involve an extensive planning process during which NCDWR reviews the project alignment to determine that NCDOT has made every reasonable effort to avoid impacts to the buffer, wetlands, and other water resources. During the design process NCDWR reviews the project yet again to verify the protection of water quality standards and that NCDOT is in compliance with the requirements of Rules .0233 and .0242 if NCDOT proposes a use within the buffer. Such uses are carefully reviewed by NCDWR to ensure the maintenance of the buffer's nutrient removal functions as defined in Rule .0233. Uses not provided for in the Table of Uses are considered Prohibited and not protective of the nutrient removal functions of the buffer and thereby are not an option for NCDOT. Since the effective date of the .0233 and .0242 Rules in the late 1990's, NCDOT and NCDWR have extended this riparian buffer protection review and approval process to the Falls Lake watershed. Given that the current process has been demonstrated to be successful and sustainable, NCDOT does not propose any modifications under the Falls Lake GREEN New Development Program.

3.1.2 Vested Projects

Biofiltration conveyance system installed in an NCDOT ROW

15A NCAC 02B .0281 (9) requires that the New Development Program "delineate the scope of vested projects that would be considered as existing development." To facilitate consistency with the existing riparian buffer protection review and approval process, vested new and widening road projects are defined in Rule 15A NCAC 02B .0233 (3) for existing uses that are present and ongoing. The provisions in Rule .0233 (3) were developed, in part, with new roadway projects in mind and have been successfully integrated into the riparian buffer protection review and approval process for many years. NCDOT does not propose any modifications to the existing vesting provisions under the Falls Lake GREEN New Development Program.

3.1.3 Insignificant Projects and Activities

NCDOT will comply with the applicable riparian buffer protection requirements of Rules 15A NCAC 02B .0233 and .0242. Under these rules 'insignificant projects' are not expressly recognized, therefore NCDOT is not proposing to create a definition for insignificant projects.

3.2 New Development Program - New Non-Road Projects

New NCDOT non-road development must achieve the Falls Lake nutrient load reduction goals in the manner set forth in Rule 15A NCAC 02B .0281 (9)(c)(ii) (rule text provided on page 9).

For the purposes of compliance with the Falls Lake Rules, new non-road development is defined as any new NCDOT-owned and operated facility installation or significant facility upgrade that results in a net increase of built-upon area and that does not meet the criteria for new road development. Generally, new non-road development is located outside of the NCDOT ROW. Examples of non-road development projects include, but are not limited to, office facilities, parking lots, rest areas, and maintenance yards. Refer to Table 3 for additional project examples of new non-road development.

Stormwater control measure implemented at the NCDOT Guilford (East) County Maintenance Yard

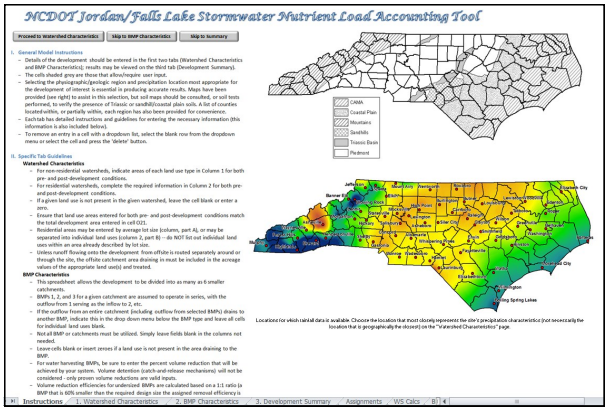
Nutrient reduction goals have been established for new non-road development that is not vested and that exceeds a defined lower threshold of significance (described in Section 3.2.3). These requirements are outlined in 15A NCAC 02B .0281 (9)(c)(ii) (provided on page 9), where specific nitrogen and phosphorus load reduction goals within the Upper Falls Lake and Lower Falls Lake are defined. The load reduction goals are established relative to either an area-weighted average loading rate of all developable lands as of a baseline period defined in 15A NCAC 02B .0275, or to a percentage reduction based on the project specific predevelopment loading rate. In order to meet these loading rate targets, NCDOT may consider the use of engineered stormwater control measures (SCMs). The effectiveness of these controls to remove nutrients will be assessed using the NCDOT Jordan/Falls Lake Stormwater Load Accounting Tool (NCDOT-JLSLAT) (see summary box on page 9 for additional information) or through another calculation method that is acceptable to NCDWR. Per 15A NCAC 02B .0281 (9)(c)(iii), NCDOT has the "option of offsetting part of their nitrogen and phosphorus loads by implementing or funding offsite management measures." These off-site measures are allowable only after achieving 50 percent or more of the needed nitrogen and phosphorus load reduction on the developed site. NCDOT may also make offset payments to the North Carolina Ecosystem Enhancement Program when necessary to meet site-specific reduction requirements. In addition to maintaining compliance with the Falls Lake Rules, new non-road development is also required to meet the conditions of NCDOT's statewide NPDES permit and other stormwater rules where applicable. Hence, every new NCDOT non-road development project will undergo a thorough stormwater management evaluation to assess compliance with multiple sets of requirements in the Falls Lake watershed.

15 NCAC 02B .0281 (9)(c)(ii)

New non-road development shall achieve and maintain the nitrogen and phosphorus percentage load reduction objectives established in 15A NCAC 02B .0275 relative to either area-weighted average loading rates of all developable lands as of the baseline period defined in 15A NCAC 02B .0275, or to project-specific pre-development loading rates. Values for area-weighted average loading rate targets for nitrogen and phosphorus, respectively, are expressed in units of pounds per acre per year: 2.2 and 0.33. The NCDOT shall determine the need for engineered stormwater controls to meet these loading rate targets by using the loading calculation method called for in Item (13) of this Rule or other equivalent method acceptable to the Division. Where stormwater treatment systems are needed to meet these targets, they shall be designed to control and treat the runoff generated from all surfaces by one inch of rainfall. Such systems shall be assumed to achieve the nutrient removal efficiencies identified in the July 2007 version of the Stormwater Best Management Practices Manual published by the Division provided that they meet associated drawdown and other design specifications included in the same document. The NCDOT may propose to the Division nutrient removal rates for practices currently included in the BMP Toolbox required under its NPDES stormwater permit, or may propose revisions to those practices or additional practices with associated nutrient removal rates. The NCDOT may use any such practices approved by the Division to meet loading rate targets identified in this Sub-item. New non-road development shall also control runoff flows to meet the purpose of this Rule regarding protection of the nutrient functions and integrity of receiving waters.

NCDOT Jordan/Falls Lake Stormwater Load Accounting Tool

North Carolina State University (NCSU), in conjunction with NCDENR, developed JLSLAT as a tool for addressing the Jordan Lake nutrient requirements. JLSLAT is a Microsoft Excel (2007) workbook that allows a user to specify site conditions, such as physiographic province, soil hydrologic group, and precipitation station, and estimate nutrient loading from the pre- and post-development land use conditions, as well as model the impact of various SCMs on post-development stormwater runoff quality.



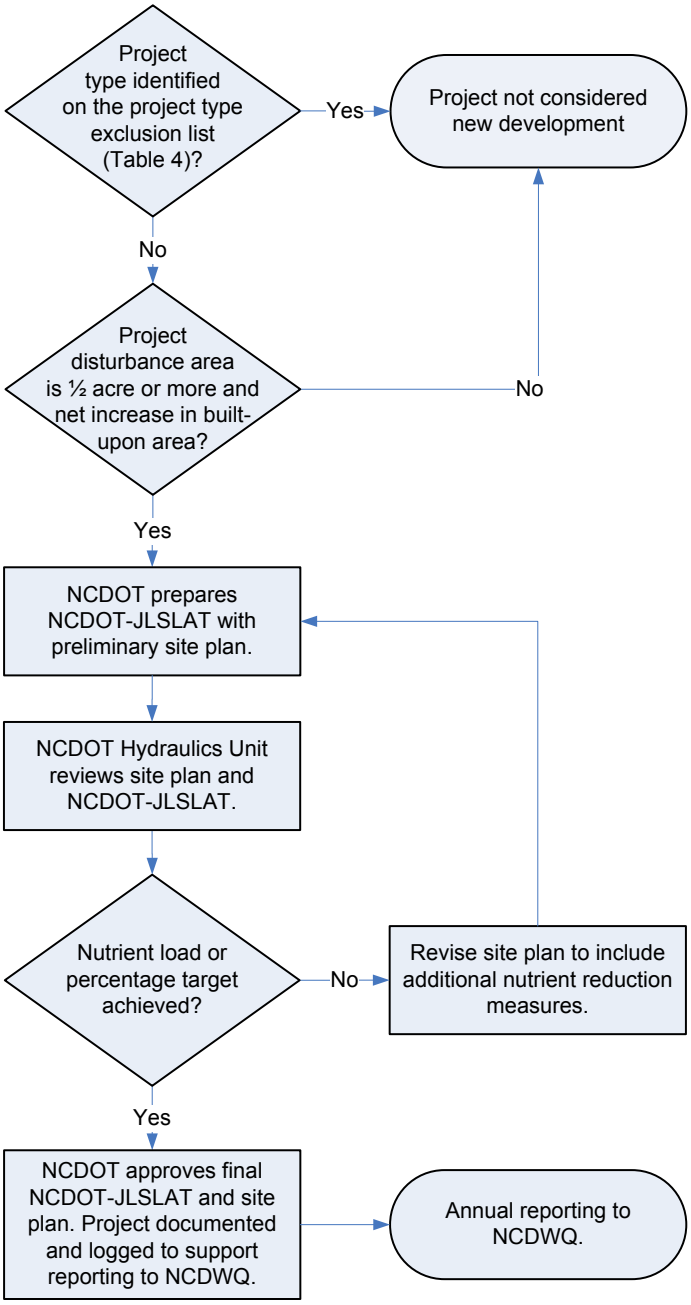
NCDOT Jordan/Falls Lake Stormwater Load Accounting Tool

The Falls Lake Rules acknowledge the unique nature of NCDOT areas and associated nutrient controls and states, "NCDOT may propose to [NCDWR] nutrient removal rates for practices currently included in the BMP Toolbox required under its NPDES stormwater permit, or may propose revisions to those practices or additional practices with associated nutrient removal rates" (15A NCAC 02B .0281 (9)(c)(ii)). Based on an extensive review and assessment of NCDOT's water quality research data, NCDOT, in coordination with NCSU, built upon the existing JLSLAT (Version 1.1) framework and methodology by updating JLSLAT to include land use and land cover (LULC) categories and SCMs specific to industrial facilities, rest areas, and non-roadway projects under NCDOT jurisdiction. The NCDOT accounting tool, NCDOT-JLSLAT, addresses the unique LULC conditions at NCDOT facilities and incorporates the range of NCDOT's nutrient management practices to estimate nitrogen and phosphorus loading from NCDOT project sites. On July 12, 2012, the EMC formally approved NCDOT-JLSLAT for new non-road development projects for use in demonstrating compliance with new non-road development nutrient reduction requirements identified in 15A NCAC 02B .0281.

In a separate report titled, "Transportation Land Use/Land Cover and Stormwater Control Measure Updates for the Jordan/Falls Lake Nutrient Accounting Tool" (NCDOT, 2012a), NCDOT has prepared a description of the steps taken to adapt JLSLAT for NCDOT applications for use in project planning in the Jordan Lake and Falls Lake watersheds. NCDOT-JLSLAT users are referred the JLSLAT User's Manual (NCSU, 2011) for instructions on how to use the tool.

3.2.1 Review and Approval Process

Rule 15A NCAC 02B .0281 (9) requires that NCDOT "establish a process by which the Division [of Water Quality] shall review and approve stormwater designs for new NCDOT development projects." To meet this requirement and the load reduction goals, NCDOT will internally review and approve projects using the procedures described in this section. NCDOT will also update the Post-Construction Stormwater Program (PCSP) to include provisions that promote compliance with this document and will submit the update to NCDWR for review and approval. NCDOT's PCSP defines implementation of the NCDOT BMP Toolbox, NCDOT staff and contractor training to implement the Toolbox and incorporates watershed strategies to control runoff from new NCDOT development and redevelopment. Projects that rely on the use of NCDOT-JLSLAT will be certified by a NC licensed professional and require that the professional affirm that the tool was used in conformity with the EMC-approved version or another method acceptable to NCDWR (See Appendix C for a copy of the certification language). Site plan and NCDOT-JLSLAT reviews will be supervised through NCDOT's Hydraulics Unit. Upon approval, NCDOT will enter the results of these reviews along with certification of completed projects into a rule compliance database and report on these activities annually as part of NCDOT's NPDES stormwater permit. Annual reporting will include a list of certified projects, descriptions of the projects and associated SCMs, project-specific copies of NCDOT-JLSLAT and other supporting calculations, an accounting of nutrient offset payments and offsite management measures, and a summary of changes in nutrient loads associated with these activities. Similar to other NPDES permit requirements, NCDOT's new non-road development activities under the GREEN Program will receive regular NCDWR review and assessment under existing NPDES auditing procedures. Assigning NCDOT the responsibility of compliance and oversight promotes an efficient and environmentally protective approach that reduces the overall level of NCDWR resources needed to implement the Rule. This internal review and approval process also allows streamlined organization within NCDOT that promotes the objectives of the GREEN Program and results in improved coordination, efficiency, and timeliness of projects.



Review and approval process for new non-road development

In implementing the new non-road development rule, NCDOT will do the following:

1. Maintain high standards and expectations for environmental stewardship.
2. Provide nutrient training to NCDOT staff and contractors.
3. Determine rule applicability on a project-specific basis.
4. Apply NCDOT-JLSLAT, or other NCDWR approved method, during site design to facilitate load reduction compliance accountability.
5. Design, review, and approve new non-road development projects.
6. Confirm that project design criteria meets the new non-road development requirements.
7. Oversee construction activities and validate the implementation of design specifications.
8. Consult with and report annually to NCDWR .

The review and approval process is illustrated on page 10. To identify the appropriate internal review and approval process, NCDOT first determines whether a new project is a road project or a non-road project (not shown in the figure). Once the project is identified as new non-road development, the area of disturbance is determined. Disturbance, for the purposes of compliance with this rule, means any land-disturbing activity associated with construction or development of a project. If the project exceeds the lower threshold of significance for project size (described in Section 3.2.3 below), results in a net increase in built-upon area, and is not listed as an excluded project (described in Section 3.2.3 below), then the nutrient reduction requirements for new non-road development apply. For these projects, NCDOT-JLSLAT will be used during the preliminary design process to determine if the proposed development exceeds project-specific predevelopment loading rates or if it exceeds the area-weighted average loading rate targets [15A NCAC 02B .0281 (9)(c)(ii)]. If the project exceeds both requirements, NCDOT will implement SCMs such that either the pre- to post-development loading rate target or the subwatershed-specific area-weighted annual loading rate target is met. Alternatively, if prohibitive site constraints exist, NCDOT will consider implementing or funding offsite management measures per 15A NCAC 02B .0281 (9)(c)(iii). Prior to preliminary plan approval, NCDOT will perform an additional, independent review to confirm that the preliminary site plan achieves compliance with the NCDOT new non-road development rules. Upon NCDOT approval, the preliminary site plan will be approved and the final NCDOT-JLSLAT and site plan will be formally documented and logged for future reporting to NCDWR. Annually NCDOT will report to NCDWR on measures taken to comply with the new non-road development rules.

3.2.2 Vested Projects

For the purposes of rule compliance, new non-road development projects that are part of NCDOT's Capital Improvements Plan, or otherwise approved for funding by NCDOT prior to January 15, 2014, will be considered vested. Vested projects will be considered as existing development and managed accordingly.

3.2.3 Insignificant Projects and Activities

The new non-road development Rule also requires NCDOT to define "lower thresholds of significance for activities considered new development" (15A NCAC 02B .0281 (9)(c)). The GREEN program established a lower threshold of significance for all non-road facilities of one-half acre in the Jordan Lake Watershed (NCDOT, 2012b). Given this precedent and the similarity in facility types and activities (as shown in Table 3) anticipated in the Jordan and Falls Lake watershed, the lower threshold for significance for non-road facilities in the Falls Lake watershed is one-half acre. This threshold was selected after evaluating the nutrient load changes associated with a variety of typical projects that NCDOT undertakes at its non-road facilities. Based on this evaluation, the one-half acre threshold was selected because it is expected to capture most all development projects including those that result in changes to existing drainage.

Additionally, all projects at NCDOT industrial facilities, regardless of disturbance area, will be covered under site-specific Stormwater Pollution Prevention Plans (SPPPs) which include best management practices (BMPs) to address nutrient management and minimize the potential for stormwater impacts.

The Rules recognize that NCDOT is engaged in a wide variety of projects and allow for a list of insignificant projects to be proposed as part of the stormwater program. For this reason, NCDOT developed a project type exclusion list (Table 4) to identify projects that are not subject to the new non-road development Rules (15A NCAC 02B .0281 (9)(c)(ii); rule text provided on page 9). These project types were selected after careful review of the Minimum Criteria List (19A NCAC 02F .0102), which lists the "types and classes of threshold of activities at and below which environmental documentation under North Carolina Environmental Policy Act is not required" (NCDENR, 2003). The project types listed in Table 4 include those from the Minimum Criteria List that are not considered to be subject to the new non-road development Rules. These projects are subject to new road development Rules.

In summary, the new non-road development Rules apply to projects that meet each of the three criteria:

1. Disturb one-half acre or more
2. Result in a net increase in built-upon area
3. Are not included in the project type exclusion list (Table 4).

Table 4. Projects not considered new non-road development
Noise barriers or alterations to existing public buildings to provide for noise reduction
Landscaping projects
Activities involving maintenance or repair needed to maintain the original function of an existing project or facility without expansion or change in use
Sampling, monitoring, and related data-gathering activities

[1] This table provides examples of projects not considered new non-road development and is not considered to be an exhaustive list. In addition to the projects listed in Table 4, other projects may be deemed as insignificant and not considered new non-road development upon approval by NCDWR.

4.0 Existing Road and Non-Road Development Program

The existing development program applies to all NCDOT development constructed prior to January 15, 2014 in the Falls Lake Watershed

The Rules require NCDOT to establish a program to identify and implement load-reducing opportunities on existing road and non-road NCDOT development within the Falls Lake watershed (15A NCAC 02B .0281 (9)(d)) (rule text provided on page 13). The existing development program applies to all NCDOT development constructed prior to January 15, 2014, including development that existed during the baseline period (2006) and interim period (January 1, 2007 – January 15, 2014). Compliance with the NCDOT existing development Rule and load reduction objectives in 15A NCAC 02B .0275 is achieved through a load reduction program that implements structural SCMs, non-structural SCMs and other activities aimed at reducing nitrogen and phosphorous loading from existing road and non-road NCDOT development in the Falls Lake watershed.

As described in this section, the existing development program requirements will be implemented through various NCDOT programs and units, including the Highway Stormwater Program, Hydraulics Unit, Roadside Environment Unit, and others. In addition, the existing development program will encompass NCDOT activities to identify NCDOT stormwater outfalls from Interstates, US, and NC primary routes (15A NCAC 02B .0281 (9)(a)) and identify and eliminate illegal discharges into NCDOT's stormwater conveyance system (15A NCAC 02B .0281 (9)(b)). Section 4.1 of this report provides a summary of NCDOT's baseline and interim development nutrient loads. These loads provide a foundation on which future existing development nutrient reductions will be reported. Section 4.2 of this report describes load-reducing activities, three examples of NCDOT programs through which implementation of those activities will occur, annual reporting, and anticipated collaboration with NCDWR and others to support further development of nutrient accounting methods.

15 NCAC 02B .0281 (9)(d)

Establish a program to identify and implement load-reducing opportunities on existing development within the watershed. The long-term objective of this effort shall be for the NCDOT to achieve the nutrient load objectives in 15A NCAC 02B .0275 as applied to existing development under its control, including roads and facilities:

(i) The NCDOT may achieve the nutrient load reduction objective in 15A NCAC 02B .0275 for existing roadway and non-roadway development under its control by the development of a load reduction program that addresses both roadway and non-roadway development in the Falls watershed. As part of the accounting process described in Item (13) of this Rule, baseline nutrient loads shall be established for roadways and industrial facilities using stormwater runoff nutrient load characterization data collected through the National Pollutant Discharge Elimination System (NPDES) Research Program under NCS0000250 Permit Part II Section G;

(ii) The program shall include estimates of, and plans for offsetting, nutrient load increases from lands developed subsequent to the baseline period but prior to implementation of its new development program. It shall include a technical analysis that includes a proposed implementation rate and schedule. This schedule shall provide for proportionate annual progress toward reduction objectives as practicable throughout the proposed compliance period. The program shall identify the types of activities NCDOT intends to implement and types of existing roadway and non-roadway development affected, relative proportions or a prioritization of practices, and the relative magnitude of reductions it expects to achieve from each;

(iii) The program to address roadway and non-roadway development may include stormwater retrofits and other load reducing activities in the watershed including: illicit discharge removal; street sweeping; source control activities such as fertilizer management at NCDOT facilities; improvement of existing stormwater structures; use of rain barrels and cisterns; stormwater capture and reuse; and purchase of nutrient reduction credits;

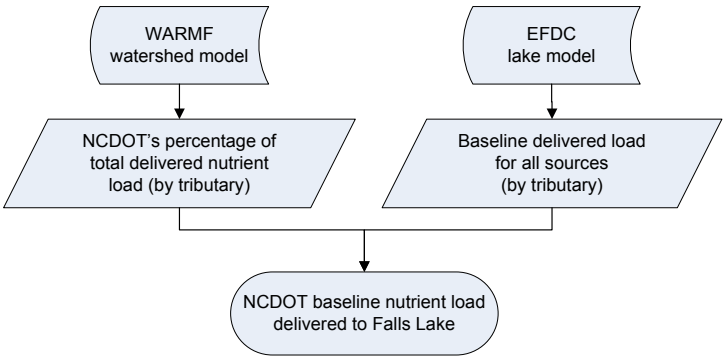
(iv) NCDOT may meet minimum implementation rate and schedule requirements by implementing a combination of at least six stormwater retrofits per year for existing development in the Falls watershed or some other minimum amount based on more accurate reduction estimates developed during the accounting tool development process;

(v) To the maximum extent practicable, retrofits shall be designed to treat the runoff generated from all surfaces by one inch of rainfall, and shall conform to the standards and criteria established in the most recent version of the Division-approved NCDOT BMP Toolbox required under NCDOT's NPDES stormwater permit. To establish removal rates for nutrients for individual practices described in the Toolbox, NCDOT shall submit technical documentation on the nutrient removal performance of BMPs in the Toolbox for Division approval. Upon approval, NCDOT shall incorporate nutrient removal performance data into the BMP Toolbox. If a retrofit is proposed that is not described in the NCDOT BMP Toolbox, then to the maximum extent practicable, such retrofit shall conform to the standards and criteria set forth in the July 2007 version of the Stormwater Best Management Practices Manual published by the Division, or other technically equivalent guidance acceptable to the Division;

4.1 Nutrient Load Accounting for Baseline and Interim Development

As a first step in developing the load reduction program, the Rules require NCDOT to establish baseline nutrient loads for NCDOT roadways and industrial facilities (15A NCAC 02B .0281 (9)(i)) and to include estimates of, and plans for offsetting, nutrient load increases from lands developed subsequent to the baseline period but prior to the implementation of the new development program (15A NCAC 02B .0281 (9)(ii)). For the purposes of compliance with the Falls Lake Rules, the baseline period is defined as calendar year 2006 and interim period is defined as the period that is subsequent to the baseline period but prior to the implementation of the new development program. Interim period development includes changes in development that occurred between January 1, 2007 and January 15, 2014.

NCDOT's nutrient loads during the baseline and interim development periods were developed using a variety of datasets, accounting tools and watershed and lake models available for the Falls Lake watershed. NCDOT's baseline loads, shown in Table 5 below, were developed using Falls Lake watershed and lake models (WARMF and EFDC) that were used to develop the Rules. NCDOT's baseline loads were approved by the North Carolina EMC on July 12, 2012. Supporting documentation discussing the methods used to calculate the baseline load is provided in a report titled Baseline Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed (NCDOT, 2012c) (see Appendix D). Nutrient load changes associated with NCDOT interim development areas were based on a detailed assessment of NCDOT road and non-road development during the 2007-2014 period, NCDOT-JLSLAT, and uniform pre-development annual loading rate estimates of 2.89 pounds/acre/year for TN and 0.63 pounds/acre/year for TP described in the Rule (15A NCAC 02B .0281 (5)(a)). Post-development TN and TP loads were calculated using GIS-based land cover area estimates and NCDOT-JLSLAT. Results of this analysis demonstrated a net decline in annual loads from NCDOT interim development and are in keeping with a number of NC research studies that have reported low nutrient concentrations in road runoff; particularly from secondary roads (which account for 99% of the interim road development area). A detailed summary of the interim development analysis is presented in Appendix E.



NCDOT's baseline nutrient load in Falls Lake was calculated using existing watershed and lake models that were prepared by NCDWR

Table 5. NCDOT Baseline and Interim Development Period TN and TP Loads (pounds/year) in the Falls Lake Watershed[1,2]

	Total Nitrogen Load (pounds/year)			Total Phosphorus Load (pounds/year)		
Baseline Period	14,657			1,931		
Interim Period	Non-NCDOT Baseline Development	NCDOT Development	Net NCDOT Load	Non-NCDOT Baseline Development	NCDOT Development	Net NCDOT Load
Primary Roads	28	61	33	6	4	(2)
Secondary Roads	1,318	1,174	(144)	287	214	(73)
Non-Road	22	19	(3)	6	2	(4)
All Development	1,368	1,254	(114)	299	220	(79)

[1] Methods used to calculate NCDOT baseline and interim development period loads are provided in Appendix D and E, respectively.
[2] Loads associated with secondary road development are considerably higher than loads for primary road development because 99% of the interim period road development was associated with secondary roads.

4.2 Implementation of Nutrient Load-Reducing Opportunities

15A NCAC .0281 (9)(d)(iii) summarizes the types of activities that NCDOT may use to meet the existing development Rule. Compliance activities will include a wide variety of structural and non-structural controls that NCDOT and NCDENR find to demonstrate a capacity to reduce nutrients from existing road and non-road development. Structural SCMs are designed to reduce pollutant transport and loadings to surface waters by holding and treating runoff during storm events. Non-structural SCMs are processes, policies, or practices implemented to influence behaviors, decisions, or actions that reduce the amount of pollution entering surface waters. Some examples of non-structural SCMs applicable to the highway environment include street sweeping, public outreach and education, and management of fertilizer application within the ROW. Non-structural SCMs can also be decision-making practices that guide NCDOT staff to engage in alternative activities or use alternative designs that result in reduced nutrient loading. NCDOT will also implement other load reducing activities in the watershed including: illicit discharge removal; improvement of existing stormwater structures; use of rain barrels and cisterns; stormwater capture and reuse; and purchase of nutrient reduction credits as described at 15 NCAC 02B .0281 (9)(d)(iii).

Example of a structural SCM: Bioretention basin with environmental education signage describing how the SCM treats parking lot runoff from a NCDOT rest area

NCDOT will initiate implementation of the EMC-approved stormwater management program for its existing development no later than January 15, 2014 so as to contribute toward the achievement of the Stage I and Stage II objectives described in 15A NCAC 02B .0275. The implementation rate and schedule for Stage I and Stage II are described below:

Stage I Rate and Schedule

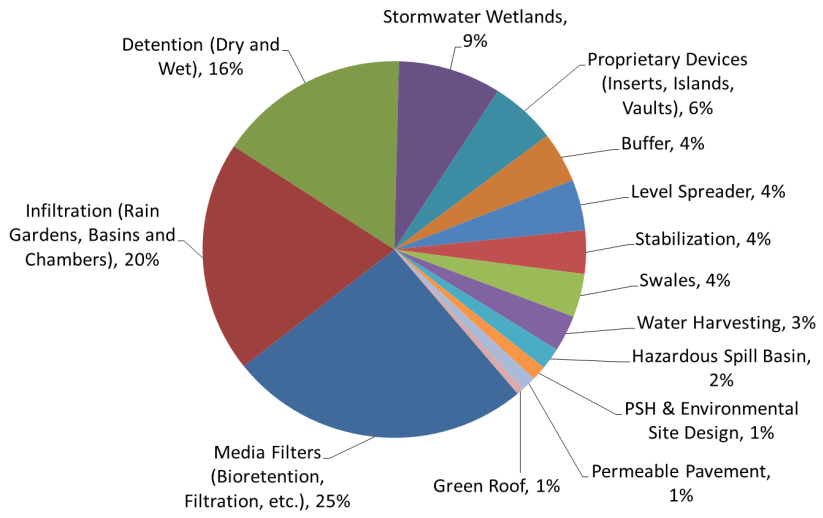
NCDOT will implement load reducing opportunities throughout the Falls Lake watershed to contribute to the achievement of the Stage I objective. NCDOT will implement six retrofits per year or a combination of structural and nonstructural nutrient load measures equivalent to six retrofits per year as described in 15A NCAC 02B .0281 (9)(d)(iv). NCDOT will continue this annual implementation rate until the Stage I objective is achieved.

Stage II Rate and Schedule

NCDOT will initiate the EMC-approved stormwater management program for its existing development no later than the Stage II beginning date specified in 15A NCAC 02B .0275. To the maximum extent technically and economically feasible, NCDOT will implement six retrofits per year or a combination of structural and nonstructural nutrient load measures equivalent to six retrofits per year as described in 15A NCAC 02B .0281 (9)(d)(iv). NCDOT will give priority to implementing load reducing opportunities in the Upper Falls Lake watershed. NCDOT will continue this annual implementation rate until the Stage II objective is achieved.

In the event that the timeframes for achieving the Stage I and Stage II objectives overlap, NCDOT will implement six retrofits per year or a combination of structural and nonstructural nutrient load measures equivalent to six retrofits per year as described in 15A NCAC 02B .0281 (9)(d)(iv).

NCDOT will implement management measures described in NCDOT's Stormwater Best Management Practices Toolbox (BMP Toolbox) and NCDENR's Stormwater Best Management Practices Manual, as well as other structural and non-structural nutrient load reducing activities, for which NCDOT can supply nutrient load reducing estimates. To the maximum extent practicable, BMP retrofits will be designed to treat the runoff generated by the one-inch rainfall event and to conform to the standards and criteria established in the most recent version of the NCDOT BMP Toolbox. It is anticipated that NCDOT will achieve the annual goal through implementation of a variety of structural and non-structural SCMs; some of which are yet to be evaluated for their nutrient-removal capability. To support this decision-making process, NCDOT commits to work cooperatively with NCDWR to develop tools and accounting methods for a wide range of load reducing activities that have not been evaluated. For SCMs that have been evaluated, NCDOT will rely on the nutrient accounting tool which defines relative magnitudes of loads based on physiographic region, drainage area, soil type, and climate variables. As practicable, NCDOT commits to implement practices on existing road and non-road development using existing retrofit project identification and implementation practices. Historically, NCDOT has implemented a wide range of BMP retrofits at maintenance yards, welcome centers, rest areas, and material storage facilities as well as in the linear ROW. Typical BMP device types installed under the NCDOT Retrofit Program are shown in the adjacent figure. The selection of BMPs depend on a number of factors, such as whether the project is roadway or non-roadway, and are designed to meet project-specific treatment objectives. In the Falls Lake watershed, NCDOT will continue to implement these practices at roadway and non-roadway facilities (e.g. NCDOT offices, maintenance yards, and storage facilities) as appropriate. The selection process for identifying load reducing opportunities used to meet the six retrofit-equivalents will prioritize those which achieve the greatest nutrient load reduction for the lowest cost.



Summary of BMP device types and historic implementation under NCDOT's Retrofit Program since inception.

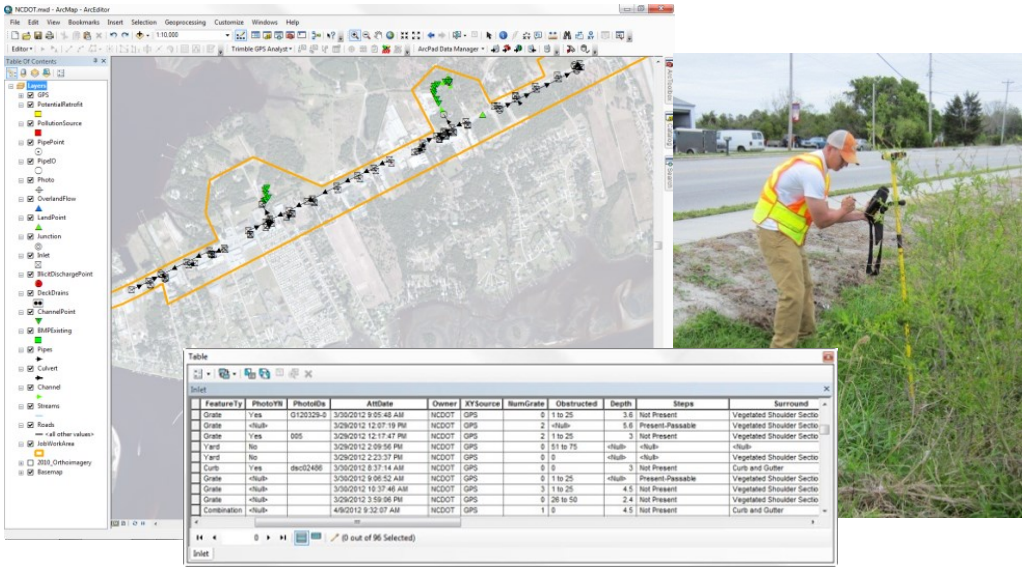
NCDOT implements a wide range of stormwater management programs and activities through several business units. Under NCDOT's GREEN program for existing development, many of NCDOT's existing activities that address stormwater requirements (for example, project planning, programming, project development, design, construction, and maintenance) will be optimized to address the nutrient reduction initiatives in Falls Lake. NCDOT has developed statewide programs to implement NPDES and other environmental requirements that are similar in nature to the existing development Rules. NCDOT requests that implementation of these stormwater activities and programs also satisfy one or more of the requirements under the Falls Lake Rules. Four examples of existing NCDOT programs that will be instrumental in implementing the existing development Rules include NCDOT's Stormwater System Inventory and Prioritization Program, BMP Retrofit Program, Inspection and Maintenance Program (Appendix B), and Illicit Discharge, Detection, and Elimination Program (IDDEP). These programs, among

many other programs, are required under NCDOT's NPDES stormwater permit and are described in the following subsections. These standards and practices will be applied in the Falls Lake watershed, in identifying and implementing retrofits and other load reducing activities to meet the retrofit directive of six control-equivalents per year.

15 NCAC 02B .0281 (11)(d) requires NCDOT to "submit annual reports to the division summarizing its activities in implementing each of the requirements in Item (9) of this Rule." Annual reporting to NCDENR will include a description of structural SCMs, non-structural SCMs, offset payments, and other measures that reduce nutrient loading from existing development. NCDOT will report on changes in nutrient loads associated with these activities, including nutrient accounting workbooks or calculations and the types of existing road and non-road development affected. Nutrient load reductions will be estimated using NCDOT-JLSLAT, established removal rates for individual practices as recommended by the Nutrient Scientific Advisory Board, or other NCDWR-approved procedures that are based on sound science. NCDOT anticipates that annual reporting will occur in conjunction with NCDOT's NPDES stormwater permit annual reporting. Similar to other NPDES permit requirements, NCDOT's existing development activities under NCDOT's GREEN program will receive regular NCDWR review and assessment under existing NPDES auditing procedures.

4.2.1 Stormwater System Inventory and Prioritization Program

NCDOT maintains a statewide inventory of implicit outfalls as part of the Department's Stormwater System Inventory and Prioritization Program. This inventory has cataloged over 116,000 state maintained road crossings over waterbodies and is updated annually to account for additional implicit outfalls from new road construction. In addition, NCDOT identifies outfalls in the field from the NCDOT ROW within selected priority areas using mapping-grade global positioning system (GPS) equipment and customized software as part of the Department's Field Inventory Program. Through this program, NCDOT identifies stormwater outfalls from interstate, US, and NC primary routes as required under 15A NCAC 02B .0281 (9)(a). Annual reporting will include a summary of activities undertaken through this program to identify outfalls from primary routes in the Falls Lake watershed.



NCDOT's Field Inventory program will be instrumental in cataloguing NCDOT stormwater outfalls along primary routes in the Falls Lake watershed

4.2.2 BMP Retrofit Program

NCDOT's BMP Retrofit Program identifies and implements SCM retrofits to preserve and protect surface waters from pollutant loading due to NCDOT activities. Statewide, this program addresses NCDOT NPDES BMP retrofit compliance requirements by identifying a minimum of 14 sites per year that are appropriate for retrofit installation and implementing a minimum of five retrofit projects per year and 70 retrofits over the five year NPDES permit term. In meeting these requirements, the BMP Retrofit program manager works closely with NCDOT Highway Stormwater Program's Research, TMDL, BMP Toolbox, and Post-Construction Stormwater Control program managers and various NCDOT Units, to develop standards (such as details, specifications, cost estimating) and processes to facilitate the implementation of creative practices that improve water quality and reduce environmental impacts.

Newly constructed Biofiltration Conveyance retrofit BMP outfitted with surface and groundwater flow monitoring equipment

4.2.3 Illegal Discharge Detection and Elimination Program

Example of Non-Structural SCM: An educational poster developed by NCDOT's IDDEP to educate staff

NCDOT is required to "identify and eliminate illegal discharges into NCDOT's stormwater conveyance system" (15A NCAC 02B .0281 (9)(b)) in the Falls Lake watershed. Compliance with this requirement is achieved through continued implementation of NCDOT Highway Stormwater Program IDDEP activities as required under NCDOT's NPDES stormwater permit. Through IDDEP, NCDOT detects and eliminates illicit discharges, spills, and illegal dumping into the NCDOT transportation separate storm sewer system, and reports such findings to NCDENR for appropriate enforcement. The NCDOT IDDEP consists of various staff, contractor, and volunteer training initiatives, investigating and reporting findings, and maintaining a standard point of contact and tracking database. NCDOT also collaborates with municipalities and other appropriate agencies to identify and report illegal discharges. When members of NCDOT staff identify a potential illicit discharge or illegal dumping site along NCDOT ROW, it is documented and reported to the NCDOT IDDEP point of contact and others as appropriate. Once verified, the activity is either resolved by NCDOT or reported to NCDENR within 30 days as required by NCDOT's NPDES stormwater permit.

Reporting of discrete illegal discharges or dumps identified through NCDOT's IDDEP will occur on an as-needed basis (typically within 30-days of verification). Annual reporting will include a summary of activities performed in the Falls Lake watershed under the NCDOT IDDEP.

5.0 Nutrient Management Education Program

15 NCAC 02B .0281 (9)(e) requires NCDOT to educate staff and contractors on proper application of nutrients in highway rights of way. In keeping with this requirement, NCDOT will initiate a Nutrient Management Education Program for staff and contractors who apply fertilizers on highway rights of way in the Falls Lake watershed. The training will address issues specific to the unique aspects of nutrient management for linear transportation construction and maintenance activities and will emphasize the most current state-recognized technical guidance on proper nutrient management.

15 NCAC 02B .0281 (9)(e)

Initiate a "Nutrient Management Education Program" for NCDOT staff and contractors engaged in the application of fertilizers on highway rights of way. The purpose of this program shall be to contribute to the load reduction objectives established in 15A NCAC 02B .0275 through proper application of nutrients, both inorganic fertilizer and organic nutrients, to highway rights of way in the Falls watershed in keeping with the most current state-recognized technical guidance on proper nutrient management.

NCDOT will utilize its web-based North Carolina Learning Center System and other training venues to connect staff and contractors with interactive training on nutrient management. The training will include content analogous to North Carolina State University Cooperative Extension Service Nutrient Management Training including topics such as a general overview of water quality impacts from nutrient applications along roadsides; how nutrients move in a linear transportation environment; roadside conservation practices for nutrient management; and how to make nutrient application decisions.

Operators involved in hydroseeding on construction sites within the Falls and Jordan Lake watersheds will receive nutrient management training through the North Carolina Learning Center System

As an ongoing effort to minimize pollutant potential of stormwater runoff and in accordance with NCDOT's NPDES permit, the department continues to conduct annual training for staff who manage the application of fertilizers. In addition to this training, NCDOT partners with the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) to analyze soil samples and provide recommendations on fertilizer composition and application rates.

6.0 Reporting

NCDOT will report annually to NCDENR on the measures taken to comply with the Rules. For new development projects, NCDOT will submit a description of new non-road certified projects and associated SCMs, project-specific copies of NCDOT-JLSLAT and other supporting calculations, nutrient offset payments and offsite management measures, and changes in nutrient loads associated with these activities. For existing development, annual reporting will include a description of structural SCMs, non-structural SCMs, offset payments, and other measures used to reduce nutrient loading along with associated nutrient load reductions. NCDOT will report on significant SCM maintenance or rehabilitation activities performed by Division Roadside and Environmental Unit Engineers (responsible for SCM maintenance) and report on how nutrient load reduction performance was affected. Lastly, annual reporting will include a summary of activities undertaken to identify outfalls from primary routes and reports of illegal discharges and dumps identified in the Falls Lake watershed. It is anticipated that GREEN program activities will be reported in conjunction with NCDOT's Annual Stormwater Report for the NCDOT Highway Stormwater Program submitted each November in compliance with its NPDES Permit.

7.0 Contacts

Andy McDaniel, PE
NC Department of Transportation
Hydraulics Unit
1590 Mail Service Center
Raleigh, NC 27699-1590
919.707.6700
ahmcdaniel@ncdot.gov

Ken Pace, PE
NC Department of Transportation
Roadside Environmental Unit
1557 Mail Service Center
Raleigh, NC 27699-1557
919.707.2927
kpace@ncdot.gov

8.0 References

NCDENR, 2003. *Department of Transportation's Minimum Criteria*. 19A NCAC 02F. Raleigh, NC: North Carolina Office of Administrative Hearings.

NCDENR, 2009. *Falls Lake Watershed Analysis Risk Management Framework (WARMF) Development. Final Report*. Prepared by N.C. Department of Environment and Natural Resources, Division of Water Quality, Planning Section, Modeling/TMDL Unit. October 2009.

NCDENR, 2010. *Falls Lake Rules*. 15A NCAC 02B .0275 through .0282 and amended .0235 and .0315 Raleigh, NC: North Carolina Office of Administrative Hearings. Approved by the North Carolina Rules Review Commission on December 16, 2010. Effective January 15, 2011.

NCDENR, 2013. http://portal.ncdenr.org/web/fallslake (accessed April 2013).

NCDOT, 2009. *NCDOT Land Use Analysis in the High Rock Lake Watershed, North Carolina*. Prepared by URS Corporation – North Carolina for the NCDOT Highway Stormwater Program.

NCDOT, 2010. *North Carolina Department of Transportation Metadata Content Standard for Geospatial Data*. Recommendations from Data Quality Group. Version 1.1.3. December 3, 2010.

NCDOT, 2012a. *Transportation Land Use/Land Cover and Stormwater Control Measure Updates for the Jordan/Falls Lake Nutrient Accounting Tool*. Prepared by URS Corporation for the NC Department of Transportation. Final version date June 2012 and approved by the NC EMC on July 12, 2012.

NCDOT, 2012b. *Stormwater Management Program for New Development in the Jordan Lake Watershed*. Prepared by URS Corporation for the NC Department of Transportation. Final version date October 2012 and approved by the NC EMC on November 8, 2012.

NCDOT, 2012c. *Baseline Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed*. Prepared by URS Corporation for the NC Department of Transportation. Final version date June 2012 and approved by the NC EMC on July 12, 2012.

NCDOT, 2012d. *NCDOT Right-of-Way and Impervious Area Land Use Analysis in the Jordan Lake Watershed*. Prepared by URS Corporation for the NCDOT Highway Stormwater Program. November 2012.

NCDOT, 2013a. *Interim Development Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed*. Prepared by URS Corporation for the NC Department of Transportation. Prepared July 2013.

NCDOT, 2013b. http://www.ncdot.gov/it/gis/ (accessed April 2013).

NCSU, 2011. *Jordan/Falls Lake Stormwater Load Accounting Tool (Version 1.0) User's Manual*. Revised January 31, 2011.

NC OneMap, 2013. http://www.nconemap.com/ (accessed April 2013).

USDA, 2013. Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/ (accessed June 2013).

9.0 Acronyms and Abbreviations

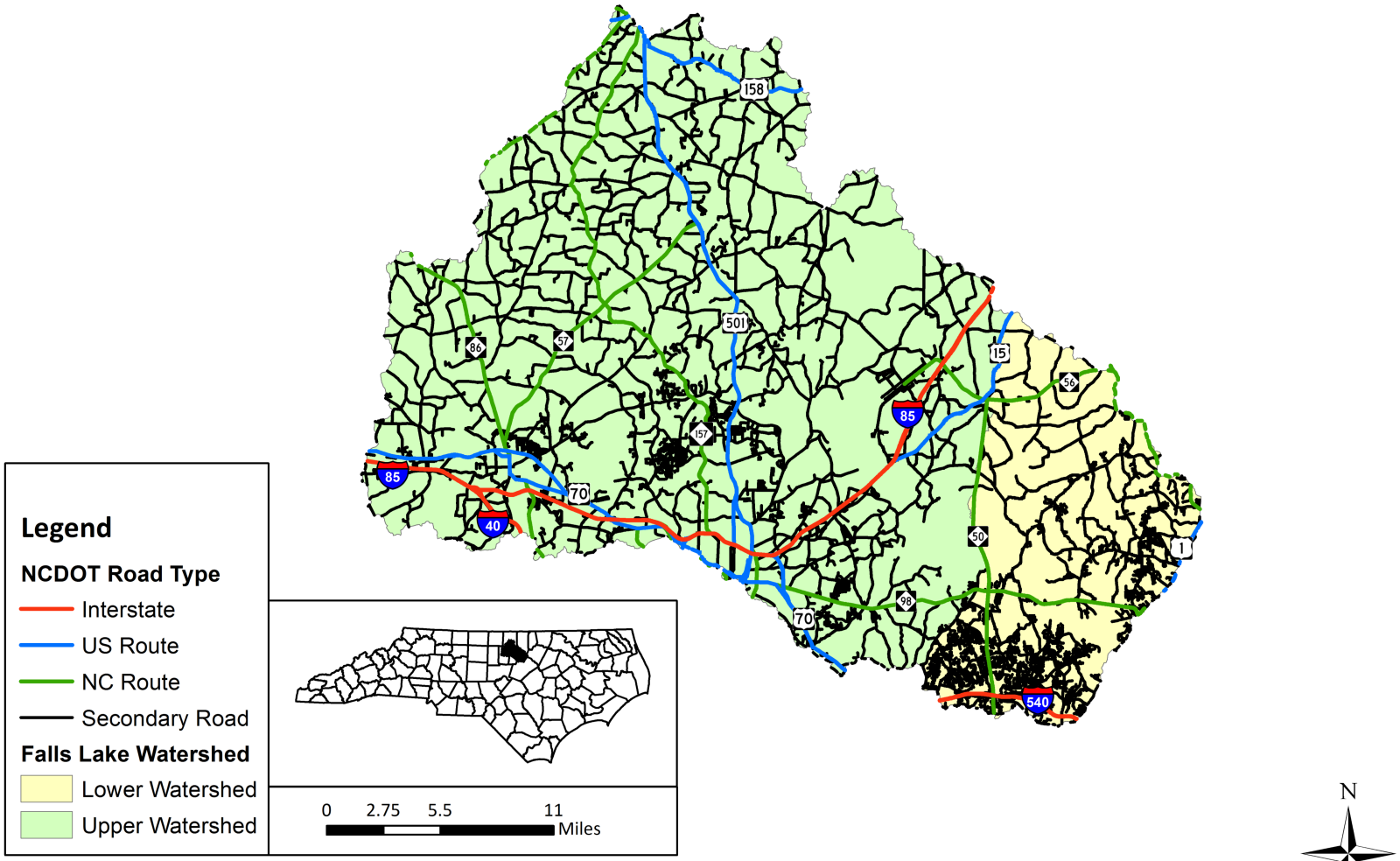
BMP	Best Management Practice
CMY	County Maintenance Yard
DMV	Division of Motor Vehicles
EFDC	Environmental Fluid Dynamics Code
EMC	Environmental Management Commission
FGDC	Federal Geographic Data Committee
Ft^2	Square Feet
GIS	Geographic Information System
GPS	Global Positioning System
GREEN	Guided Reduction of Excess Environmental Nutrients
I&M	Inspection and Maintenance
IDDEP	Illicit Discharge, Detection, and Elimination Program
JLSLAT	Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool
Lbs	Pounds
LOS	Level of Service
NC	North Carolina
NCAC	North Carolina Administrative Code
NCDA&CS	North Carolina Department of Agriculture and Consumer Services
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOT	North Carolina Department of Transportation
NCDOT-JLSLAT	NCDOT Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool
NCDWQ	North Carolina Division of Water Quality
NCDWR	North Carolina Division of Water Resources
NCSU	North Carolina State University
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NSW	Nutrient Sensitive Water
PCSP	Post Construction Stormwater Program
QA/QC	Quality Assurance / Quality Control
ROW	Right-of-way
SCM	Stormwater control measure
SCMS	Stormwater Control Management System
SPPP	Stormwater Pollution Prevention Plan
SR	Secondary Route
US	United States
USDA	United States Department of Agriculture
WARMF	Watershed Analysis Risk Management Framework
Yr	Year

Appendix A

NCDOT Roads in the Falls Lake Watershed

This page is intentionally left blank

NCDOT ROADS IN THE FALLS LAKE WATERSHED



Notes:

1. The roads shown in this drawing represent NCDOT owned or managed roads and are based on the first quarter 2013 release of NCDOT's primary and secondary routes (https://connect.ncdot.gov/resources/gis/Pages/GIS-Data-Layers.aspx). Approximate mileage associated with each NCDOT road category is as follows: Interstates: 97 miles, US Routes: 116 miles, NC Routes: 125 miles, and Secondary Roads: 1,505 miles.
2. The Falls Lake Watershed boundary was obtained from NCDWQ's website (http://portal.ncdenr.org/web/fallslake/)

This page is intentionally left blank

Appendix B

NCDOT Inspection and Maintenance Program

This page is intentionally left blank

NCDOT Inspection and Maintenance Program

NCDOT has installed numerous stormwater control measures (SCM) within NCDOT rights-of-way across the state to reduce the amount of pollutants found in stormwater. A SCM is an engineered structure or device that is generally designed to slow down or hold water for a short time and remove pollutants before the water is released to a surface water body or as the water infiltrates to the ground. SCMs are widely referred to as best management practices (BMPs). They are also called "post-construction SCMs" because they are designed to stay in place and treat runoff after an impervious surface is built, as opposed to temporary erosion control practices (e.g., silt fences, sediment basins) used during a construction project. As of the spring of 2013, NCDOT's active SCM inventory included over 1,450 SCMs statewide.

Stormwater control measures must be routinely inspected and maintained so that they continue to function as designed. If proper maintenance is not provided, the pollutant removal performance of the SCM may be compromised. NCDOT has developed an Inspection and Maintenance (I&M) Program to address NPDES permit requirements for maintaining SCM assets. This program includes dedicated personnel responsible for the functionality of NCDOT's Stormwater Control Management System (SCMS, pronounced "skims") website, an SCM I&M Manual, training, program auditing, and cross-training between design engineers, construction, and maintenance staff to increase stormwater control measure I&M awareness within NCDOT.

I&M Program – National Pollutant Discharge Elimination System Compliance Overview

The overall goals of the I&M Program are to maintain National Pollutant Discharge Elimination System (NPDES) permit compliance and provide NCDOT field personnel the tools they need to effectively inspect and maintain SCM inventories.

Initially, the I&M Program team worked with NCDOT Information Technology staff and developed a database to track SCM inventories, inspections, and maintenance. NCDOT performed baseline inspections on all known stormwater controls and piloted an I&M Program with Division 3. During this pilot program the I&M team began developing a website to manage SCM inventories, document inspections and maintenance, and track the initiation and design of retrofit SCMs. A naming convention was agreed upon and the I&M Program team drafted the SCM I&M Manual.

Division Roadside Environmental Engineers refer to NCDOT's SCM I&M Manual for proper SCM function, inspection details, and maintenance techniques. I&M activities are documented in SCMS, and Level of Service (LOS) ratings are assigned to each SCM inspected. In addition, NCDOT Hydraulics Unit staff utilize SCMS to track and document information related to the design and construction of retrofit SCMs.

In recent years, the I&M Program has focused on training Division Roadside Environmental and Division Environmental personnel to manage their SCM inventories and document the inspection and maintenance of their stormwater controls on the SCMS website. Additionally, upgrades were made to SCMS to increase functionality and the I&M Program team provided training to division personnel on these upgrades. Anticipated program updates include the addition of chapters to the Stormwater Control I&M Manual and the promotion of communication between design, construction, and maintenance personnel.

The I&M Program is an integral element of NCDOT's NPDES Program. While the program receives NCDWQ approval on an annual basis, NCDOT is in regular communication with NCDWQ regarding the components and activities performed under the I&M Program throughout the year.

NCDOT's SCMS

NCDOT developed the SCMS website to track SCM inventories and manage the I&M performed on their stormwater control measures (see Figures B1 and B2). SCMS offers extensive functionality including entering and storing I&M records for each SCM; mapping/location features; tracking SCM inventories by division, county, or individually; tracking research on a specific control; storing SCM-specific regulatory and roadway data; storing images and documents associated with an SCM; and generating reports. Each time an inspection is performed for a SCM, a grade or LOS rating is assigned based on the status of the SCM. Inspection details, maintenance needs determined at the time of the inspection, and the LOS rating are tracked in SCMS. NCDOT division and Highway Stormwater Program management can view the status of inspection records, the average LOS's per division, and the I&M history for each SCM, among many other I&M program indicators. The divisions are, in turn, measured on the average LOS of their active stormwater control measures.

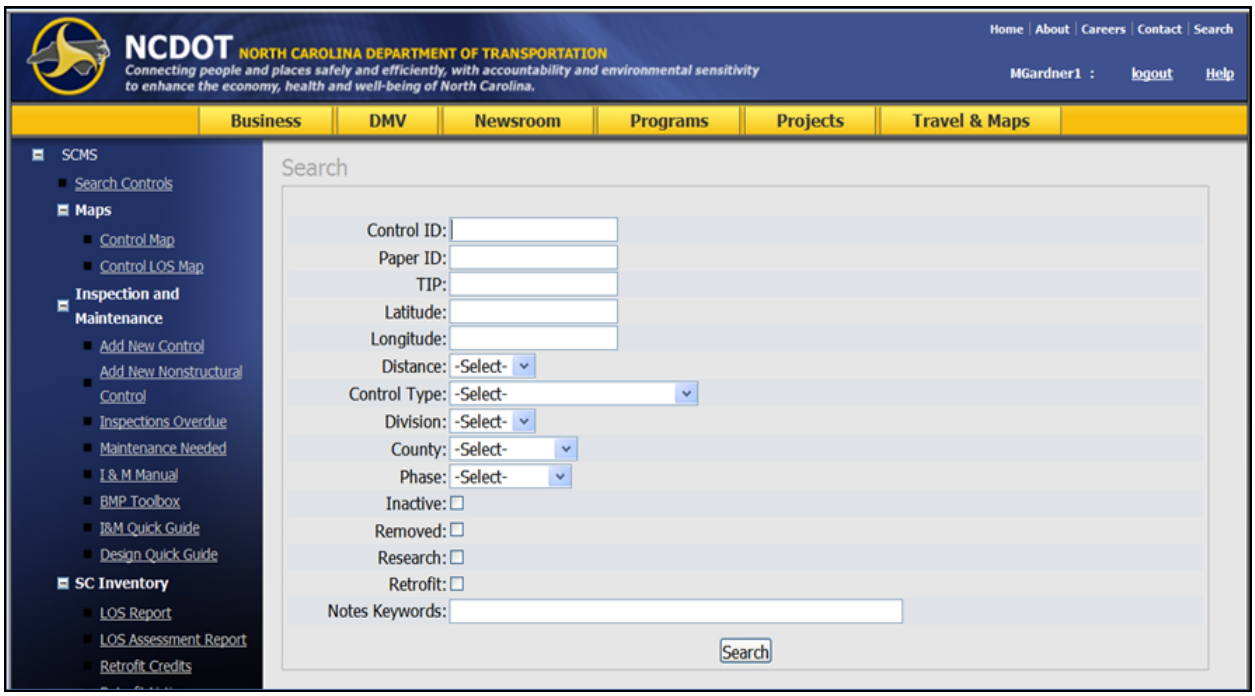


Figure B1. The Search page in NCDOT's SCMS website. Stormwater control measures can be searched by type, county, division, phase, or a combination of these and other identifiers.

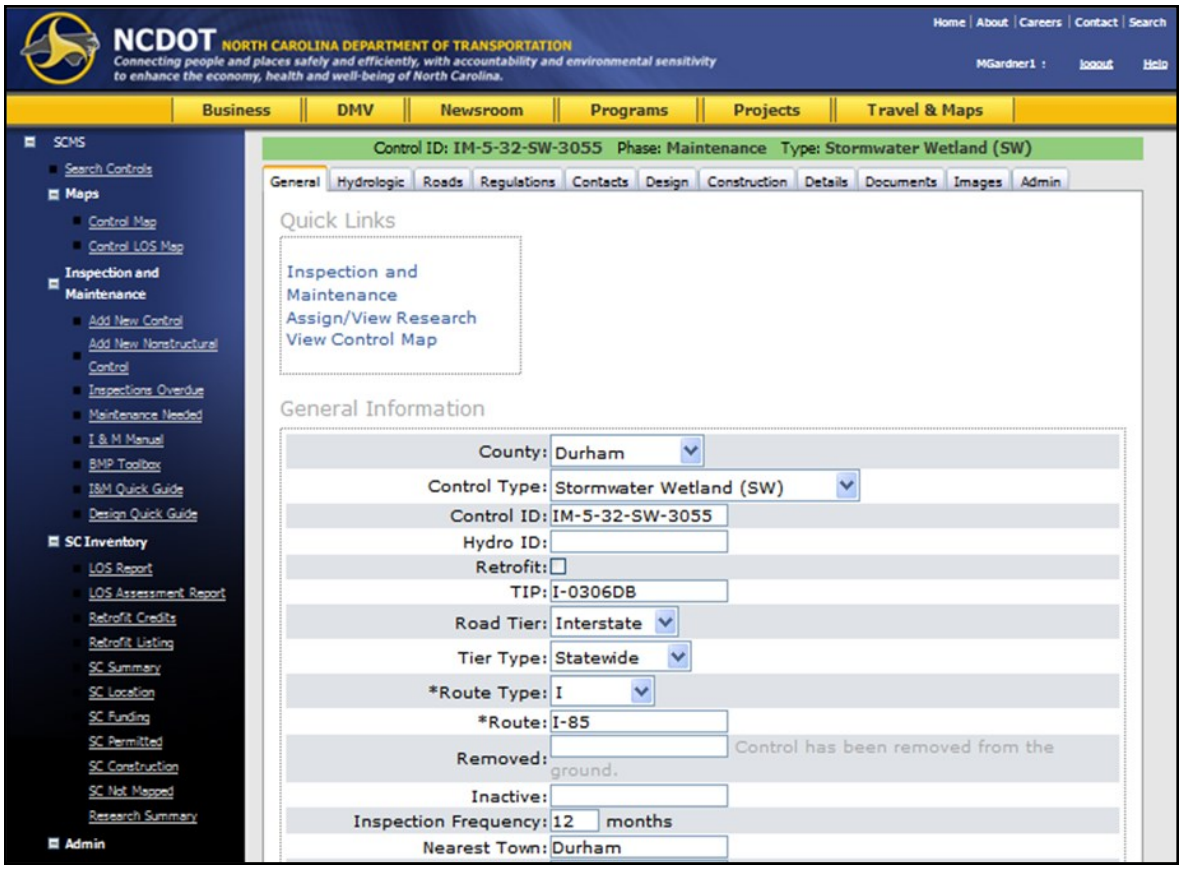


Figure B2. The General Information page in SCMS for a Stormwater Wetland in Durham County within the Falls Lake Watershed.

NCDOT's Stormwater Control Measure I&M Manual

NCDOT developed a Stormwater Control Measure I&M Manual to serve as guidance for inspecting and maintaining stormwater controls on NCDOT's rights-of-way. The first four introductory chapters include a general discussion of inspection requirements and maintenance considerations (including plant species identification and reporting requirements for post-construction, structural SCMs).

The remaining chapters are dedicated to the different types of stormwater controls. Each chapter focuses on a specific SCM and includes a general description of the SCM and its components, guidance on I&M requirements for each component of the SCM, photos of the SCM, and detailed diagrams of the SCM (see example in Figure B3) that show the major treatment mechanisms.

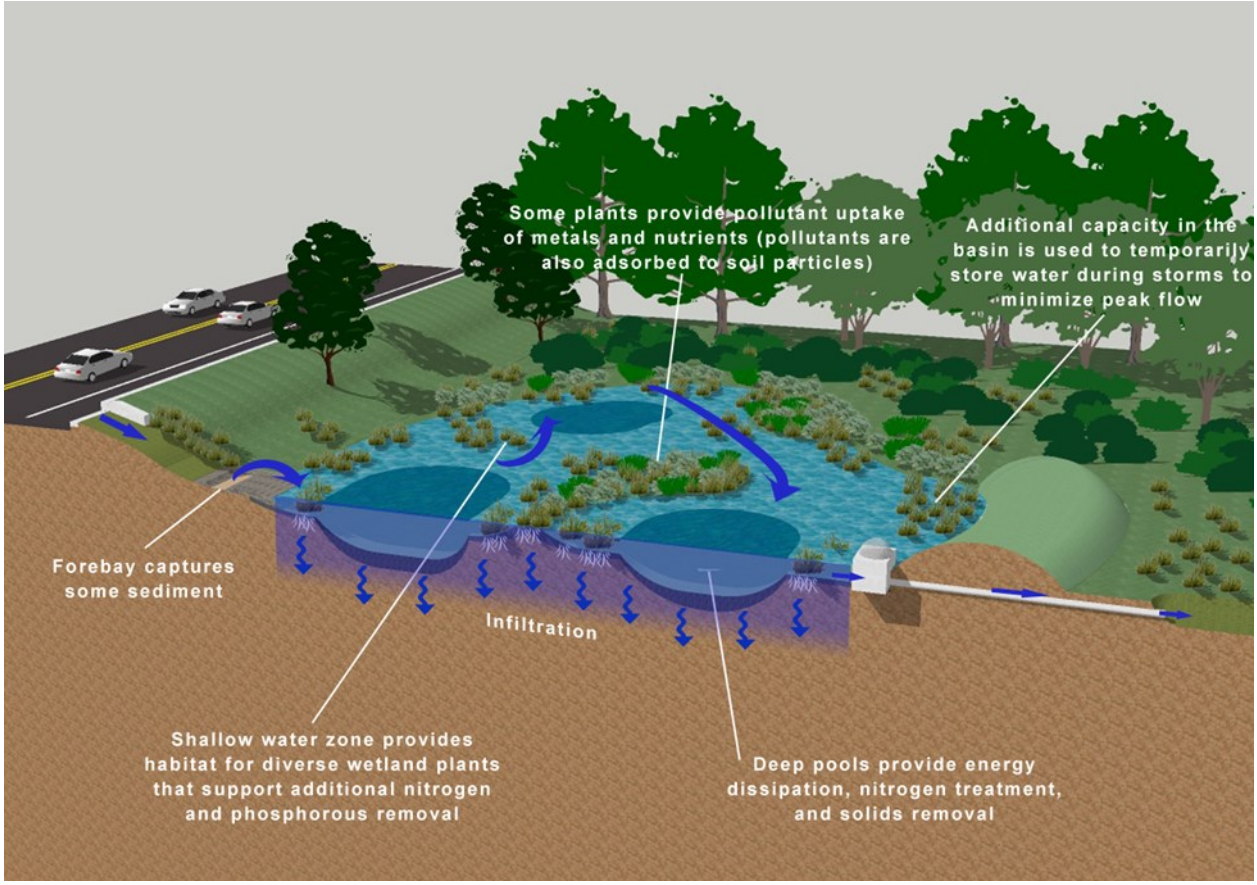


Figure B3. An example of the diagrams used in NCDOT's Stormwater Control I&M Manual: A cutaway of a stormwater wetland flow diagram and treatment processes.

Appendix C

NPDES Certification Statement

This page is intentionally left blank

NPDES Certification Statement

Please see Section 3.2.1 for additional information regarding the applicability of this certification statement.

"I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."

This page is intentionally left blank

Appendix D

Baseline Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed

This page is intentionally left blank

Baseline Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed

In partial fulfillment of 15A NCAC 02B .0281

Prepared by:
URS Corporation – North Carolina
1600 Perimeter Park Drive
Suite 400
Morrisville, NC 27560

Prepared for:
NC Department of Transportation
Hydraulics Unit
1590 Mail Service Center
Raleigh, NC 27699-1590
919.707.6700
hydraulics@ncdot.gov

June 2012

This report was approved by the North Carolina Environmental Management Commission on July 12, 2012.

Introduction

The Falls Lake Rules (15A NCAC 02B .0275-.0282, .0235, and .0315) establish a nutrient management strategy designed to reduce algal growth in Falls Lake through the reduction of nitrogen and phosphorus sources in the watershed. Under the rules, all major contributors of nutrients in the watershed, including the North Carolina Department of Transportation (NCDOT), are required to reduce their loading of total nitrogen (TN) and total phosphorous (TP) and to meet specific percent reduction goals to restore water quality standards in the lake. The rules were approved by the N.C. Rules Review Commission on December 16, 2010 with an effective date of January 15, 2011.

As part of the stormwater requirements for state and federal entities (15A NCAC 02B .0281), by July 15, 2012, North Carolina Division of Water Quality (NCDWQ) is required to submit a nutrient accounting framework to the North Carolina Environmental Management Commission (EMC) for approval. The framework shall:

> *"… include tools for quantifying load reduction assignments on existing development for parties subject to this Rule, load reduction credits from various activities on existing developed lands, and a tool that will allow subject parties to account for loading from new and existing development and loading changes due to BMP implementation. The Division shall work in cooperation with subject parties and other watershed interests in developing this framework."* (15A NCAC 02B .0281 (13))

Additionally, 15A NCAC 02B .0281 (9)(d)(i) states:

> *"As part of the accounting process described in Item (13) of this Rule, baseline nutrient loads shall be established for roadways and industrial facilities using stormwater runoff nutrient load characterization data collected through the National Pollutant Discharge Elimination System (NPDES) Research Program under NCS0000250 Permit Part II Section G;"*

In accordance with these requirements, the NCDWQ, NCDOT, and URS developed an approach for calculating baseline nutrient loads for NCDOT in the Falls Lake watershed. The approach is based on existing data and models used to develop the Falls Lake Rules. This report describes the technical approach and steps used to calculate NCDOT's baseline TN and TP loads.

Overview of Existing Models

In 2009, NCDWQ completed a watershed model and lake nutrient response model in accordance with Session Law 2005-190 (North Carolina Senate Bill 981) and to address impaired chlorophyll-a and turbidity conditions in Falls Lake. These models were subsequently used to support the development of the Falls Lake Nutrient Management Strategy and Rules.

- **Watershed Analysis Risk Management Framework (WARMF)** – This model was used by NCDWQ to simulate conditions in the Falls Lake watershed and, in particular, quantify nutrient contributions from point and nonpoint sources (NCDWQ, 2009a). The model was calibrated in five main tributaries draining to the upper watershed: Flat River, Knap of Reeds Creek, Ellerbe Creek, Little River and Eno River. The remainder of the watershed model was not calibrated,

- **Environmental Fluid Dynamics Code (EFDC)** – This model simulates conditions within Falls Lake and was applied by NCDWQ to predict chlorophyll-a concentrations in the lake in response to

tributary nutrient loading and in-lake processes (NCDWQ, 2009b). This model was used as the basis for the Stage I and II nutrient reduction goals stated in the rule (15A NCAC 02B .0275 (3)).

Technical Approach for Calculating NCDOT Baseline Loads

The Falls Lake WARMF and EFDC models provide the best available estimates of existing nutrient source contributions in the watershed and nutrient loading to the lake. As presented in Figure 1, for this project, output from the Falls Lake WARMF model was used to determine NCDOT's relative percentage of nutrient load delivered to Falls Lake during the 2006 baseline period. Tributary flow and water quality inputs, available in the EFDC model, were used to determine the TN and TP tributary loads delivered to Falls Lake from all sources in the watershed during the baseline period. TN and TP loads from NCDOT were calculated for each tributary by multiplying the NCDOT percentage of total delivered load by the total delivered baseline load in each tributary. NCDOT TN and TP loads for the entire watershed were then calculated as the sum of all NCDOT tributary loads.

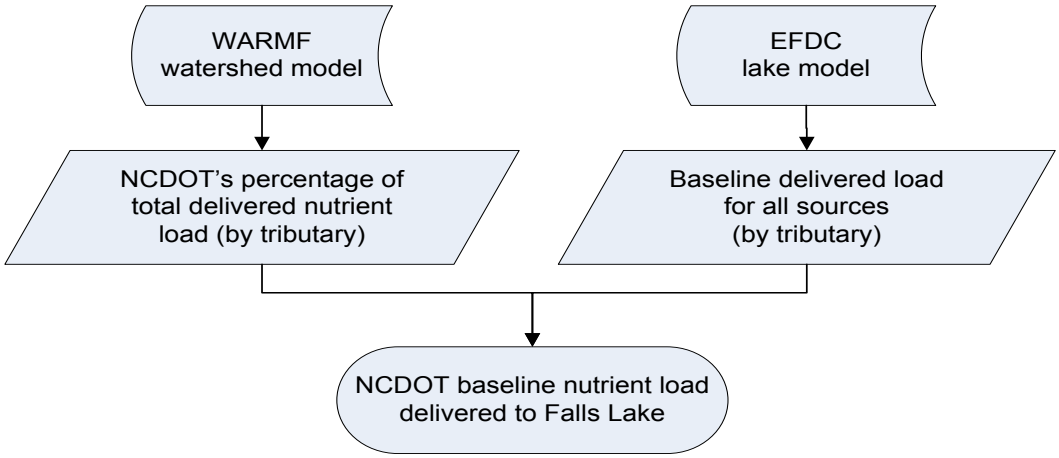


Figure 1. Method Used to Calculate NCDOT's Baseline Nutrient Load in Falls Lake.

For this evaluation, all model parameters, inputs and outputs were used "as is" with the exception of soil layer hydrology input revisions requested by NCDWQ (see discussion on page 4); no additional flow or water quality data was used, nor was any data removed from the original datasets. All decisions related to the methods and technical approaches used in this project were discussed in detail with NCDWQ staff during the project and are described in this report.

Because the Falls Lake EFDC and WARMF models were developed in parallel, and model boundary conditions were not directly linked, NCDWQ, NCDOT and URS collaborated on a method to align WARMF subwatershed and catchment boundaries with the EFDC tributary boundaries. This step was necessary for this evaluation because tributary boundary conditions in EFDC (Figure 2) were used to define the total delivered loads while WARMF catchments were used to calculate the associated percentage of delivered load that was attributable to NCDOT in those tributary loads. WARMF subwatershed and catchment assignments to tributaries (Figure 3), developed for this evaluation, were made based on their proximity to tributary boundaries in EFDC.

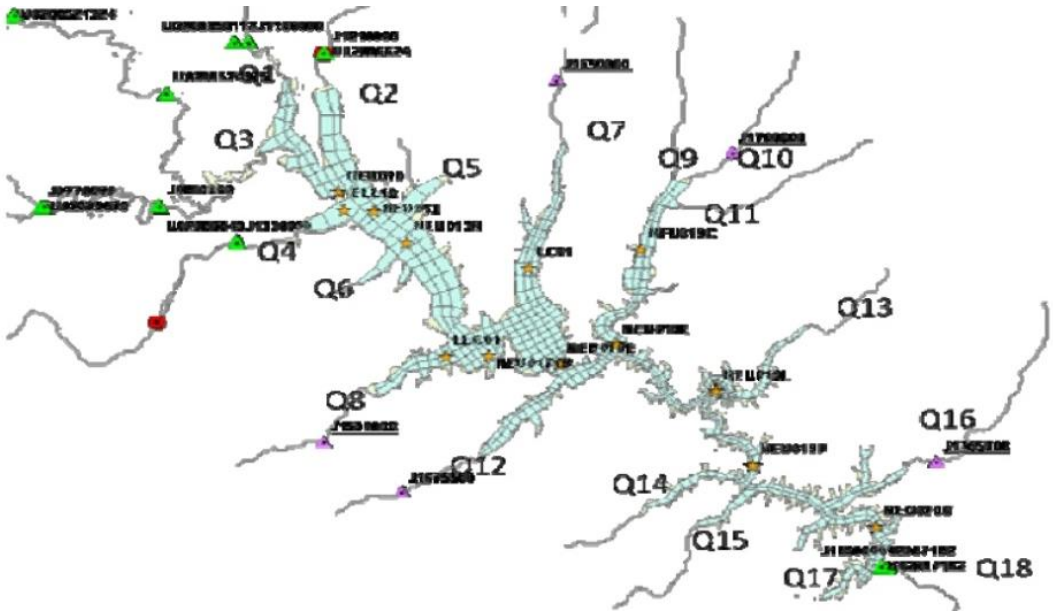


Figure 2. Falls Lake EFDC Model Tributary Inputs (Source: NCDWQ, 2009b).

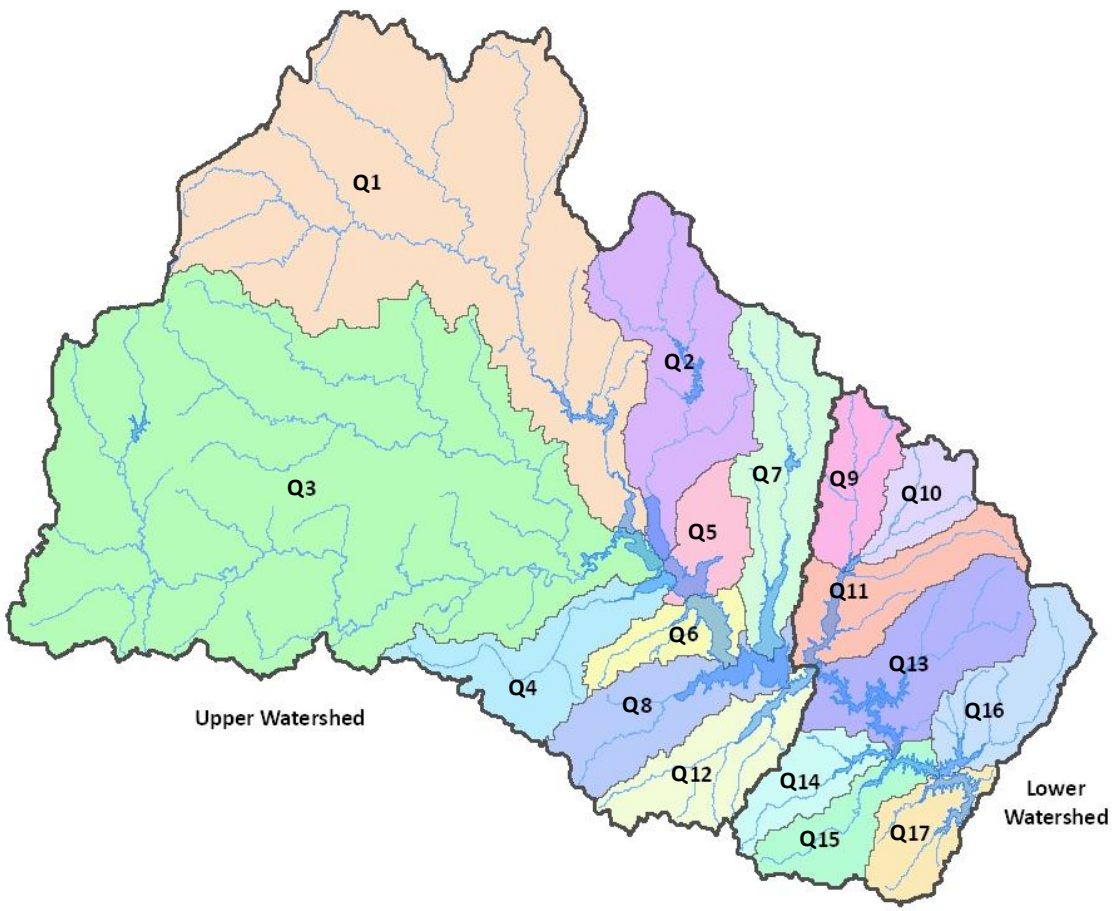


Figure 3. Falls Lake WARMF Subwatersheds and Corresponding EFDC Tributary Assignments.

NCDOT Percentage of Baseline Nutrient Loads Delivered to Falls Lake

The relative percentage of TN and TP loads attributable to NCDOT was calculated using WARMF estimates of delivered NCDOT loads in the seventeen subwatersheds shown in Figure 3. In general, this process involved an accounting of NCDOT's relative contribution from WARMF tributaries and catchments that drain directly to Falls Lake. NCDOT's percent contribution in tributary loads, was based on the percentage of delivered load ("Source Contribution" in WARMF) attributable to NCDOT at the downstream reach, prior to its confluence with the lake. Similarly, for catchments that drain directly to Falls Lake, the relative load attributable to NCDOT ("Source Contribution") was used to estimate the percentage of NCDOT delivered load in these catchments. An area-weighted approach was then used to incorporate NCDOT's relative contribution in the catchments that drain directly to the lake with NCDOT's contribution in the tributaries. A similar area-weighted approach was used in subwatersheds where two streams (in WARMF) were grouped as a single tributary input (in EFDC).

The remainder of this section provides a step-by-step summary of the approach used to calculate the percentage of delivered load attributable to NCDOT in each of the 17 subwatersheds:

1. During preliminary model discussions with NCDWQ, the project team identified revisions that were needed for the New Light Creek subwatershed (subcatchment 255[1]) in WARMF. Based on NCDWQ instruction, URS revised model inputs for "Initial Moisture," "Field Capacity" and "Sat. Moisture" soil layer hydrology inputs in subcatchment 255 such that they match inputs used for subcatchment 72 (Adugna Kebede, NCDWQ, personal communication, May 17, 2012). Subcatchment 72 is located directly downstream of subcatchment 255. The revised soil layer hydrology input parameters are presented in Table 1.

   Table 1. Soil Layer Hydrology Input Revisions in New Light Creek (Subcatchment 255).

Layer	Initial Moisture	Field Capacity	Sat. Moisture
1	0.3	0.4	0.5
2	0.2	0.3	0.45
3	0.22	0.22	0.35
4	0.35	0.2	0.35
5	0.35	0.15	0.35

2. The Falls Lake WARMF model was run with a beginning date of January 1, 2004 and an ending date of December 31, 2005. Upon completion of the model run, the model was resaved as "FallsLakenewbound_04-05_nlc" and closed. This model scenario served the purpose of providing an initial condition for the baseline, 2006 model simulation period.

3. The Falls Lake WARMF model was opened and saved under a new project file name ("FallsLakenewbound_06_nlc"). The model beginning date was defined as January 1, 2006 and ending date was defined as December 31, 2006. The "Initial Conditions from WARMF Start File" was checked and "FallsLakenewbound_04-05_nlc" file was selected as the initial condition file.

[1] Subcatchment 255 is labeled as "Subcatchment ID 455" in WARMF.

The model was run for all watersheds and, upon completion, saved as "FallsLakenewbound_06_nlc".

4. WARMF subwatersheds and catchments were assigned to EFDC tributaries as presented in Figures 2 and 3.

5. WARMF simulates NCDOT as a unique land cover category and assigns TN and TP loads to NCDOT similar to other land categories and nutrient sources in the watershed. Using WARMF output, the percentage of TN and TP loads delivered to Falls Lake attributable to NCDOT was calculated in each subwatershed (1-17). In most cases, this calculation included an assessment of NCDOT's contribution in the tributary as well as NCDOT's contribution in catchments that drain directly to Falls Lake, as follows:

    a. ***Subwatersheds that drain to tributaries*** – TN and TP loads for all tributaries were obtained in WARMF using the "Source Characterization" output. The percentage of total load attributable to NCDOT was calculated for each tributary by dividing the total tributary load (kg/year) by NCDOT's contribution load (kg/year) in each tributary.

    b. ***Catchments that drain directly to Falls Lake*** – TN and TP loads for all catchments draining directly to Falls Lake were obtained in WARMF using the "Source Characterization" output. The percentage of total load attributable to NCDOT was calculated for each catchment by dividing the total load (kg/year) by NCDOT's contribution load (kg/year) in that catchment.

    c. ***Tributaries with impoundments*** – WARMF uses the "managed load" category to account for loads draining to impoundments that are modeled within a subwatershed. To account for the NCDOT percentage of managed load that is delivered to Falls Lake, the percentage of load delivered to the lake that is attributable to NCDOT is multiplied by the total load from "Managed Flow" at the downstream segment to the lake. This load is then added to the reported delivered load for NCDOT at the tributary-lake confluence to arrive at the total delivered load attributable to NCDOT from that tributary.

6. Using the catchment size and percent load contributions from NCDOT, an area-weighted approach was used to incorporate NCDOT's relative contribution in the subwatersheds that drain directly to the lake with those catchment contributions that drain to tributaries. Similarly, an area-weighted approach was used in cases where two streams (in WARMF) were grouped as a single tributary input in EFDC.

Baseline Nutrient Loads Delivered to Falls Lake from All Sources

Flow and water quality inputs used to develop the Falls Lake EFDC model were used to determine the baseline nutrient load from all sources in the watershed. The following steps outline the approach used to calculate the total delivered TN and TP loads for all sources in each of the 17 EFDC tributaries:

1. USGS flow and water quality data for calendar year 2006 were obtained from two Falls Lake EFDC model input files: "qser.inp" and "wqpsl.inp". Daily flow data (cubic meters per second) were copied from the EFDC "qser.inp" file into Microsoft Excel and the "Text to Columns" Excel

function was used to arrange data. Drainage area ratios for each tributary and the number of receiving lake segments were obtained from the “qser.inp” and “efdc.inp” files and tabulated. Daily flows were multiplied by the corresponding drainage area ratios and number of receiving lake segments to calculate daily flow (cubic meters per second) for each tributary.

2. Daily water quality data (concentrations as mg/L) were obtained from the EFDC "wqpsl.inp" file and transferred into Microsoft Excel. The "Text to Columns" Excel function was then used to arrange data in separate cells by parameter and daily data for five nitrogen species and four phosphorus species.

3. Daily TN and TP loads for each tributary were calculated for each nitrogen and phosphorus species using daily nutrient concentrations, daily flow data (calculated under step 1) and unit conversion factors. Annual TN and TP loads were calculated as the sum of daily loads for each respective nutrient species. The TN annual load was based on the sum of refractory particulate organic nitrogen, labile particulate organic nitrogen, dissolved organic nitrogen, ammonia nitrogen, and nitrite + nitrate nitrogen annual loads. The TP annual load was based on the sum of refractory particulate organic phosphorus, labile particulate organic phosphorus, dissolved organic phosphorus, and total orthophosphate annual loads.

NCDOT Baseline Nutrient Loads

Baseline TN and TP loads were calculated for NCDOT in the Falls Lake Watershed by multiplying the fraction of total load attributable to NCDOT by the corresponding total TN and TP delivered loads by tributary. The final, baseline NCDOT TN and TP loads delivered to Falls Lake are presented in Tables 2 and 3.

Table 2. 2006 Baseline TN and TP Loads (pounds/year) for all Sources and NCDOT in the Upper, Lower, and Entire Falls Lake Watershed.

	Baseline Loads from all Sources (pounds/year)		NCDOT Baseline Loads (pounds/year)	
	TN	TP	TN	TP
Upper Watershed	1,081,425	136,852	12,542	1,714
Lower Watershed	137,738	18,686	2,114	216
Entire Falls Lake Watershed	1,219,163	155,538	14,657	1,931

Table 3. NCDOT Percentage of Total Delivered Nutrient Loads and 2006 Baseline Loads (pounds/year) for all Sources and NCDOT by Tributary.

Tributary Label	Stream Name	Upper/ Lower Watershed	NCDOT Fraction of Total Delivered Load (%)		Baseline Load From All Sources (pounds/year)		NCDOT Baseline Load (pounds/year)	
			TN	TP	TN	TP	TN	TP
Q1	Flat River	Upper	1.5%	0.4%	123,748	10,466	1,798	38
Q2	Knap of Reeds Creek	Upper	0.4%	0.1%	160,110	43,366	647	26
Q3	Little River and Eno River	Upper	1.1%	0.9%	223,301	20,127	2,397	191
Q4	Ellerbe Creek	Upper	1.2%	2.4%	432,292	42,731	5,186	1,022
Q5	Unnamed Tributary	Upper	2.9%	4.0%	15,246	1,826	437	73
Q6	Panther Creek and Rocky Branch	Upper	1.5%	1.6%	18,422	2,550	269	41
Q7	Ledge Creek and Lake Rogers	Upper	1.3%	1.1%	42,687	5,114	542	57
Q8	Little Lick Creek	Upper	2.1%	3.4%	40,528	5,609	866	192
Q9	Robertson Creek	Lower	0.9%	0.5%	21,026	2,566	181	13
Q10	Beaverdam Creek	Lower	0.4%	0.3%	18,552	2,264	73	7
Q11	Smith Creek	Lower	1.1%	0.4%	18,552	2,264	201	10
Q12	Lick Creek	Upper	1.6%	1.5%	25,091	5,063	400	75
Q13	New Light Creek	Lower	1.2%	0.7%	27,210	3,321	320	24
Q14	Upper Barton Creek	Lower	1.8%	1.1%	13,591	2,742	250	30
Q15	Lower Barton Creek	Lower	5.1%	2.2%	14,637	2,953	740	65
Q16	Horse Creek and Lowery Creek	Lower	2.3%	4.1%	15,382	1,638	349	67
Q17	Honeycutt Creek and Cedar Creek	Lower	0.0%	0.0%	8,789	936	0	0
All Tributaries					**1,219,163**	**155,538**	**14,657**	**1,931**

Project Deliverables

The following electronic files were used to support information presented in this report:

1. WARMF modeling files – WARMF model inputs and outputs are provided in a folder titled "FallsLake_NewCalNewAg." Two models runs used to support this project include:

    a. "FallsLakenewbound_04-05_nlc" – this model run includes revisions to "Initial Moisture," "Field Capacity" and "Sat. Moisture" soil layer hydrology inputs in New Light Creek (subcatchment 255) based on NCDWQ instruction and as described on page 4 of this document. This model run was used to simulate the January 1, 2004 – December 31, 2005 initial condition for the baseline, 2006 model simulation period.

    b. "FallsLakenewbound_06_nlc" – this model run includes revisions to "Initial Moisture," "Field Capacity" and "Sat. Moisture" soil layer hydrology inputs in New Light Creek (subcatchment 255) based on NCDWQ instruction and as described on page 4 of this document. This model run was used to simulate the January 1, 2006 – December 31, 2006 baseline period.

2. EFDC modeling files – EFDC modeling inputs used to support this project are included in a model folder titled "Final2006Model."

3. Calculations used to support the NCDOT baseline TN and TP load analysis are presented in the following two Microsoft Excel files:

    a. "EFDC Nutrient Loads .xlsx" – This Excel file includes flow and water quality data obtained from EFDC and all calculations related to the baseline loads for TN and TP for all sources in each tributary.

    b. "WARMF and NCDOT Baseline Loads.xlsx" – This Excel file includes delivered nutrient loads from WARMF, calculations used to determine NCDOT's relative percentage of TN and TP loads delivered to Falls Lake in each tributary (Q1-Q17), and calculations used to determine NCDOT's delivered TN and TP loads in each tributary and watershed-wide.

References

NCDWQ, 2009a. *Falls Lake Watershed Analysis Risk Management Framework (WARMF) Development – Final Report*. Prepared by the NC Department of Environment and Natural Resources, Division of Water Quality, Modeling and TMDL Unit. October 2009.

NCDWQ, 2009b. *Falls Lake Nutrient Response Model – Final Report*. Prepared by the NC Department of Environment and Natural Resources, Division of Water Quality, Modeling and TMDL Unit. November 30, 2009.

This page is intentionally left blank

Appendix E

Interim Development Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed

This page is intentionally left blank

Interim Development Nutrient Loads from North Carolina Department of Transportation in the Falls Lake Watershed

TABLE OF CONTENTS

E-Executive Summary E-3

E-1.0 Background and Purpose E-4

E-2.0 Interim Road and Non-Road Development Analysis E-5

E-3.0 Interim Load Analysis E-19

E-4.0 Data Limitations, Constraints, and Assumptions E-22

LIST OF TABLES

Table ES-1. Nutrient loading associated with NCDOT road and non-road development that occurred during the interim period in the Falls Lake watershed E-3

Table E-1. NCDOT non-road facilities in the Falls Lake watershed E-5

Table E-2. Datasets used in support of the road analysis E-6

Table E-3. GIS attributes used to calculate ROW and impervious widths E-7

Table E-4. Attributes added by URS to calculate ROW and impervious area widths E-8

Table E-5. Description of GIS datasets associated with this report E-8

Table E-6. NCDOT impervious and ROW interim development areas in the Falls Lake watershed E-14

Table E-7. Datasets used to support the non-road analysis E-15

Table E-8. Pre-development and post-development land cover conditions at the Durham CMY (traffic services building) E-16

Table E-9. NCDOT-JLSLAT inputs used to calculate nutrient loading changes associated with NCDOT interim primary road development for the post-development condition E-19

Table E-10. NCDOT-JLSLAT inputs used to calculate nutrient loading changes associated with NCDOT interim secondary road development for the post-development condition E-19

Table E-11. Pre-development and post-development nutrient loading conditions associated with NCDOT primary and secondary road development in the Falls Lake watershed during the interim period. Pre-development loads are based on uniform rates (15A NCAC 02B .0281 (5)(a)) and post-development loads are based on NCDOT-JLSLAT E-20

Table E-12. NCDOT-JLSLAT inputs used to calculate nutrient loading changes associated with NCDOT interim non-road development for both pre-development and post-development conditions at the Durham CMY (traffic services building) E-20

Table E-13. Pre-development and post-development condition with BMP associated with non-road development at the Durham CMY (traffic services building) E-21

Table E-14. Nutrient loading associated with NCDOT road and non-road development that occurred during the interim period in the Falls Lake watershed E-21

LIST OF FIGURES

Figure E-1. An example of gaps greater than 1 foot (left). After editing, the ROW buffer is updated to represent the corrected ROW (right). E-10

Figure E-2. An example of island polygons commonly found between the lanes of highways and interstates (left). URS inserted new polygons to fill the gaps (right). E-10

Figure E-3. An example of editing in the impervious area polygon. Black-line polygons, shown in the left and middle image, were auto-generated using a buffer on the road centerline. Red lines, shown in the middle image, identify manual edits. The right image shows the corrected impervious area in red. E-12

Figure E-4. An example of an inaccurate automated buffer due to an error in attribute data. Results from the automated buffer procedure (left image) and corrected impervious area (right) are shown. E-12

Figure E-5. An example illustrating a case where road centerlines and calculated impervious surface buffers do not match roads shown on aerial orthophotographs. E-13

Figure E-6. NCDOT ROW (white boundary) and impervious area (yellow boundary) associated with primary route interim period development. The Falls Lake WARMF watershed model boundary is shown in red. E-14

Figure E-7. Baseline, pre-development condition during 2006 (top image) and associated land cover categories (bottom image) at the Durham CMY. E-17

Figure E-8. Proposed, interim period post-development condition (top image) and associated land cover categories (bottom image) at the Durham CMY. Site changes include demolition of several small buildings and construction of a new traffic services building, paint storage building, parking lot, and stormwater wetland detention basin. E-18

E-Executive Summary

The Falls Lake Rules establish a nutrient management strategy to reduce algal growth in Falls Lake. As part of the Rules, contributors of nutrients, including the NC Department of Transportation (NCDOT), are required to reduce their loading of total nitrogen and total phosphorus in order to meet the nutrient load objectives of the Rule and restore water quality standards in the lake. The Rules require NCDOT to develop and implement a Stormwater Management Program for both new and existing road and non-road development activities, and account for nutrient load changes on lands developed subsequent to the baseline period but prior to implementation of its new development program (15A NCAC 02B .0281 (9)(d)(ii)). This period, referred to as the "interim development" period, began on January 1, 2007 and extends through January 15, 2014.

15A NCAC 02B .0281 (9)(d)(ii)

(ii) The program shall include estimates of, and plans for offsetting, nutrient load increases from lands developed subsequent to the baseline period but prior to implementation of its new development program. It shall include a technical analysis that includes a proposed implementation rate and schedule. This schedule shall provide for proportionate annual progress toward reduction objectives as practicable throughout the proposed compliance period. The program shall identify the types of activities NCDOT intends to implement and types of existing roadway and non-roadway development affected, relative proportions or a prioritization of practices, and the relative magnitude of reductions it expects to achieve from each.

NCDOT's Stormwater Management Program in Falls Lake must document NCDOT's interim development load along with the intended implementation rate and schedule for activities aimed at offsetting any increases in loads. As described in this report, NCDOT's interim development area was defined using best available road and non-road datasets, project site plans and aerial imagery. Nutrient loads associated with the interim development were calculated using uniform pre-development loading rates and the nutrient accounting tool, NCDOT-JLSLAT. The net change in total nitrogen and total phosphorus associated with NCDOT's interim development is presented in Table ES-1.

Table ES-1 Nutrient loading associated with NCDOT road and non-road development that occurred during the interim period in the Falls Lake watershed

Interim Period Nutrient Loading	Primary Road Development	Secondary Road Development	Non-Road Development	All NCDOT Development
Development Area (acres)	10	456	4	470
Total Nitrogen				
Pre-development Load (lbs/yr)	28	1,318	22	1,368
Post-development Load (lbs/yr)	61	1,174	19	1,254
Net Interim Development Load (lbs/yr)	33	(144)	(3)	(114)
Total Phosphorus				
Pre-development Load (lbs/yr)	6	287	6	299
Post-development Load (lbs/yr)	4	214	2	220
Net Interim Development Load (lbs/yr)	(2)	(73)	(4)	(79)

lbs/yr = pounds per year

E-1.0 Background and Purpose

As part of the stormwater requirements for state and federal entities, the North Carolina Department of Transportation (NCDOT) is required to estimate nutrient load changes on lands developed subsequent to the baseline period but prior to implementation of its new development program (15A NCAC 02B .0281 (9)(d)(ii)). This period, referred to as the "interim development" period, begins on January 1, 2007 and extends through January 15, 2014. NCDOT's Stormwater Management Program in Falls Lake must document the nutrient loading changes associated with NCDOT's interim development area along with the intended implementation rate and schedule for activities aimed at offsetting any increases in loads. In accordance with this requirement, NCDOT developed an approach for calculating the change in nutrient loading associated with NCDOT's interim development area in the Falls Lake watershed. As described in this report, the approach relied on best available Geographic Information System (GIS)-based estimates of NCDOT road and non-road development during the baseline and interim period, collaboration with NCDOT Division staff (Divisions 5 and 7), uniform predevelopment loading rates, and NCDOT's Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool (NCDOT-JLSLAT).

On July 12, 2012, baseline total nitrogen (TN) and total phosphorus (TP) loads were approved by the North Carolina Environmental Management Commission (EMC) for NCDOT in the Falls Lake watershed. These loads were calculated using models that were developed by NCDWQ to support the Falls Lake Rules (NCDOT, 2012c). NCDOT's baseline development was based on NCDOT ROW estimates calculated for the Watershed Analysis Risk Management Framework (WARMF) watershed model which were developed using NCDOT's Road Condition 2004 GIS dataset. NCDOT's road centerline GIS dataset includes routes (Interstate, US, NC, Secondary Routes, and Ramps) and attributes of the NCDOT state road system, is updated four times annually by NCDOT's GIS Unit, and is distributed on NCDOT's Enterprise GIS website. As described in Section E-2.0 of this report, the WARMF NCDOT ROW estimates were, in part, used in this analysis to identify where NCDOT interim development had occurred in the watershed.

In July 2012, the EMC also approved a NCDOT nutrient accounting framework for use in Falls Lake watershed planning and rule compliance. The nutrient accounting framework, "NCDOT-JLSLAT", maintains the fundamental structure of North Carolina Department of Environment and Natural Resources' (NCDENRs') original Jordan/Falls Lake Stormwater Load Accounting Tool (JLSLAT) and the methods used to evaluate loading rates and load reductions, while allowing NCDOT to estimate nutrient loads specific to NCDOT facilities. A 2012 report titled *Transportation Land Use/Land Cover and Stormwater Control Measure Updates for the Jordan/Falls Lake Nutrient Accounting Tool* (NCDOT, 2012a) summarizes the steps taken to adapt JLSLAT for NCDOT applications. As described in Section E-3.0 of this report, NCDOT-JLSLAT was used to calculate changes in nutrient loads associated with NCDOT's interim development for road and non-road areas.

E-2.0 Interim Road and Non-Road Development Analysis

NCDOT development includes both road development and non-road development (see Tables 2 and 3 in Section E-3.0 of the Falls Lake Guided Reduction of Excess Environmental Nutrients (GREEN) Report for project type examples). NCDOT's road centerline GIS dataset[1] represents the best available resource for identifying where changes to the NCDOT road system have occurred since the baseline period. The dataset is updated frequently and it provides exhaustive details regarding NCDOT road and ROW characteristics. The process for identifying NCDOT's interim development area included a detailed comparison of NCDOT's baseline ROW dataset (used to support the WARMF watershed model) with NCDOT's current road centerline GIS dataset (issued first quarter 2013). Using GIS, NCDOT roads (polyline segments) that were added to the road centerline dataset during the interim period were identified and exported as a separate GIS polyline layer. This layer was used as a basis for preparing NCDOT interim development impervious area and ROW area polygon datasets. Characterization of the interim development impervious and ROW areas involved a series of automated and manual editing steps in ArcGIS (Sections E-2.1 of this document) that were similar to those performed by NCDOT staff and contractors to support modeling studies in Falls Lake, High Rock Lake, and Jordan Lake watersheds (NCDENR, 2009; NCDOT, 2009; NCDOT, 2012d).

NCDOT's interim development loads are affected by property transfers (sales or acquisitions) as well as land cover changes on properties that existed during the baseline period. At the time of this analysis, NCDOT operated and maintained eight non-road facilities in the Falls Lake watershed, including four administrative buildings and four industrial facilities. A list of the eight non-road facilities is provided in Table E-1.

Table E-1. NCDOT non-road facilities in the Falls Lake watershed

Administrative Facilities	Industrial Facilities
Durham Division of Motor Vehicles (DMV) Office	Granville County Salt Storage Yard
Durham NCDOT Division Engineer Office	Durham County Maintenance Yard
Durham NCDOT Resident Engineer Office	Orange County Maintenance Yard
Durham NCDOT Resident Engineer Office Property	Person County Maintenance Yard

To identify non-road properties that may have been acquired by NCDOT during the interim period, URS evaluated state-owned property GIS datasets, site plans and drawings maintained for NCDOT non-road facilities. URS also conducted verbal inquiries with NCDOT Division 5 and Division 7 staff. These evaluations and staff inquiries revealed that all eight non-road properties existed during the baseline period and that no additional properties were acquired or sold by NCDOT in the Falls Lake watershed during the interim period.

To identify changes in development within each of the eight non-road properties, URS technicians evaluated a series of aerial imagery datasets to characterize land development changes. For this

[1] NCDOT GIS available at https://connect.ncdot.gov/resources/gis

analysis, URS technicians evaluated orthophotographs for the years 2006 through 2010 to identify changes in land cover on a site-by-site basis. This assessment revealed that changes in land cover had occurred at the Durham County Maintenance Yard (CMY) but not at any of the remaining seven facilities. Verbal inquiries with NCDOT Division 5 and Division 7 staff confirmed these findings. Section E-2.2 of this document describes steps taken by URS to evaluate the land cover changes associated with interim development at the Durham CMY.

E-2.1 Interim NCDOT Road Development

This section describes procedures used to develop the ROW and impervious areas associated with changes in road development during the interim period. In general, NCDOT road development that occurred since the baseline period was identified and exported to a separate polyline dataset. ROW and impervious area polygons were then developed by buffering the polyline dataset (Section E-2.1.3). Buffer distances were determined using attributes available in the road centerline data and, in select cases, typical road widths as presented in NCDOT Roadway Design Manual or aerial imagery. Automated procedures were followed by manual editing and quality assurance and control steps to promote consistency and improve accuracy of final ROW and impervious area GIS datasets. All GIS-related steps described in this report were performed using ArcGIS, Version 10.0.

E-2.1.1 Data Sources

Datasets that were used in support of the analysis are presented in Table E-2. Past (2004) and current (2012 and 2013) NCDOT road centerline datasets were used to develop NCDOT ROW and impervious area datasets. At the onset of the project, URS downloaded the most current NCDOT road centerline dataset that was available at the time (fourth quarter 2012). During the project, NCDOT released an updated version of the road centerline dataset (first quarter 2013). This updated version was evaluated to identify revisions added since the fourth quarter 2012 release. These 2013 revisions were incorporated in the development of ROW and impervious cover evaluations described in this section.

Aerial orthophotographs were used as a visual aid for the generation of ROW and impervious area datasets. These images represent the best aerial orthophotographs available at the time of this project.

Table E-2. Datasets used in support of the road analysis

Layer Type	Description
NCDOT Road Datasets	NCDOT road dataset titled “Road Condition 2004” was used to support the development of NCDOT’s ROW for the WARMF model. The fourth quarter 2012 and first quarter 2013 releases of NCDOT’s road data (“RD_CHAR_MLPST”) were used in defining changes in development since the Road Condition 2004 dataset. All polyline datasets were obtained from the NCDOT GIS Unit (NCDOT, 2013b).

Table E-2. Datasets used in support of the road analysis (continued)	
Layer Type	Description
NCDOT ROW used to develop WARMF	This polygon dataset includes NCDOT ROW in the Falls Lake watershed based on the Road Condition 2004 GIS layer. This dataset was prepared by NCDOT during the development of the Falls Lake WARMF model (NCDENR, 2009). This dataset is titled "falls_nlcd2001".
Aerial imagery	Statewide orthophotography (2010 and 2012) that is available through nconemap.com. Data originate from the North Carolina Department of Agriculture and Consumer Services.
Falls Lake watershed boundary	Watershed boundary obtained from NCDWQ's website (NCDENR, 2013).

In developing the ROW and impervious cover polygons, URS used existing attribute information available in the NCDOT road datasets (presented in Table E-3) as well as new attributes that were developed specifically for this project (presented in Table E-4).

Table E-3. GIS attributes used to calculate ROW and impervious widths	
Attribute Name	Description
RW_WID	ROW value estimating the width (measured in feet) of an NCDOT ROW.
SHLDR_LFT_TYP_CD	Type of left shoulder material. Shoulder type categories are as follows: Grass or Sod = "1", Gravel or Stone = "2", Bituminous = "3", Curb Bituminous = "4", Concrete = "5", Curb Concrete = "6", and Tie Bar = "7".
SHLDR_RGT_TYP_CD	Type of right shoulder material. Shoulder type categories are as follows: Grass or Sod = "1", Gravel or Stone = "2", Bituminous = "3", Curb Bituminous = "4", Concrete = "5", Curb Concrete = "6", and Tie Bar = "7".
SHLDR_WID_LFT_QTY	Left shoulder width. The total usable shoulder width (measured in feet) on the left side of the road determined in the direction of the inventory. For curbed sections, no value is presented.
SHLDR_WID_RGT_QTY	Right shoulder width. The total usable shoulder width (measured in feet) on the right side of the road determined in the direction of the inventory. For curbed sections, no value is presented.
SRFC_WID	Surface width. This attribute contains the paved surface width (measured in feet) or from ditch to ditch on unpaved roads. This width may be for one direction of travel or the total for both directions depending on the road type and method of inventory. For multi-lane undivided highways with turn lanes or mountable medians, the edge-to-edge or face-to-face width is presented.
MDN_WID	Median width. The total median width (measured in feet) for divided roadways. Median width includes the area from inside the edge of the surface pavement to inside the edge of adjacent surface pavement. Includes paved or unpaved median (inside) shoulder widths.
MDN_TYP_CD	Median type. Median type categories are as follows: Rigid Positive Barrier = "1", Continuous Turn Lane = "2", Paved Mountable = "3", Curb = "4", Grass = "5", Unspecified Positive Barrier = "6", Parkland, Business, etc. = "7", Couplet = "8", and Flexible Positive Barrier = "9".

Table E-4. Attributes added by URS to calculate ROW and impervious area widths	
Attribute Name	Description
BUFFER_LEFT	NCDOT-owned area (measured in feet) left of the road centerline.
BUFFER_RIGHT	NCDOT-owned area (measured in feet) right of the road centerline.
ROW_EST	Estimate of total NCDOT ROW width (measured in feet) calculated for a given road segment.
BUFF_DIST	Estimate of NCDOT impervious road width (measured in feet) calculated for a given road segment.

Table E-5 provides a description of datasets associated with this project. Metadata for the ROW and impervious cover datasets were prepared using Federal Geographic Data Committee (FGDC) standards and NCDOT guidelines (NCDOT, 2010).

Table E-5. Description of GIS datasets associated with this report	
GIS Dataset Name	Description
NCDOT_Interim_ROW	NCDOT interim development ROW area in the Falls Lake watershed. This dataset includes the roadway and any area adjacent to the roadway that is under the ownership of NCDOT (e.g., median, shoulders, and adjacent vegetated and non-vegetated corridors) that were added during the interim period.
NCDOT_Interim_Impervious	NCDOT interim development impervious area in the Falls Lake watershed. This dataset includes paved road and shoulder surfaces associated with NCDOT roads that were added during the interim period.
NCDOT_Durham_CMY_Pre	Land cover type estimates for the pre-development condition at the Durham CMY facility, Durham traffic services building.
NCDOT_Durham_CMY_Post	Land cover type estimates for the post-development condition at the Durham CMY facility, Durham traffic services building.

E-2.1.2 Quality Assurance and Quality Control

The procedures used to develop the ROW and impervious area datasets required GIS technicians to perform data processing and manipulation. Quality assurance and quality control (QA/QC) procedures were used to aid in achieving the level of accuracy needed for this analysis. Because the ROW and impervious surface area datasets were created using different methodologies, the QA/QC process (described in Sections E-2.1.3 and E-2.1.4) for each dataset is specific to that dataset. After completion of the draft NCDOT ROW and impervious datasets, a final review of each dataset was conducted by a technician independent of the project.

E-2.1.3 Method to Develop the Interim Development ROW Dataset

NCDOT's fourth quarter 2012 NCDOT road centerline dataset was initially used to identify and characterize where changes to the NCDOT road network had occurred in the Falls Lake watershed during the interim period. During the course of this project, NCDOT released an updated road dataset

(first quarter 2013) and URS evaluated this dataset to identify and incorporate any additional interim period development that had been added since the fourth quarter 2012 release. This assessment resulted in the addition of three secondary roads to the interim road dataset.

To identify changes in NCDOT road development that occurred during the interim period, the current road centerline dataset (fourth quarter 2012 release, augmented by first quarter 2013 release) was first clipped using the Falls Lake watershed boundary to isolate the area of interest. A visual comparison of this dataset to the WARMF landuse polygon dataset (titled "falls_nlcd2001") was used to identify road centerline segments present in the current (2013) road centerline datasets that were not present in the "falls_nlcd2001." These new road centerlines were selected and exported as a new feature dataset (referred to as "NCDOT interim period polyline dataset" in this report). This new feature dataset included NCDOT development that occurred during the interim period through first quarter 2013 release of NCDOT's road centerline dataset and was used as the basis for preparing NCDOT interim impervious and ROW areas. Attributes listed in Table E-3. GIS attributes used to calculate ROW and impervious widths were added to this dataset. The ROW width (ROW_EST) calculation was dependent on available data and road type. In previous NCDOT ROW evaluations, a separate methodology was used to estimate ROW area for interstates (NCDENR, 2009; NCDOT, 2009; NCDOT, 2012d). For this analysis, no interstates were added during the interim period, thus a separate analysis of interstate ROW was unnecessary. The following formulas were used to calculate ROW_EST for US highway, NC highway, secondary route (SR), and ramp road types:

I. If a value for RW_WID was available, then ROW_EST = RW_WID.
II. If a value for RW_WID was not available and SRFC_WID > 0 and MDN_WID <= 100, then ROW_EST = SRFC_WID + MDN_WID + SHLDR_WID_LFT_QTY + SHLDR_WID_RGT_QTY.
III. If a value for RW_WID was not available and SRFC_WID > 0 and either MDN_WID > 100 or MDN_TYP_CD < 3, then ROW_EST = SRFC_WID + SHLDR_WID_LFT_QTY + SHLDR_WID_RGT_QTY.
IV. If a value for RW_WID was not available, SRFC_WID = 0, and the road type was a ramp, then ROW_EST = 24.
V. If a value for RW_WID was not available, SRFC_WID = 0, and the road type was not a ramp, then ROW_EST was populated based on the ROW_EST of adjacent or connecting road segments.

Using the calculated ROW_EST for each US, NC, SR and ramp centerline, a new ROW polygon dataset was developed using left and right buffers and the following formulas:

- BUFFER_LEFT = ROW_EST/2
- BUFFER_RIGHT = ROW_EST/2

Next, 2010 aerial imagery was used to manually correct the ROW polygon dataset to resolve areas where the ROW did not properly align with aerial imagery. During this step, GIS technicians identified missing or incomplete polygons, gaps, slivers, islands, or incorrect polygons. Once identified, improper geometry was updated and edited to properly represent NCDOT ROW for interim NCDOT development in the Falls Lake watershed. These techniques did not require that ROW polygons line up precisely with

ROW as indicated by aerial orthophotographs. Rather, the purpose of this exercise was to identify and fix significant errors that could lead to the mischaracterization of ROW areas.

An Esri Topology was created to locate and fix any missing or incomplete polygons. The "Must Have No Gaps" topology rule was chosen to eliminate voids or gaps of a specific size between polygons. The specific size of the gaps, known as the tolerance, can be set within ArcGIS. For this project, the tolerance was set to a distance of 1 foot. When the Topology Tool was utilized, gaps or slivers less than 1 foot were automatically closed. Gaps or slivers greater than 1 foot were flagged for manual editing. Figure E-1 displays a typical example of a gap or missing polygon. In the case of gaps that were greater than 1 foot, GIS technicians manually edited and merged the polygons to represent a continuous ROW surface. Topology validation was rerun to confirm that the updated geometry did not contain gaps.

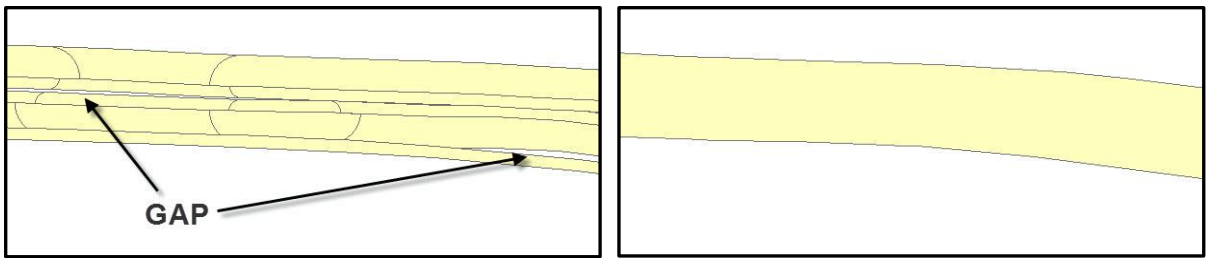


Figure E-1. An example of gaps greater than 1 foot (left). After editing, the ROW buffer is updated to represent the corrected ROW (right).

Figure E-2 illustrates an example of "islands," or areas of empty space surrounded by other ROW polygons. Islands were typically encountered along major interstates, highways, and other divided roads that featured two centerlines; one for each direction of traffic. These areas are part of the NCDOT ROW even if they are farther from the centerline than indicated by the initial buffer attributes. GIS technicians drew new polygons encompassing the "islands," then reran the topology validation to confirm that the updated geometry did not contain gaps.

Figure E-2. An example of island polygons commonly found between the lanes of highways and interstates (left). URS inserted new polygons to fill the gaps (right).

E-2.1.4 Method to Develop the Interim Development Impervious Area Dataset

The impervious cover dataset was developed by first calculating the "BUFF_DIST" attribute for each road segment in the NCDOT interim period polyline dataset. This polyline dataset was based on the first quarter 2013 release of NCDOT's road centerline dataset and includes all roads that were added since NCDOT's baseline ROW dataset that was used to support the WARMF watershed model). For US highway, NC highway, SR, and ramp road types, "BUFF_DIST" was calculated as "SRFC_WID" divided by 2. For ramps with a "SRFC_WID" value of 0, the "BUFF_DIST" was set to a standard width of 24 feet. For all road types except ramps, if SRFC_WID = 0 , then "SRFC_WID" was populated based on adjacent or connecting roads with a "SRFC_WID" value greater than "0." As previously described, no interstates were added to the NCDOT road system during the interim period.

A polygon dataset representing NCDOT impervious area was generated by buffering the NCDOT interim period polyline dataset using the BUFF_DIST attribute field. Next, the polygon dataset was manually edited using 2010 aerial imagery to resolve cases where (1) the impervious area did not align with aerial imagery, (2) there were missing pieces of the impervious area at intersections, or (3) there were slivers of impervious area that were not included in the buffer. The techniques used did not require that impervious area polygons line up perfectly with impervious surfaces shown by aerial orthophotographs. Rather, these steps were taken to validate that estimates were a reasonable representation of impervious surface for that feature area. This exercise allowed URS to identify and manually correct errors that may have occurred using the automated procedures.

During the editing process, GIS technicians visually compared the calculated impervious surface polygons to aerial orthophotographs to verify that the calculated area provided a relatively good representation of the image provided in the aerial orthophotographs. A scale of 1:1,000–1:1,500 (scale reciprocal) was used for this process. This process allowed for observance and correction of data anomalies or errors. Anomalies were most often due to incorrect and/or inaccurate road centerline data that were likely due to the relative age of the aerial photographs used to develop the original NCDOT road centerline data. In instances where the buffer did not accurately represent the impervious surface shown on the aerial photographs, the buffer was modified. In some instances where the buffer varied 4 feet or more from the actual impervious surface, the buffer was deleted, and the centerline was rebuffered using a distance measured on the aerial orthophotograph by the GIS technician. Examples of the editing process are shown in Figure E-3, Figure E-4 and Figure E-5.

When intersections were encountered, GIS technicians drew new polygons to represent the sections of impervious surface that existed in the turn lane areas of the roads (Figure E-3).

Figure E-3. An example of editing in the impervious area polygon. Black-line polygons, shown in the left and middle image, were auto-generated using a buffer on the road centerline. Red lines, shown in the middle image, identify manual edits. The right image shows the corrected impervious area in red.

In some cases, attribute data used to develop the impervious dataset was inaccurate and thus led to errors in the resulting impervious surface area (Figure E-4). In this instance, the width of the impervious area buffer was overestimated when compared to the aerial orthophotograph (left). The image on the right shows the corrected impervious area.

Figure E-4. An example of an inaccurate automated buffer due to an error in attribute data. Results from the automated buffer procedure (left image) and corrected impervious area (right) are shown.

Occasionally, the road centerline was slightly misaligned when compared to the aerial orthophotographs. In these cases, if the impervious surface polygon properly represented the total area covered by the road, no edits were made (Figure E-5).

Figure E-5. An example illustrating a case where road centerlines and calculated impervious surface buffers do not match roads shown on aerial orthophotographs.

E-2.1.5 Post-Processing of ROW and Impervious Area Datasets

A series of post-processing steps were performed to correct areas of overlap (double counting of road areas) within the ROW and impervious datasets. Processing steps included the following:

1. In cases where roads of different classification intersect, the ROW or impervious area associated with the intersected road was assigned to the roadway of higher priority. For this process, the following priority ranking was used: Interstate (highest class) > US highway > NC highway > SR > ramps (lowest class). To perform this step, both the ROW and impervious datasets were first converted to separate datasets based on road type. This process involved using the "Select by Location" ArcGIS feature, yielding one new dataset for each road type for both the ROW and impervious datasets. Using the road hierarchy for each road dataset, the "erase" procedure was applied on both the ROW and impervious datasets. This was accomplished by using an "erase" command to extract the intersected pieces of NCDOT ROW or impervious area for lower class road types and to prevent double counting of NCDOT ROW and impervious areas.
2. The "dissolve" procedure was performed for each individual road type (US highway, NC highway, SR, and ramp) for each dataset.
3. The impervious dataset was merged with the ROW dataset to create the final ROW dataset. This step was performed so that the ROW included all impervious area.
4. Using the baseline NCDOT ROW dataset, the "erase" procedure was applied to both ROW and impervious cover datasets to remove any interim development ROW or impervious area that overlapped with the baseline NCDOT area dataset.
5. Each dataset was clipped to the Falls Lake watershed boundary to remove any buffer area outside the watershed boundary.
6. Impervious and ROW areas associated with each road type were calculated.

E-2.1.6 Interim Road Development Results

Results of the interim road GIS analysis are presented in Table E-6. Of the 466 acres of interim development ROW area, approximately 98% of the development area (456 acres) was associated with secondary routes while 2% (10 acres) was associated with primary routes. The primary route interim development area included one NC Highway 10-acre project (shown in Figure E-6).

Table E-6. NCDOT impervious and ROW interim development areas in the Falls Lake watershed

NCDOT Road Category	NCDOT Road Type	Impervious Area (Acres)	Pervious ROW Area (Acres)	Entire ROW Area (Acres)
Primary Routes	Interstate	0	0	0
	US Highway	0	0	0
	NC Highway	4	6	10
Secondary Routes	Secondary Roads	160	208	368
	Ramps	15	73	88
All Roadways		179	287	466

Note: All values presented in this table are based on a conversion of ArcGIS results (in square feet) to acreage and the use of Gaussian rounding (also known as "banker's rounding") to arrive at values rounded to the nearest acre.

Figure E-6. NCDOT ROW (white boundary) and impervious area (yellow boundary) associated with primary route interim period development. The Falls Lake WARMF watershed model boundary is shown in red.

E-2.2 Interim NCDOT Non-Road Development

As described in Section E-2.0, development changes during the interim period occurred at one NCDOT non-road facility, the Durham CMY (3910 Guess Road, Durham, NC 27705). At the time of this analysis, construction on a new traffic services building was underway, but not complete.

E-2.2.1 Data Sources

Datasets that were used to support the non-road development analysis are presented in Table E-7. Aerial orthophotography was used as a visual aid to generate the pre-development land cover dataset. At the time of this project, the construction of the Durham traffic services building on the Durham CMY was in progress. Site plan drawings were used to estimate land cover areas associated with the anticipated post-development condition.

Table E-7. Datasets used to support the non-road analysis

Layer Type	Description
Aerial Imagery	Statewide imagery for years 2006 - 2012 obtained through nconemap.com and ESRI services. Data originate from the North Carolina Department of Agriculture and Consumer Services.
NCDOT Site Plan Drawings	Site plan for the Durham traffic services building located at the Durham CMY (3910 Guess Road, Durham, NC 27705) prepared by NCDOT Division 5 staff.

E-2.2.2 Method to Develop the Interim Development Land Cover Dataset

To identify changes in development at the Durham CMY, URS technicians evaluated a series of aerial imagery datasets for the traffic services building area of disturbance. Imagery collected in March 2006 was used as the primary source for characterizing the pre-development condition. Using ArcGIS, technicians created polygons for each land cover in the project disturbance area and assigned each polygon to a land cover category in NCDOT-JLSLAT. The pre-development condition included several small buildings, parking lots, sidewalks, pervious, uncovered material storage, and open space areas. The pre-development condition did not include any known structural stormwater controls. URS contacted NCDOT Division staff to obtain a plan drawing for the anticipated traffic services building and used this information to estimate the post-development condition. Similar to the pre-development condition analysis, technicians evaluated the site drawings, prepared a land cover polygon dataset and area estimates for the post-development condition using ArcGIS. Based on the post-development site plan, the project area will include two buildings, parking lots, open space, and an extended wetland detention basin. The extended wetland detention basin receives all of the runoff from the project area as shown in the project design plans.

E-2.2.3 Interim Road Development Results

Tabulated results of the land cover types and associated areas (square feet) are presented in Table E-8. Aerial imagery and land cover representation are shown in Figure E-7 and Figure E-8 for the pre-development condition and post-development condition, respectively.

Table E-8. Pre-development and post-development land cover conditions at the Durham CMY (traffic services building)

Land Cover Category	Pre-development (ft^2)	Post-development (ft^2)
Parking lot	51,500	62,431
Roof	14,661	18,642
Pervious storage	21,513	---
Sidewalk	883	7,154
Open space	76,304	67,418
Extended Wetland Detention Basin	---	9,216
Total Area	164,861	164,861

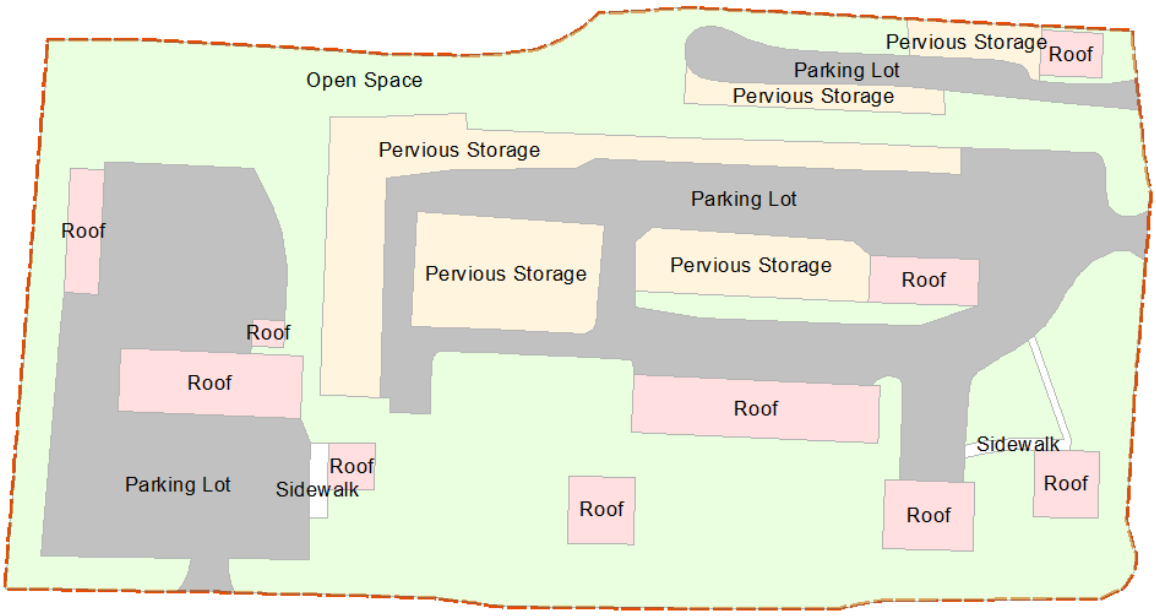
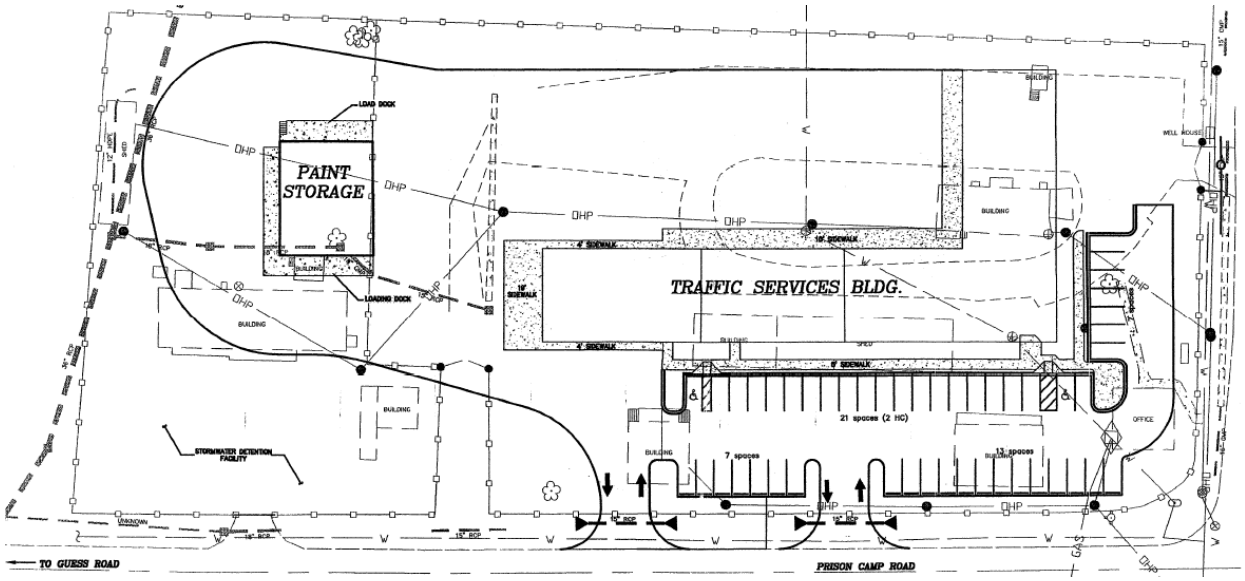


Figure E-7. Baseline, pre-development condition during 2006 (top image) and associated land cover categories (bottom image) at the Durham CMY.



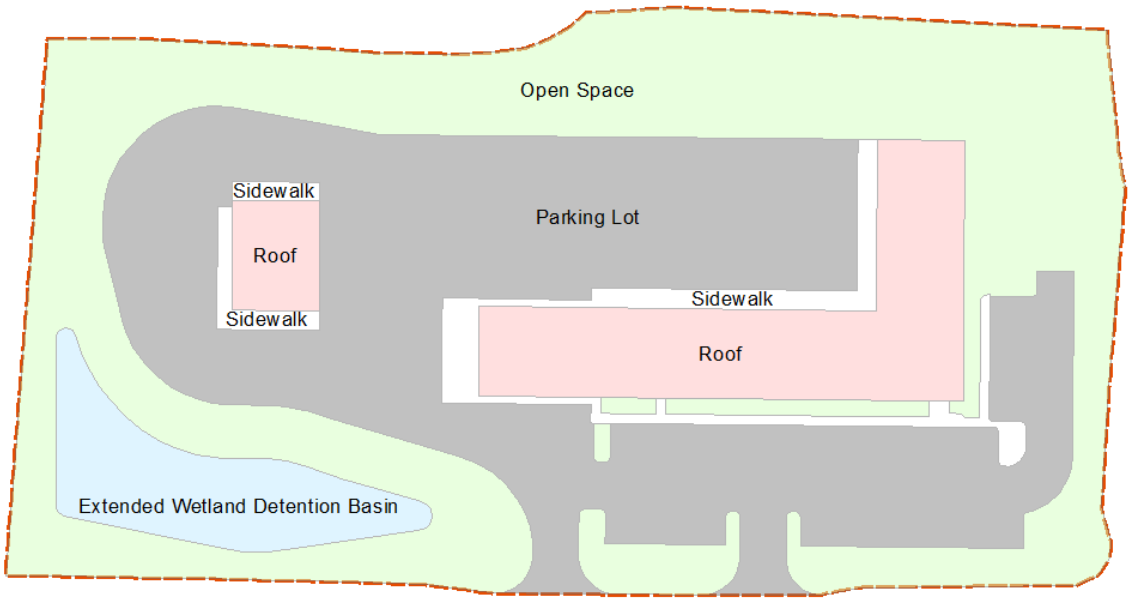


Figure E-8. Proposed, interim period post-development condition (top image) and associated land cover categories (bottom image) at the Durham CMY. Site changes include demolition of several small buildings and construction of a new traffic services building, paint storage building, parking lot, and stormwater wetland detention basin.

E-3.0 Interim Load Analysis

Changes in nutrient loading associated with NCDOT road development during the interim period were calculated by first estimating changes to NCDOT's road system in the Falls Lake watershed (Section E-2.1 of this report) and then calculating the pre- and post-development load associated with those areas. Pre-development TN and TP loading conditions were calculated using uniform loading rates of 2.89 pounds/acre/year for TN and 0.63 pounds/acre/year for TP as described in 15A NCAC 02B .0281 (5)(a). Post-development nutrient loads from roads were calculated using NCDOT-JLSLAT and primary road edge-of-pavement, secondary road edge-of-pavement, and open space (unfertilized) areas defined through the ArcGIS analysis (Section E-2.1 of this report). Inputs used to calculate changes in nutrient loads associated with interim primary and secondary road development are shown in Table E-9 and Table E-10, respectively. NCDOT-JLSLAT results for primary and secondary interim road analyses are shown in Table E-11.

Table E-9. NCDOT-JLSLAT inputs used to calculate nutrient loading changes associated with NCDOT interim primary road development for the post-development condition

NCDOT-JLSLAT Parameter	NCDOT-JLSLAT Input
Physiographic/Geologic Region	Piedmont
Soil Hydrologic Group	D[1]
Precipitation location	Butner
Total Development Area (ft^2)	420,641
Land Use/Cover Categories	**Area (ft^2)**
Transportation - Primary road EOP	169,083
Pervious - Open space (unfertilized)	251,558

[1] Project area soil types include "WsB", "WsC" and "Ur" and are primarily characterized by the "D" soil hydrologic group (USDA, 2013).

Table E-10. NCDOT-JLSLAT inputs used to calculate nutrient loading changes associated with NCDOT interim secondary road development for the post-development condition

NCDOT-JLSLAT Parameter	NCDOT-JLSLAT Input
Physiographic/Geologic Region	Piedmont
Soil Hydrologic Group	D[1]
Precipitation location	Butner
Total Development Area (ft^2)	19,866,227
Land Use/Cover Categories	**Area (ft^2)**
Transportation - Secondary road EOP	7,615,998
Pervious - Open space (unfertilized)	12,250,229

[1] Project area soil types include "WsB", "WsC" and "Ur" and are primarily characterized by the "D" soil hydrologic group (USDA, 2013).

Table E-11. Pre-development and post-development nutrient loading conditions associated with NCDOT primary and secondary road development in the Falls Lake watershed during the interim period. Pre-development loads are based on uniform rates (15A NCAC 02B .0281 (5)(a)) and post-development loads are based on NCDOT-JLSLAT.		
Primary Road Development	Pre-Development	Post-Development
Total Nitrogen Loading (pounds/acre/year)	2.89	6.40
Total Phosphorus Loading (pounds/acre/year)	0.63	0.40
Secondary Road Development		
Total Nitrogen Loading (pounds/acre/year)	2.89	2.57
Total Phosphorus Loading (pounds/acre/year)	0.63	0.47

Non-road NCDOT interim development nutrient loading changes were calculated using results of the ArcGIS exercise described in Section E-2.2 and NCDOT-JLSLAT. For this analysis, pre-development and post-development loads were calculated using inputs presented in Table E-12. NCDOT-JLSLAT results for the interim non-road analysis are presented in Table E-13.

Table E-12. NCDOT-JLSLAT inputs used to calculate nutrient loading changes associated with NCDOT interim non-road development for both pre-development and post-development conditions at the Durham CMY (traffic services building)			
NCDOT-JLSLAT Land Use/Cover Category		NCDOT-JLSLAT Input	
Physiographic/Geologic Region		Piedmont	
Soil Hydrologic Group		D[1]	
Precipitation location		Butner	
Total Development Area (ft^2)		164,861	
NCDOT-JLSLAT Land Use/Cover Category		Pre-development (ft^2)	Post-development (ft^2)
Industrial	Parking lot	51,500	62,431
	Roof	14,661	18,642
	Pervious, uncovered storage	21,513	---
Transportation	Sidewalk	883	7,154
Pervious	Open space (unfertilized)	76,304	67,418
Areas Taken up by BMPs		---	9,216
Total Area		164,861	164,861
Post-development areas treated by a stormwater wetland at the Durham CMY			
NCDOT-JLSLAT Land Use/Cover Category		Post-development area (ft^2) treated by a Stormwater Wetland	
Industrial	Parking lot	62,431	
	Roof	18,642	
Transportation	Sidewalk	7,154	
Pervious	Open space (unfertilized)	67,418	

[1] Project area soil types include "WsB", "WsC" and "Ur" and are primarily characterized by the "D" soil hydrologic group (USDA, 2013).

Table E-13. Pre-development and post-development condition with BMP associated with non-road development at the Durham CMY (traffic services building)		
Site Characteristics	Pre-Development Condition	Post-Development Condition with Stormwater Wetland
Total Nitrogen Loading (pounds/acre/year)	6.06	5.14
Total Phosphorus Loading (pounds/acre/year)	1.51	0.65

Resulting interim development TN and TP loads (pounds/year) for pre- and post-development conditions are presented in Table E-14. Net TN and TP interim development loads, represent the change in NCDOT loads during the interim period and are calculated by subtracting the pre-development loads from the post-development loads. As shown in Table E-14, NCDOT interim development resulted in a net decline in both TN and TP. TN loads declined by 114 pounds/year while TP load declined by 79 pounds/year.

Table E-14. Nutrient loading associated with NCDOT road and non-road development that occurred during the interim period in the Falls Lake watershed				
Interim Period Nutrient Loading	Primary Road Development	Secondary Road Development	Non-Road Development	All NCDOT Development
Development Area (acres)	10	456	4	470
Total Nitrogen				
Pre-development Load (lbs/yr)	28	1,318	22	1,368
Post-development Load (lbs/yr)	61	1,174	19	1,254
Net Interim Development Load (lbs/yr)	33	(144)	(3)	(114)
Total Phosphorus				
Pre-development Load (lbs/yr)	6	287	6	299
Post-development Load (lbs/yr)	4	214	2	220
Net Interim Development Load (lbs/yr)	(2)	(73)	(4)	(79)

lbs/yr = pounds per year

E-4.0 Data Limitations, Constraints, and Assumptions

NCDOT does not maintain a single statewide spatial database of its impervious cover or ROW property boundaries. As a result, the datasets described in this report were prepared using a methodology expressly developed to support the Falls Lake interim development analysis. The procedures and assumptions employed in the methodology represent a balance between managing the cost of preparing the datasets and the relative accuracy needed to support the intended modeling purpose and use of the information. The methodology employs simplifying assumptions, such as 'the ROW boundary generally runs parallel to the road centerline'. This assumption is generally an accurate one, but in reality, at any given location, the true ROW boundary may be skewed relative to the road centerline. Additionally, the methodology did not provide for the realignment of road centerlines when it was observed that these centerlines did not perfectly correspond with roads depicted in the aerial orthophotography. However, if a considerable discrepancy was encountered, GIS technical professionals used guidance from NCDOT and aerial orthophotography to modify the ROW and impervious area polygons using best professional judgment. With these considerations in mind, NCDOT and URS recommend that the use of these datasets be limited to the intended purposes described in this document. These datasets should not be used for delineating actual property boundaries. NCDOT and URS make no warranty, expressed or implied, regarding the accuracy or completeness of these datasets.