



TOWN OF CARRBORO

NORTH CAROLINA

TRANSMITTAL

PLANNING DEPARTMENT

DELIVERED VIA: ☒ HAND ☐ MAIL ☐ FAX ☐ EMAIL

To: David Andrews, Town Manager
Mayor and Board of Aldermen

From: Randy Dodd, Environmental Planner
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Date: February 27, 2017

Subject: Synopsis of Stormwater Management in Carrboro

Background and Summary

This Town stands on the giving and receiving ends of stormwater regulations and programs. This memorandum summarizes stormwater management in Carrboro in three general areas – 1) what is stormwater/stormwater management and what does the Town do; 2) who regulates the Town and how, and; 3) other programs and initiatives. Selected links to additional/supplemental details are provided at the end of the memo.

Information

What is Stormwater/Stormwater Management and what does the Town do?

Stormwater (aka stormwater runoff) refers to the water running off of developed areas during and after rain. In undisturbed/forested watersheds, about 5% of the annual precipitation becomes surface runoff, with the remainder evaporating, being used by vegetation, and infiltrating into the ground. In developed watersheds, the amount of water running off can approach or exceed 50% of the annual precipitation, depending on the degree of development and implementation of both structural and nonstructural approaches to deal with the stormwater runoff. Stormwater concerns focus on the negative consequences of excessive runoff and its effects on people (health and safety), property/infrastructure, erosion, impacts to aquatic biota (local and downstream), stream channel stability, and groundwater recharge.

“Stormwater management” is an umbrella term for the host of activities pursued to minimize the negative consequences of runoff. For the past several decades, about 5% impervious cover within a watershed has been recognized as a threshold for when stormwater management needs kick in to protect biota and aquatic and riparian habitat. Most of Carrboro has been developed to a level that exceeds this amount of impervious cover¹. Though interdependent, stormwater management interests can be broken down into four related but separate environmental contexts, described in greater detail below: water quality management; erosion control from disturbed land; stream channel integrity; and flooding. A broad description of the stormwater management provisions of the Land Use Ordinance is also provided, followed by a description of the Town’s programmatic activities and services.

Water quality management focuses primarily on minimizing impacts on aquatic and human health associated with toxic chemicals (e.g., heavy metals, pesticides, synthetic organic chemicals), nutrient enrichment (e.g., inorganic and organic fertilizer), oxygen demanding organic waste, microbial/bacteriological contamination, siltation/sedimentation/turbidity, and related habitat degradation. Water quality has been regulated since 1999 by utilizing stormwater control measures that treat the first 1” of rain from a storm event that remove at least 85% of the “total suspended solids”. 1” rain events happen on average several times a year. The emphasis on managing this amount of runoff takes into account the “first flush” concept in which a large majority of contaminants in runoff accumulate between rain events and then are carried in this first inch of rain. Carrboro has been relying on State design manuals and methods to identify the appropriate control measures to utilize for all development permitted under the Land Use Ordinance (more below). However, several areas of Town were developed when stormwater management and stream buffer ordinance provisions either did not exist or did not include more extensive stormwater management provisions.

Erosion control of for new development (including clearing and grading) falls under specific state regulations which, for private development in Carrboro, is administered by Orange County staff. Erosion control for public infrastructure/facilities is regulated by the State. Bonafide agricultural, forestry, and mining are exempt from local regulation in Orange County, and are regulated under state and federal authority. Erosion control regulatory authority focuses on utilizing approved best management practices (e.g., site preparation; site stabilization with seed/straw/matting; silt ponds with inlet and outlet protection and skimmers; perimeter protection; non-erosive conveyance) for the construction site. Compliance for erosion control is limited to oversight of the correct design, installation, and maintenance of the BMPs in the site’s erosion control plan; state law limits the ability to regulate the turbidity of water running off construction sites. The erosion control authority for construction/development projects does not extend to stream bank erosion of jurisdictional streams, nor to post construction erosion.

Stream Channel Integrity. During the past 10-20 years, watershed management has increasingly turned towards concepts recognized within the discipline of fluvial geomorphology, the study of the form and function of streams and the interaction between streams and the landscape around them. 'Fluvial' refers to the processes associated with running waters, 'geo' refers to earth and 'morphology' refers to channel shape. In this paradigm, an emphasis is placed on integrating stormwater management efforts that are site oriented with larger landscape and watershed scale efforts. Geomorphically motivated stream work can involve both less extensive (“stream repair”) and more extensive (“stream restoration”) projects which involve reforming the stream channel itself to create a more stable channel. In urban and urbanizing areas, channel geomorphology can be significantly compromised from more natural stream form and function; “natural channel design” techniques can be used to improve the channel form and function. Such projects can be relatively complex and expensive, given the sensitive ecology, engineering,

¹ An analysis completed as part of the 2012 Bolin Creek Watershed Restoration Plan revealed that the most upstream extent of the watershed was about 5 % impervious, with the highest % impervious (slightly > 20%) in Carrboro occurring in the Tanbark Branch watershed in downtown Carrboro.

regulatory and earth moving components. All intermittent (seasonally flowing) and perennial (continually flowing) streams are considered to be “jurisdictional”, which means that their fundamental form and integrity are regulated under federal law, administered by both the Army Corps of Engineers and the State, primarily under Sections 401 and 404 of the Clean Water Act.

While the largest floods move large amounts of sediment over short periods of time and shape the valleys and floodplain, they are relatively rare. The current scientific/engineering understanding recognizes the importance of “bankfull” flows as the condition when channels receive their maximum erosive stress and of the most importance in defining a stream's shape. The term bankfull refers to the water level stage that just begins to spill out of the channel into the floodplain. Bankfull flows tend to occur on the average two out of every three years, and are greater than the flow associated with the 1” water quality design storm but less than flows during flood events. This means that management to dampen the peak runoff and associated flooding from a storm through detention and subsequent release of water during the hours following the peaking of runoff can actually increase streambank erosion if the volume released approaches the “bankfull” flow. Carrboro passed LUO provisions in 2012 limiting the allowable increase in the annual volume of runoff specifically to recognize and address this potential. For over a decade, Carrboro has also been participating in Bolin Creek watershed restoration activities which prioritize geomorphic restoration.

Flooding. Management of stormwater quantity is driven by insuring no increase in the “peak” flow during a storm event for the 1 to 25 year recurring design storms (in a 24 hour period), or an amount of rainfall and runoff on the order of 5 times more than for the water quality design storm, and also an amount of water exceeding the bankfull/channel forming flow.

Managing flooding in regulated floodplains falls under state and federally administered floodplain management programs, with a prime concern being impacts on insurable properties. These regulations involve a continual updating of maps of flood zones regulated through flood modeling studies performed by the NC Floodplain Mapping Program, with oversight from FEMA. In Carrboro, these areas are located adjacent to the largest tributaries, i.e., Morgan Creek, Bolin Creek, and Toms Creek. It is worth noting that while federal and state floodplain regulation insures that new structures are not located in regulated flood zones and mapping is kept up to date, and provides relief for affected property in regulated flood areas, it does not cover low lying lands adjacent to smaller tributaries, nor overland runoff outside of recognized stream channels. The Town’s participation in the National Flood Insurance Program, starting in 1976, has allowed property owners access to subsidized insurance rates and grant funding. At the time the Town’s participation began, the city limits encompassed approximately two square miles and is estimated to have included about 3,500 residences. Few properties are affected by flooding of regulated floodplains; nuisance flooding of properties in low-lying areas occurs in several areas, primarily those developed prior to the mid-1970s. The Town’s Drainage Policy, adopted in 1984, contains the framework for deciding how drainage responsibilities are determined and paid for (*Attachment*).

Stormwater Requirements in Land Use Ordinance. The Town Land Use Ordinance was put in place effective November 25, 1980, replacing the earlier, separate subdivision regulations and zoning ordinance. [Article XVI](#) of the Land Use Ordinance addresses flood damage prevention, stormwater management from new development, watershed protection, and water quality buffer protection. Stormwater related provisions include sedimentation and erosion control during construction (implementation has been delegated to Orange County); impervious surface limitations and other development standards for the University Lake watershed; performance standards for regulating peak flow, water quality from the 1” storm, and annual stormwater volume; and maintenance of structural stormwater control measures such as detention basins and bioretention (rain gardens). A series of updates to these requirements have been pursued over several decades to respond to Town interests and initiatives

and also to federal and state requirements. The land use planning requirements for water supply watershed protection were amongst the first to be developed in North Carolina, and several of the other provisions exceed state and federal minimum requirements.

Stormwater Conveyance System and Facilities Maintenance Program and Services. Under the NPDES permit, the Town is responsible for defining and maintaining a “Municipal Separate Stormwater Sewer System” (“MS4”) for the conveyance of runoff within Town limits. This system is by definition public, and therefore occurs in the public right of way or through dedication to the Town. Carrboro’s current stormwater conveyance system utilizes a combination of conveyance approaches, ranging from curb and gutter for runoff from streets, sidewalks and shoulders, underground piping, grassed swales, ditches including those with rip rap or armor, and for some conveyances, detention and/or dissipation systems at outlets prior to entering receiving waters. The Town has mapped a total of 88 miles of stormwater conveyances (of all types including open channels and pipes), 52 miles of which are on Town property, 13 miles of which are on State property, and 23 miles of which are on private property.

The Town initiated this stormwater mapping effort in 2000. The program has involved inventorying all storm drainage facilities within the Town’s corporate limits and ETJ. All public drainage structures and many private structures have been mapped, including surveying of public structures. The mapping program has included determination of:

- ☐ Horizontal and vertical location of storm drainage structures and open end culverts
- ☐ Sizes and types of the piping connecting the drainage structures
- ☐ Type and condition of storm drainage structures.
- ☐ Visual inspection of each structure to detect illicit discharges or other irregularities.

The Town is maintaining and improving this data on an ongoing basis. The Town has also completed a major update to stream data that has improved the accuracy and classification of perennial, intermittent, and ephemeral streams.²

Efforts for keeping pollutants out of the system and maintaining and inspecting the system include:

- ☐ Integrated Pest Management Program (IPM) - The Town has adopted an IPM policy and program as a comprehensive approach that gives priority to prevention and management of pests including insects, weeds, and plant disease by the least toxic method.
- ☐ Street Sweeping – The Town has a vacuum sweeper truck for removal of sediments and pollutants from street surfaces in the downtown district and on some arterial and residential roads.
- ☐ Basin Clean Out Program - currently on as needed basis with more attention given to on-going problem locations. The Town’s sweeper is equipped with a "wander hose" attachment that allows removal of debris and sediments from curb inlets and catch basins.
- ☐ Vehicle Wash Area - Public Works has a wastewater separator tank that is connected to a sanitary sewer system. Periodically, the contents of tank are removed by a licensed and regulated disposal company.

² Mapped streams include 136 miles of streams (70 miles of ephemeral (Town buffered) streams and 66 miles of jurisdictional streams)

Other corrective measures, maintenance activities, and schedules will be reviewed and updated as part of the reissuance of the NPDES permit and updating of the Stormwater Management Plan to include consider for preventing release of pollutants from Town operations. Examples of specific operational areas to be evaluated include:

- ☐ Streets and Infrastructure: Maintenance activities and inspection procedures for street sweeping, leaf collections, and solid waste collections;
- ☐ Storm Water Conveyance Systems: Update protocol and schedule for cleaning swales, catch basins, and pipe systems and proper disposal of waste from clean-up operations;
- ☐ Road Salt/Sand: Evaluate storage conditions and application protocol and rates;
- ☐ Vehicle washing activities: Ensure all vehicles are washed only in appropriate facilities.

Who regulates the Town and how?

NPDES Permit. In 1990, under the authority of the federal Clean Water Act and starting with large (population >100k) municipalities (and industries), EPA began regulating stormwater runoff. In 2000, the scope was extended to smaller municipalities, and EPA delegated the authority to the State to issue these municipalities (including Carrboro) a stormwater permit. The initial Carrboro permit was issued effective July 1, 2005, and required the Town to develop and implement a comprehensive stormwater management program that includes six minimum measures:

- (1) Public education and outreach on stormwater impacts
- (2) Public involvement/participation
- (3) Illicit discharge detection and elimination
- (4) Construction site stormwater runoff control (delegated to Orange County)
- (5) Post-construction stormwater management for new development and redevelopment, and
- (6) Pollution prevention/good housekeeping for municipal operations.

The permit was renewed in 2011, and is due to be renewed again within the next month. The Town updated a required Stormwater Management Plan in 2012 that describes how the Town intends to fulfill the requirements of the permit³. Preliminary thoughts on potential new activities to improve efforts under this permit and plan are appended at the end of this memo. The Public Works facility has a separate NPDES stormwater permit that applies only to that site.

Jordan Lake Rules. As a waterbody that has been identified as “impaired”, there has been a several decade’s long process by the State and stakeholders, with oversight by the USEPA, to develop a strategy to restore water quality in Jordan Lake. A set of regulations were adopted in 2009 (the “Jordan Lake Rules”) with a variety of subsections applying to different regulated parties. As a regulated entity in the upper New Hope watershed, Carrboro has been subject to the upper New Hope percent reduction goals for nitrogen (8%) and phosphorus (5%) for existing development in Carrboro. Rule provisions related to nutrient (fertilizer) management and buffers have been fully implemented⁴, however, provisions relating to stormwater management from both new and existing development have been placed on hold until 2019 pending further study, most recently by S.L. 2016-94. Staff have estimated that it will cost the Town a minimum of about \$4M to meet the required reductions under the existing development part of the Rules

³ The permit and plan are available at <http://www.townofcarrboro.org/pzi/Env/Water/swhome.htm> along with additional program details.

⁴ The Town’s buffer provisions exceed minimum state requirements most notably by requiring wider buffers for jurisdictional streams and also including buffers for smaller ephemeral streams.

as developed in 2009, and have been identifying potential retrofit projects for the past five years as part of State reporting requirements, with more information appended below and in the Town's [Capital Improvements Program](#)

Table 1: Summary of Stormwater Regulations Applicable to the Town

Regulation/ Initiative	Description	Town Response
NPDES Permit	Includes public participation and outreach; illicit discharge; good housekeeping and pollution prevention for Town owned property/infrastructure; and post construction stormwater control. Post construction program is implemented through LUO, which includes stormwater management requirements for water quality and peak flow for many years. Most recent update was limiting increase in annual runoff volume in 2012.	Town has delegated erosion control implementation to Orange County; state regulations apply.
Jordan Lake Rules	Rules adopted in 2009 established requirements for existing and new development, buffers, and nutrient management. The existing and new development provisions have been legislatively delayed.	Town has implemented buffer provisions (for new development) that provide some geomorphic protection. Buffers serve as proxies for flood prone areas for smaller tributary streams. Nutrient management requirements were established in Town Code. Staff experience has been that requirements for nitrogen and phosphorus removal for new and existing development do not offer protection beyond other LUO provisions
Bolin Creek Watershed Restoration	Since 2006, with Chapel Hill as partner, Town has worked to improve stream geomorphology and water quality. Relevant activities are also covered in regulatory programs-main added emphasis is on retrofits and restoration.	Town has pursued grant projects that have included several stream repair and stormwater retrofit projects.
National Flood Insurance Program	Insures that new structures are not located in regulated flood zones; provides relief for affected property	Town joined program in 1976 and established floodplain regulations soon after. Ongoing work with Army Corps of Engineers and NC Floodplain Mapping Program to extend reach by mapping floodplains and establishing regulatory flood zones further upstream than minimums required.
Section 401/404 of Federal Clean Water Act	Protects jurisdictional streams from damage via grading, piping, etc.	This is implemented by Army Corps and NCDWR. Town coordinates to obtain copies of permits and determine applicable requirements.

Other Programs and Initiatives.

Bolin Creek Watershed Restoration Team. Carrboro staff worked with Chapel Hill and other local, state and federal agency staff in 2006 to create the Bolin Creek Watershed Restoration Team (BCWRT) to proactively respond to the listing of Bolin Creek on of state and federal impaired waterbodies. At the time, the Bolin Creek watershed was selected as one of only 7 watersheds in the state to receive focused state and federal assistance in preparing grant applications and leveraging other resources to remove Bolin Creek from the impaired waters list. The selection was based on Bolin Creek's impairment listing and the existence of restoration planning efforts for the larger Morgan and Little Creek Watersheds, along with the local capacity for progressive environmental initiatives. The BCWRT's long term goal is to improve the health of Bolin Creek and its tributaries and remove it from the impaired waters list. This is an ambitious goal that will require a robust commitment.

To date, the following successes have been achieved:

- In 2003, a watershed assessment of the Little Creek watersheds in which Bolin Creek is located was completed
- In 2004, a management study of the Morgan and Little Creek watersheds was completed.
- In 2006, the NC Division of Water Quality and EPA pledged staff assistance.
- In 2007, the Team received a Clean Water Management Trust Fund grant that was used to conduct a detailed geomorphic analysis to identify areas of erosion, instability, and other high risk locations.
- In 2008 and 2009 the Team received two federal "319" grants to pursue restoration projects, planning, and monitoring, one led by Chapel Hill and the other led by Carrboro. Both grant efforts were successfully completed, including on the ground restoration projects in both towns and a planning/engineering study of a drainage area in downtown Chapel Hill. In 2012, a Watershed Restoration Plan and Watershed Situation Assessment for Bolin Creek were completed as part of the grant project efforts.

Additional information is available from the links provided at the end of this memo.

Ongoing Creek Monitoring. Benthic macroinvertebrate (aquatic insect) monitoring is a primary means used by the NC Division of Water Resources to assess creek health, but state resources are only able to support infrequent (every 5 years at best) and limited benthic monitoring. Recognizing this, the Town has been pursuing much more extensive benthic monitoring for the past 15 years as a primary means for assessing creek health. This sampling continues to reveal impacts that warrant close attention. Sampling on Bolin Creek has consistently indicated Good-Fair water quality in upper Bolin Creek, especially at the most upstream site (just upstream of Winmore). Areas further downstream have fluctuated between a Good-Fair and a Fair rating. ("Fair" is the threshold which triggers listing on the State's impaired streams list.) Chapel Hill is also using benthic insects as a key indicator; abundant benthic and other data continue to indicate that Bolin Creek becomes more degraded as it flows downstream through Chapel Hill. This long term record of annual or better monitoring on Bolin Creek along with recent sampling of some smaller tributaries has created one of the best benthic macroinvertebrate monitoring small stream datasets in North Carolina. The declining aquatic health moving downstream along Bolin Creek indicates the ongoing stress to the creek. Bolin Creek from below Pathway Drive to its confluence with Little Creek in Chapel Hill has been listed on the State/federal impaired streams (303d) list for many years.⁵ Morgan Creek has been sampled upstream of University Lake, however, there is no suitable benthic habitat and therefore no sampling downstream of University Lake in Carrboro's jurisdiction due to the extensive stream channel incision.

⁵ Benthic monitoring reports can be found at <http://www.townofcarrboro.org/pzi/Env/Water/bcmonitor.htm> .

Other Monitoring. With installation funds provided by the North Carolina Ecosystem Enhancement Program, streamflow measurement using a permanent United States Geological Survey (USGS) gage on Bolin Creek near the municipal boundary (on Umstead Road) was initiated in 2012. Chapel Hill and Carrboro staff have worked out a cost sharing agreement for the ongoing operation and maintenance of the gage. This gage provides real time information of the cumulative runoff for roughly the northern half of Carrboro. There is also a USGS maintained stream gage on Morgan Creek just upstream of University Lake. From 1993 to 2008, Carrboro contracted with the Town of Chapel Hill Engineering Department to monitor stream water quality and gauge the effectiveness of stormwater management programs. Monthly testing included three sites in Carrboro. The waters were tested for water temperature, pH level, dissolved oxygen, specific conductivity, turbidity, nutrients, metals, and the presence of fecal coliform bacteria. In 2009, Chapel Hill discontinued this program and shortly thereafter began implementing a new effort focusing on more extensive benthic monitoring as a more holistic indicator of aquatic health.

Summary Comments.

Integration of Different Management Approaches and Objectives. While there is certainly some overlap and opportunities for synergy in addressing the different elements of stormwater management discussed above, this overlap has limitations. For example, reducing the nitrogen and phosphorus in runoff in consideration of the existing development provisions of the Jordan Lake rules would result in relatively minor improvements in addressing flood management concerns, but would have more synergy with NPDES permit and Bolin Creek Watershed Restoration activities. Similarly, management of stormwater conveyance infrastructure for very specific drainage areas and property issues could provide localized flood mitigation/drainage improvement benefits, but with little or no improvement for downstream aquatic ecosystems. Examples of a few interventions that have fairly universal stormwater benefits include reestablishment of woody vegetation and removal or disconnection of impervious surfaces or replacement of impermeable pavement with permeable pavement because of the increased infiltration, interception, and evapotranspiration.

Appendices

Links to additional information

Carrboro Stormwater homepage: <http://www.townofcarrboro.org/287/Stormwater>

Carrboro NPDES Stormwater Management Plan:
<http://www.townofcarrboro.org/DocumentCenter/Home/View/578>

The Town participates in the Clean Water Education Partnership
<http://www.nccwep.org/>

NCDWR Jordan Rules: <http://portal.ncdenr.org/web/jordanlake/implementation-guidance-archive>

NCDWR presentation: http://portal.ncdenr.org/c/document_library/get_file?uuid=5aa1cee4-ed17-41c6-b601-ba3a4f2bb87f&groupId=235275

Nutrient Scientific Advisory Board: <http://deq.nc.gov/about/divisions/water-resources/planning/nonpoint-source-management/nutrient-scientific-advisory-board/>

Carrboro Benthic Sampling Studies: <http://www.townofcarrboro.org/702/Benthic-Monitoring>

Carrboro Bolin Creek Website: <http://www.townofcarrboro.org/280/Bolin-Creek-Watershed-Restoration>

NCSU Bolin Creek Website: http://www.bae.ncsu.edu/programs/extension/wqg/srp/bolin_creek.html

Chapel Hill Bolin Creek Website: <http://www.townofchapelhill.org/town-hall/departments-services/public-works/stormwater-management/local-watersheds-water-quality/watershed-assessments-recommendations/bolin-creek-watershed-restoration-team>

The Town participated in/presented at a well-attended local symposium on “Caring for our Creeks” in 2012 <http://bolincreek.org/blog/symposium-2/>

NPDES Stormwater Permit

On February 20, 2017, Town staff received a draft permit renewal from NCDWR staff. Staff are still reviewing the draft permit; exact requirements/changes for the next cycle therefore are still being determined. Potential areas of staff investigation for ongoing permit implementation and the next permit cycle are summarized in Table 1.

Table 1: NPDES Permit Potential New Activities

<u>Potential New Activity</u>	<u>Notes</u>
<i>Administrative:</i> annual analysis of the capital and operation and maintenance expenditures and staff resources for stormwater; potential for new annual reporting requirements and goal to create a high quality, community oriented annual report.	Additional staff time anticipated.
<i>Public Education, Outreach and Public Participation:</i> new permit could require more extensive outreach and participation program.	Additional staff time anticipated. The Town participates in the Clean Water Educational Partnership, a consortium of several dozen governmental members in central and eastern NC coordinated by TJCOG staff. CWEP has focused historically on broad media campaigns.
<i>Illicit Discharge Detection and Elimination:</i> detect dry weather flows; employee training; improved public reporting mechanism; procedures to identify and eliminate failed septic systems; Enforcement Response Plan (ERP); enforcement tracking	Additional staff time anticipated.
<i>Post Construction Runoff Control:</i> More detailed inventory of post-construction structural stormwater control measures; recordation of maintenance responsibility; fully implement program for long-term operation and maintenance of structural BMPs, including verification of maintenance and inspections; provide educational materials and training for developers; may also consider establishing incentives and/or requirements such that development projects design, install, implement, and maintain stormwater control measures that promote infiltration of flows and groundwater recharge for the purpose of maintaining stream base flow, evapotranspire, harvest, and use stormwater discharges; more fully implement Enforcement Response Plan (ERP), including recordkeeping and follow-up associated with enforcement actions; post-construction requirements for public transportation.	A total of about 170 structural stormwater control measures (a new term for what used to be called “best management practices or BMPs) have been permitted by the Town under the LUO. Implementation of maintenance of these measures to date has assumed landowner responsibility, with the Town providing inspections, notification of items needing maintenance, and having legal authority to take over maintenance under neglect. Additional staff resources will be needed to fully implement this maintenance and inspection program.

Table 2: Summary of Current Structural Stormwater Control Measures in Carrboro

<u>SCM Type</u>	<u>Number</u>	<u>Ownership</u>	<u>Number</u>
Dry detention (flooding)	64	HOAs	55
Bioretention (aka rain garden; water quality)	50	CHCCS	32
Ponds (both)	19	Other (mix of commercial, multifamily, public)	83
Other (e.g., wetlands, cisterns, underground devices)	37		

Jordan Lake Rules

The following tables list the types of activities that are/potentially are eligible to receive credit under the Existing Development provisions of the Jordan Lake Rules.

Table 3: Stormwater Practices for Credit for Jordan Lake Rules

Bioretention	Removal of impervious surface
Constructed Wetland	Permeable Pavement
Sand filter	Redirecting runoff from impervious areas
Filter Strip	<i>Off-line regional treatment systems</i>
Grassed swale	<i>*Pond Retrofits</i>
Infiltration device	<i>*Remedy Malfunctioning Septic System</i>
Extended dry detention	<i>*Remedy Discharging Sand Filter</i>
Rainwater harvesting system	<i>Improved Street Sweeping</i>
Treatment of redevelopment	<i>Retrofitting bioretention & grassed swales</i>
Overtreatment of new development	<i>Soil Amendments</i>

(Italics): practice in need of DWR approved accounting before being implemented

**: practices being studied by Nutrient Scientific Advisory Board*

Table 4: Ecosystem Practices for Credit for Jordan Lake Rules

-Wetland or riparian buffer restoration	<i>-Land conversion to wetlands</i>
-Reforestation w/ conservation easement or protective covenant	<i>-Stream Restoration/Enhancement</i>
-Land Improvement (e.g., bare patches -> vegetation)	

(Italics) practice in need of DWR approved accounting

Table 5: Potential Retrofits for Addressing Jordan Lake Existing Development Rules

<u>Type of Retrofit</u>	<u>Location</u>	<u>Notes</u>
Bioretention and vegetated swale	Anderson Park	Concept study completed by Sungate
Stormwater wetland; rainwater harvesting; disconnected impervious surface;	MLK Park	Stormwater control measures are currently being studied as part of MLK design project
Stormwater wetlands or bioretention	Town land adjacent to Morgan Creek	Preliminary site assessment completed.
Stormwater wetland; potential stream restoration	Carrboro Elementary School	Concept studies completed by CH2M Hill and NCSU
Stormwater wetland, bioretention, permeable pavement	McDougle School	Concept study completed by Sungate
Detention and bioretention retrofits	Carrboro High School	Concept study completed by Sungate
Bioretention, wetland, permeable pavement	OWASA WTP	Concept study completed by Sungate
Retrofit of detention basin	Carrboro Plaza	Concept studies completed by Tetra Tech, CH2M Hill, Sungate