Application for Section 319
Non Point Source Pollution Control Grant---FY2008

Division of Water Quality
North Carolina Department of Environment and Natural Resources

1. Project Title	Bolin Creek Watershed Restoration Initiative

2. Sponsor					
Organization Name	Town of Chapel Hill				
E-mail address					
Mailing Address	405 Martin Luther King Jr., Blvd.				
City	Chapel Hill	State	NC	Zip	27514
Telephone		Fax Number			
Federal Tax ID Number	56-6001199				

3. Project Coordinator or Primary Contact[1]					
Name	Trish D'Arconte				
Title	Stormwater Engineering Technician				
E-mail Address	pdarconte@townofchapelhill.org				
Mailing Address	405 Martin Luther King Jr., Blvd.				
City	Chapel Hill	State	NC	Zip	27514
Telephone (if different from above)	919-969-7202	Fax Number (if different from above)		919-969-7276	

[1] **A one-page Statement of Qualifications must accompany applications to confirm that anyone designing, installing, or monitoring the proposed project is qualified to do so. Include in the statement any past and/or ongoing 319 grant funded projects.**

Total Section 319 Funds Requested	$369,930	***5. Type of Funding Requested (check one)***	Competitive Base	Restoration (Incremental) **X**
Match funds or in-kind Match Services	$246,428	***6. Type of Project (check one)***	**X**	Development or implementation of a Watershed Restoration Plan
				Development or implementation of a TMDL
4. Total Project Cost	$616,320			Innovative BMP Technology Demonstration
				Education/Technology Transfer
				Other: (please indicate)

NC Application for Section 319 NPS Pollution Control Grant

7. General Goal of Project (Check all that apply)	Protect and/or Maintain Water Resource Quality	Restore Water Resource Quality X	Educate X	
8. Project Start Date	1/2009	***Project End Date***	12/2011	
9. Geographic Coverage	Statewide	Regional	Watershed X	Site Specific

10. Project Location	
River Basin	Cape Fear River Basin
Watershed(s)	Bolin Creek (drains to Jordan Lake)
Watershed size	7800 acres
303(d) listed Stream	Yes **X** No
303 (d) list number Stream Reach Code	16-41-1-15-1-(0.5)b
HUC(s) (14 digit USGS Hydrologic Unit Codes)	03030002060100
County	Orange
USGS. 7.5 minute topographic quadrangle map(s) in project area	Chapel Hill, NC quad
Position coordinates of project location	Latitude 35° 55’ 00” Longitude 79° 03’ 30”

11. NPS Pollution Sources to be addressed (Check all that apply)			
	Agriculture		Waste Disposal (includes onsite systems)
	Construction	**X**	Hydrologic Modification
	Silviculture		Marina and Recreational Boating
X	Urban runoff/Stormwater		Groundwater Loading
	Resource Extraction		Natural Sources
X	Habitat Modification (drainage/filling wetlands, streambank destabilization)		Other:

12. NPS Pollutants to be addressed (check all that apply)			
X	Excess Nitrogen		Pesticides
X	Excess Phosphorus		Oil and grease
X	Sedimentation	**X**	Temperature
	Pathogens/Bacteria		pH
	Metals		Alterations
X	Low dissolved oxygen		Other:

12a. *Estimate Load Reduction, if checked for excess nitrogen, excess phosphorus and/or sedimentation*	
# pounds of nitrogen saved from project implementation Baldwin Park Stream Restoration – estimated 4800 pounds per year (for 1000 foot segment – extrapolated from smaller segment calculation – 2lbs per ton of sediment) BMPs for Baldwin Park – UNKNOWN (as advised by NCSU) Mill Race trib gully repair – estimated 1400 pounds per year per gully (for a total of 2800 pounds of nitrogen for 2 gullies) Mill Race trib outfall protection - UNKNOWN Mill Race trib streambank stabilization – UNKNOWN	Reference: EarthTech Geomorphic Assessment Report (9/2007) Morgan/Little Local Watershed Plan (8/2004)
# pounds of phosphorus saved from project implementation Baldwin Park Stream Restoration – estimated 2400 pounds per year (for 1000 foot segment – extrapolated from smaller segment calculation – 1 lb per ton of sediment) BMPs for Baldwin Park - UNKNOWN Mill Race trib gully repair – estimated 700 pounds per year per gully (for a total of 1400 pounds for 2 gullies) Mill Race trib outfall protection - UNKNOWN Mill Race trib streambank stabilization – UNKNOWN	Reference: EarthTech Geomorphic Assessment Report (9/2007

# tons of soil saved from project implementation Baldwin Park Stream Restoration – estimated 2400 tons per year (for 1000 foot segment – extrapolated from smaller segment calculation – 2.4 tons/yr/ft) BMPs for Baldwin Park – UNKNOWN (as advised by NCSU) Mill Race trib gully repair – estimated 700 tons per year per gully (for a total of 1400 tons for 2 gullies) Mill Race trib outfall protection - UNKNOWN Mill Race trib streambank stabilization - UNKNOWN	Reference: EarthTech Geomorphic Assessment Report (9/2007)
Load Reduction Model Used: STEPL, Region 5, L-THIA, Other: BANCS	

13. Project Abstract (short concise summary of the project – DO NOT EXPAND SPACE PROVIDED)
This set of projects is the first of what is expected to be a multi-year program to improve the biological health of the Bolin Creek Watershed as part of the participation of the Towns of Chapel Hill and Carrboro in EPA's Watershed Restoration Program. Because some project areas are under private ownership, we propose that funding for the Baldwin Park and Mill Race tributary projects be dependent on acquiring provisional property-owner approval. 1. Development of a 9-element Watershed Restoration Plan based on existing studies and with significant stakeholder input. 2. An alternatives analysis for a piped urban stream for methods to control the severe runoff conditions other than or in addition to the use of an in-line BMP where the spring daylights. 3. Subwatershed-wide stormwater and erosion control for a tributary to Mill Race (tributary to Bolin Creek) in Chapel Hill. 1. Restoration of a pair of small streams in/along a park in Carrboro (Baldwin Park), including energy -dissipating BMPs and stream enhancement along additional segment,

	Year 1	Year 2	Year 3	Year 4	Year 1	Year 2	Year 3	Year 4		
Personnel/Salary	0	0	0	0	$27,597	$33,117	$33,117	$5,519	$99,350	Chapel Hill & Carrboro staff time, volunteer time
Fringe Benefits	0	0	0	0	$9,111	$10,934	$10,933	$1,822	$32,800	Chapel Hill & Carrboro fringe benefits
Supplies	$1,667	$2,000	$2,000	$333	0	0	0	0	$6,000	Includes educational supplies, supplies for watershed restoration plan meetings, etc.
Equipment	$12,000	0	0	0	0	0	0	0	$12,000	2 automated samplers, 2 pressure transducers, dataloggers and setup
Travel	0	0	0	0	$833	$1,000	$1,000	$167	$3,000	Use of Carrboro & Chapel Hill vehicles + gas for monitoring, educational events / stakeholder meetings
Contractual	$106,430	$106,431	$106,431	0	$16,476	$16,476	$16,476	0	$368,720	To NCSU Water Quality Group to pay for design and construction, incl. vegetation; alternatives analysis; lab analysis
	0	0	0	0	$20,300	$25,825	$15,825	0	$61,950	EEP preservation survey, Carrboro rain gardens, Carrboro bug sampling, Chapel Hill water quality sampling
Other	3500	0	29,000	0		0	0	0	$32,500	Permitting and 5% contingency (as recommended by NCSU)
Total Direct									$0	
Indirect									$0	
Annual Totals	$123,597	$108,431	$137,431	$333	$74,317	$87,352	$77,351	$7,508	$616,320	
Grand Total	$369,792				$246,528					
% of Total Budget	60 %				40 %				100%	

***Note: Non-Federal match must be a minimum of 40% of the total project budget

15. Budget Summary (Combined federal and match funds)							
	BMP Implementation	Project Management	Education Training or Outreach	Monitoring	Technical Assistance	Other	**Total**
Personnel	0	32,100	6000	25,500	0	35,750	99,350
Fringe Benefits	0	10,450	2150	7550	0	12,650	32,800
Supplies	0	0	5000	0	0	1000	6000
Equipment	0	0	0	12,000	0	0	12,000
Travel	0	0	750	2000	0	250	3000
Contractual	300,000	0	0	18,720	50,000	0	368,720
Operating Costs							
Other	29,000	3500				61,950	94,450
Total	329,000	46,050	13,900	65,770	50,000	111,300	616,320

16. Local and State Match (non-federal) Summary	
Total Match amount	$246,528
Cash Match	$49,428
In-kind Match	$197,100
Source(s) of Cash Match	Town of Chapel Hill Town of Carrboro NC State University Water Quality Group
Source(s) of In-kind Match	Town of Carrboro: staff time, demo rain garden installation, website, monitoring Town of Chapel Hill: staff time, project administration, monitoring, reports Friends of Bolin Creek: monitoring NC Ecosystem Enhancement Program: Bolin Creek Preservation Survey

17. Project Partners (may add more, if needed)[2]			
Agency Name	Town of Carrboro		
Agency Address	301 West Main Street, Carrboro, NC 27510		
Role/contribution to Project	Carrboro lead contact. Coordinate Carrboro implementation efforts (Carrboro is "co-champion" in the Restoration Initiative with Chapel Hill)		
Contact Person	Randy Dodd	Phone No.	919-918-7326
E-mail address	rdodd@townofcarrboro.org		
Agency Name	Ecosystem Enhancement Program		
Agency Address	1652 Mail Service Center, Raleigh, NC 27699-1652		
Role/contribution to Project	Bolin Creek preservation project		
Contact Person	Mike Herrmann	Phone No.	919-715-5458
E-mail address	Michael.Herrmann@ncmail.net		
Agency Name	NC State University – Water Quality Group		
Agency Address	Campus Box 7637, Raleigh, NC 27695-7619		
Role/contribution to Project	Engineering design, construction oversight, data analysis		
Contact Person	Greg Jennings	Phone No.	919-515-6791
E-mail address	jennings@ncsu.edu		
Agency Name	Friends of Bolin Creek		
Agency Address	Box 234, Carrboro, NC 27510		
Role/contribution to Project	Volunteer assistance with sample collection and site monitoring		
Contact Person	Dave Otto	Phone No.	
E-mail address	davidaotto@earthlink.net		

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18. Project Milestone Schedule		
Time Period/Date	Activities (List specific quantifiable outputs or activities that will be achieved during each quarter)	Anticipated % of Requested Funding Spent[1]
First Quarter (Sep, 2008)	• Start local (Chapel Hill and Carrboro) permitting process • Start 401/404 permitting process • Initial project design • Put together general outline of watershed restoration plan, determine and schedule action items • Submit quarterly report	2%
Second Quarter (Oct-Dec 2008)	• Consult with property owners and stakeholders, revise project plan • Baseline channel geomorphic characterization, install bank pins and scour chains to measure erosion • Have kickoff public information meeting letting people know what's going on and solicit input for watershed restoration plan • Collect and summarize studies and information for watershed restoration plan • Set up meetings with specific watershed stakeholders • Install automated stormwater samplers and level loggers • Start collecting monthly water quality samples and discharge measurements for a rating curve • Get final approval from private property owners • Baseline channel morphology at Baldwin Park and Mill Race trib • Finalize contract for Tanyard Branch alternatives analysis • Submit quarterly report	10%
Third Quarter (Jan-Mar 2009)	• Local and 401/404 permit applications approved • Construction contracts finalized – Mill Race trib and Baldwin Park • Monthly monitoring activities: baseflow water samples at Baldwin Park and Mill Race trib, stormflow samples as appropriate, discharge measurements, collect streamflow data from datalogger, measure for erosion on bank pins/scour chains • Start meetings with specific watershed stakeholders • Submit quarterly report	20%
Fourth Quarter (Apr-Jun 2009)	• Start construction – Mill Race Trib and Baldwin Park • Monthly monitoring activities • Meetings with specific watershed stakeholders • Submit quarterly report	30%
Fifth Quarter (Jul-Sep 2009)	• Monthly monitoring activities • Start construction – Carrboro rain garden(s) • Meetings with specific watershed stakeholders • Submit quarterly report	40%

Sixth Quarter (Oct-Dec 2009)	• Complete construction • Complete riparian/bank/rain garden plantings • Hold riparian plant care workshops with property owners • Install signage at Baldwin Park • "ribbon-cutting" events • Monthly monitoring activities • Meetings with specific watershed stakeholders • Submit quarterly report	50%
Seventh Quarter (Jan-Mar 2010)	• Monthly monitoring activities • Present first draft of Watershed Restoration Plan to specific watershed stakeholders for comment and modification • Submission of first draft of Plan to DWQ / EPA for review • General public information meeting, updates • Submit quarterly report	60%
Eighth Quarter (Apr-Jun 2010)	• Monthly monitoring activities • Present second draft Watershed Restoration Plan to boards and commissions – work with them to integrate and resolve conflicts between the watershed plan and other existing plans • Submit quarterly report	65%
Ninth Quarter (Jul-Sep 2010)	• First round of annual post-project morphology monitoring at Baldwin Park and Mill Race trib • Replace/refresh bank/riparian plantings as needed • Monthly monitoring activities • Submit quarterly report	70%
Tenth Quarter (Oct-Dec 2010)	• Monthly monitoring activities • Revise Watershed Restoration Plan as needed in response to comments from Boards and Commissions, resolve conflicts with other plans • Tanyard Branch alternatives analysis completed, report presented • Submit quarterly report	80%
Eleventh Quarter[2] (Jan-Mar 2011)	• Monthly monitoring activities • Submit quarterly report • Modification and Presentation of final Draft Watershed Restoration Plan as necessary • Submission of final Draft Plan to DWQ / EPA for final review	90%
Twelfth Quarter (Apr-Jun 2011)	• Monitoring data analysis • Present final Draft Watershed Restoration Plan for approval and adoption by Town Council / Board of Aldermen	98%
Thirteenth Quarter (July-August 2011)	• Submit final project report	100%

[1] Please show anticipated dollar amount, percent of grant spent that quarter, and cumulative percent of grant spent for project. Quarterly invoices will only be reimbursed up to percent indicated. Unused funds will carry forward to next quarter.

[2] 10% of grant will be held until receipt of Final Project Report

19. Background and goals of the project. Expand space, if necessary

Bolin Creek's headwaters are located in Orange County, NC, north and west of the Town of Carrboro. Flowing south and east, Bolin Creek flows through the Towns of Carrboro and Chapel Hill and is a major tributary to Little Creek (eventually flowing to Jordan Lake). Moving downstream, the watershed transitions from rural to suburban to dense urban. (See the attached maps of the watershed and surrounding area, and locations of proposed projects.)

Bolin Creek is impaired for biological integrity (NCDENR-DWQ). It exhibits a progressive decline in watershed functional health from up to downstream (EEP August 2004). As one moves downstream, the increasing impervious surface area generates higher stormwater flows that in turn can have a negative impact on the stream morphology. The high stormwater flows can cause erosion of the stream banks, aggregation or degradation of the channel, and other impacts. The greater impervious surface also can result in reduced base flow that can have a negative impact on the biological community. The greater developed area also provides a greater source of potential toxic substances to the stream.

In 2002 and 2003, assessments of the Bolin Creek watershed conducted by DWQ-WARP indicated that several effects of urbanization, including habitat degradation, riparian degradation, channel incision/embeddedness, low base flow, and toxicity, are believed to be the primary factors stressing this watershed. Most of these problems were more prominent as one moves downstream in the watershed. Other potential stressors included temperature (ranges and extremes), high BOD/COD, nutrients, and cross-connections or leaks from sanitary sewer lines. No streamflow data were taken as part of this study but scour and related morphological and hydrological modifications were considered a primary contributor to the aforementioned stressors. It has been recommended that feasible and cost-effective stormwater retrofit projects be implemented to mitigate the hydrologic and potential toxic effects of existing development (NCDENR-DWQ June 2003).

In 2003 through 2004, the NC Ecosystem Enhancement Program (then Wetlands Restoration Program) undertook a Local Watershed Planning Initiative for the Morgan and Little Creek watersheds, of which Bolin Creek is a part. Although the resulting EEP report made some recommendations for preservation opportunities, stream restoration projects, and potential stormwater management measure retrofit sites, these were selected based on the particular requirements of the EEP. These requirements are based on the use of the EEP as a mitigation bank for the state's Department of Transportation, and selected projects did not target specific identified problem areas or stressors.

The Bolin Creek Watershed Restoration Initiative was started in 2006 to provide organization and support for the Towns of Chapel Hill and Carrboro to participate in EPA's Watershed Restoration Program. The primary goal of the Initiative is to restore the biological health of the Bolin Creek Watershed. The Initiative focuses on hydrologic modification and habitat degradation by addressing some of the primary causes of these stressors including streambank and streambed erosion, disconnection from stream floodplains, sedimentation, scour, thin or absent forested riparian buffers, the "flashy" nature of urban stream hydrographs, very low base flow, the effects of stream crossings, and purposeful modifications such as channelization and desnagging. Water quality issues related to toxins will be addressed separately by the Towns' respective Illicit Discharge Detection and Elimination programs as part of their NPDES MS4 permits.

In 2007, the Bolin Creek Watershed Restoration Team decided a geomorphological analysis of the watershed with BMPs targeted to problem areas would identify projects more likely to have measurable results and directly address the Team's goal. The Team applied for and was awarded a CWMTF stormwater minigrant. These funds were used to contract with EarthTech to conduct a geomorphological

analysis including surveying the entire watershed and walking the majority of the watercourses in the watershed. During this survey, potential stormwater management measures and stream restoration sites targeted to the worst problems were identified, with a greater focus on the former. EarthTech's report serves as an initial guide in the selection of projects for this 319 grant application. The restoration team plans to concentrate its efforts in individual subwatersheds over time in order to concentrate hydrological, morphological, and biological improvements that can be most readily detected as measurable results. The projects proposed for this 319 grant are based on this concentrated approach.

20. A detailed description of the project. Note: if project entails developing or implementing a Watershed Restoration Plan, see section 25. Expand space, if necessary

Develop a Watershed Restoration Plan

The DWQ June 2003 Little Creek Biological Assessment Report, EEP 2004 Morgan and Little Creek reports, and the 2007 Town of Carrboro Bolin Creek geomorphological assessment prepared by EarthTech will be incorporated into a comprehensive Watershed Restoration Plan for Bolin Creek. These existing watershed studies already contain a considerable amount of information that can be compiled to meet the 9 required elements of a watershed restoration plan. The Bolin Creek Watershed Restoration Plan will focus on the hydrologically-related stressors identified in these studies, but will also address other water quality issues and develop appropriate solutions and the locations for those solutions.

In addition to the 9 elements, it will include an analysis of development scenarios, a geodatabase of identified problems and solutions, evaluate local ordinances and capabilities with regard to supporting or inhibiting restoration and preservation efforts, examine future development scenarios and determine Town ordinance and planning needs for protection and preservation of Bolin Creek and its tributaries, catalog other activities in the basin, and be ultimately coordinated with the Towns' Comprehensive Plans and other specific plans such as the Greenways Plan. Detailed studies of individual subwatersheds may be needed to refine the plan where there are complex conditions identified. Orange Water and Sewer Authority (the utility handling sanitary sewer service), the University of North Carolina at Chapel Hill (as a major land owner), and the Federal Railroad Administration (railroads appear to affect many points along Bolin Creek) and *Orange County Soil and Water District??* will likely be involved in order to meet their concerns and include their planned activities that may affect Bolin Creek or other portions of the watershed.

Alternatives Analysis for Stormwater Management in a Tanyard Branch Subwatershed

One of the high-priority projects identified by Earth Tech was the bank reshaping, stabilization, and riparian reforesting of an upper segment of Tanyard Branch. By Earth Tech's estimates this deeply incised and severely eroding stream segment contributes over 1900 tons of sediment per year to the Bolin stream system. Further site reconnaissance found potential conflicts with a nearby sanitary sewer line and an existing greenway trail. In addition, Chapel Hill staff were aware of significant erosion occurring upstream of this site just below a large stormwater outfall. The area draining to this outfall is approximately 98% impervious surface (all downtown Chapel Hill), and includes a historically-known spring that has since been piped. Staff concluded (and have observed) that the energy from this drainage could be sufficient to severely degrade any stream restoration or bank stabilization undertaken downstream.

In order to address this, staff inquired with EPA about the use of an in-line BMP to control the flow and

volume from this combined spring-stormwater system. Because it would be placed along a perennial stream it would need to meet requirements for 401/404 certification. The primary requirement to address would be an analysis of alternatives for the management of runoff flow and volume in this subwatershed, using such methods as cisterns, green roofs, underground storage, etc. that would be appropriate for high -density urban situations, and comparing the costs for implementation of the needed amount of each BMP type to the cost of an in-line BMP at the stormwater outfall. This analysis would also review issues related to general public support, landowner cooperation, compatibility of local ordinances and development plans, and feasibility in general.

Tributary to Mill Race Erosion Control

Mill Race is a major tributary of Bolin Creek draining a portion of the Historic District of Chapel Hill. This area is densely urban and largely built-out, rugged with a shallow depth to bedrock, has piped springs and convoluted stormdrainage, and sanitary sewer lines running down most stream valleys, with streams pushed against the valley walls. A large tributary to Mill Race has two severely-eroded gullies, one of which was highlighted as one of the 32 high priority projects in the Earth Tech report. This gully was estimated by Earth Tech to contribute 701 tons of sediment per year (estimate made using the BANCS model). The second gully is similarly steep but has not cut into the hillside as deeply. We assume that the two gullies are eroding at similar rates.

Further site reconnaissance found the following: a) streambed scour/incision and deposition of the pea-gravel/sand mix (used for sidewalks in the Historic District) below a stormwater outfall at the top of the stream, b) a sanitary sewer line crossing the stream near the bottom of the subwatershed which is being undermined, and c) along the length of the stream - lack of bank vegetation, bank collapse, and heavy instream deposition of “Chapel Hill gravel” (the aforementioned pea-gravel/sand mix) due to the proximity of a sanitary sewer line to the stream and the apparent use of Chapel Hill gravel as fill material to flatten out the easement for vehicle access. (The native soil in this area is a very fine silt-clay, the apparent native stream bed material is boulders and bedrock. This is typical for this area of Town.) Kudzu has also infested the middle portions of the stream valley and is eliminating the tree canopy.

The conceptual plan for this project calls for repair of the two gullies by adding pipe to the existing stormwater outfalls and bringing the runoff to the bottom of hill and using a BMP to dissipate energy and allow infiltration. The outfall at the top of the subwatershed is to be retrofitted to reduce scour, permeable pavers (and other methods) have been suggested to replace the gravel sidewalks in that block to reduce the deposition of sand and gravel in the stream, correcting the undermining of the sanitary sewer crossing (possibly by installation of step-pools), and treatment of the sanitary sewer easement to stabilize the streambanks and reduce erosion. Between the largely built-out condition of the subwatershed, and Chapel Hill ordinances requiring no increase in off-site runoff in new and redevelopment, we do not anticipate problematic changes in hydrology that might negate our efforts to improve hydrology.

Water quality monitoring would include monthly base flow and storm flow suspended sediment and nutrient samples, and continuous measurement of dissolved oxygen and temperature throughout storm events, upstream of the confluence with Mill Race. Bank pins would be installed to monitor hillslope and streambank erosion. Depending on the treatment of the sanitary sewer easement, annual monitoring may include cross-section and longitudinal surveys, pebble counts, checking on vegetation survivorship, and instream morphology. The primary reason for this monitoring is to demonstrate measurable improvement in this subwatershed.

Baldwin Park Stream Restoration

Baldwin Park is a small urban “pocket park” on the boundary between Carrboro and Chapel Hill. A small stream traversing the park, flowing into Tanyard Branch (one of the major, highly-urbanized tributaries to

Bolin Creek), was highlighted as one of the 32 high priority projects in the Earth Tech report. This stream was estimated by Earth Tech to contribute 28.3 tons of sediment per year (estimate made using the BANCS model). The upper portion of the stream has been put into a pipe and street runoff drains directly to the stream. Site reconnaissance identified a tributary to this stream to the east that has scour at the upper end where runoff drains from the street. Both tributaries have instream scour and erosion, poor instream habitat and morphology, minimal to no vegetation on the banks except close-cut grass (Carrboro side) and a few trees (Chapel Hill side) with the exception of the confluence area that is almost entirely privet.

The conceptual plan for this project is a combination of the Earth Tech recommendations and further additions recommended by NC State's Water Quality Group. Stream restoration, including changes in channel cross-section, reducing bank slopes, creating a bankfull bench, and improving riffle and pool habitats would be done on about 300 feet of each of the tributaries. Stream enhancement (vegetating the banks) would be done on an additional 400 feet of the Chapel Hill tributary. 3 BMPs for handling street runoff would be placed at the upper ends of the streams to prevent degradation of the restored channels. Similar to the projects on the tributary to Mill Race, between the largely built-out condition of the subwatershed, and Chapel Hill ordinances requiring no increase in off-site runoff in new and redevelopment, we do not anticipate problematic changes in hydrology that might negate our efforts to improve hydrology.

Water quality monitoring would include monthly base flow and storm flow suspended sediment and nutrient samples, and continuous monitoring of dissolved oxygen and temperature throughout storm events, just below the confluence of the streams. Bank pins and scour chains would be installed to monitor instream scour. Annual monitoring would include cross-section and longitudinal surveys, checking on vegetation survivorship, pebble counts, and instream morphology. As in the case with the proposed management measures for the tributary to Mill Race, the primary reason for this monitoring is to demonstrate measurable improvement in this subwatershed.

Other Supporting Activities

In addition to the aforementioned projects and monitoring, the Towns of Carrboro and Chapel Hill will continue monitoring activities in other parts of the Bolin Creek watershed that are supportive of documentation of measurable improvement (see Section 22 below for details). Carrboro will be installing two demonstration rain gardens in highly visible public locations. The Ecosystem Enhancement Program will be surveying and evaluating a segment of Bolin Creek for preservation and some restoration in the upper portions of the watershed that have much lower levels of development.

21. Monitoring/Environmental Data Collection Describe in section below how project data will be used (i.e. demonstrate effectiveness of BMPs installed, calculate load reductions, data to be used for TMDL development, data to be used for State use support purposes, etc.). If monitoring is needed to document a demonstration project or water quality improvement, a Quality Assurance Project Plan (QAPP) will be required (reviewed and approved by DWQ). For guidance and additional information, visit: http://www.epa.gov/owow/monitoring/volunteer/qappcovr.htm

In order to demonstrate measurable improvement in these subwatersheds, monitoring of individual project locations around the Baldwin Park stream restoration/BMP sites and sites on the tributary to Mill Race will be conducted. Sediment mobilization, water quality and field parameters, soil erosion, stability/quality of stream banks and instream features and habitats, and survivorship of desired riparian vegetation will be used as indicators of success of these projects. Monitoring will commence when a Quality Assurance Program Plan has been developed at the beginning of the contract period to obtain sufficient data to properly compare pre- and post- conditions at these sites. A QAPP Level 2 will be developed with assistance from the NC State Water Quality Group. This group has considerable experience assisting others to write QAPPs for 319 grant projects.

Carrboro, Chapel Hill, and NC DWQ will continue their existing monitoring efforts which can also be used to demonstrate measurable improvement in the Bolin Creek watershed as a whole. Chapel Hill has been collecting base flow water quality samples at three points along the mainstem of Bolin Creek since 1994. Parameters include suspended sediment, turbidity, nitrogen series, phosphorus, fecal coliform, metals, and field parameters. Discharge measurement is not conducted yet but is planned in the near future. Carrboro currently conducts annual macroinvertebrate collection at four points along the mainstem of Bolin Creek. DWQ conducts fish sampling at 3 stations and benthic macroinvertebrate sampling at 5 stations once every five years. DWQ has no ambient water quality monitoring stations in the watershed. See the attached map showing locations of Carrboro, Chapel Hill, and DWQ monitoring sites.

Complimentary to and independent of the Bolin Creek watershed restoration efforts, the Towns are beginning stream walks and monitoring activities as part of their NPDES Phase 2 permits to address illicit discharges and connections. The areas that Bolin Creek flows through are both the oldest and most dense parts of both Chapel Hill and Carrboro, and thus are likely to have much higher priority in their respective IDDE programs. It is expected that these activities will address the issue of toxins as contributing stressors as identified in the 2003 Biological Assessment report.

22. Public Involvement

- Direct consultation with the Historic District Commission to address the use of highly erodible pea-gravel/sand for sidewalks, and come up with acceptable alternatives or treatments.
- Direct consultation with the Orange Water and Sewer Authority regarding erosion treatments of their streamside sanitary sewer lines.
- Direct consultation with local residents and property owners (and/or their landscapers) to vegetate the projects in a way that is aesthetically pleasing, sufficiently easy to maintain, and meets concerns regarding neighborhood crime (i.e. hiding places), in addition to the usual enhancement goals of bank stability, shade, and native species. Following construction we would offer Riparian Plant Maintenance Workshops – intended to allow property owners to learn how to care for the riparian plants they have selected (plant selection by owners helps guarantee care and acceptance) and would serve as prototype for a Stream Steward Program involving riparian planting and maintenance. This may extend to possible targeted eradication of invasive species and subsequent monitoring will also likely involve local garden clubs, the North Carolina Botanical Garden, and Orange County's Master Gardener.
- Involvement of neighborhood associations local to the projects.
- Carrboro will be constructing 2 rain gardens in public spaces with educational signage.
- "Ribbon cutting" ceremonies involving local officials and the media to publicly present completed projects.

- Educational signage for Baldwin Park.
- A Bolin Creek Watershed Restoration Initiative webpage and email list server to keep interested citizens informed of project status, and offer a venue for continued conversation with Chapel Hill and Carrboro staff. This might include summarized/condensed versions of quarterly reports.
- Involvement of Friends of Bolin Creek volunteers in collecting water quality samples, annual stream morphology and vegetation monitoring and replenishment.
- Development of the Watershed Restoration Plan is expected to involve a considerable number and variety of stakeholder groups, from Town Departments, UNC-Chapel Hill, Orange Water and Sewer Authority, the Federal Railroad Administration, property-owner and neighborhood associations, among others. We expect to directly solicit the involvement of different stakeholder groups in order to focus on their concerns more effectively.
- One or two “kickoff” public informational meetings at the beginning of the contract period to update citizens on status of Bolin Creek Watershed effort as well as to gain valuable insight when developing 9 element watershed restoration plan.

These activities are not unlike the kinds of activities already used by the Towns to meet NPDES Phase 2 permit requirements. However, the activities for this project are targeted both in area and in topics particular to the Bolin Creek Watershed Restoration Initiative and its related projects, and are in addition to the existing involvement, outreach, and educational programs currently in place. Existing educational and public involvement programs include stormdrain marking, presentations to schools, information tables at Town events, general stormwater management program newsletters, a pollution/drainage hotline, etc.

23. Project Measures of Success or "Measurable Results Anticipated from the Project"

Some of the management measures planned for this project are designed to reduce hydrologic impacts of existing developed areas in the watershed. These practices are expected to reduce stormwater volumes and peaks, thus reducing streambank erosion, streambed aggregation and degradation, etc. Other management measures planned for this project are related to improving water quality, particularly in stormwater flows. These water quality management measures should also generate some improvements specifically addressing the hydromodification, sediment transport, temperature, and dissolved oxygen stressors.

It is expected that significant improvement in benthic communities is likely to take longer than the three-year duration of this project. The very small size of the project streams also limits the probable maximum diversity that can be expected. However, reducing the impact of these stressors should lead to recovery of benthic communities in the watershed.

Specific improvements expected from this 3-year set of projects include:
- reduced export of sediment from both Baldwin Park and Mill Race tributary watersheds
- improved instream habitat for macroinvertebrates
- reduced levels of nitrogen and phosphorus
- reduced maximum temperatures in stormwater
- increased environmental interest and involvement in a lower-income population
- general education of the Towns' populations regarding stream functions, health, protection, restoration
- demonstration to the local environmentally-oriented population of the Towns' commitment to environmental protection and sustainability
- alternatives analysis that enables watershed restoration projects with a higher probability of success in a high-density urban area

Bolin Creek Watershed Restoration Initiative goals:
- improve physical and chemical stream conditions to encourage the recolonization and diversification of the stream macroinvertebrate community in Bolin Creek, and thence to restore full uses to this impaired stream

Possible side effects:
- increase rainfall infiltration to groundwater throughout the watershed, with the aim to increase the extremely low base flows identified as a potential stressor
- provide an example of successful watershed restoration to be applied to other officially impaired (and unclassified but imperiled) waterbodies and their watersheds in the Chapel Hill – Carrboro area
- broader use of Low Impact Development, redevelopment that reduces urban hydrologic effects, and increased environmental sustainability of public and private landowner (and resident) activities

24. List Project Outputs and Products (All 319 funded projects are <u>required</u> to submit <u>Quarterly Progress Reports</u> and a detailed <u>Final Project Report</u>, which must be submitted at least *30 days before* the end of the contract for DWQ review and approval.)

- Nine element Watershed Restoration Plan, integrated with other Town Plans.
- Alternatives analysis for inline and/or watershed-wide runoff management in upper Tanyard Branch.
- Quarterly reports and final report.
- Construction of 3 BMPs and stream restoration/enhancement (approximately 1000 feet) in Baldwin Park with signage.
- Repair of 2 gullies an installation of associated BMPs, BMP reducing sidewalk erosion in Historic District, treatment reducing streambank erosion along sanitary sewer easement and crossing.
- 2 Riparian Plant Maintenance workshops.
- 2 “ribbon-cutting” ceremonies with local government officials.
- Installation of 2 Carrboro rain gardens with signage.
- Creation of a geodatabase containing locations and information on identified stream water quality, morphology, or other problems, and locations and information on proposed stream restoration and stormwater BMP projects.
- Regular updates from staff to public email listserver and webpage.
- Installation of 2 pressure transducers to measure stage and establishment of rating curves for each site
- Installation of 2 automated storm samplers to collect “first flush” and composite storm samples
- Pre- and post-construction morphological, erosion, and vegetation survivorship monitoring data for the two subwatersheds.
- 72 (36 for each site) monthly base flow and 240 (120 for each site) storm flow samples (approximately 20 storms per year, 2 samples per storm) analyzed for suspended sediment, nitrogen series, and phosphorus.
- Continuous temperature and dissolved oxygen measurements for storms before and after project installation.

25. Projects Developing or Implementing a Watershed Restoration Plan must include EPA's 9 Key Elements for Watershed Restoration Plans. Draft Plans must be submitted to DWQ for review and approval at least *60 days before* end of the project/contract period.

NOTE: Please provide information on the following ONLY if applying for Incremental funds to develop or implement a Watershed Restoration Plan: (use additional pages if necessary)

1 *An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in the watershed*

The Division of Water Quality with financing from the Clean Water Management Trust Fund (CWMTF) conducted a Little Creek watershed (includes Bolin Creek) assessment and completed a report of their results on June 2003. This assessment identified potential stressors and sources of biological impairment, and outlined a general watershed strategy that recommended restoration activities and management measures to address problems. Primarily it found poor habitat, hydrologic/morphologic modification, excessive algal growth, toxic conditions, low base flows, high/flashy storm flows, bed/bank erosion and related effects of sediment to be the primary stressors. Nutrients, fecal coliform, organic loading, and dissolved oxygen contribute but are considered indicators of stormwater inputs or contributing sources as much as stressors themselves.

The Ecological Enhancement Program contracted with TetraTech to conduct a Morgan and Little Creeks (includes Bolin Creek) Local Watershed Planning effort that included assessment and implementation. A series of reports were generated from this effort in 2003 and 2004. These reports also identified stressors, described assessment tools and methods needed to further evaluate indicators, and identified areas for restoration, protection and preservation.

Most recently, the Town of Carrboro (with Chapel Hill as primary partner) contracted with EarthTech to conduct a geomorphological assessment of the Bolin Creek watershed. The field work was conducted in the spring/summer of 2007 and the report was just completed November 2007. EarthTech's geomorphological analysis included surveying the entire watershed and walking the majority of the watercourses in the watershed. During this survey, potential stormwater management measures and stream restoration sites were identified, with a greater focus on the former.

Information from the three studies referenced above will all be used to develop several sections of the Nine Element Watershed Restoration Plan. Many of the following stressors have been identified as a problem to some degree, being part of a collection of stressors common in highly urbanized watersheds, but only a few of them have been identified as primary stressors in the Bolin Creek Watershed. Many of these stressors are not chemical in nature but are nonetheless causes of biological impairment in the Bolin Creek Watershed, thus a "load reduction" cannot be associated with these per se.

A table similar to the one presented below may be used in the stressor and source section of the watershed restoration plan for summary purposes.

Table 1:

Source	Stressors	Indicators	Watershed Function (WA)
Increased impervious	Increased peak flow and volume, bank and bed erosion/channel	Flow/discharge, geomorphic	Fish/benthic habitat,

surface (a)	incision, source of suspended sediment, direct stormwater inputs to streams, metals/toxins, high stormflow temperatures, collects aerially deposited nitrogen, low infiltration, altered hydrology and geomorphology	characterization, sediment movement, temperature, base flow, bank stability, metals	geomorphic processes, hydrology, water supply
Riparian vegetation removal (b) (c)	Increased Temperature, Lowered Dissolved Oxygen (DO) bank and channel erosion, source of sediment, reduces habitats, increases growth of algae	Discharge/flow, geomorphic characterization, habitat characterization, Bank stability, temperature, sediment movement	Fish/benthic habitat
Suspended sediment, land disturbing activity (d)	Embeddedness, covers/reduces habitats and organisms, adsorbs toxins and fecal coliforms	TSS, turbidity (f)	Fish/benthic habitat, water supply, recreation
Leaking sanitary sewer, poorly functioning septic, dogs	Source of nitrogen and organic carbon, fecal coliform, increases growth of algae, low dissolved oxygen	Nutrients, chlorophyll-a, dissolved oxygen, and fecal coliform	water supply, recreation
Direct channel/flow modifications	Reduce habitats, channel incision, disconnection from floodplain, interfere with morphological dynamics, reduce colonization	Geomorphic characterization, habitat characterization, sediment movement	Fish/benthic habitat, geomorphic processes, hydrology

(a) Increased impervious surface causes the following:
    1) Increased stormwater stream flow generating greater streambank erosion and streambed scouring and also greater deposition in areas of slower flow.
    2) Decreased base stream flows that can cause less deep water habitat during dry periods.

(b) Riparian (area adjacent to stream) vegetation removal can open tree canopy, causing increased water temperatures and decreased dissolved oxygen levels

(c) Riparian vegetation removal can weaken streambanks and lead to greater streambank erosion.

(d) Construction, agriculture, forestry, mining, and other activities can cause erosion and generate sediment. Stormwater leaving these sites can transport increased sediment to nearby streams.

(e) Leaking sanitary sewer lines, poorly-functioning septic systems, and dogs can be the source of the following:
    1) Nutrients that combine with sunlight and other factors to cause excessive algal growth. Decaying algae can deplete DO in water and can alter aquatic habitat.
    2) Fecal coliform from livestock that can adversely affect humans who have contact with waters.

(f) TSS – Total Suspended Solids, Turbidity (both measures of sediment, cloudiness in water) and Chlorophyll-a, Dissolved Oxygen (DO), etc. have water quality standards that can be violated.

2 *A **description of the NPS management measures** that will need to be implemented to achieve load reductions as well as to achieve other watershed goals identified in the watershed based plan*

The following list of NPS management measures is based on the list of stressors and sources of impairment shown above in Table 1. Many of the stressors in Table 1 are common to highly urbanized watersheds, but only a few of them have been identified as primary sources of impairment in the Bolin Creek watershed. Therefore, the completed nine element plan will refine/improve upon these tables.

In Table 2 (shown below), management measures to be implemented as part of this project are associated with the stressors and sources they are designed to address. Loading reductions (or other expected changes) for the different management measures would be determined, along with costs for installation and maintenance, and technical feasibility.

Indicators or methods of measuring effects of particular stressors are provided in Table 1. Criteria or targets used to determine if loading reductions are met or some other measure of effectiveness will be developed as part of the process of identifying watershed goals.

The Bolin Creek headwaters area is rural and the aquatic biological communities are supported in this area. Yet this area is at the greatest risk of future degradation due to future development. EEP prioritized Bolin Creek subwatersheds for preservation, protection and restoration. The Bolin Creek upper subwatersheds were all identified as good candidates for preservation and protection. Management measures such as making necessary revisions to ordinances, etc. will also be identified in the watershed restoration plan.

Table 2:

Stressor	Sources	Management Measures	Criteria (a)
Increased peak flow and volume, flashiness	Increased impervious surface (b), direct discharges to streams, riparian vegetation removal (c)	BMPs to reduce peak flows and volumes, disconnecting impervious surfaces, LID	Flow/discharge monitoring
Increased Temperature, Lowered Dissolved Oxygen (DO)	Riparian vegetation removal (d), runoff over hot pavement, effects of algae and bacteria, organic carbon	Planting riparian vegetation, BMPs to increase infiltration, increase stormwater retention, address nitrogen, carbon, and fecal sources	Temperature averages and extremes, DO monitoring
Weakened and eroded streambanks, bed erosion, channel incision/disconnection from floodplain, embeddedness	Riparian vegetation removal (f), impervious surfaces, channel modifications	Planting riparian vegetation, enlarged culvert stream crossings, hardened open stream crossings, methods to reduce instream erosion, restorations of natural channel form	Geomorphic characterization and stability, streambed composition, riparian cover, incision
Suspended sediment	Land disturbing activity (g),	Planting riparian vegetation, BMPs to prevent movement	TSS and turbidity

	impervious surfaces, instream scour and erosion, riparian vegetation removal	of sediment into stream, BMPs to reduce peak flows and volumes (reduce instream erosion)	monitoring, bank/bed erosion surveys
Excessive nutrients, algae, and bacteria, Lowered DO	Fertilized acreage, dog population, leaking sanitary sewer (h), poorly maintained septic systems, aerial N deposition, sediment acting as incubator	Education for dog owners, planting riparian vegetation, property owner / land manager education for fertilizer use, addressing leaking sanitary sewer lines (particularly crossings), education about maintenance for septic system owners	Nitrogen, fecal coliform, and DO monitoring, possibly BOD/COD
Poor macroinvertebrate habitat (e)	Sedimentation / embedding, desnagging, riparian vegetation removal (d), channel incision, channelization	Reducing sediment loads, restricting instream activities, planting riparian vegetation (especially forest), reshaping channel cross-section and plan form, larger culverts to pass flood flows or large sediment, reducing instream scour and erosion, increasing instream heterogeneity	Habitat quality and heterogeneity, bed sediment sorting, pool depth, biotic indices, geomorphic characterization, riparian cover
low base flow (e)	Reduced infiltration, “connected” impervious surfaces, drought	Disconnecting impervious surfaces, “ripping” compacted soil or other soil amendment, microtopography, infiltration BMPs, cisterns and rain barrels for irrigation	7Q10
toxic pollutants common to stormwater and urban areas	Illicit discharges and dumping, cross connections, leaking USTs, road washoff, pesticide use	(Not to be addressed as part of this project – part of local NPDES Phase 2 activities)	

(a) Most monitoring would be conducted before, during and after management measure implementation. Please note that these measurements are done to determine effectiveness of management measures. It is just as important to conduct instream biological monitoring to determine if stream is recovering as a result of management measure implementation.
(b) The increased impervious surface causes a greater volume of stormwater to enter stream channel causing increased erosion of streambanks and sedimentation of aquatic habitat.
(c) Riparian (adjacent to stream) vegetative buffers can act to slow the entry of runoff to the stream by creating a rougher surface, less compacted soil, more opportunities for infiltration, as well as direct uptake of water.
(d) Riparian vegetation removal can open canopy and cause increased water temperatures and decreased dissolved oxygen levels.
(e) These are not normally considered pollutants that could have load reductions, but would be considered positive water quality improvements if addressed

	(f) Riparian vegetation removal can weaken streambanks and lead to greater streambank erosion. (g) Construction, agriculture, forestry, mining, and other activities can generate sediment. Thus, stormwater leaving sites with these land disturbing activities will carry increased sediment when it enters the stream. (h) Leaking sanitary sewer, poorly-functioning septic systems, and dogs can be sources of the following: 1) Nutrients that combine with sunlight and other factors to cause excessive algal growth. Decaying algae can deplete DO in water and can alter aquatic habitat. 2) Fecal coliform that can adversely affect humans who have contact with waters.
3	*An **estimate of the load reductions** expected for the management measures* See section 13a above for an estimate of the load reductions expected as part of this set of projects. Loading reductions for specific management measures are still being researched, and in most cases the original load contributed is not known. NCSU researchers have determined that current load reductions are unknown. However, we expect that more will be understood about loading reductions that are more applicable to our area after the first set of projects are installed and monitored. Not all stressors are chemical or can be expressed as loads, such as peak flow or habitat degradation. Instead of loading reductions, some other target for improvement will be determined based on similar sized streams in the Piedmont. These targets would be developed as part of the process of identifying watershed goals. A chlorophyll-a TMDL and associated nutrient management plan has been developed for the entire Jordan Lake watershed of which Bolin Creek is a part. When comparing existing and buildout conditions in the Bolin Creek watershed, there are projected nutrient loading rate increases in all of the Bolin Creek subwatersheds (See Tables 3-2 and 3-3 in EEP Detailed Assessment Report – July 2004). Thus, the stormwater management measures developed as part of the watershed restoration initiative should also help to offset these nutrient increases.
4	*An **estimate of the amount of technical and financial assistance needed** associated costs and or sources and authorities that will be relied upon, to implement the plan* Issues and needs for the entire watershed restoration initiative will be evaluated as part of developing the watershed restoration plan. However, some general assumptions regarding the kinds of activities can be made based on current conditions and the proposed set of projects for this specific grant. Staff of the Towns of Carrboro and Chapel Hill have varying amounts of experience with writing plans and reports, water quality, geomorphic and biological monitoring, riparian vegetation and invasive species removal, presentations, working with landowners, and education and outreach. We expect this first set of projects to develop further staff experience in the permitting process, project administration, and data analysis, and provide a better general understanding of modeling and of BMP construction and maintenance. Of these activities, we anticipate requiring financial and some technical assistance only with monitoring, particularly laboratory analysis costs. Chapel Hill has a dedicated stormwater utility funding source. We expect to contract maintenance out where Town resources are insufficient. Maintenance costs will probably be rolled into the Towns' operating budgets in this case.

	Our initial projects will rely on NC State's Water Quality Group for recommendations of BMPs, engineering design, construction oversight, construction and materials, and data analysis. As the Towns do not forsee having staff resources for recommendations of BMPs, engineering design, complex modeling, construction oversight, construction and materials, and determining maintenance requirements, we expect to continue to contract these services either through NCSU or a private contractor. The Towns will probably largely rely on outside Federal and State grants and funding sources for these aspects of plan implementation.
5	*An **information/education component** that will be used to enhance public understanding of the project* Public involvement is more than keeping citizens informed of the watershed efforts and soliciting input. Because much of the headwaters portion of Bolin Creek watershed is undeveloped, Bolin Creek stakeholders have a unique opportunity to provide significant protection to the watershed so that after it is restored, it will remain in that state. Restoring and protecting the watershed will be all the more effective with an involved citizenry. Bolin Creek Watershed Restoration Team held a public meeting in March 2007 to provide stakeholders with general information and solicit their input. Many broadcast methods (such as TV/radio/newspaper ads, school programs, etc.) extend beyond the population living or working in the Bolin Creek Watershed, and are already being employed separately for larger-area NPDES Phase 2 activities. Education/outreach/involvement activities specific to Bolin Creek will probably involve more "live" interaction such as workshops, meetings, festivals, hikes, cleanups, demonstrations, ribbon-cuttings, etc. that will be located along Bolin Creek at popular points (such as parks), project locations, or at meeting places within the basin. The following players will likely be involved in the public education efforts: Towns of Carrboro and Chapel Hill Orange County UNC-CH NC Ecosystem Enhancement Program Friends of Bolin Creek Orange County SWCD North Carolina Botanical Garden Orange Water and Sewer Authority NCSU – Water Quality Group Development of the Watershed Restoration Plan is expected to involve many different stakeholder groups and types. Specific stakeholder involvement will involve more than just individual citizens, but be targeted to add input from public and private agencies and entities engaging in activities in the basin to ensure a more coordinated approach to water resources management. See Section 23 for public education, outreach, and involvement activities specific to the projects proposed in this grant application as an example of the kinds of events and activities that will form part of an information/education component.
6	*A **schedule for implementing the NPS management measures** identified in this plan that is reasonably expeditious*

	An implementation schedule will be dependent on the full set of management measures identified in the final watershed restoration plan as prioritized by feasibility, potential to effect improvements, and stakeholder inputs. This schedule potentially may be altered by the approval of the Jordan Lake Nutrient Management Strategy by the State (Bolin is a tributary to Jordan) that also stipulates the installation and retrofitting of nutrient-controlling BMPs following an approved implementation schedule. Local governments must identify stormwater retrofit locations/projects, conduct feasibility studies, and propose an implementation schedule within three years from the date the Rules become effective. Depending on the results of feasibility studies, BMPs and projects in the Bolin Watershed may be reprioritized based on their potential to meet nutrient targets in addition to needs specific to the Bolin Watershed. Preliminary investigations have determined that some techniques to control nonpoint sources and moderate the effects of flashy urban drainage in highly urban areas (particularly in older, denser neighborhoods in both Towns) will have to be phased in over a decade or more since we may need to use small distributed methods such as cisterns, green roofs, underground storage, etc. Answering these kinds of questions is part of the goal of the stormwater alternatives analysis for the Upper segment of Tanyard Branch. For a rough schedule for implementing the proposed management measures that are part of this project, please refer to Section 18, the Project Milestone Schedule.
7	*A description of interim,* ***measurable milestones for determining whether NPS management measures*** *or other control actions are being implemented* Possible types of implementation milestones, to be refined in the final watershed restoration plan: • Number of identified projects completed, in progress, in the queue, or ruled out due to infeasibility • Number of outfall protection/treatment BMPs installed, also as percent of total number of outfalls, also as area of basin draining to such features • Number of properties installing stormwater BMPs specific to each property • Length of degraded stream restored • Length of degraded/open riparian zone reforested or vegetatively stabilized • Number of sanitary sewer crossings/access points that are hardened, protected, or made unnecessary • Low Impact Development/Design used as preferred methods in Town ordinances and guidelines • Amount of riparian zone that is in sanitary sewer easement • Changes in Town/OWASA/NCDOT procedures or ordinances identified as having more environmentally-friendly alternatives • Stream crossings / culverts converted to oversized or bottomless culverts • Revisions of Town Plans to coordinate with the Watershed Restoration Plan, and integration of the Watershed Restoration Plan in Chapel Hill's Stormwater Master Plan and its Comprehensive Plan
8	*A set of* ***criteria that can be used to determine whether loading reductions are being achieved*** *overtime and substantial progress is being made towards attaining water quality standards* Criteria used to evaluate effectiveness of the sets of projects and activities proposed for this grant: • Habitat heterogeneity/quality indices, stream morphology metrics, streambed composition

	• Temperature averages, extremes • Dissolved oxygen • Suspended sediment in stormflow and baseflow • BEHI, riparian vegetation metrics • Nitrogen and phosphorus Criteria that may be used to evaluate success of the watershed restoration initiative: • Improvement in storm hydrograph for mainstem Bolin Creek: lower peaks, longer tails, higher base flow / 7Q10 • Improvement in stream benthic macroinvertebrate community For some specific criteria associated with load reductions, please refer to Table 2. Criteria for determining whether load reductions or other physical changes in stream characteristics are being achieved will be further developed as part of the watershed restoration plan.
9	*A **monitoring component** to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item 8.* See Section 22 for a description of current and proposed monitoring. Proposed monitoring will include measures of effectiveness of the proposed projects (BMPs, stream restoration, etc.).

26. References and Literature Cited

NC Department of Environment and Natural Resources, Division of Water Quality, Planning Branch. 2003. Assessment Report: Biological Impairment in the Little Creek Watershed. A report of the WARP (Watershed Assessment Restoration Project).

Tetra Tech. 2004. Targeting of Management Report. In: NC Ecosystem Enhancement Program, 2004. Morgan and Little Creeks Local Watershed Plan.

EarthTech of North Carolina, Inc. 2007. Bolin Creek Watershed: Geomorphic Analysis and Potential Site Identification for Stormwater Structures and Retrofits.