Upper Neuse River Basin Association

Memorandum

To: Chris Mankoff, NC Ecosystem Enhancement Program

From: Chris Dreps, Upper Neuse River Basin Association

Date: February 10, 2006

Re: Little Lick Creek Local Watershed Plan
Memorandum #5—Watershed Management Strategies recommended for Little Lick Creek.

The following memorandum recommends comprehensive watershed management strategies for improving and maintaining water quality and aquatic habitat conditions in the 21 square-mile Little Lick Creek Watershed. The management strategies have been developed as a part of the NC Ecosystem Enhancement Program (NC EEP)-funded Little Lick Creek Local Watershed Plan.

Little Lick Creek is currently impaired due to its inability to support sufficient levels of aquatic life and its low levels of dissolved oxygen. The nine Little Lick Creek watershed management strategies recommended in this technical memorandum comprise a comprehensive approach to restoring water quality and aquatic habitat.

The following watershed management strategies are the culmination of 14 months of watershed analysis, fieldwork, planning, and prioritization by watershed stakeholders. A technical team of project stakeholders initially met 6 times to guide the Upper Nuese River Basin Association, the Center for Watershed Protection, the Triangle J Council of Governments, and other project partners in conducting fieldwork, monitoring, and analysis. Once the fieldwork and assessment tasks (tasks 1-3) of the project were complete, the Technical Team met 4 additional times and conducted over 50 reviews of specific recommendations to produce this technical memorandum.

The memorandum proposes nine detailed management strategies for implementation by local, regional, and state-level watershed stakeholders. The recommendations are presented in the three sections listed below.

Watershed Restoration Projects

1. Stream Repair Projects
2. Riparian Buffer Restoration
3. Stormwater Retrofits

Strategies to Prevent Future Degradation

4. Critical Lands Protection

5. Better Site Design
6. Improved Enforcement of Existing Rules

Strategies to Increase Watershed Stewardship

7. Watershed Outreach and Education
8. Adopt-a-Stream Programs
9. Stream and Watershed Monitoring

Each section begins with a general background identifying a specific area of management needs. The background section also summarizes the analysis, fieldwork, monitoring, and modeling findings that led the Little Lick Creek Project Partners and Technical Team to recommend the particular management approach. The discussions reference earlier technical memoranda, the references of which are provided at the end of this document. Each recommendation then offers a specific set of steps that the Little Lick Creek Project Partners and Technical Team members suggest for addressing the management needs. In addition, each recommendation section recommends specific steps, general cost types, and a list of potential pitfalls for use in implementing the recommendations.

This and other project memoranda, maps, and general information are available on the project website, www.unrba.org/littlelick.

Table of Contents

I. Watershed Restoration Strategies

Little Lick Creek's impairment is due its inability to support sufficient levels of aquatic life and its low levels of dissolved oxygen. Restoration of the watershed is a major objective of the Little Lick Creek Local Watershed Plan. Toward this end, the Little Lick Creek Technical Team and Project Partners have focused on a comprehensive, watershed-wide strategy for restoration. The overall management approach is based on 9 management strategies, 3 of which are meant to restore watershed functions to the Little Lick Creek Watershed. The Little Lick Creek partners and technical team refer cumulatively to these three approaches, stream repair, buffer restoration, and stormwater retrofit projects, as "watershed restoration."

Little Lick Creek is located in the Triassic Basin, where sedimentary soils are almost devoid of rocky material. The alluvial soils underlying the stream valleys formed from the erosion of the parent Triassic materials. These soils, primarily Chewacla around the streams and White Store in upland areas, are extremely erosive with stormwater runoff. There are very few developed areas of the Little Lick Creek watershed with streams in good condition, particularly in areas that were developed prior to riparian buffer protection and stormwater management requirements.

Little Lick Creek Technical Memorandum #4—Priorities for buffer restoration, stream repair, and stormwater retrofits in Little Lick Creek presents the priority watershed restoration projects and the methodology summarized in this introduction. The prioritization process described in this memorandum was a months-long effort that began in the winter of 2005 with general assessments of the water quality, habitat, and land use in the 13 subwatersheds identified for monitoring and analysis. The Upper Neuse River Basin Association (UNRBA), Triangle J Council of Governments (TJCOG), and Center for Watershed Protection (CWP), NC Division of Water Quality (NCDWQ), Durham Stormwater Services (DSS), and Durham County Engineering mapped the subwatersheds, assessed current and expected future land use, modeled general runoff conditions, conducted ambient and biological monitoring to assess conditions in the watershed.

Based on findings from this work, these project partners prioritized the most urban areas in Little Lick Creek (subwatersheds 1-8) for field assessments and conducted two stages of fieldwork in January and March, 2005. During field assessment, project partners walked and assessed over 30 stream miles (41%) of Little Lick Creek and tributaries and conducted one week of windshield tours of the watershed to identify potential stormwater retrofits and pollution "hot spots" (UNRBA 2005b). Table 2 summarizes key fieldwork findings and potential watershed restoration opportunities.

Sub-shed	Stream Conditions			Restoration Opportunities		
	Length Assessed (feet)	% Total Length Assessed	Reach Condition	# Stream Repair	# Buffer Rest. (length)	# Retrofits
1	19,694	52%	Poor	1	5 (4,700)	12
2	17,697	97%	Poor	1	6 (3,900)	9
3	11,649	43%	Poor	2	2 (1,070)	6
4	17,816	49%	Poor	6	1 (270)	6
5	21,294	83%	Poor	8	4 (2,650)	15
6	16,842	55%	Poor	2	0	7
7	9,006	32%	Fair	0	1 (200)	6
8	25,165	88%	Fair	0	0	3
9	894	2%	Good	0	0	3
10	9,819	55%	Fair	3	2 (500)	1
11	1,993	6%	Poor	0	1 (750)	0
12	3,641	15%	Good	0	0	0
13	4,142	10%	Poor	1	2 (650)	3
LLC Total	159,652	41%	Poor	24	24 (14,690)	71

Table 1: Little Lick Creek stream reach conditions and watershed restoration

The objective of the fieldwork was to encounter restoration opportunities; therefore, the fieldwork results are inherently biased toward reaches in poor condition. However, the high percentage of total stream length assessed in many of the subwatersheds provides confidence of the poor conditions in the upper watershed.

The Technical Team guiding the Little Lick Creek Local Watershed Plan recommended watershed restoration strategies for restoring water quality and aquatic habitat functions to many of the degraded reaches of Little Lick Creek. The recommendations are:

1. Stream Repair Projects;
2. Buffer Restoration Projects; and
3. Stormwater Retrofit Projects.

The following pages detail these watershed restoration recommendations.

Recommendation 1:
Stream Repair Projects

REVIEWERS

Chris Mankoff (Chris.Mankoff@ncmail.net)
Cherri Smith (chsmith@durhamnc.gov)
John Cox (john.cox@durhamnc.gov)
Sally Hoyt (sch@cwp.org)

Reviewed by full Technical Team: Feb. 8, 2006

Watershed Management Category: Watershed Restoration

Priority Areas:
Priority stream repair opportunities identified during Little Lick Creek field assessments, especially those opportunities that can be combined with other restoration or land protection projects to maximize the water quality benefits to Little Lick Creek.

Background:
The practice of stream repair with the objective of restoring water quality and aquatic habitat is relatively new. In general, stream repair projects are undertaken to prevent bank erosion and improve channel stability, improve aquatic habitat, and improve amenities and safety on degraded stream reaches (CWP 2004b). Restoring a stream to a natural and stable pattern, profile and dimension enables a stream to carry sediment under a variety of flows conditions, improving aquatic habitat. Incised streams may no longer be able to access the historic floodplain; benching an incised stream can provide a new, lower floodplain that will reduce streamflow velocities and provide for removal of pollutants. Bioengineering can stabilize stream banks, preventing loss of soil and providing habitat for aquatic life.

Triassic Basin streams often have poor habitat even in undeveloped watersheds. In urbanized watersheds, the altered hydrology tends to lead to further loss of habitat. Stream repair projects that incorporate a variety of natural structures such as root wads, log vanes, rock vanes and J-hooks, and bioengineering to stabilize stream banks can enrich the habitat, improving support for aquatic life.

Improved grade control can eliminate stagnant pools where low dissolved oxygen tends to occur.

Stream repair and restoration projects provide opportunities to establish protected riparian buffers. (The benefits of restoring riparian buffers is discussed in Recommendation #X)

In January 2005, fieldwork teams assessed stream corridors in Little Lick Creek to identify stream repair needs, among other impacts. These teams identified and

documented 24 stream repair opportunities in the watershed (Hoyt 2005). The Little Lick Creek Technical Team of experts from local government, NC Division of Water Quality, the Center for Watershed Protection, and other State and Federal agencies prioritized these stream repair opportunities based on their potential to restore critical watershed functions such as water quality. Figure 1 illustrates the 24 stream repair opportunities (UNRBA 2005b includes a larger map and detailed references to restoration projects).

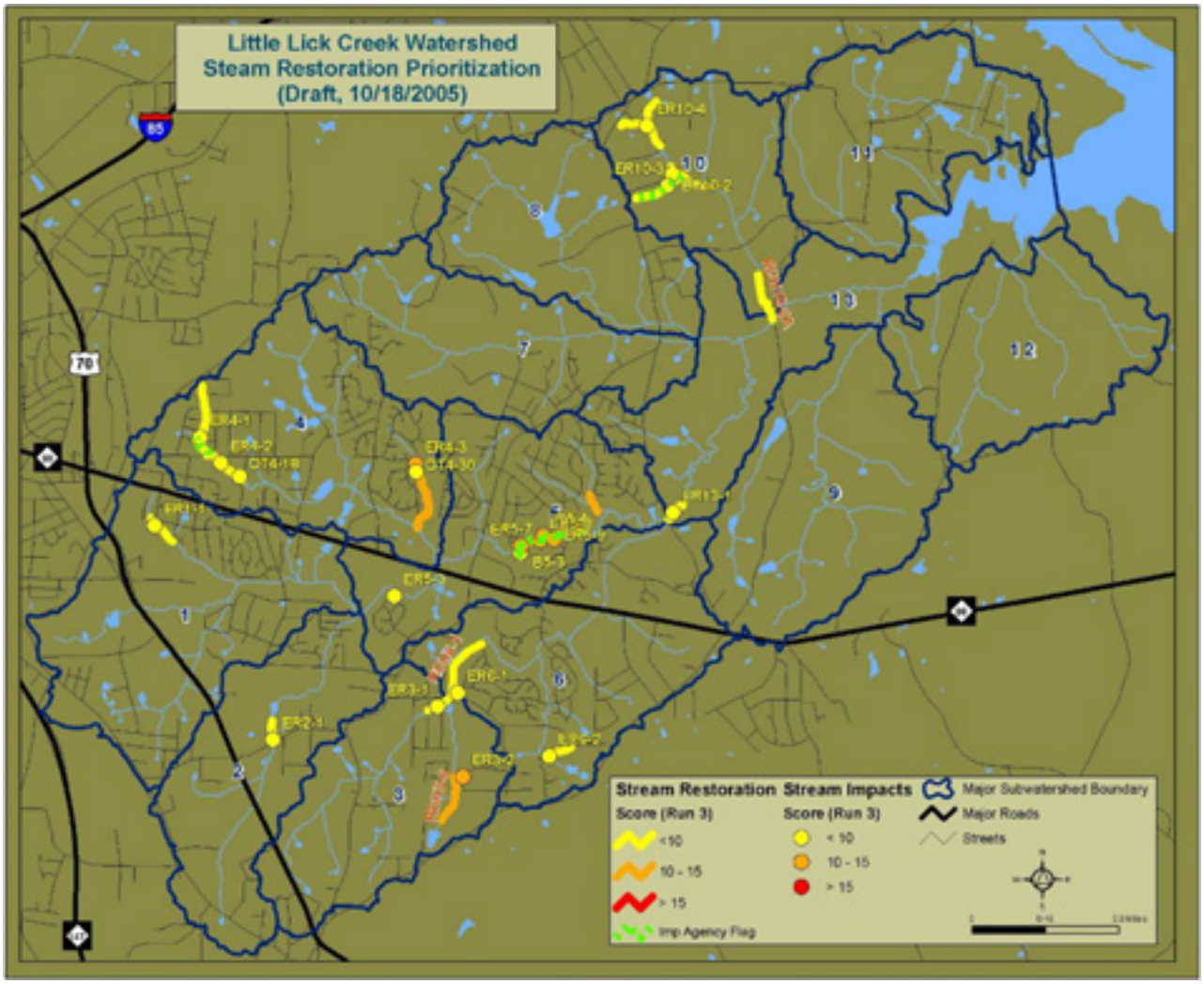

Figure 1: Stream repair opportunities in the Little Lick Creek Watershed

Figure 1 divides the projects into three prioritization categories, the highest categories shown in orange and red. In addition, restoration opportunities meeting NC Ecosystem Enhancement Program criteria are highlighted in green. The following list summarizes the key stream repair-related findings of the fieldwork and prioritization processes.

- Stream assessment identified over 2,000 feet of channel redesign opportunities, including three projects with potential for funding by agencies such and NC Ecosystem Enhancement Program.

- Stream repair opportunities include several potential hard bank stabilization, soft bank stabilization, outfall retrofits, grade control, and in-stream habitat enhancement projects. Most of these potential projects occupy only short stretches of stream and do not meet NC Ecosystem Enhancement Program's minimum project length criterion of 1500 linear feet. However, the impacts are significant and should be addressed as soon as possible to prevent them from enlarging.
- Eight projects are either on public land or on land owned by a reportedly willing land owner (five of the eight opportunities are on one stream reach, 5-10B in The Crossings Golf Club).
- Twenty of the 24 stream repair opportunities identified lie in subwatersheds 1 through 6. These subwatersheds also contain the great majority of stormwater retrofit opportunities (55 of 71 total opportunities; see Recommendation #3: Stormwater Retrofit Projects) and stream repair opportunities (18 of 24 opportunties, see Recommendation #2: Riparian Buffer Restoration).
- Subwatersheds 4 and 5 contain over half of the stream repair opportunities (14 of 24).

Figure 2: Stream erosion (Reaches 5-10B and 4-9) contributes massive amounts of sediment to LLC

Little Lick Creek is recognized by the State of North Carolina as "impaired" because of its inability to support aquatic life and because of low dissolved oxygen levels. Degraded areas of the stream that are in need of repair may contribute significantly to the creek's impaired condition. NC Division of Water Quality's monitoring of the aquatic insect communities in the watershed reveals that insect diversity is low at all locations in the upper watershed, where stream repair needs are the greatest.

Little Lick Creek and other streams on Triassic Basin soils are distinct from other Piedmont watersheds; their highly erosive bedrock and alluvial soils that lack rocky material make them highly vulnerable to in-stream erosion. Both monitoring and fieldwork confirm that the greatest threat facing habitat in Little Lick Creek is severe sedimentation. The CWP estimates that as much as two-thirds of the overall sediment load in Little Lick Creek may come from channel erosion (Hoyt 2005b). Once stream

bottoms deepen, they undermine stream banks, which erode and fail over time, causing the stream to widen. Although repairing these areas will not, on its own, bring recovery to water quality and aquatic habitat, it is an important element of watershed restoration in Little Lick Creek. Repairing the many sections of stream that are being degraded by active erosion will significantly reduce the overall sediment load in these streams.

Recommended management strategy:
The Center for Watershed Protection's Watershed Treatment Model (Hoyt 2005b) predicts that the greatest reductions in sediment (total suspended solids, or TSS) will come from protection of riparian buffers and improved erosion and sediment control practices (see Recommendation #6: Improved Enforcement of Existing Regulations). Stream repairs should, whenever possible, be combined with buffer restoration and upland stormwater retrofits to enhance the repair's long-term effectiveness.

The City and County of Durham and NC Ecosystem Enhancement Program should partner to protect the high priority stream repair opportunities in Little Lick Creek. The partners should prioritize opportunities involving public land or willing landowners.

The City and County should contact landowners on lands intersecting high priority stream repair opportunities identified in this plan and tell them about the effort, the goal to repair the stream, and opportunities to fund these projects. If necessary, assist landowners in meeting with potential funding agencies.

Annual stream walks or review of aerial photography can provide a great forum for identifying stream and buffer restoration opportunities that may change over time. In addition, stream walks or aerial photography review will improve the effectiveness of stormwater management practices and result in fewer hydrologic impacts to streams (see Recommendations #9: Stream Monitoring and #6: Improved Enforcement of Existing Regulations). Ultimately, eliminating severe hydrologic impacts to streams will reduce the need for costly stream repairs.

NC Ecosystem Enhancement Program should consider broadening its current stream restoration criteria to include smaller projects such as grade control, especially where these projects can be combined to equal greater stream length. Including such projects, especially where they can be combined, can prevent impacted streams from worsening and prevent additional water quality and aquatic habitat degradation.

Basic Implementation Steps:

1. Durham City and County work with the NC Ecosystem Enhancement Program to field-verify the priority stream repair opportunities identified in Hoyt (2005) and UNRBA (2005b).
2. Durham and NC EEP implement priority stream repair projects, starting with opportunities on public lands and private lands with willing owners. Make public education a priority on public projects.

3. All project partners should work together to implement the full range of watershed management strategies recommended in this memorandum to prevent future stream degradation. Prevention is the best strategy for protecting water quality in Little Lick Creek.

Costs:

- Additional staff time teaming with NC EEP to implement priority projects, providing GIS and other information used to design the repair, coordinating with other stakeholders, facilitating project review, contacting land owners, creating GIS database, reviewing aerial photography, creating educational materials on public projects.

- Costs of stream repair projects

Funding Opportunities:

- NC Ecosystem Enhancement Program (can fund priority stream repair projects that meet NC EEP criteria)
- Stormwater utility fees (to fund stormwater services staff time on field verification, grant proposals, project implementation, and education)
- Parks and Recreation Department funding for projects on public parks, especially where restoration can be included as part of a park construction or renovation project.
- Grants (EPA Section 319 grant, for example)

Potential Pitfalls

Repairing streams is very expensive. Stream repair projects are very effective in stable, fully developed watersheds. They also are of value in developing watersheds to address problems caused by prior development, provided that future development is required to adequately control stormwater runoff. Stream repair is not a replacement for watershed management, but rather an immediate response to stabilize streams by reducing active erosion and degradation. It is necessary to also protect riparian buffers and to manage the quantity and quality of stormwater from new development. To ensure that these protections remain effective, it it necessary to periodically inspect BMPs and buffers (see Recommendation #6: Improved Enforcement of Existing Regulations). The long-term goal should be to eliminate the need for future stream repairs.

It is important to involve landowners from the beginning. Stream repairs are expensive, time consuming, and complex. Without landowner involvement and support, the needed projects will never occur.

Recommendation 2:
Riparian Buffer Restoration

REVIEWERS

Chris Mankoff (Chris.Mankoff@ncmail.net)
Cherri Smith (chsmith@durhamnc.gov)
John Cox (john.cox@durhamnc.gov)
Sally Hoyt (sch@cwp.org)

Reviewed by full Technical Team: Feb. 8, 2006

Watershed Management Category: Watershed Restoration

Priority Areas:
Priority buffer restoration opportunities identified during Little Lick Creek field assessments, especially those opportunities that can be combined with other restoration or land protection projects to maximize the water quality benefits to Little Lick Creek.

Background:
There is broad, scientifically based consensus that intact riparian areas are essential for the healthy functioning of streams (McNaught et al 2003). Trees, shrubs and grasses in the riparian area stabilize the soil against erosion, remove sediment, nitrogen and phosphorus from overland stormwater runoff, and reduce the volume and rate of stormwater runoff. The deeper roots of woody vegetation remove nitrogen and phosphorous that would otherwise enter streams in shallow groundwater and stabilize stream banks against erosion that is the source of much of the sediment that clogs urban streams. Tree canopy shades streams, reducing the wide fluctuations in water temperature that occur in unshaded streams. In addition, riparian trees provide habitat and nutrients necessary for aquatic life. Exposed roots and overhanging vegetation improve the diversity of aquatic habitat, trees deposit leaves and other small debris that form the base of the stream's ecosystem, while fallen trees and other large woody debris dissipate energy and regulate water and sediment flow. Without sufficient vegetated riparian buffers, stream banks are more likely to erode, more runoff and more pollutants will enter the stream, and habitat for aquatic life will be degraded.

The City and County of Durham recognize the importance of riparian buffers and require their protection around perennial and intermittent streams on newly developed land. All newly developed sites in Little Lick Creek must protect at least a 50-foot undisturbed riparian buffer, and buildings must be set back at least 10 feet from the buffer. In areas closer to Falls Lake, the required buffer is larger. In addition, Durham has regulations protecting the 1% annual chance flood zone (the "100-year floodplain"), which in Little Lick Creek comprises an area much wider than the 50-foot minimum buffer. However, the riparian buffer protection rules apply to new development(rezonings, subdivisions, and site plans) only. Areas built upon prior to 1999 (Durham's Natural Resources Protection Standards Ordinance) received no such protection, and individual lots platted before that time are exempted from the current rules. The result is that many riparian areas on built-upon land in the Little Lick Creek Watershed are impacted.

In January 2005, fieldwork teams assessed stream corridors in Little Lick Creek to identify riparian buffer restoration needs, among other impacts. These teams identified and documented 24 riparian buffer restoration opportunities in the watershed (Hoyt 2005). The Little Lick Creek Technical Team of experts from local government, NC Division of Water Quality, the Center for Watershed Protection, and other State and Federal agencies prioritized these buffer restoration opportunities based on their potential to restore critical watershed functions such as water quality. Figure 3 illustrates the 24 buffer restoration opportunities (UNRBA 2005b includes a larger map and detailed references to restoration projects).

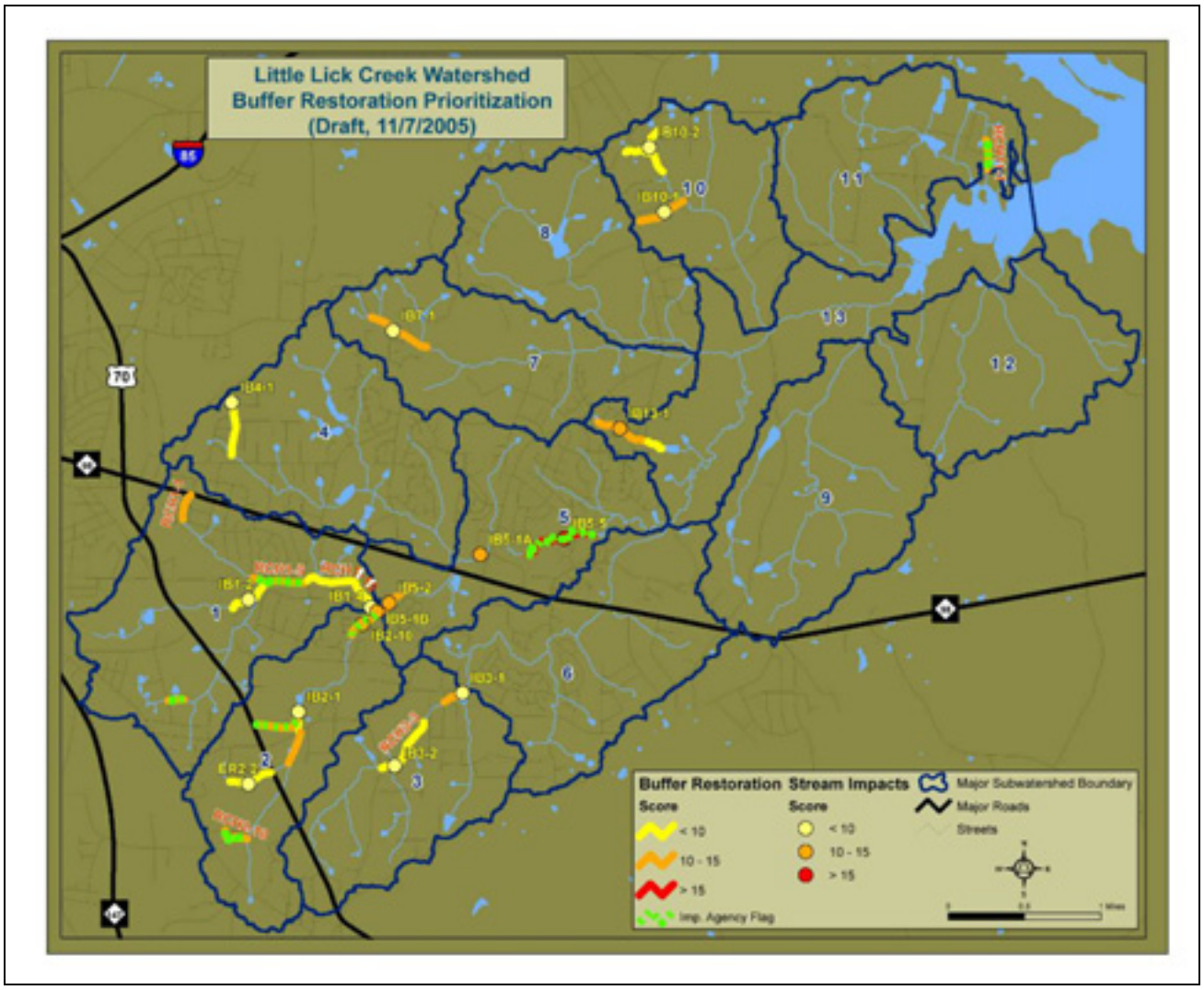

Figure 3: Buffer restoration opportunities in the Little Lick Creek Watershed

Figure 3 divides the projects into three prioritization categories, the highest categories shown in orange and red. In addition, restoration opportunities meeting NC Ecosystem Enhancement Program minimum criteria for riparian area width (50 feet from each stream bank) and length (1000 linear feet) are highlighted in green. The following list summarizes the key buffer restoration-related findings of the fieldwork and prioritization processes.

- Up to 15,000 linear feet (almost 3 miles) of riparian buffers were identified and prioritized for some level of restoration.
- Six buffer restoration opportunities meet current NC Ecosystem Enhancement Program minimum criteria for buffer restoration.
- Six projects are either on public land or on land owned by a reportedly willing land owner.
- Many buffer restoration opportunities are contiguous within the same stream corridor (in subwatersheds 1, 2, 3, 5, and 10).
- Most of the opportunities, over 11,000 feet (over 2 miles), lie in subwatersheds 1, 2, and 5. These subwatersheds also contain the greatest number of stormwater retrofit opportunities (36 of 71 total opportunities; see Recommendation #3: Stormwater Retrofit Projects) and stream repair opportunities (10 of 24 opportunities, see Recommendation #1: Stream Repair Projects).
- Many impacted riparian buffers are the result of sewer right-of-ways, where vegetation is controlled to prevent tree growth and maintain access

Figure 4: Restoring buffers will improve water quality in Little Lick Creek (RCH 2-14, left and RHC 5-10, right)

Restoring the recommended riparian buffers will require varying approaches based on the restoration need and site realities. For example, the first restoration opportunity shown in Figure 4 on the left (RCH 2-14) may only allow room for a minimal amount of buffer plantings combined with stormwater retrofits to reduce hydrologic impacts to the stream. The buffer restoration opportunity on the right (RCH 5-10) is a golf course where in some areas plantings will be low to avoid interfering with play. Despite differing site realities, each of these projects has potential water quality and aquatic habitat benefits.

Where buffer restoration opportunities are adjacent to urban and suburban areas, buffers can be designed with public safety in mind. There does not have to be a choice between healthy vegetated riparian buffer and public safety. Combining large trees with low growing vegetation, trimming lower branches, and managing the vegetation can maintain sight lines so that people living near the project can feel secure.

Little Lick Creek is recognized by the State of North Carolina as "impaired" because of its inability to support aquatic life and because of low dissolved oxygen levels (NC Division of Water Quality no longer rates Triassic Basin streams because the habitat and carrying capacity are not well understood). Impacted riparian areas may be one major contributor to the creek's impaired condition. NC Division of Water Quality's monitoring of the aquatic insect communities in the watershed reveals that aquatic life community structures downstream of impacted riparian areas exhibit degradation. In addition both monitoring and fieldwork revealed that the greatest threat facing habitat in Little Lick Creek is severe sedimentation. The watershed's streams are prone to severe sediment impacts from development, especially where there are few or poor stormwater controls or where there are no riparian buffers. Conversely, stream reaches in Little Lick Creek where streamside zone have woody vegetation are more resistant to channel erosion than are streams that are mowed to the top of the bank. And because there are few areas of rocky substrate, streambank roots may be the only line of defense as flows associated with development increase.

Little Lick Creek and other streams on Triassic Basin soils are distinct from other Piedmont watersheds; their highly erosive bedrock and alluvial soils that lack rocky material make them highly vulnerable to in-stream erosion. Once stream bottoms deepen, they undermine stream banks, which erode over time and cause the stream to widen. In most areas of Little Lick Creek, the streambank root systems may be the only line of defense for preventing massive stream channel erosion and sedimentation.

Recommended management strategy:
The Center for Watershed Protection's Watershed Treatment Model (Hoyt 2005b) predicts that the greatest reductions in sediment (total suspended solids, or TSS) will come from protection of riparian buffers and improved erosion and sediment control practices (see Recommendation #6: Improved Enforcement of Existing Regulations). Restoring impacted riparian buffers is an important piece of the overall effort to protect buffers in Little Lick Creek.

The City and County of Durham and NC Ecosystem Enhancement Program should partner to protect the high priority riparian buffer restoration sites in Little Lick Creek. Where opportunities exist on public land, the City, County or landowning agency should prioritize restoration on these projects (in some cases, a change of land management practices or simple plantings may suffice).

The City and County should contact landowners on lands intersecting high priority buffer restoration opportunities identified in this plan and tell them about the effort, the goal to restore these buffers, and opportunities to fund these projects. If necessary, assist landowners in meeting with potential funding agencies and forwarding the implementation process.

Annual stream walks or review of aerial photography can provide a great forum for identifying stream and buffer restoration opportunities, which may change over time. In addition, stream walks will help the City and County to strengthen enforcement of the riparian buffer protection regulations (see Recommendations #9: Stream Monitoring and #6: Improved Enforcement of Existing Regulations). The long-term goal should be to have no buffer restoration needs in the watershed.

Basic Implementation Steps:

1. Durham City and County works with the NC Ecosystem Enhancement Program to field-verify the priority buffer restoration opportunities identified in Hoyt (2005) and UNRBA (2005b).

2. Durham and NC EEP implement priority buffer restoration projects, starting with opportunities on public lands and private lands with willing owners. Make public education a priority on public projects.

3. Durham Stormwater Services, Durham County Stormwater Management, and Durham Soil and Water Conservation District contact streamside land owners with mass mailings educating them about the importance of protecting riparian vegetation and offering to work with homeowners to restore buffers (see Recommendation #7: Watershed Outreach and Education).

4. City and County create a geographic information systems (GIS) map of legally protected riparian buffers as part of the approval of new development applications in Little Lick Creek and conduct regular reviews of aerial photography to insure that legally protected buffers are maintained.

Costs:

- Additional City and County staff time teaming with NC EEP to evaluate, coordinate, and implement priority projects

- Additional City and County staff time to (1) create a GIS map of protected buffers and to update it for approved development applications that involve buffer protection, (2) periodically use available GIS aerial photography and/or satellite imagery to evaluate where protected buffers have been impacted, and (3) create and distribute educational materials and conducting outreach (a cost associated with recommendation #7).

- Costs of restoration projects

Funding Opportunities:

- NC Ecosystem Enhancement Program (can fund priority buffer restoration projects)
- Stormwater utility fees (fund stormwater services staff time on grant proposals, outreach, education)
- Parks and Recreation Department funding for projects on public parks, especially where restoration can be included as part of a park construction or renovation project.
- Grants (EPA Section 319 grant, for example)

Potential Pitfalls

Restoring stream buffers is much more expensive, and likely less effective than protecting stream buffers. A strong enforcement program that includes annual stream walks or review of aerial photography is a way to ensure that buffer regulations are having their intended effect (see Recommendation #6: Improved Enforcement of Existing Regulations). The long-term goal should be to have no buffer restoration needs in the watershed.

It is important not to overlook the deforestation of buffers that occurs in back yards. If Durham is to find ways to protect the buffers, outreach, education and additional oversight like those recommended herein will be necessary. These will require additional resources.

Recommendation 3:
Stormwater Retrofit Projects

REVIEWERS

John Cox (john.cox@durhamnc.gov)
Joe Albiston (jalbiston@co.durham.nc.us)
Chris Mankoff (Chris.Mankoff@ncmail.net)
Steve Kroeger (steve.kroeger@ncmail.net)
Sally Hoyt (sch@cwp.org)

Reviewed by full Technical Team: Jan. 25 and Feb. 8, 2006

Implementation Scale: Site

Priority Areas: Potential stormwater retrofit sites identified and prioritized by the Little Lick Creek Project Partners and Technical Team.

Background:

In Little Lick Creek, existing conditions in the more urbanized, upper subwatersheds have resulted in poor hydrology, significant in-stream and upland erosion, and pollution. As the watershed has developed, both the volume and the rate of stormwater runoff has increased dramatically. Because of the altered hydrology, streams have become unstable and begun to both downcut and erode their banks. Where trees and other woody vegetation have been removed from along streams, bank erosion has accelerated.

Stormwater runoff from impervious surfaces carries high loads of nitrogen, which appear to be contributing to algal blooms in Falls Lake. Impervious surfaces also contribute copper (from brake pad wear), zinc (from corrosion and from tire wear), hydrocarbons and other pollutants. The result is habitat and water quality degradation, which have contributed to the state's designation of Little Lick Creek as water quality impaired, and resulting in the need for a management strategy to restore biology and water quality.

Stormwater retrofits are structural and vegetated Best Management Practices (BMPs) installed within the stream corridor or upland areas to capture and treat stormwater runoff before it reaches the stream. Stormwater BMPs include wet ponds, stormwater wetlands, bioretention (rain gardens), infiltration trenches, sand filters, level spreaders, grass swales, disconnection of impervious surfaces to promote overland flow, and riparian buffers (Hunt 2005). Stormwater retrofits are a primary practice for restoring urbanized subwatersheds in Little Lick Creek because they can remove and/or treat stormwater pollutants, minimize channel erosion, and help restore stream hydrology (CWP 2004). The Center for Watershed Protection classifies stormwater retrofits based on the area they treat: *storage retrofits* (ponds, wetlands, filtering and infiltration practices) can treat from 5 to hundreds of acres, and *on-site retrofits* capture runoff from individual rooftops, parking lots, and streets.

In January and March 2005, the Little Lick Creek partners conducted field assessment work to identify restoration and retrofit opportunities throughout the watershed. Seventy potential retrofit sites were identified and visited. These sites are detailed in a subsequent memorandum from the Center for Watershed Protection (Hoyt & Tomlinson 2005). The Upper Neuse River Basin Association and Little Lick Creek project partners prioritized the stormwater retrofit opportunities for implementation. A December 2005 technical memorandum from the Upper Neuse River Basin Association details the prioritization process and presents the priority projects (UNRBA 2005b).

Figure 5 illustrates 71 potential stormwater retrofit priorities identified in Little Lick Creek fieldwork and prioritized by the Little Lick Creek Technical Team. All are considered feasible projects; however, project partners should conduct site visits to verify the results and begin implementing the priority projects.
The figure divides these projects into three prioritization categories; high (yellow); higher (orange); and highest (red) priority.

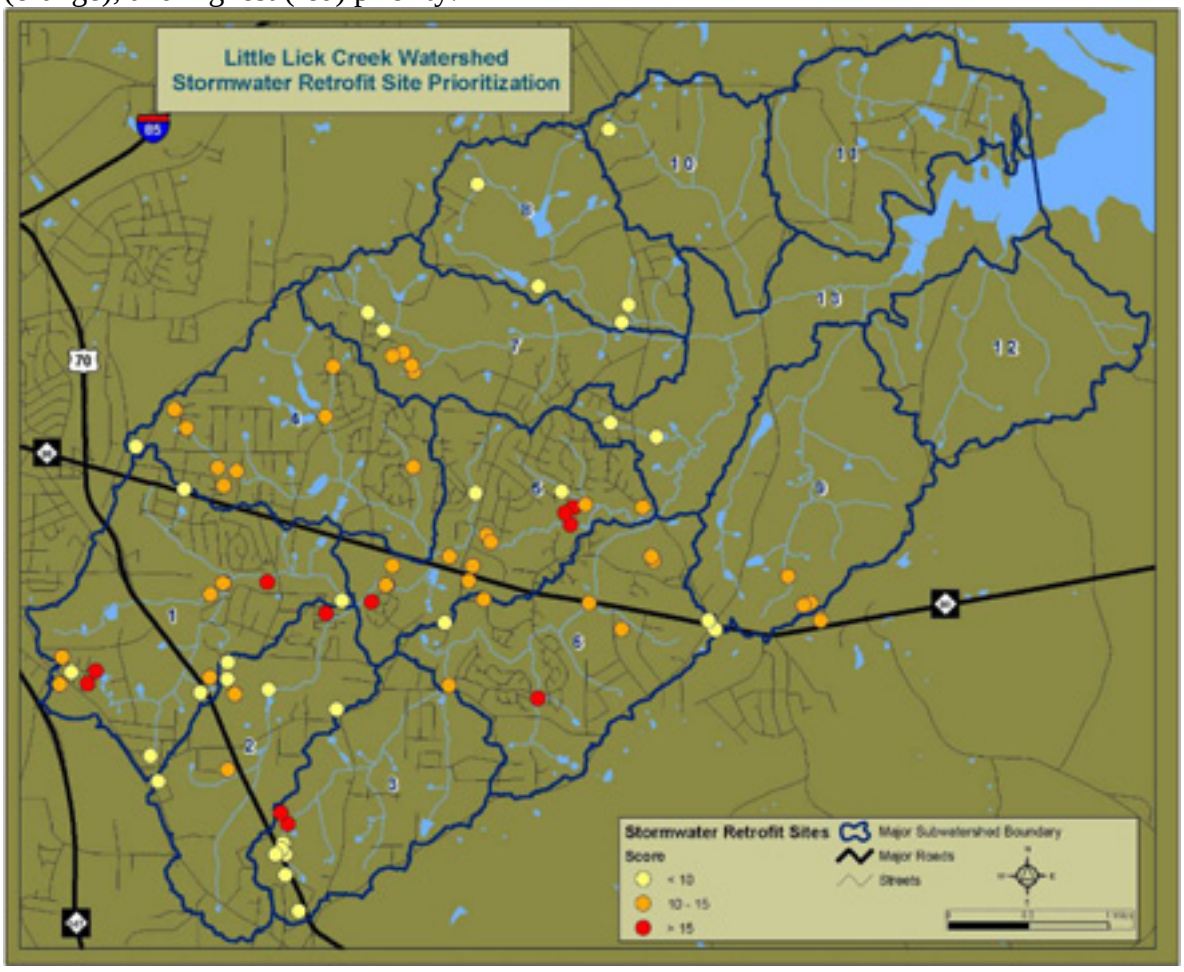

Figure 5: Stormwater Retrofit Priorities in Little Lick Creek

The following list summarizes important findings of the fieldwork and prioritization process.

- Nine retrofit opportunities meet "highest priority" criteria.

- Many of the projects exist in clusters and could be combined with stream repair, buffer restoration, or critical land protection projects.
- Forty-eight of the retrofit opportunities are in subwatersheds 1-5, the most urbanized portion of the watershed.
- Nineteen projects are either on public land or on the land of a reportedly willing landowner.
- At least 5, and possibly more, retrofit opportunities could treat areas over 10 acres.
- Although stormwater retrofits can improve local water quality, in a stream reach for example, they are a relatively expensive and ineffective way to manage watersheds compared with management strategies that prevent degradation. Implementing the priority stormwater retrofits could reduce the watershed's annual sediment loading (total suspended solids, or TSS) by 2%, annual total nitrogen (TN) loading by 0.4%, and annual total phosphorous (TP) loading by 1% (Hoyt 2005b). The predicted reductions are greatest in subwatersheds #3 (6% TP and 13% TSS reductions) and #6 (5% TP and 5% TSS reductions).

Recommended Management Strategy:

The Center for Watershed Protection recommends several strategies for implementing stormwater retrofits in Little Lick Creek. The following summarizes the recommendations (Hoyt & Tomlinson 2005).

In residential areas, the following strategies are recommended.

Use on-lot stream buffers and rain gardens in older neighborhoods—Homeowners and other landowners can implement rain gardens and stream buffers to treat stormwater on small to medium-sized lots. Both practices offer land owners a relatively simple way to participate in the reduction of polluted runoff. Implementers should focus on areas where multiple practices can be implemented as part of a single project.

Preserve existing forests and wetlands as filter areas—Opportunities exist to protect several areas where forests, wetlands, or historic farm ponds are serving to treat stormwater runoff. Development of these areas will result in compounded impacts because runoff from the newly developed site and the runoff currently being treated by the site will impact the receiving stream.

Figure 6. Forested area treating stormwater runoff (SR 5-6)

Encourage planting of trees and shrubs— It is a fact that the majority of the rainfall in forested areas never reaches the ground! Trees and other vegetation intercept precipitation, retard runoff, shade impervious surfaces, and reduce heating of stormwater runoff. In many cases, the best possible stormwater retrofit is to plant native trees and vegetation on developed sites. Figure 7, in subwatershed #1, shows older (left) and newer (right) neighborhoods. The newer neighborhood has "tree save" areas, but the developed portions of each parcel has very little woody vegetation. The City of Durham has been awarded the designation of "Tree City" for 22 years because of its tree protection and urban forestry programs; however, the City's requirements do not extend to building lot vegetation. In addition to the dedicated tree save areas, the City and County should encourage planting trees on individual home building lots.

Figure 7: Planting of trees on existing lots can improve water quality

Convert existing dry ponds to wet ponds or stormwater wetlands-Retrofitting existing storage retrofits can provide water quality benefits through simple changes such as altering the BMP's riser configuration. There are a handful of opportunities to create such retrofits in Little Lick Creek. Two excellent examples are stormwater retrofits (SR) 1-2 and 1-3 (see Figure 8) in subwatershed 1. A simple reconfiguration could transform these dry detention ponds into extended dry detention or dry detention with pocket wetlands and provide much greater water quality benefits.

Figure 8. Existing dry ponds can be great retrofits (SR 1-3)

Construct stormwater controls for apartment complexes and mobile home communities-There are several apartment complexes in subwatershed 4, and two large mobile home communities in subsheds 2 and 5 that are good targets for stormwater treatment. The apartments offer opportunities to treat large parking lots, primarily with bioretention. The mobile home communities can be treated with a combination of structural BMP's, reforestation, and stream repair techniques.

In commercial, institutional, and public lands, the following strategies are recommended:

Address commercial areas on-site controls and pollution source control measures—There are multiple opportunities along NC Highway 98 and Interstate 70 in Little Lick Creek for treating stormwater runoff from commercial areas. In general, the large commercial parking lots in this corridor can be retrofitted with bioretention areas. Focus specifically on the projects identified at gas stations and large institutional sites.

Retrofit public sites as demonstration projects—Public lands such as parks, schools, and libraries present excellent opportunities for stormwater retrofits due to their public ownership, large areas of both impervious cover and open space, and opportunities to partner with City or County staff (e.g., teachers) and the public. In Little Lick Creek, projects have been identified at Southern High School (Fig. 9), Neal Middle School, Oak Grove Elementary, CR Woods Park, and Birchwood Park. The City and County should incorporate retrofit (and restoration) into their Capital Improvements Program.

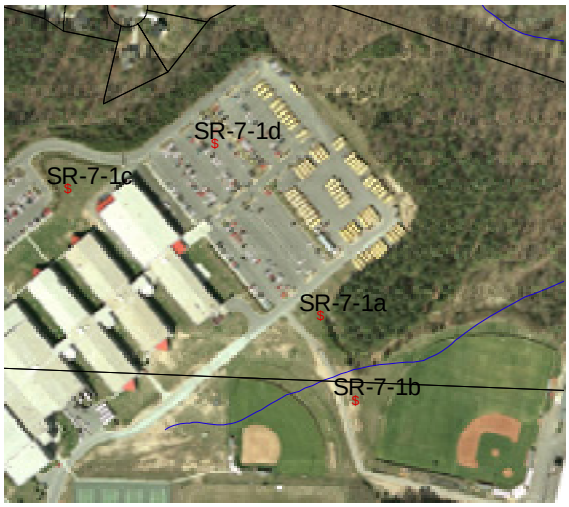

Figure 9. Retrofit opportunities at Southern High School (SR 7-1)

Outreach to churches to maintain and enhance sheet flow off parking lots—Fieldwork identified ten churches in Little Lick Creek where retrofits could treat 35-50 acres of runoff. An outreach campaign can work with these churches to implement stormwater retrofits and protect key areas from future building or parking lot expansion. Outreach to churches provides a forum for discussing watershed stewardship with watershed residents (Figure 10).

Figure 10. Churches can be stewards of Little Lick Creek

Treat larger drainage areas in City-owned land—The City of Durham should consider treating stormwater runoff from surrounding roads in two existing parks, CR Wood Park and Birchwood Park. In addition, the City should consider treating a large amount of stormwater on the city land of the former Little Lick Creek wastewater treatment plant. These are excellent opportunities where one landowner, the City, can make a great difference in water quality on Little Lick Creek.

Connect Sand Filter Onsite Wastewater Treatment Systems to Public Sanitary Sewer Systems— Durham County Health Department reports that there are 440 sand filter-type systems in the Little Lick Creek watershed and that public sewer is available for 270 of these systems. Sand filter systems were installed in areas where soils could not support conventional septic systems. Professional experience and Little Lick Creek fieldwork (Hoyt 2005) suggests that these systems have a high rate of failure. In fact, it is now required that such systems be permitted by the state (see Recommendation #6: Improved Enforcement of Existing Regulations). Moreover, even functioning systems can contribute high concentrations of nitrogen to the watershed. A Durham Stormwater Services study of thirty functioning sand filter systems reveals that the average system exports concentrations of 26 mg/L. At such concentrations, the 440 systems in Little Lick Creek could be adding over 5,900 pounds of total nitrogen annually. Removing 270 of these systems could remove over 3,600 pounds of total nitrogen from the watershed each year. At $57/pound, the value of removing this nitrogen from the watershed is over $206,800. The City, County, NC Division of Water Quality, NC Division of Environmental Health, and NC Clean Water Management Trust, and NC Ecosystem Enhancement Program should form a task group to search for innovative ways to meet the recommendations in this plan.

Basic Implementation Steps and Alternatives:

1. Durham City and County endorse the stormwater retrofit recommendations presented in the Little Lick Creek Local Watershed Plan.

2. NC Ecosystem Enhancement Program, Durham City, Durham County, and other partners prioritize stormwater retrofit opportunities from the Little Lick Creek LWP for implementation.

3. Implement priority projects through NC EEP (through contracts with NC State University's Water Quality Group) or other potential funding sources.

4. Durham City Stormwater Services should use its utility as leverage to encourage landowners in Little Lick Creek to implement stormwater BMP's. The stormwater utility is a powerful tool for reducing existing stormwater impacts: the City could allow for reductions in stormwater utility fees to landowners that reduce the effects of impervious cover through implementing effective stormwater retrofits. However, the current fees are too low to encourage homeowners to retrofit their properties.

5. Maintain a shared Durham City and County database of all stormwater BMP's, and include stormwater retrofit practices in that database.
6. Require annual inspections of all stormwater retrofits to ensure they are operating properly and achieving pollutant reductions (Durham already requires annual inspections for all new stormwater BMP's).

7. Provide BMP practice maintenance and certification training for all stormwater inspections, maintenances and design and review staff (training being piloted now by NC State University Water Quality Group).

Costs:

- Jurisdiction: developing geographic information systems (GIS) database, coordinating retrofit prioritization and project proposals, review and approval of designs, recording of O & M agreements, inspecting construction, conducting annual inspections and follow-up actions, managing program, any new equipment (e.g., cameras, lights, tape measures, handheld GPS unit) needed for program.
- Landowners: time or matching funds for implementing retrofits, maintenance, repairs

Funding Opportunities:

- Neuse nitrogen offset fees (administered by NC EEP specifically for stormwater retrofits in the Neuse. Durham projects paid over $180,000 into this fund in 2002-2003 alone.)
- NC Department of Transportation, where stormwater impacts are directly associated with an NC DOT road.
- Grants (NCDWQ 319 grant program)
- City of Durham Stormwater Utility
- In-kind and matching provided by landowners

Potential Pitfalls:

- Reduction of City of Durham stormwater utility fees for landowners implementing retrofits will cause a loss of revenue. Fees are currently too low to provide incentive for property owners or developers (1) to give up land for retrofits, and (2) to sign an agreement to maintain retrofits forever.
- Stormwater retrofits need to be inspected regularly to ensure that they function properly
- Stormwater retrofits may need special engineering and attention to function effectively in the Triassic Basin soils of Little Lick Creek. Specifically, techniques using infiltration may require backfilling with imported soils and more regular inspection to prevent clogging. This raises the cost of stormwater retrofits in the watershed.

II. Strategies to Prevent Future Degradation

Little Lick Creek is listed as biologically impaired by the NC Division of Water Quality, and restoration is a major objective of this planning effort. However, the greatest long-term threat to water quality and aquatic habitat is from innappropriate development in the watershed. Greater than one-half of Little Lick Creek's 21 square-mile watershed is currently covered by rural, forested, or agricultural land. Under current zoning and water supply watershed protection ordinances, these "developable" lands will no longer be agricultural or forestry lands. They are zoned to be almost entirely low-density residential.

Will partners in Little Lick Creek watershed be able to improve water quality and aquatic habitat conditions from their current degraded state? In the future, the Northern Durham Parkway will run through the center of the watershed and built-upon area will increase from 35% to 85%. Ultimately, 78% of the watershed will be under residential development and 15% is expected to be open space (UNRBA 2005a). Will the current land use, stormwater and buffer regulations protect the functions aspired to in this planning effort while the level of development in the watershed triples?

As the watershed develops, it will become more impervious to stormwater infiltration. The current level of impervious cover (rooftops, roads, parking lots, and driveways) is 11%. When that level increases to 23% and several subwatersheds (1-4) exceed 30% impervious cover, as this plan predicts, instream runoff will increase and cause further stress on the already stressed stream channels.

At the same time as property owners in the City and County continue to develop the watershed, the State of North Carolina is legally required to enforce the restoration of this impaired water body. In addition, Little Lick Creek flows into Falls Lake, a nutrient sensitive reservoir under active study for development of a nutrient management strategy. The reservoir may also be declared impaired.

Exacerbating this challenge are Little Lick Creek's highly erosive, Triassic Basin soils, which are extremely susceptible to damage from increased runoff. White Store (which covers 69% of the watershed) and other Triassic Basin sedimentary soils are almost devoid of bedrock to act as grade control. For this reason, the Little Lick Creek watershed is highly susceptible to both habitat and water quality degradation, primarily from hydrologic changes that lead to in-stream erosion and high levels of suspended materials. The watershed is impaired and will become further, possibly irreparably, impaired under current planning and development practices.

The following recommendations are crucial to protecting the water quality and habitat functions of the Little Lick Creek Watershed from future degradation. It is recommended that partners in Little Lick Creek utilize three strategies to prevent future degradation of the Little Lick Creek watershed:

1. Critical Lands Protection (LLC Recommendation #4)

2. Better Site Design (LLC Recommendation #5)

3. Improved Enforcement of Existing Rules (LLC Recommendation #6)

As Durham City, County, and other watershed partners implement the recommended approaches, they can expect fewer impacts on the watershed from new development. The result will be better water quality, and a cleaner living environment, for future watershed residents. Ultimately, a cleaner environment will mean more desirable neighborhoods and better quality of life.

Recommendation 4:
Protection of Lands Critical to Water Quality and Aquatic Habitat

REVIEWERS

Cherri Smith (chsmith@durhamnc.gov)
George Rogers (george.rogers@ci.raleigh.nc.us)
Sally Hoyt (sch@cwp.org)
John Cox (john.cox@durhamnc.gov)

Reviewed by full Technical Team: Jan. 11, 2006

Watershed Management Category: Strategies to Prevent Future Degradation

Implementation Scale: Site and Watershed

Priority Areas:

Little Lick Creek Technical Team members developed a detailed conservation analysis for the 21-square-mile Little Lick Creek Watershed. The analysis identifies and prioritizes lands critical to water quality and aquatic habitat for voluntary land protection efforts.

Background:

Conservation of land around surface waters is perhaps the most cost-effective and long-term water quality protection strategy available. Protection of vegetated riparian buffers along headwater streams, tributaries, and lakeshores provides natural and effective protection against nonpoint source pollutants and reduces future impacts from additional development.

Currently, about 10% of the Little Lick Creek watershed is protected natural area (UNRBA 2005a). Even with Durham's new and more protective buffer and floodplain regulations, the ultimate percent of protected natural area will be just under 12%. That is an increase of less than 200 acres of undeveloped land in a watershed that will ultimately experience over 50% of its currently undeveloped lands turned to subdivisions.

The conversion of farmlands and forest to suburban development will have negative consequences for water quality in Little Lick Creek. When fully built-out, the watershed will export 24% more nitrogen than it currently does, according to the Center for Watershed Protection's Watershed Treatment Model (appendix to UNRBA 2005a). This increase occurs despite accounting for the urban growth boundary, the use of structural stormwater management practices, and increased levels of homeowner education. Such a future would be bad news for both the creek and Falls Lake, but it need not ever occur. We can better protect Little Lick Creek's water quality and aquatic habitat through protecting an increased area of lands.

The Little Lick Creek Technical Team, Triangle J Council of Governments, the Durham City-County Planning Department, and the UNRBA conducted an analysis of lands critical for meeting the watershed management goals set out in Technical Memorandum #1 (UNRBA 2005a). The analysis uses scientifically-based criteria to identify over 143 acres of land on 320 tracts that are critical to water quality and aquatic habitat. Table 2 lists the criteria and related Little Lick Creek planning goals. For an explanation of the criteria and analytical process behind

the analysis, see "Little Lick Creek Local Watershed Plan Technical Memorandum #2: Suggested Approach for Critical Lands Protection Analysis" (UNRBA 2005b).

Landscape Analysis Criteria (functional criteria)	**Watershed Management Goals**	**Criterion's Relative Priority**
Endangered, threatened or rare species or natural communities	3	High
NC Natural Heritage Areas	3,4	High
Wetlands	2,4	High
Floodplains	2,3,4,5	High
Steep slopes near streams or rivers	2,3,4	High
Highly Erosive Soils	2,3,4	High-Low (based on soil erosion potential)
Outstanding geologic characteristics	3,5	Medium
Significant forest cover	1,2,3,4,5	High-Low (based on forest type)
Areas close to Little Lick Creek or tributary: 50 feet	1,2,3,4	High
Areas close to Little Lick Creek or tributary: 100 feet	2,3,5	High
Areas close to Little Lick Creek or tributary: 330 feet	3	Medium
Parcel-level Criteria	**Management Goals**	**Areas Flagged**
Large tracts (e.g., >50 acres)	3,5,6	Tracts >10 acres, >15 acres
Tracts in close proximity to protected lands	5,6	Adjacent or within ¼-mile
Farmlands designated as prime agricultural lands or part of an agricultural preservation district	6	Tract w/ prime ag. soils and under ag. tax valuation
Tracts with recognized historical or cultural features	6	Tract w/ recognized site
Tracts with significant amount of frontage to Little Lick Creek	3,5,6	Tract w/ > ¼-mile of frontage to LLC or tributary
Tracts under threat by development	All goals	Tract zoned for more intensive use
Tracts that lack current protections if developed (esp. in floodplains)	All goals	Tracts grandfathered-not required to meet buffer & floodplain regs.

Goals: 1. Improve watershed hydrology; 2. Improve water quality; 3. Restore/Protect Aquatic and Riparian Habitat; 4. Protect water quality and habitat in Falls Lake; 5. Improve natural conditions for people living in watershed; 6. Foster community stewardship

Table 2: Criteria and data sets proposed for the Little Lick Creek Critical Lands Protection Analysis

The landscape analysis portion of the critical lands protection analysis results in an area-weighted map of all lands in the watershed. The parcels-level analysis portion identifies the parcels containing the most highly-weighted ("critical") lands. Since the objective of the critical lands analysis is to identify the location of resource-rich, critical areas, the landscape analysis does not score any of the parcels-specific information. The parcels-level analysis strictly provides information about the parcels containing the critical lands.

Upon review of initial results, the Little Lick Creek Technical Team prioritized tracts of land receiving the highest overall landscape values (over a score of 12). The following list highlights some of the findings.

- The landscape analysis identifies a total of 143 acres of "critical" high resource value lands located on 320 tracts that total 3,492 acres (26% of the watershed)
- Well over ½ of the highest-value critical land (82 acres) is located on 13 tracts, each of which has over 3 acres of critical land
- 78 of the critical tracts are over 10 acres, 64 are over 15 acres, and 18 are over 50 acres
- 63 of the critical parcels are within ¼-mile of public land
- 14 of the parcels are on prime farmland
- 41 parcels have over ¼-mile of stream frontage
- 57 parcels contain a planned trail
- 133 parcels are "developable"
- 31 parcels are grandfathered out of current floodplain and buffer regulations
- 3 parcels contain historic or cultural features
- 51% and 44% of the area of subwatershed 9 and 10, respectively, is covered by parcels with the highest-value critical lands.

A map of the landscape analysis results (Figure 11) shows that most of the highest-scoring lands identified as high priority lie within the Little Lick Creek's 1% chance flood zone (the area where the annual statistical chance of a flood is 1%, often called the "100-year floodplain"). The moderately high-scoring areas also lie within the floodplain and along the creek's riparian buffers. Upland areas receive relatively low scores in this analysis.

Just as the landscape analysis does not include parcels-level considerations such as parcel size or proximity to protected land, it does not exclude areas based on these considerations. Thus, many of the priority tracts are located on lands where outright acquisition or easement is unlikely. In fact, almost ½ of the tracts (154 of 320) are less than 1 acre in size. This highlights the need for multiple management strategies to protect critical lands. The recommended strategies are described below.

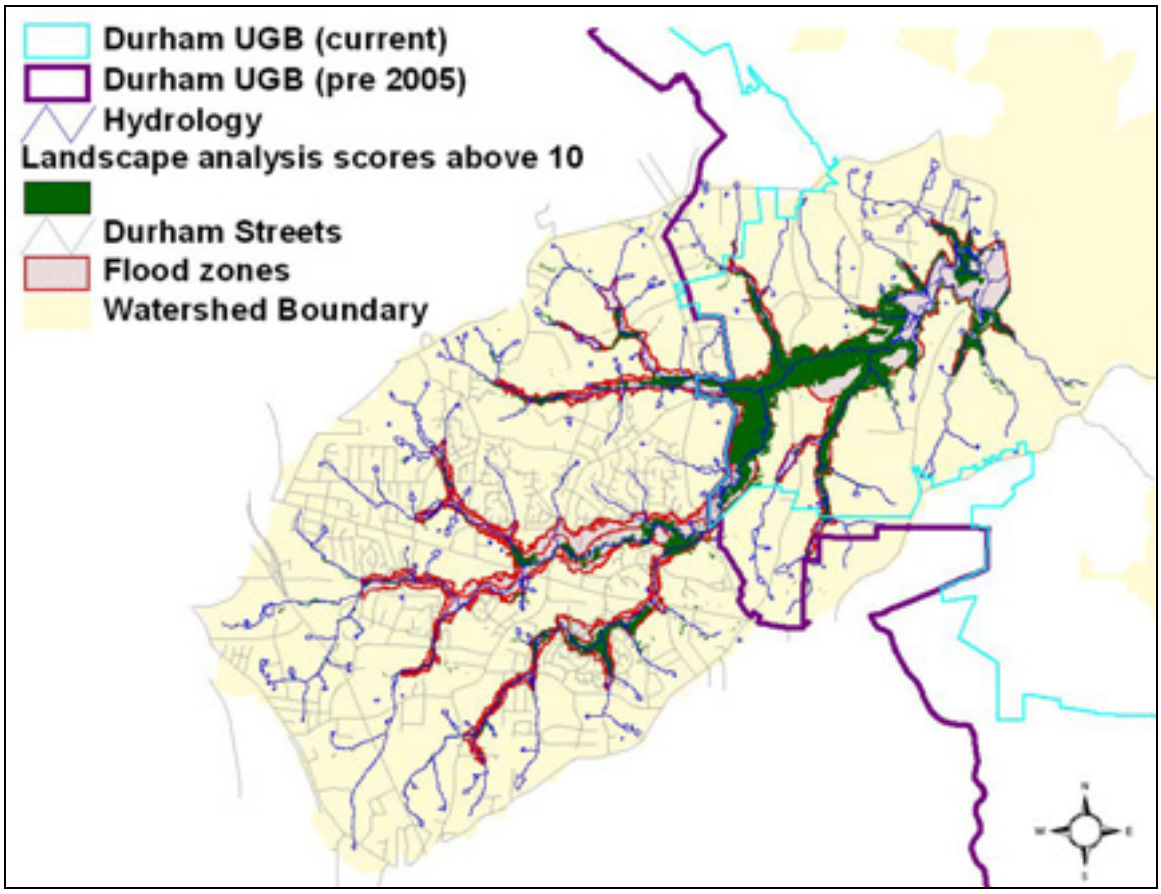

Figure 11: Little Lick Creek Landscape Analysis Results

Recommended Management Strategy:

The City and County of Durham, the Triangle Land Conservancy, and other entities should partner to protect the lands identified as high priority by the Little Lick Creek. A multi-pronged land protection approach is recommended.

1. *Tracts that protect the greatest area of high-value conservation land should be protected using voluntary measures such as land acquisition and conservation easements. The City and County should target these areas in the East Durham Open Space Plan and identify the targeted lands that are adjacent to public land, contain prime farmland, contain historical or cultural features, have greater than ¼-mile of stream frontage, and contain planned trails. In addition, partners should prioritize the developable parcels and the parcels, especially those that are exempted (grandfathered) from current floodplains and buffer protection ordinances because they were platted prior to the adoption of these protections.*

2. *Small (less than 1-acre), developed tracts make up 48% of the total tracts with high value lands. The total land area of these tracts is about 2% of the total critical tracts identified and significantly less than 1% of the watershed. The City, County, and TLC should assess whether existing regulations will adequately protect these lands, find approaches to protect lands that will not be adequately protected by existing regulations, and educate landowners*

about the ecological and water quality value of maintaining these lands in an undisturbed state (see Recommendation #7: Watershed Outreach and Education).

3. *A visual examination of the 143 acres of critical lands (lands scoring over 12 in the landscape analysis) reveals that the vast majority of these lands would be completely protected by a strong ordinance prohibiting development in the 100-year floodplain of Little Lick Creek. Additional visual analyses indicates that the great majority of the lands scoring above 4 in the analysis would be protected by the combination of a strong floodplain protection ordinance and a strong 50-foot riparian buffer ordinance (a score of 4 indicates the presence of at least two criteria; the combination of a high-priority criterion, such as a 15% slope, and a low-priority criterion, such as moderately erosive soils, equals a score of 4). Since Durham's minimum buffer regulations in the Neuse require at least a 50-foot buffer(and larger buffers within the ½-mile of Falls Lake), and since Durham has adopted an ordinance restricting development in the floodway and floodway fringe, Durham can protect these lands by strictly enforcing the existing rules (see recommendation #6, Improved Enforcement of Existing Rules).*

4. *The City and County of Durham's Comprehensive Plan moves the City's urban growth boundary further into subwatersheds 9 and 10 (see Figure 11). Thus, urban growth will extend into 53% of subwatershed 9 and 42% of subwatershed 10. Durham should consider returning the boundary to its previous location, which more closely followed the hydrologic divides. Reasons for moving the boundary include:*

    - *Falls Lake's ½-mile critical area is not hydrologically-based, and sites outside the critical area but within subwatersheds 9, 10, and 13 will effectively transfer pollutants to the lake because of proximity and reduced in-stream travel times to the lake.*
    - *NC Division of Water Quality has found that subwatershed 9 contains possibly the best aquatic habitat ever encountered in NC Triassic Basin geology, and subwatershed 10 may have similar areas. NC DWQ and Durham Stormwater Services want to use the site in subwatershed 9 as a reference site.*

Basic Implementation Steps:

1. Durham City, Durham County and local land trusts review the Little Lick Creek Critical Lands Protection Analysis and set objectives and timelines for protecting key lands.
2. Durham City, Durham County, and land trusts implement the recommendations through land use plans and ordinances, open space plans, greenways master plans, parks and recreation master plans, watershed protection plans, and other plans and ordinances.
3. Durham City, Durham County, and land trusts work through voluntary efforts with landowners to protect the tracts with the greatest area of critical land. Use fee-simple acquisitions, easements, and other approaches.
4. Land trusts and local governments conduct outreach and education to landowners and the public on the importance of land protection. Focus on those landowners with critical lands on their properties.
5. On lands that will be developed, Durham City and County should:

   a. Adopt floodplains protection ordinances that maintain natural floodplains functions to the greatest extent possible;
   b. Strongly encourage conservation subdivisions, which require the protection of steep slopes, floodplains, and other vulnerable lands;
   c. Conduct a formal study on the need for reducing the threshold in the steep slopes ordinance in the Triassic Basin, where soils are very vulnerable to erosion; and
   d. Ensure that existing buffers are maintained (see Recommendation #6).
6. Include prioritized lands in version 2 of the Upper Neuse Watershed Management Plan recommendations. UNRBA should model protection of prioritized lands as part of a "conservation scenario" that will quantify, in terms of several important water quality parameters, the value of protecting priority lands. The conservation scenario may assess the water quality benefits of floodplain, or steep slopes, or other ordinances.

Costs:

- Little Lick Creek Local Watershed Plan Critical Lands Protection Analysis ($5,000)
- Land acquisition costs (fee-simple or lost use rights/conservation easements)
- Outreach costs to contact, discuss acquisitions and easements with, or provide education to land owners (land trusts and local governments can conduct outreach)
- Local government staff time to revise development ordinances and enforce codes
- Upper Neuse water quality model of high-priority critical lands (grant or local government partnership funded)

Funding Opportunities:

- NC Ecosystem Enhancement Program
- NC Clean Water Management Trust Fund
- Existing and future state and local bonds
- Public water supply users, including municipal systems and water and sewer authorities (e.g., City of Raleigh)

Potential Pitfalls:

- Implementation of this recommendation will depend greatly upon stakeholder input; therefore, it is crucial that local government staff understand the goals and criteria guiding the effort.
- Underfunding land protection is a potential problem. In Little Lick Creek, where development is rapid and land protection benefits are local and regional (Falls Lake), Durham should partner with Raleigh and other cities that depend upon the reservoir to find funding solutions.

Recommendation 5:
Better Site Design

REVIEWERS

John Cox (john.cox@durhamnc.gov)
Joe Pearce (jpearce@co.durham.nc.us)
Chris Mankoff (Chris.Mankoff@ncmail.net)
Sally Hoyt (sch@cwp.org)

Reviewed by full Technical Team: Jan. 11, 2006

Implementation Scale: Watershed

Priority Areas: All new development sites in the Little Lick Creek Watershed

Background:

The site design practices used on a new development project can greatly influence the overall effect the site will have on watershed hydrology. Site development changes the amount and quality of stormwater runoff, the amount of groundwater recharge, evaporation, and plant transpiration. These hydrologic alterations greatly increase stream flow downstream from the site, eroding stream banks and beds, increasing the concentrations of pollutants such as sediment in the water, stressing aquatic habitat, and causing floods.

Little Lick Creek's Triassic Basin soils are extremely vulnerable to changes in hydrology. In fact, hydrologic impacts pose the single greatest management challenge in the Little Lick Creek watershed. Little Lick Creek fieldwork and monitoring teams observed eroded stream banks and beds throughout even moderately-developed portions of the watershed. Little Lick Creek Technical Memorandum #4 and appendices (UNRBA 2005b) documents multiple impacts in the watershed, including erosion impacts, impacted buffers, and high concentrations of sediments and other pollutants.

For these reasons, environmentally-sound site design practice is a crucial need in the Little Lick Creek watershed, where it is clear that significant land disturbance will occur in the future. Currently, stormwater management for any new development in the Little Lick Creek Watershed currently must meet City of Durham Natural Resource Protection Standards (1999), Falls Lake Water Supply Watershed Overlay Zoning Districts (1994), and the Neuse River Stormwater Management for Nitrogen Controls (2001) rules. Forthcoming requirements under federal Phase II regulations will soon provide additional requirements for post-construction treatment of stormwater runoff from new development. Under these regulations, any newly developed sites must meet the following guidelines for stormwater management:

- Maintain the peak flow leaving the site at pre-developed level for the 1-year, 24-hour storm;

- Avoid development in floodplains;

- Avoid development on slopes of over 25%;
- Protect at least a 50-foot buffer around streams, wetlands, lakes and ponds;
- Take measures to reduce Total Nitrogen on sites where impervious area exceeds 23%;
- If the site is in the Water Supply Watershed Overlay District, treat runoff on all sites with impervious area exceeding 24% (all sites exceeding 24% impervious will have to provide treatment under phase II requirements); and
- If the site is in the Water Supply Watershed Overlay District, preserve buffers of 50-150 feet around streams and 250-1000 feet around reservoirs.

These requirements were created to maintain an acceptable level of water quality in *currently healthy* surface waters. What about water bodies that are already impaired? If we are to restore degraded and impaired watersheds while actively allowing development, new development must cause no further harm to those systems. Stated another way, we must find stormwater management approaches that prevent further degradation to the greatest extent possible. In Little Lick Creek's watershed, where erosion potential is the greatest threat to water quality, the key is to manage hydrology on development sites so that post-development stormwater peak flow and total volume (the "hydrograph") match pre-development flows to the greatest extent possible.

Recommended Management Strategy:

In Little Lick Creek, stakeholders have set the goals of protecting and restoring aquatic habitat and reducing the amount of nutrients and other key pollutants entering the system (UNRBA 2005a). One innovative, performance-based approach is increasingly used around the country. The "Low-Impact Development (LID)" approach to stormwater management offers a change from conventional stormwater management. The major objective of the LID approach is to mimic a site's natural, or pre-development, drainage functions to the greatest extent possible.

LID is a challenging standard to meet, and may be practically impossible on higher-density sites on Little Lick Creek's soils. However, the LID approach is most easily implemented and most successful on low-density residential sites like those sites that are likely to predominate in Little Lick Creek watershed in the future. The future land use analysis conducted for Little Lick Creek predicts that when land in the watershed has been built to the densities allowable under current regulations, 74% of the watershed will be residential homes on lots larger than 1/8 of an acre (UNRBA 2005a) and the watershed's level of impervious cover will be 23%. The approach may be practical on such sites if designers and developers are allowed the flexibility and held to high environmental performance standards. In many cases, the LID approach will allow developers to save money by reducing the need for costly stormwater conveyance systems.

The LID approach relies on a host of stormwater management practices, which can be categorized into five practices:

1. Runoff Minimization--achieved through porous pavement and green rooftops

2. Rainwater Capture--Cisterns and rain barrels capture rainfall from rooftops for later irrigation or infiltration.

3. Landscaping--Bioretention facilities (rain gardens), low areas within a parking lot or a yard, collect rainfall, filter the water through layers of mulch and soil, and then discharge the water, usually through an under-drain system.

4. Infiltration--Practices of rainwater capture, landscaping, and conveyance can be altered to maximize infiltration rates.

5. Conveyance--LID uses vegetated channels rather than curbs and gutters for transporting stormwater. Vegetated channels provide opportunities to slow and infiltrate water and to filter pollutants.

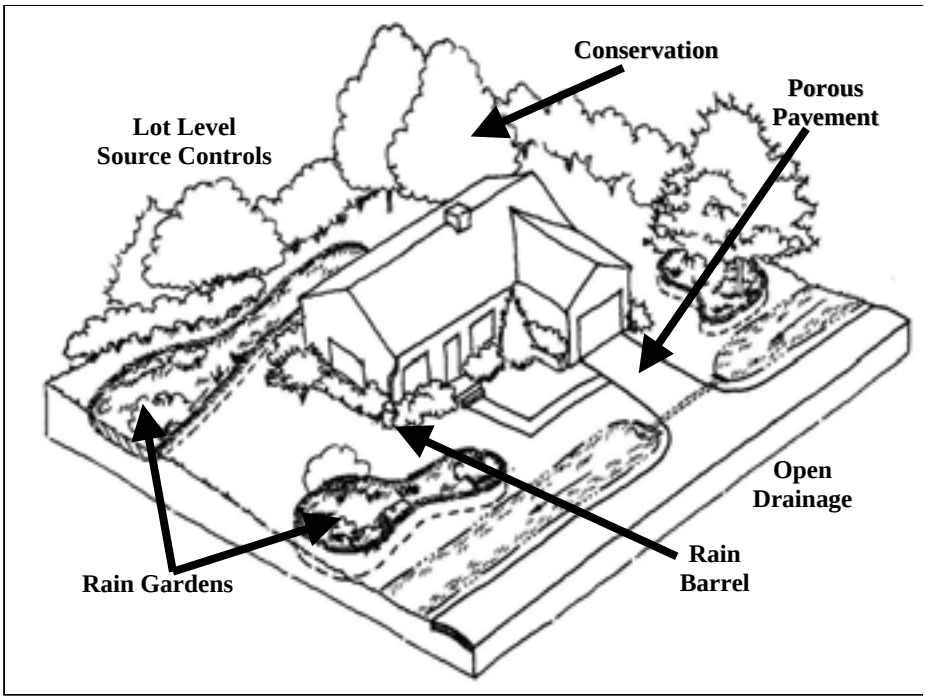

Figure 12: LID site (Prince George's County, MD 1999)

In order stop the current high rates of erosion and subsequent degradation in the Little Lick Creek watershed, Durham City and County should revise existing stormwater management approaches in Little Lick Creek to ensure that newly developed sites meet a hydrologic performance standard such as "Low-Impact Development". Where such a standard is not practical, Durham City and County should consider changing some existing development rules to encourage development that more closely mimics the LID standard. Implementing the following changes would reduce watershed impacts (note that many of the following recommendations will be necessary under a LID approach).

- The City and County buffer regulations (and the Neuse Regulations) apply to new development only. Fieldwork revealed that there is currently no way to ensure that the required 50-foot buffers remain buffered. Recommendation #6: Improved Enforcement

of Existing Rules recommends practical approaches for inspection and enforcement of riparian buffer regulations.

- Sewer lines are frequently located within 15 feet of the stream bank, and stream buffers in these locations are required to be destroyed. Consider changing the Durham Unified Development Ordinance language in UDO 8.5.5(J)(3) to read, "3. The line is generally located at least 45 feet from the top of the stream bank and the easement is no closer than 30 feet from the top of the bank". Such a rule will make local practice consistent with statewide Neuse Buffer Rules. The City and County should also study the possibility of encouraging native grasses or, at the least, maintaining existing vegetation in the mowed right-of-way at a greater height. Such an approach would be more hydrologically friendly to the riparian area and stream.

- Create stronger protections for wetlands. Protect small (less than one acre) wetland areas adjacent to intermittent streams that currently escape protection (these are not on the USGS or SCS maps). Do not allow stormwater management facilities within the wetland or its buffer.

- Allow grass channels in lieu of curb and gutter in low-density residential areas. Where this is not practical, require that all discharges from curb-and-gutter systems, even those in low-density developments, receive treatment to reduce nitrogen at least 30% in accordance with the Neuse Buffer Rules. This makes the City and County requirements consistent with the Neuse Buffer Rules. Directing flow from rooftops, driveways, and parking areas to natural areas or grass will reduce the water peaks, volumes, and pollution flowing to surface waters. Lot drainage can be graded so that flows can be discharged to lawn, with swales used to ensure positive drainage. Disconnecting impervious surfaces from street drainage, particularly curb and gutter, can reduce the size of BMP required on a new development site.

- Meet the Upper Neuse Watershed Management Plan phosphorous reduction goals for new development.

- Encourage the use of bioretention with underdrain systems in landscaped areas of parking lots for stormwater treatment.

- Encourage, or require, the use of the conservation subdivision ordinance allowed in Durham's Unified Development Ordinance (see Recommendation #4). Require that open space be maintained in natural condition.

- Within the Triassic Basin, adapt the steep slopes ordinance to reduce the required slope. Observation in Little Lick Creek suggests that land disturbance may cause significant erosion at a slope of 15%. (See Recommendation #4)

- Consider requiring development on previously-platted lots that are grandfathered from having to meet Neuse Requirements to meet LID. These sites would only have to treat runoff at the lot level.

- Increase incentives to preserve existing trees/forested areas on developing sites.

Basic Implementation Steps and Alternatives:

1. Adopt performance standards for Phosphorous (and TSS?) (see Upper Neuse Watershed Implementation Plan recommendation #1 for more details on implementing performance standards for phosphorous).

2. Adopt and begin using the Upper Neuse Site Evaluation Tool (**www.unrba.org/set**) to oversee nitrogen and phosphorous standards (and eventually, LID standard)

3. Partner with the state and NCSU as they develop the NC LID manual. Adopt the LID performance standard along with the LID manual as part of Durham's Stormwater Ordinance. Alternatively, adopt the changes to existing ordinances described in **Recommended Management Strategies**.

4. Implement an annual inspection program for stormwater best management practices in both the City and County. The City of Durham requires, as a condition for development approval, an operation and maintenance agreement with property owners for each stormwater BMP. The developer and/or property owner must also post a perpetual performance surety, which the City can use to ensure that the property owner repair any problems. Durham stormwater engineers inspect BMPs before a certificate of occupancy is issued to verify proper construction. (The UNRBA does not recommend stormwater BMP's without, as a minimum, an annual inspections program. See Upper Neuse Watershed Implementation Plan recommendation #4 for more details on implementing an annual BMP inspection program).

5. Enforce civil and, where appropriate, criminal penalties for noncompliance.

Costs:

- Jurisdiction: developing geographic information systems (GIS) database, hiring new inspectors and support staff (inspecting LID sites could increase required staff hours in Little Lick Creek from an estimated 0.4 FTE to 5 FTE), conducting initial SET reviews by planning and engineering departments, conducting inspections and follow-up actions, training, managing program, equipment (e.g., cameras, lights, tape measures, handheld GPS unit), vehicles
- Landowners: maintenance, repairs

Funding Opportunities:

- Development plan review fees
- BMP plan review fees
- Inspections and maintenance fees

- Stormwater fee
- Financial performance bonds/guarantees/agreements (to fund inspections program)
- Operation permit issuance and reissuance fees
- Re-inspection fees

Potential Pitfalls:

- Existing site development and engineering requirements inhibit application of LID. Greater flexibility may need to be provided in situations where a developer elects to use LID on such constraints as visual buffers, front and side setbacks, engineering requirements that curb and gutter be installed on roads that overlay sewer mains, etc. Rather than "relaxing" existing development standards for conventional development to facilitate LID, it may be necessary to develop alternate development standards that apply to developments that implement LID.
- North Carolina currently does not encourage the use of several of the stormwater management practices recommended in the national Low-Impact Development Manual. For example, large rooftop catchment cisterns are currently being used across NC to harvest rooftop stormwater for future use in landscaping or even non-potable indoor uses. However, the State does not give pollution removal credit for use of cisterns. Meanwhile, building codes make reuse of rooftop stormwater for flushing toilets very difficult to implement. It is recommended that the City, County, and UNRBA work with NC State University and the state's Low-Impact Development Working Group as it develops the NC Low-Impact Development Manual. Additionally, the City, County and UNRBA should encourage the NC Environmental Management Commission to include innovative practices in the State's Best Management Practices Manual and in building codes.
- The use of innovative stormwater management is likely to meet many obstacles such as lack of knowledge about their application and lack of understanding of their benefits for reducing runoff volume and pollutants. It is recommended that the City and County of Durham, along with the Upper Neuse River Basin Association, attempt to encourage pilot projects to implement Low-Impact Development techniques and further study their usefulness in a variety of land use settings.
- Ongoing maintenance on the part of BMP property owners is a problem. The public may perceive some stormwater BMPs, particularly innovative BMPs, to be unkempt or undesirable, and make small changes in landscaping that can affect the functionality of the stormwater practice. An annual inspections program is essential to maintaining the functionality of BMPs. Community outreach and education is needed to help preserve the original design of the system.
- Because of the Triassic Basin clay soils in Little Lick Creek, LID practices such as bioretention and infiltration will be subject to clogging if the areas draining to them is disturbed. Efforts should be made to use LID in areas that are likely to be stable.
- LID vastly increases the number of BMPs in a development. While each LID BMP may take much less time to inspect than a conventional BMP, wider use of LID will result in annual inspections of given development to take longer; more inspection staff will be required.

- Stormwater BMPs are often designed by engineers with little or no experience designing hydraulic/hydrologic systems. This may result in improper design. Certification or additional training programs may be necessary.
- Stormwater practices may look fine on paper, but because they are often improperly constructed, insufficiently protected during the construction process, or poorly sited, they may not function. Therefore, stringent BMP inspection requirements are needed.
- It can be difficult to determine the proper amount of money required for a performance guarantee.
- Because LID is new, and designers have little experience with it, multiple inspections and plan reviews may be needed before compliance is achieved for some developments.
- The location of BMPs can be "lost" if not recorded accurately. This happens when parcel information, and not absolute latitude/longitude, is used to record a BMP's location.
- Citizen and business education is vital for proper maintenance of BMPs.
- BMP inspections should not be done without some way of ensuring that failures are corrected over the long term life of the BMP… (performance bonds, etc)

Recommendation 6:
Improved Enforcement of Existing Rules

REVIEWERS

John Cox (john.cox@durhamnc.gov)
Joe Pearce (jpearce@durhamnc.gov)
Joe Albiston (jalbiston@durhamnc.gov)
Chris Outlaw (chris.outlaw@durhamnc.gov)
Bobby Louque (Robert.louque@durhamnc.gov)
George Rogers (George.rogers@ci.raleigh.nc.us)

Reviewed by full Technical Team: Jan. 11, 2006

Implementation Scale: Watershed

Priority Areas: All areas of the watershed subject to regulations protecting water quality and aquatic habitat, and in particular:

- Erosion and sediment control on new development sites;
- Existing sites adjacent to riparian areas and floodplains;
- Developed sites with stormwater best management practices; and
- Areas where trash and other large items are dumped; and
- Sites where broken sewer lines and failing septic systems were found during fieldwork.

Background:

Current Durham City and County ordinances are generally favorable to watershed protection. Both communities have rules governing erosion control, stormwater management, floodplain protection and riparian buffer protection. Although there exist opportunities for improvements to the watershed protection ordinances (see Recommendations #4 and #5), ordinances in Little Lick Creek have the potential to protect vital components of the watershed.

Fieldwork in January and March of 2005 revealed examples in which failure to enforce ordinances led to impacts degrading watershed functions. The key findings, reported in technical memorandum from the Center for Watershed Protection (Hoyt 2005 & Hoyt and Tomlinson 2005), include instances of poorly functioning erosion and sediment controls, illicit discharges from septic systems and failing sanitary sewer lines, trash dumping, impacted buffers on new and existing development, and poorly designed stormwater management controls.

Erosion and Sediment Control—Fieldwork revealed construction sites with poorly functioning erosion and sediment controls discharging significant quantities of sediment to Little Lick Creek and its tributaries. Without proper controls and enforcement, construction site erosion will be a serious problem in Little Lick Creek. Specific examples of sediment and erosion control enforcement problems included:

- Cardinal Lake – a large, existing lake that was being used as a sediment basin for new development, and excavated material was being stockpiled adjacent to the lake. NC DWQ Little Lick Creek Local Watershed Plan stream sampling revealed several standards exceeding state action levels. Subsequently, Durham County issued a Notice of Violation to the developer for buffer zone violations, inadequate erosion control measures, and failure to minimize the extent and duration of disturbance to a lake or watercourse. It was later found that the NCDENR Division of Water Quality had waived 401 Water Quality Certification because DWQ had failed to take action on the 401 application within 60 days of receipt.
- Sites which relied primarily on sediment basins for sediment control , rather than using a combined approach that also considers preventing erosion through the establishment of effective ground cover and construction of stabilized conveyance channels.
- Failure to maintain erosion and sediment controls. For example, silt fences that were overtopped by sediment or undermined by erosion were noted.

Figure 13: Suspended sediments in Cardinal Lake and downstream tributary (Reach 8-14)

During 2005, Durham County improved several areas of sediment and erosion control oversight:

- County Erosion Control staff conducted inspector training with specific emphasis on watercourse protection;
- On large development sites, Durham County and NC Division of Water Quality inspectors have completed joint inspections;
- In 2005, Durham County completed more than 2200 erosion and sediment control inspections (every permitted site was inspected monthly, and at-risk sites were inspected more frequently);
- Erosion control plans now must cover the project from inception to completion, including the building lot phase of development;

- Staff has encouraged the use of improved devices including basin skimmers, and catch basin silt sacks; and
- Durham County has developed a GIS layer of active sedimentation and erosion control projects and stream watersheds (these data layers allow for the rapid assessment of sites which may be impacting specific stream reaches).

The City of Durham's pollution reporting hotline has noted a reduction in erosion and sediment-related complaints during 2005. The pending revisions to the State's erosion control design manual should further improve the sedimentation and erosion control device designs. However, it is not clear whether NC Division of Water Quality oversight in the watershed has improved following the Cardinal Lake incident.

Impacted Buffers—Little Lick Creek partners observed instances where current regulations were not having the intended effect of protecting the riparian buffer. Observations included: sanitary sewer lines running parallel to the stream, with less than 30' of undisturbed vegetative buffer between the cleared right-of-way and the top of bank; new residential developments where vegetation had been removed to the stream bank; and stream channels converted to roadside ditches with driveway culverts.

Figure 14: Failure to protect buffers degrades water quality (Reach 2-11)

Stormwater Management—There is a great increase in the number of post-construction stormwater management controls in the Little Lick Creek watershed. Many new development sites had poorly designed or poorly constructed stormwater management controls. Subsequent discussions with Durham City Stormwater Services revealed that many of these poorly designed BMP's were not built to the specifications approved by the City.

Trash Dumping—A range of trash dumping behaviors were observed in Little Lick Creek, including: organic material (yard waste) and miscellaneous household trash along the stream corridor behind homes; oil filters, automotive trash, and even automobiles; dumping of construction materials; and dumping associated with commercial areas. City staff have reported that residents illegally put leaves in street gutters and occasionally dump yard wastes in catch

basins, and that, when landlords evict tenants, the tenants' belongings are sometimes illegally dumped.

Figure 15: Little Lick Creek being used as a dump site

Sewer and wastewater discharges—Fieldwork revealed many instances of failing onsite wastewater treatment systems and a few broken sewer lines. Specifically, in addition to conventional septic systems, there are 440 sand filter-type onsite wastewater treatment systems in the watershed, the densest of any area in the Upper Neuse. Durham Stormwater Services sampling found that the average sand filter system exports over 30,000 colony forming units of fecal coliforms per 100 ml. These bacteria persist in the environment and cause a risk to public health. In addition, high concentrations of other pollutants such as nitrogen and biochemical oxygen demand contribute to low dissolved oxygen and impair water quality, reducing the stream's ability to support aquatic life (see Recommendation #3: Stormwater Retrofit Projects). Additionally, a single broken sewer line can discharge thousands of gallons of raw sewage before being detected. Such discharges are prohibited under the following regulations:

- Durham County Ordinance 14-158 prohibits illegal discharges;
- State sewage regulations, 15A NCAC 18A, prohibit surfacing wastewater from septic systems
- City of Durham Ordinance 23-140 to 150 (currently being revised).
- The NPDES permit for the City of Durham's wastewater collection system prohibits sewer overflows, which are considered to be any discharge or leak of any size;
- The NC Division of Water Quality requires permitted sand filter onsite wastewater systems with access to public sewer systems to hook up to the public system (only about 15% of the systems have been permitted by DWQ); and
- Some discharges violate NC building code. (However, a building or structure is required to comply with the building code that existed at the time the building was constructed.

Changes in the building code do not apply retroactively. This and other building code issues are a source of frustration for stormwater managers nationwide.)

Figure 16: Failing sand filters (left) and sanitary sewers (right) pose health risks and harm water quality

Recommended Management Strategy:

Durham City and County have taken important steps to improve enforcement of existing regulations since the Little Lick Creek partners conducted the January and March, 2005 fieldwork. In particular, Durham County Engineering has strengthened its erosion and sediment control program and hired stormwater management staff. .In addition Durham City/County Planning has added two field inspectors who ensure tree protection fencing (often used to mark stream buffers) has been maintained, and site plans (which designate stream buffers) are being followed.

Specific steps to improve enforcement of existing regulations are listed below.

Erosion and Sediment Control

Responsible parties: Durham County and NC Division of Water Quality

The Center for Watershed Protection's Watershed Treatment Model predicts that a program of weekly inspections, the implementation and maintenance of controls at a rate of 90% or greater, and additional education of contractors regarding effective practices could result in an 8% reduction of annual sediment (total suspended solids, or TSS) loading (Hoyt 2005b). These reductions would be greatest in subwatersheds that currently have large active construction sites. Specifically, the following steps could be taken.

- NPDES General Permit NCG010000 is issued by NC Division of Water Quality for all construction sites over 1 acre. This permit requires the permit holder to conduct inspections and report on erosion control devices and stormwater outfalls after rain events and once or twice weekly, dependent upon the impairment classification of the stream. Due to staffing issues, the Division of Water Quality completes very few inspections to ensure these permit requirements are met. For sites located inside the city, Durham City Stormwater conducts inspection of permitted construction sites in response to staff

observations and citizen complaints, and refer compliance problems to the state; the City does not have sufficient staff to conduct routine inspection of permitted sites. The Division of Water Quality should either complete inspections to ensure the NPDES permit reports are being completed as required or provide incentives to Durham County to complete these inspections.

- Stream protection barrier fencing should be required for all projects.
- Projects involving draining impoundments should be inspected by NC Division of Water Quality regulators at the onset of the draining project.
- Contractor, engineering, and erosion control regulator training should be provided.
- City of Durham monitoring of turbidity in Little Lick Creek shows a significant decline in the frequency of turbidity violations since the County hired the current Erosion Control Administrator. Improved training of staff and increased vigilance in enforcement should be given more time to bear fruit. However, if improved enforcement during 2006 does not adequately control turbidity, then the Division of Water Quality should consider listing Little Lick Creek as impaired for turbidity related to construction, see website <h2o.enr.state.nc.us/su/construction303d>.

Impacted Buffers

Responsible parties: Durham City Stormwater Services and Durham County Stormwater Management

The City and County of Durham should conduct post-development inspections to ensure that buffers have been managed as required by Durham ordinance. This could be done cost effectively by developing a GIS map of the location of protected buffers based on land development applications, and then using already available aerial photography and/or satellite imagery to verify that buffers remained well vegetated. Field inspections would only be required where there appear to be violations requiring enforcement. In addition, Durham stormwater services staff should conduct regular stream assessments like the assessment undertaken in Little Lick Creek in early 2005. Regular stream assessment will require additional staff. Since riparian buffers constitute the most effective stormwater management tool, it makes sense that buffers should receive the same level of oversight as do other stormwater management controls. Durham City and County should both ensure level spreaders are installed at discharge points to stream buffers.

The Center for Watershed Protection's Watershed Treatment Model predicts that a combination of 1) buffer restoration, 2) more stringent guidelines that give specific criteria for uses of buffers, and 3) education and enforcement actions to prevent the encroachment on and deforestation of buffers could reduce by 4% the annual sediment (TSS) load watershed-wide (Hoyt 2005b).

Stormwater Management

Responsible parties: Durham City Stormwater Services and Durham County Stormwater Management

Since Durham City Stormwater Services began regular inspection of existing best management practices, staff repeatedly encountered situations where the facility had not been built in accordance with the design. Registered design professionals are currently required to submit 'As-Built' drawings that certify "to the best of their knowledge and belief" the facility was built in accordance with the approved plans. This does not explicitly require the design professional to inspect construction or to thoroughly check for conformance. Certification of "substantial

conformance" is ambiguous. The current requirement for As-Built certification has not resulted in properly constructed stormwater management facilities.

As an interim strategy, Stormwater Services has shifted focus away from inspecting existing BMPs to inspecting new construction so that improper construction can be corrected while the contractor is still at the work site. Inspection of new construction is educating the contractors, and holding them accountable for building BMPs in accordance with approved plans, but currently requires more time than current staffing will allow.

City Stormwater Services does not have sufficient staff both to inspect new construction and to conduct annual inspections of the existing BMPs within the City (currently more than 400), as required by the City's NPDES Stormwater permit To reduce the number of additional staff that will need to be hired, the City should consider shifting some of the responsibility back on the design professional through a strengthened As-Built certification requirement.

Many other jurisdictions have experienced the same problems. To combat this problem, Maryland recently began requiring certification that the facility was constructed in accordance with the plans except as noted in red on the drawings, and that the red-noted exceptions do not adverse affect the facility's ability to comply with design and performance requirements. This certification is explicitly based on "sufficient and appropriate onsite inspections and material tests conducted during construction." In addition to an explicit certification statement, Maryland also requires a tabulation comparing As-Built calculation results with design calculation results for storage volume, peak flow, etc.

Although the City and County began requiring BMPs in 1994, the number of projects requiring BMPs increased dramatically in 2001 with adoption of Neuse stormwater requirements. Forthcoming Phase II rules will require additional development projects to implement BMPs. Because the number of BMPs being constructed each year has increased, the total number of existing BMPs that need to be inspected annually has been increasing. Staffing levels should be reviewed annually for adequacy.

Trash Dumping

Responsible parties: Durham City Solid Waste Management Department and Stormwater Services Division

Enforcing littering regulations presents challenges for any local government, especially in low-visibility areas like stream corridors. Durham should work to include citizens in efforts to clean up Little Lick Creek. Advertising a hotline for citizens to call with tips will facilitate enforcement. Other activities could include homeowner education, neighborhood stream clean-up events, large item trash pick up days on a regular basis (e.g., 2-4 times a year), and siting household waste collection sites in apartments complexes or using a mobile oil recycling program that covers the watershed on a regular basis. The City has addressed problems with household hazardous waste collection by subsidizing this program. The City may be able to reduce problems with dumping of white-goods and yard waste by similar measures. The City should review the fees it charges for white goods pick-up and for participating in the yard waste pick-up/recycling program.

Sewer and Wastewater Discharges

Responsible parties: Durham County, Durham City, and NC Division of Water Quality

Durham City, County and NC Division of Water Quality should work together with other stakeholders such as NC Division of Environmental Health and others to explore opportunities to improve the enforcement mechanisms to prevent:

- Failures of wastewater lines within the stream corridor;
- Failures of onsite wastewater treatment systems; and
- Instances where high-risk onsite systems (such as sand filter systems) are not being hooked up to available public sewer systems.

Basic Implementation Steps:

1. Review practices and staff levels to determine whether existing staff could undertake the recommended enforcement activities (for example, citizen hot lines, sediment and erosion control trainings, or additional stormwater BMP inspections will likely require additional staff time).
2. Implement regular field assessment (stream walks) in Little Lick Creek as an additional check on the effectiveness of regulations and enforcement. Report findings to the City Council and County Commission as part of a regular environmental report. (This will require additional staff time)
3. Require, as a condition of project approval, that stormwater management practices be recorded using global positioning system (GPS) and geographic information systems (GIS) technologies. Maintain a database of all practices (see Recommendation #5, Better Site Design).
4. Where appropriate, increase the level of fines for noncompliance with regulations.

Costs:

- Jurisdiction: developing geographic information systems (GIS) database, staff time spent conducting any additional review, inspections and follow-up actions, any new equipment (e.g., cameras, lights, tape measures, handheld GPS unit) needed for program.

Funding Opportunities:

- Development plan review fees
- BMP plan review fees
- Inspections and maintenance fees
- Stormwater fee
- Operation permit issuance and reissuance fees
- Re-inspection fees

Potential Pitfalls:

Changing requirements in ways that increase workload without increasing the staff and material assets necessary to enforce the current levels of regulation will lead to failures in water quality protection!

.

III. Watershed Stewardship

Land use studies, field work, and water quality monitoring make clear the challenges facing the Little Lick Creek watershed both now and in the future. This document recommends several strategies for restoring basic watershed functions and preventing future degradation. However, it is clear that restoration and protection will not be possible without increased stewardship of the watershed on many levels and by many different groups.

Little Lick Creek needs stewards at various levels. In order to plant the seeds of stewardship, the general level of awareness of the creek must be raised. How can we expect people to take actions to protect the creek if they do not know they live in the watershed that has functions and provides important ecosystem services? Additionally, a high level of awareness will not, on its own, improve water quality and aquatic habitat. Only a deeper sense of stewardship formed through action can lead people to change habits or take action to protect Little Lick Creek.

The following section recommends three approaches for improving stewardship in the Little Lick Creek watershed. *Recommendation #7: Watershed Outreach and Education* recommends that the City of Durham's excellent stormwater education program provide targeted education for landowners with the goals of protecting more backyard riparian buffers, maintaing on-site wastewater treatment systems, preventing commercially-related water pollution, and implementing restoration and stormwater retrofit projects.

Recommendation #8: Adopt-a-Stream Programs suggests that citizens throughout the watershed can work together through the City's Adopt-a-Stream program to take active responsibility for the well-being of the creek. The responsibilities range from walking the stream to measuring water quality and reporting findings. All activities are relatively simple, and Stormwater Services staff members are ready to respond to water quality pollution incidents. One group of Girl Scouts has recently adopted a section of Little Lick Creek.

Recommendation #9: Water Quality Monitoring suggests several short and long-term objectives for improving monitoring of watershed conditions. In order to protect the creek, we must develop a deeper understanding of baseline conditions, the creek's hydrologic response to development, and of the pollutants entering the creek. This level of understanding can only be accomplished through increased monitoring. This monitoring must come from both government (City and County) and watershed citizens. City and County government has the experience and expertise in overseeing monitoring, while citizens will provide the needed eyes, ears, and (sometimes) noses needed for vigilance.

The stewardship strategies recommended herein will require additional resources of time and effort. Little Lick Creek occupies less than 7% of the entire City of Durham, and the needs are great. Durham Stormwater Services' environmental educator and water quality staff already operate very efficiently in providing a loose network of water quality monitoring and education throughout the city. Increasing such efforts may seem a

challenge; however, there are compelling reasons why the City and County should implement these strategies. First, Little Lick Creek is already impaired. As the watershed grows increasingly more urban, hydrologic impacts, erosion, and pollution potential will worsen. If local and state governments must work to help the stream to recover from diffuse sources of degradation, they will have to depend upon a diffuse source of actors to ensure that the strategies are implemented, rules are enforced, and that water quality and habitat goals are being met.

Another compelling reason for increasing the level of monitoring and stewardship in Little Lick Creek is to protect Falls Lake. The state is developing a nutrient management strategy for the Lake, which is nutrient sensitive and may be impaired. A nutrient management strategy will require polluters to reduce the amount of nutrients (nitrogen and phosphorous) entering the lake. New development will face increasing pressures to reduce impacts (see Recommendation #5: Better Site Design), and communities in the Falls Lake Basin will be forced to find ways to reduce existing pollutant loads (see Recommendations 1-3). Communities will also need to show the effectiveness of management strategies, and monitoring and stewardship practices like those recommended will be necessary.

Recommendation 7:
Watershed Outreach and Education

REVIEWERS

Laura Webb Smith (laura.smith@durhamnc.gov)
Steve Kroeger (steve.kroeger@ncmail.net)
Sally Hoyt (sch@cwp.org)

Reviewed by full Technical Team: Jan. 25, 2006

Implementation Scale: Watershed

Priority Areas: Areas where practices pose significant risks to water quality and aquatic habitat and outreach and education may help landowners to prevent pollution. The areas of focus include:

- Parcels located along stream buffers or floodplains;
- Homes or businesses with on-site wastewater treatment systems;
- Vehicle maintenance repair operations, gas stations, restaurants, or businesses with significant amounts of unprotected outdoor storage;
- Homes or businesses where trash dumping has been found to be a problem (see Recommendation #6: Improved Enforcement of Existing Regulations; and
- High-profile stream repair, buffer restoration, and stormwater retrofit opportunities, especially in schools and parks.

Background:

Fieldwork in January and March of 2005 revealed many instances of potential pollution "hot spots" in the Little Lick Creek watershed (Hoyt 2005, and Hoyt and Tomlinson 2005). Stream assessments revealed:

- *Littering*—Many homes and businesses located along stream buffers store or dispose of waste, often hazardous materials, in the riparian buffer; and
- *Poor maintenance of on-site wastewater treatment systems*—Many instances where improper onsite wastewater treatment system maintenance, particularly of sand filter-type systems, resulted in raw sewage entering surface waters (Hoyt 2005).

Upland site surveys revealed that many business operations may have re-occurring on-site pollution problems, listed below.

- *Vehicle maintenance and repair operations*—a large number of operations exhibited improper materials storage, unsafe and illicit discharges, and improper vehicle storage (Figure 17). These operations can exert a significant impact on water quality by discharging toxins such as solvents, waste oil, antifreezes, and other fluids to surface waters. Visits to these sites during rainfall revealed that pollutants were flowing to surface waters

- *Gas stations*—Fieldwork teams observed runoff (primarily diesel) from fueling station parking lots (Figure 17). Spilled gas and other petroleum products at gas stations can be a significant source of copper, zinc, and petroleum hydrocarbons.

- *Outdoor materials storage*—Storing materials uncovered can be a source of unwanted products in surface waters during storm events. Problems observed include lack of secondary containment areas, improper labeling of storage containers, and uncovered outdoor storage of hazardous materials.

- *Restaurant pollution source control*—Recurring pollution at restaurants in Little Lick Creek included grease storage, wash water disposal, and dumpster management.

Figure 17: Improper storage of waste and fuels (left) and uncovered fueling sites (right) pollute Little Lick Creek and Falls Lake.

In addition, field work identified many opportunities for stream repair, buffer restoration, and stormwater retrofit projects (see Recommendations #1-3) and critical lands protection (Recommendation #4). These are areas where urban development has caused stormwater impacts that degrade water quality and aquatic habitat. Restoration and retrofit projects can improve the situation, but these can only be done with the active involvement of Little Lick Creek residents and landowners.

Recommended Management Strategy:

Durham City and County have taken important steps to improve stormwater management in the Little Lick Creek watershed since partners conducted the January and March, 2005 fieldwork. In particular, Durham County Engineering has strengthened its erosion and sediment control program and hired stormwater management staff. Durham City Stormwater Services'

stormwater educator has taken steps to raise the level of watershed stewardship through a new Adopt-a-Stream program (see Recommendation #8: Adopt-a-Stream Programs).

Figure 18: Stream clean-ups instill watershed stewardship

Specific outreach and education actions that the City and County Stormwater Services staff could take to prevent pollution are listed below.

- Contact all streamside landowners, possibly through a mass mailing, to educate them about proper maintenance of riparian buffers and the regulations governing (and penalties for noncompliance with) littering.
- Educate all landowners, possibly though a mass mailing, in Little Lick Creek with on-site wastewater treatment systems about proper maintenance and inspection of these systems (Durham County Health Department has specific recommendations, including inspections every 3-5 years). Pay special attention to sand filter-type systems, which observation suggests are failing at high rates.
- Conduct outreach presentations and discussions with landowners and business owners identified by fieldwork (Hoyt and Tomlinson 2005). Specifically:
    - Work with small auto repair and sales shops to discuss storing parts in covered areas, creating secondary containment for storage tanks, and regularly inspecting vehicles stored outdoors for leaks;
    - Contact the NC Central University program currently coordinating a study addressing these small businesses;
    - Work with existing gas stations to encourage them to cover currently uncovered fueling stations and to implement gas station stormwater retrofits (see Recommendation #3: Stormwater Retrofit Projects);

  - Work with business identified as having significant storage of outdoor materials with the objectives to cover, contain, and reduce the materials being stored;
  - Work with businesses to ensure routine dumpster inspections; and
  - City Water Management work with restaurants with recurring pollution incidents (see Hoyt and Tomlinson 2005) to identify practices for preventing grease discharges. Some solutions are simple and low-cost, such as installing a grease trap, using a grease hauling or rendering service, or washing equipment/garbage cans in a designated indoor area.
- Conduct mailings and/or outreach to landowners to encourage them to implement the restoration, retrofit, and land protection projects recommended in Recommendations 1-4 of this plan. Most of the recommendations are for private landowners, and many of these people will not know of the opportunities without outreach. There are significant opportunities to implement retrofit and restoration projects on public property, especially schools. Involve teachers and other staff who may be able to champion these projects.

Basic Implementation Steps:

1. Identify and prioritize areas for education and outreach in Little Lick Creek. Detail the tasks and time frames for achieving the recommendations (responsible parties are Durham Stormwater Services Stormwater Educator and Durham County Stormwater Educator).
2. Identify existing local educational materials and/or adapt materials from other localities. NC State Cooperative Extension is a good source for outreach materials, including septic system maintenance. Additionally, a compilation of educational material sources by type of site can be found in the Center for Watershed Protection publication *Urban Subwatershed Restoration Manual 8: Pollution Source Control Practices*
3. Send mailed materials to landowners, providing a mechanism for letter recipients to contact and ask questions.
4. Conduct outreach presentations with Oak Grove Elementary, Neal Middle, and Southern High Schools about the science of watersheds (Durham Stormwater Services has recently trained three Southern HS teachers). Propose local government-school partnerships to conduct watershed restoration projects (for example, see Recommendation #3: Stormwater Retrofit Projects)
5. Conduct outreach presentations to priority businesses.
6. Coordinate with city/county staff pursing restoration, retrofit, and land protection recommendations to ensure that educational opportunities for the surrounding community are maximized. Educational opportunities may include teacher trainings, classroom presentations, community clean-up and awareness days, and any mailings targeted to watershed residents.

Costs:

- Jurisdiction: mass mailing materials, staff time spent developing and sending mailing materials, outreach presentations materials and other materials such as hand-outs, staff time spent conducting outreach.

Funding Opportunities:

- Stormwater fee (many outreach and education recommendations fall under existing NPDES Phase II requirements)
- Outreach and education grants (EPA Section 319(h) water quality grants)

Potential Pitfalls:

- Outreach and education efforts can provide valuable information to watershed residents and business owners. However, it is important to understand that outreach and education may not result in improved watershed stewardship. It is important that outreach and education efforts help people in the watershed to find opportunities to make a positive difference. Adopt-a-stream programs (see Recommendation #8), stream clean-ups, and student projects (see Recommendation #3: Stormwater Retrofit Projects) are activities that can encourage better watershed stewardship.
- Don't toil in the shadows! Start with positive, high-visibility outreach projects where success is likely. For example, start by working with the schools to implement projects, educate students about watersheds, and raise watershed awareness. Then build upon the successes to address the more entrenched, difficult problems.
- Staff time – Reaching targeted residents one-by-one is effective but time consuming.

.

Recommendation 8:
Adopt-a-Stream Programs

REVIEWERS

Laura Webb Smith (laura.smith@ncmail.net)
Steve Kroeger (steve.kroeger@ncmail.net)

Reviewed by full Technical Team: December 14, 2005 and Jan. 11, 2006

Watershed Management Category: Watershed Stewardship

Background:
Fieldwork and monitoring findings in Little Lick Creek illustrate the abundance and diversity of impacts to stream water quality and habitat (CWP 2005a &2005b). Various impacted buffers, stream erosion, erosion and sediment control violations, sewer leaks, and failing septic systems exist at any given time. These impacts can directly affect aquatic life and the quality of drinking water, and it is impossible for local governments to detect all of these. However, it is possible for trained citizens to detect many common problems that affect water quality, and strengthen existing water quality programs in the City and County.

Figure 19: Adopt-a-Stream can enhance oversight of Durham's water quality regulations

Detecting water quality and habitat degradation requires the involvement of the entire community. At the same time, it is clear that many business and homeowners, even entire neighborhoods, need to better understand their own responsibility in protecting the watershed. Changing attitudes and action will require outreach and education by the City and County (see Rec. #7 Outreach and Education) and action from within the community.

Durham residents vary in our knowledge of environmental and watershed issues. However, it is clear that there are many people who understand the value of clean streams and water supplies. It is also clear that there are great resources among our citizens. The City of Durham recently formed an "Adopt-a-Stream" program that recognizes these community strengths and draws on them to protect waterways from pollution.

Volunteers commit to at least two years of monitoring at one of three levels, the highest of which places volunteers on a stream at least twice a month to conduct visual monitoring and measure designated water quality parameters Volunteers are provided training and monitoring kits and have direct contact with Durham Stormwater Services to report findings. In addition, volunteers are expected to conduct two stream clean-ups per year and have the option of conducting biological monitoring (Durham Stormwater Services 2005). The program is sufficiently frequent and flexible to support basic monitoring that could detect and report water quality problems to the City and County.

Recommended Management Strategy:
Implement the City's Adopt-a-Stream program to raise the level of stewardship and increase oversight in Little Lick Creek.

Raising the level of environmental stewardship cannot come from outreach and education alone. Watershed stewardship occurs when individuals take active responsibility for managing the resource, usually through managing a small portion such as a stream reach. People are most likely to take an active role when there is an opportunity to act, and the Adopt-a-Stream program provides such an opportunity. The City and County of Durham should encourage citizens throughout the watershed to participate in the program at one of the three levels.

Increasing oversight will require additional vigilance. It is recommended that the City and citizens of the watershed establish an Adopt-a-Stream program in the most impacted subwatersheds in Little Lick Creek, subwatersheds 1-8. The City could work with citizens to ensure that the most appropriate stream reaches are covered, and some criteria for targeting sites might include reaches:

- With easy access to the stream;
- Where at least one, but preferably a group of, interested citizens live;
- Downstream of areas with high densities of septic systems;
- Downstream of active construction sites;
- Where known impacts exist (such as knick points, impacted buffers, or trash sites); and
- Near schools, where science classes could establish long-term water quality monitoring sites.

The highest two levels of stream adoption include regular walks and visual monitoring of the stream reach. The highest level, the "Piedmont Stonefly Level", visually monitors at least twice per month and measures designated water quality parameters (Durham Stormwater Services 2005). Parameters that might prove easy to measure and valuable in Little Lick Creek are listed below.

- Ammonia—used by Durham Stormwater Services to detect wastewater spills.
- Specific conductance—signals the existence of ions in the water and is another way of detecting potential wastewater spills.
- Turbidity—a relatively inexpensive and effective way of detecting residues in the water, turbidity is used by the state to regulate sediment and erosion control.
- Nutrients—somewhat harder than the previous parameters to measure, nutrients such as phosphorous and nitrogen (in various forms) contribute to algae production in the creek and reservoir downstream.
- pH—a measure of hydroxide ions (the acidity) of water, pH is easy to measure and extremely low or high levels often signal industrial spills.
- Temperature – affects many other parameters in water, including the amount of dissolved oxygen available, the types of plants and animals present, and the susceptibility of organisms to parasites, pollution and disease. Temperature changes due to weather, shade and discharges, and sites that exhibit extreme temperatures change may be useful for identifying causes of stream degradation.

Basic Implementation Steps:

1. Using information in the Little Lick Creek project and from other sources, identify the areas of greatest need for monitoring.
2. Approach neighborhoods, homeowners associations, scout troops, schools, and others to request their help in helping to protect the water in Little Lick Creek.
3. Register groups as officially recognized Durham Adopt-a-Stream Program and North Carolina Stream Watch members.
4. Focus the highest level groups toward oversight, and train volunteers in the use of the appropriate parameters.
5. On a regular basis, review and evaluate the effectiveness of Adopt-a-Stream groups in aiding the City (and County) with oversight.
6. Consider creating and maintaining a web site where Adopt-a-Stream volunteers can report and debate issues.

Costs:

Time spent training volunteers, assisting them, and reviewing their work. Time spent collecting their data and entering it into a database.

Equipment such as pH meters, thermometers, turbidity meters (or basic test kits), conductivity meters, ammonia test kits, benthic macroinvertebrate sampling equipment, and boxes for storage.

Printing of guidance manuals and data sheets.

Funding Opportunities:

- Stormwater Utility fee
- Grants (through NCDENR Stream Watch Program, EPA's Office of Environmental Education, etc.)

Possible Pitfalls:

- There exist legal tresspass issues with citizens walking along riparian areas of streams. However, involving citizens who live along the stream to participate (or allow others to participate) can overcome such challenges.
- Volunteers will need regular training to improve their sampling techniques and to understand how to document and present findings. A training program should be required as part of the Adopt-A-Stream Program.
- Initially, citizens may misreport information or may need to contact Durham Stormwater Services to receive guidance. The division should be prepared to provide volunteers with such guidance.

Recommendation 9:
Stream and Watershed Monitoring

REVIEWERS

Chris Outlaw (chris.outlaw@durhamnc.gov)
Bobby Louque (Robert.louque@durhamnc.gov)
Chris Mankoff (Chris.Mankoff@ncmail.net)
Steve Kroeger (steve.kroeger@ncmail.net)
Laura Webb Smith (laura.smith@durhamnc.gov)

Reviewed by full Technical Team: Dec. 14, 2005 and Jan. 11, 2006

Watershed Management Category: Watershed Stewardship

Background:
Little Lick Creek is recognized by the State of North Carolina as "impaired" because of its inability to support aquatic life and because of low dissolved oxygen levels. The City of Durham Stormwater Services (DSS) monitors two sites in the Little Lick Creek watershed, at sites 3 and 5 in Figure 20 below. In addition, NC Division of Water Quality (NC DWQ) has conducted chemical, biological, and toxics sampling across 11 sites in the watershed, shown in Figure 20 as numbered circles.

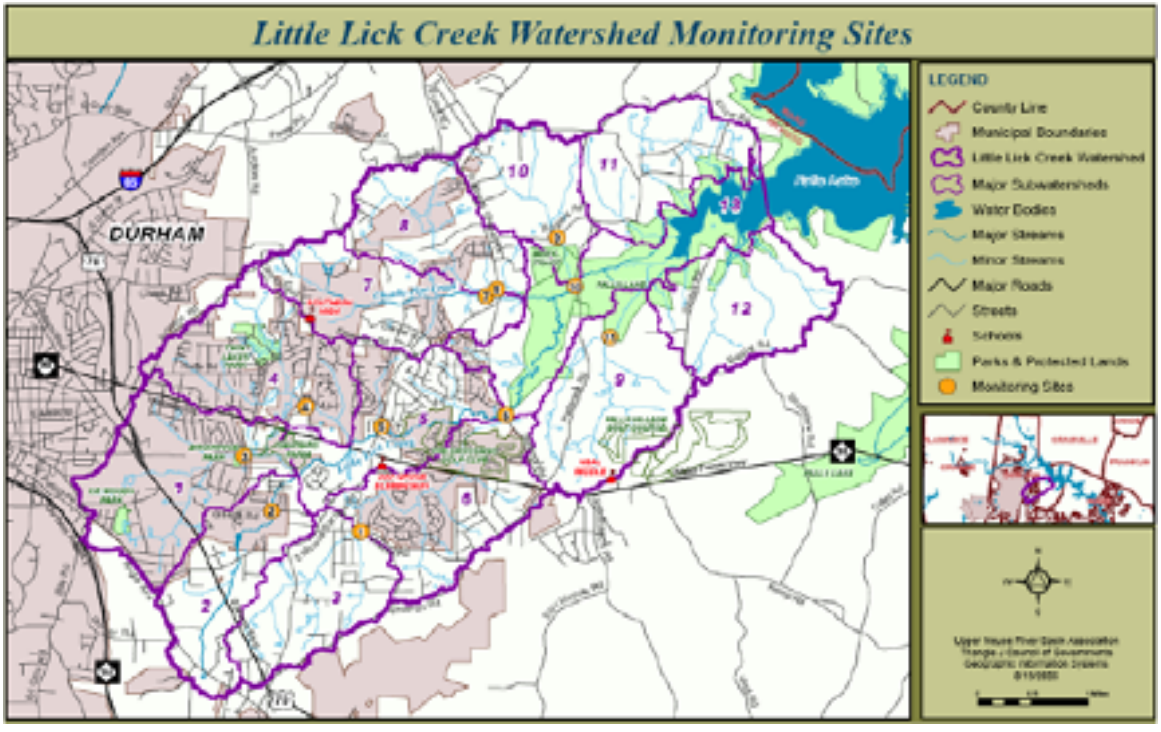

Figure 20: Sampling sites in the Little Lick Creek watershed

The watershed is experiencing a fast rate of growth, and the amount of urban development is expected to double in when the watershed is built to the extent allowable under current regulations. These facts pose significant questions that must be answered if we hope to successfully protect water quality and aquatic habitat. The most immediate questions are about the watershed's existing conditions. What is the cause of Little Lick Creek's impairment? Do the Triassic Basin geology and soils support levels of aquatic life that are distinct from other surrounding areas? If so, what is the Triassic Basin's "reference" condition for aquatic life?

Monitoring conducted during early 2005 provided NC DWQ and DSS with the following general observations about Little Lick Creek's conditions:

- Streams in the Little Lick Creek watershed may be prone to severe sediment impacts from development, especially where there are few or poor stormwater controls or where there are no riparian buffers;
- Little Lick Creek has poor aquatic life ratings; however, there have been observations of good aquatic life in relatively undeveloped tributary streams with rocky substrates; NC DWQ no longer provides ratings for benthic macroinvertebrates from streams in the Triassic basin since no reference condition from this geologic area have been found. One sampling site in the Little Lick Creek basin has aroused the interest of many benthic biologists since fauna uncommon to the Triassic basin were found there.
- Little Lick Creek's dissolved oxygen and aquatic life vary greatly with seasonal flow (have species in the Triassic Basin evolved to adapt to these conditions?);
- Very high results for ammonia collected during stormflow was observed in subwatershed 5 at Stallings Rd., and high specific conductance was recorded in subwatershed 3 (these are under investigation and may signal that wastewater is a problem in the upper watershed);.

The fact that Little Lick Creek is currently being planned for a doubling of overall impervious cover (development) over the current level raises important management questions. What will be the results, in terms of important water quality and habitat indicators, of this development? Can the recommended management strategies be enough to slow the course of degradation? Can management stabilize the stream's condition? Can management reduce the amount of nutrients, sediment, and other pollutants entering the stream and Falls Lake?

Monitoring and fieldwork conducted in early 2005 provide several observations regarding management:

- Stream reaches in Little Lick Creek with riparian buffers are more resistant to channel erosion than are streams with no buffers And because there are few areas of rocky substrate, streambank roots may be the only line of defense as flows associated with development increase;
- At the time of fieldwork and monitoring, field staff found a high number of instances where stormwater management and sediment and erosion control

devices were not working as planned, and DSS staff followed up with enforcement on many of these failures (see Rec. #7-Improved Enforcement);
- Very high levels of residues, turbidity, and concentrations of aluminum and iron were found in subwatershed 8, and these were likely caused by a large-scale failure (and violation) of sediment and erosion control practices;
- Some streams draining areas of steep slopes were experiencing massive erosion;
- Follow-up monitoring conducted by NC DWQ in December in subwatershed 3 may point to failing septic systems in the high specific conductance levels; and
- The level of watershed stewardship practiced by residents and small businesses appears to be low. High amounts of litter, dump sites, and unkempt outdoor storage areas at businesses are a few indicators (see Rec. #9, Adopt-a-Stream Programs).

Recommended short-term monitoring objectives

1. ***Establish a better understanding of baseline conditions in the Triassic Basin***—NC DWQ has discontinued benthic macroinvertebrate rating in Triassic Basin streams because of lack of a good reference site. Benthic macroinvertebrate monitoring in LLC subwatershed #9 suggest that reference conditions may exist in sites with rocky substrates and forested watersheds. It is strongly suggested that NC DWQ and DSS conduct additional biological and chemical monitoring at sites in this and other potential reference watersheds to establish a better understanding of "reference" conditions in the Triassic Basin. It is important that nutrients and other ambient monitoring be included in this study.

2. ***Find out the extent of wastewater pollution***—The Little Lick Creek watershed has an estimated 6,000 on-site wastewater treatment systems (UNRBA 2002) and more than 440 of these are sand filter-type systems. These systems may be contributing significant nutrients, fecal coliforms, and other pollutants to the system. These may pose a public health threat and may degrade water quality in the creek and in Falls Lake. Field observation of failing systems and stream sampling suggest that failure of septic systems in Little Lick Creek may be a significant problem. It is strongly suggested that NC DWQ and DSS conduct follow-up monitoring downstream of concentrated areas of septic systems. Because sand-filter systems are widely known to have high rates of failure and are permitted by the state, the relevant stakeholders should pursue a strategy for addressing the problem systems (see Rec. #4 Hot Spot Detection & Elimination). Such monitoring might include, but is not limited to, ammonia testing, specific conductance testing, and fecal coliforms analysis.

3. ***Conduct sediment toxicity studies in Little Lick Creek***—to protect aquatic life, it is important to understand how toxics may be affecting the aquatic life. Are toxics affecting the biological monitoring results that cause the impairment listing of Little Lick Creek?

4. ***Study important management questions***—If we are to innovate stormwater management, we must understand the potential management interventions on watersheds. Local, state, and other partners in Little Lick Creek should conduct

watershed studies to assess the benefits of such interventions as stormwater retrofits, stream restoration, and innovative management approaches such as Low-Impact Development. Such studies could be done at a catchment (less than 1 square-mile) scale and might include paired watershed, upstream-downstream, or before-after studies.

Long-term monitoring programs that are needed

1. ***Establish annual stream walks to gage the progression of in-stream erosion***— The Little Lick Creek partners and technical team have expressed unanimous support for the Unified Stream Assessment approach conducted in Little Lick Creek in February 2005. Field-based stream assessments are a crucial part of monitoring for understanding the management needs facing the creek. Since Little Lick Creek is in particular danger from hydrologic and erosion impacts, stream walks can include more detailed measurements and tracking of stream channel morphology.

Figure 21: Stream flow gages are crucial for monitoring water quality

2. ***Establish a long term flow gage in Little Lick Creek***—There are several reasons why Durham (and agency partners) should establish a stream flow gage in Little Lick Creek. One major reason is that understanding watershed-wide loading of nutrients and other pollutants depends upon accurate flow estimates. Understanding these loading rates will become ever more critical as the State of North Carolina develops a nutrient management strategy for Falls Lake (and likely sets nutrient management limits on new development in the creek). In addition, managing sediment in Little Lick Creek means managing hydrology, an

approach which will necessitate a more complete understanding of the watershed's hydrologic response to storm events.

3. ***Involve citizens***—It is clear that the current monitoring and oversight is not sufficient to answer any of the most important management questions facing the creek. In addition, there will never be sufficient City or County staff to effectively guard against the myriad of spills, violations, and other impacts that occur. The gap between monitoring needs and local resources will only get bigger. For that reason, we must depend upon well-trained and committed citizens to assist the City and County with a baseline level of oversight. Volunteer stream monitors can be effectively used to assist governments with basic oversight and enforcement (see Rec. #9, Adopt-a-Stream Programs).

4. ***Flow and nutrient loading to Falls Lake***. –NC DWQ is currently developing a nutrient management strategy for Falls Lake. This effort may lead to development of a Total Maximum Daily Load (TMDL). Either approach would trigger state and local regulations to limit the amount of nutrients (likely nitrogen and phosphorous) entering the lake. Along with the USGS flow gage recommended above (4), measuring the nutrient loading from Little Lick Creek will require nutrient sampling.

Basic Implementation Steps:

5. Durham City Stormwater Services and Durham County Engineering should follow-up on the short-term monitoring recommendations in this plan by doing the following:

    - Work with NC Division of Water Quality and NC State University's Water Quality Group to conduct additional biological and chemical monitoring at sites in this and other potential reference watersheds to establish a better understanding of "reference" conditions in the Triassic Basin;

    - Conduct sediment toxicity studies in Little Lick Creek to help determine baseline conditions for aquatic life in the watershed; and

    - Conduct follow-up monitoring downstream of concentrated areas of septic systems, and conduct meetings with stakeholders to decide upon a course of action for addressing the suspected high number of failing systems in Little Lick Creek (see Recommendation #6, Improved Enforcement of Existing Rules). It may be impossible to determine the true baseline conditions for aquatic life before addressing sewage spills in the watershed.

6. Conduct regular stream walks in Little Lick Creek to update the assessment conducted for this project.

7. Establish a long-term stream gage and nutrient monitoring sites in the Little Lick Creek watershed. This gage will be necessary for understanding the watershed's

hydrology, and both the gage and nutrient monitoring are essential for modeling pollutant loading to Falls Lake.

8. Establish voluntary Adopt-a-Stream groups to assist Durham Stormwater Services with oversight of water quality regulations (see Recommendation #8, Adopt-a-Stream Programs).

Costs:

- Additional staff time conducting annual stream walks, conducting additional monitoring, training volunteer monitors, and keeping track of monitoring data.

- Additional equipment, including USGS stream flow gage and equipment for volunteer monitors to measure specified water quality parameters, e.g. turbidity and ammonia.

Funding Opportunities:

- Stormwater utility fees
- Water utility fees
- Grants (EPA Section 319 grant, for example)

Potential Pitfalls

Coordination, communication and staffing organization between Durham City and County must operate at a high level for many of these recommendations to occur. Durham City and County should consider establishing protocols for communication and oversight, especially when monitoring involves enforcement of water quality regulations.

.

IV. Conclusions

The nine Little Lick Creek watershed management strategies recommended in this technical memorandum comprise a comprehensive approach to restoring water quality and aquatic habitat in the 21 square-mile Little Lick Creek Watershed. Although any single set of recommendations will have positive effects on its own, each addresses a unique management need.

The Little Lick Creek watershed management strategies were developed as a part of the NC Ecosystem Enhancement Program (NC EEP)-funded Little Lick Creek Local Watershed Plan. The management strategies are the culmination of 14 months of watershed analysis, fieldwork, planning, and prioritization by watershed stakeholders. A technical team of project stakeholders met 10 times over this period to guide the Upper Nuese River Basin Association, the Center for Watershed Protection, the Triangle J Council of Governments, and other project partners in completing project tasks. The effort is described in detail on the project website, www.unrba.org/littlelick.

General Conclusions

The Little Lick Creek Technical Team and Project Partners present the following general watershed management conclusions.

- Little Lick Creek is currently impaired due to its inability to support sufficient levels of aquatic life and its low levels of dissolved oxygen.
- We must better understand the baseline watershed conditions in Triassic Basin streams, particularly aquatic life, dissolved oxygen, hydrology, and sediment transport. NC Division of Water Quality does not rate Triassic Basin streams based on aquatic life and other key water quality indicators, yet the Draft 2006 303(d) List of Impaired Streams lists Little Lick Creek based on aquatic life and low dissolved oxygen. Clearly, the NC DWQ and local governments should partner to conduct further monitoring that will allow NC DWQ to consistently rate Triassic Basin streams.
- The state is developing a nutrient management strategy for the Lake, which is nutrient sensitive and may be impaired. A nutrient management strategy will require polluters to reduce the amount of nutrients (nitrogen and phosphorous) entering the lake. New development will face increasing pressures to reduce impacts, and communities in the Falls Lake Basin will be forced to find ways to reduce pollutant loads.
- The Triassic Basin soils that comprise the Little Lick Creek watershed are almost devoid of rocky material, with the exception of a few metamorphic Diabase intrusions. Instream erosion caused by hydrologic changes from urban development is, by far, the greatest source of sediment in the stream.
- One of the greatest potential water quality threats in the watershed is failing septic systems and sewer spills. It will be necessary to remove this threat to water quality from Little Lick Creek before we can hope to restore aquatic life and water quality to the watershed. In particular, the creek has the greatest density of sand-filter type systems in the entire Upper Neuse Basin. Sand filter-type systems

exhibit high rates of failure. Unlike other septic systems, the failures can go unnoticed for long periods of time because they discharge the raw, untreated sewage directly into streams. Even properly functioning sand filter systems export high concentrations of nutrients to streams, contributing to algae growth and low levels of dissolved oxygen.

- This planning effort reveals the need for significant additional management needs in Little Lick Creek. Since Little Lick Creek occupies only a small portion of Durham City and County, staff members are not able to spend the time sufficient for the necessary management and oversight. Durham City's stormwater fees are among the lowest in the region.

Watershed Restoration Conclusions

The following list summarizes the major conclusions identified in Recommendations 1-3, the Watershed Restoration Strategies. Restoring water quality and aquatic habitat conditions within the Little Lick Creek Watershed is complicated by several factors such as lack of understanding of baseline stream conditions, sewer and septic impacts, utilities, and rapid urban development. The great majority of restoration and retrofit opportunities lie in subwatersheds 1-5. 18 (of 24) stream repair opportunities, 18 (of 24) buffer restoration opportunities, and 48 (of 71) retrofit opportunities are in this upper 1/3 of the watershed. Watershed-wide, restoration projects must be part of a comprehensive approach toward restoring water quality and aquatic habitat.

Recommendation #1: Stream Repair Projects recommends various repair projects, many of which meet NC EEP minimum criteria. The major benefits of stream repair are improved in-stream hydrology and reduction of sediments, which can improve aquatic habitat and raise dissolved oxygen levels.

Recommendation #2: Riparian Buffer Restoration identifies 24 restoration opportunities. Durham City and County have relatively strong buffer protections. However, areas built or subdivided before the current regulations need protection. Buffer restoration projects will provide great benefits for reducing erosion, regulating water temperature, and providing habitat. Streams with riparian buffers support significantly more diverse aquatic life that those with unbuffered riparian areas.

Recommendation #3: Stormwater Retrofit Projects identifies 71 retrofit opportunities in the watershed. These projects can help the City and County reduce the levels of nutrients like nitrogen and phosphorous entering the stream. The environmental benefits of these projects are localized; however, the watershed-wide educational benefits of a few major projects could be great.

Preventing Future Degradation Conclusions

The following list summarizes the major conclusions identified in Recommendations 4-6, the management strategies for preventing future watershed degradation. The major prediction of the planning effort is that current levels of impervious cover are expected to

more than double (from 11% to 23%). Restoring Little Lick Creek will require strong approaches for preventing impacts from future land use changes.

Recommendation #4: Critical Lands recommends several areas where protecting lands will have high water quality and aquatic habitat benefits. Many of these tracts are on large, streamside parcels. Enforcing the floodplains protection and buffer ordinances will be the greatest single step toward protecting the most important lands. Durham's ordinance restricting development on slopes greater than 25% are not effective in the Little Lick Creek Watershed, where urbanization of lower gradient slopes causes water quality impacts.

Recommendation #5: Better Site Design recommends a strong hydrology performance standard approach toward reducing impacts from new urban development. If this approach is not feasible, several detailed alternative approaches are offered.

Recommendation #6: Improved Enforcement of Existing Rules suggests several approaches for improving oversight of sediment and erosion control, stormwater management practices, buffer regulations, littering, and sewer and wastewater discharges. The City and County have excellent programs in place for enforcement, but additional resources are needed to ensure the effectiveness of these programs.

Stewardship Conclusions

The following list summarizes the major conclusions identified in Recommendations 7-9, the management strategies for strengthening watershed stewardship. Increasing protection of the Little Lick Creek Watershed will depend upon strong stewardship. The current level of stewardship practices such as outreach, education, citizen involvement, and stream monitoring will not be sufficient to prevent diffuse sources of pollution to Little Lick Creek. The general level of public awareness of the creek must increase, and the efforts will not be effective without the active participation of watershed residents and business owners.

Recommendation #7: Watershed Outreach and Education recommends that the City of Durham's excellent stormwater education program provide targeted education for landowners with the goals of protecting more backyard riparian buffers, maintaining on-site wastewater treatment systems, preventing commercially-related water pollution, and implementing restoration and stormwater retrofit projects.

Recommendation #8: Adopt-a-Stream Programs suggests that citizens throughout the watershed can work together through the City's Adopt-a-Stream program to take active responsibility for the well-being of the creek. Adopt-a-Stream programs should be more central to the City's (and State's) regulatory monitoring.

Recommendation #9: Water Quality Monitoring suggests several short and long-term objectives for improving monitoring of watershed conditions. In order to protect the creek, we must develop a deeper understanding of baseline conditions, the creek's

hydrologic response to development, and of the pollutants entering the creek. This level of understanding can only be accomplished through increased monitoring. This monitoring must come from both government (City and County) and watershed citizens.

V Reference:

Center for Watershed Protection (2004). "An Integrated Framework to Restore Small Urban Watersheds." Version 1.0. Volume 1 of the *Urban Subwatershed Restoration Manual Series*. March. Available at www.cwp.org.

Center for Watershed Protection (2004b). "Urban Stream Repair Practices." Version 1.0. Volume 4 of the *Urban Subwatershed Restoration Manual Series*. November. Available at www.cwp.org.

Durham Stormwater Services (2005). The City of Durham's Adopt-a-Stream Program brochure, instructions, and proposal for stream adoption (available by contacting Laura Webb Smith at (919) 560-4326 or laura.smith@durhamnc.gov).

Hoyt, Sally (2005). Memorandum: Summary of Field Work Activities in Little Lick Creek-January 2005. Memorandum from Sally Hoyt, of Center for Watershed Protection, to the UNRBA. March 10.

Hoyt, Sally (2005b). Memorandum: Little Lick Creek-Watershed Treatment Model. Memorandum from Sally Hoyt of the Center for Watershed Protection. June 15.

Hoyt, Sally and Jennifer Tomlinson (2005). Memorandum: Summary of Field Work Activities in Little Lick Creek-March 2005. Memorandum from Sally Hoyt and Jennifer Tomlinson, of the Center for Watershed Protection, to the UNRBA. April 29.

Hunt, William F. III (2005). "Urban Waterways: Urban Stormwater Structural Best Management Practices." Available at http://www.bae.ncsu.edu./people/faculty/hunt/ag588-15.pdf

McNaught, David, Joseph Rudek and Elizabeth Spalt (2003). *Riparian Buffers: Common Sense Protection of North Carolina's Water*. A report produced by Environmental Defense that reviews the literature on riparian buffers and recommends basic protection strategies.

Prince Georges County, Maryland Department of Environmental Resource Programs and Planning Division 1999. *Low-Impact Development: An Integrated Design Approach*. June.

Tetra Tech (2003). *Upper Neuse Watershed Management Plan.* May. Available on UNRBA website: www.unrba.org

UNRBA (2002). "Issue Brief: Management of On-Site Wastewater Disposal Systems." A technical memo produced by the Upper Neuse River Basin Association.

Upper Neuse River Basin Association (2005a). "Revised Little Lick Creek Local Watershed Plan Technical Memorandum #1—Initial watershed characterization, existing water quality data, stakeholder process and project goals." Technical memorandum to NC Ecosystem Enhancement Program. February. Available on www.unrba.org/littlelick

Upper Neuse River Basin Association (2005b). "Little Lick Creek Technical Memorandum #4—Priorities for watershed restoration in Little Lick Creek" Technical memorandum to NC Ecosystem Enhancement Program. December. Available at www.unrba.org/littlelick

Upper Neuse River Basin Association (2005c). *Little River Riparian Corridor Conservation Plan* (plan being conducted by the Upper Neuse River Basin Association for the Eno River Association, October, 2005).