Memorandum

Date: June 7, 2007

To: Chris Dreps
Upper Neuse River Basin Association

From: Sally Hoyt and Anne Kitchell
Center for Watershed Protection

Re: Lick Creek Fieldwork – Findings and Recommendations

CENTER FOR WATERSHED PROTECTION
8390 Main Street, 2nd Floor
Ellicott City, MD 21043
410.461.8323
FAX 410.461.8324
www.cwp.org
www.stormwatercenter.net

1.0 Introduction

The purpose of this memo is to document field findings and recommendations derived from stream and upland assessments conducted by the Center for Watershed Protection (CWP), Upper Neuse River Basin Association (UNRBA), City of Durham Stormwater Services Water Quality and Plan Review, Durham County Stormwater and Erosion Control Division, and the NC Ecosystem Enhancement Program in the Lick Creek Watershed the week of February 26 -March 7, 2007. The goal of these field assessments was to evaluate conditions and restoration activities in the stream corridor (Subtask 2.1), and to identify potential stormwater pollution prevention and retrofit opportunities (Subtask 2.2) as part of the Lick Creek Watershed Restoration Plan.

Planning efforts were prompted by the biological impairment status of Lick Creek, and potential nutrient concerns associated with downstream Falls Lake, a drinking water reservoir for Raleigh, NC. The causes of impairment to aquatic life and the sources of nutrients in Lick Creek were not specifically identified, however poor water quality, high sediment loads, and the lack of stable habitat are all common factors that can contribute to biological impairment. In-stream habitat is influenced by natural stream geomorphology and bed material composition; availability of large woody debris and leaf packs, and disruption by the increased stormwater discharge due to urbanization. Typical sources of nutrient loads can include cropland, highly fertilized turf and lawns, wastewater treatment plants, leaking sewers and septic systems, and animal waste. The Lick Creek Initial Watershed Characterization Memo (Dreps, 2007) provides additional information on the watershed and its impairment status.

This memo describes the methods used to more accurately identify the causes of impairment and pollution sources in the Lick Creek watershed (Section 2), presents findings and preliminary management recommendations based on field observations (Section 3), and provides a brief characterization of each subwatershed (Section 4). Attached are tables summarizing all the restoration, enforcement, and protection opportunities identified in the field (Attachment A), as well as subwatershed maps

depicting their locations (Attachment B). An example subwatershed management strategy is also included as a framework for subsequent development of the Lick Creek Watershed Restoration Plan (Attachment C).

2.0 Stream Corridor and Upland Assessment Methods

Teams consisting of CWP, UNRBA, City of Durham Stormwater Services Water Quality and Plan Review, Durham County Stormwater and Erosion Control Division, and the NC Ecosystem Enhancement Program conducted stream and upland assessments in the Lick Creek Watershed the week of February 26 -March 2, 2007. Table 1 lists participants in each assessment team. Pollution sources and threats to aquatic habitat in the Lick Creek watershed were identified using the Unified Stream Assessment (Kitchell and Schuler, 2004), the Unified Subwatershed and Site Reconnaissance (Wright *et al*., 2004), and a stormwater retrofit inventory. These methods focus on identifying potential restoration projects (i.e. stormwater retrofits, stream stabilization, buffer plantings, trash cleanup, polluted discharge prevention). In total, 29 miles of stream corridor, all commercial areas, all suburban residential areas, all active construction sites, existing stormwater management practices, and the proposed stream restoration site at Olive Branch Rd. were assessed. Every subwatershed was visited.

Prior to fieldwork CWP prioritized subwatersheds for the stream corridor assessment, beginning with those with the most urbanized areas and the most agriculture. A representative sample of other reaches was assessed. In-stream reconnaissance used CWP's Unified Stream Assessment method to identify outfall locations (32 outfalls evaluated), severely eroded stream banks (8), utility crossings (7), impacted riparian buffers (27), trash dumping (9), stream crossings (16), channel modifications (1), and other miscellaneous impacts (31) within the stream corridor. The reach assessment was used to document conditions in impacted reaches, identify good quality reaches, and numerically rate 78 reaches based on the physical in-stream and riparian corridor conditions. Another 15 reaches were walked but not numerically scored.

Thirteen hotspots were identified using GIS prior to the fieldwork. Field reconnaissance at 16 potential stormwater hotspots (e.g., gas stations, commercial areas) included evaluation of vehicle operations, outdoor materials, waste management, physical plant, landscaped areas, and stormwater infrastructure. Each hotspot was rated on the likelihood that current site practices are causing stormwater runoff contamination. Five sites are confirmed stormwater hotspots; five sites are potential stormwater hotspots. Appropriate follow-up actions were suggested for each hotspot.

Twenty-eight potential retrofit sites were identified during desktop analysis. This included potential storage and on-site retrofits. After evaluation, only three sites were considered feasible. Two of these sites, with drainage areas of six and nine acres, are potential pocket wetlands downstream of highway outfalls. The third site would provide stormwater treatment for a 1.5 acre parking lot.

The results of the field assessment are reported by the type of follow-up action recommended: enforcement, repair, protection, major and minor restoration project, and targeted education. The specific sites for these actions are listed in the tables in Appendix A and located on maps in Appendix B. Sites where impacts were observed, but were subsequently confirmed as permitted are grouped as "approved" impacts. Also, the locations of in-stream diabase sills and riffle structures were also recorded.

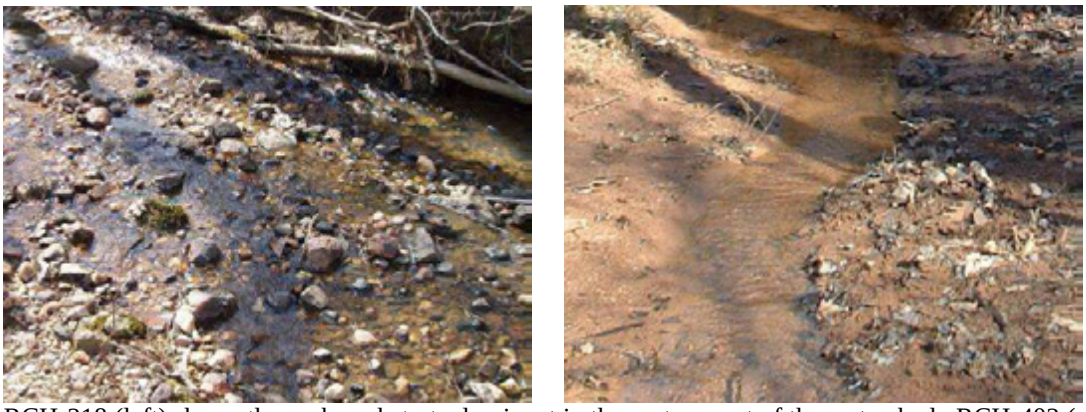
Table 1. Lick Creek Field Assessment Teams

Subshed	Date	Team	Assessment
1	Mon, February 26	Sally Hoyt, Chris Dreps, Bobby Louque, Brandon Culberson	Stream Corridor
	Tues, February 27	Sally Hoyt, Sarah Bruce	Hotspots
	Tues, February 27	Anne Kitchell, Rebecca Ferres, Chris Outlaw	Stream Corridor
	Wed, February 28	Anne Kitchell, Sarah Bruce, Rebecca Ferres, Chris Outlaw	
	Wed, February 28	Sally Hoyt, Raghu Badami, Dave Brown, Jake Chandler, Sandi Wilbur	Retrofits
2	Mon, February 26	Anne Kitchell, Joe Albiston, Chris Outlaw, Kathy	Stream Corridor
	Tues, February 27	Sally Hoyt, Sarah Bruce	Hotspots
	Wed, February 28	Sally Hoyt, Raghu Badami, Dave Brown, Jake Chandler, Sandi Wilbur	Retrofits
	Wed, February 28	Anne Kitchell, Sarah Bruce, Rebecca Ferres, Chris Outlaw	Stream Corridor
	Thu, March 1	Sally Hoyt, Jon Baker, Brandon Culberson	
3	Wed, February 28	Anne Kitchell, Sarah Bruce, Rebecca Ferres, Chris Outlaw	
	Fri, March 2	Sally Hoyt, Julie Tasillo	
	Thu, March 1	Anne Kitchell, Sarah Bruce	
4	Thu, March 1	Anne Kitchell, Sarah Bruce	
	Fri, March 2	Anne Kitchell	
5	Wed, February 28	Bobby Louque, Brandon Culberson	
6	Wed, February 28	Chris Dreps, Bill Haley, Mike Hermann	
	Thu, March 1	Sally Hoyt, Jon Baker, Brandon Culberson	
7	Tues, February 27	Julie Tasillo, Joe Albiston, Michele Droszcz, Bobby Louque	
	Wed, February 28	Julie Tasillo, Jon Baker	
	Thu, March 1	Julie Tasillo, Bill Haley	
8	Mon, February 26	Julie Tasillo, Sarah Bruce, Rebecca Ferres	
	Tues, February 27	Julie Tasillo, Joe Albiston, Michele Droszcz, Bobby Louque	
	Wed, February 28	Julie Tasillo, Jon Baker	
9	Thu, March 1	Julie Tasillo, Bill Haley	
	Thu, March 1	Sally Hoyt, Jon Baker	
10	Tues, February 27	Chris Dreps, Brandon Culberson	
11	Wed, February 28	Chris Dreps, Bill Haley, Mike Hermann	

3.0 Overall Stream Conditions

Lick Creek falls in the transition zone from the Triassic Basin to the Slate Belt geology. Subwatersheds 1, 3, 4, 5, 6, 9, and 11 reflect Triassic conditions and are similar to those in the Little Lick watershed to the west. However, the Lick Creek streams have more frequent diabase sills which create riffles not found in the dominant clay-bottomed streams of Little Lick Creek. The bed material in Laurel Creek (subwatersheds 8 and 10)

and Rocky Branch (subwatershed 7) is significantly different from Lick Creek's other subwatersheds.



RCH-218 (left) shows the rocky substrate dominant in the eastern part of the watershed. RCH-402 (right) shows bed material in a relatively un-impacted Triassic Basin stream.

A considerable portion of the perennial stream channels in Lick Creek are entrenched (disconnected from floodplain), show evidence of historic widening, are dominated by sediment bed load transport, and have little to no stable in-stream habitat structure (i.e. large woody debris, riffles, leaf packs). Many of these features are characteristic of the Triassic Basin and likely reflect stream adjustments to historic clear cutting and agricultural land use. With the exception of a few areas in larger second or third order streams, most stream banks looked relatively stable (have moss growing on them), rather than showing evidence of active erosion. For example, RCH-302 pictured below, demonstrates historic downcutting and floodplain disconnection but stabilized banks with a moss-coating.

Historic impacts resulting in channelization in RCH-302 (left) and RCH-301 (right).

Triassic Basin streams are highly erosive and susceptible to minor increases in stormwater runoff volume. Experience in the Little Lick Creek Watershed has shown that the easily erodible soils will experience bank erosion at a low threshold of hydrologic change. In fact, some of the most degraded reaches observed in Lick Creek were associated with uncontrolled runoff from existing developments (e.g. ER-100 downstream of the Foxridge Apartments) and below active construction projects (e.g.

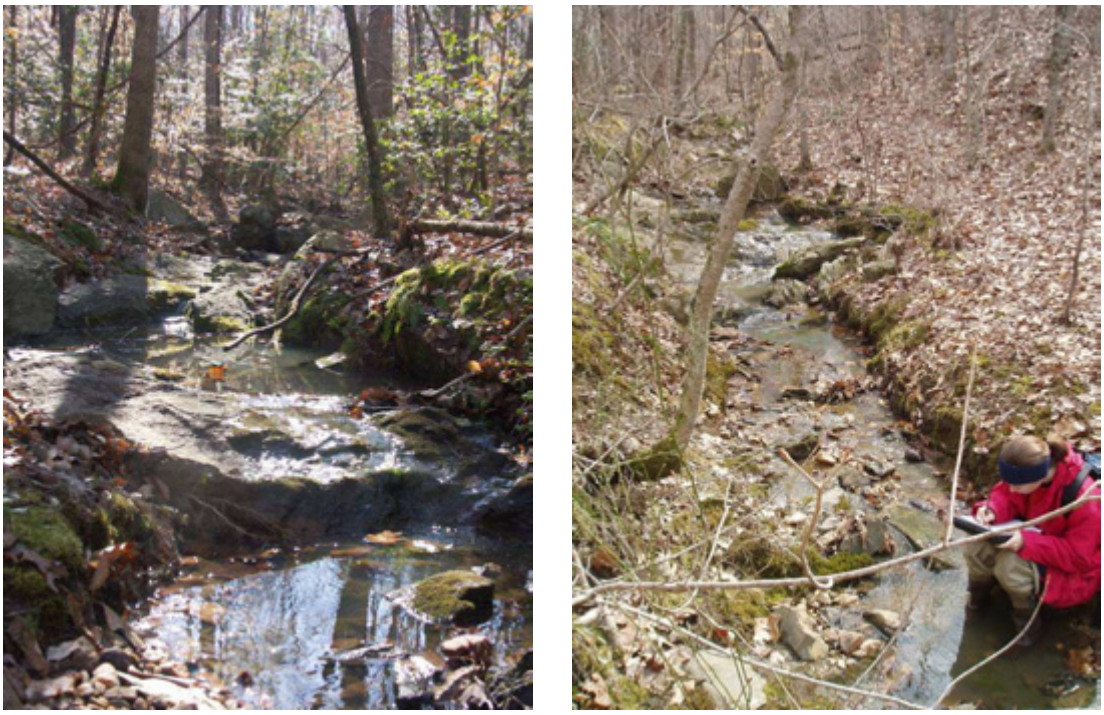
ER-110 headcut in Brightleaf and RCH-120 below Ravenstone). Since most of the watershed falls within the Durham Growth Boundary, streams that are relatively stable now are at risk from impending development.

RCH-402 Before the power lines the stream is un-impacted (left). After passing through the power line easement (middle), the stream shows rapid downcutting (right). This illustrates the impact of a small land cover change from forest to meadow.

The physical in-stream and riparian corridor condition ratings were used to categorize the streams as Optimal, Sub-Optimal, Marginal, or Poor. The numerical ratings are summarized below and can be found in *Table A-99: Stream Reaches.*

- 5 optimal-condition reaches scored in the highest category for every measure of in-streams and riparian quality. These included: RCH-206, 207, 208, 506, and 507. It is notable that all of these streams are located in the Laurel Creek subwatersheds (8 and 10). Due to the Slate Belt geology, these streams were less susceptible to historic bank erosion and downcutting as the Triassic streams.
- 49 suboptimal-condition reaches are have primarily stable geomorphic conditions and forested buffers. These reaches may have historic or isolated impacts.
- 23 marginal-condition reaches are located adjacent to and downstream of development in the Route 70 corridor, recent timber harvesting sites, and the active construction sites (Brightleaf, Brightwood Trails, Ravenstone, and smaller sites in Wake County).
- 1 poor-condition reach is located at the Kingsmill Dairy.

The current biological impairment status of Lick Creek is based on monitoring of one site in Lick Creek's Triassic Basin area. The aquatic biology at this site was compared to indices established form non-Triassic Basin streams, which tend to have more in-stream habitat structure that support a more diverse macro-invertebrate community. No biological reference or standard has been established in the Triassic Basin. This field work further supports the recommendation of other project partners that an alternate index is needed to evaluate Triassic Basin streams.


RCH-506 (left) and RCH-206 (right) Optimal reaches in Laurel Creek.

4.0 Findings and Recommendations

The purpose of the field assessment efforts was to identify and document specific sources of pollutant loading and causes of biological impairment, as well as to identify restoration activities to help address these issues. Based on field observations, however, it is likely that the biological impairment status is more likely attributed to the highly erosive geological characteristic of the Triassic Basin and historic impacts from agricultural uses, rather than to extensive water quality and hydrologic changes commonly associated with urbanization. Very few restoration opportunities were found along the stream corridor (i.e. streambank stabilization, riparian buffer planting) or in the uplands (i.e. retrofits, pollution prevention). Conversely, extensive impacts to streams and wetlands from active construction activities were observed. Given the imminence of future development in the watershed, the susceptibility of Triassic soils and stream channels to erosion, and the downstream drinking water supply in Falls Lake, we believe the focus of the Lick Creek Restoration Plan should be to minimize future impacts and to preserve high quality areas. A few restoration activities will complement the overall "prevention" strategy

As a result, the most promising management strategy for the watershed will likely involve actions to minimize impacts from active construction, protect sensitive areas from future development, and implement both major and minor restoration projects in existing urban, agriculture, and silviculture areas.

The following discussion of findings provides support for preliminary watershed recommendations, as well as a list of follow-up actions. These findings are not ranked in

order of importance. More information on specific sites referenced in the discussion can be found in the tables in Attachment A and can be located on maps provided in Attachment B.

The findings contain a general description, specific examples, recommendations for immediate action by UNRBA, recommendations for future action that are proposed for inclusion in watershed plan, and a list of information needed to support recommendations in watershed plan. The "recommendations for immediate action by UNRBA" are steps that should be initiated immediately, prior to the completion of the watershed plan.

The findings reference the tables in Appendix A. These tables are divided by project type to allow them to be passed to project partners or other agencies interested in specific types of projects. The tables contain an initial project ranking of high, medium, or low. These rankings are based on the professional judgment of the field team leaders. They are used to provide an immediate, relative look at the most needed actions.

1. Inadequate erosion and sediment control at construction sites—Extensive erosion and sediment control violations were observed at active construction sites including both single family home sites to the largest developments in the watershed. At two major developments in Subwatershed 1 – Brightleaf and Brightwood Trails –compliance with approved erosion and sediment control plans was particularly poor, resulting in visible sediment deposition in nearby wetlands, lakes, and streams. Many of these sediment laden discharges can be attributed to lack of maintenance on structural S&E practices. The sites with failed sediment and erosion control in Durham County were visited by inspection staff and issued notices of violation (NOVs). Clean-up work to remove sediment from impacted wetlands, as well as repairs to S&E practices has reportedly begun since field assessments.

Specific sites for follow-up enforcement are listed in Appendix A, *Table A-2: Enforcement*. Some examples of common violations include:

- Sediment deposition in Snappy's Lake and wetland complex in Brightleaf due to failing or inadequate sediment control practices.
- Silt fences filled to the top with sediment (e.g. MI-309, OT-120, MI-307); breached or with gaps (e.g. MI-311, OT-120); and placed across stream channels (e.g. ER-111, SC-111).
- Poor inlet protection and excessive buildup of sediment on roads (e.g. near IB-110).
- Sediment ponds lacking storage volume because they are full of sediment (e.g. MI-205).
- No posting of copies of the approved S&E plans on site.

Recommendations for Immediate Action by UNRBA:

- Determine status of Wake County S&E violations.
- Follow-up with water quality sampling results at Snappy's Lake.
- Work with County/Brightleaf to provide additional S&E control for direct outfalls into Snappy's Lake (OT-112).

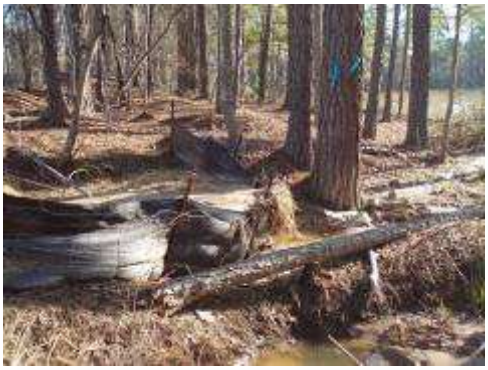
- Contact Audubon International regarding requirements for a signature site. Notify this group of the violations at Brightleaf.

Recommendations for Future Action (proposed for inclusion in Watershed Plan):

- Increase inspection frequency of active construction sites in Durham County. Sites are currently visited once per month.
- Raise fees for S&E permits in Durham County to support increased inspection frequency.
- Formalize coordination between Durham County and City of Durham regarding site stabilization approval prior to approval of stormwater ponds and storm drains.

Information needed to support recommendations in Watershed Plan:

- Compare number of construction sites to the number of construction sites with violations as a measure of how widespread the lack of compliance is.
- Emphasize the amount of current construction and the average annual amount of construction until build-out. These figures were calculated as part of the WTM.

MI-309 (left) Silt fence at bottom of slope is adjacent to stream and wetland and filled to brim with sediment. OT-120 (right) Bulging silt fence at edge of Snappy's Lake.


MI-205 (left) Filled sediment basin lacks functional storage. Near IB-110 (right) Un-maintained inlet protection.

2. Uncontrolled sediment discharges from "agricultural" sites —Field crews observed turbid flows in streams draining from properties with large areas of exposed soil that are zoned agriculture and are not required to have grading permits from the County. While similar discharges from residential, commercial, and industrial development sites are regulated, these properties claim an "agricultural" exemption from Durham County

erosion and sediment control regulations though their current use does not include row crops or pastures. Instead, at least two of these properties are part of the land development industry, as they receive material from cleared sites or trade in fill dirt. Durham County officials have no regulatory authority to require S&E at these sites regardless of frequent sediment discharges from the site or chronic downstream water quality complaints. The sites are subject to State water quality regulations; however, the NC DWQ has not exercised regulatory authority here.

Five sites specifically identified include:

- Kingsmill Dairy. Active construction including roads, culverts, and buffer clearing was observed at the Kingsmill Dairy site. No erosion and sediment controls were present and all riparian vegetation was removed in some stretches (IB-210). Significant sediment deposition was observed downstream of this site, a finding that correlates with the downstream turbidity readings that are consistently the highest among City of Durham monitoring sites. Downstream neighbors complain of the sediment influx and the higher storm flow discharges. This bovine R&D facility has also constructed several buildings in recent years, indicating that the lack of erosion controls may be a long-term impact.
- A receiving site for fill dirt and debris from clearing and grubbing is located off Coley Rd (MI-208). Approximately 20 acres of a 65 acre parcel are part of the landfill operation. The owner, Allan Currin, indicated that an intermittent stream on site is going to be filled for future expansion. Currin Brothers also own 90 acres further south on Coley Road, which includes a closed landfill approximately 15 acres in size.
- Fill dirt is received, stockpiled, and sold at a private property located at 4627 Leesville Road. Several acres of soil are exposed and stockpiles have steep slopes in excess of technical guidelines. This site has reportedly lacked temporary stabilization for at least three years. This site was identified as source of turbid flow observed near the Amish Barn along Hwy 70.
- A property off Virgil Rd (MI-201) appears to be a large concrete block casting site, though it is not identified as an industrial operation. The site has ineffective sediment traps where site runoff which includes fines from aggregate is discharged to the stream.
- A site (SC-209) that appears to receive excavated dirt and debris from clearing and grubbing is located at 6103 Kemp Road.

These sites are listed in Appendix A *Table A-2: Enforcement*.

Recommendations for Immediate Action by UNRBA:

- Report these five sites described above to DENR DWQ for illicit discharge of sediment from exposed soils.
- Continue to document downstream turbidity after rain events. This could include asking residents downstream of the sites to photograph and record details.
- Obtain permit issued by Corps to Allan Currin for the Coley Road landfill site.

Recommendations for Future Action (proposed for inclusion in Watershed Plan):

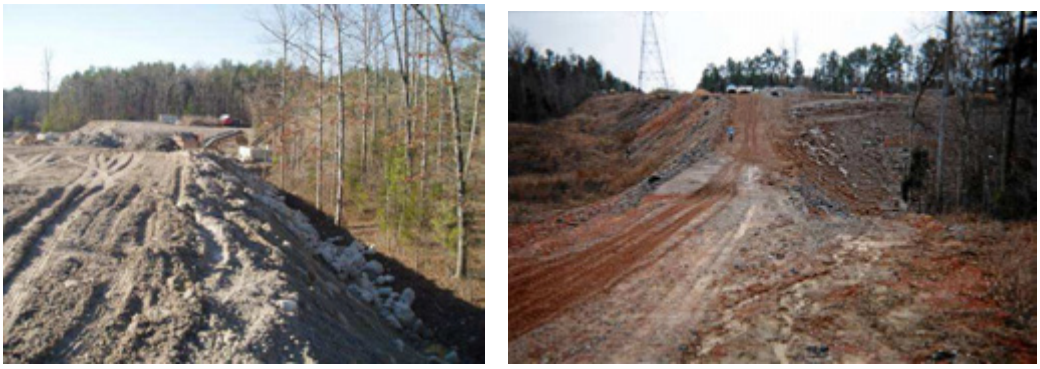
- DWQ should also investigate how the regulations can be clarified to continue to exempt the target farming operations while disallowing these abuses of the exemption.
- SWCD should offer landowners technical assistance on effective sediment and erosion controls.
- UNRBA and Durham County should educate citizens about the procedure for reporting these sites.

Information needed to support recommendations in Watershed Plan:

- Contact DWQ regarding the enforcement of Neuse rules pertaining to agriculture. The Neuse rules are applied to agriculture on a County-by-County basis. If there were exemptions created due to the relatively small amount of agriculture in Durham County, these exemptions could be revisited.

IB-210 Cleared buffer and road construction lacking S&E controls at Kingsmill Dairy.

MI-208 Coley Road land-filling operation.



MI-201 (left) Concrete block maker. SC-209 (right) Dirt and debris receiving site.

3. Water quality requirement for post-construction stormwater management— Local and state regulations do not require new developments with less than 23% impervious cover to design post-construction stormwater controls to treat water quality. New developments such as Brightleaf and Brightwood Trails have only 1-year detention dry ponds for post-construction stormwater treatment. Extensive research from shows that water quality, hydrology, physical stream quality, and biological integrity all begin to show signs of degradation around 10% impervious cover (CWP, 2003). The new developments in Lick Creek are designed to be just under the impervious cover threshold at which Neuse rules require water quality treatment.

In addition, current stormwater requirements give no incentive to use environmentally sensitive site and stormwater design (aka better site design or low impact development) that minimize impervious cover and use trees and un-compacted pervious to maintain a predevelopment hydrologic regime. Even Brightleaf, "Triangle's Environmental Community", has used a typical subdivision design that is not oriented towards reducing unneeded impervious surfaces, preserving natural channels, etc. In developments in the Lick Creek watershed, the 1-year detention requirements have been met with numerous small ponds. These ponds are unimaginative in their use of space within the site and are impacting streams and stream buffers, such as the ones placed at the back in Brightleaf (e.g. MI-301. See Appendix A, *Table A-1: Approved Impacts*). Innovative site designs that incorporate stormwater management into roadway right-of-ways or site designs that minimize the total runoff will result in less buffer encroachment and stream impact from stormwater treatment facilities.

The current rate-control-only stormwater practices are approved with the knowledge that the municipality will in the future return to retrofit the facilities to provide water quality treatment. The need to retrofit is driven by existing Neuse rules, the MS4 NPDES program, official impairment designations of streams such as Lick Creek, and the possible future impairment designation and TMDL for Falls Lake. Water quality trends and modeling show that the current program will not prevent degradation of Falls Lake. The cost of the future water quality retrofits that may be required to meet a Falls Lake TMDL will be bourn by taxpayers as retrofits becoming part of the City budget or as they are funded via state and federal grants. The opportunity to have the cost bourn by developers and homebuyers is missed when water quality concerns are not considered at the time of new development.

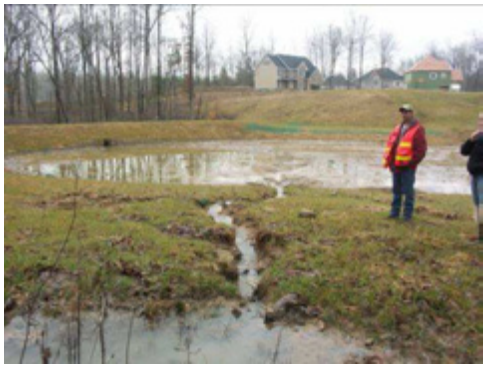
Recommendations for Future Action (proposed for inclusion in Watershed Plan):

- In order to meet overall water quality goals of Falls Lake and the larger Neuse River Basin, we recommend post-construction water quality treatment be required for all new developments.
- In addition to the 1-year detention requirement, which provides some channel protection storage, discharge volume criteria should be considered. A performance criteria which limits the increase in volume, rather than peak discharge, could spur the use of environmentally sensitive design (LID/BSD).

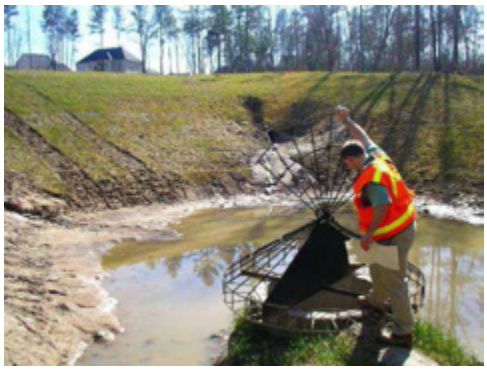
- Increase nutrient offset fee to push the economic incentive towards providing stormwater management rather than paying a nitrogen offset fee.

Information needed to support recommendations in Watershed Plan:

- Review permit conditions in the new City of Durham MS4 NPDES permit.
- Review findings from most recent study on nitrogen offset fees.
- Review the criteria used to designate a "Conservation Subdivision" and discuss with City-County Planning whether changes are needed to the criteria.




MI-301 (left) This approved in-stream pond at Brightleaf destroyed a natural stream and buffer. MI-303 (right) This pond in Brightleaf demonstrates the typical unimaginative site layout and short flow path. MI-303 is recommended for a retrofit to lengthen the flow path.




One of the 40 one-year detention ponds in Brightleaf. The small volume and short flow path (left) will make water quality retrofits difficult. The steep slopes (right) impede maintenance access.

4. Impacts from infrastructure crossing the stream corridor—The design and placement of new sewer lines and road crossings associated with development in Lick Creek does not minimize impacts to streams and wetlands. The new developments come with gravity sewers than run parallel to the mainstem of Lick Creek, encroaching upon forested buffers and crossing the creek and its tributaries frequently in relatively short distances (e.g. UT-301, 302, 303). At most of these crossings, extensive rip rap is often used, creating steep side slopes and causing hydrologic modifications that may reduce wetland functions (see sewer crossing wetland near Alyea Ct. in Brightleaf). Some road crossing culverts in the new developments are not flow-aligned (SC-301), and a surprising number showed evidence of erosion around headwalls and/or embankment failure. Design standards for sewer crossings and stream culverts could be modified to

minimize the effect on the stream or wetland function. For examples of these sites see Appendix A, *Table A-1: Approved Impacts.*

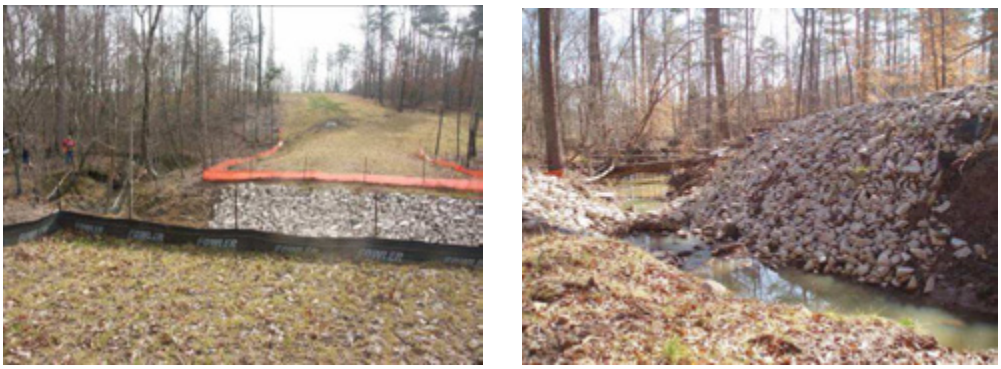
Recommendations for Immediate Action by UNRBA:

- Follow-up with structural repairs to headwalls. Refer to Appendix A, *Table A-2: Enforcement* for a list of the sites at active construction sites that need repair.

Recommendations for Future Action (proposed for inclusion in Watershed Plan):

- Review criteria for stream crossings. Determine if design criteria for sewers needs revision or if more stringent oversight is needed.
- Review proposed infrastructure mapping to determine number and location of stream crossings; propose alternative layouts or designs (i.e. reduce number of crossings through site design, use bottomless culverts where possible).

SC-301 Golden Parkway (misaligned culvert); SC-111 poor drainage design behind headwall of interlocking concrete block; SC-112 poor headwall design.



UT-303 (left) Sewer crossing in Brightleaf is one of three is close proximity. UT-110 (right) demonstrates the typical steep side slopes and small rip-rap.

5. Buffer and floodplain encroachment –Numerous impacts to stream and wetland buffers were seen at recent and active development sites, as well as in timber harvesting areas. Impacts include clearing of riparian vegetation, encroachment of infrastructure, deposition of fill materials, discharge of sediment, and changing of the natural hydrology. Many of these impacts were approved as variances from the Neuse buffer rules by the NC Division of Water Quality during permitting. For example, several acres of impacts to the 50 foot buffer were approved in Brightleaf. Approval of buffer impacts should be

linked with more stringent oversight of erosion and sediment control, stormwater management, and education efforts, as loss of buffer function leaves the respective stream or wetland more susceptible to degradation.

Recommendations for Immediate Action by UNRBA:

- Continue to visit and document approved buffer impact locations to educate local officials, inspectors, DWQ and residents on indirect impacts associated with buffer loss.

Recommendations for Future Action (proposed for inclusion in Watershed Plan):

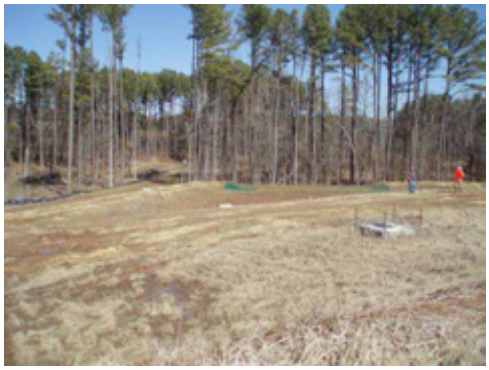
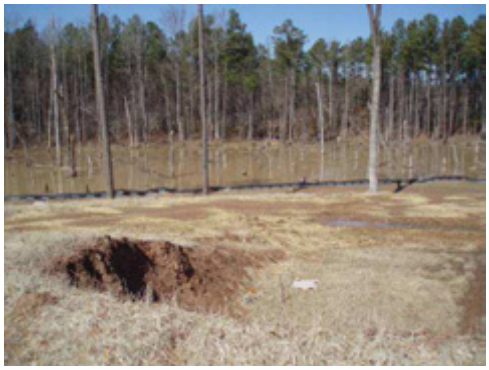
- Stop approving buffer impacts. The 50 foot buffer required by the Neuse rules is minimal. DWQ should hold the line here and not approve impacts or exceptions.
- Utilize the wider buffer requirement made possible by the East Durham Open Space plan (300 ft from top of bank on each side).
- Increase the 25' required buffer to match the Neuse stream buffer rules. Increases in the stream and wetland buffer would have a significant benefit in the Triassic basin.
- Indirect impacts to wetlands need to be considered during impact review process. This may necessitate the addition of local wetland protection ordinances.
- Encourage natural drainage channels should be used for drainage in new developments. The value of these zero-order, ephemeral, intermittent streams has been document and supports a focus on environmental sensitive design/LID/BSD.
- UNRBA and/or a local environmental group should arrange to be on the contact list to receive notification of wetland and buffer permit applications.

Information needed to support recommendations in Watershed Plan:

- Review forestry buffer regulations.
- Review site plans for Brightleaf to confirm the extent of the approved impacts.
- Learn about the process for obtaining buffer exemptions.
- Task EEP with tracking down how/where impact fees were used to mitigate

UT-111 (left) sewer cuts wetland in half. UT-305 (right) the Brightleaf pump station at Brightwood Trails is adjacent to the wetlands and likely in the wetlands.


IB-110 impacted wetlands directly and indirectly. Not the fill slopes in or adjacent to the wetland off Woodsdale Court (left) and the proximity of the sewer to the wetland near Alyea Court (right).

IB-110 the wetland hydrology is impacted by the bisecting sewer (left) and by the lack of buffer (right) near Alyea Court.

6. Protection of high quality streams and wetlands—More than half the watershed falls within the Durham Growth Boundary. Based on observed impacts at existing construction sites and in some of the timber harvesting areas, we recommend making a concerted effort to protect high quality streams, ponds, and wetlands through targeted land preservation and better enforcement of land development regulations in the Lick Creek watershed. This effort should tie in with the Upper Neuse Conservation Plan and East Durham Open Space Plan.

Recommendations for Immediate Action by UNRBA:

- Pass the list associated with this memo onto the Triangle Greenways Council for their use in identifying high quality areas for protection. Specific high quality streams and wetland areas preliminarily identified as high quality can be found in Attachment A, Table A4: Protection.

Recommendations for Future Action (proposed for inclusion in Watershed Plan):

- Use this list of high quality reaches to support the recommendations in the East Durham Open Space plan.
- Identify which priority sites are most vulnerable to future development and coordinate with plan review staff to encourage open space protection during the site design phase as well as more stringent S&E and stormwater control for proposed developments adjacent to priority areas.

- Determine how to use mitigation funds from wetland impacts or the Neuse N offset fees to purchase stream corridor parcels to support administrative costs of placing properties in perpetual easement.

7. Delineation of streams and wetlands—Stream and wetland layers from various sources were utilized in the field: USGS 1:24,000 quads, Durham Stormwater Services Hydro-l and Hydro-p, DEM-generated streams, and the NWI. Many small, first order DEM-generated streams were not captured by USGS or Durham mapping, however, they were verified as flowing streams by ground crews. Field crews did not have Wake County stream layers or the Durham County soil maps in the field. Therefore, these sources were not compared. Streams identified on the maps automatically trigger protection during the land development process.

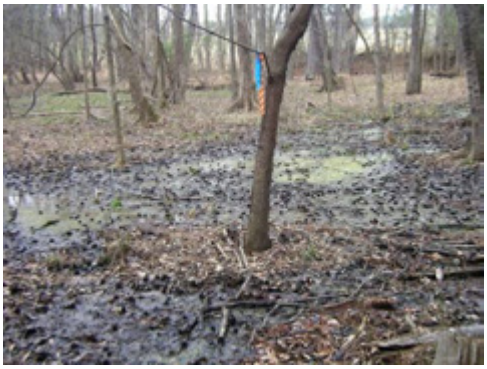
In addition, field crews noted significant differences between the NWI layer and wetland locations in the field. These differences may be due to beaver activity, as beaver complexes are creating systems of ponds not shown on the various hydrographic or NWI maps. Wetland delineation flagging observed in a number of locations did not appear to fully cover the true wetland extent. Buffer clearing and logging roads were both observed in wetlands, outside of flagged wetland boundaries.

Recommendations for Immediate Action by UNRBA:

- We recommend a further comparison of the streams verified by field crews to the Durham County soil maps and Wake County mapping. If these streams are also missing from these additional regulatory resources, we recommend updating local stream maps referenced for regulatory purposes with the DEM layer.
- Investigate the process for verification of wetland delineations (both urban and forestry) and interview agency staff to evaluate oversight capacity

Recommendations for Future Action (proposed for inclusion in Watershed Plan):

- Greater oversight of consultant's delineations by Corps and State.
- A local wetland inventory should be conducted to revise NWI. We recommend using wetland delineations associated with recent developments as a basis for the local inventory.
- 100 year floodplains need to be delineated and protected upstream of current points, to a designated catchment size. The FEMA delineation begins at a 1 sq mile drainage area.
- Local protection may be needed for intermittent and ephemeral stream channels.



RCH-304 (left) These beaver dam impoundments and associated wetlands are not shown on the NWI. The valley is also not shown to have a floodplain. RCH-331 (right) is an example of wetland area where the flagged boundary was not discernable.

8. Major restoration projects— There were very few restoration opportunities identified in the watershed. At most 25 acres of drainage area bay received water quality treatment by retrofits and 1 linear mile of stream buffer reforestation. Major restoration projects (i.e. stormwater retrofits, stream restoration, large buffer planting projects) require engineering design, construction by a contractor, long-term maintenance and/or project management by a local government. Potential restoration projects would provide stormwater treatment for existing development or return farmland to historic floodplain wetlands. A list of the major restoration opportunities can be found in *Table A-6: Major Restoration* in Attachment A.

High priority restoration sites include:

- R-300 is a proposed pocket wetland to treat 6 acres of runoff from the Route 70-Mineral Springs intersection, the Burger King, and the Pizza Hut parking lot. This wetland is proposed for the poor quality natural remnant between Pizza Hut and the environmental remediation business to the east.
- R-301 is a proposed pocket wetland at a Route 70 outfall just east of R-300. The 4 acre drainage area includes McDonald's at Route 70. This area is currently a mix of meadow and some trees.
- Falls Village Golf Course has many stream channels that cross the fairways without buffers. This is a prime opportunity to prevent stream erosion and the need for future stream restoration by stabilizing the banks with vegetation now. The sections of stream through the fairways should be planted with a no-mow meadow mix for 50 feet, or as far as possible, on each side. The riparian vegetation along currently forested sections of stream must be protected during the coming development.
- Integrating wetland restoration with the proposed stream restoration project downstream (and potentially upstream) of Olive Branch Road may provide water quality and downstream channel protection beyond the immediate bank protection measures. While the eroding banks are very dramatic and have prompted the channel reconstruction project, this section of stream has a 4.5 square mile drainage area which is rapidly developing. This indicates that channel change will occur for decades to come. Buffer reforestation may be the most valuable

and cost effective restoration strategy given this situation. If possible given spaced constraints hardwood bottom, braided channel, floodplain areas as found elsewhere in the watershed should be created. This will provide flood storage and the water quality benefits of wetlands.

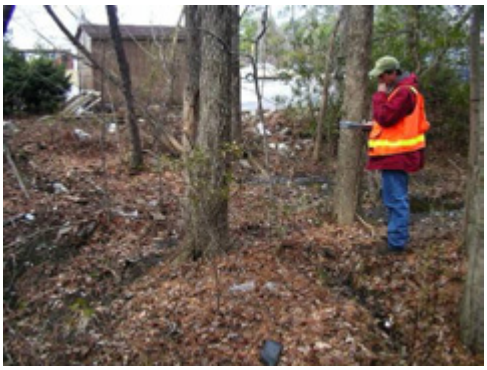
- Other buffer plantings identified as high priority in Table A-6 will have the typical benefits of bank stabilization, creating habitat, and providing stream shade.

Recommendations for Immediate Action by UNRBA:

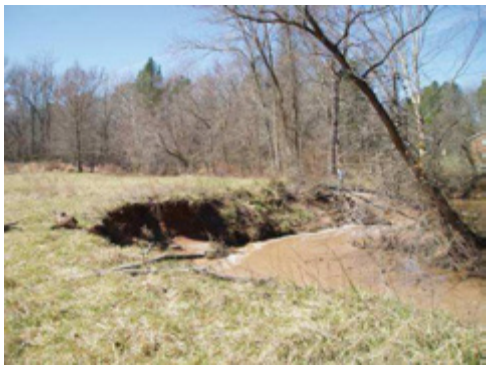
- Work with SWCD on design for stream restoration project near Olive Branch Rd. Considering new development upstream, restoration should entail reconnection to floodplain and buffer planting.
- Share list of high priority projects with County and City for incorporation into Capital Improvements Budget
- Evaluate the geomorphic monitoring plan associated with the SWCD stream restoration project. If the monitoring plan has a short duration or spatial scale, work with project partners to identify someone interested in providing long term monitoring. This would be an interesting project about the response of a Triassic Basin channel to upstream development and the effectiveness of stream restoration in Triassic Basin streams.

Recommendations for Future Action (proposed for inclusion in Watershed Plan):

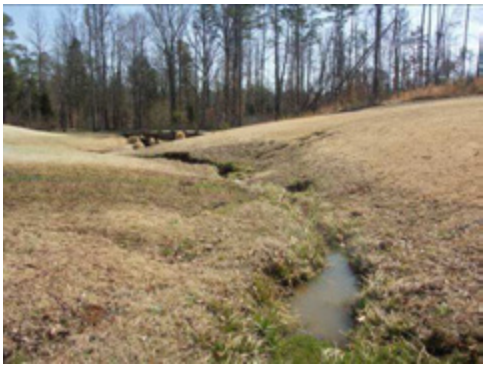
- Develop planning level cost estimates and potential stakeholder list for high priority projects in order to begin soliciting funding and implementation partners. Propose an implementation schedule as part of watershed plan.



R-300 (left) Proposed wetland downstream of Pizza Hut and Burger King in degraded natural area remnant.
R-301 (right) Proposed wetland area downstream of Route 70 outfall.




RCH-340 (left) Olive Branch stream restoration site with potential to incorporate floodplain wetlands. R-302 (right) Proposed dry swale at Triangle Pointe Apartments.

RCH-521 (left) and RCH-517 (right) Two of several potential buffer plantings at Falls Village Golf Course.

9. Restoration projects to be implemented by volunteers—Opportunities exist for small restoration projects that can utilize volunteer efforts and can serve as "quick wins" for on-the-ground implementation. These projects are fairly simple to design and relatively inexpensive when compared to the major restoration projects. Additionally, these projects can often be constructed by volunteers with the technical assistance of local government staff or extension agents. Examples include trash cleanups, simple buffer planting and small, stormwater retrofits like MI-303 in Brightleaf (lengthen flow path and add vegetation in existing practice). A list of minor restoration opportunities can be found in *Table A-7: Volunteer Restoration Projects* in Attachment A.

Recommendations for Immediate Action by UNRBA:

- Begin to solicit interest in various projects during public meetings; consider moving forward with implementation as a way to generate additional interest and support in the watershed planning process
- Pass list of potential projects, to City and County education and volunteer coordinators.

Recommendations for Future Action (proposed for inclusion in watershed plan):

- Integrate projects into watershed education and outreach plan. Include who will initiate the projects, who will provide technical support, and possible funding sources.



Proposed volunteer projects include buffer planting on rural and pasture lands, such as IB-170 (left), and on residential properties, such as RCH-152 (right).

10. Suspicious discharges from septic systems—Septic systems are prevalent throughout Lick Creek. Due to the geology, traditional septic system designs are not possible in many locations. Sand filter systems that discharge to the stream via a pipe or with spray irrigation of the discharge are not uncommon. Failing sand filter septic discharges do not appear to be as wide spread a problem in Lick Creek as they were in Little Lick. However, one neighborhood presents a problem. There may be other isolated sites that were not seen by field teams.

A concentrated number of septic system discharges to the stream (RCH-122, 151, 152) were found in an existing low density residential neighborhood near Olive Branch Rd., Bookman Rd, Hester Rd., and Rondelay Rd. Chlorinators were observed for some of these systems, but not all. Sudsy and sewage smelling discharges were observed at OT-133 and OT-139, OT-154. This neighborhood is adjacent to Ravenstone, which has run new sewer lines. These discharges may be from un-maintained sand filter systems or from washing machine discharges that bypass the septic system.

Another concern is the spray irrigation of septic discharge at Kingsmill Dairy. The sprayers here are directed into the riparian corridor.

Recommendations for Immediate Action by UNRBA:

- Follow-up with investigations to determine which systems need chlorination devices or other system upgrades. Ask the County who is responsible for investigating this type of illicit discharge. Educate residents about proper maintenance and request voluntary compliance.
- Request inspection of the Kingsmill Dairy spray irrigation set-up.

Recommendations for Future Action (proposed for inclusion in watershed plan):

- Target neighborhood with septic maintenance education.
- Inform landowners with sand filter systems about the need for an NPDES permit. Assist landowners with this process.
- Propose alternative strategies to tie neighborhood into sewer lines either through cost sharing, capital improvements, or restoration/mitigation funding
- If landowners are not willing to provide necessary maintenance and apply for NPDES permits, pursue enforcement actions.

11. Outreach and education targets—Opportunities for additional, targeted education to specific watershed residents, businesses, and the development community were also identified. Outreach to businesses, particularly along the Route 70 corridor, is needed to educate site managers about illicit discharges and best management practices. Efforts should be made to educate local elected officials and the public on the impacts of impervious cover to aquatic systems, the susceptibility of the Lick Creek watershed to future impairment due to growth potential and Triassic conditions, and potential management techniques to minimize future impacts (i.e. buffers, better site design, post-construction stormwater quality treatment). Specific educational targets can be found in *Table A-7: Targeted Outreach and Education* in Attachment A.

Recommendations for Immediate Action by UNRBA:

- Ask County to visit McDonald's and Carolina Livery, as these were confirmed illicit discharges with sudsy wash water flowing directly into storm drains.
- In coordination with the County, contact trucking business along Route 70 to conduct hotspot site assessments. First, learn what environmental regulations these trucking storage and transfer operations are subject to. Then contact owners for permission. Conduct the site visit prepared to offer suggestions on pollution prevention practices.

Recommendations for Future Action (proposed for inclusion in watershed plan):

- Outreach to residents is needed about the value and function of streams. This includes buffer management, lawn care, and proper septic system maintenance. The neighborhood along Olive Branch Rd, Bookman, and Rondelay Road is the first priority.
- Tie education for residents into the volunteer restoration projects.
- Identify areas where the County and City can share materials and outreach strategies to educate businesses about pollution prevention.
- Identify local or state resources for providing training to local officials, staff and the development community (i.e. NCSU, CEPSCI, NEMO)

Information needed to support recommendations in Watershed Plan:

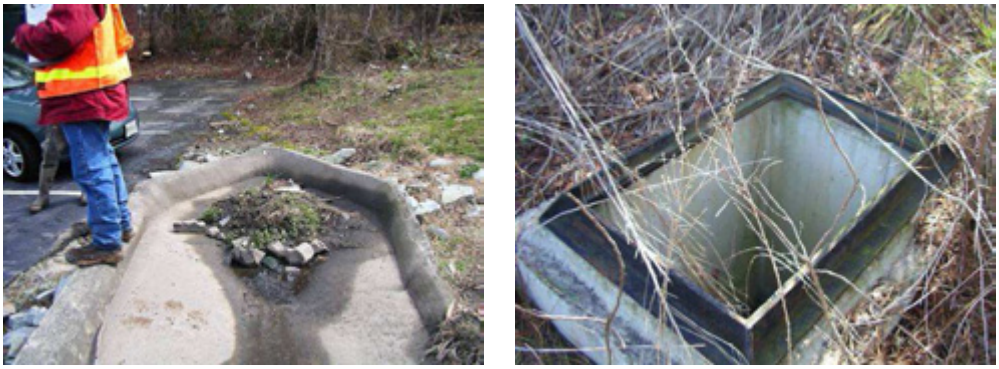
- Become familiar with the County's IDDE ordinance and determine if it is as thorough as the City's recently adopted ordinance.

H-300 McDonald's at Route 70 and Mineral Springs Road. Dumpster area is set up for washing (left). Wash-water leaves the dumpster area (middle) and flows though parking lot to storm drain inlet near parking lot entrance from Route 70 (right).

12. **Municipal infrastructure repairs—**While walking the streams, field crews noted culverts, outfalls, inlet structures, and other drainage infrastructure that were in need of repair and/or regular maintenance. Several of these sites, mostly highway drainage related, should be revisited to repair noted concerns. A specific list of these sites are provided in Attachment A, *Table A-3: Repair*.

Recommendations for Immediate Action by UNRBA:

- Forward list of repair sites to DOT or other appropriate public works agency



Repair projects include storm drain infrastructure such as this inlet at Pizza Hut (MI-306) (left) and stormwater management ponds (MI-320) (right).

5.0 Subwatershed Summaries

Below are brief descriptions of each of the 11 subwatersheds based on mapping analyses and field assessments. These narratives are intended to be expanded upon as subwatershed management strategies are developed and incorporated into the overall watershed management plan. A more detailed subwatershed strategy is provided in Attachment C as an example how information could be organized by subwatershed in the watershed plan. Additional information on subwatershed features, current and future conditions, and estimated pollutant loading and treatment options is being developed using the Watershed Treatment Model (WTM).

Subwatershed 1 ***(Headwaters, "Brightleaf"):*** The majority of this 1079 acre (1.7 sq miles), formerly rural, headwater subwatershed falls within the annexed portion of City of Durham. Almost half of the stream miles were walked in this subwatershed (5.4 of 11.9 total miles). Currently at 10.7% impervious cover, this subwatershed contains two of the three large construction sites in the Lick Creek watershed (>200 acres of active construction). When complete, the Brightleaf and Brightwood Trails subdivisions will contain over 1200 new residences. The Route 70 corridor cuts across the western tip of the subwatershed and contains existing commercial land uses, predominantly fast food and mobile home sales. A large power line ROW bisects the subwatershed further downstream. Some agricultural lands are located along Sherron Road, the western boundary of the subwatershed and of the watershed. There is one established stream monitoring station in this subwatershed.

At the Brightleaf and Brightwood Trails subdivisions, extensive impacts to wetlands and streams were observed. While some of these impacts were approved during the permitting process, a large number of sediment and erosion control violations were found, compounding wetland and stream impacts. If these sites are representative of the type of development that will be occurring throughout the urban growth area of Lick Creek, then protecting drainages during all phases of the development cycle, particularly during the construction phase, will need to be a critical component to overall watershed management.

Subwatershed 2 ***(Headwaters):*** This mostly rural, headwater subwatershed is 1310 acres in size (2.05 sq miles) and has the most commercial area and the highest % current impervious cover in the watershed (14.3%). Situated southeast of Subwatershed #1, the Route 70 commercial corridor and power line ROW cross the eastern tip of the subwatershed. Some commercial and residential restoration opportunities along this corridor exist, such as stormwater retrofits, buffer planting, culvert repair, and trash cleanup. Under 25% of the stream networked in Subwatershed 2 was field assessed (approximately 4 of 15 total miles). The field effort focused on the commercial areas and all road crossings. Excessive turbidity was observed in a tributary draining a 5-acre agriculturally-exempt parcel which has a complex regulatory history. There are a significant number of small farm ponds at the headwaters of many tributaries throughout this subwatershed. The most downstream portion of the stream network opens into an extensive wetland complex.

Currently, approximately 60 acres are in active construction, and another 60 acres cut forest. Considering that all of the subwatershed falls within the Durham Growth Boundary, the potential for new development, particularly expansion of Brightleaf into this subwatershed are anticipated. Currently, only a small portion of the subwatershed has been annexed into the City. A large publicly owned parcel is situated near the Brightleaf subdivision along the boundary with subwatershed 1. There are two monitoring stations in this subwatershed.

Subwatershed 3 ***(Mainstem and Direct Drainage, "Ravenstone"):*** This subwatershed (757 acres) is downstream of the confluence of Subwatersheds 1 and 2. Approximately

3.6 miles of 8.5 total stream miles were evaluated by field crews. The mainstem channel below the wetland complex at this confluence is wide and deeply incised, and can be clearly viewed from the Olive Branch Rd. crossing. The reaches immediately below and upstream of the Olive Branch Rd. bridge have been previously identified for stream restoration projects. There is a proposed monitoring station at this bridge. Current impervious cover is 12.4%, however the entire subwatershed falls within the designated growth boundary.

There are two significant residential developments in Subwatershed 3—an established residential neighborhood between Bandcock Dr. and Hester Dr., and a new subdivision still under construction called Ravenstone (~90 acres in active construction). Suspicious discharges from septic tanks were observed in streams throughout the older residential area, which is the County and is not on the sewer network. The highest concentration of onsite sand filter systems is located here. The adjacent neighborhood, Ravenstone, was annexed into the City and is on sewer. A very large stormwater pond captures drainage from Ravenstone prior to discharging into the mainstem; however headcutting and streambank erosion below outfall structure was observed. Preventing erosion at Ravenstone appears to be a consistent challenge.

Subwatershed 4 ***(Headwaters, "Doc Nichols"):*** The smallest of all the subwatersheds at 698 acres (1.1 sq miles), this subwatershed is bound by a few low-density residential parcels along Doc Nichols Rd. to the north and east. The majority of the land use here is forested, however much of this area has been cleared for timber harvesting (>100 acres). Current impervious cover estimated at 2.8%. The upper reaches of the subwatershed are steep, and exposed diabase sills were frequently observed. Upstream of the Olive Branch Rd. crossing, the mainstem is broadened by extensive beaver wetland complexes. There is a stream gauge at this road crossing. Timber harvesting has impacted the wetland buffer and many of the first order streams draining to the mainstem, extensively. All of this subwatershed falls within the designated growth boundary.

Subwatershed 5 ***(Headwaters):*** This 1600 acres (2.5 sq mile) subwatershed is mostly forested (>750 acres) and unmanaged rural lands with rural residential (3-10 acres/du). Most residences are on septic systems; there are five known sand filter septic systems in the subwatershed. Similar to subwatersheds 1 and 4, the stream network discharges into a large wetland complex at the down stream end. Olive Branch Rd. bisects the subwatershed, which is bordered to the south by Leesville Rd and the east by Virgil Rd. Current impervious cover estimated at 3%. Only 2 miles of the total 17.2 stream miles were actually walked. There is one potential contamination site mapped. CWP staff did not get into this subwatersheds; Bobby Louque and Brandon Culberson conducted assessments here.

Subwatershed 6 ***(Mainstem and Direct Drainage):*** Subwatershed 6 (1500 acres) is located on the west side of the Lick Creek watershed and is bisected by NC 98. Field teams walked 4.3 miles of 18 total stream miles. North of NC 98, the tributaries cross Falls Village Golf Course in many locations. These reaches lack buffers or are piped under the fairways. While a significant portion of this area is forested, these forested

areas are slated for a development that will be interlaced with the golf course. Current impervious cover is approximately 4%. There are approximately 23 acres of active construction in the subwatershed. South of NC 98 several tributary stream buffers are impacted by pasture areas. Along the mainstem, wide floodplain valleys contain forested wetlands. Some of these wetlands had delineation flagging present. These the hydrology and vegetation indicated wetland conditions outside of the flagged areas; our fieldwork was not intended to delineate wetlands, therefore we did not examine the soils or make detailed notes of the areas. There are over 100 acres of protected natural area in this subwatershed.

Subwatershed 7 ***(Martin Creek):*** This 1550 acre subwatershed is bordered by Carpenter Pond Road to the South, Virgil Road to the West, Coley Road to the East and Falls Lake to the North. Land use is predominantly comprised of forest cover with minimal development (<5% impervious cover). The streams are in good condition with signs of wildlife, mature forested buffer, and diabase sills. We walked over 2 miles (out of 17.4 total stream miles). A major portion of this subwatershed falls within the Durham Growth Boundary. Development is scattered throughout the subwatershed including low density residential areas, the Kingsmill Dairy farm, a Progress Energy substation, an old landfill, and a fill and debris storage site. One private residence on Southview Road Evidence of wetland and floodplain filling was observed behind a residence on Southview Rd and near a junkyard on Old Kemp Rd. The Kingsmill Dairy Farm located off Kemp Road cleared several acres including stream buffers to increase its operations. Excessively turbid flows have been reported by downstream neighbors, in fact, this subwatershed has shown some of the highest turbidity readings monitored by the City. Other impacts at the farm include a lack of sediment and erosion control on cleared construction areas. Located off of Coley Road is a site that receives fill dirt and debris. The owner indicated that an intermittent stream on site is going to be filled for future expansion. The subwatershed is crossed several times by power lines.

Subwatershed 8 ***(Upper Laurel Creek):*** This 1294 acre subwatershed contains some of the highest quality streams in the watershed. The geology of this subwatershed is more similar to the Slate Belt than to the Triassic Basin. Land use is mostly rural forested, but some agricultural and very low density residential (0.5-2 acre/du) areas exist. Current impervious cover is very low (~3.2%). There is a large residential development located in the northeast corner off Carpenter Pond Road. Several intermittent streams show signs of impact by the development including buffer loss, multiple road crossings and poor erosion and sediment control along the streams. In contrast, the streams in the remaining subwatershed contain a healthy forested buffer and good habitat (note that 1 out 14 total stream miles were walked). Located in the southern tip of the subwatershed are two horse farms (~50 animals) and an auto junk yard. The watershed is bordered by Coley Road to the west and Carpenter Pond Road to the east with power lines that crisscross the subwatershed twice.

Subwatershed 9 ***(Lower Mainstem and Direct Drainage):*** This 1959 acre (3.1 sq mi) subwatershed drains directly to the lake. There are 570 acres of protected natural area in the watershed; it is one of the most undeveloped subwatersheds with a scattering of farms

and one small residential development located near the lake off Wentz Drive. This subwatershed has at least one location of wastewater spray irrigation, and it has the second highest number of sand filter septic systems in the watershed (though 7 systems is a relatively low number). This subwatershed is not located within the Durham Growth Boundary. The subwatershed is bordered by Baptist Road to the north and Southview road to the east. The streams walked in this subwatershed (1.5 out of 24 total stream miles) were rural in character. The uppermost channels run through pastures, but the perennial streams generally are stable and have forested buffers.

Subwatershed 10 ***(Lower Laurel Creek):*** This 1430 acre (2.2 sq mi) subwatershed contains some of the highest quality streams in the watershed. The geology of this subwatershed is more similar to the Slate Belt than to the Triassic Basin. Chris Dreps and Brandon Culberson conducted a limited assessed of this subwatershed; walking 2.4 of the 16 total stream miles. Land use consists of mostly forested and unmanaged rural lands. Over 170 acres of protected natural areas are in this subwatershed. Current impervious cover is estimated around 5%, and there are about 70 acres of active construction.

Subwatershed 11 ***(Falls Lake Direct Drainage):*** This is the northernmost subwatershed that drains approximately 881 acres directly to Falls Lake. A majority of the land is federally protected forest land that forms the Falls Lake State Recreation Area (~470 acres). In the southeast corner is a small residential development located off of Old Creedmoor Road. This road also forms the western boundary of the subwatershed. The major landmark in this subwatershed is the Rollingview Marina located on Falls Lake. The marina implements environmentally friendly practices that include conducting boat maintenance in a designated area away from the lake, placing shut-off valves on the fueling stations to prevent spills, and requiring that all boat oil changes are conducted by the marina. Current subwatershed impervious cover is less than 5%. Chris Dreps evaluated streams on the east side of the subwatershed; approximately 1 mile of 10.6 total stream miles was walked.

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