Little Alamance, Travis, & Tickle Creek Watersheds Assessment:

An Ecosystem Enhancement Program Funded Local Watershed Plan Phase II

Piedmont Triad Council of Governments

June 2008

PIEDMONT TRIAD COUNCIL OF GOVERNMENTS

Ecosystem Enhancement PROGRAM

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Section 1 Background Information: NC Ecosystem Enhancement Program Planning Process

Little Alamance Creek is considered an impaired waterbody by the NC Division of Water Quality (DWQ). NC DWQ monitoring indicated the waters of Little Alamance Creek violate the Clean Water Act (CWA) for "impaired" biological integrity; an analysis conducted in 2000 determined that the stressor was urban stormwater runoff. Travis and Tickle Creeks are listed as impaired in the 2008 Draft 303(d) list for having "Fair" bioclassifications, meaning that the watersheds did not possess the ecology they should, according to NC DWQ standards.

The EEP Local Watershed Plan (LWP) process was deemed appropriate to develop a plan to remedy these water quality issues. In addition, the LWP is designed to address EEP's institutional need to mitigate for impacts to streams and wetlands in the Haw River Basin from NC Department of Transportation (NCDOT) projects and other development-related impacts. Originally, Travis & Tickle Creeks (TT) Watershed was included in the LWP due to field-observed opportunities to restore impacted streams and wetlands along with the subwatershed's proximity to the ecologically- and socially-valued Haw River. The impaired status of the Travis & Tickle Creeks now makes such attentions a necessity.

The PTCOG conducted a LWP Phase I assessment of the water quality impacts and watershed needs in both Little Alamance Creek & Travis and Tickle Creeks (LATT) watersheds in 2006; application for LWP Phase II/III funding followed. In the winter of 2006/2007, the North Carolina Piedmont Triad Council of Governments (NC PTCOG) began Phase II of a watershed assessment funded by the NC Environmental Enhancement Program (EEP). Six goals for the project were identified during Phase I by the project's stakeholder group. These six goals are:

- **Increase local government awareness of the impacts of urban growth on water resources –** through a review and analysis of current local watershed policies and ordinances, ascertain what is already being done to manage urban water impacts, and work with these governments to improve their understanding of the environmental, social, and economic benefits of stormwater management.

- **Strengthen watershed protection standards –** through watershed policy review, identify weaknesses in current watershed management approaches and work with current planning and administrative staffs to improve water quality protections within their jurisdictions for sustainable watershed management.

- **Improve water quality through stormwater management –** identify projects and programs that may aide urban jurisdictions in their management of stormwater and restore impaired waters (i.e., Little Alamance, Tickle, and Travis Creeks) to supporting status.

- **Identify and rank parcels for retrofits, stream repair, preservation, and/or conservation –** through a combination of GIS analysis and field work, objectively locate and prioritize projects within both watersheds that most efficiently and effectively restore supporting habitat conditions to both watersheds and facilitate stewardship.

- **Assess aquatic health to identify stressors that are the most likely causes of poor biological conditions –** NC DWQ assessments of both watersheds will help identify pollution sources, allowing for strategic project and policy approaches for quick and effective mitigation.

- **Meet requirements of outside funding sources for implementation of projects –** identify potential federal, state, and private funding sources for further watershed evaluation and/or project implementation, and have a working knowledge of what their criteria are for project proposals.

EEP approved funding for LWP Phase II/III watershed assessments in Winter 2007, and work began in Spring 2007. This report builds upon the watershed characterization by analyzing water quality data, policies, regulation, and field assessments to determine the current status of watershed conditions in and around impaired waters. The innovative and effective approach to local watershed planning employed by EEP in the Little Lick Creek LWP in Durham County, NC, was used as a template for this plan.

NC EEP Local Watershed Planning

"The mission of EEP is to restore, enhance, preserve, and protect the functions associated with wetlands, streams, and riparian areas, including but not limited to those necessary for the restoration, maintenance, and protection of water quality and riparian habitats throughout NC" (NC EEP). The LWP process seeks to achieve EEP's mission by developing plans that outline steps needed to achieve a functional improvement of a watershed's water quality, habitat, and hydrology. By working in smaller, local watersheds of the US Geological Survey's (USGS) 14-digit hydrologic units codes (HUCs), EEP is able to work at a scale where it is easier to characterize the problems and assets of a watershed. As a result, LWPs are customized to achieve local watershed needs.

EEP partnered with the PTCOG to determine the sources of impairment to biological habitat in the LATT watersheds. This analysis will determine a list of priority projects, programs, and policies that can best restore these creeks' clean waters, improve hydrologic function, and provide sustainable stewardship solutions for the growing jurisdictions encompassed by the watersheds. Both the PTCOG and EEP will follow through on this knowledge by partnering with other stakeholders to implement projects that will best serve the watersheds and restore their functions.

This Phase II document summarizes field work and methods used to identify impairments to subwatersheds, NC Division of Water Quality (DWQ) monitoring data, and GIS land use assessments. These data will be used to prioritize projects and recommend policy measures in the Phase III document for the Little Alamance, Travis, & Tickle Creek watersheds.

EEP requires that LWPs include resource professionals and concerned citizens as part of a stakeholder team that guides the planning process within their watershed. Stakeholders have a vested interest in improving water quality in the watersheds where they live and work due to the benefits such improvements bring to their own health, safety, and enjoyment. The framework of the LWP process grants stakeholders access to NC technical and funding resources to develop and implement local recommendations for watershed improvements. EEP has repeated successes of the LWP process as an efficient, effective approach towards these ends; much of this success is attributed to the inclusion of local stakeholders. The insight and experience brought to the process by local citizens and groups is valuable, and complements the scientific information collected by the DWQ and other LWP partner organizations. To learn more about the NC EEP and the Local Watershed Planning process, visit: http://www.nceep.net/pages/lwplanning.htm

The Little Alamance, Travis & Tickle Creeks Local Watershed Planning Group

During the spring of 2006, the PTCOG identified and contacted interested groups with a stake in the management of the LATT watersheds. These groups attended a June, 2006 project kickoff meeting. Several of this original group chose to become members of the group to guide the development of the Little LATT LWP. The Local Watershed Planning Group consists of a Technical Team and a Community Stakeholder group.

Project Partners

The LATT Technical Team worked to initiate, facilitate, organize, guide (through the development of technical information), and financially support the development and implementation of recommendations contained in the LATT LWP. These team members are listed in the accompanying box.

The PTCOG was responsible for land use analysis, both field- and GIS-based watershed analyses, management strategy development, stakeholder management, policy review, and being the primary project contact. Several PTCOG staff members contributed to the LATT LWP technical team. Cy Stober was the Primary Project Manager, working with prior contributions from Phase I Project Manager, Paula Sloneker. Other PTCOG Planning staff provided input and guidance including Paul Kron, Ginger Booker, and Jesse Day. Kristen Selikoff, PTCOG GIS Manager, carried out all GIS-based watershed characterization and analysis, using the NC EEP Little Lick Creek

Little Alamance & Travis/Tickle Creeks Local Watershed Plan Technical Team

Piedmont Triad Council of Governments
Cy Stober, Water Resources Planner
Paula Sloneker, Environmental Planner
Kristen Selikoff, GIS Manager
Jesse Day, Bicycle & Pedestrian Planner
Paul Kron, Planning Director
Ginger Booker, Assistant Director

NC Ecosystem Enhancement Program
Mike Herrmann
Deborah Amaral
Perry Sugg
Kristie Corson
Anjie Ackerman

NC Division of Water Quality
Steve Kroeger
Stratford Kay
Tom Yocum

EcoLogic Associates, Inc.
Ken Bridle, Ph.D.
Kyle Hoover
Joe Mickey

LWP as a template for watershed valuation.

EcoLogic Associates, Inc., served as a third-party consultant and primary expert for the field-based watershed analysis. This included the streamwalks and windshield analyses, which were adapted from the Center for Watershed Protection (CWP) Unified Stream Assessment (USA) & Unified Subwatershed and Site Reconnaissance (USSR) methods, respectively. Ken Bridle, Ph.D., of EcoLogic Associates, Inc., became the primary analyst of field data in Phase II, and was a critical member of the LATT Technical Team. The NC EEP Project Managers were Deborah Amaral, Ph.D, and Mike Herrmann. Kristie Corson and Perry Sugg of EEP have been active in reviewing potential projects and implementing pilot projects identified early in the planning process. Steve Kroeger, Stratford Kay, and Tom Yocum (NC DWQ) managed watershed monitoring and assisted with other fieldwork.

The Community Stakeholder Group

The Community Stakeholder Group consists of members of the local community who can implement or are affected by the LWP, and those who are interested in improving the quality of the community's environment. The Community Stakeholder Group has few ongoing commitments to the project. Their main role is to provide input into the process and to ensure that the Technical Team considers a broad, diverse range of community interests. The Community Stakeholder Group also has the critical role of helping the Technical Team understand and account for local watershed conditions and problems.

Little Alamance & Travis/Tickle Creeks Local Watershed Plan Community Stakeholders

ALAMANCE COUNTY

- Bryan Hagood, Parks & Recreation
- Phil Ross, Soil & Water Conservation District
- Rick Bailey, Soil & Water Conservation District
- Gary Murray, Soil & Water Conservation District
- Rett Davis, Cooperative Extension

CITY OF BURLINGTON

- Gary Hicks, Public Works
- Tony Laws, Parks & Recreation
- Bob Patterson, Stormwater
- Steve Shoaf, Utilities
- Bob Harkrader, Planning

TOWN OF ELON

- Mike Dula, Manager
- Sean Tencer, Planning

TOWN OF GIBSONVILLE

- Ben Baxley, Manager
- Brandon Parker, Planning

CITY OF GRAHAM

- Aaron Holland, Planning
- Mike Leinwand, Planning
- Melody Wiggins, Parks & Recreation
- Donnie Brooks, Public Works

GUILFORD COUNTY

- Warren Simmons, Engineering
- Roger Bardsley, Planning
- Alex Ashton, Planning
- Gary Cox, Soil & Water Conservation District
- Millie Langley, Soil & Water Conservation District
- Brenda Morris, Cooperative Extension

Section 2 Watershed Assessment

The LATT watershed assessment is the result of several levels of analysis guided by the LATT Project Stakeholders, Technical Team, and watershed management goals. This section describes the components of the analysis and the major findings.

LATT Watershed Plan Documents

(http://www.ptcog.org/eep/downloads.htm)

LATT Local Watershed Plan;

NC Division of Water Quality: Evaluation of Water Quality, Habitat, and Stream Biology in the Little Alamance, Tickle, and Travis Creek Watersheds;

Technical Memorandum #1: LATT Watershed Characterization (Phase I) Report – Stakeholder charter, existing water quality data; policy summary, and monitoring plan;
Technical Memorandum #2: LATT Watershed Assessment (Phase II) Report – Methods and Results of watershed analyses, including GIS, field work, and NC DWQ Monitoring Report;
Technical Memorandum #3: LATT Watershed Implementation Plan (Phase III) – Watershed management strategies for the LATT watersheds, centered on prioritized policy and project recommendations.

Watershed Management Goals

The LATT Stakeholders Group developed goals and objectives to guide the watershed planning process and the formation of the *LATT LWP*. The goals listed below are both short- and long-term strategies to restore water quality, and invest in management that prioritizes watershed function and health.

This *Little Alamance, Travis, & Tickle Creek Watersheds Assessment* document addresses Goals 2, 3, & 5. All of these management goals will be fully addressed in the Management Report and Implementation Plan.

1) Increase local government awareness of the impacts of urban growth on water resources;
2) Strengthen watershed protection standards;
3) Improve water quality through stormwater management;
4) Identify and rank parcels for retrofits, stream repair, preservation, and/or conservation;
5) Assess aquatic health to identify stressors that are the most likely causes of poor biological conditions; and
6) Meet requirements of outside funding sources for implementation of projects.

Detailed Watershed Assessments

The PTCOG's Phase I report describes the preliminary watershed characterization, the formulation of the project's stakeholder and technical team along with the Phase II watershed assessment strategy (PTCOG, 2007). The next steps in the process were to:

- Investigate the causes of water quality impairment in both LA and TT (in-stream and upland fieldwork, water quality monitoring, further analyze of land use data, and a synthesize of resulting data);

- Examine water quality data and observed impacts from fieldwork to determine potential causes of impairment (technical team and project stakeholder meetings, analysis of NC DWQ watershed report); and

- Strategize on the most effective and efficient approaches for project, program, and policy implementation, and outline a timetable for implementation.

This Phase II document covers the first two items mentioned; Phase III covers the last item listed. All of these topics and concerns will be summarized comprehensively in the *LATT Local Watershed Plan.*

Watershed Restoration Fieldwork and Prioritization

Methods

Based on findings from the watershed characterization, LATT stakeholders and technical team members decided to concentrate limited resources and staff time conducting restoration fieldwork in LA subwatersheds LA 2, LA 3, LA 6, LA 7, LA12, and LA 13, as well as a small catchment area in subwatershed LA 10 (at the base of subwatershed LA 7). TT subwatersheds that received a detailed field evaluation were TT 4, TT 6, TT 7, TT 8, and TT 11. 18 miles of the LA watershed's streams were walked, and almost 16 miles of the TT watershed's streams were walked. The following sections describe the steps from conducting fieldwork to assessing and prioritizing restoration projects in the LATT watersheds.

In areas where stream walks were not completed, roadside surveys of stream and wetland restoration opportunities were conducted. The roadside surveys were completed mainly in TT subwatersheds where resources limited the number of streams that could be walked.

The fundamental purpose of the fieldwork was to identify the most promising restoration projects within the watershed. This project's field work was led by the staff of EcoLogic Associates, Inc., a regional environmental consulting firm that featured experienced and well-reputed ecological and riparian experts. These evaluations were based upon past EEP watershed restoration precedents, which relied upon CWP protocols. The process adapted its approach to field work from the USA and USSR protocols developed by the CWP (Schueler & Kitchell). While these CWP methods of evaluation accurately reflect watershed health, the resources necessary for a thorough execution of the protocols are prohibitory. These approaches also presume a framework of land use regulation that do not exist within the LATT watersheds. Adapting the CWP's USA methodology for fieldwork to ensure efficiency in data collection, the PTCOG and EcoLogic developed ratings of different reaches and identified potential sites for restoration or conservation efforts (UNRBA 2006). The adapted USA and USSR field methodologies are referred to here as streamwalk assessments and upland assessments, respectively.

Results

Streamwalk Assessments

Streamwalk assessment data was collected by field teams composed of stakeholder volunteers, and led by EcoLogic, PTCOG, and DWQ staff. The teams were assigned subwatersheds for detailed study, and they were expected to walk every stream mile within those subwatersheds, noting significant impacts to water quality (i.e. failing streambanks, leaky sewers, etc. – see Figures 1 – 3). Data collection was overseen by the EcoLogic staff, ensuring the quality and consistency of data collected by the field teams: at each impact, a GPS point was taken, at least one digital photograph was taken, and a brief description of the impact and the apparent water quality was noted. These impacts were collected as an Excel database and a GIS Geodatabase back at the PTCOG office, and are available in both formats (Figures 5 & 6; Appendix A).

Figure 1: Stream Restoration Site in the Little Alamance Watershed

Figure 2: Failing Stormwater Culvert in Little Alamance Watershed

Figure 3: Log Jam & Failing Bank in Travis & Tickle Creeks Watershed

Selection of these priority subwatersheds was based upon stakeholder priorities and needs, as well as identification of likeliest sources of impairment through GIS analysis. For example, a subwatershed known to suffer regular flash flooding events that is also a site of dense commercial and residential land use was selected for streamwalk assessment, while a rural, agricultural subwatershed that has few water quality or stormwater concerns was not. Consequently, almost all of the subwatersheds that received streamwalk assessments in the LATT watersheds were in the more urbanized – and more highly-impaired – LA watershed.

Streamwalk fieldwork required that project stakeholders walk and assess over 18 stream miles (77%) of LA and tributaries, focusing primarily on impacted reaches in the urban areas. Over 16 stream miles (28%) of TT and its tributaries were directly analyzed using fieldwork, guided by local knowledge of impaired areas, DWQ monitoring sites, and proximity to growing urban areas (Table 1). Table 1 shows the general channel conditions by subwatershed.

In summary, the LATT watersheds' streambank assessments offered 246 individual opportunities to improve watershed function and health (Table 1 & Appendix A). Some of these opportunities had multiple advantages if addressed (i.e. wetland restoration + buffer enhancement + stormwater improvement), which actually created more restoration opportunities than sites noted on maps (Figures 5 & 6). This list includes opportunities observed in both the streamwalk and upland assessments.

As expected, the results of the LATT fieldwork showed different needs and opportunities in each watershed. The LA watershed had more instances of stormwater and sewer systems compromises, as well as more intensely impacted streambanks (Table 1; Appendix A). The LA watershed streamwalks identified 156 Best Management Practice (BMP) project opportunities. BMPs are defined in this project as those practices that best benefit the watershed health. This includes restoration and preservation projects that will improve and protect watershed health and functions. The specific types of impacts are listed below:

- 24 instances of riparian buffer enhancement or restoration
- 39 sites where the streambank requires structural enhancement
- 9 instances of streambank failure, requiring comprehensive restoration
- 8 needs for landowner education
- 2 locations of invasive plant species dominance
- 8 log jams that significantly disrupt stream structure and flow
- 3 ponds that require work to return them to full function
- 16 failures in stormwater systems that need retrofitting
- 3 stormwater pipes that are functionally failing
- 2 observations of leaking sewer systems
- 4 trash dumps that need to be cleaned up

The TT watershed had impacts from livestock and wetland opportunities that are rarely encountered in the LA watershed (Table 1; Appendix A). The TT watershed streamwalks identified 90 BMP project opportunities. The specific types of impacts are listed below:

- 17 instances of riparian buffer enhancement or restoration
- 15 sites where the streambank requires structural enhancement
- 8 instances of streambank failure, requiring comprehensive restoration
- 9 opportunities to restore or enhance potential wetlands to full health and function
- 5 wetlands needing preservation efforts
- 9 instances of landowner education
- 2 locations of invasive plant species dominance
- 7 log jams that significantly disrupt stream structure and flow

- I observed livestock crossing that was having negative water quality impacts
- 2 ponds that require work to return them to full function
- 5 failures in stormwater systems that need retrofitting
- 1 stormwater pipe that is functionally failing
- 2 observations of leaking sewer systems
- 3 trash dumps that need to be cleaned up

When the fieldwork data was reassessed, the need for simplification of this list of projects was evident. The PTCOG used a simple analysis of grouping all projects within 100 yards of each other into "project clusters" (Figure 4). This created a more manageable list of 65 project clusters, 24 in the TT watershed and 41 is the LA watershed (Figures 7, 8).

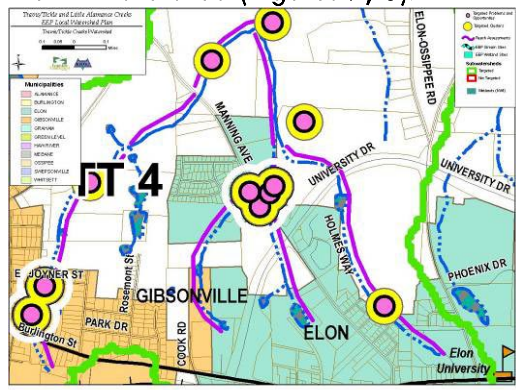

Figure 4: Clustering of Potential BMPs Within 100 yds

Completed LATT Field Work 4/30 - 5/16			
Subwatershed	**Stream Miles Covered**	**Total Stream Miles**	**BMPs Identified**
LA2	2.07	3.064	32
LA3	1.34	2.518	18
LA5	0.65	1.748	6
LA6	1.70	2.928	7
LA 7	2.16	3.015	16
LA 10 - partial	0.94	3.225	4
LA12	2.33	6.291	35
LA13	7.11	1.047	38
Little Alamance Totals	**18.3**	**23.836**	**156**
Percentage of Streams Walked	**77%**		
TT4	4.88	10.397	23
TT6	4.57	17.093	23
TT7	2.41	12.046	20
TT8	1.54	9.076	3
TT11	2.40	8.279	21
Totals	**15.8**	**56.891**	**90**
Percentage of Streams Walked	**28%**		

Table 1: Potential Projects Identified Through LATT Field Work

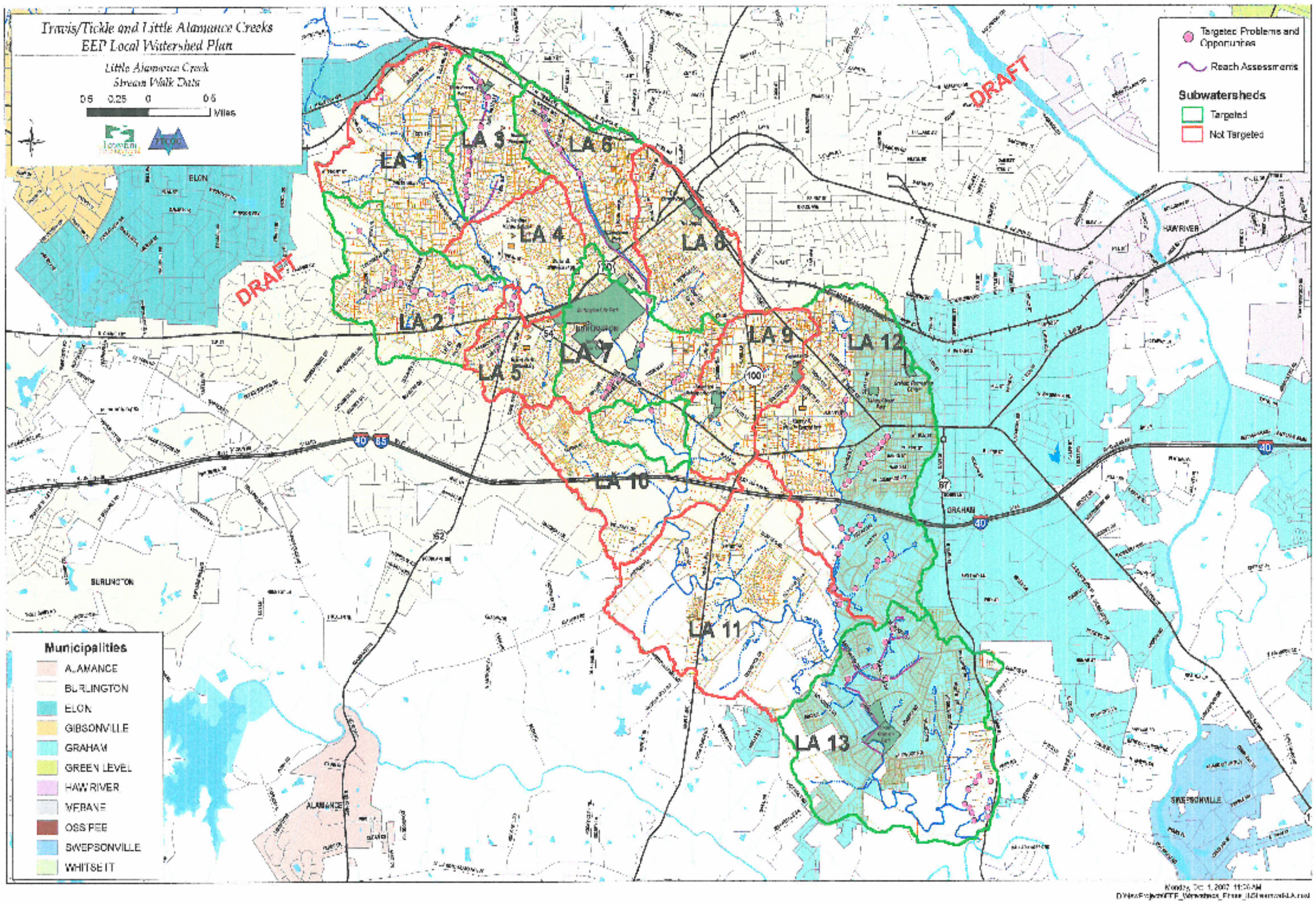

Figure 5: Potential Projects Identified by LA Fieldwork

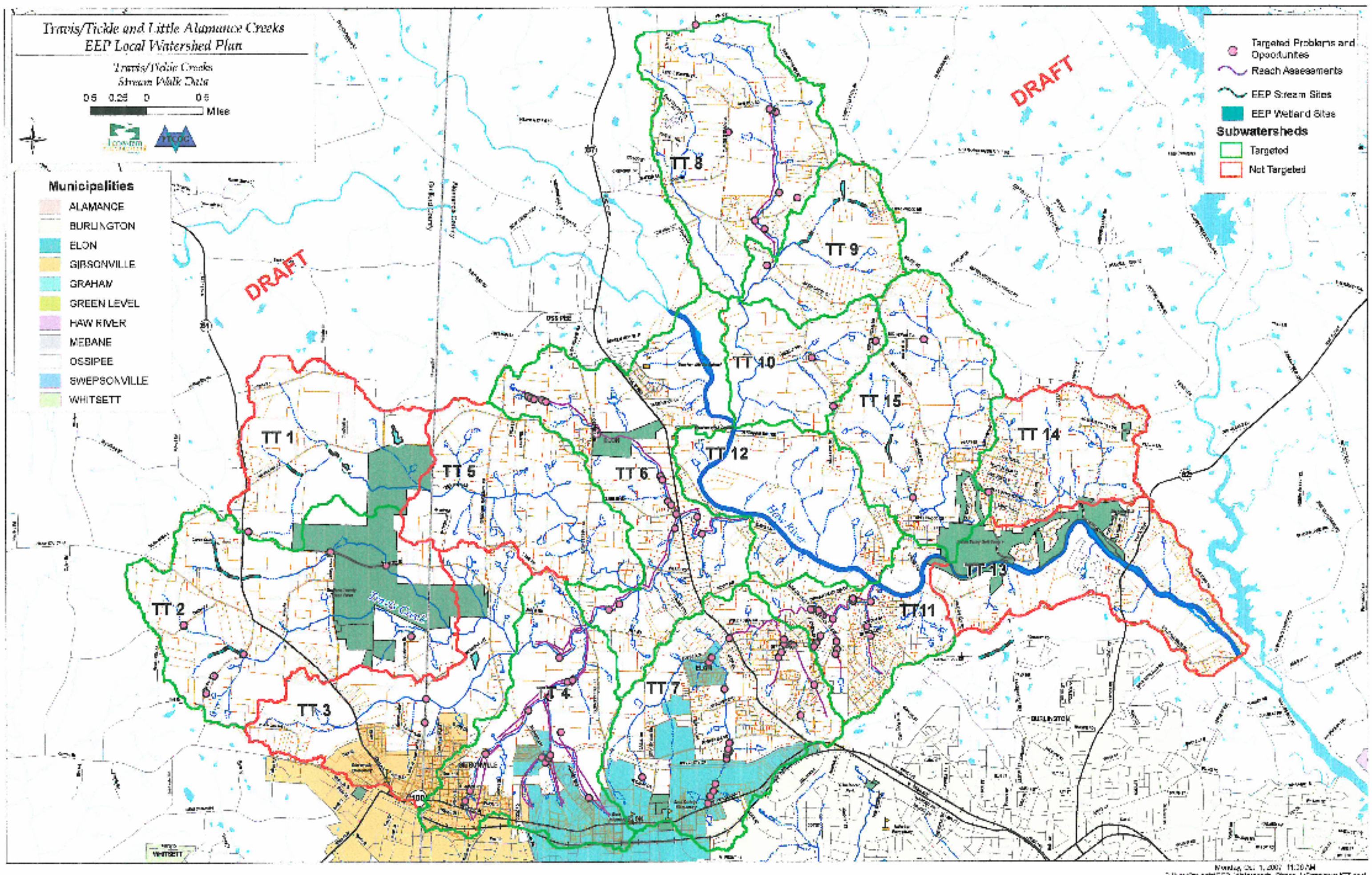

Figure 6: Potential Projects Identified by TT Fieldwork

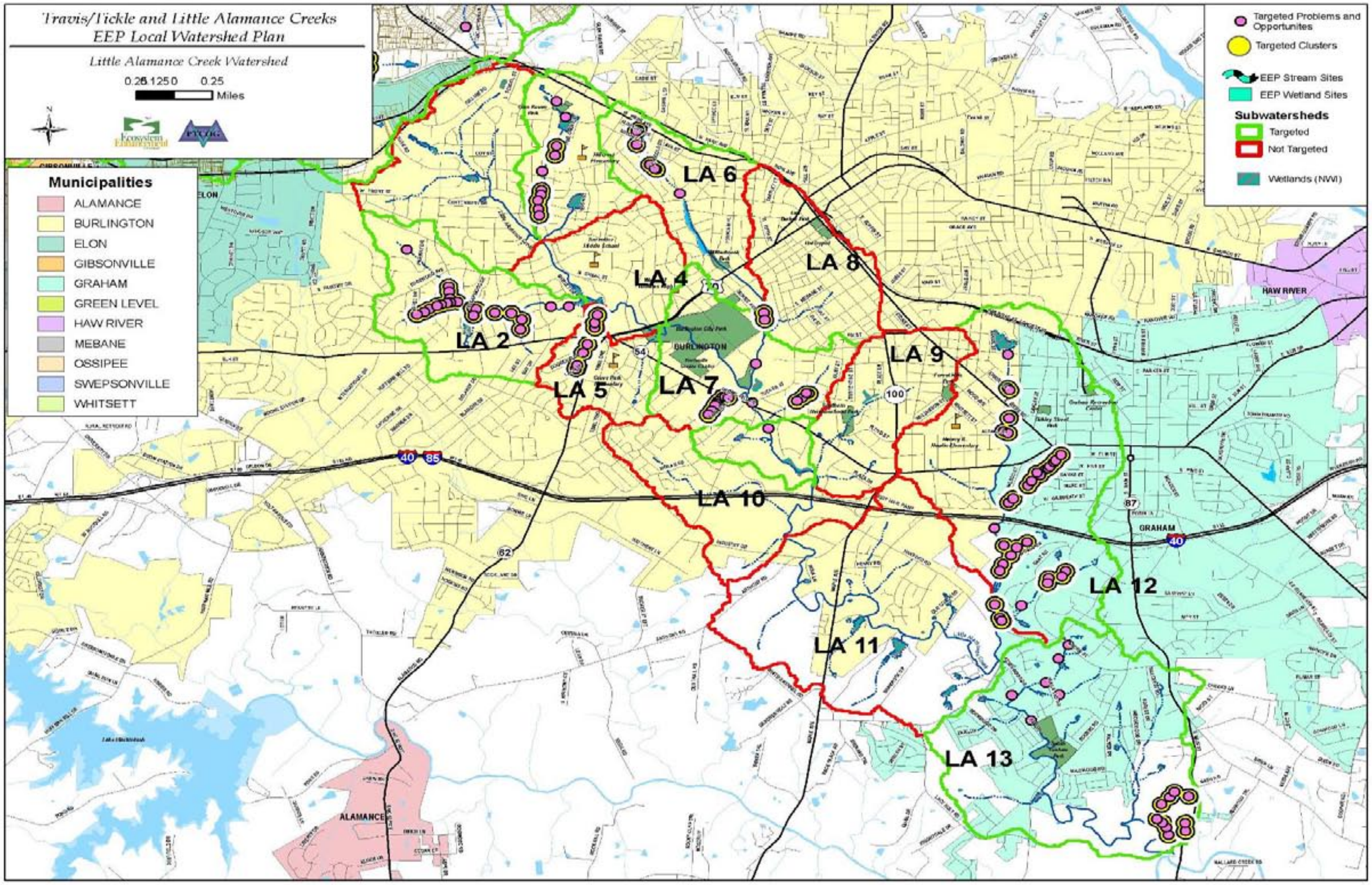

Figure 7: Potential LA BMPs With Clusters

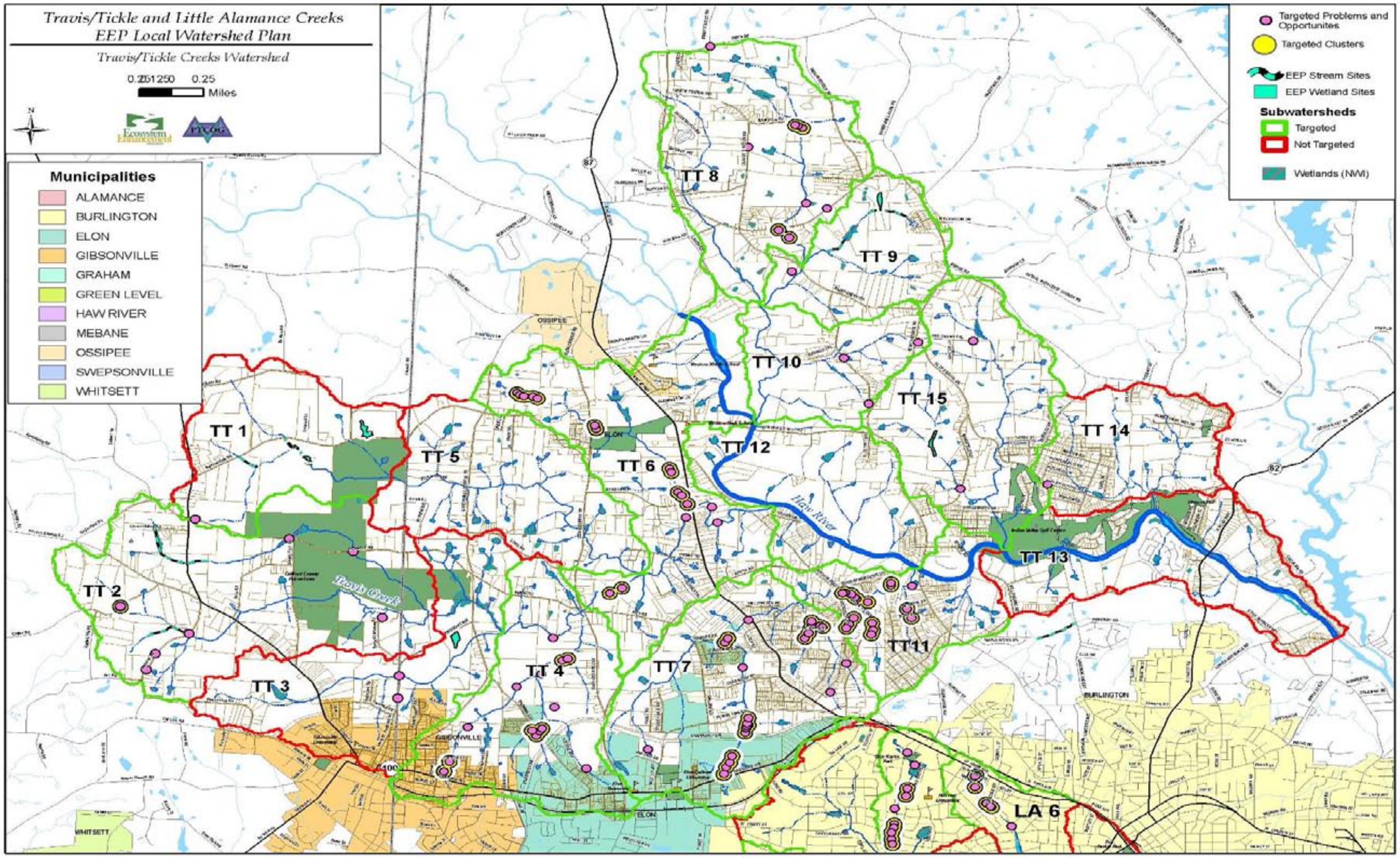

Figure 8: Potential TT BMPs With Clusters

Upland Assessments

Under the CWP approach, urbanized subwatersheds with numerous stormwater and non-point source (NPS) impacts receive the modified USSR assessment, in which the field teams survey the watershed from a car, noting potential impairment sources that could receive further attention. The USSR approach is designed to efficiently survey complex urban landscapes with multiple watershed stressors. In the LATT watersheds, most of the urbanized watersheds received detailed streamwalk assessments, while the rural subwatersheds of the TT watershed were largely unattended to. Furthermore, the more rural landscape of TT watershed required a more efficient use of resources to cover large amounts of land covered by larger parcels. These lands are also under greater development expansion pressure, and may require more immediate attention than the already developed urban areas of LA watershed. This approach was not applied to upland urban impacts, as it has been in other restoration efforts.

The PTCOG and EcoLogic staffs surveyed the subwatersheds TT 2, TT 8, TT 9, TT 10, TT 12, & TT 15 for possible preservation, conservation, restoration, and green space opportunities. These data were then incorporated by the PTCOG into the watershed Geodatabase and Excel database (Figures 5 & 6; Appendix A). These subwatersheds were identified in Phase I as having important resources warranting conservation consideration, and GIS analysis that highlighted large parcels with steep slopes and floodplain lands. . LA watershed was not included in these upland assessments, as the watershed restoration opportunities there were highlighted through the more intensive and thorough streamwalk assessments. The less intensive modified USSR approach to watershed assessment yielded fewer but larger project opportunities than the streamwalk assessments. From these upland assessments, PTCOG and EcoLogic found the following 12 potential opportunities:

- 2 wetland restoration opportunities
- 3 riparian enhancement and/or restoration sites
- 3 sites with needed livestock exclusion
- 1 pond that needs to be restored to full function
- 3 sites that are well-tended and in need of preservation efforts

Water Quality Monitoring

The LA and TT watersheds are two distinctly different watersheds. LA Subwatersheds 1-9 are located within the City of Burlington; while subwatersheds 12 and 13 encompass the downstream LA watershed in the City of Graham (Figures 5 & 6). LA is federally-listed for impaired benthic community on the US EPA 303(d) waters database. The Cities of Graham and Burlington are NPDES Phase II communities and are implementing the stormwater management measures required under this program.

Both Travis and Tickle Creeks were listed as "impaired" for biological habitat on the NC DWQ's 2008 draft 303(d) list. The sources of impairment to Travis and Tickle Creeks are currently listed as unknown, but they are estimated to be due to a combination of agricultural and stormwater impacts from surrounding landscapes. The northern watershed is entirely rural, and field assessments and DWQ monitoring data indicate that these streams' impairment is largely due to a lack of riparian buffers and livestock exclusion from these waters. The Towns of Elon and Gibsonville are located in three urbanized subwatersheds in the southeast portion of the Travis and Tickle Creek Watershed. These towns are NPDES Phase II communities and are implementing the stormwater management measures required by federal and state regulations. Tickle Creek and the headwaters of Travis Creek are also subject to high turbidity and nitrogen levels. This indicates agricultural impacts from livestock and fertilizer runoff that could be remedied with exclusion fencing and a riparian buffer network.

The NC DWQ conducted subwatershed monitoring, as described in *Evaluation of Water Quality, Habitat, and Stream Biology in the Little Alamance, Tickle, and Travis Creek Watersheds* (NC DENR, 2008). The NC DWQ team sampled:

- Physical and chemical parameters at 20 sites in subwatersheds LA6, 7, 10, 11, &13; and TT1, 2, 3, 4, 5, 6, 7, 9, &15; and
- Benthic macroinvertebrates in subwatersheds LA7, 10, &13 (reference site); and TT4 (reference site), 5, 6, 7, 9, &15.

Figures 9 and 10 are maps of the subwatersheds and sampling sites.

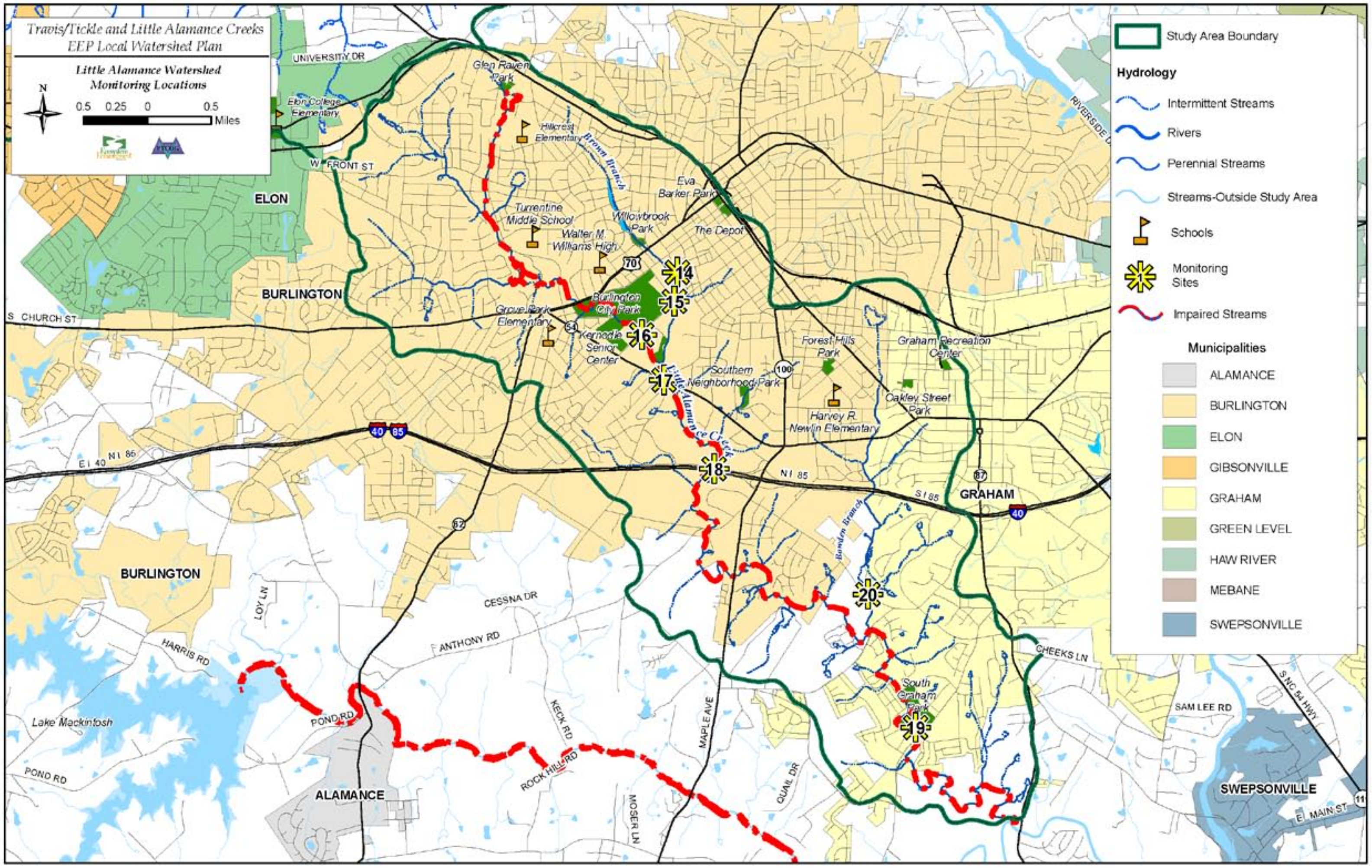

Figure 9: LA DWQ Monitoring Sites

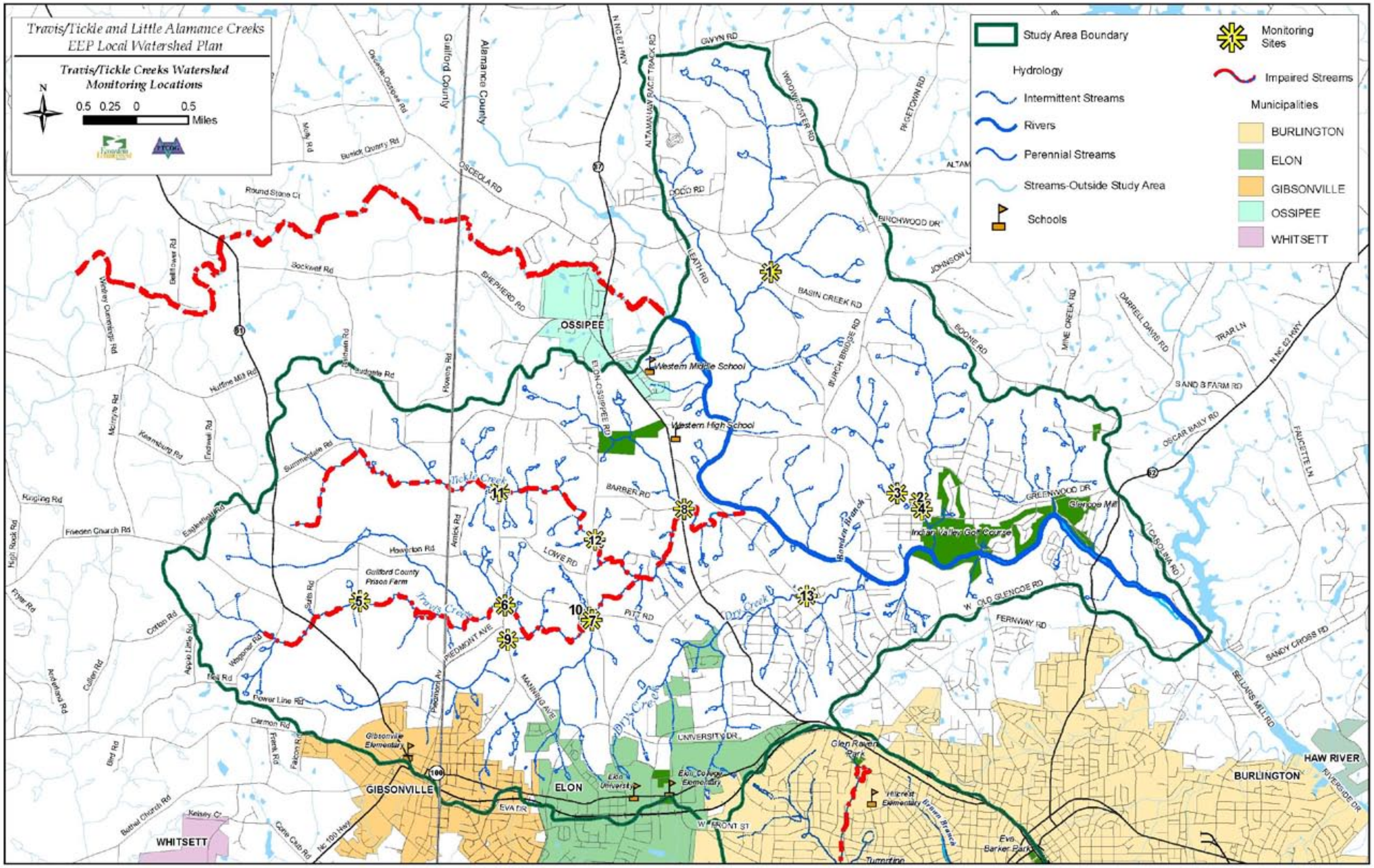

Figure 10: TT DWQ Monitoring Sites

Physical and Chemical Parameters

- The highest counts of fecal coliform bacteria occurred at Site 1 (Basin Creek), a Haw River tributary; Sites 15 and 14 (Willowbrook Creek and a UT to Willowbrook Creek), LA tributaries; and at Site 16 (LA at Mebane St.) Coliform counts in Basin Creek were higher than the rest of the TT watershed, indicating that there may be compromises in the septic systems and/or livestock accessing streams in the area.
- Site 1 had the highest recorded turbidity levels at baseflow; Site 19 (LA at Rogers Rd.) had the highest turbidity levels under stormflow conditions. The LA watershed headwaters had the lowest turbidity levels.

Both fixed and volatile total suspended solids (TSS) levels were highest at Site 1. Site 14 had comparable TSS-volatile levels following storm events.

- Three metals were found within the LATT watersheds
  - Copper was found at multiple sites in the watersheds. It was found above the NC DWQ action level (7 μg/L) at baseflow at Site 19. Only two stormflow samples had no copper present in them; all stormflow samples had copper concentrations that violated the action level.
  - Lead was recorded above the reporting limit (14 μg/L) at Site 15 one time, following a storm event. Lead is a potentially toxic element linked to developmental disabilities in children.
  - Like copper, zinc was measured in all but two stormflow samples. It was detected above the action level (50 μg/L) in baseflows at Site 15 one time, and on the same date as the lead detection. Zinc was also recorded at measurable levels four times from baseflow samples.
- Sodium levels were highest in the LA watershed, and specifically in the City of Burlington. The highest concentrations were measured at Sites 14 and 15. High sodium levels can be indicative of failures in sewage system infrastructure.
- Site 1 had the highest ammonia levels in the TT watershed, though Site 11 (Tickle Creek at Gibsonville-Ossipee Road (aka SR NC1500) had notably high levels.
- The highest levels for all nitrogen species amongst all LATT sites were consistently found at Site 16. The origin of this pollution is unknown, but could be correlated with elevated sodium levels, indicating leaky sewage lines.
- The highest phosphorous values in the LATT watersheds were consistently found at Sites 1 and 14. Stormflow measurements of phosphorous were consistently higher than baseflow levels.
- Aluminum, iron, and manganese were all recorded at higher levels in the TT watershed than in LA watershed. These metals are common in the soils of the Piedmont region of NC, and are often evidence of soil erosion. Their higher concentrations in stormflow could be reflective of high erosion levels. These metals are not of public health concern at the levels measured.

The DWQ made the following observations and conclusions within the two watersheds:

- The LA watershed area is degraded largely due to the effects of urbanization.
- Due to the gravity of the monitoring results, LA is the primary watershed of concern, particularly its headwater tributaries. This watershed will require considerable attention to prevent further degradation, restore water quality, and improve conditions for aquatic organisms
- The TT watershed currently is less impacted than the LA watershed, but shows signs of degradation. Development in this area very likely will lead to further stream degradation and more water quality issues unless some effort is made to ameliorate current problem areas and to prevent degradation at other sites. Currently, most of the attention in this watershed needs to be directed toward issues of bank stability and maintaining the continuity of the riparian zone.
- The Basin Creek subwatershed has elevated fecal coliform and nutrient levels, likely due to cattle access in its headwaters.
- An unnamed tributary southeast of Basin Creek has high-qualtiy aquatic bug communities illustrative of minimally impacted streams.
- The headwaters of Dry Creek are urban, and development is progressing downstream toward the Haw River. Further degradation of this stream is expected unless an effort is made to preserve the riparian zone. Sites 5 & 6 illustrate conditions which could be contributing to impairment in Travis Creek. Site 5 is upstream of the large Guilford County Prison Farm. Site 6, downstream of the farm, has higher levels of Total Phosphorus Nitrogen and higher turbidities. Streams on this farm are accessed by cattle and lack adequate riparian forest cover. These stressors negatively impact aquatic ecosystems, and may be a primary contributor to impairment of Travis Creek.

<u>Aquatic Life (Benthic Macroinvertebrates)</u>

Prior to this LWP, biological sampling, including benthic macroinvertebrate and fish community monitoring, was conducted in LA from 1985 to 2003, with most samples collected in 2003. LA has been rated either “Poor” or “Fair” by NC DWQ at all sites since 1985. LA at SR 2309 was sampled three times for fish in the past. It rated “Good” in 2003, “Fair” in 1998, and “Good” in 1993 (NCDENR 2005). Prior to this study, Travis and Tickle Creeks had not been sampled for benthic macroinvertebrates, thus no prior data are available. Biological assessments conducted in 2006 resulted in LA receiving "Poor" bioclassifications and Tickle and Travis Creeks receiving "Fair" bioclassifications. These two bioclassifications denote depressed biological communities and resulted in these streams being placed on EPA's 2008 303(d) draft list.

As part of the LATT LWP, NC DWQ sampled 10 sites in TT and 3 sites in LA for benthic macroinvertebrates in Fall 2006. LA was clearly more impaired than TT, and this is likely due to the effects of urbanized areas with high percentages of impervious surface (NC DENR, 2005; NC DENR, 2006). However, the presences of high metals levels – including lead – and conductivity indicate the presence of other pollutants on Willowbrook Creek (aka Brown Branch). An unnamed tributary (UT) of the Haw River in subwatershed TT 15 has exemplary biological habitat, with the presences of two intolerant caddisfly species noted. Many of the other tributaries in this watershed are depleted of oxygen and have high fecal coliform bacteria levels, best seen in Basin Creek, a northern tributary of the Haw River. These are often attributed to unmitigated runoff of animal waste and denuded soils from an adjacent stockyard and cattle pasture.

LATT Water Monitoring Challenges

Drought Conditions

NC experienced the worst drought in recorded history from 2007 – 2008; as of this report, it persists (NCDC, 2008). The Piedmont region was notably affected by this drought, and the water quality sampling data that DWQ conducted may have been affected by these conditions. In the words of the report: "*..there were several occasions of low flow throughout the LATT LWP area and no observable flow on several occasions* [in perennial streams]*, especially in the smaller tributaries. Most of the smaller tributaries were not sampled for macrobenthos, and samples could not be collected on several occasions.*" According to NC DWQ, this may have slowed stream flow, lowered dissolved oxygen concentration raised water temperature, increased pollutant concentrations, and/or been hospitable for organisms that thrive under stressful conditions, notably algae. The macrobenthic communities assessed in September 2006, however, were likely not significantly impacted by the "Abnormally Dry" conditions the chemical and physical data were sampled under. Taxa collected at that time (e.g., mayflies and caddisflies) indicated that streams were experiencing continuous flow.

Stormflow vs. Baseflow Results

Stormwater impacts watershed health numerous ways. For the purposes of water quality testing, it is known to significantly raise pollutant concentrations, particularly of fecal coliform bacteria, total phosphorous, metals, and turbidity. This is especially true in the first of the first inch of rainfall, in which pollutants are most highly concentrated. Furthermore, impervious surfaces increases stormwater volume and intensity, which will result in the disturbance of stream sediment, and any pollutants that have bound the sediment. This can include volatile organic substances and toxic, hydrophobic industrial byproducts. These potential impacts must be acknowledged when analyzing data sampled following precipitation events, which includes a number of values that violate NC standards.

Urbanization

Urban areas concentrate impervious surfaces and augment stormwater impacts upon water quality. They also serve as concentrations of residents, and increase pollution levels associated with human activity, such as hydrocarbons from automobile use. In examining the otherwise physically similar TT and LA watersheds, a correlation between urbanization and impaired habitats in the LA watershed must be acknowledged.

Watershed Restoration Project Prioritization

Following the field work in the LATT watersheds, the PTCOG developed a list of potential projects for the watershed. Using the *Little Lick Creek Local Watershed Plan* (UNRBA, 2006) protocol for Conservation Assessment as a basis for parcel prioritization, projects were prioritized based upon both their occupancy of, or proximity to, a potential restoration project, and their land attributes.

The LATT Conservation Assessment is a GIS-based analysis, which values fourteen land parcel attributes, adding them together for potentially a total value of 26 (See Table 2). The highest Conservation Value of a parcel was 19. The attributes were selected based upon the accuracy they reflect of a land use's potential conservation value to the watershed. Larger, steeper, forested publicly-owned parcels with wetland and streams that have either been preserved as agricultural or sited with a potential project are of the most value for preservation and/or enhancement. Lands in close proximity to such attributes can also contribute to ecological conservation in the watersheds by coordinating efforts amongst parcels that can have synergistic benefit for water quality. While this approach is not perfect, it is accurate at identifying most of the watershed's ecologically valuable lands. Parcels that were not selected by this process but had value to stakeholders were manually selected and included in a GIS shapefile and database (Figure 11).

A build-out scenario is a powerful tool in predicting lands prone to development pressures. However, in the absence of any Transportation Analysis Zone (TAZ) studies in the area and a lack of land use zoning in Alamance County, informative build-out scenarios are not possible.

LATT Conservation Analysis		
Parameter		Possible Points
Impervious Surface	<5%	
	<10%	
	<20%	3
Wetlands		1
100-Year Floodplain		1
Slope	>15%	1
Soils	"Highly Erodible"	1
Forest Cover	>50%	1
Stream Buffer Presence	>330 ft	
	>100 ft	
	>50 ft	3
Acreage	>50	
	>20	
	>10	3
Public Land	Parcel	
	Within .25-miles	2
VAD Land	Parcel	
	Within .25-miles	2
Haw River Corridor	Parcel	
	Within .25-miles	2
EEP Site	Parcel	
	Within .25-miles	2
Potential BMP Site	Parcel	
	Within .25-miles	2
DWQ Monitoring Site	Within .50-miles of Noted "Good" Water Quality	1
		25

Table 2: LATT Conservation Attributes

The Stressor Assessment attempts to highlight areas that are in need of more immediate restoration due to current detrimental impacts they are having upon watershed health and/or the potential to be developed and further impact the watershed through a loss of hydrologic and biological function. Similar to the Conservation Assessment, the Stressor Assessment was based solely upon its land use and coverage attributes and proximity or presence of a potential project (See Table 3). Many of the impacts that were observed in the field are not incorporated into this assessment, which is a significant flaw. Continual stakeholder comment and input will, hopefully, remedy these omissions. Some of these attributes are the same for both assessments due to their importance to estimating both conservation and stressor values of parcels (i.e. if steeps slopes are forested, they are less likely to cause soil erosion; if they have already been developed or cleared for agriculture, they are potentially current sources of water quality stress). The cumulative potential Stressor Value is 19; the highest actual Stressor Parcel was 11 (Figure 12).

A parcel's Conservation and Stressor Values were significant factors when determining the sites highlighted in the LATT Project Atlas. It was important both to conserve sensitive lands and target sites currently degrading the water quality the most. Using NC DWQ sampling data to target areas of poor water quality complemented this qualitative approach. Addressing those upstream impacts is a directly effective way to strategically restore water quality to supporting status, while concurrently strategically planning restoration efforts in the downstream areas gives planning staffs hydrologically-based holistic approach to watershed restoration.

LATT Stressor Analysis		
Parameter		Possible Points
Impervious Surface	>20%	3
	>10%	
	>5%	
Wetlands		1
Streams	First-order	1
100-Year Floodplain		1
Slope	>15%	1
Soils	"Highly Erodible"	2
	Hydric	
Stream Buffer Presence	<50 ft	3
	<100 ft	
	<330 ft	
Highway	<.25 miles form Class 1 road	1
Forest Cover	<50%	1
EEP Site	Parcel	2
	Within .25-miles	
Potential BMP Site	Parcel	2
	Within .25-miles	
DWQ Monitoring Site	Within .50-miles of Noted "Poor" Water Quality	1
		19

Table 3: LATT Stressor Attributes

The TT watershed scored more priority parcels within its bounds than did the LA watershed. This is most likely due to two factors: the Haw River and average parcel size. The How River flows through the TT watershed, and parcels adjacent to the river and/or within 0.25 miles of it were considered in the Conservation Assessment. The Haw River is the dominant ecological feature of the region, and many of the stakeholders are interested in its promise as an ecotourism attraction. These communities have already invested in such a future by collectively funding the Haw River Trail coordinator, who has led efforts to conserve lands in the Haw River Corridor. LA watershed is more densely-populated and urbanized than the more agrarian TT watershed. As a result, the land parcels are smaller. With riparian buffers having a potential value of 3 in both the Stressor (for buffers <30, <50, & <100 feet) and Conservation Assessments (for buffers >30, >50, & >100 feet), many mid-sized parcels were left out. From a holisitic perspective, most of the largest LA parcels are mid-sized relative to the largest TT watershed parcels, which are commonly over 50 acres in size.

The DWQ reference site also factored into parcel valuation, and strategic parcel conservation efforts. This site is located in subwatershed TT 15, which includes riparian corridor lands of the Haw River, and could benefit from conservation efforts. It has a large amount of "open space" due to the public golf course within the watershed.

The PTCOG will issue a Phase III document that includes a Project Atlas that details these findings. Each priority project will receive a detailed profile that describes the current land use, land use history, its contribution (or protection) from water

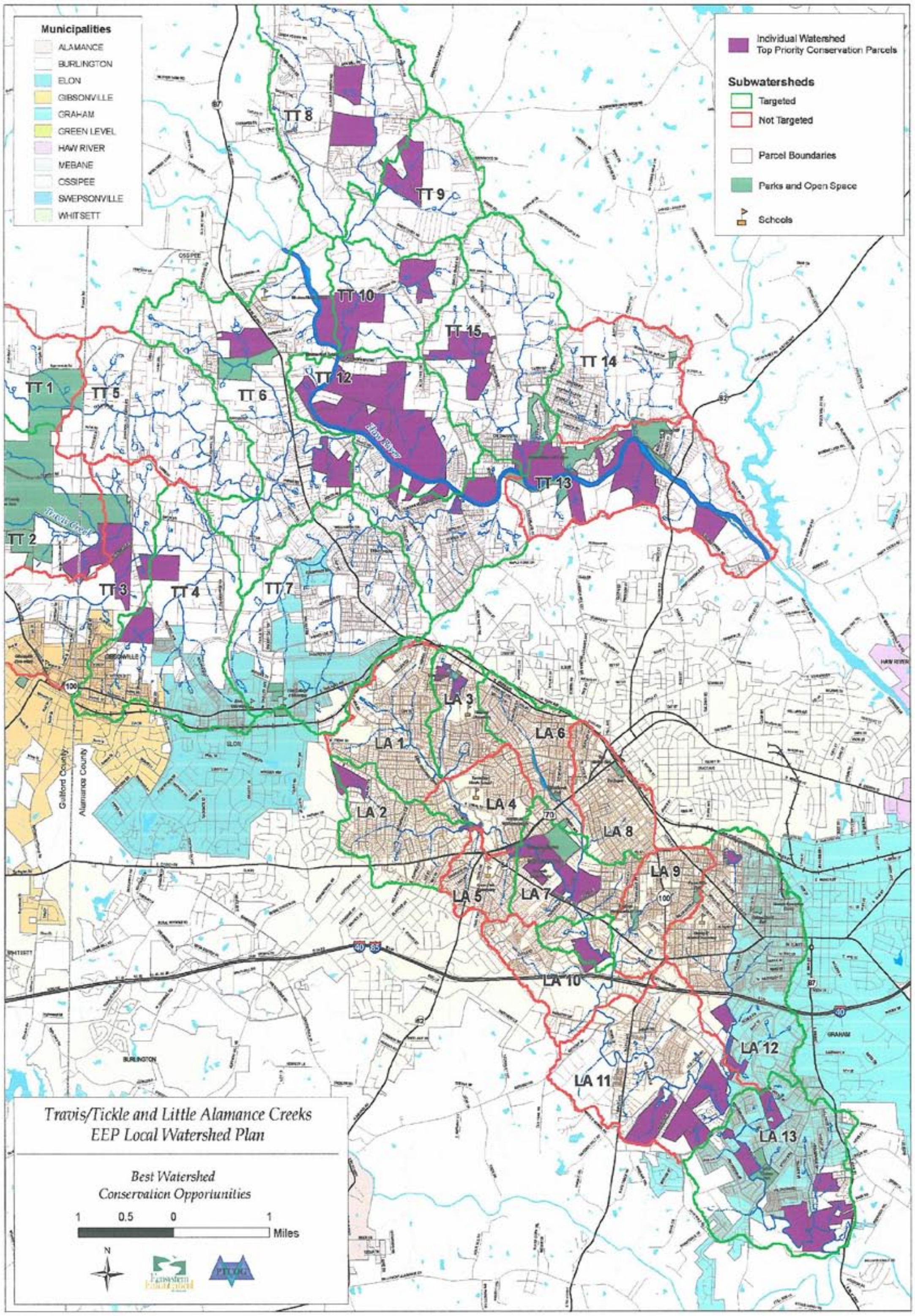

Figure 11: LATT Conservation Priorities

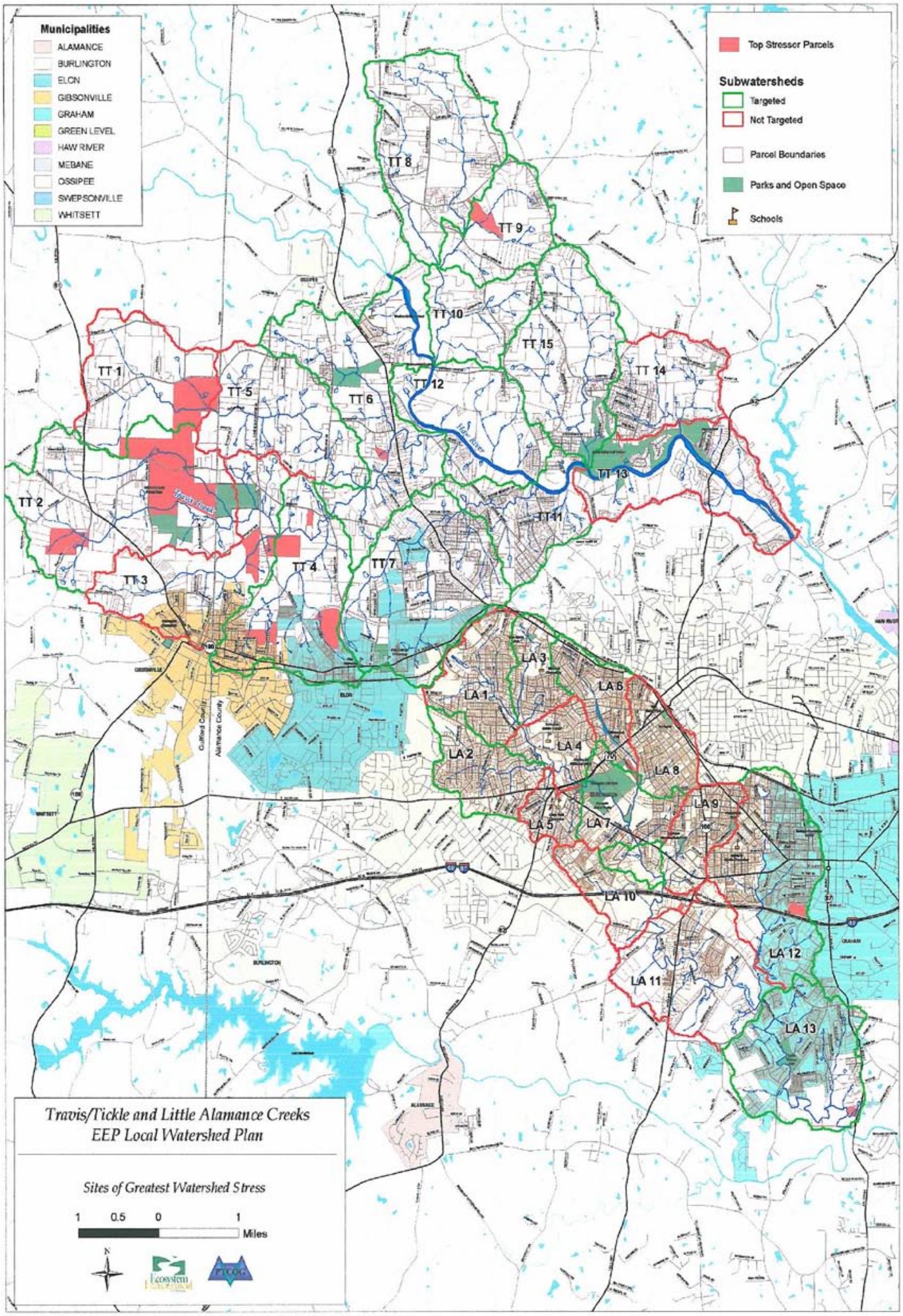

Figure 12: LATT Stressor Priorities

quality impairment, and a recommended management strategy to most effectively restore the riparian and water habitats. The projects will be arranged such that those that can most effectively address water quality concerns for the least resources will be ranked highest. This atlas will include both potential restoration and preservation projects, and address the unique watershed management regimes the LA and TT watersheds require. Included with the Project Atlas are ten policy recommendations that will guide all stakeholders and residents toward sustainable watershed stewardship. The policy and project recommendations are designed to complement each other and effectively restore healthy watershed conditions if implemented together.

Most of the priority projects occur in the TT watershed. Many of these are excellent opportunities for agricultural conservation and watershed protection. The most dramatic example of these opportunities is in subwatershed TT 12. There are three parcels owned by two landowners that total over 500 acres, have an average conservation value of 18, and all have riparian corridors on the Haw River. One of these properties – the Iseley Farm – is being conserved under a collective effort from the land owner, Alamance County Soil & Water Conservation District, Piedmont Land Conservancy, and EEP. This landowner has adapted conservation agricultural practices to decrease their environmental impacts and has placed significant lands under conservation easements.

Both subwatersheds TT 9 and TT 15 have a total of 6 parcels that are included in the Project Atlas for further attention. The TT 15 subwatershed priority parcels total 332 acres, and have an average conservation value of 15. This subwatershed is the site of the relatively pristine NC DWQ monitoring site, and conservation efforts there, especially in the headwaters, could have restorative impacts on downstream waters, such as the Haw River.

The TT 9 subwatershed has over 213 acres in priority lands with an average conservation value of 15 and an average stressor value of only 3. These lands are also upstream of the DWQ Basin Creek monitoring site, which was a site of consistently poor water quality, notably due to high nutrient and fecal coliform levels. These degraded waters are due principally to an upstream stockyard in TT 8 that produces high levels of sediment and manure, but conservation of these other lands could ensure that the waters don't further degrade and/or be part of a coordinated restoration effort of the Basin Creek subwatershed.

It is necessary to also mention TT 4, which includes the suburban areas of Gibsonville and Elon. This subwatershed is not within the city limits, and has high growth potential, especially given the large parcels located there. Amongst the four priority parcels located in this subwatershed, the area totals 232 acres, has an average conservation value of 16, and an average stressor value of only 2. These are desirable lands to maintain as open space for the nearby communities, for water quality benefit, and for Alamance County heritage purposes. At a minimum, development of the parcels should occur in a manner that prevents degradation to water quality and aquatic resources. TT 4 should be viewed as being a top priority under the most development pressures of all priority subwatersheds in the TT watershed.

In LA watershed, the project priorities are almost entirely restoration needs. This is most apparent in subwatershed LA 7, where nine parcels of only 60 acres have an average conservation value of only 2 and a stressor value of 8, including the parcel with the highest stress value of 11. These are almost all office lots of about an acre in size that are completely impervious and without trees. Tree planting at these offices, for example, are a BMP that could potentially offset their stormwater contributions to the LA watershed. They are also on the main stem of Little Alamance Creek, and increase the volumes and intensities of stormwater flow into the catchment. These lands are also downstream of the DWQ site noted for being in the poorest health: the confluence with Willowbrook Creek. While DWQ tries to identify the source(s) of chemical impairment there, land use solutions can also be of restorative benefit. Rehabilitation of the armored channel at the juncture of subwatersheds LA 6, LA 7, & LA 8 is a critical step to reduce the level of impervious surface at a hydrologically critical point in the LA watershed. The City of Graham may be willing to partner on any such restoration efforts, given the downstream impacts Burlington's land uses have had, and the resulting degraded water quality that may be restored through such a project.

These parcels and their associated restoration and/or conservation opportunities were submitted to the public for comment. At their request, a few parcels were included that are local priorities for watershed restoration. Again, all projects, within 100 yards of each other were considered a single potential project, and are considered as such in the final report for this project- *Technical Memorandum #3: LATT Project Atlas*. A total of 58 parcels containing priority projects were identified using this methodology.

Summary

The LATT watersheds are all currently impaired, according to the 2008 Draft 303(d) list. Little Alamance Creek is in much worse shape than the TT watershed streams, and has historically been in need of greater attention. This document describes the current situation in these watersheds; the Phase III document details project and policy solutions to these restore the watersheds to health.

The likely cause of impairment in LA watershed is stormwater runoff due to high levels of impervious surface and lack of stormwater control. Stream walks in this watershed turned up 16 failing stormwater systems, 39 sites where stream banks were stressed and 9 sites where banks were failing due to stress from stormwater runoff. Focusing restoration and stewardship efforts on the urban center of subwatershed LA 7 appears to be an effective way to serve the public and environmental needs of this watershed. Restoration efforts here also may assist in identifying and neutralizing the pollution source of nutrients and metals at the confluence of Willowbrook and Little Alamance Creeks. Improving stormwater management in Burlington is likely to improve the water quality at the downstream monitoring sites in Graham.

TT watershed has better water quality than LA watershed, but still has needs: there are 8 streambank failures, 15 streambanks in need of restoration, and 8 stormwater system needs. TT watershed also offers a number of open space preservation opportunities, which is both a way in which to guide future development and preserve sensitive headwaters and wetlands that serve important hydrologic functions. Working with the Alamance County Soil & Water Conservation District is critical to engaging these landowners: the organization's successful implementation of programs such as voluntary agricultural districts make them the best partner for working in the Tickle, Travis Watershed. There are three subwatersheds that could serve as excellent opportunities to both address water quality concerns and engage the citizenry about watershed stewardship.

Subwatershed TT 9 is an excellent conservation and restoration opportunity. Many of the parcels within it are large parcels that could be preserved as agriculture or open space, as well as serve as a coordinated restoration effort on Basin Creek. It is necessary to directly address the fecal coliform, sediment, and nutrient violations of Basin Creek. Similar efforts could be put forth in TT 4 and TT 11 to protect those waters against northward development from Elon and Burlington. The close proximity of these subwatersheds to the Haw River may have an added economic benefit for all local governments. Equally important, though, is preserving TT 15 as the "Good" water quality subwatershed for all stakeholders to strive towards.

The large number of impacts and needs that could restore the watershed's health and function have been described here, along with some determinations of pollution sources and key subwatersheds for initial work. It is important to focus energies on both restoration and preservation in these watersheds, and it is important to recognize those priority areas for both types of efforts. The Phase III document will provide stakeholders a guiding document on the policy and project needs of the LATT watersheds.

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Appendix A

Little Alamance, Travis, & Tickle Creek Watersheds Field Assessment Data							
Subwatershed	**Category**	**Photo ID**	**Site Description**	**Jurisdiction**	**Action**	**Category Code**	**Color Code**
LA12A	BE	LA86	LDS from Sidney Lane road crossing - GPS Pt 0.05	City of Graham	Buffer enhancement	BE: Buffer Enhancement	Alamance Co.
LA12A	BE	LA88	LDS from Border Street, note LB bank armoring and RB scour	City of Graham	Buffer enhancement	BR: Buffer Restoration	Burlington
LA12A-UT2	BE	LA74	LUS from Wilson St. culvert and eroding RB, notice use of round-up on banks	City of Graham	Buffer enhancement	CE: Cattle Exclusion	Elon
LA12A-UT2	BE	LA83	LUS from W. Pine St., lack of buffer and riprap 200' (est) lined channel to Burton St.	City of Graham	Buffer enhancement	IP: Invasive Plants	Gibsonville
LA12A-UT2	BE	LA84	LUS from Burton St. It is hard to see but 300' (est) channel armored with surge stone,	City of Graham	Buffer enhancement	LE: Landowner Education	Graham
LA12BUT1	BE	LA101	LUS showing 300' narrow pasture buffer that needs to be improved	City of Graham	Buffer enhancement	LJ: Log Jam	
LA13B, RCH 1	BE	NA	Channel north of West Ave has no woody buffer	City of Graham	Enhance buffer with woody plantings	PW: Pond Work	
LA13B, RCH 5	BE	NA	Sewer line right-of-way impacts riparin buffer	City of Graham	Replant some woody plants and alter mowing of ROW	SE; Stream Enhancement	
LA2 Reach 3	BE	LA108	LDS from confluence with UT2 showing bank armoring and lack of buffer	City of Burlington	Buffer enhancement	SP: Stormwater Pipe	
LA2 UT1 Rch 4	BE	LA117	LDS from driveway along Colonial Drive	City of Burlington	Buffer enhancement	SR: Stream Restoration	
LA2 UT1 Rch 4	BE	LA118	LUS from driveway showing riprap channel	City of Burlington	Buffer enhancement	SS: Santiary Sewer Maintenance	
LA2 UT2 Rch 5	BE	LA120	LUS from above Colonial Street, stream ripraped to where it goes underground.	City of Burlington	Buffer enhancement	SW: Stormwater Retrofit	

LA2 UT4 Rch 7	BE	N/A	LDS small narrow buffer below Laurel Hill Dr. to Church St.	City of Burlington	Buffer enhancement
TT4	BE	N/A	Impacted buffer/clear-cutting to stream edge.	Alamance County	Bank stabilization/Planted buffer
TT7A, RCH 9	BE	TT87	Stream work complete and silt fence still in place	Town of Elon	Remove fence and posts
TT7A, RCH1	BE	TT89	Sewer line Right-of-way impacts riparin buffer	Town of Elon	Improve right-of-way maintenance to minimize riparian and creek impacts
TT7B, RCH?	BE	TT108	buffer incrochment ny new devlopment river left	Town of Elon	restore woody buffer
TT7B, RCH?	BE	TT106	buffer incrochment by new devlopment river left	Town of Elon	Survey upland and restore buffer
TT7B, RCH?	BE	TT96	Sediment catchment at head of reach collecting lots of sediment	Town of Elon	Seed and cover exposed surface above this catchment
TT7B, RCH?	BE	TT69	Impacted buffer and duck pond in floodplain	Town of Elon	Buffer planting around lake
	BE	LA66	Creek though mobile home park is lacking woody buffer	Alamance County	Buffer enhancement
	BE		and down cutting in lower reach of picture		Buffer enhancement
LA13A	BE/LE	LA24	Grass clipping actively being dumped in channel at this location and another directly	City of Graham	Landonwer education
LA13A	BE/LE	LA21	Landonwer spraying along streambed and stormwater channel along road. (reach 9B)	City of Graham	Landonwer education/Planted buffer
LA13B, RCH 15	BE/LE	LA32	Mowing to edge of channel	City of Graham	Stop mowing, replant woody buffer
LA7A, RCH 8	BE/LE	LA5	Small creek through residential, buffer lacking	City of Burlington	Work with landowners to restore woody buffer
LA7A, RCH 8	BE/LE	LA6 - LA8	Small creek through residential, buffer lacking	City of Burlington	Work with landowners to restore woody buffer
TT11 Reach 20	BE/LE	TT46	LUS from Gordon St. crossing showing mowed buffer, both banks, GPS Pt.23	Alamance County	Buffer enhancement
TT4	BE/LE	TT6	Impacted buffer/mowing to stream edge.	City of Gibsonville	Landonwer education/Planted buffer
TT4	BE/LE	TT7	Impacted buffer/mowing to stream edge.	City of Gibsonville	Landonwer education/Planted buffer
TT4	BE/LE	TT89	Impacted buffer/mowing to stream edge.	Alamance County	Landonwer education
TT4	BE/LE	TT15	Impacted buffer on left side along yards	Alamance County	Landowner education/planting

TR: Trash Dump

WE: Wetland Enhancement

WT: Wetland Preservation

WR: Wetland Restoration

TT6A	BE/LE	TT60	LDS lack of buffer LB for 800', with riprap on first 50', GPS Pt 28. Landowner throwing	Alamance County	Buffer enhancement
TT6A	BE/LE	TT62	LDS lack of buffer in yards	Alamance County	Buffer enhancement
TT4	BE/SP	TT19	Impacted buffer/bank erosion and culvert undermining (reach 12)	Town of Elon	Stream design/bank stabilization
LA13B, RCH 15	BR	LA36	Lake at head of reach has no woody buffer	City of Graham	Buffer planting around lake
LA13B, RCH 9	BR	N/A	Failing Armored banks	City of Graham	bankfull bench, plant woodies
LA2 UT4 Rch 7	BR	N/A	LS showing lack of buffer to bridge and back waters of lake, end of stream	City of Burlington	Buffer enhancement/bank stabilization
LA7A, RCH 3	BR	LA1	Bare banks with no veg	City of Burlington	Stop herbicide spraying, Plant woody riparian plants
LA7A, RCH 3	BR	LA2	Bare banks with no veg	City of Burlington	Stop herbicide spraying, Plant woody riparian plants
LA7A, RCH 8	BR	LA11, LA12	Reach has armored banks and no riparin buffer in commercial area	City of Burlington	Recommend landscape treatments that benefit the creek and allow the bussness to be seen.
LA7B, RCH?	BR	LA18, LA19	Armored and naked channel with some bank failure	City of Burlington	Work with landowners to stabilize banks and add some woody plants in buffer
LA7B, RCH?	BR	LA20	Riparian buffer impacted by mowing, no woodies and bank failure	City of Burlington	Riparin buffer restoration (Good Demonstration site!)
LA7B, RCH?	BR	LA17	New house with bare soil to water line	City of Burlington	Inform Sediment Inspector and Restore buffer
TT11 Reach 20	BR	TT45	LDS below St. Regis Drive showing approx 160' of no buffer, GPS Pt 18	Alamance County	Buffer enhancement
TT11 Reach 20	BR	TT46	LDS from Gordon St. showing lack of buffer. RB, GPS Pt 23	Alamance County	Buffer enhancement
TT7A, RCH 10	CE	TT84	Animal Crossing	Town of Elon	Culverted dry crossing or hardened stream crossing and animal exclusion from creek
LA6	IP	LA53, LA54	Invasive weeds (periwinkle, poison ivy, privet, clematis (reach 2)	City of Burlington	Invasive weed control
LA7B, RCH?	IP	LA13	Large patch of bamboo covering more than 100 meters of river left	City of Burlington	Consider control to contain the spread up and down stream
TT6A	IP	TT61	Bamboo grove, invasive exotic	Alamance County	remove bamboo grove/bank stabilization
	IP	LA72	Channel ok but buffer is heavily infested with invasive privet and	Alamance County	Invasive Exotoc plant removal

			other plants		
LA13B, RCH 16	LE	N/A	Ungrounded water pump in creek used by nursery to irrigate from creek	City of Graham	Check with nursery, recommend grounding pump
LA13B, RCH 17	LE	LA35	Reach starts at gray water drain from nearby house	City of Graham	Graywater BMP
LA13B, RCH 8	LE	NA	Many back yard buffer impacts	City of Graham	Educate about buffer restoration
LA6	LE	LA51	Preservation candidate	City of Burlington	Landonwer education
LA7A, RCH 8	LE	LA9	Landowner cuting channel banks with spade	City of Burlington	Work with landowners to restore stabile channel geomentry
TT7B, RCH?	LE	TT94, TT96	River right missing buffer in residential back yards	Town of Elon	Landowner education
TT8	LE	N/A	Preservation candidate below clear cut and through wooded section in reach 4	Alamance County	Landonwer education
LA13A	LJ	N/A	Log debris jam (reach 1)	City of Graham	Remove debris jam
LA13A	LJ	N/A	Extremely large log jam (roughly 20 large trees) (reach 3)	City of Graham	Remove debris jam
LA13B, RCH 16	LJ	LA31	Log and trash jams in creek	City of Graham	Cut or remove logs that span the channel
LA7A, RCH 5	LJ	LA3	Tall eroding bank on river right	City of Burlington	Remove logjam and lay back bank and plant
LA7A, RCH 6	LJ	LA4	Log and trash jam at bridge box	City of Burlington	Remove logjam
LA7A, RCH NA	LJ	N/A	Little Alamance Creek through Central Park has two bever pond that need removing.	City of Burlington	
TT4	LJ	TT17	Log jam	Alamance County	Remove log jam
TT6B	LJ	TT49	LDS to large debris jam, starting to blow out RB where Alex is standing, GPS Pt 21	Alamance County	Remove debris jam/bank stabilization
TT6B	LJ	TT51	Debris jam causing severe bank erosion on LB-LDS, cut out logs GPS Pt 32	Alamance County	Remove debris jam/bank stabilization
TT7A, RCH1	LJ	TT88	Beaver dams across channel	Town of Elon	Remove or manage beavers
TT7A, RCH1	LJ	TT90	Log and trash jam at bridge box NC Hwy 87	Town of Elon	Remove
TT7B, RCH?	LJ	TT105	log jam in creek	Town of Elon	remove log jam
	LJ	LA71	Log and trash jams just below Mobile home park	Town of Elon	clear channel of obsiticles
LA12B	LJ/TR	LA93	6' high debris jam and trash collector that needs to be removed	City of Graham	Remove debris jam
LA12B	LJ/TR	LA94	Second 6' high debris jam and trash collector that needs to be	City of Graham	Remove debris jam

			removed		
LA13A	PW	LA22	Algea in pond, landowner interested in water quality and cleaning pond	City of Graham	Upstream BMP's/landowner
LA13B, RCH 1	PW	N/A	Pond North of West Ave emits foul water	City of Graham	Standpipe Repair, Pond Aeration, Drain Pond
LA13B, RCH 17	PW	N/A	pond has no overflow pipe and dam is leaking	City of Graham	Check dam integrity and retrofit as needed
TT7A, RCH1	PW	TT76	Pond overfull	Town of Elon	Fix overflow system
TT7B, RCH?	PW	TT98, TT99	Pond filling with sediment	Town of Elon	Install catchment basin and seed and cover upland
LA12A	SE	LA89	LB eroding at GPS Pt 0.38, needs to be stabilized before impacts sewer line	City of Graham	Bank stabilization
LA12A	SE	LA91	LB scour opposite cement bag wall	City of Graham	Bank stabilization
LA12A-UT2	SE	LA73	LDS, eroding LB and house (being threatened by bank erosion)	City of Graham	Bank stabilization
LA12A-UT2	SE	LA75	LUS from Ward St., notice use of round-up by town (LB-LDS)	City of Graham	Bank stabilization/buffer enhancement
LA12A-UT2	SE	LA76	severe erosion (LDS-LB) threatening Banks Street-easy to repair with reshaping	City of Graham	Bank stabilization/buffer enhancement
LA12A-UT2	SE	LA79	LUS 300'+ retaining wall being undercut and in danger of failure	City of Graham	Bank stabilization but will be difficult
LA12A-UT2	SE	LA80	LUS showing lined channel, both banks and bedrock outcropping at Franklin St.	City of Graham	Bank stabilization but will be difficult
LA12A-UT2	SE	LA85	LUS to W. Elm St. showing house being undermined by creek. Stream channel on	City of Graham	Bank stabilization and remove culvert
LA12B	SE	LA92	LDS showing 100' of bank erosion and undercutting	City of Graham	Bank stabilization
LA12B	SE	LA95	LDS at severe 7' high bank scour, LB	City of Graham	Bank stabilization
LA12B	SE	LA96	LDS at 500'+ of severe bank scour & erosion along 10' high banks, backwaters VFW lake	City of Graham	Bank stabilization/buffer enhancement
LA12B	SE	LA97	LDS at severe bank scour and 10'-12' high banks, backwaters of old VFW lake bed.	City of Graham	Bank stabilization/buffer enhancement
LA12B	SE	LA98	LDS at severe bank erosion, both banks	City of Graham	Bank stabilization/buffer enhancement
LA12B	SE	LA99	LDS at 25' high severe bank scour/erosion. This is the site of the old VFW dam	City of Graham	Bank stabilization/buffer enhancement

LA13A	SE		Bank Erosion (reach 1)	City of Graham	Bank stabilization
LA13B, RCH 16	SE	LA37	Creek enters pipe with grass catcher gill and over flow hole	City of Graham	Remove grass grill and fill hole, or daylight creek
LA13B, RCH 2	SE	N/A	Channel south of West Ave straight, entrenched and poor buffer	City of Graham	bankfull bench, plant woodies, remove invasives
LA13B, RCH 9	SE	N/A	Eroding Plunge Pool at Broadway Dr. Culvert	City of Graham	Stabilize failing banks and defect flow from banks
LA2 Reach 2	SE	LA103	LUS from Shadowbrook Drive at junction of Westover, 50' eroding bank that would be	City of Burlington	Bank stabilization/buffer enhancement
LA2 Reach 2	SE	LA105	LUS to brick lined channel & confluence UT1. Notice drop outlet at concrete apron.	City of Burlington	This entire structure should be removed
LA2 Reach 3	SE	LA112	LDS to backwaters of lake showing impacted buffer and bank armoring	City of Burlington	Buffer enhancement/bank stabilization
LA2 UT1 Rch 4	SE	LA114	LUS above Shadowbrook Drive, 125' eroding banks, both sides	City of Burlington	Bank stabilization/buffer enhancement
LA2 UT1 Rch 4	SE	LA115	LDS below Westbrook Drive showing riprap channel	City of Burlington	Buffer enhancement
LA2 UT1 Rch 4	SE	LA119	LUS above Westbrook Drive, vegetation growing in channel	City of Burlington	Buffer enhancement
LA2 UT1 Rch 4	SE	LA116	LDS LB erosion problem, not large but will get worse is not corrected	City of Burlington	Bank stabilization/buffer enhancement
LA2 UT4 Rch 7	SE	N/A	LDS below Lacy St. showing bank erosion	City of Burlington	Bank stabilization/buffer enhancement
LA2 UT4 Rch 7	SE	N/A	LDS showing lack of buffer along 600'+ of stream channel in residential development	City of Burlington	Buffer enhancement/bank stabilization
LA3	SE	LA45	Bank Failure at culvert, power pole in standing water (reach 8)	City of Burlington	Bank stabilization
LA3	SE	LA47	Bank Failure below culvert on both banks (reach 8) landowner has contacted Gary	City of Burlington	Bank stabilization
LA6	SE	LA52	Bank stabilization failure (reach 2)	City of Burlington	Remove and provide bank stabilization
TT11 Reach 19	SE	TT65	LDS 70'+ severe bank erosion, GPS Pt 6	Alamance County	Bank stabilization
TT11 Reach 19	SE	TT64	11 LDS showing severe bank erosion below sever line crossing GPS Pt 10; 12 LUS to	Alamance County	Bank stabilization & debris removal
TT4	SE	TT8	Bank erosion, but also good candidate for preservation (good buffer, contiguous landowner)	Alamance County	Bank stabilization/Landowner education
TT4	SE	TT9	Bank erosion, resulting from clear-cutting.	Alamance County	Bank stabilization/Planted buffer

TT6A	SE	TT59	Old stream ford causing a channel block and fish barrier	Alamance County	Restoration - remove blockage
TT6A	SE	TT59	LUS bank scour that goes around the bend for 100', GPS Pt 26	Alamance County	Bank stabilization
TT6B	SE	TT50	LDS at 100' of severe bank scour, GPS Pt 28	Alamance County	Bank stabilization
TT6B	SE	N/A	LDS showing severe high bank scour, approx. 200' long, GPS Pt 33	Alamance County	Bank stabilization
TT7A, RCH 10	SE	TT83	Fish passage problem at culvert	Town of Elon	modify culvert or pool elevation to allow fish passage upstream
TT7B, RCH?	SE	TT103	Bare earth stream crossing for sewer line maintenance	Town of Elon	seed and cover exposed surface
TT7B, RCH?	SE	TT100	Stream culvert opens under road shoulder	Town of Elon	Extend cuvert and imporve headwall
TT8	SE	N/A	Bank erosion on left and right bank (reach 2)	Alamance County	Bank stabilization (access may be an issue)
	SE	N/A	Along the creek from Hilldale Dr to Little Alamance opportunity for daylighing and other BMPs behind the old mill		
	SE	N/A	downstream side of W. Elm St. culvert is concrete lined for 25' until it reaches the		Remove concrete apron-restore channel
LA12A	SE or SR	LA90	LDS at RB armored with cement bags for approx. 200' - bank armoring	City of Graham	Remove wall and bank enhancement
LA2 Reach 2	SE/BE	LA104	LDS along Shadowbrook Drive and 300' of riprap, both banks	City of Burlington	Buffer enhancement
LA2 Reach 2	SE/BE	LA106	LDS to Oakland Drive, eroding RB that landowner wants fixed. LB ok	City of Burlington	Bank stabilization/buffer enhancement
TT6B	SE/BR	TT48	4 LDS showing RB with less than 10' wide buffer, approx 1500' long, PGS Pt 4;	Alamance County	Buffer restoration/bank stabilization
	SE/BR		5 LDS, RB needs stabilization and buffer GPS Pt 6; 6 LUS showing lack of buffer from		
LA2 Reach 3	SE/IP	LA111	LDS to impacted buffer with some bamboo	City of Burlington	Buffer enhancement/bank stabilization
LA2 UT4 Rch 7	SE/SR	N/A	LDS showing bank erosion/scour that is common along this reach	City of Burlington	Buffer enhancement/bank stabilization
LA3	SE/SR	LA42	Bank Failure (reach 7)	City of Burlington	Bank stabilization
LA3	SE/SR	LA46	Bank modification failing (reach 8)	City of Burlington	Bank stabilization
TT4	SE/SW	TT12,	Impacted buffer/bank erosion	Town of Elon	Stream design/bank

		TT13	(reach 9)		stabilization
LA12A-UT2	SF	LA81	LDS to Franklin street culvert and undercutting of road curbs, LB	City of Graham	Repair roadway undercutting
LA13A	SF	N/A	Stormwater channel entrance to stream	City of Graham	Dissipator
LA13A	SF	N/A	Stormwater channel entrance to stream	City of Graham	Dissipator
LA13A	SF	N/A	Stormwater channel entrance to stream	City of Graham	Dissipator
LA13B, RCH 13	SF	N/A	Needs stormwater detention basins between new development and LA Creek	City of Graham	Install stormwater BMP ponds and require new development to include
LA13B, RCH 16	SF	LA29	Sewer line right-of-way culverts washing away	City of Graham	Stabilze and resize and reset culverts
LA13B, RCH 17	SF	LA28	Road storm drain headcut to lower level bypassing swale and entering lake directly	City of Graham	Repair drain outfall and divert into grassy swale
LA2 Reach 1	SF	LA102	LUS to pipe stream outfall on golf course, needs to be improved	City of Burlington	Stormwater retrofit
LA2 Reach 3	SF	LA109	LUS to Gurney Street culvert and concrete drop outlet that is a fish barrier	City of Burlington	Retrofit drop outlet to allow fish passage
LA2 UT4 Rch 7	SF	N/A	One of two stormwater drain channels that need retrofitted behind senior living facility	City of Burlington	two Stormwater retrofits
TT11 Reach 19	SF	N/A	Stormwater outfalls at new development, GPS Pt 4		Retrofit with stormwater detention ponds
TT4	SF	TT14	Concrete apron for sewer crossing has water undermining it (reach 9)	Town of Elon	repair/replace
TT7B, RCH?	SF	TT104	headcut formed by new storm drain	Town of Elon	Build surge pool and sediment trap
	SF		a fish migration barrier		Culvert retrofit
LA13A	SP	LA23	Filling culverts (reach 11)	City of Graham	Culvert repair/replace
LA2 Reach 3	SP	LA110	LUS to 30' concrete stormwater outlet, last joint is lose and needs repair	City of Burlington	Repair last pipe joint
LA6	SP	LA55	Culvert undermining (reach 2)	City of Burlington	Culvert repair
TT4	SP				culvert replace/repair
TT4	SP/SW	TT11	Filling culverts (reach 9)	Town of Elon	Culvert repair/replace
LA12A-UT2	SR	LA82	LUS to W. Pine St. and excessive riprap in channel and along both banks. Riprap	City of Graham	Remove riprap and use natural channel

LA13B, RCH 15	SR	LA34, LA 33	Channel from lake needs structural support and bank stabilization	City of Graham	Step down structure below dam and channel bank restoration below
LA13B, RCH 6	SR	N/A	Deep entrenched channel, with berms in some locations, no buffer	City of Graham	Remove berms, create benches, plant woody buffer
LA2 UT1 Rch 4	SR	LA113	LUS showing concrete lined stream bottom and brick walled channel	City of Burlington	This entire structure should be removed
LA2 UT3 Rch 6	SR	LA121	LUS showing deeply entrenched channel. No floodplain access	City of Burlington	Stream restoration
LA2 UT3 Rch 6	SR	LA122	LDS stream is still head cutting upstream, no floodplain access	City of Burlington	Stream restoration
LA3	SR	LA39	Headcut providing bank erosion (reach 3)	City of Burlington	Design to restore channel
LA3	SR	LA44	Overwidened channel, power line in water (reach 7)	City of Burlington	Design to restore channel
LA3	SR	LA40, LA 41	Bank erosion (reach 5)	City of Burlington	Design to restore channel
TT6A	SR	TT56	LDS to severe bank scour, both banks, est length 1000', GPS Pt 17	Alamance County	Bank stabilization
TT6A	SR	TT63	23 LUS to old dam and bank armoring, 24 LDS at channel modification, 25 LUS at	Alamance County	Restoration, get channel out of armoring
TT7A, RCH 10	SR	TT85, TT86	No buffer and failing banks in horse pasture	Town of Elon	Stream and Buffer restoration
TT7A, RCH 12	SR	TT77	Long streach of creek headwater in pipe	Town of Elon	Investigate possible daylighing
TT7B, RCH?	SR	N/A	straightened and headcut creek with very deep channel	Town of Elon	Channel Restoration/enhancement
TT8	SR	N/A	Bank erosion on left and right bank. Impacted buffer. Cattle in stream. Reach 5	Alamance County	Bank stabilization, stream restoration, cattle exclusion fencing
	SR	N/A	There is a stream section just upstream of NC 87 that has many logjams and resulting bank failure that could benefit from restoation and stabolization	Alamance County	
	SR	N/A	Lower reach has very high and unstable banks	Alamance County	Possible stream and buffer restoration
LA13B, RCH 6	SS	N/A	Leaking sewer manholes	City of Graham	Repair manhole leaks/overflow problem cause
LA6	SS	LA49	Manhole (stormwater) not functioning (reach 1)	City of Burlington	Replace manhole
TT7B, RCH?	SS	TT107	suspicious liquid dripping from this pipe	Town of Elon	Have public works check this pipe

TT7B, RCH?	SS	TT95	Wet spot around manhole in left of photo	Town of Elon	Check for manhole leak or groundwater problem
LA12, RCH3?	SW	LA63	Culvert under Moore St half filled with sediment	City of Graham	Clean Culvert
LA3	SW	LA38	Filling Culvert (reach 1)	City of Burlington	Culvert repair
LA3	SW	LA43	Culvert failure (reach 7)	City of Burlington	Culvert repair
LA6	SW	LA48	Undermining culvert (reach 1)	City of Burlington	Culvert repair
LA6	SW	LA50	Undermining culvert (reach 1)	City of Burlington	Culvert repair
TT11 Reach 20	SW	TT45	LUS to 36" concrete culvert under St. Regis Drive. Last two joints under road are	Alamance County	Culvert repair
TT4	SW	TT10	Fish passage problem, sewer easement crossing	Alamance County	repair/replace
LA12A-UT2	TR	LA78	LUS debris jam should be removed, could cause a problem at downstream	City of Graham	Remove debris jam
LA12BUT1	TR	LA100	LUS to stream crossing that needs to be removed and replaced with a bridge	City of Graham	Remove debris in stream
LA13B, RCH 13	TR	N/A	Several collection points of foatable plastic trash	City of Graham	Clean up trash accumulations
LA13B, RCH 4	TR	N/A	Some road side dumping into riparian area	City of Graham	Cleanup
TT11 Reach 19	TR	N/A	Trash dump on RB, lots of tires and white goods (mosquito breeding area) GPS Pt 13	Alamance County	Clean up old dump site
TT6B	TR	TT47	Trash dump showing frig in stream and bank trash, GPS Pt 7	Alamance County	Clean up old dump site
TT7B, RCH?	TR	TT93	Debris in culvert mouth at Robinhood Road Curve	Town of Elon	Clean out debris
LA12A	WE	LA87	LUS from Border Street showing stream, sewer line and wetland	City of Graham	Wetland enhancement
LA13A	WE	LA27	Wetland enhancement. Community retention wetland (open space area) could be	City of Graham	Wetland enhancement
LA13B, RCH 14	WE	N/A	berm along RCH 6 alters confluence creating a small wetland	City of Graham	Remove berms and/or enhance wetland
TT6A	WE	TT55	Head cut in dam. Needs to be stopped or it will eventually drain wetland	Alamance County	Restoration/preservation
TT7A, RCH 10	WE	TT81, TT82	Small wetlands along creek	Town of Elon	Possible preservation and enhancements
	WE	LA62	Small wetland	Town of Elon	Wetland enhancement?

	WE/BE	N/A	(reach 5-several thousand feet)		Planted buffer, wetland enhancement, stream clean (manure dumping)
TT6A	WE/SR	TT58	LUS to 3.5' head cut that is slowly draining a wetland, also fish migration barrier. This	Alamance County	Restoration
TT11 Reach 19	WR	TT67	8 recently ditched wetland GPS Pt 7; 10 LDS to ditched wetland, GPS Pt 10	Alamance County	Restoration and protection
TT7A, RCH 12	WR	TT78 - TT 80	Nice post pipe catchments almost wetlands	Town of Elon	Constructed Wetland BMP or at least no mowing
TT7B, RCH?	WR	TT92	Sediment coming out of storm drain over silt fence	Town of Elon	Install catchment basin and seed and cover upland
TT7B, RCH?	WR	TT101, TT102	Stream buffer limited and possible wetland restoation site under power lines	Town of Elon	Explore restoration potential
TT7B, RCH?	WR/SR	TT68, TT91	Potential wetland and stream restoration and enhancement	Town of Elon	Landowner Willing to help!
TT4	WT	N/A	Preservation candidate	Alamance County	Landonwer education
TT4	WT	TT16	Preservation candidate	Alamance County	Landonwer education
TT6A	WT	TT53	Wetlands at GPS Pt 3. Excellent floodplain hardwood forest wetlands	Alamance County	Preservation/protection
TT6A	WT	TT54	Bog site formed by old pond beg, muck 4' deep, head cut at head of site threatens site	Alamance County	Restoration/preservation
TT6A	WT	TT52	Wetlands at GPS Pt 2. Excellent floodplain hardwood forest wetlands	Alamance County	Preservation/protection
LA13A		LA24	above concerned landonwer who owns pond, we spoke to landonwer. (reach 14)	City of Graham	
LA2 Reach 2		LA107	LDS & LUS at Cedarwood Drive showing riprap channel and culvert drop outlet that is	City of Burlington	Bank stabilization/buffer enhancement
LA2 UT4 Rch 7		LA123	LDS from Lacy St., channel is intermittent for 100' at this location with bank scour	City of Burlington	