Little Alamance Creek 4b Demonstration Project

Existing Data Inventory

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List of Acronyms and Abbreviations

µg/L	Micrograms per Liter
BEHI	Bank Erosion Hazard Index
BMP	Best management practice
CFS	Cubic feet per second
DWQ	Division of Water Quality
DWR	Division of Water Resources
LATT	Little Alamance, Travis, and Tickle Creeks
mg/L	Milligrams per Liter
NBS	Near bank stress
NC	North Carolina
NCDENR	North Carolina Department of Environment and Natural Resources
NCDOT	North Carolina Department of Transportation
NCEEP	NC Ecosystem Enhancement Program
NSW	Nutrient Sensitive Water
SPMD	Semipermeable membrane device
SR	State Route
TKN	Total Kjeldahl Nitrogen
TMDL	Total maximum daily load
UCFRBA	Upper Cape Fear River Basin Association
USGS	United States Geological Survey

1.0 Introduction

This document provides a summary of available watershed information and water quality data for the Little Alamance Creek watershed. This document was prepared for the North Carolina Department of Transportation (NCDOT), the City of Burlington, and the City of Graham under a collaborative project to address impairment in the creek through a Category 4b demonstration. The assessment provided herein will be used to identify data gaps, develop strategies for collecting additional data and implementing stormwater controls, and to prepare the Category 4b demonstration report.

1.1 Project Background

Portions of Little Alamance Creek (Cape Fear River Basin) are impaired and included on the 2012 North Carolina 303(d) List of Impaired Waters published by the North Carolina Department of Environment and Natural Resources Division of Water Quality (DWQ) based on a "poor" bioclassification rating. In October 2010, the DWQ prepared a draft total maximum daily load (TMDL) report to address the impairment. The TMDL report identified stormwater runoff and hydromodification as potential contributors to impairment and used impervious cover as a surrogate for biological impairment because no specific pollutants were known or identified. Subsequent to the draft TMDL report, representatives from NCDOT and the cities of Burlington and Graham (hereafter, "project team") participated in meetings with representatives from the North Carolina Division of Water Resources (DWR) Modeling and TMDL Unit, Stormwater Permitting Unit, and local governments statewide to discuss alternatives to traditional TMDL development in watersheds where the stream is listed as "Category 5" (not meeting designated uses) but the pollutant causing impairment is unknown. During the course of these discussions, the group took steps to investigate the feasibility of preparing a Category 4b demonstration as an alternative to the draft impervious cover limitation TMDL. Category 4b demonstrations are used to address impaired waters where a TMDL is not required because the waterbody is expected to meet standards due to other pollution control requirements.

During the summer of 2012, the project team committed to supporting a Category 4b process in Little Alamance. As part of this commitment, the project team will jointly prepare a Category 4b demonstration describing management actions that, when implemented, will contribute to the overall goal of restoring water quality and achieving a benthic macroinvertebrate community bioclassification of "Not Impaired", "Good-Fair", or better. This plan will be submitted to DWR on or before August 23, 2014.

1.2 Purpose of this Document

The purpose of this document is to summarize existing water quality and watershed data and information relevant to the impairment in Little Alamance Creek. This document also provides a description of activities performed by the project team to date, a preliminary assessment of data gaps, and recommendations on additional data collection or analysis.

1.3 Activities to Date

Over the past year the project team has collaborated to develop and prioritize project goals and tasks, participated in a watershed tour, and prepared a report outline. Key project activities and milestones are shown in Table 1.

Table 1. Key project activities and milestones completed by the project team to date.

Date	Project Activity or Milestone
September 7, 2012	Project team kick-off meeting.
October 10, 2012	Project kick-off meeting held with NCDWQ and project team. Project schedule, deliverables, roles responsibilities, and points of contact defined.
January 28, 2013	Category 4b demonstration outline prepared.
February 28, 2013	Project team meeting and watershed tour. Project team member roles/responsibilities in preparing the Category 4b demonstration, desired project outcomes, and opportunities for implementing best management practices (BMP) discussed. The team meeting was followed by a half-day watershed tour during which the project team drove throughout the watershed, walked portions of the stream, discussed pending watershed improvement projects and teaming opportunities, and identified areas that had the potential to support BMP retrofits.
May 7, 2013	Project team coordination meeting with DWQ staff. Project progress, field visit, and report outline discussed.
June 28, 2013	Full project schedule and roles prepared for project team comment.
September 3, 2013	Project progress and coordination meeting with DWR staff.
October 22, 2013	Coordination meeting with United States Environmental Protection Agency and DWR staff.

1.4 Team Members, Roles, Responsibilities

The project team includes NCDOT and representatives from the cities of Burlington and Graham. Team members, along with their associated roles and responsibilities are shown below in Table 2.

Table 2. Team members, roles, and responsibilities.

Name	Organization (Representing)	Roles and Responsibilities
Josh Johnson	Alley, Williams, Carmen & King, Inc. (City of Graham)	Project management and report preparation
Michael Layne	City of Burlington	Project management
Patrick Blandford	HDR, Inc. (City of Burlington)	Task management and general support
Kenneth Trefzger	HDR, Inc. (City of Burlington)	Task management and general support
Andy McDaniel	NCDOT	Project management
Craig Deal	NCDOT	Report preparation
Brian Jacobson	URS Corp. – North Carolina (NCDOT)	Task management and report preparation
Melissa Bauguess	URS Corp. – North Carolina (NCDOT)	Data assessment and report preparation

2.0 Existing Data Inventory

2.1 Data Sources

A search for existing data on the Little Alamance Creek watershed consisted of internet research and personal communication with the cities of Burlington and Graham, NC, and also Elon University. Table 3

lists the data sources that were reviewed for information pertaining to Little Alamance Creek. Not all sources reviewed contained data specific to Little Alamance Creek.

Table 3. Existing documents reviewed for data on the Little Alamance Creek watershed, sorted by document source and publication date. The three documents in bold type contain the majority of available data pertaining to water quality and stream biology.

DWQ Documents - Cape Fear River Basin
1996 Cape Fear River Basinwide Water Quality Plan
2000 Cape Fear River Basinwide Water Quality Plan
2005 Cape Fear River Basinwide Water Quality Plan
2009 DWQ Biological Assessments - Cape Fear
2009 Cape Fear River Basin Basinwide Assessment Report Whole Effluent Toxicity Program, 2004 – 2008
2009 DWQ Lake and Reservoir Assessments – Cape Fear River Basin
2009 DWQ Cape Fear River Basin - Ambient Monitoring System Report
2009 Upper Cape Fear River Basin Association (UCFRBA) 2009 Annual Report
DWQ Documents – Little Alamance Watershed
2006 DWQ Draft Summary of Existing Water Quality Data for Little Alamance, Travis, and Tickle Creek (LATT)
2007 Evaluation of Water Quality, Habitat, and Stream Biology in the LATT Watersheds, Final Report
2008 Evaluation of Water Quality, Habitat, and Stream Biology in the LATT Watersheds, Draft Final Report
Undated. Prusha, DWQ LATT Benthic Study Review
2010 Total Maximum Daily Load to Address Impaired Biological Integrity in the Little Alamance Creek Watershed
NC Ecosystem Enhancement Program (NCEEP) Documents
2007 LATT Watershed Characterization Phase I, Final Report
2008 Little Alamance Creek Stream Restoration Plan (Arcadis)
2008 LATT Local Watershed Plan Phase II
2008 LATT Watersheds Report and Project Atlas, Phase III
2009 LATT Summary of Findings and Recommendations
Undated NCEEP LATT Local Watershed Plan Fact Sheet
Elon University Documents
2010 Elon University Little Alamance Restoration Alliance Meeting - Slide Presentation
Little Alamance Land Cover Summary Statistics
Haw River Watershed and Little Alamance Watershed Map
Little Alamance Watershed Map
Watershed Assessment and Restoration Program (WARP) Reports
2002 Biological Impairment in Little Troublesome Creek Watershed – Rockingham County
2003 Assessment Report- Biological Impairment in Horsepen Creek Watershed – Guilford County
Other
EPA STORET Database, http://www.epa.gov/storet/
2007 US Geological Survey (USGS) Data Series 279
State Climate Office of North Carolina, http://www.nc-climate.ncsu.edu/
NC Natural Heritage Program, http://www.ncnhp.org/
USFWS, http://www.fws.gov/

2.2 Watershed Characteristics

The Little Alamance Creek watershed is located in the upper Cape Fear River Basin, within the Haw River subbasin. Little Alamance Creek flows into Big Alamance Creek approximately three miles upstream of its confluence with the Haw River. This section presents an overview of watershed characteristics, including drainage area, ecoregion, climate, and land use. The following table lists some general identifying information about the Little Alamance Creek watershed.

Table 4. General watershed characteristics.

Characteristic	Description
River Basin	Cape Fear River Basin
Subbasin	Haw River
USGS Hydrologic Unit Code	03030002040110
NCDWQ Subbasin	03-06-03
NC stream index number	16-19-11
NC stream classifications	Class C: Protection of aquatic life and secondary recreation Nutrient Sensitive Water (NSW): a supplemental classification, which carries additional regulatory requirements for agricultural and stormwater management practices.
Associated jurisdictions	Alamance County, Burlington, Graham
Watershed Area	16 sq. mi. watershed 13 subwatersheds (as delineated for NCEEP Local Watershed Plan)
Named Tributaries and Lakes	Boyd Creek (Bowden Branch on USGS topo map), Willowbrook Creek, Mays Lake, May Brook, Walker Brook, Coble Brook, Powell Lake Branch, Gant Brook, Gant Lake, Lamm Brook, Meadowbrook Branch

2.2.1 Ecoregion

The Little Alamance Creek watershed is located in the Piedmont physiographic province of North Carolina. The elevation ranges from approximately 450 feet at the confluence with Big Alamance Creek to 700 feet in the headwater regions. The Little Alamance Creek watershed is located entirely within one Level IV Ecoregion – the Southern Outer Piedmont. This ecoregion has lower elevations, less relief, and less precipitation than its neighboring ecoregions. Gneiss, schist, and granite are typical rock types, and the rocks are more intensely deformed and metamorphosed than the geologic materials in neighboring ecoregions. The rocks are covered with deep saprolite and mostly red, clayey subsoils.

The watershed is composed mainly of three geological types: quartzite in the northern headwaters of the watershed, and metamorphosed gabbro and diorite, and mafic metavolcanic rock in the middle and lower portions of the watershed.

The predominant soil association in the Little Alamance watershed is Mecklenburg-Elon–Cecil, comprising almost the entire watershed south of Route 70. The Vance-Appling–Enon-Cecil association is found north of Route 70 and encompasses the majority of the hydric soils found in the watershed. Hydric soils can be found throughout the watershed within the floodplain, but most predominantly along the Little Alamance Creek stream beds and surrounding area north of Route 70.

2.2.2 Climate

Extensive climatic data for the Little Alamance Creek watershed are available through the State Climate Office of North Carolina. Temperature and precipitation records go back over one hundred years. There are multiple weather stations in Alamance County, four of which are currently active. One of these, located in Graham, has collected climatic data from 1902 to present.

Alamance County receives approximately 45 inches of rainfall per year, and another 4 inches per year of frozen precipitation. The greatest one-day precipitation was 6.71 inches in 1954. Recent droughts have impacted data collection efforts in the watershed. A significant drought was occurring in 2007 when DWQ was performing an evaluation of water quality and stream biology. All North Carolina rivers and streams commonly have a maximum flow in late spring, with low flow in fall.

The Normal Monthly Mean Temperature in Alamance County is 59.2 °F; the Normal Monthly Maximum Temperature is 71.2 °F; and the Normal Monthly Minimum Temperature is 47.1 °F. The highest temperature on record was 105°F and the lowest was -6 °F.

2.2.3 Land Use

Land use and land cover in the watershed play a substantial role in stream water quality and aquatic habitat. There is relatively good information on these watershed features, as well as information on how these features have changed over time. Elon University conducted an analysis of parcel and census data to determine land use. Approximately 80% of the parcels are residential, and roughly 6.6% of the parcels contain riparian areas; these numbers are based on the number of parcels and not on the total area of land.

Elon University provided a land cover analysis based on aerial photographs from the years 1956, 1984, and 2009. Table 5 shows how road length, forested area, and the number of buildings changed between these years.

Table 5. Change in land use over time.

Year	Total Road Length (miles)	Forested Area (percent of watershed)	Number of Buildings
1956	136	37.2	5,200
1984	174	33.3	8,204
2009	195	27.4	9,637

Elon University also estimated the percent of the watershed area that was covered in impervious surfaces for various years. Between 1984 and 2010 the percentage of impervious surface was estimated to increase from 24.6% to 30.0%. This translates to approximately 86 acres of additional impervious surface.

Table 6. Estimated percent impervious surface over time.

Year	Estimated Percent Impervious Surface
1984	24.6%
1993	27.0%
2001	28.6%
2005	29.6%
2010	30.0%

The first phase of NCEEP's Local Watershed Plan for Little Alamance, Travis, and Tickle Creeks included an analysis of land use. The results from the analysis are provided in Table 7.

Table 7. Little Alamance Creek watershed land use (Source: 2007 LATT Watershed Characterization Phase I, Final Report; NCDOT area estimated to be approximately 4.8% of the watershed).

Type	Acreage	Percentage
Agriculture	318.0	3.6%
Commercial	565.5	6.6%
Industrial	1,082.1	12.4%
Institutional	171.1	1.9%
Mobile Homes	2.9	0.0%
Multifamily	545.3	6.2%
Office	226.6	2.6%
Open Space/Recreational	256.9	2.9%
Single Family	5,233.0	59.7%
Vacant	360.4	4.1%
Total Acreage in Parcels	8,761.8	100.0%

In addition to the work done by Elon University and NCEEP, land cover analysis was included in the DWQ report *Evaluation of Water Quality, Habitat, and Stream Biology in the Little Alamance, Tickle, and Travis Creek Watersheds* (2008). During 2006 and 2007, the DWQ conducted monitoring at seven sites in the Little Alamance Creek watershed (Sites 14, 15, 16, 17, 18, 19, and 20). The land use data of the drainage area for each sampling site were obtained from the National Land Cover Database 2001. Table 8 shows the contribution of each category of land use within the drainages of each of the monitoring locations. Most of the drainages are highly developed.

Table 8. Percent land cover type for the drainage areas of selected monitoring sites across the Little Alamance Creek watershed (National Land Cover Database 2001).

Location	Drainage Area (sq. mi.)	High Density Developed	Low Density Developed	Forest	Agriculture	Herbaceous	Water
UT to Willowbrook Cr at Kime St.	0.4	61.6	38.5	0.0	0.0	0.0	0.0
Willowbrook Cr at Mebane St (SR 1363)	1.3	21.3	78.7	0.0	0.0	0.0	0.0
Little Alamance Cr at Mebane St (SR 1363)	4.4	12.7	85.8	1.3	0.1	0.1	0.1
Little Alamance Cr at NC 54 (Tucker St.)	6.4	37.1	53.1	8.4	1.0	0.5	0.0
Little Alamance Cr at I-85 Frontage Rd (SR 1398)	7.7	29.6	61.6	8.4	0.2	0.1	0.0
Little Alamance Cr at Rogers Rd. (SR 2309)	14.1	13.2	40.3	26.1	13.3	6.8	0.2
Bowden Br at Hanford Rd (SR 2304)	2.5	19.3	65.2	11.2	2.1	2	0.0

2.3 Water Quality Data

Water quality sampling efforts have not been continuous or widespread throughout the watershed. The majority of the water quality data exists for one location, Little Alamance Creek at SR 2309 (Rogers Road). Additional locations throughout the watershed were sampled in support of DWQ's TMDL study and NCEEP's Local Watershed Plan. The following sources for water quality data were identified.

Table 9. Sources for water quality data in the Little Alamance Creek watershed.

Data Source	Date Range of Data Collection	Number of Sites Sampled
EPA STORET data download	1968-1975	1
2007 Selected Physical, Chemical, and Biological Data for 30 Urbanizing Streams in the North Carolina Piedmont Ecoregion, 2002–2003.	2/25/2003-7/11/2003	1
USGS Gage Station 0209679804		
2010-12 TMDL to Address Impaired Biological Integrity in the Little Alamance Creek Watershed	June 2003	5
2006 DWQ Draft Summary of Existing Water Quality Data	July 2006	8
2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in the Little Alamance, Travis, and Tickle Creek Watersheds	December 2006-August 2007	6
2009 DWQ Biological Assessments – Cape Fear	July 2008	1

The various data sources collect and report data in different ways, and therefore combining or summarizing the results would be inadvisable. This document focuses more on the extent or completeness of data available, rather than reiterating the results of the various reports. The original data sources (summarized below) contain more detailed information if desired.

The data downloaded from EPA STORET were collected from Little Alamance Creek at SR 2309 between 1968 and 1975. Analytical techniques and quality assurance procedures have improved since that time period.

In 2002-2003 the US Geological Survey (USGS) conducted sampling on Little Alamance Creek at SR 2309 as part of a National Water Quality Assessment study. The purpose of the study was to examine the effects of urbanization on stream ecosystems. Biological, chemical, and physical data were collected on 30 streams across the piedmont of North Carolina. The SR 2309 location is referred to as USGS Gage Station 0209679804 for this USGS study. Continuous stream stage and stream temperature measurements were collected hourly for one year, from November 16, 2002 to November 15, 2003. Standard USGS streamgaging techniques for collection of streamflow data were not used because of the short term of data collection at the sites and limited resources for the project. Instead, a submersible pressure transducer with an internal data logger was used. Water chemistry samples were taken twice, on February 25, 2003 and July 11, 2003. Parameters included basic physiochemical parameters and nutrients as well as pesticides and herbicides.

The DWQ conducted a TMDL stressor study in June 2003 that included five sample locations. The study focused on benthic collections but some physiochemical data were collected at the same time.

In July of 2006, DWQ personnel collected a limited amount of field data to ascertain if any water quality problems could be readily identified, and to aid in the development of a plan for additional monitoring.

In support of the NCEEP Local Watershed Plan, DWQ conducted additional sampling at seven sites in the watershed from December 2006 to August 2007. The sites are identified as 14, 15, 16, 17, 18, 19, and 20 in the *Evaluation of Water Quality, Habitat, and Stream Biology in the Little Alamance, Travis and Tickle Creek Watersheds* (DWQ, 2008). The sampling included water quality data for physical parameters, nutrients, metals, and bacteria. Samples were taken approximately monthly during baseflow, and on three occasions during stormflow. The number of samples for each parameter and site varies.

2.3.1 Physicochemical Parameters

Physicochemical parameters such as pH, specific conductance, dissolved oxygen, and temperature are the most abundant type of water quality data available for Little Alamance Creek. The historical data from 1968-1975 included these parameters (minus specific conductance) as well as alkalinity and biochemical oxygen demand, two parameters that have not been analyzed since. These data included approximately 18 samples at one location – Little Alamance Creek at SR 2309.

Physicochemical parameters were measured on a limited basis in 2003 by DWQ (one sample at each of five locations) and USGS (two samples at one location). One additional measurement at SR 2309 was taken by DWQ in 2008 with the biological assessment.

The majority of the physicochemical data were collected in 2006 and 2007 by DWQ. In July of 2006, single measurements of specific conductance were measured at eight bridge crossings across the

watershed. In addition, duplicate data sondes were installed at Little Alamance Creek at SR 2309 that recorded temperature, pH, specific conductance, dissolved oxygen and the percent saturation of dissolved oxygen. Data were recorded at hourly intervals between July 25 and 31, 2005, for a total of 270 measurements for each parameter. The most widespread sampling effort was from December 2006-2007 when DWQ measured these same parameters at six sites across the watershed, collecting at least 30 observations for each parameter.

Table 10. Summary of available physicochemical data for the Little Alamance Creek watershed

Data Source	Date range of Data Collection	Number of Sites Sampled	Approximate Number of Samples per Site
EPA STORET data download	1968-1975	1	18
2007 USGS Report USGS Gage Station 0209679804	2/25/2003-7/11/2003	1	2
2010-12 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed	June 2003	5	1
2006 DWQ Draft Summary of Existing Water Quality Data	July 2006	8	270 at SR 2309 1 at others
2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in Little Alamance, Travis, and Tickle Creek	December 2006-August 2007	6	30-34
2009 DWQ Biological Assessments – Cape Fear	July 2008	1	1

The 2008 DWQ report identified that the highest specific conductance measurements occurred in the headwater tributaries of Little Alamance Creek and that values decreased at downstream monitoring locations. DWQ concluded that dissolved substances were originating from the urban area of downtown Burlington and were being diluted further downstream. Willowbrook Creek samples showed several instances of supersaturated dissolved oxygen concentrations, which were attributed to dense algal blooms noted during sampling. Lower portions of the watershed were found to experience very low levels of dissolved oxygen, falling below the 4.0 mg/L water quality threshold on several occasions. DWQ attributed these occurrences to seasonal patterns associated with high air temperatures that were exacerbated by extreme drought conditions and very low flow. Water temperature and pH measurements were found to be within normal ranges.

2.3.2 Nutrients

Data for nutrients is somewhat more limited for the watershed. Three datasets were found containing nutrient data. The historic data from SR 2309 included four nutrient samples in 1971 and 1972. Ammonia, inorganic nitrogen, and Total Kjeldahl Nitrogen (TKN) were sampled once in 1971; in 1972, ammonia, inorganic nitrogen, TKN, and phosphorus were sampled once.

In 2003, USGS measured nutrients in two samples at SR 2309 for the following parameters: TKN, ammonia, nitrate plus nitrate, nitrite, particulate nitrogen, total nitrogen, orthophosphate, and phosphorus.

The most widespread sampling effort was from December 2006-2007 when DWQ measured nutrients at six sites across the watershed, collecting at least 30 samples for each of the following parameters: ammonia, inorganic nitrogen, TKN, total nitrogen, and phosphorus. All parameters had 34 baseflow samples and two stormflow samples.

Table 11. Summary of available data on nutrients in water quality samples.

Data Source	Date range of Data Collection	Number of Sites Sampled	Approximate Number of Samples
EPA STORET data download	1968-1975	1	2
2007 USGS Data Series 279 USGS Gage Station 0209679804	2/25/2003-7/11/2003	1	2
2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT	December 2006-August 2007	6	30-34

The 2008 DWQ report identified a few trends in the nutrient data. One site, Little Alamance Creek at Mebane Street, was found to have consistently high ammonia nitrogen concentrations and the highest TKN observed during the study. Willowbrook Creek and UT to Willowbrook Creek were found to have the highest phosphorus concentrations. Willowbrook Creek and its UT were also high in ammonia and sodium. The 2008 DWQ report indicated that elevated nutrient concentrations at Little Alamance Creek at Mebane Street and Willowbrook Creek and its UT could be linked to the potential presence of malfunctioning septic or sewage sources.

2.3.3 Metals

Only one dataset was found in which metal concentrations were reported. DWQ sampled six locations for both toxic and non-toxic metals between December 2006 and August 2007, approximately monthly. Results for several toxic metals (arsenic, cadmium, chromium, mercury, nickel, and silver) were below the detection limit and were not reported. Three other toxic metals (copper, lead, and zinc) were found and reported. Other metals analyzed included aluminum, iron, manganese, calcium, magnesium, potassium, and sodium. Metals were sampled at six sites 10-15 times at low flow and two times during high flow conditions. A summary of the available data on metals in the Little Alamance Creek watershed is shown in Table 12.

Table 12. Summary of available data on metals in water quality samples.

Data Source	Date range of Data Collection	Number of Sites Sampled	Approximate Number of Samples
2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT	December 2006-August 2007	6	10-15

Copper, zinc, and lead were found at measureable concentrations within the watershed, especially in samples collected under high flow conditions. Copper was detected in all but two high flow samples, and most high flow samples exceeded the 7 µg/L action level. In addition, one low flow sample taken at Little Alamance Creek at SR 2309 was at the action level of 7 µg/L copper. Lead occurred above the reporting limit only once, in a high flow sample at Willowbrook Creek. The report stated that this may have

originated from runoff from an old city vehicle maintenance facility or possibly from a landfill in the subwatershed. The Willowbrook Creek Site also exceeded the action level for zinc (50 µg/L) in the same high flow sample, which may also have originated from the same source as the lead. Zinc was measured in all but two high flow samples, and detected in four low flow samples.

Among the other metals, calcium and magnesium were noted as having somewhat elevated low flow concentrations, possibly due to the abundance of pavement in the urban areas. Both were lower during high flow samples, indicating dilution during rain events. Sodium concentrations were also elevated, particularly at Willowbrook Creek and Little Alamance Creek at Mebane Street, which is directly downstream of Willowbrook Creek. The report stated that the higher sodium could be an indicator of raw sewage contamination, but could also have originated from other sources. Because Willowbrook Creek also had higher levels of ammonia, nitrogen, and phosphorous, lead, and zinc, further investigation was recommended in this area.

2.3.4 Other Water Quality Data

The USGS study in 2003 included analysis of some additional parameters that have not been included in the other datasets. The study included the total concentration and the quantity of pesticides, fungicides, herbicides, insecticides, and nematicides. In addition, a Pesticide Toxicity Index was calculated for cladocerans (water fleas), benthic macroinvertebrates, and fish.

The USGS study also included several organic constituents: total particulate carbon, particulate inorganic carbon, particulate organic carbon and dissolved organic carbon were measured in the two samples.

USGS also collected data with semipermeable membrane devices (SPMDs) to examine concentrations of hydrophobic organic compounds over time. The SPMDs were placed at each site for a period of approximately 6 weeks during April and May 2003. SPMDs are passive samplers that concentrate trace levels of hydrophobic organic compounds in the water column. They are designed to mimic the bioaccumulation of organic compounds in the fatty tissues of aquatic organisms.

Table 13. Summary of other available water quality data.

Data Source	Date range of Data Collection	Number of Sites Sampled	Approximate Number of Samples
2007 USGS Data Series 279 USGS Gage Station 0209679804	2/25/2003- 7/11/2003	1	2

2.3.5 Fecal Coliform Bacteria

Two datasets were found containing data on fecal coliform bacteria. The historical data from SR 2309 contained 12 samples from July 1968 to February 1975.

DWQ also measured fecal coliform in water samples at six stations between December 2006 and August 2007. A total of 34 samples were analyzed, ranging from one to nine samples per site. The report indicated that fecal coliform pollution is present at multiple sites. All available data on bacteria are summarized in the table below.

Table 14. Summary of available bacteria data for the Little Alamance Creek watershed.

Data Source	Date range of Data Collection	Number of Sites Sampled	Approximate Number of Samples
EPA STORET data download	1968-1975	1	12
2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT	December 2006-August 2007	6	34

2.4 Biological Data

Biological sampling in Little Alamance Creek has been documented since 1985. DWQ assigns each site a "bioclassification" rating according to how many species are present at a sample site and the relative abundances of the species. There are five bioclassifications ratings – Poor, Fair, Good-Fair, Good, and Excellent – indicating how well aquatic life is being supported. Documents containing biological data are shown in Table 15.

Table 15. Biological data sources for the Little Alamance Creek watershed.

Data Source	Survey Date	Number of Sites Surveyed
1996 Cape Fear River Basinwide Water Quality Plan	July 1985	1
2000 Cape Fear River Basinwide Water Quality Plan	July 1998	1
2007 Selected Physical, Chemical, and Biological Data for 30 Urbanizing Streams in the North Carolina Piedmont Ecoregion, 2002–2003	May 2003	1
2005 Cape Fear River Basinwide Water Quality Plan	June 2003	5
2010 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed	June 2003	5
2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT	September 2006	3
2009 DWQ Biological Assessments – Cape Fear	July 2008	1
DWQ Little Alamance, Travis, and Tickle Creeks Benthic Study Review – Prusha (undated)	Unknown	3

2.4.1 Benthic Macroinvertebrates

Benthic macroinvertebrates have been surveyed at seven locations throughout the Little Alamance Creek watershed. Six of these locations have been surveyed once – five in 2003 and two in 2006.

Little Alamance Creek at SR 2309 has been sampled five times by DWQ between 1985 and 2008. The site received a bioclassification rating of "Fair" or "Poor" each time. The site was Not Rated in 2008 due to low streamflow as a result of drought, but would have otherwise rated as "Fair." The USGS also conducted macroinvertebrate sampling at SR 2309 in 2003. The data were collected for the National Water Quality Assessment Program study, and included a variety of organisms including insects, bivalves, gastropods, and annelids. The survey did not provide a bioclassification to compare with the DWQ rating, but documented 47 species of macroinvertebrates at the site. Benthic macroinvertebrate data are summarized in Table 16.

Table 16. Benthic macroinvertebrate data summary.

Sample Location	Date	DWQ Bioclassification
Coble Branch at Engleman Ave	6/24/2003	Not Rated
Little Alamance Cr at Overbrook Rd.	6/24/2003	Poor
Little Alamance Cr at NC 54	9/12/2006	Poor
Little Alamance Cr near I-85	6/23/2003	Poor
Little Alamance Cr I-85 Frontage Rd.	9/12/2006	Poor
Little Alamance Cr at NC 49	6/23/2003	Poor
Little Alamance Cr at Rogers Rd (SR 2309)	7/29/1985	Fair
	7/10/1998	Poor
	5/20/2003	N/A
	6/23/2003	Fair
	9/12/2006	Poor
	7/14/2008	Not Rated

2.4.2 Fish

The fish community has been sampled four times at one site - Little Alamance Creek at SR 2309. Three of the surveys were conducted by DWQ (1993, 1998, and 2003,) and one by USGS (2003). DWQ assigned Bioclassification ratings of Good, Fair, and Good, respectively (see Table 17 below). The USGS does not calculate the same bioclassification rating, but reported a total of 16 fish species. The most abundant species were the bluehead chub (43), crescent shiner (35), and the tessellated darter (33).

Table 17. Summary of fish sampling data.

Sample Location	Date	Bioclassification
Little Alamance Cr at Rogers Rd (SR 2309)	1993	Good
Little Alamance Cr at Rogers Rd (SR 2309)	1998	Fair
Little Alamance Cr at Rogers Rd (SR 2309)	2003	Good
Little Alamance Cr at Rogers Rd (SR 2309)	June 2003	N/A

2.4.3 Protected Species

There are no federally protected species in Alamance County. Four aquatic species are listed as Federal Species of Concern. Two vertebrates, the American eel (*Anguilla rostrata*) and the Carolina darter (*Etheostoma collis lepidinion*) have no state status. Two mussel species, the Carolina creekshell (*Villosa vaughaniana*) and the Yellow lampmussel (*Lampsilis cariosa*) are listed as Federal Species of Concern and North Carolina Endangered.

2.5 Habitat Assessment

Data for habitat assessments were found in three documents, listed below in Table 18. The assessments were generally conducted concurrently with benthic macroinvertebrate sampling.

Table 18. Habitat assessment data sources for the Little Alamance Creek watershed.

Data Source	Survey Date	Number of Sites Surveyed
2010-12 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed	June 2003	5
2008 DWQ Evaluation of Water Quality, Habitat and Stream Biology in LATT	September 2006-August 2007	7
2009 DWQ Biological Assessments – Cape Fear	July 2008	1

Habitat assessment scores ranged from 53 to 93, out of a maximum possible score of 100. The Little Alamance Creek at SR 2309 site has been assessed three times, with scores of 73, 67, and 57 in 2003, 2006, and 2008 respectively.

2.6 Channel Data

Morhpological data for the Little Alamance Creek watershed is very limited. The TMDL Stressor Study performed by DWQ in 2003 included some basic channel characteristics at each of the five benthic sampling sites. A stream restoration project conducted in Burlington's City Park included more detailed morphological data for the mainstem of Little Alamance Creek and one unnamed tributary.

Table 18. Morphological data sources for the Little Alamance Creek watershed

Data Source	Survey Date	Number of Sites Surveyed
2010 TMDL to Address Biological Integrity in the Little Alamance Creek Watershed	June 2003	5
2007 USGS Data Series 279; USGS Gage Station 0209679804	2003	1
2008 Little Alamance Creek - Stream Restoration Plan - Arcadis	Unknown	2

2.6.1 Stream Morphology

A stream restoration project was conducted by NCEEP on a 2,633-linear-foot section of Little Alamance Creek in City Park in Burlington. The only available morphological data have been obtained from the restoration plan for this project. Prior to restoration activities, this section of Little Alamance Creek was approximately 30 to 60 feet wide at the top of the bank, with banks ranging between 4 and 8 feet high, and bank height ratios between 1.0 and 1.4. An unnamed tributary included in the project was approximately 5 to 10 feet wide at the top of bank, with bank heights of 2 to 4 feet and bank heights ratios between 1.0 and 1.3.

Little Alamance Creek's cross sectional area ranged between 79.3 $ft^2$and 125.0 ft^2 with an average of 95.0 ft^2. Channel width ranged from 31.8 feet to 42.5 feet with an average of 36.2 feet, and mean depth ranged between 2.2 feet and 2.9 feet, with an average of 2.6 feet. The width to depth ratio ranged between 11.6 and 17.0 with an average of 14.0.

The pattern of the reach was slightly meandering, with a sinuosity of 1.2. The average water surface slope of the section was 0.24 percent. Approximately 65 percent of the stream reach was comprised of

pools. In the middle section of the project reach, the existing pools were separated by fairly short and steep bedrock steps.

2.6.2 Substrate Composition

The primary information on substrate composition comes from the NCEEP stream restoration plan for the section of Little Alamance Creek in City Park. The streambed in that section was comprised mainly of sand, though there is some occurrence of bedrock. The particle size distribution of Little Alamance Creek's substrate prior to restoration was: D_{16} = 0.2 mm, D_{35} = 0.7 mm, D_{50} = 2.4 mm, D_{84} = 138.0 mm, and D_{95} = 216.0 mm.

Substrate composition was also estimated at the five benthic sampling sites in 2003.

2.6.3 Streambank Stability

Quantitative information on streambank stability is available for a portion of Little Alamance Creek in Burlington's City Park. This information was collected as part of a stream restoration project. Bank erosion had caused the stream to become overly wide in some sections and mid-channel bars had developed because the stream did not have the capacity to transport sediment through these reaches.

Prior to restoration, a Bank Erosion Hazard Index (BEHI) analysis was performed on Little Alamance Creek and its unnamed tributary. The ratings ranged from low to extreme on Little Alamance Creek and from low to very high on the unnamed tributary. Contributing to the high, very high, and extreme ratings were high bank heights, shallow rooting depths, and low rooting densities (a function of the lack of woody vegetation). Near bank stress (NBS) ranged from low to extreme on both Little Alamance Creek and the unnamed tributary. Extreme NBS ratings were due to high banks, central bars, and tight meander bends. Based on these ratings, an estimated 694 tons of sediment per year were being contributed by this reach of Little Alamance Creek, and the unnamed tributary was contributing an additional 55 tons of sediment per year.

2.6.4 Flow Data

There are no active USGS gages located in the Little Alamance Creek watershed. The nearest active gage station, 02094500, is located on Reedy Fork west of Little Alamance near Gibsonville, NC. The station has data for gage height and discharge for years 1928-present. Another long-term gage station is located to the east of Little Alamance; Station 02096500 is located on the Haw River in the town of Haw River, NC. The station has data for precipitation, gage height, and discharge for years 1928-present.

Three data sources were identified with flow data in the Little Alamance Creek watershed, shown in Table 19.

Table 19. Sources of flow data for Little Alamance Creek watershed

Data Source	Date range of Data Collection	Number of Sites Sampled	Approximate Number of Samples
EPA STORET data download	1968-1975	1	8
2007 USGS Data Series 279 USGS Gage Station 0209679804	7/15/2002 - 7/14/2003	1	365 days of hourly mean
2008 Little Alamance Creek - Stream Restoration Plan – Arcadis	Unknown	1	

The data downloaded from EPA's STORET database indicated that stream gage height was measured on Little Alamance Creek at SR 2309 from December 1970 to February 1975. A total of 8 stage heights were reported, ranging from 11.75 feet to 17.8 feet. On four of these dates, a calculated mean flow was also reported, ranging from two to nine cubic feet per second (cfs). However, the stage and discharge are not correlated as expected – the highest stage measurement corresponds with the lowest discharge calculation. The reliability of these historical data is not known.

Stream flow data were collected as part of the USGS study on urbanizing piedmont streams in 2002 and 2003. Continuous stream stage data were collected hourly for one year, from 11/16/2002 to 11/15/2003. Standard USGS stream gaging techniques for collection of streamflow data were not used because of the short term of data collection at the sites and limited resources for the project. Instead, a submersible pressure transducer with an internal data logger was used. Daily mean discharges were computed for the period of record. The overall mean discharge for the year was 14.9 cfs. USGS calculated numerous other statistics, including measures of flashiness and frequency of high and low flow, and duration of high and low flow.

The bankfull discharge was also estimated for the stream restoration project in Burlington's City Park. Little Alamance Creek has a drainage area of 4.2 square miles at this location. The average velocity for the channel was measured at 2.5 feet per second, which was multiplied by the average cross sectional area of the channel, for a calculated discharge of 237.5 cfs at bankfull flow.

2.7 NPDES Wastewater Treatment Point Source Discharges

There are no known NPDES-permitted wastewater treatment facilities in the Little Alamance Creek watershed.

2.8 Stormwater Outfall Inventory

The cities of Burlington and Graham have completed field inventories of stormwater infrastructure within their respective municipal boundaries. An inventory of the stormwater infrastructure is currently being conducted by NCDOT.

3.0 Summary of Existing Data

While some categories of data are more complete than others, the Little Alamance Creek watershed is lacking comprehensive water quality data to explain the poor benthic community results.

3.1 Spatial Distribution

Data for the Little Alamance Creek watershed have been collected from a total of 11 different locations. Various studies and reports sometimes refer to the same location by different identifying codes. Table 20 lists the location of each sampling site and a cross-referencing of the various codes that the location has been sampled under. Figure 1 shows a map of the watershed with the location of each sampling site.

Table 20. Location and identity code information for all sample sites in the Little Alamance Creek watershed

Location	Latitude	Longitude	Watershed Area (mi^2)	TMDL ID	Benthic ID	2008 Eval ID
Coble Branch at Engleman Ave	36.086111	-79.469722	0.6	B1	BB42	
Little Alamance Cr at Overbrook Rd	36.083333	-79.452778	4.4	B2	BB193	
Unnamed Tributary to Willowbrook Cr at Kime St	36.0872	-79.4429	0.4	-		14
Willowbrook Cr at Mebane St (SR 1363)	36.0839	-79.4433	1.3	-		15
Little Alamance Cr at Mebane St (SR 1363)	36.0801	-79.4479	4.4	-		16
Little Alamance Cr at NC 54 (Tucker St)	36.074444	-79.443889	6.4	-	BB47	17
Little Alamance Cr at I-85 Frontage Rd (SR 1398)	36.0650	-79.4376	7.7	B3	BB46	18
Little Alamance Cr near I-85	36.065	-79.437778	7.4	-	BB78	
Bowden Br at Hanford Rd (SR 2304)	36.0509	-79.4160	2.5	-		20
Little Alamance Cr at NC 49	36.052778	-79.435	9.0	B4	BB131	
Little Alamance Cr at Rogers Rd (SR 2309)*	36.0359	-79.4092	14.1	B5	BB388	19

* Little Alamance Creek at SR 2309 is also identified as Site B1920000 in the historical STORET data, and as USGS Gage Station 0209679804.

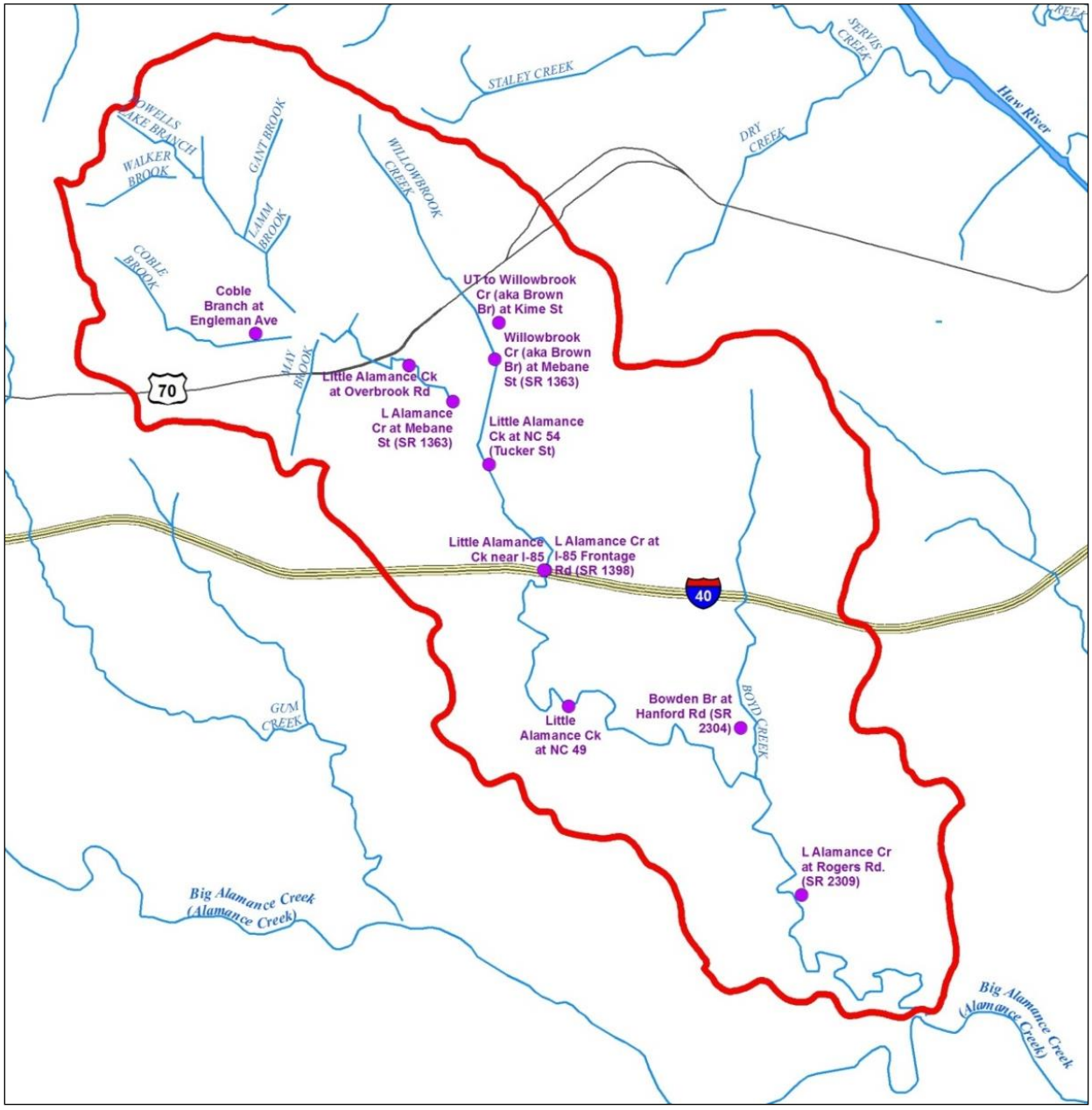

Figure 1. Little Alamance Creek watershed showing the spatial distribution of the 11 sites where data have been collected

3.2 Temporal Distribution

Water quality sampling efforts in the watershed span almost 40 years. The earliest known samples were taken in July 1968. No data were collected between 1975 and 1985, when limited biological monitoring resumed. More concentrated data collection efforts took place in 2003 and 2007.

3.3 Extent of Available Data

Table 21 presents a qualitative summary of the relative completeness of the various data categories. In an effort to distill and summarize the findings of the data inventory into a single table, each data category was given a qualitative rating of the relative completeness of the available data (Table 21). The ratings are loosely defined as follows:

Inadquate: Very limited data relative to other parameters in the watershed. Data may be limited by total samples or by spatial and temporal variability and additional data collection would be useful.

Moderate: Some data are available and have a greater number of data points or capture some degree of spatial and temporal variability. However, data are not sufficient to draw conclusions or establish baseline conditions.

Adequate: The existing dataset includes much or all available data and there is not a significant need for additional data collection. (Note – this does not necessarily equate to a large quantity of data. For example, NPDES-permitted wastewater discharges do not exist in the watershed, but since the availability of these data are complete, the category was given a rating of Adequate).

Table 21. Availability of information on Little Alamance Creek watershed

Category	Inadequate	Moderate	Adequate
Watershed Characteristics			
General Information			X
Ecoregion			X
Climate			X
Land Use			X
Water Quality Data			
Physicochemical parameters		X	
Nutrients	X		
Metals	X		
Bacteria	X		
Biological Data			
Benthic macroinvertebrate sampling		X	
Fish sampling	X		
Habitat assessment		X	
Channel Data			
Stream Morphology	X		
Substrate composition	X		
Streambank stability	X		
Flow Data		X	
NPDES WWTP Point Source Discharges			X
Stormwater Outfall Inventory		X	

General information about the watershed is widely available and complete. Availability of water quality data is sparse, with slightly more complete data for physicochemical parameters. Biological data are generally sparse and are considered inadequate to support most planning and water quality and watershed planning decisions or needs. Benthic macroinvertebrate data collections span over 20 years, and therefore were given a rating of moderate. There is minimal information on channel characteristics and stability. Flow data is somewhat more complete, as data were collected continuously for one year near the bottom of the watershed.

4.0 Conclusions

Overall, the available data on Little Alamance Creek are not sufficient to draw definitive conclusions about the source of the biological impairment or support development of a TMDL. The creek is impaired for aquatic life only, and no specific pollutants were identified. The existing reports attributed the impairment to the generally understood conditions of an urban watershed, including the following sources:

- Hydromodification
- Insufficient riparian buffer
- Streambank erosion
- Pollutants in stormwater runoff
- Degradation of in-stream habitat

These conclusions were largely identified through field studies that occurred during a period of drought. Regardless, no known water quality pollutants or pollutant sources have been identified to date.

5.0 References

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