Findings and Recommendations

For Lower Creek

Ecosystem Enhancement PROGRAM

Catawba River Basin

Local Watershed Planning (Phase I)



MACTEC

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FINDINGS AND RECOMMENDATIONS

CATAWBA RIVER BASIN LOCAL WATERSHED PLANNING
LOWER CREEK, NORTH CAROLINA

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1.0 INTRODUCTION

The North Carolina Ecosystem Enhancement Program (NCEEP) has initiated comprehensive watershed planning efforts in certain high-priority local watersheds in order to meet the following primary objectives:

1. Assessment of historical and current watershed conditions;
2. Identification of major causes and sources of watershed degradation (including water quality impairment, aquatic habitat degradation, and flooding problems);
3. Involvement of local stakeholder groups in determining major watershed issues and high-priority focus areas;
4. Prediction of future watershed conditions under alternative land use and watershed management scenarios;
5. Development of a package of watershed restoration and protection recommendations, including:
    b) Identification of restoration, enhancement, and preservation opportunities in order to assist the North Carolina Department of Transportation (NCDOT) in meeting future compensatory mitigation needs for stream, riparian buffer, and wetland impacts;
    c) Identification of non-traditional mitigation projects (e.g., stormwater best management practices [BMPs], urban retrofits, agricultural practices) for targeted sites or subwatersheds; and
    d) Identification of a long-term follow-up strategy to assist localities in implementation of specific watershed protection recommendations developed during the planning process.

The NCEEP generally selects areas for watershed planning due to three primary factors:

1. Documented water quality and aquatic habitat problems in selected stream segments;
2. The opportunity to partner with local agencies and municipalities that have already initiated watershed protection or restoration efforts; and
3. Ongoing threats to local watershed health attributable to agricultural activities, urban/suburban development, planned highway construction projects, clearing of riparian buffers, and/or other non-point sources.

The NCEEP Local Watershed Planning (LWP) efforts are moving toward a watershed assessment approach that emphasizes lost or impacted (and restorable) functions of key watershed components (streams, riparian buffers, wetlands, and contributing uplands) – within the context of an integrated landscape or ecosystem approach. These functions generally fall into three primary categories:

- Water quality protection;
- Habitat; and
- Floodwater storage.

These three functional areas are often the focus of watershed assessment and restoration efforts associated with the LWP process.

Whereas the NCEEP has funding to implement specific restoration, enhancement, and preservation projects that may receive compensatory mitigation credit, the primary responsibility for watershed-based 'non-traditional' mitigation projects (e.g., stormwater management practices) will rest with local government entities. As part of the development of Local Watershed Plans, the NCEEP and its consultants will work with local stakeholder groups to recommend politically and financially feasible watershed solutions, including assistance in identifying possible funding sources for the recommended solutions.

The NCEEP has retained MACTEC Engineering and Consulting, Inc. (MACTEC) to conduct a technical assessment of watershed conditions within the Lower Creek Watershed, including hydrologic unit (HU) 03050101080010 and HU 03050101080020. MACTEC's support services to the NCEEP began in July 2003 and were substantially completed in December 2003. The tasks for MACTEC's watershed characterization effort are outlined below:

Task 1.2.1 - Compilation and Review of Existing Data and Information

Task 1.2.2 - Initial Visual Assessment of the Watershed

Task 1.2.3 - Subwatershed Delineation (and Modeling)

Task 1.2.4 - Findings and Recommendations Report

The purpose of this Findings and Recommendations Report is to summarize the results of these tasks and provide vital information regarding the Lower Creek Watershed (including both 14-digit HU's). This report compiles and summarizes key local watershed characterization findings (including technical memoranda, geographic information system [GIS] products, and tables) and presents collected information pertaining to the condition of wetlands, streams, riparian buffers, contributing uplands, and water quality within the local watersheds. Specifically, this report includes local watershed summaries for the following categories:

- Data Summary
- Physical Features of the Local Watershed
  - Hydrology and Subwatershed Delineation
  - Geology and Soils
  - Land Use and Land Cover
- Functional Assessment
  - Water Quality and Aquatic Habitat
  - Local Watershed Functions
- Local Water Quality Initiatives

- Threats to Local Watershed Functions

Preliminary watershed characterizations were developed based on the information collected and are summarized below. These characterizations provide essential data needed to successfully conduct future detailed assessment of representative subwatersheds and preliminary identification of local watershed improvement projects.

2.0 PRELIMINARY WATERSHED CHARACTERIZATION

The preliminary watershed characterization of Lower Creek includes a description of local physiographic features, a functional assessment based on currently available information, and statements regarding primary threats and areas in need of more detailed assessment.

The Lower Creek Watershed is predominantly located within the Northern Inner Piedmont Physiographic Region (North Carolina Department of Environment and Natural Resources [NCDENR], 2003a). Low to high hills and ridges characterize this ecoregion, along with low to moderate-gradient streams with cobble, gravel, and sandy substrates. The underlying geology consists of igneous and metamorphic rocks, specifically granite and gneiss. Chewacla, Masada, and Congaree series soils are common along Lower Creek. Cecil, Pacolet, and Rion series soils are common in upland areas of the watershed. Local soil survey data generally characterize the prevailing topography as gently rolling land with moderately steep slopes along drainageways (USDA, 1989 and USDA, 2002).

The Lower Creek Watershed includes both HU 03050101080010 (Upper Lower Creek) and HU 03050101080020 (Lower Lower Creek). For purposes of this LWP process, the Lower Creek Watershed was divided into subwatersheds according to hydrology, land use, and topography (Appendix C, Figure C-1). Each subwatershed is approximately one to five square miles in size, and was delineated to facilitate the characterization of specific drainage areas within the watershed and to help identify potential problems and/or opportunities at the catchment level. Regarding subwatershed designations, the prefix ‘UL’ refers to Upper Lower Creek, while the prefix ‘LL’ refers to Lower Lower Creek.

Previous studies by the United States Geologic Survey (USGS), the North Carolina Department of Environment and Natural Resources (NCDENR), and the Western Piedmont Council of Governments (WPCOG) have indicated that water quality, aquatic habitat, and hydrologic processes within the Lower Creek Watershed been degraded by stormwater runoff, non-point source (NPS) pollutants, channel alteration, and riparian buffer impacts. Recent visual observation of conditions in the watershed (by the NCEEP, the DWQ, and MACTEC) has revealed the presence of eroding streambanks, incised channels, in-stream sedimentation, an absence of riparian buffers, and evidence of previous channelization.

2.1 PHYSICAL FEATURES

According to the North Carolina Center for Geographic Information and Analysis (NCCGIA), the Lower Creek Watershed is approximately 98.2 square miles in extent, including HU 80010 (approximately 40.6 square miles) and HU 80020 (approximately 57.6 square miles). Within this watershed are the City of Lenoir, the Town of Cedar Rock, the Town of Gamewell, and a portion of the Cajah's Mountain community (Figure 1). The Lower Creek Watershed is located in the Catawba River basin, and extends from northeastern headwaters in Caldwell County to a southwestern terminus at Rhodhiss Lake (in Burke County). United States Geological Survey (USGS) stream gauge data are not available for this watershed. Lower Creek is the third largest drainage area for Rhodhiss Lake (second only to the Catawba River and the Johns River (WPCOG, 1998).

2.1.1 Hydrology and Subwatershed Delineation

Total stream length in the watershed (NCCGIA, 1996) is approximately 208.3 miles (1,099,824 linear feet [lf]) for the 98.2-square-mile drainage area, resulting in a density of approximately 2.1 stream miles/square miles. In order to assess conditions in the study area, MACTEC divided the Lower Creek Watershed into 29 subwatersheds, differentiated by their presence in either the Upper Lower Creek HU 80010 (subwatersheds UL01 through UL13) or the Lower Lower Creek HU 80020 (subwatersheds LL01 through LL16) (see Appendix C, Figure C-1). General subwatershed characteristics are summarized in Table 1 and are discussed in subsequent sections of this document.

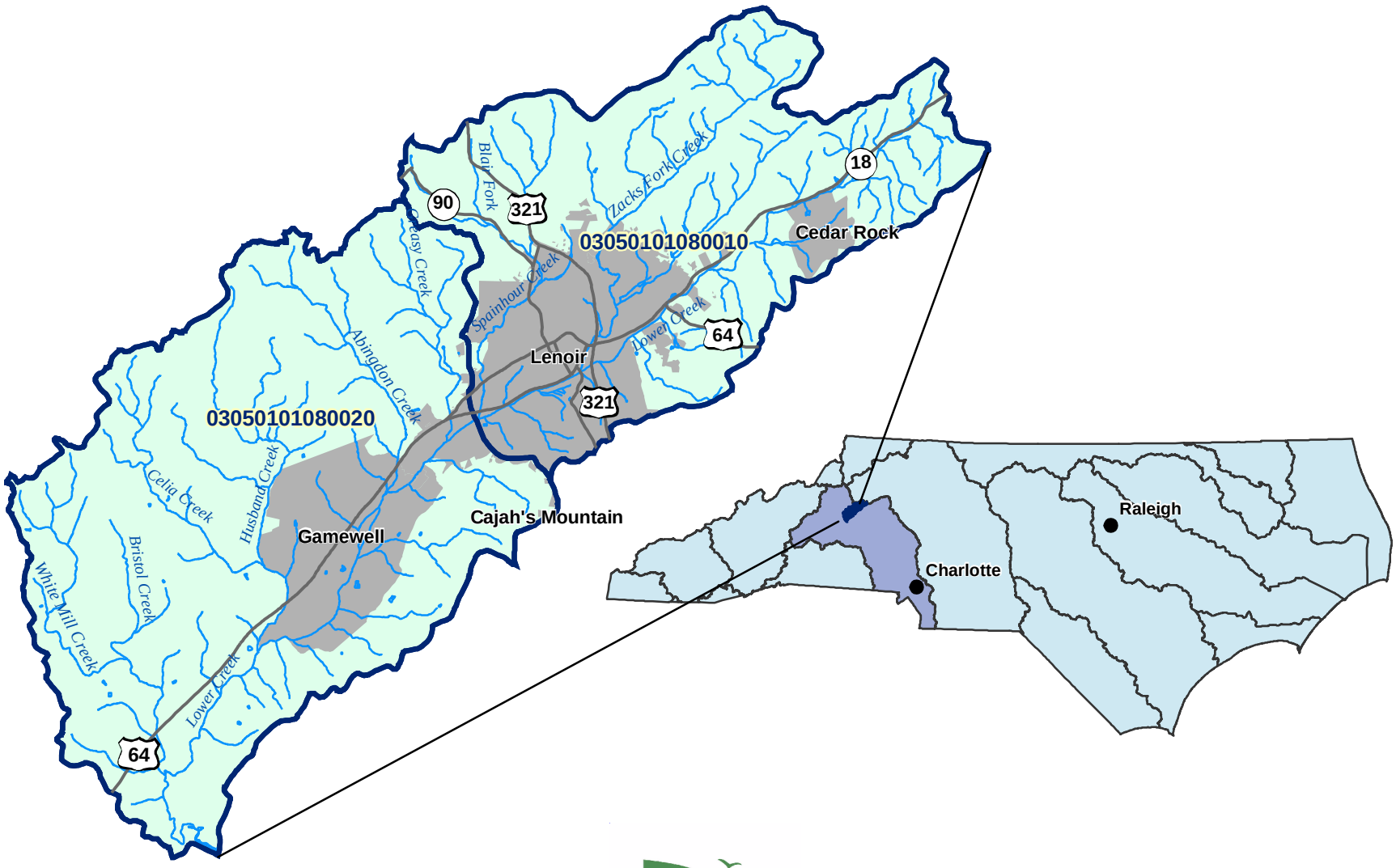
Table 1: Lower Creek Watershed Characteristics

SUB-WATERSHED	APPROXIMATE AREA (square miles)	IMPERVIOUS COVER	AGRICULTURAL LAND USE	FORESTED LAND USE	URBAN LAND USE	FLOODPLAIN ENCROACH-MENT	WETLAND AREA	POTENTIAL WETLAND LOSS	NPDES DISCHARGERS	NCNHP OCCURRENCES
UL01	3.12	<1.0%	11%	89%	0%	<1.0%	0.3%	7.1%	0	0
UL02	2.83	<1.0%	25%	75%	0%	<1.0%	0.2%	10.6%	0	0
UL03	3.83	1.1%	23%	76%	1%	<1.0%	0.3%	12.0%	1	0
UL04	2.94	<1.0%	13%	87%	0%	<1.0%	0.1%	9.3%	0	0
UL05	3.15	<1.0%	1%	99%	0%	<1.0%	0.2%	4.7%	0	0
UL06	4.50	<1.0%	10%	90%	0%	<1.0%	0.3%	7.3%	1	0
UL07	1.85	24.9%	20%	55%	25%	2.1%	0.1%	10.7%	0	0
UL08	3.52	9.4%	13%	77%	10%	1.7%	0.3%	8.7%	0	1
UL09	2.44	30.6%	23%	47%	31%	4.9%	0.4%	15.1%	0	1
UL10	3.00	43.8%	10%	46%	44%	6.9%	0.8%	5.3%	0	0
UL11	3.66	38.2%	18%	43%	38%	4.6%	0.6%	6.4%	0	0
UL12	2.95	1.4%	5%	94%	1%	<1.0%	0%	4.0%	0	0
UL13	2.81	<1.0%	4%	95%	1%	<1.0%	0.1%	11.4%	1	0

SUB-WATERSHED	APPROXIMATE AREA (square miles)	IMPERVIOUS COVER	AGRICULTURAL LAND USE	FORESTED LAND USE	URBAN LAND USE	FLOODPLAIN ENCROACH-MENT	WETLAND AREA	POTENTIAL WETLAND LOSS	NPDES DISCHARGERS	NCNHP OCCURRENCES
LL01	3.42	<1.0%	5%	94%	1%	<1.0%	0%	9.2%	1	0
LL02	4.29	13.9%	23%	63%	14%	1.9%	0.5%	7.8%	0	0
LL03	1.96	7.1%	26%	67%	7%	<1.0%	0.9%	2.3%	1	1
LL04	5.33	1.1%	9%	90%	1%	<1.0%	0.1%	6.5%	0	0
LL05	5.67	<1.0%	9%	91%	0%	<1.0%	0.3%	8.6%	0	0
LL06	2.90	1.8%	29%	69%	2%	<1.0%	0%	11.3%	0	0
LL07	5.07	8.0%	29%	63%	8%	<1.0%	1.0%	2.1%	0	0
LL08	3.71	1.3%	28%	71%	1%	<1.0%	0.1%	<1.0%	0	0
LL09	2.15	1.0%	20%	79%	1%	<1.0%	1.9%	7.1%	0	0
LL10	3.44	<1.0%	19%	80%	0%	<1.0%	0.3%	3.9%	0	0
LL11	2.51	<1.0%	6%	94%	0%	<1.0%	0.4%	4.9%	0	0
LL12	4.76	<1.0%	6%	93%	0%	<1.0%	0.4%	0.9%	0	0
LL13	2.99	<1.0%	8%	91%	0%	<1.0%	0.8%	ND	0	0
LL14	3.11	<1.0%	21%	78%	1%	<1.0%	7.4%	<1.0%	1	0
LL15	4.62	<1.0%	18%	81%	1%	<1.0%	4.3%	ND	0	0
LL16	1.66	<1.0%	1%	99%	0%	<1.0%	5.6%	ND	0	0

Note: As indicated, percentages are based on percent of subwatershed area.

Land use decisions often affect hydrologic processes (e.g., by influencing stormwater runoff patterns and infiltration), water quality (e.g., by creating conditions that may either contribute or filter potential pollutants), and habitat (e.g., by influencing terrestrial and/or aquatic habitat structure). To better understand and anticipate such effects, MACTEC derived estimates of percent impervious cover (IC), percent agricultural land (including rural residential land), percent forested land, and percent urban land for each subwatershed. The estimates shown in Table 1 were developed using 1996 NCCGIA land use/land cover data, and indicate the approximate percentage of subwatershed area in each land use category. Impervious cover estimates were derived from NCCGIA land use/land cover data (1996) by defining impervious land as those features with Low Intensity Developed or High Intensity Developed attributes (in EarthSat land cover data, see Appendix A, Figure A-2). Percent impervious cover was then calculated by dividing the area of impervious land by total area of each subwatershed. Using NCCGIA data, Agricultural Land Use was defined as the 'cultivated' and 'managed herbaceous cover' categories. In contrast, Forested Land Use was defined as including: 'evergreen shrubland,' 'deciduous shrubland,' 'mixed hardwoods/conifers,' 'mixed shrubland,' 'mixed upland hardwoods,' 'mountain conifers,' 'southern yellow pine,' and 'unmanaged herbaceous cover.' Urban Land Use includes both 'high intensity developed' and 'low intensity developed.' The following categories were excluded from these classifications: 'unconsolidated sediments,' 'exposed rock,' 'water bodies,' and 'not within state land cover databases.'



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Project Study Area Location

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Since discussions with local stakeholders have indicated concerns regarding previous floodplain filling in the watershed, approximate extents of floodplain encroachment were also estimated. Percent floodplain encroachment was calculated by creating an arithmetic overlay utilizing Federal Emergency Management Agency (FEMA) Q3 Flood Data and NCCGIA land cover data. Q3 Flood Data are digital representations of Flood Insurance Rate Map (FIRM) information intended for use with GIS technology. However, FEMA data does not include all floodplain areas, and may exclude floodplains along some small first-order streams. Wetland information was derived from U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) coverages (Appendix A, Figure A-5). In order to identify subwatersheds with wetland losses (and therefore potential wetland restoration opportunities), percent wetland loss was derived from an overlay operation comparing NWI wetland extents and Natural Resources Conservation Service (NRCS) hydric soil extents (Appendix A, Figure A-3). Limitations of this approach include potential NWI underestimation of wetland extents (i.e., NWI coverages may not include all small wetland areas), and potential overestimation of NRCS hydric soil extents (i.e., NRCS data includes both hydric soils and hydric inclusion soils). National Pollutant Discharge Elimination System (NPDES) dischargers and N.C. Natural Heritage Program (NCNHP) element occurrences were derived from 1996 NCCGIA and 2003 NCNHP data.

2.1.2 Geology and Soils

The Lower Creek Watershed is characterized by Inner Piedmont Belt geology (North Carolina Geological Survey [NCGS], 2003). Major rock types described by the NCGS include two intrusive formations, OCgm – Migmatitic Granitic Gneiss (foliated to massive, granitic to quartz dioritic; biotite gneiss and amphibolite common) and OCg – Metamorphosed Granitic Rock (equigranular to megacrystic, foliated to massive; includes Toluca Granite). Two metamorphic formations are prevalent in the Lower Creek Watershed, CZbg – Biotite Gneiss and Schist (inequigranular, locally abundant potassic feldspar and garnet; inter-layered and gradational with calc-silicate rock, sillimanite-mica schist, mica schist, and amphibolite; contains small masses of granitic rock) and CZms – Mica Schist (garnet, staurolite, kyanite, and sillimanite occur locally; lenses and layers of quartz schist, micaceous quartzite, calc-silicate rock, biotite gneiss, amphibolite, and phyllite) (NCGS, 2003).

The Caldwell County Soil Survey (USDA, 1989) describes the following soil mapping units within the Lower Creek Watershed: Chewacla-Masada-Congaree (along floodplains), Cecil-Pacolet-Rion, and Evard-Hayesville-Saluda (in headwaters/uplands areas). Chewacla-Masada-Congaree soils are nearly level to strongly sloping, somewhat poorly drained to well-drained soils that have a loamy or clayey subsoil or loamy underlying material and have been formed in recent or old alluvium. These soils are

used mostly for row crops, hay, or pasture. Seasonal wetness is the main limitation, and occasional flooding is a hazard. Cecil-Pacolet-Rion soils are gently sloping to steep, well-drained soils that have clayey or loamy subsoil and have been formed in residium from igneous and metamorphic rock. Uses of these soils include row crops, woodlands, and urban development. Slope steepness is the main limitation to development, and erosion is a concern in these areas. Evard-Hayesville-Saluda soils are moderately sloping to very steep, well-drained soils that have loamy subsoil and have been formed in residium from granite gneiss. Most areas of this soil are forested. These areas are usually not used for cropland, building site development, or recreational facilities because of steep slopes. Unpublished Burke County soil survey data (USDA, 2002) describes the following soil mapping units in the watershed: Arkaqua-Banister-Colvard (along floodplains and stream terraces) and Fairview (in headwaters/uplands areas).

According to the USDA (USDA, 1991), hydric soils in Caldwell County include Roanoke Loam (Ro) and frequently flooded Wehadkee loam (Wk). The following hydric inclusion soils are also found in Caldwell County: Chewacla loam (Cm [4]), Dogue fine sandy loam (DoB [54B]), and Tate fine sandy loam (TaB [10C] and TaD). In Burke County, the USDA (1993) lists the following hydric soils: Nikwasi loam (40A), Roanoke loam (89A), Tate-Nikwasi complex (105B), Wehadkee silt loam (86A), and Worsham fine sandy loam (80A). Only one hydric inclusion soil was noted in Burke County: occasionally-flooded Wehadkee (15A).

The soil erodibility characteristics of a watershed are often depicted by K factor (Appendix A, Figure A-4). K factors are a component in the Universal Soil Loss Equation (USLE) and represent the susceptibility of soil to sheet and rill erosion. Soils high in clay content have low K factor values (approximately 0.05 to 0.15) because they resist detachment. Coarse soils (e.g., sandy soils) have low K factor values (approximately 0.05 to 0.2) because they produce minimal runoff. Medium textured soils (e.g., silt loam) have moderate K factor values (approximately 0.25 to 0.4) because they are moderately susceptible to detachment and runoff. Soils with high silt content are the most erodible and tend to have K factor values greater than 0.4 (Institute of Water Research [IWR], 2002). K factors are primarily based on percentage of silt, sand, and organic matter (up to four percent), and on soil structure and permeability (USDA, 1989). Unfortunately, county soil surveys do not always consistently apply K factors to given soil types. Despite this inconsistency, a K factor analysis is useful for a general characterization of soil erodibility. Soil erodibility (K-factor) within the Lower Creek Watershed ranges from 0.10 to 0.38, while soil erodibility throughout Caldwell County ranges from 0.02 to 0.69. Erodible soils (i.e., K factor values >0.4) within the Lower Creek Watershed are primarily concentrated along the mainstem of Lower Creek (see Appendix A, Figure A-4), indicating that stream banks may be relatively susceptible to erosion in

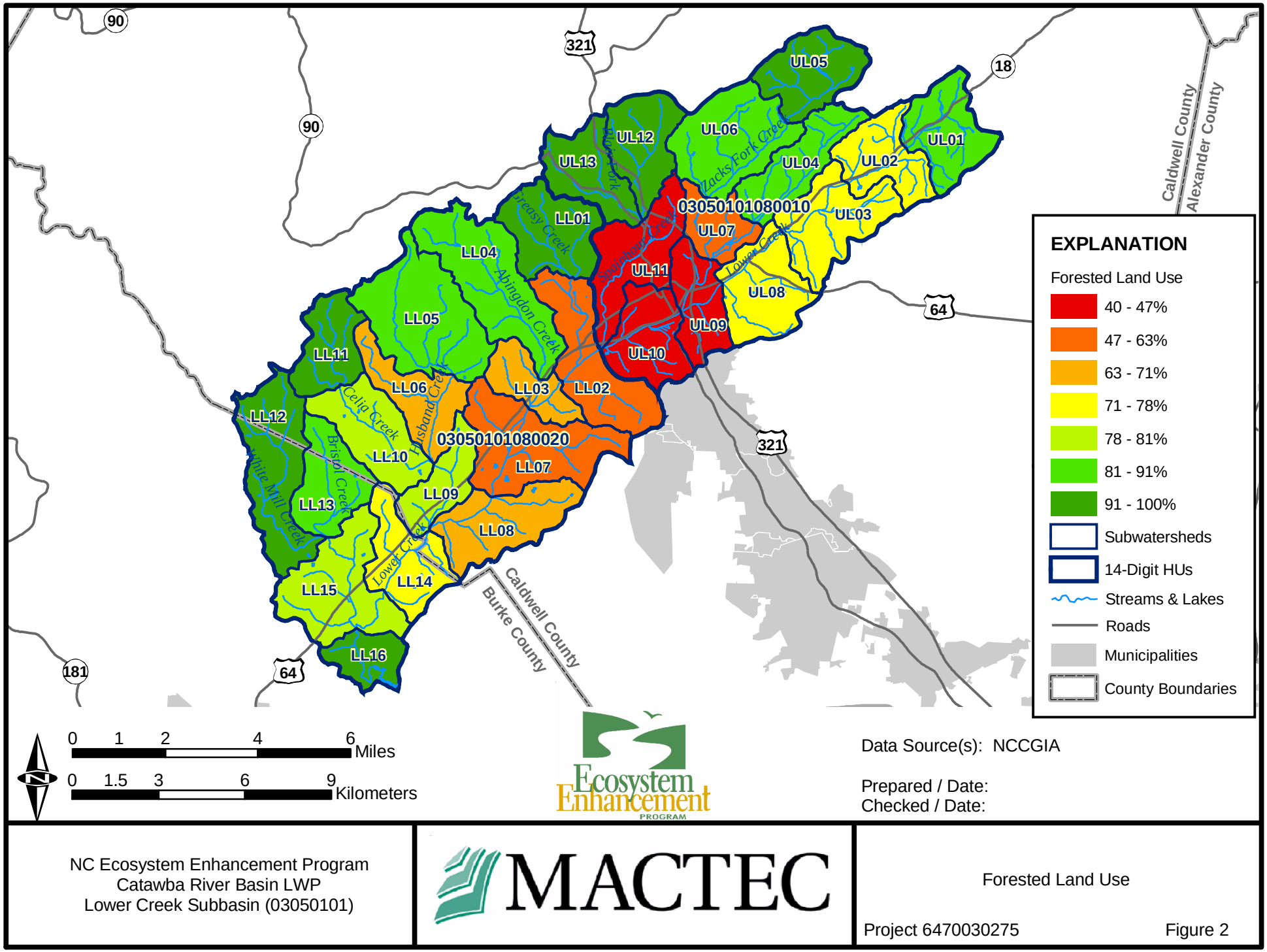
these areas. Burke County was not included in this analysis as digital soils data are not currently available.

2.1.3 Land Use and Land Cover

The NCEEP frequently evaluates land use and land cover data to help identify potential stream and wetland restoration opportunities. NCGIA data (1996) indicates land use within the watershed to be approximately 75% forest, 14% agricultural (cultivated row crops and pasture), and 11% urban (Figure 2, Figure 3, and Figure 4). Additional land use and land cover analyses were used to estimate impervious cover for individual subwatersheds using available 1996 NCCGIA land cover data (Figure 5). The highest levels of impervious cover in this largely rural watershed are located in the City of Lenoir, the Town of Cedar Rock, and the Town of Gamewell. In addition, MACTEC also utilized available information regarding soils and wetlands to facilitate the identification of potential target subwatersheds.

2.2 FUNCTIONAL ASSESSMENT

Watershed functions are intimately linked by the downgradient flow of water, sediment, and other materials from upland areas. Alterations to wetlands, streams, and riparian buffers (as well as impervious cover and land use changes) can alter the ability of a watershed to perform functions related to hydrology, water quality, and habitat. Preliminary identification of impacts to hydrology, water quality, and habitat functions in the Lower Creek Watershed was achieved by compiling and analyzing existing data, conducting GIS analyses, and performing preliminary field reconnaissance. Initial efforts focused on the condition of wetlands, streams, riparian buffers, contributing uplands, and water quality within the watershed. In particular, impacts related to impervious cover and land use change along riparian corridors were noted during field reconnaissance efforts. A summary of potentially impacted functions follows.



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Forested Land Use

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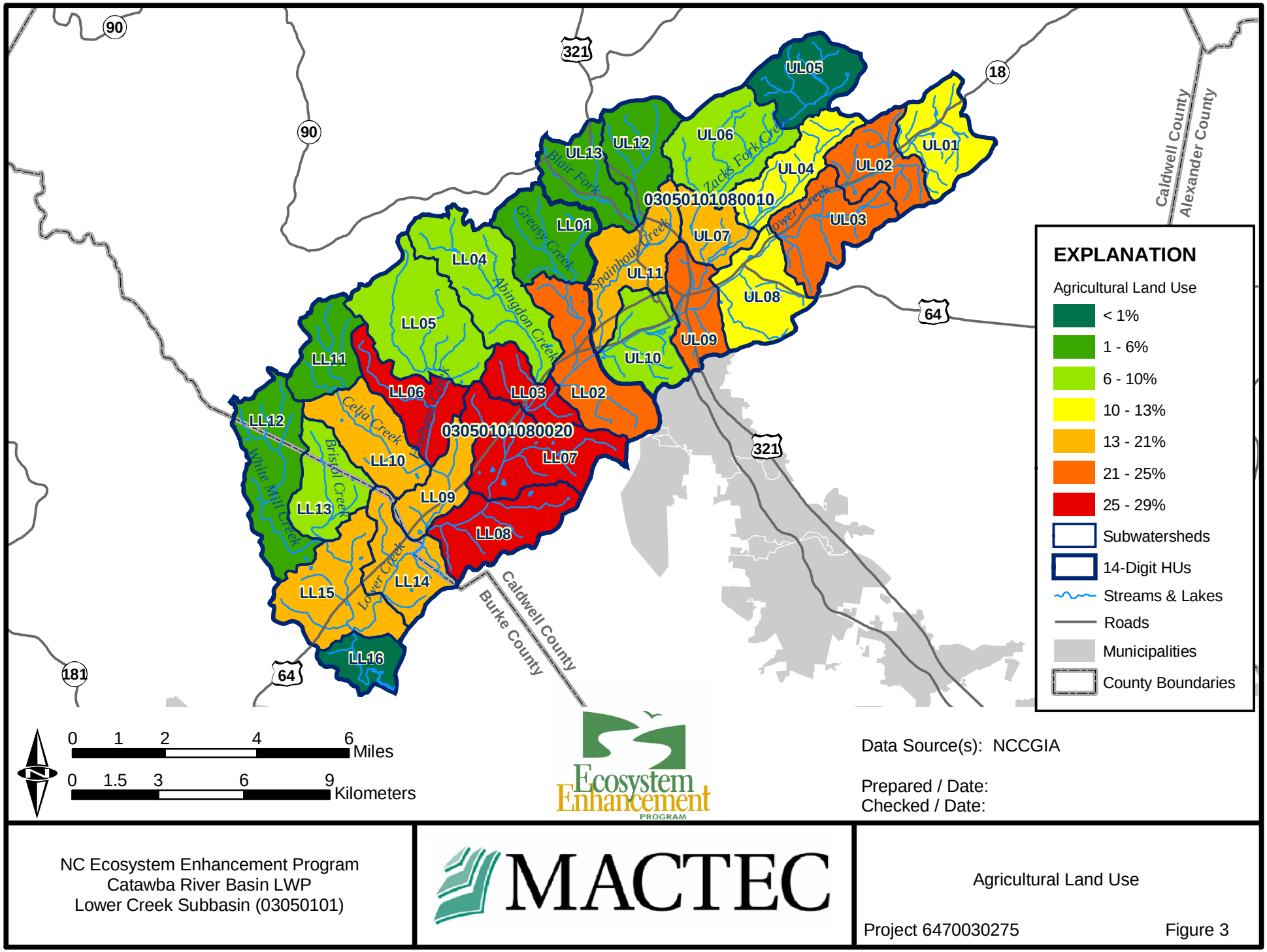

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Agricultural Land Use

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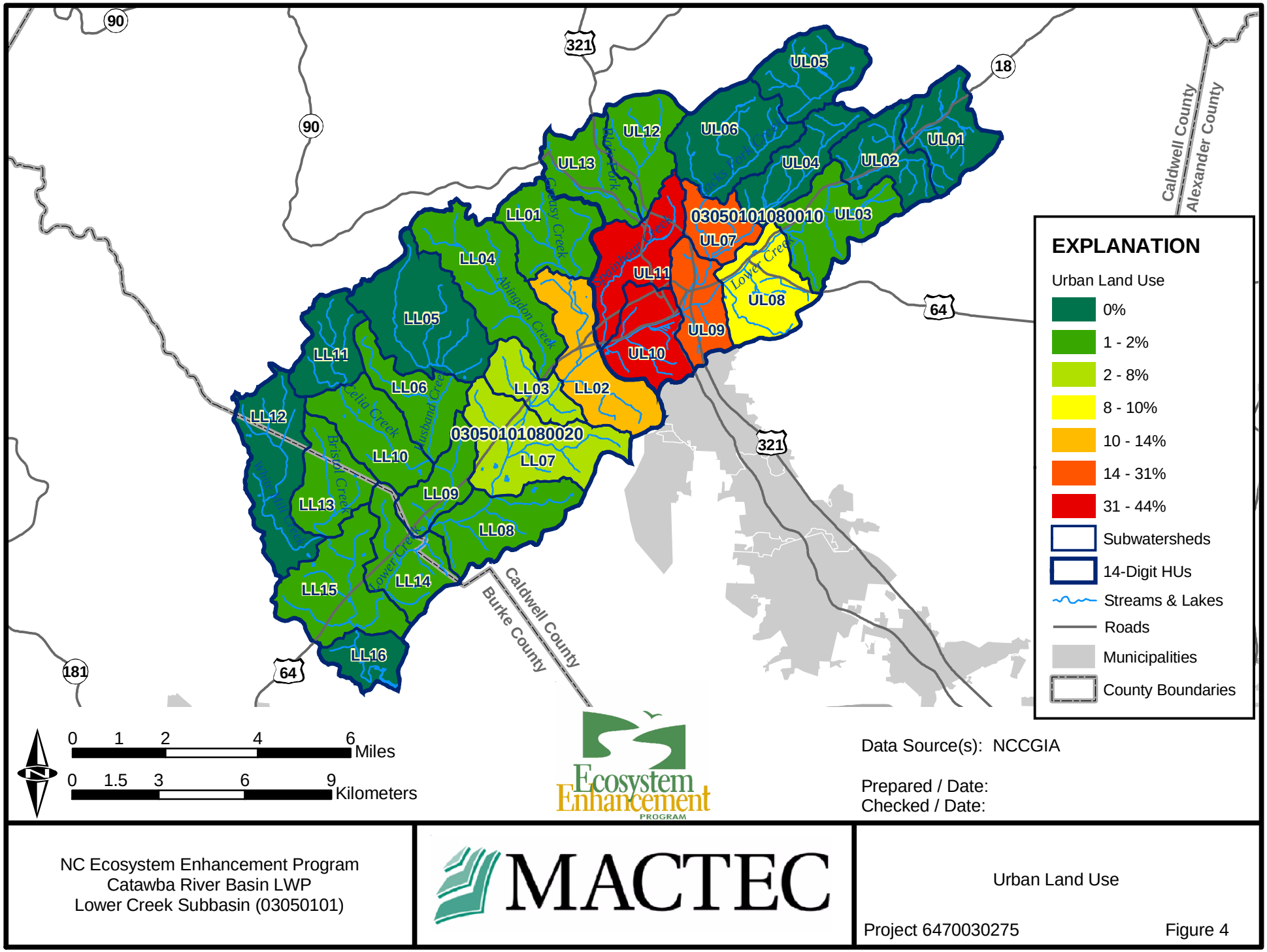

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Urban Land Use

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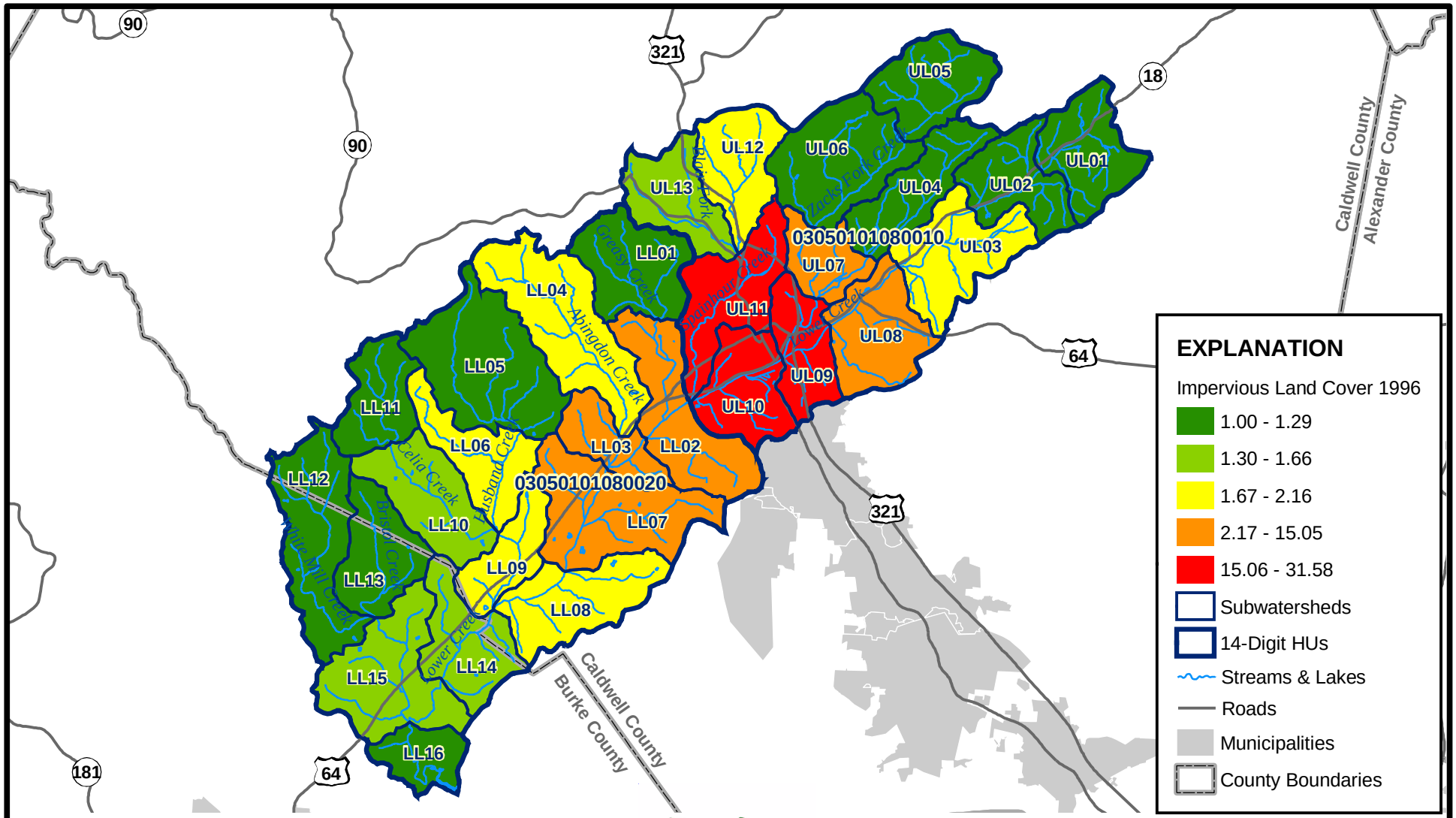

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Impervious Cover

Project 6470030275 Figure 5

2.2.1 Hydrology

Hydrologic functions in the Lower Creek Watershed are closely associated with rural land use patterns and decisions. Many first-order streams in this watershed originate in northern forested areas currently managed primarily for silvicultural purposes. In contrast, many second-order and third-order streams are located in the central, lower elevation valleys, areas dominated by agricultural croplands, pastures, and rural residential land use. It is in many of these larger central valleys that the presence of ornamental nursery operations is particularly evident. While urbanized areas like Lenoir, Cedar Rock, and Gamewell also influence local watershed hydrology, these impacts are generally most clearly evidenced within the towns themselves and in the channels immediately downstream of these urbanized areas. Consideration of the entire watershed area reveals that the majority of land in the study area has not yet become urbanized.

Since the majority of the Lower Creek Watershed is rural in character (0-5% impervious cover), most impervious cover impacts are concentrated around the existing urbanized areas of Lenoir (subwatersheds UL07, UL09, UL10, and UL11, at 15-45% impervious cover) and Gamewell (subwatersheds LL02, LL03, and LL07, with 5-15% impervious cover). Although the relationship between impervious cover and increased stormwater runoff is well documented, other factors (e.g., slope, soils, and conveyance system types) also play a role in the hydrologic response of a watershed to stormwater runoff. Despite continued debate regarding the impact of specific levels of imperviousness and influence on hydrological function, watersheds with impervious cover greater than 10% consistently exhibit evidence of reduced/impacted hydrologic function (CWP, 2003). Watersheds with riparian corridors that have experienced more than a 20% increase in urban land use have also been identified as suffering from reduced/impacted/lost hydrologic function (CWP, 2003).

During field reconnaissance efforts, stream channel incision (Figure 6) and widening processes (Figure 7) were observed throughout the watershed. These processes were primarily noted along streams that lacked riparian buffers (i.e., minimal root mass stabilization) and along channels in urbanized areas (e.g., stormwater conveyances). Evidence of significant streambank erosion and downstream sedimentation (aggradation) was also observed at various locations in the watershed. Impacts from construction activities, agriculture, and new development (e.g., residential and commercial) may be contributing to this hydrologic impairment (Figure 8).



Figure 6: Stream down-cutting (incision) along Lower Creek at golf course, 07/31/03 (UL09)



Figure 7: Streambank erosion along Lower Creek, 07/31/03 (LL07)



Figure 8: Construction activities along Zacks Fork at soccer complex, 09/04/03 (UL07)

Additional hydrologic impacts in the watershed have resulted from channel modifications and alteration of natural stream channel plan, dimension, and profile at various locations. Many streams were likely previously channelized (via straightening and relocation) in local agricultural areas, to maximize available cropland (Figure 9). More recently, other streams appear to have been piped or diverted for residential, commercial, and industrial development. In undisturbed stream channels, such alterations often disturb a natural state of dynamic equilibrium, and may create further instability in the downstream channel network. As each stream adjusts to such alterations, the processes of streambank erosion, lateral migration, channel incision, and/or streambed aggradation may be initiated. When alterations are implemented along streams that have already been previously impacted, these modifications may exacerbate such existing problems (e.g., streambank erosion, channel incision) and may prevent the streams from recovering to a naturalized state of quasi-equilibrium. For example, channelized streams lined with riprap (Figure 10) were observed throughout the Blair Fork (UL13) subwatershed, along with channels in close proximity to adjacent roadways (e.g., stream channels within approximately ten feet of Indian Grave Road and Valway Road).



Figure 9: Streambank Channelized Husband Creek tributary at tree farm, 09/19/03 (LL06)



Figure 10: Channelized Blair Fork along Valway Road tributary, 09/19/03 (UL13)

Preliminary observations indicate that many streams within the Lower Creek Watershed are incised, are characterized by actively-eroding streambanks, or are being impacted by in-stream sediment accumulation (sedimentation). While stormwater runoff from urbanized areas may be a contributing factor to this impairment in many areas (e.g., Lower Creek and Zacks Fork in/downstream of Lenoir), the presence of such problems in rural portions of the watershed may indicate other processes at work, including the theoretical process of historic valley filling/incision. It has been suggested that poor erosion and sediment control practices in eastern North America during the 19th century may have accelerated natural erosion rates and subsequently led to the 'filling' of some valley areas with an overburden of deposited sediment. This theory suggests that such valley areas may have then become stabilized over time with vegetation, and that recent channel incision (degradation) may represent an effort by the stream channels to reach their historic streambed elevations. This theory and its potential applicability to the Lower Creek Watershed should be discussed with knowledgeable local geomorphologists during future phases of the project.

2.2.2 Water Quality

Since water quality data for the Lower Creek Watershed are somewhat limited (one NCDENR Division of Water Quality [DWQ] station on Lower Creek, and DWQ biological monitoring stations on other tributaries, NCDENR 2003b), it is difficult to establish identifiable trends, extents of pollution, and potential sources of water quality impairment (due largely to spatial and temporal variability). Based on available water quality data, NPS pollutants (e.g., sediment, nutrients, and coliform bacteria) are likely are likely impacting water quality in the study area. In 2003, the DWQ summarized water quality and biological monitoring data for Lower Creek as follows (NCDENR, 2003b):

"The entire length of Lower Creek below the junction of Zacks Fork (approximately 12.7 miles) is listed on North Carolina's 2002 303(d) impaired stream list as partially supporting. Causes of impairment noted on the 2002 303(d) list are habitat degradation and turbidity; and urban runoff, non-urban development, and municipal point sources were noted as potential sources of impairment. Several major tributaries to Lower Creek (Zacks Fork , Spainhour Creek, Greasy Creek, and Bristol Creek) are also listed as partially supporting on the 303(d) list. Nonpoint sources of pollution such as agriculture, urban runoff, and non-urban development are listed as potential sources of impairment. The upper reach of Lower Creek is currently listed as fully supporting. Stream quality data for the Lower Creek watershed include DWQ benthic, fish, and habitat assessments and DWQ ambient data. In addition, the USGS collected a limited amount of data in 1993-1994 on nutrients and fecal coliform bacteria in Lower Creek (Giorgino and Bales, 1997), which are not summarized here.

Historic Monitoring 1984-1992

Benthic macroinvertebrates were collected in 1984, 1987, 1990, and 1992 in Lower Creek in or downstream of Lenoir. All samples were rated Fair. Zacks Fork Creek was sampled in 1987 and rated Fair.

1997 Watershed Study

"[The] DWQ conducted a watershed survey in 1997 in response to a request from the Western Piedmont Council of Governments [WPCOG] ([NCDENR] DWQ, 1997). Among the four monitoring sites on Lower Creek, the three downstream sites located in or downstream of Lenoir were rated Fair. A site at NC 90, which was upstream of Lenoir, was rated Good-Fair. The greatest stress in Lower Creek was at SR 1142, which was located below the densest urban development, Lenoir's wastewater treatment plant (WWTP), and three major tributaries, each of which had Fair bioclassifications. Five tributaries of Lower Creek were also sampled--Zacks Fork Creek, Spainhour Creek, Greasy Creek, Husband Creek, and Bristol Creek. All streams but Husband Creek (rated Good-Fair) were rated Fair. Analysis of benthic community composition of each site did not indicate impacts from severe nutrient or organic enrichment or toxic conditions. A lack of protective buffers and many potential non-point sources of pollution were noted in the watershed. Potential pollution sources noted included a golf course, industries, agriculture (livestock), commercial areas, and residential developments. Impacts from urban and sub-urban development in and around Lenoir were pinpointed as major factors in biological community degradation. The study did not detect additional impacts to Lower Creek from Lenoir's WWTP, but this may have been masked by the water quality problems above the discharge.

2002 Watershed Study

"Each stream sampled in 1997 was sampled again in 2002, and a number of sites were added to determine differences in benthic communities of urban and non-urban streams. Degraded benthic communities characterized all sites in the Lower Creek watershed ([NCDENR] DWQ, 2003f). As in 1997, none of the communities sampled in 2002 indicated severe nutrient or organic enrichment, or toxic conditions. Many sites had severe streambank erosion with little protection by a riparian buffer zone. Sandy substrates provided poor habitat, limiting benthic diversity. Poor habitat coupled with urban impacts from Lenoir produced the most stressed benthic communities as demonstrated in Lower Creek, lower Zacks Fork Creek, and lower Spainhour Creek. Tributaries, such as Abingdon Creek, upper Husband Creek, Bristol Creek, and the unnamed tributary (UT) to Spainhour Creek that did not drain urban areas, supported more diverse or intolerant benthic communities. Runoff from agriculture (cropland and livestock) and

residences located in tributary catchments likely affected the benthic communities in these streams, but not as severely as urban runoff from Lenoir. The UT to Spainhour Creek and the Bristol Creek watershed (including White Mill Creek) were the only systems that supported benthic communities with long-lived stoneflies and philopotamid caddisflies.

Lower Creek

"All of the Lower Creek sites had impaired benthic communities, rated Fair or Poor. The Lower Creek sites retained their Fair ratings (SR 1303, SR 1142, and SR 1501) or declined (NC 90) from 1997. Contrary to 1997, the most upstream location on Lower Creek (NC 90) received the lowest rating (Poor) of the four mainstem Lower Creek sites. The most downstream site at SR 1501 appeared to recover slightly from the upstream sites. Lenoir's WWTP effluent did not appear to further impact the benthic fauna, although the dissolved oxygen value of 5.6 mg/L3 may be an indication of a dissolved oxygen sag from the WWTP. This was the only Lower Creek site in 2002 where stoneflies were collected, although neither of the two stonefly taxa were abundant.

Zacks Fork Creek

"An upper Zacks Fork Creek site was sampled and rated Not Impaired, supporting a more diverse benthic community (EPT richness of 19) than the lower Zacks Fork Creek site (EPT richness of 6). The upstream habitat was much better than that downstream (total habitat score of 55 vs. 26), and the upper site was above the urban influences of Lenoir. Of particular concern at the lower Zacks Fork Creek site was an elevated conductivity reading of 1000 umhos/cm. The site was located just downstream of a golf course and within Lenoir. The 2002 lower Zacks Fork Creek benthic community was much less diverse than that of 1997; EPT richness dropped from 18 to 6.

Spainhour Creek Watershed

"The small UT to Spainhour Creek supported the most intolerant benthic community (biotic index of 4.66) in the Spainhour Creek watershed, but the stream's small size likely limited diversity (EPT richness of 13). In comparison, the benthic community from urban-influenced Blair Fork was severely impacted (EPT richness of 5, biotic index of 6.42). Spainhour Creek itself was much more tolerant than UT to Spainhour, with a biotic index of 6.46. There was little change in the benthic community between 1997 and 2002 in Spainhour Creek, although that of 2002 was slightly more tolerant. Cumulative water quality impacts and habitat degradation that occurs as Spainhour flows southwest through the City of Lenoir likely contribute to the declining benthic fauna at the downstream Spainhour site.

Greasy Creek

"An upstream site was sampled on Greasy Creek in 2002 to differentiate between benthic communities and habitat in the upper portion of this watershed versus downstream, which was sampled in 1997 and 2002. Although habitat was better at the upstream site (more in-stream structure and less sand and silt), there were no notable differences in the benthic communities at the upstream and downstream sites. EPT scores were low at both sites. There was little change in the benthic community of the downstream Greasy Creek site between 1997 and in 2002.

Abingdon Creek

"Abingdon Creek was characterized by a benthic community with the second highest EPT richness (20) in the Lower Creek watershed; it was rated Not Impaired. The Abingdon Creek watershed is less urban and appears to be one of the less impacted catchments in the Lower Creek, although there are potential sources of impact, including timber operations, agricultural fields and minimal riparian zones.

Husband Creek Watershed

"An upper site on Husband Creek was sampled in 2002 and supported a much more diverse benthic community than the lower Husband Creek site (EPT richess of 24 vs. 14). This upper site had the highest EPT taxa richness of all sites sampled in the Lower Creek watershed. Between 1997 and 2002, a drop in EPT richness from 20 to 14 occurred for the downstream site; however, based on upon community composition analysis and consideration of seasonal variation, this drop does not reflect a true decline in community health. A sample was also collected in Celia Creek, which is a tributary to Husband Creek. This site was characterized by low EPT taxa richness (10), but many taxa collected were intolerant. The small drainage area may limit diversity in this stream. Considering drainage area, the taxa collected, and EPT richness, Celia Creek appears to be minimally to moderately impacted.

Bristol Creek Watershed

"Rural Bristol Creek and its tributary, White Mill Creek, were characterized by fairly limited EPT richness (12 and 14, respectively), but intolerant and long-lived taxa were present. The small sizes of both streams may limit benthic diversity and abundance.

Comparison Sites

"Smoky Creek and Gunpowder Creek, located in watersheds adjacent to the Lower Creek watershed, were sampled as part of the basinwide assessment program in August 2002 and are used for comparison

to sites in the Lower Creek watershed. Unlike Lower Creek and many of its tributaries sampled during this study, Smoky Creek and Gunpowder Creek drain rural catchments. Gunpowder Creek was dominated by sand and was a comparison for Lower Creek. It was rated Good-Fair, characterized by a more diverse and intolerant community than any site on Lower Creek sampled in 2002. Smoky Creek was a smaller creek and provides a comparison for sites like Abingdon Creek, UT to Spainhour, and upper Husband Creek, which have like mixes of cobble, gravel, and sand substrates. Smoky Creek was rated Good-Fair and had a higher EPT richness and lower biotic index than any site in the Lower Creek watershed.

Ambient Monitoring Data, N.C. Division of Water Quality

"[The] DWQ has monitored chemical/physical parameters on Lower Creek at SR-1501 since 1973. This site is located below the Town of Lenoir WWTP discharge. For the period of 1998-2002, nutrients were relatively high, with a median total nitrogen (TKN+NO_2/NO_3) concentration of 1.2 mg/L and median total phosphorus of 0.1 mg/L. Twenty percent of samples were above NC's action level for copper of 7 µg/L. Fecal coliform bacteria levels were high, with the geometric mean of 277 colonies/100 mL for 55 samples (N.C. standard is 200 colonies/100 mL for 5 samples collected in 30 days).

NPDES Facilities

"There were six wastewater treatment plants permitted through the NPDES program in the Lower Creek watershed during the period of 2001 to 2003; however, three of these are either no longer operating or now send their waste to Lenoir's WWTP. A record review indicates that no facility has consistent problems, although the City of Lenoir has exceeded its permitted limits for total suspended solids and biochemical oxygen demand twice in the past two and a half years."

As noted by the DWQ, riparian buffers are absent along many streams in the Lower Creek Watershed. Without such forested buffers, there is only limited filtering of stormwater/NPS pollutants before they reach adjacent stream channels. Forested riparian buffers provide a vegetated transition zone between surface waters and human land uses. During visual assessment efforts in the Lower Creek Watershed, riparian buffers were typically found to be either sparse or entirely absent along many stream channels. This was particularly evident along Zacks Fork, Lower Creek, and an unnamed tributary to Husband Creek (Figure 11 and Figure 12).



Figure 11: Lack of riparian buffer on Husband Creek at golf course, 09/04/03 (LL05)



Figure 12: Lack of riparian buffer on Tributary to Zacks Fork, 09/04/03 (UL06)

While the majority of stream channels in the Lower Creek Watershed are Class C surface waters, Lower Creek is listed as WS-IV/CA downstream of Bristol Creek (See Appendix A, Figure A-6 for classifications. See Appendix A, Figure A-7 for use-support ratings). The WS-IV classification indicates that the downstream-most portion of Lower Creek and five of its tributaries are in a Water Supply Watershed. The WS-IV designation is generally applied to surface waters that are utilized for drinking water, culinary, or food processing purposes, and is typically used when a WS-I, WS-II, or WS-III classification is not feasible (usually in moderately-developed or highly-developed watersheds). The WS-IV classification involves no categorical restrictions on discharges, though the additional Critical Area (CA) classification of Lower Creek (applied downstream of Bristol Creek and around Rhodhiss Lake) does require no new landfills, specified agricultural BMPs, and regulated residential development (using either a Low Density Option of 24% built-upon area [two dwelling units per acre] or a High Density Option of 24-50% built-upon area).

According to the DWQ (NCDENR, 2002b and NCDENR, 2003b), data collected at the Lower Creek/SR-1501 monitoring station [C17500000]) also indicate consistently high concentrations of fecal coliform (3,000 colonies (c) per 100 mL, 2,000 c/100mL, and 8,400 c/100mL). For the DWQ sampling period from 1998-2002, the geometric mean was 277 c/100mL for 55 samples. The North Carolina standard is 200 c/100mL for five samples collected in 30 days (NCDENR, 2003b). Elevated fecal coliform levels may be indicative of failing septic systems, land development, urban runoff, and/or agricultural/rural residential inputs. The DWQ also noted high nutrient concentrations during some sampling efforts (NCDENR, 2003b). Nutrient inputs may be produced by a variety of sources, including fertilizer runoff (from agricultural and/or residential areas), treated wastewater effluent, urban stormwater runoff, failing septic systems, animal concentrations (e.g., concentrated animal feeding operations [CAFO] or migratory waterfowl), atmospheric aerosols, and detergents. High coliform levels and nutrient loadings have the potential to affect downstream water quality in Rhodhiss Lake (a local water supply), as elevated nutrient levels may increase the risk of eutrophication.

2.2.3 Habitat

Aquatic habitat in the Lower Creek Watershed includes both high-gradient headwater streams (to the north and northwest), lower-gradient channels in forested and agricultural areas (in the central and southern portions of the local watershed), and incised urban conveyances (in Lenoir, Cedar Rock, and Gamewell). These various environments provide equally variable aquatic habitat resources. Forested subwatersheds (and associated first and second-order tributaries) to the northeast likely contain the

greatest diversity and abundance of aquatic macroinvertebrate assemblages (due to available habitat diversity, high water quality, and low predation pressure), while fish abundance and diversity may be highest in the second and third order channels adjacent to Lower Creek (due to perennial stream flow and a greater abundance of prey). In contrast, urban channels in and around Lenoir may be dominated by pollution-tolerant organisms. Studies by the USGS (Giorgino and Bales, 1997), the NCDENR (1997, 2002b, and 2003b), the WPCOG (1998 and 2003), and MACTEC field reconnaissance efforts indicate that elevated urban stormwater discharges may be impacting physical aquatic habitat structure, may be contributing to water quality degradation (e.g., urban pollutants, including toxins, hydrocarbons, oils, grease, and fuels), and may be transporting high sediment loads (which can smother or bury interstitial spaces in riffles, important as 'resting' and 'feeding' areas for the aquatic larvae of many species). However, such degradation is not limited only to urban channels, as rural streams in the Lower Creek Watershed have also been affected by sedimentation and habitat structure impacts related to NPS pollutants, channel alteration, and riparian buffer impacts. The DWQ has summarized overall habitat observations in the local watershed as follows (NCDENR, 2003b):

"Habitat evaluations at the 17 benthos sites sampled in 2002 in the Lower Creek drainage resulted in a range of scores between 26 and 70 out of a possible 100 points. The highest scores (70 and 55) were found at the upper Greasy Creek site and at the upper Zacks Fork Creek site. As with benthic community metrics, generally the highest habitat scores were recorded at upstream sites on tributaries and in catchments that were located southwest of Lenoir. Habitat scores declined from the upper sites to the lower sites on Zacks Fork (55 to 26) and Greasy Creek (70 to 42). Lower Creek mainstem sites had the lowest habitat scores due to the sandy substrates, severe erosion, absence of riffles, and small riparian zones. Comparison sites on Gunpowder Creek and Smoky Creek also had limited habitat scores (48 and 62, respectively), but were still rated Good-Fair. Like Lower Creek, comparison site Gunpowder Creek was dominated by sand and had high embeddedness and a moderate amount of in-stream structure. Habitat likely plays a role in impairment of sites in the Lower Creek watershed, but it is not the only factor in benthic degradation. For more detailed discussion, see the Catawba basinwide assessment report ([NCDENR] DWQ, 2003f), the 2003 Lower Creek study memo ([NCDENR] DWQ 2003e) and the 1997 Lower Creek watershed assessment memo ([NCDENR] DWQ, 1997).

"Fish community samples were collected in Lower Creek at SR 1501 in 1997 and 2002. The fish community was rated Good-Fair in 2002 and 1997 (NCIBI = 42 and 44, respectively). More species, total fish, species of suckers, and piscivores were collected in 2002 than in 1997. In 1997, only 49 fish were collected (the fewest fish of any site monitored that year) in contrast to 211 collected in 2002. However, these "gains" were offset in 2002 by an absence of intolerant species, fewer insectivores, and a higher

percentage of diseased fish. In 1997, two species (redbreast sunfish and bluegill sunfish) dominated the community; this contrasted to five species (tessellated darter, bluehead chub, redbreast sunfish, bluegill sunfish, and yellow perch), which constituted 73 percent of all the fish collected in 2002. In 1993, Lower Creek at SR 1142 was sampled. This received a similar NCIBI score of 44 and rated Good-Fair. For more detailed discussion, see the Catawba basinwide assessment report ([NCDENR] DWQ, 2003f)."

The low impervious cover levels (<10%) found in 15 of the 16 Lower Lower Creek subwatersheds suggest that stormwater runoff impacts to habitat are minimal in this portion of the study area. In fact, all but one of these subwatersheds has less than 10% impervious cover, the threshold frequently associated with physical habitat degradation (CWP, 2003). In support of this conclusion, field observations revealed the presence of aquatic habitat resources (e.g., large woody debris, variable stream depths, riffles/pools, and undercut streambanks) in some areas (Figure 13 and Figure 14). It is estimated then that observed impacts may be more the result of commercial, agricultural, and rural residential land use decisions than IC extent (and urban stormwater runoff) in this portion of the study area.



Figure 13: White Mill Creek, 09/04/03 (LL12)

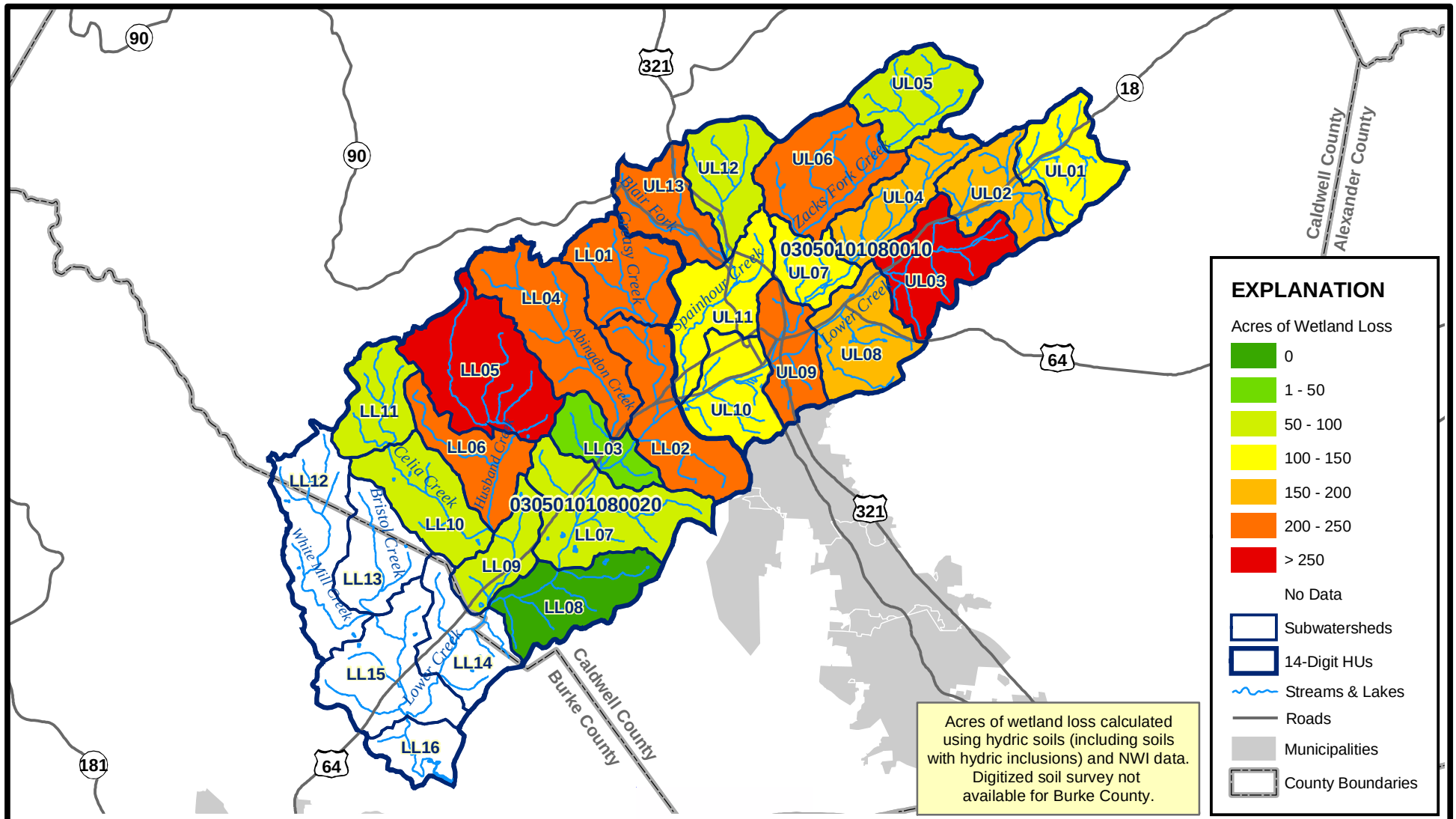


Figure 14: Lower Creek, 09/19/03 (LL08)

In general, the watershed's stream channels have been impacted by a variety of factors, including land use activities, stormwater runoff, NPS pollutants, channel alteration, riparian buffer impacts. These stressors have likely contributed to the channel incision (down-cutting), streambank erosion, and sedimentation observed in many of the study area's subwatersheds.

Within the Lower Creek Watershed, MACTEC identified potentially significant wetland habitats by using 1999 NWI data (USFWS, 2003) and county hydric soil lists (USDA, 1991 and USDA, 1993). Subwatersheds were evaluated for potential wetland loss by comparing hydric soil extents (see Appendix A, Figure A-3) with current NWI wetland extent data (see Appendix A, Figure A-5). The difference between hydric soil extent (potential wetland area) and NWI wetland extent was identified as potentially 'lost' wetland area (Figure 15). This estimated potential wetland loss was the calculated for each subwatershed. This assessment assumes that hydric soil areas would have historically been dominated by wetlands, and that human land use decisions have reduced actual wetland extents in hydric soil areas over time. Limitations of this approach include potential NWI underestimation of wetland extents (i.e., NWI coverages may not include all small wetland areas), and potential overestimation of NRCS hydric soil extents (i.e., NRCS data includes both hydric soils and hydric inclusion soils). As a result, data presented in Figure 15 may represent an over-estimation of potential wetland losses.

However, using this approach does provide a useful method of comparing 'potential' wetland losses between subwatersheds. It is anticipated that subwatersheds with high estimated wetland losses may provide the greatest potential for NCEEP wetland restoration opportunities. Available soils and NWI data indicate that the greatest historic wetland losses have likely occurred near the Town of Cedar Rock (subwatersheds UL02 and UL03), near the City of Lenoir (subwatersheds UL07 and UL09), near the Town of Gamewell (subwatersheds LL01, LL02, LL06, and LL09), and in two subwatersheds in the northwestern portion of the Lower Creek Watershed (subwatersheds UL06 and UL13). These subwatersheds may therefore provide opportunities to restore historic wetlands both in urban areas (UL02, UL03, UL07, UL09, LL01, LL02, LL06, and LL09) and in rural areas (UL06 and UL13).



Data Source(s): NCCGIA, USFWS, NRCS

Prepared / Date:
Checked / Date:

NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

Potential Wetland Loss

Project 6470030275 Figure 15

The geographic positions of Caldwell County and Burke County (between the Piedmont and Mountain physiographic provinces) provide a wide variety of habitat for both terrestrial and aquatic organisms, including many rare species. In the Lower Creek Watershed (subwatersheds UL08, UL09, and LL03 [NCNHP, 2003]), the NCNHP lists three element occurrences of dragonfly species listed as State Significantly Rare, including the Edmund's Snaketail (*Ophiogomphus edmundo*), the Maine Snaketail (*Ophiogomphus mainensis*), and the Mountain River Cruiser (*Macromia margarita*). See Appendix A, Figure A-13 for NCNHP Element Occurrences. NCNHP element occurrences are locations of rare and endangered species, important natural ecosystems (terrestrial or aquatic), and animal habitats. In the element occurrence database, the NCNHP also includes sites with particular biodiversity significance (attributable to rare species, rare or high quality natural communities, or other ecological features).

According to DWQ records from September 9, 2002 through 11, 2002, *Ophiogomphus* spp. were observed at sites ZFK1 (subwatershed UL07), SPH (subwatershed UL11), UTSPH (subwatershed UL12), GCR2 (subwatershed LL02), ABCR (subwatershed LL03), CCR (subwatershed LL10) and BCR (subwatershed LL15), and abundant at GCR1 (subwatershed LL02) and WMCR (subwatershed LL12). *Macromia* spp. were also observed at sites LC2 (subwatershed UL08) and LC3 (subwatershed LL08), and were abundant at site LC4 (subwatershed LL14). While these two genera were observed, it is unknown whether these observations were of the previously-mentioned rare species. Since these areas may provide habitat for rare species, preservation and enhancement opportunities should be considered in the noted subwatersheds. However, urbanization near some of the noted observation areas may limit both opportunities for preservation and actual habitat quality.

While the noted genera have been observed in these specific subwatersheds, other rare species observed elsewhere in Caldwell County and Burke County may also reside in the Lower Creek Watershed (but have not yet been observed). These include both federal and state-listed species, and many that utilize aquatic and riparian habitat resources for a portion of their life cycles (see Appendix A, TABLE ?).

2.3 LOCAL WATER QUALITY INITIATIVES

Notable local water quality initiatives currently being implemented within the Lower Creek Watershed include:

- Land use zoning in both Caldwell County and Burke County
- Caldwell County Flood Damage Prevention Ordinance
- Caldwell County Watershed Protection Ordinance
- Burke County Watershed Protection Ordinance

- Lenoir NPDES Phase II plan
- Caldwell County proposed local erosion and sediment control (ESC) permitting program
- DWQ preparation of a calibrated TMDL model for Lower Creek
- Construction of the Lenoir Greenway system
- WPCOG Study – Lower Creek Watershed Project (WPCOG, 1998)
- USGS Study – Hydrologic, Water-Quality, and Meteorologic Data from Selected Sites in the Upper Catawba Basin, North Carolina, January 1993 Through March 1994 (Jaynes, 1994)
- USGS Study – Rhodhiss Lake, North Carolina: Analysis of Ambient Conditions and Simulation of Hydrodynamics, Constituent Transport, and Water-Quality Characteristics, 1993-94 (Giorgino and Bales, 1997)
- WPCOG Study – A Comprehensive-Based Modeling Approach for Predicting Sediment and Nutrient Loads in the Rhodhiss Lake Watershed (WPCOG, 2003)

2.3.1 Local Ordinances

In addition to countywide zoning, Caldwell County has adopted a Flood Damage Prevention Ordinance and a Watershed Protection Ordinance. Burke County also has countywide zoning, and has enacted a Watershed Protection Ordinance. These ordinances are primarily intended to minimize floodplain filling and limit development in water supply watershed areas in each county.

In 1993, Caldwell County adopted a Flood Damage Prevention Ordinance (amended in 2000) that restricts development and floodplain encroachment within areas of special flood hazard (as defined by the Federal Emergency Management Agency [FEMA] for Caldwell County in 1988). This ordinance appointed the County Planning Director to administer and implement the policies, established a penalty process, and stipulated required details to be indicated on proposed development plans. The ordinance also noted specific standards for residential construction, non-residential construction, manufactured homes, recreation vehicles, elevated buildings, temporary structures, and accessory structures. Within floodways, restrictions include no encroachment, fill, or development (unless no demonstrated flood level increase would result), as well as no new manufactured homes (except in existing manufactured home parks and subdivisions). Along streams without established base flood elevations and/or floodways, no encroachment is allowed within 20 feet of the streambanks (or five times the width of the stream, whichever is greater), unless no demonstrated flood level increase would result. According to the ordinance, a no-rise certification is required for commercial or industrial development within a flood hazard area, although a single-family residential landowner is permitted to fill up to 10,000 square feet. This ordinance affects FEMA floodways mapped within the NCEEP Lower Creek watershed, primarily in the vicinity of Lenoir.

In 1996, Caldwell County also adopted a Watershed Protection Ordinance for DWQ WS-IV Water Supply Watersheds. This ordinance establishes development restrictions for a Critical Area (CA) that extends 0.5 mile from a drinking water point of intake, and for a Protected Area (PA) that extends five miles from a drinking water point of intake. Restrictions for Critical Areas (WS-IV-CA) include: a maximum of two dwelling units per acre (residential), a maximum of 24% built-upon area (non-residential), no new landfills or sludge application sites, a minimum ten-foot vegetative buffer along USGS perennial streams (for agricultural activities after 1993), BMP use requirements (for agricultural operations with more than 100 animals), and no hazardous material storage without an implemented spill containment plan. Restrictions for Protected Areas (WS-IV-PA) include: a maximum of two dwelling units per acre (residential, *with* curb and gutter systems) or three dwelling units per acre (residential, *without* curb and gutter systems), a maximum of 24% built-upon area (non-residential, *with* curb and gutter systems) or 36% built-upon area (non-residential, *without* curb and gutter systems), BMP use, a requirement to direct stormwater away from surface waters, and no hazardous material storage without an implemented spill containment plan. Within Protected Areas, non-residential development may occupy up to 10% of the remaining watershed with a maximum of 70% built-upon area (when approved as a Special Intensity Allocation [SIA]). Cluster development is allowed in all watershed areas (except WS-1), subject to zoning. The ordinance notes that 30-foot vegetative buffers along all USGS perennial streams are required for new low-density development, while 100-foot buffers are required for new development in excess of the low-density option. New development within these buffers is allowed for water-dependant structures and public projects when no practicable alternative exists. The ordinance applies to projects that require a state-approved erosion/sedimentation control plan, designates the County Planning Director as the Watershed Administrator, establishes the County Planning Board as the Watershed Review Board (for variance appeals), establishes a Watershed Protection Permitting process, provides options for stormwater management measures, and establishes a violation/fine program. This ordinance primarily affects the southwestern portion of the NCEEP Lower Creek watershed.

In 1994, Burke County adopted a Watershed Protection Ordinance to protect Public Water Supply Watersheds in the county (as defined by the N.C. Environmental Management Commission [EMC]). The ordinance establishes a Watershed Review Board, a Watershed Administrator position, a schedule for application review (typically 45 days after initial consideration), development densities, and minimum lot sizes. This ordinance divides the county into six watershed protection regions, as follows: WS-I, WS-III-CA (Critical Area), WS-III-BW (Balance of Watershed), WS-IV-CA (Critical Area), WS-IV-PA (Protected Area), and WS-BC (Balance of the County). Cluster development is allowed in all watershed areas (except WS-I). "A minimum one hundred (100) foot vegetative buffer is required for all new

development activities that exceed the low-density option; otherwise, a minimum thirty (30) foot vegetative buffer for development activities is required along all perennial waters indicated on the most recent versions of USGS…topographic maps" Burke County, 1994). Some exceptions were allowed for existing land uses prior to 1994, and minor variance authority allows for cases that will not be contrary to the public interests. High-density development is allowed in WS-IV-CA and WS-IV-PA watershed areas. In WS-IV-CA watershed areas, if a sedimentation and erosion control plan is required, and development "exceeds 24% built-upon area, then engineered stormwater controls shall be used to control runoff from the first inch of rainfall and development shall not exceed 50% built-upon area" (Burke County, 1994). In WS-IV-PA watershed areas, if a sedimentation and erosion control plan is required, and development "exceeds 24% built-upon area or 36% built-upon area for non-single family residential projects without curb and gutter street system, engineered stormwater controls shall be used to control runoff from the first inch of rainfall and development shall not exceed 70% built-upon area" (Burke County, 1994).

Additionally, "all stormwater controls shall use wet detention ponds as a primary treatment system unless alternative stormwater management measures…are used" (Burke County, 1994). "Wet detention ponds shall be designed to remove 85% of total suspended solids in the permanent pool and storage runoff from a one inch rainfall from the site above the permanent pool" (Burke County, 1994). "The discharge rate from these systems following the one inch rainfall design storm shall be such that the runoff does not draw down to the permanent pool level in less than two (2) days and that the pond is drawn down to the permanent pool level within five (5) days" (Burke County, 1994). "The mean permanent pool depth shall be a minimum of three (3) feet" (Burke County, 1994). Vegetative filters are to be constructed for the overflow and discharge of all stormwater, are to be at least thirty feet in length, and are to accommodate the 10-year, 24-hour storm with a 10-year, 1-hour intensity, with a slope of five percent or less. Salient items from the Burke County Watershed Protection Ordinance are summarized in Table 2.

Table 2: Burke County Watershed Protection Ordinance

WATER-SHED	WS-I	WS-III-CA	WS-III-BW	WS-IV-CA	WS-IV-PA	WS-BC
Land Use Intensity	Low	Low-Moderate	Low-Moderate	Moderate-High	Moderate-High	Not Indicated
Residential Land Use	No	Yes (1 dwelling unit/acre)	Yes (2 dwelling units/acre)	Yes (2 dwelling units/acre)	Yes (2 dwelling units/acre)	Yes (2 dwelling u-nits/acre)
Agricultural Land Use	Yes (10-ft buffers and BMP' s [if >100 animals])	Yes (10-ft buffers and BMP' s [if >100 animals])	Yes	Yes (10-ft buffers and BMP' s [if >100 animals])	Yes	If allowed under zoning and LUMO regulations
Silvicultural Land Use	Yes	Yes	Yes	Yes	Yes	Yes
Non-residential Land Use	No	Yes (12% built-upon area)	Yes (24% built-upon area)	Yes (24% built-upon area)	Yes (24% built-upon area)	If allowed under zoning and LUMO regulations
Residential Density	N/A	12%	24%	24%	24% (up to 36% if no curb and gutter)	As allowed under zoning and LUMO regulations
Non-residential Density	N/A	12%	24% (10% of watershed may be developed at up to 70% built upon area)	24%	24% (up to 36% if no curb and gutter)	As allowed under zoning and LUMO regulations
Other	Allowed - Water withdrawal, treatment, and distribution; restricted road access; power transmission	No toxic or hazardous material storage (unless spill containment plan is implemented)	No toxic or hazardous material storage (unless spill containment plan is implemented)	Development requiring state erosion control plan is subject to ordinance	Developme nt requiring state erosion control plan is subject to ordinance	Watershed Permit required for new developme nt
Landfills	No	No	No	No	No Dischargin g Landfills	If allowed by zoning

Source: Burke County (1994)

The ordinance requires that subdivision applicants provide a description of "storm water drainage facilities" or a drainage system that "diverts stormwater runoff away from surface waters and incorporates best management practices to minimize water quality impacts" (Burke County, 1994). Penalties for violations are considered to be misdemeanors, and an appeal process is available. This Burke County

ordinance primarily affects water supply watershed areas in the southwestern portion of the NCEEP Lower Creek watershed.

The City of Lenoir is currently a NPDES Phase II community. The city has contracted with AMEC Earth and Environmental (AMEC) to help develop proposed regulations and an implementation plan, and anticipates the formation of a stormwater utility in the future, along with a local fee schedule to fund this utility. This Phase II effort is being coordinated by the City of Lenoir's Public Works director and the Caldwell County Planning Director. Public education components of Lenoir's Phase II plan are currently being prepared by the WPCOG. More details of this effort should be available once the Phase II plan has been completed by AMEC. This effort will primarily affect NCEEP Lower Creek subwatersheds in the vicinity of Lenoir (UL07, UL09, UL10, UL11, and LL02).

Caldwell County's anticipated adoption of local ESC ordinances has been previously pursued, but was subsequently delayed due to funding issues. There is local governmental interest in such a program, along with concerns regarding what is perceived as inconsistent enforcement of state ESC regulations at present. At present, this proposal is temporarily on hold. If implemented in the future, this program will primarily affect NCEEP subwatersheds in Caldwell County (all subwatersheds except those portions of LL12, LL13, LL14, LL15, and LL16 that are located in Burke County).

The DWQ is currently preparing a calibrated model for 1997 flows in the Lower Creek watershed. It is anticipated that this effort will lead to the development of a Total Maximum Daily Loading (TMDL) for sediment (as well as a greater understanding of total suspended solids [TSS]). Input from DWQ personnel developing this model will likely be incorporated into revised recommendations during Phase II of the Lower Creek LWP effort. It is anticipated that DWQ data and conclusions will help determine sediment inputs from upland sources and streambank erosion. This should be significant, as stormwater runoff and associated streambank erosion may be a primary contributor of in-stream sediment loads (both as bedload and suspended load). Once completed, this effort should provide greater understanding of sediment loads throughout the NCEEP Lower Creek Watershed.

Lenoir's proposed greenway system will eventually include approximately 4.9 miles of trails along local stream channels (notably Zacks Fork). In 2003, approximately 2.0 miles of greenway were constructed. In the next one to two years, the city anticipates completion of the remaining 2.9 miles. Of note, field observations have indicated the potential for stream and/or wetland restoration efforts along portions of the existing and proposed greenway. The City of Lenoir has previously received funding through the

North Carolina Clean Water Management Trust Fund (CWMTF) for greenway acquisition (see Appendix A, Figure A-8). This greenway system primarily affects urban subwatersheds within the City of Lenoir.

Previous Lower Creek Studies

Previous research efforts by the Western Piedmont Council of Governments (WPCOG, 1998), the USGS, and the NCDENR have been conducted in the Lower Creek watershed. The results of these studies indicate that stormwater, NPS pollutants, and riparian buffer impacts have likely contributed to water quality degradation in the watershed.

In 1996, the WPCOG was awarded a water quality planning grant from the NCDENR. The WPCOG used this funding to develop a watershed management plan for Lower Creek (the Lower Creek Watershed Project). In this effort, the WPCOG conducted stakeholder meetings, located municipal stormwater outfalls, delineated 'subbasins', reviewed DWQ water quality and macroinvertebrate data, evaluated land use/land cover, identified local zoning ordinances, projected future population change, described soils, and prioritized subbasins (high, medium, and low priority) for future NPS controls and sediment management BMP's (WPCOG, 1998). Recommendations from this report were categorized as either 'watershed protection recommendations' or 'urban stormwater recommendations.' Watershed Protection recommendations included: 1) establishment of 50-foot buffers along perennial streams in the Lower Creek watershed, 2) identification of landowners in priority subbasins that would be interested in NPS control demonstration projects, 3) development of a public education strategy to highlight Lower Creek pollution sources, 4) encouragement of bioengineering streambank stabilization in the watershed, 5) establishment of a Lower Creek Non-Point Source Team to implement recommendations and evaluate progress. Urban Stormwater recommendations included: 1) adoption of strategies and regulations to minimize additional impervious cover in the watershed (e.g., limit parking areas, limit street widths, limit cul-de-sac pavement), 2) avoidance of curb-and-gutter stormwater systems, 3) encouragement of cluster development (or open space zoning) near perennial streams, 4) treatment of potential pollutant 'hot spots,' 5) storm drain labeling, 6) local government participation in regional stormwater discussions (WPCOG, 1998).

Observations from this study (WPCOG, 1998) include:

Wastewater discharges – The Lenoir WWTP discharge volume was approximately 4.08 million gallons per day (MGD) in 1997.

Stakeholder involvement – A total of six stakeholder meetings were held. More public involvement was observed in initial meetings than in latter meetings (which were predominately attended by agency personnel). One local group (The Healthy Caldwellians) was active in many discussions. Local issues of concern raised during the initial public meeting (March 18, 1997) included financial costs, science-based decisions, vegetation removal, drainage, pesticide usage, underground storage tanks (UST's), mega stores/malls, legal responsibility of clean-up efforts, and education. Issues discussed by the Stakeholders Group in subsequent meetings included identification of polluters, identification of enforcement agencies, increased awareness of NPS pollutants, poor land management decisions, solutions to similar problems elsewhere, mandatory animal waste plans, landowners interested in BMP's, potential funding sources, and environmental publications. Newspaper articles regarding Lower Creek and water quality were published in the Caldwell News (March 12, 1997) and the Charlotte Observer (March 16, 1997).

Stormwater outfalls – Stormwater outfalls along Lower Creek were located with GPS along approximately 3.5 miles of channel, between N.C. Highway 90 and the N.C. Highway 18/Southwestern Loop intersection. Collected data included pipe diameter and composition/material.

Bacteria – The WPCOG collected a total of 13 samples at the Antioch Road crossing of Lower Creek (between April 28, 1997 and June 26, 1997). This sampling effort revealed uniformly high fecal coliform bacteria counts throughout Lower Creek (arithmetic mean: 2,119 colonies per 100 ml of water, geometric mean: 722 colonies per 100 ml of water). The WPCOG subsequently collected fecal coliform data at ten DWQ sites in the Lower Creek watershed on June 12, 1997. The results of this sampling effort also indicated high fecal coliform concentrations throughout the watershed, "with values ranging from 340 to 5,400 colonies per 100 ml" (WPCOG, 1998). Finally, the WPCOG collected more water samples at twelve locations (six on Lower Creek) on August 18, 1997. These samples also revealed elevated bacteria levels, with the lowest measurement being 700 colonies per 100 ml of water. The North Carolina state water quality standard is 200 colonies per 100 mL of water (geometric mean).

Subbasins – The WPCOG delineated approximately 15 'subbasins,' as follows: Abingdon Creek (AB), Bristol Creek (BR), Greasy Creek (GR), Husband Creek (HU), Lower Creek #1 (LC1), Lower Creek #2 (LC2), Lower Creek #3 (LC3), Lower Creek #4 (LC4), Spainhour Creek (SP), Unnamed #1 (UN1), Unnamed #2 (UN2), Unnamed #3 (UN3), Unnamed #4 (UN4), Unnamed #5 (UN5), and Zacks Fork (ZF). The WPCOG subbasins were delineated on the basis of named streams (rather than by drainage area) and generally contain one to six NCEEP subwatersheds as summarized in Table 3, following:

Table 3: Subbasin/Subwatershed Comparison

STREAM NAME	WPCOG SUBBASIN	APPROXIMATE NCEEP SUBWATERSHED(S)
Abingdon Creek	AB	LL04
Bristol Creek	BR	LL12, LL13, and LL15
Greasy Creek	GR	LL01 and Northwestern LL02
Husband Creek	HU	LL04, LL05, LL06, LL09, LL10, and LL11
Lower Creek #1	LC1	UL01, UL02, UL03, and Northern UL08
Lower Creek #2	LC2	Southeastern UL08, UL09, and UL10
Lower Creek #3	LC3	Southeastern LL02, LL03, LL07, and LL08
Lower Creek #4	LC4	Southeastern LL14, LL15, and LL16
Spainhour Creek	SP	UL11, UL12, and UL13
Unnamed #1	UN1	Northwestern LL03
Unnamed #2	UN2	Northwestern LL07
Unnamed #3	UN3	Northwestern LL14
Unnamed #4	UN4	Western LL16
Unnamed #5	UN5	Southern LL16
Zacks Fork	ZF	UL04, UL05, UL06, UL07, and Northern UL09

Water quality improvements – Water quality in Lower Creek has generally improved since the 1960's, when "concentrations of toxic compounds such as phenols and cyanide were present in waters below the outfalls of furniture industries, and dyes from textile plants frequently discolored streams within the watershed" (WPCOG, 1998, p7). Additionally during the 1960's, fecal coliform bacteria concentrations occasionally numbered in excess of one million colonies per 100 ml of water (WPCOG, 1998). This study attributes water quality improvements partly to Clean Water Act (CWA) implementation, a North Carolina phosphate detergent ban in the 1980's, and a reduction in the number of private outfalls (and permitted dischargers) in the watershed.

Land use – The WPCOG estimated that over 80% of the land area in each subbasin was dominated by residential and residential/agricultural land use, and that approximately 65.4% of the total watershed area was characterized by residential and agricultural land uses. This study also noted that the majority of industrial and commercial land use (approximately 5.7% of watershed land use) was concentrated along Lower Creek and Spainhour Creek, and that the 1990 WPCOG *Catawba River Non-Point Source Study* had previously estimated commercial/industrial land use in the watershed to be approximately 4% (from aerial photograph interpretation). Three WPCOG subbasins evidenced high levels (>7%) of industrial/commercial land use, including Lower Creek #2 (7.4%), Lower Creek #3 (8.1%), and Spainhour Creek (14.3%).

Zoning – "Except for the recently incorporated Village of Cedar Rock, all local governments in the Lower Creek watershed have zoning and subdivision regulations. Like many western North Carolina counties,

however, Burke and Caldwell Counties have only recently adopted [countywide] zoning" (WPCOG, 1998, p10). This study notes that Burke County had only adopted zoning in selected portions of the county by 1997, and that no county erosion control regulations were in place at that time (WPCOG, 1998, p10). Features of local land use regulations are summarized in Table 4.

Table 4: Local Land Use Regulations

LOCAL GOVERNMENT	INCORP-ORATED	ZONING	SUBDIVISION REGULATIONS	WATERSHED ORDINANCE
Burke County	1777	Yes (1997)	Yes (1998)	Yes (1994)
Caldwell County	1841	Yes (1986)	Yes (1969)	Yes (1994)
Cedar Rock	1997	No	No	No
Gamewell	1981	Yes (1990)	Yes (1990)	Yes (1993)
Lenoir	1851	Yes (1962)	Yes (1977)	No

Source: WPCOG (1998)

Land cover – "Land cover within the watershed is dominated by two forest categories, mixed hardwoods/conifers and mixed upland hardwoods, collectively comprising over 64% of the region" (WPCOG, 1998, p10), particularly in the northern and eastern portions of the watershed. This study also noted that "managed herbaceous cover was the third most prevalent class and includes pastures, hay, and golf courses. This land use class is common along streams throughout the watershed indicating that many natural riparian buffers have been altered or destroyed" (WPCOG, 1998, p10). Additional land cover types included mountain conifers in the southwestern portion of the watershed (12.5%), high-intensity development with >80% man-made surfaces (3.6%), and low-intensity development with 50-80% man-made surfaces (2.4%). Low-intensity development and high-intensity development were most prevalent in Lenoir and along the N.C. Highway 18 corridor. Four WPCOG subbasins "had developed (high and low intensity classes combined) areas comprising 10% or more of their total land area: Spainhour, UN1, LC2, and UN2. The cultivated class which includes row crops such as corn as well as non-row crops like wheat and oats, comprised only 0.3% of the watershed. This class may also include first year trees raised in nurseries." (WPCOG, 1998)

Population – Population estimates were derived by calculating the Caldwell County incorporated area population (1996 N.C. Office of State Planning data) and dividing by the total incorporated land area, resulting in an estimated population density of approximately 0.15 persons/acre (WPCOG, 1998). After extrapolating this approach and adding municipal populations, the WPCOG estimated the overall Lower Creek watershed population to be approximately 24,079 residents. Projected future population growth in Burke and Caldwell Counties is anticipated to be low (0.5% - 1.0% annually), with lower population growth rates in rural areas than in urban areas (WPCOG, 1998). Local planners anticipate that the

greatest future population growth will likely occur in subbasins Lower Creek #1, Lower Creek#2, and Lower Creek#3 within the next 10-20 years (WPCOG, 1998).

Soils – The majority of the Lower Creek watershed is dominated by well-drained Cecil and Pacolet soils along Piedmont upland sideslopes. Poorly-drained Chewacla and Wehadkee soils were commonly noted along floodplains within the watershed.

Priority subbasins – In addition to providing general recommendations for the Lower Creek watershed, the WPCOG also prioritized the delineated subbasins for future NPS controls and sediment management BMP's (WPCOG, 1998), as follows:

High priority subbasins – Lower Creek #2 (industrialized corridor, minimal or absent riparian buffers, stormwater discharges, channel alterations), Spainhour (greatest extent of high-intensity and low-intensity development [>21% combined], extensive commercial and industrial development), Lower Creek #1 (greatest extent of cultivated cropland in watershed, one gravel quarry and two golf courses along Lower Creek, proposed residential subdivisions).

Medium priority subbasins – Zacks Fork (cattle access, southern portion of subbasin is urbanized, planed Lenoir greenway corridor), Husband Creek (largest subbasin in the watershed, golf course and large dairy farm, proposed industrial park in southern portion of subbasin, high DWQ bioclassification scores, impacted riparian areas, severe streambank erosion), Greasy Creek, Lower Creek #3 (severe streambank erosion, proposed residential development), Unnamed #1 (moderately high percentage of low-intensity and high-intensity development (15.1%), Unnamed #2 (>50% of land area classified as managed herbaceous), Bristol Creek (second largest subbasin in watershed, DWQ observations of in-stream silt accumulations, large cattle operation in southwestern portion of subbasin, largest wetland area in Lower Creek watershed), and Lower Creek #4 (severe streambank erosion).

Low priority subbasins – Unnamed #3 and Unnamed #4 (rural, minimal commercial/industrial development, minimal projected population growth).

In 1994, the USGS published a report in cooperation with the WPCOG that summarized water quality data, hydrologic data, and meteorologic data collected at selected sites in the upper Catawba River basin between January 1993 and March 1994. This data was collected from Rhodhiss Lake, Lake Hickory, and three tributaries (including Lower Creek), for the purposes of characterizing water quality and calibrating hydrodynamic models for the two reservoirs. This data was subsequently analyzed and published by the USGS in 1997 (Giorgino and Bales, 1997).

In 1997, the USGS published a research report in cooperation with the WPCOG in an effort to "describe ambient hydrologic and water-quality conditions, to estimate loadings of nutrients and suspended solids from selected tributaries and point sources, and to simulate hydraulic circulation and water-quality characteristics in Rhodhiss Lake using a hydrodynamic computer model" (Giorgino and Bales, 1997). The report summarized Rhodhiss Lake data collected between 1993 and 1994, and involved use of the USACE CE-QUAL-W2 model.

Results of this study (Giorgino and Bales, 1997) included:

"Rhodhiss Lake was constructed in 1925 to supply hydroelectric power for a growing population and textile industry. Today, in addition to power generation, the reservoir is used for drinking- and industrial-water supply [City of Lenoir], recreation, waste assimilation, and habitat for fish and wildlife" (Giorgino and Bales, 1997). "Based on nutrient concentrations, Rhodhiss Lake is classified eutrophic. However, nuisance levels of phytoplankton were rarely observed, possibly because short residence time and mixing patterns suppressed algal growth" (Giorgino and Bales, 1997).

USGS records from 1967 indicated "that concentrations of nitrate, phosphate, and chloride in Lower Creek were elevated compared to levels in undisturbed streams" (Giorgino and Bales, 1997 and Wilder and Slack, 1971). USGS records from the 1970's also indicated that concentrations and yields of suspended sediment in Lower Creek were comparable to those in other streams affected by urban construction in the Catawba River Basin, and were higher than those streams in forested or agricultural watersheds nearby" (Giorgino and Bales, 1997 and Simmons, 1993). NCDENR records from 1994 suggested that Lower Creek water quality degradation was likely due to high concentrations of sediment and fecal coliform bacteria, and that these impacts were from both point and non-point sources.

The City of Lenoir wastewater treatment plant discharged an average of 0.097 m^3/s [1993-94] into Lower Creek. During drier months, point-source discharges along Lower Creek accounted for a greater proportion of streamflow, and specific conductance measurements were higher.

Nutrient levels in Lower Creek were generally higher than those in Rhodhiss Lake and in two tributaries of Lake Hickory. "Elevated concentrations [of nitrogen] in Lower Creek reflected inputs from numerous domestic and industrial discharges and from nonpoint sources including urban and agricultural runoff" (Giorgino and Bales, 1997, p15). Elevated total phosphorus (TP) concentrations may be the result of inputs from both nonpoint sources and resuspension of streambed sediments. "Dissolved inorganic forms of nitrogen – NO_2+NO_3 and NH_4 – accounted for approximately…54 percent [of the total nitrogen load] at Lower Creek site 53. Loadings of PO_4 accounted for…11 percent [of the total phosphorus load] in

Lower Creek" (Giorgino and Bales, 1997). While the majority of suspended solids and nutrients may have originated from nonpoint sources, "point sources contributed significant amounts of nitrogen and phosphorus. For example, although the Lenoir-Lower Creek WWTP accounted for less than 1 percent of the TSS load measured at Lower Creek site 53, it accounted for 34 and 25 percent of the TN [total nitrogen] and TP loads, respectively" (Giorgino and Bales, 1997).

"Lower Creek had high specific conductance, high concentrations of total suspended solids, and was nutrient enriched. Fecal coliform concentrations exceeded 200 cols/100 ml in 76 percent of the samples. The two highest values occurred when streamflow was elevated, but values in excess of 200 cols/100 ml were observed across a wide range of flow conditions" (Giorgino and Bales, 1997).

"Results indicated that almost all the suspended solids and the majority of the nitrogen and phosphorus entering the headwaters of the reservoir originated from nonpoint sources…Nonetheless, point sources contributed significant amounts of nutrients" (Giorgino and Bales, 1997).

2.3.2 Assessment of Local Water Quality Initiatives

The noted local water quality initiatives (ordinances and studies) provide valuable insights regarding the condition of Lower Creek and its tributaries, and these efforts support continued research in the watershed. Results of these previous research efforts indicate that water quality and habitat have been primarily impacted by stormwater runoff, NPS pollutants, and bacteria. The WPCOG's focus on prioritization of subbasins, as well as recommendations for public policy changes (e.g., 50-foot buffers along perennial streams) and practical implementation projects (e.g., demonstration projects) are consistent with NCEEP goals for the Lower Creek Watershed.

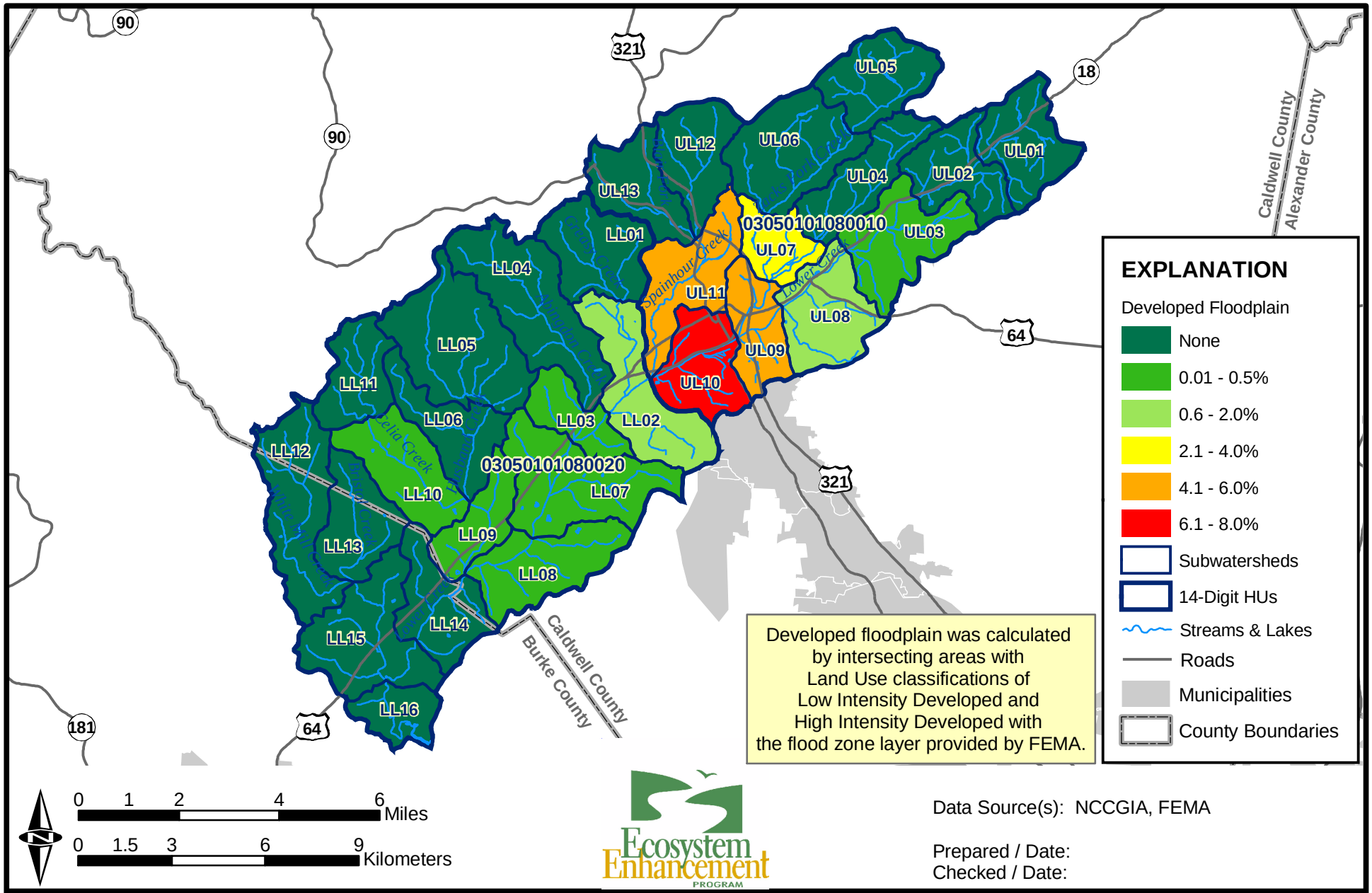
2.4 THREATS TO LOCAL WATERSHED FUNCTIONS

In September 2003, MACTEC conducted field observations in the local watershed to assess possible lost functions of streams, wetlands, and adjacent riparian areas (Appendix B). Observations and potential threats to Lower Creek Watershed functions are summarized in Table 5, with Figure 16 providing a assessment of floodplain encroachment. Note that these data only include conditions observed during preliminary reconnaissance efforts. It is likely that additional impacts may be occurring along unobserved stream channels (e.g., channel alteration and aggradation/degradation), and in subwatersheds with minimal roadway networks (e.g., predominantly forested subwatersheds). The stressors most likely

responsible for the greatest degradation of water quality, aquatic habitat, and hydrology are indicated in bold font.

Table 5: Potential Threats to Lower Creek Watershed Functions

SUSPECTED STRESSOR	PRELIMINARY INDICATOR(S)	SUSPECTED SOURCE(S)	SUSPECTED CAUSE(S)
Stormwater Runoff	Degraded water quality, channel instability (streambed scour), IC>5%	Commercial, industrial, and residential development, construction, urban runoff	Insufficient stormwater quantity management
NPS Pollutants	Degraded water quality, previous research data	Agricultural, residential, and urbanized areas, livestock in/adjacent to streams	Stormwater runoff pollutants, streambank erosion, fecal coliform bacteria, inadequate ESC practices
Channel Alteration	Channel instability (streambank erosion), degraded aquatic habitat	Previous agricultural and commercial development	Channel straightening, piping, channel excavation
Riparian Buffer Impacts	Channel instability (streambank erosion), degraded aquatic habitat, disturbed riparian buffer	Residential/commercial development, agriculture	Clearing for development and agriculture
Floodplain Encroachment	Evidence of floodplain encroachment (>1%)	Residential/commercial development	Development and filling within floodplain areas
Metals	Elevated levels of: aluminum, copper, iron, or manganese	Excess sedimentation in streams	Insufficient stormwater quality management, inadequate ESC practices
Wetland Loss	Estimated wetland loss >5%	Commercial, industrial, and residential construction, agriculture	Wetland fill for residential/commercial development and agriculture



Data Source(s): NCCGIA, FEMA

Prepared / Date:
Checked / Date:

NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

Floodplain Encroachment

Project 6470030275 Figure 16

3.0 DETAILED ASSESSMENT SCOPING

The next phase of this study will address missing data, preliminary targeted subwatersheds, and recommended indicators and methods (related to hydrology, water quality, and habitat).

3.1 MISSING DATA

Missing data and resources are summarized in Appendix A. Missing data include information related to culverts, greenway areas, utility lines, cleared riparian buffers, infrared images, local topography, and concentrated animal feeding operations (CAFO). For many analyses in this study, MACTEC used 1996 NCCGIA land cover information (Appendix A, Figure A-2). While this data provided sufficient accuracy and detail for most assessment efforts, recent (e.g., 2000-2002) data would have been preferred. In future phases of this project, tax parcel data may be assessed for its value in better identifying (and quantifying) current land use patterns. MACTEC will pursue this and other alternative data sources during subsequent phases of the project.

3.2 PRELIMINARY TARGETED SUBWATERSHEDS

Criteria used to develop subwatershed scores (for the purpose of identifying preliminary targeted subwatersheds for detailed field review) are summarized in Table 6. Data used in the scoring were obtained from previous reports, historical documentation, existing GIS coverages, previous GIS analyses, and preliminary field investigations. Data are generally summarized in Table 1 through Table 9 of this report.

A number (1-29) was first assigned to each subwatershed for each parameter/characteristic being compared, based upon the subwatershed's relative rank within the 29 overall Lower Creek subwatersheds. For example, the subwatershed with the highest percent impervious cover (subwatershed UL10) was given a rank of 29, while the subwatersheds with lowest percent impervious cover (subwatersheds UL01, UL02, UL05, UL06, LL11, and LL16 with 0.00% IC) were given a rank of 1. In general, subwatersheds were ranked so that the highest ranks (e.g., 20-29) indicate either the greatest degree of degradation or the greatest need for restorative action (to address hydrology, water quality, and/or habitat issues). Rankings were then multiplied by a weighting factor to establish the final (weighted) score.

Table 6: Subwatershed Ranks and Scores

SUBWATERSHED	APPROXIMATE AREA (SQUARE MILES)	IMPERVIOUS COVER	Rank	AGRICULTURAL LAND USE	Rank	FORESTED LAND USE	Rank	URBAN LAND USE	Rank	FLOODPLAIN ENCROACHMENT	Rank	WETLAND AREA	Rank	POTENTIAL WETLAND LOSS	Rank	DWQ BIOTIC INDEX	Rank	DWQ QUALITATIVE RANK	SCORE
UL01	3.12	<1.0%	0	11%	13	89%	18	0%	0	<1.0%	1	0.30%	5	7.10%	13	0	NR	NR	**14**
UL02	2.83	<1.0%	0	25%	25	75%	10	0%	0	<1.0%	1	0.20%	5	10.60%	21	0	NR	NR	**29**
UL03	3.83	1.10%	1	23%	22	76%	11	1%	1	<1.0%	1	0.30%	5	12.00%	25	0	NR	NR	**196**
UL04	2.94	<1.0%	0	13%	15	87%	17	0%	0	<1.0%	1	0.10%	5	9.30%	20	0	NR	NR	**59**
UL05	3.15	<1.0%	0	1%	1	99%	28	0%	0	<1.0%	1	0.20%	5	4.70%	8	0	NR	1	**13**
UL06	4.50	<1.0%	0	10%	12	90%	20	0%	0	<1.0%	1	0.30%	5	7.30%	15	0	NR	1	**15**
UL07	1.85	24.90%	16	20%	20	55%	4	25%	19	2.10%	20	0.10%	5	10.70%	22	0	NR	1	**249**
UL08	3.52	9.40%	7	13%	14	77%	12	10%	10	1.70%	10	0.30%	5	8.70%	18	6.46	15	20	**277**
UL09	2.44	30.60%	22	23%	24	47%	3	31%	22	4.90%	20	0.40%	5	15.10%	26	6.77	20	20	**304**
UL10	3.00	43.80%	28	10%	11	46%	2	44%	28	6.90%	25	0.80%	10	5.30%	10	6.67	20	20	**282**
UL11	3.66	38.20%	25	18%	16	43%	1	38%	25	4.60%	20	0.60%	10	6.40%	11	6.46	15	20	**282**
UL12	2.95	1.40%	1	5%	4	94%	24	1%	1	<1.0%	1	0.00%	0	4.00%	7	4.66	1	5	**170**
UL13	2.81	<1.0%	0	4%	3	95%	27	1%	1	<1.0%	1	0.10%	5	11.40%	24	6.42	15	20	**184**
LL01	3.42	<1.0%	0	5%	5	94%	26	1%	1	<1.0%	1	0.00%	0	9.20%	19	5.28	5	20	**147**
LL02	4.29	13.90%	10	23%	23	63%	6	14%	10	1.90%	10	0.50%	5	7.80%	16	5.28	5	20	**271**
LL03	1.96	7.10%	7	26%	26	67%	7	7%	7	<1.0%	1	0.90%	10	2.30%	5	6.52	20	20	**247**
LL04	5.33	1.10%	1	9%	9	90%	19	1%	1	<1.0%	1	0.10%	5	6.50%	12	5.60	10	1	**137**
LL05	5.67	<1.0%	0	9%	10	91%	21	0%	0	<1.0%	1	0.30%	5	8.60%	17	5.48	5	1	**105**
LL06	2.90	1.80%	1	29%	28	69%	8	2%	4	<1.0%	1	0.00%	0	11.30%	23	5.48	5	1	**152**
LL07	5.07	8.00%	7	29%	29	63%	5	8%	7	<1.0%	1	1.00%	10	2.10%	4	6.10	15	20	**243**
LL08	3.71	1.30%	1	28%	27	71%	9	1%	1	<1.0%	1	0.10%	5	<1.0%	2	6.52	20	20	**205**
LL09	2.15	1.00%	1	20%	19	79%	14	1%	1	<1.0%	1	1.90%	15	7.10%	14	5.24	5	20	**197**
LL10	3.44	<1.0%	0	19%	18	80%	15	0%	0	<1.0%	1	0.30%	5	3.90%	6	5.78	10	5	**155**
LL11	2.51	<1.0%	0	6%	6	94%	25	0%	0	<1.0%	1	0.40%	5	4.90%	9	5.78	10	5	**24**
LL12	4.76	<1.0%	0	6%	7	93%	23	0%	0	<1.0%	1	0.40%	5	0.90%	3	4.87	1	5	**81**
LL13	2.99	<1.0%	0	8%	8	91%	22	0%	0	<1.0%	1	0.80%	10	NR	0	5.56	10	5	**55**
LL14	3.11	<1.0%	0	21%	21	78%	13	1%	1	<1.0%	1	7.40%	29	<1.0%	1	6.14	15	20	**133**
LL15	4.62	<1.0%	0	18%	17	81%	16	1%	1	<1.0%	1	4.30%	25	NR	0	5.56	10	5	**110**
LL16	1.66	<1.0%	0	1%	2	99%	29	0%	0	<1.0%	1	5.60%	29	NR	0	0	NR	NR	**-18**

Since IC and 'urban land use' distributions in subwatersheds are generally biased toward lower estimates (i.e., 15 subwatersheds with <1% impervious cover vs. only four subwatersheds with >20% impervious cover), relative ranks were assigned to individual subwatersheds as follows: <1%=rank of 0, 1%-2%=rank of 1, 2%-5%=rank of 4, 5%-10%=rank of 7, 10%-15%=rank of 10, 15%-20%=rank of 13, 20%-25%=rank of 16, 25%-30%=rank of 19, 30%-35%=rank of 22, 35%-40%=rank of 25, and >40%=rank of 28. Additionally, since floodplain encroachment values range only from <1% to 6.9%, relative ranks were assigned to individual subwatersheds as follows: <1%=rank of 1, 1%-2%=rank of 10, 2%-5%=rank of 20, 5%-10%=rank of 25. Estimated wetland areas in the Lower Creek subwatersheds range from 0.0% to 7.4% of subwatershed areas. As a result, wetland area ranks are as follows: 0%=rank of 0, 0.0%-0.5%=rank of 5, 0.5%-1.0%=rank of 10, 1.0%-2.0%=rank of 15, 2%-4%=rank of 20, 4%-6%=rank of 25, and >6%=rank of 29. Wetland losses were ranked on the basis of estimated wetland loss as a percentage of subwatershed area. Biotic Index estimates included in Table 6 reflect DWQ data collected September 9-11, 2002 (NCDENR, 2004b). DWQ water quality data provided for Table 6 included Biotic Index scores and qualitative assessments of water quality/habitat quality (based on EPT Richness, EPT Biotic Index scores, Biotic Index scores, and BioClassifications). Biotic Index ranks were assigned as follows: 4.5-5.0=rank of 1, 5.0-5.5=rank of 5, 5.5-6.0=rank of 10, 6.0-6.5=rank of 15, >6.5=rank of 20. DWQ qualitative assessments were ranked as follows: "Not impaired"=rank of 1, "Not rated, but sensitive species present"=rank of 5, "Impaired (fair or poor), or indications of a severely impacted community"=rank of 20. In Table 6, the designation 'NR' indicates that a subwatershed was 'Not Ranked' on the basis of the specific characteristic noted.

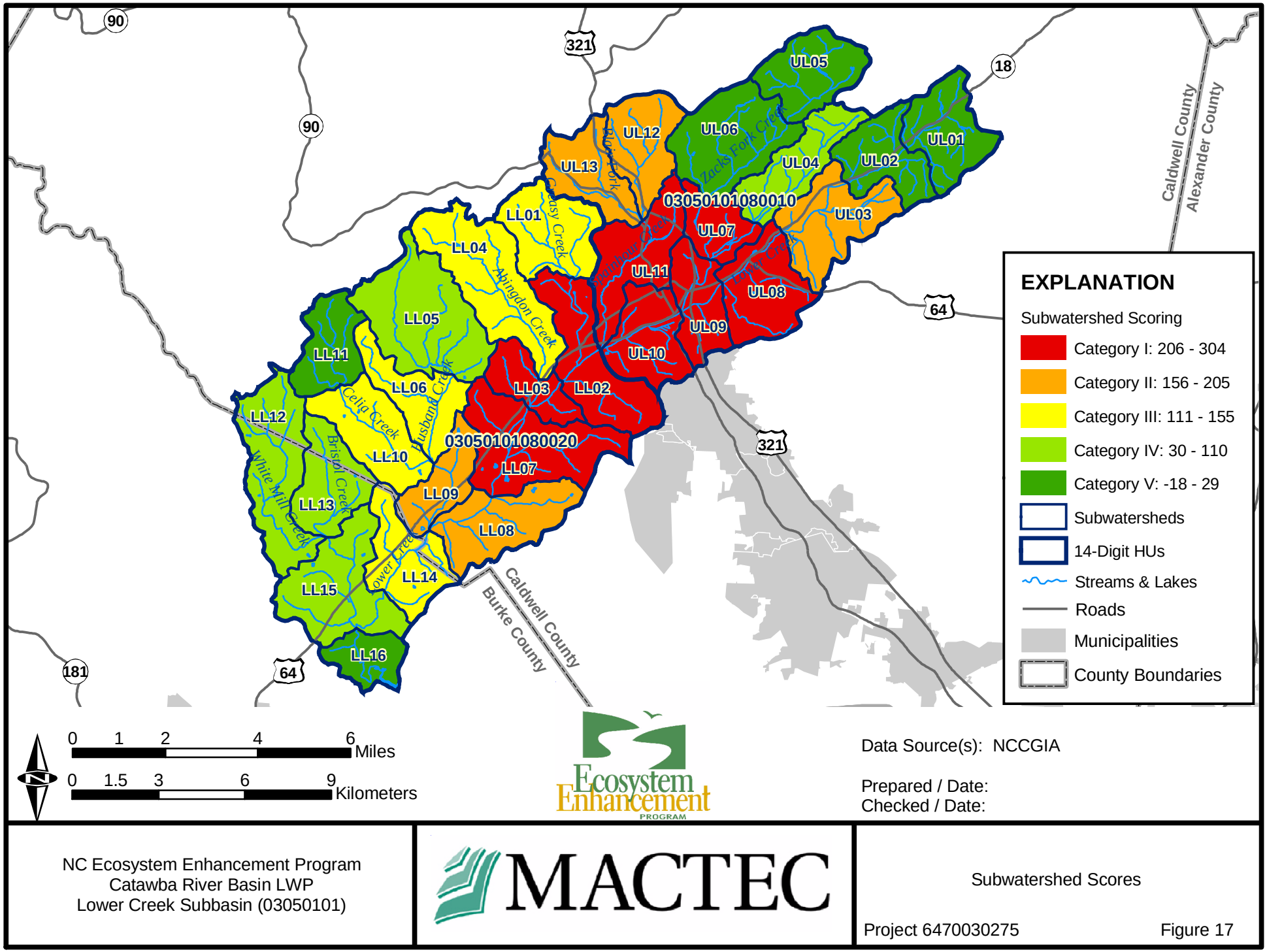
Weighting factors of +10, +5, +2, +1, and -1 were assigned based upon the estimated impact of the criterion to hydrology, water quality and/or habitat, as well as the expected utility of the data. For example, impervious cover received a relatively high weighting factor of +5 due to relatively well-established impacts to hydrology, water quality, and habitat associated with impervious cover (CWP, 2003). Larger absolute factors (e.g., +10) were used for criteria with characteristically low raw scores (e.g., number of major NPDES dischargers). Other criteria (e.g., percent wetland) received lower weighting factors (i.e., -1) due to potential inaccuracies associated with the data. For example, the source material used to produce NWI data is derived from high altitude aerial photography, and may exclude some small wetlands (see Appendix A, Figure A-5). Total scores were established according to the following formula:

Total Score =
+ 5 × *Impervious Cover Rank*
- 1 × *Forested Land Use Rank*
+ 1 × *Agricultural Land Use Rank*
+ 2 × *Urban Land Use Rank*
+ 2 × *Floodplain Encroachment Rank*
- 1 × *Wetland Area Rank*
+ 1 × *Wetland Loss Rank*
+10 × *Number of Major NPDES Dischargers*
+10 × *Number of Minor NPDES Dischargers*
+ 2 × *DWQ Biotic Index Rank*
+ 2 × *DWQ Qualitative Assessment Rank*

Subwatershed scores are presented in Table 7 and on Figure 17. High scores indicate evidence of potential degradation of hydrology, water quality, and habitat, while low scores indicate fewer impacts to subwatershed integrity. Note that the highest scores typically correspond to urban/developed subwatersheds.

Table 7: Subwatershed Categorization

CATEGORY	SCORE RANGE			SUBWATERSHED
I	206	-	304	UL07, **UL08**, **UL09**, **UL10**, **UL11**, LL02, LL03, LL07
II	156	-	205	**UL03**, UL12, UL13, **LL08**, **LL09**
III	111	-	155	**LL01**, LL04, **LL06**, **LL10**, LL14
IV	30	-	110	UL04, **LL05**, LL12, LL13, **LL15**
V	-18	-	29	UL01, **UL02**, UL05, **UL06**, **LL11**, LL16



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MACTEC

Subwatershed Scores

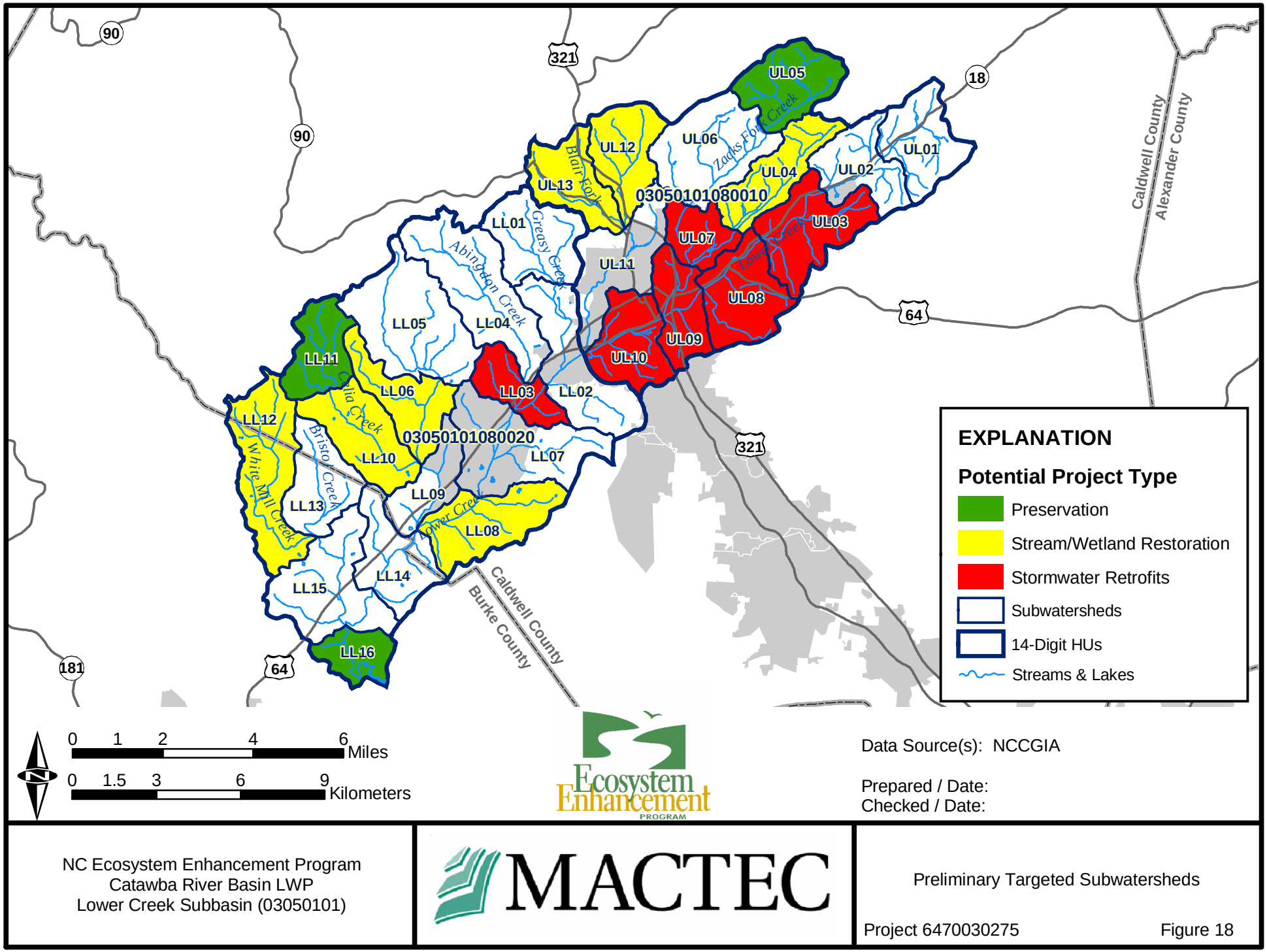
Project 6470030275 Figure 17

Following subwatershed score tabulation, MACTEC used the optimal method (i.e., 'natural breaks' in ArcView®) to group similar values together and determine the appropriate number of categories. This statistical analysis established five categories (I through V) of subwatershed scores (see Table 7). These five categories are representative of conditions encountered throughout the study area: highly-impacted (Category I), moderately-impacted (Categories II through IV), and minimally-impacted (Category V). The establishment of representative categories of subwatersheds helps ensure that a range of habitats and potential mitigation opportunities will be reviewed. For example, highly developed/impacted subwatersheds (Category I) may present more stormwater retrofit opportunities while moderately impacted subwatersheds (Categories II through IV) may present more traditional stream and/or wetland restoration opportunities. Similarly, less impacted subwatersheds (Category V) may provide potential examples reference (or baseline) conditions for comparison to impacted subwatersheds. However, it is anticipated that a variety of mitigation opportunities (e.g., stormwater retrofits, enhancement, restoration, preservation, etc.) may exist within most subwatersheds, regardless of score or classification.

MACTEC identified specific targeted subwatersheds for additional assessment by selecting the highest-scoring subwatersheds in Categories I though V. Selection of these target subwatersheds should help focus future site identification efforts on those subwatersheds with the greatest need for restorative action/improvement. This approach should also help ensure efficient use of resources (e.g., time and personnel) in future mitigation site identification efforts. In this initial assessment, MACTEC selected approximately the highest-scoring 50% of subwatersheds in Categories I through V (see Table 7, Table 8, and Figure 18). This approach produced a total of 15 targeted subwatersheds. If future efforts reveal that site identification can be better accomplished with a smaller number of target subwatersheds, the NCEEP may alternatively select the six highest-scoring 25% of subwatersheds in each category (UL02, UL08, UL09, LL08, LL10, and LL15), instead of the highest-scoring 50% of subwatersheds. See Figure 18 for geographic distribution of categories and subwatershed scores.

Table 8: Targeted Subwatersheds

HYDROLOGIC UNIT			TARGETED SUBWATERSHED(S)
80010	(Upper	Lower	UL02, UL03, UL06, UL08, UL09, UL10, UL11
Creek)			
80020	(Lower	Lower	LL01, LL05, LL06, LL08, LL09, LL10, LL11, LL15
Creek)			



NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

Preliminary Targeted Subwatersheds

Project 6470030275 Figure 18

3.3 RECOMMENDED INDICATORS AND METHODS

Four significant stressors in the Lower Creek watershed will be assessed during subsequent Phase 2 assessment efforts. These include stormwater runoff, NPS pollutants, channel alteration, and riparian buffer impacts. Since impacts from these stressors are often interconnected, each stressor will be investigated on the basis of both individual and cumulative effects. Indicators of stressor impacts include degraded water quality, channel instability (streambed scour and streambank erosion), aquatic habitat degradation, IC>5%, disturbed riparian buffers, and data from previous research efforts. It is anticipated that the majority of water quality impacts, hydrologic instability, and habitat degradation in the watershed are related to these four issues.

3.3.1 Stormwater Runoff

Impacts - *Water quality* impacts associated with stormwater runoff typically include suspended sediment loads and nonpoint source pollutants, while *hydrology* impacts may be most obvious in streambank erosion and streambed scour (channel incision) processes. Stormwater runoff may impact (degrade) aquatic *habitat* by disturbing interstitial spaces in streambed substrates, promoting habitat simplification via sedimentation of riffles and pools, as well as removal of in-stream habitat (e.g., woody debris) via channel/streambed scour.

Study Methods – In order to document the effects of stormwater runoff, Phase 2 efforts will include DWQ pollutant 'hot spot' investigations and MACTEC stream channel surveying. DWQ will investigate potential pollutant 'hot spots' during field reconnaissance efforts throughout the Lower Creek Watershed, and will analyze water quality in streams that seem suspect (e.g., have high specific conductance, smell of volatile organics, etc.). DWQ will utilize previously-collected MACTEC subwatershed reconnaissance data to initially identify potential hot spots. In each of the eight subwatersheds with >5% IC (UL07, UL08, UL09, UL10, UL11, LL02, LL03, and LL07) and along at least one reference stream, MACTEC will survey permanent stream channel cross-sections. A threshold of 5% has been selected in order to assess anticipated impacts in subwatersheds with >10% IC, and to also document the potential for stormwater runoff impacts associated with lower IC extents (i.e., 5%-10%). In order to quantify the estimated physical affects of stormwater discharge volumes on channel morphology, this effort will document bank erosion hazard index (BEHI) score, bankfull cross-sectional area, bank/height ratio, entrenchment ratio (ER), width/depth (W/D) ratio, and Rosgen stream classification. Following two precipitation events of at least two inches within 24 hours, these permanent cross-sections will be re-surveyed and will be compared to the initial cross-sections. This effort will help document the rates at

which streambank erosion may be occurring over a short timeframe (i.e., months), and will allow future surveying of these same cross-sections to document streambank erosion occurring over a longer timeframe (i.e., years).

Application Areas – DWQ 'hot spot' investigation sites will be determined in the field by DWQ personnel. MACTEC channel surveying will be implemented at representative locations in the eight subwatersheds with greater than 5% IC (UL07, UL08, UL09, UL10, UL11, LL02, LL03, and LL07).

Goals – DWQ monitoring efforts should identify potential urban pollutant 'hot spots' that may require additional study and/or BMP consideration, while MACTEC surveying efforts should a) provide a record of channel evolution over time (as compared to the reference reach), b) allow comparison between urban channels throughout the Lower Creek Watershed, c) help quantify urban streambank erosion rates, and d) help provide actual streambank erosion rates associated with BEHI scores. Surveyed cross-sections may also be compared to regional curves and to reference reach data, in order to assess the sampled channels in relation to background/baseline conditions. The eventual goals of these efforts will be to identify potential stormwater BMP's to reduce the noted the noted impacts, to identify specific urban stormwater runoff issues that are significantly affecting water quality (e.g., pollutant sources, streambank erosion areas, and elevated stormwater discharge catchments), and to locate subwatersheds that should be considered for future actions (e.g., further monitoring and/or BMP implementation).

INDICATOR	METHODS	APPLICATION AREAS	GOALS
Degraded water quality, channel instability (streambed scour), IC>5%	DWQ urban hot spot investigations; MACTEC channel surveying	Urbanized areas, DWQ sampling locations, subwatersheds with >5% IC (UL07, UL08, UL09, UL10, UL11, LL02, LL03, and LL07)	To detect pollutant hot spots, identify urban stressor pollutants, document channel morphology impacts (stormwater runoff volume), identify potential stormwater management BMP opportunities

3.3.2 NPS Pollutants

Impacts - NPS pollutants may include stormwater pollutants from urban areas (e.g., toxins, metals, petroleum products, hydrocarbons, etc.), suspended sediment from areas of disturbed soil (e.g., eroding streambanks, construction sites, active croplands, etc.), nutrients (e.g., nitrates and phosphates) from residential, agricultural, and commercial areas, and fecal coliform bacteria (animal access to surface waters). *Water quality* impacts associated with NPS pollutants typically include elevated concentrations of nutrients, hydrocarbons, and metals, along with increased turbidity (suspended sediment) and sedimentation. *Hydrologic* impacts of NPS pollutants are primarily related to excess sedimentation,

which may alter the balance between sediment bedload and streamflow discharge. This alteration may then initiate a process of accelerated stream channel aggradation, excessive lateral channel movement, and subsequent streambank erosion. NPS pollutants affect aquatic *habitat* primarily by increasing stresses upon aquatic organisms (e.g., toxins), by reducing food accessibility (i.e., turbidity reduces visibility for 'sight' predators), and by eliminating streambed interstitial spaces available for spawning/resting habitat (due to sedimentation).

Study Methods – In order to identify and characterize NPS pollutants, DWQ will conduct water quality monitoring of stormflow at five sampling locations in the Lower Creek Watershed (NPS pollutant concentrations are typically high in stormwater runoff). Stormflow water quality (metals, nutrients, semi-volatile organics, solids, turbidity) will be assessed in the following urban tributaries: Zacks Fork, Spainhour Creek, Blair Fork, and a small unnamed urban tributary in an industrial area of Lenoir. Greasy Creek, which drains a rural and residential area, will also be sampled as a 'rural' reference stream. DWQ anticipates that five samples will be collected at each sampling location. Additionally, DWQ plans to characterize baseflows (10 samples anticipated) and stormflows (five samples anticipated) at the existing DWQ ambient monitoring site on Lower Creek. In order to characterize the extent of sedimentation impacts, MACTEC will conduct substrate composition assessments (using Wolman pebble counts) at each DWQ monitoring site, and at a representative location in each of the targeted subwatersheds. These pebble counts will include both pavement (larger-diameter, erosion-resistant surface substrate) and subpavement (smaller-diameter, erosion-prone subsurface substrate) sampling. It is anticipated that pebble counts in the targeted Category IV and V subwatersheds may provide insights regarding 'reference' substrate composition (i.e., 'background/baseline' conditions), while pebble counts in the targeted Category I, II, and III subwatersheds may reveal substrate characteristics more typically encountered in degraded subwatersheds.

Application Areas – DWQ will conduct stormflow sampling along Zacks Fork (which includes subwatersheds UL04, UL05, UL06, UL07, and UL09), Spainhour Creek (subwatershed UL11), Blair Fork (which includes subwatersheds UL12 and UL13), an unnamed urban tributary in Lenoir, and Greasy Creek (which includes subwatersheds LL01 and LL02). DWQ will also collect and differentiate stormflow and baseflow samples at the existing DWQ Lower Creek ambient water quality monitoring station (subwatershed LL14). MACTEC will conduct substrate assessments at the five DWQ monitoring locations, and along representative stream reaches in the targeted subwatersheds (UL02, UL03, UL06, UL08, UL09, UL10, LL05, LL06, LL08, LL09, LL10, LL11, and LL15).

Goals – These monitoring efforts should provide greater insights regarding NPS baseflow/stormflow pollutant characteristics (and concentrations) within the Lower Creek Watershed. Collected data should allow comparisons between individual subwatersheds, while 'reference' stream data should provide insights regarding extent of degradation (from baseline/undisturbed conditions). With the greater insights provided by these efforts, it is anticipated that specific NPS pollutants (e.g., suspended sediment, nutrients, fecal coliform bacteria) can be better targeted as stressors by future restoration and BMP implementation efforts.

INDICATOR	METHODS	APPLICATION AREAS	GOALS
Degraded water quality, previous research data	Baseflow/stormflow water quality monitoring, substrate composition assessment	Water quality monitoring along Zacks Fork, Spainhour Creek, Blair Fork, Greasy Creek, unnamed Lenoir tributary, and DWQ ambient station; substrate assessment in subwatersheds UL02, UL03, UL06, UL08, UL09, UL10, LL05, LL06, LL08, LL09, LL10, LL11, and LL15.	To identify (and characterize) specific baseflow/stormflow pollutants and characterize sedimentation

3.3.3 Channel Alteration

Impacts - Field reconnaissance observations indicate that many stream channels within the Lower Creek Watershed may have been previously channelized. *Hydrologic* impacts of channelization often include channel incision (resulting from steeper gradient streams), initiation of channel instability, and disruption of sediment/discharge relationships. Channelization and subsequent incision may also impact *water quality*, since streambank instability and erosion may result in increased downstream turbidity and sedimentation. When channelization does accelerate incision, tributaries may also become incised, and the deposition of eroded streambed/streambank material downstream may lead to subsequent lateral channel movement and further streambank erosion. In addition to the immediate physical impacts of channelization (e.g., excavation), this type of channel alteration may impact *habitat* by reducing the abundance of riffles and pools, by removing woody debris (that provides cover), and by increasing downstream sedimentation (thereby smothering important interstitial habitat. Once channelized, streams may require many years to reach a subsequent state of quasi-equilibrium and become naturalized again. During that time period, water quality, hydrologic processes, and aquatic habitat may be extensively altered and degraded.

Study Methods – In order to identify potentially channelized streams within the Lower Creek Watershed, MACTEC will use historic NRCS aerial photography, along with 1996 NCCGIA data. Stream channel

centerlines indicated on historic NRCS aerials will be digitized and overlaid with the more-recent NCCGIA hydrography layers. Representative channelized stream reaches will be visually identified on these overlays, and will then be ground-truthed in the field (and photographed) by MACTEC and DWQ personnel. DWQ will collect information on aquatic habitat, bank stability, buffer status, benthic community health, sources of pollution, and potential future stream restoration sites. This combined effort should provide valuable insights regarding potential 'limiting' effects of aquatic habitat on biological communities, and should help identify and characterize channelized stream reaches.

Application Areas – Aerial photography analysis will be conducted for the Category I, II, and III targeted subwatersheds.

Goals – It is anticipated that this effort will help characterize the effects of channelization in the lower Creek Watershed. Collected data should help explain whether the existing degradation noted along many stream reaches is the result of previous channelization, should identify whether channelization was/is a potential cause of upstream/downstream degradation, and should aid in the identification of potential future stream restoration sites.

INDICATOR	METHODS	APPLICATION AREAS	GOALS
Channel instability, degraded aquatic habitat	GIS analysis, field verification	Category I, II, and III targeted subwatersheds	To characterize the extent of channelization and identify potential restoration sites

3.3.4 Riparian Buffer Impacts

Impacts - Forested riparian buffers are an integral component of many aquatic ecosystems. These buffers provide root mass stabilization of streambanks, produce coarse particulate organic matter (CPOM) as a food source for aquatic organisms, reduce water temperatures, provide cover for aquatic organisms, and help maintain habitat connectivity. Previous studies and field reconnaissance efforts have revealed that forested riparian buffers are either narrow or completely absent along many stream channels within the Lower Creek Watershed. These buffers are often cleared for development (residential and commercial), silviculture (tree/shrub nurseries), and/or agriculture (crop/pasture lands). Clearing of buffers often affects *habitat* by reducing stream shading (thereby increasing water temperature), by eliminating in-stream cover (as provided by logs and woody debris), and by reducing the natural connectivity between uplands, riparian areas, and aquatic ecosystems). *Water quality* impacts associated with riparian buffer clearing generally include reduced pollutant removal from runoff and reduced root mass stabilization of streambanks (and subsequent streambank erosion/downstream sedimentation). Removal of forested

buffers may also affect *hydrologic* relationships by eliminating precipitation absorption by organic matter on the forest floor (thereby increasing the volume of runoff directly entering a stream channel).

Study Methods – In order to assess the extent of riparian buffer impacts in the targeted subwatersheds, MACTEC will use infrared orthophotos and/or 1993 black and white aerial photos to calculate the length of stream channel with absent/minimal forested riparian buffers, the length of stream channel with forested riparian buffers (>50 feet in width), and the length of stream with forested riparian buffer (>50 feet in width) along only one streambank. Field verification of buffer estimates will be conducted by MACTEC at representative locations, and will be photo-documented. DWQ qualitative assessments of riparian buffer structure and quality may also be integrated with this effort, in order to develop a description of 'typical' buffer characteristics associated with buffer width.

Application Areas – Riparian buffer assessment efforts will be implemented in the targeted subwatersheds (UL02, UL03, UL06, UL08, UL09, UL10, LL05, LL06, LL08, LL09, LL10, LL11, and LL15). Depending upon the value and insight provided by these initial evaluations, riparian buffer assessments may then be implemented for the entire Lower Creek Watershed.

Goals – The goals of this effort are to document riparian buffer extents in the targeted subwatersheds, and to identify potential opportunities for restoration. Since existing vegetation may disguise areas that were historically affected by previous buffer impacts (>20 years ago), initial buffer assessment efforts will be evaluated to determine whether assessment efforts should be extended to the entire Lower Creek Watershed.

INDICATOR	METHODS	APPLICATION AREAS	GOALS
Channel instability, disturbed riparian buffers	GIS analysis, field verification	Targeted subwatersheds	To document buffer extents and identify potential opportunities for restoration

4.0 POTENTIAL IMPLEMENTATION OPPORTUNITIES

During Phase 2 efforts, MACTEC will rank potential restoration opportunities identified within the Lower Creek Watershed, in coordination with the NCEEP and local stakeholders. The result of this effort will be a ranking of potential projects for individual subwatersheds. Estimated costs and benefits (quantified for analysis) can then be developed for the highest-priority opportunities, in order to assist the NCEEP in deciding on the optimal combination of projects. In addition to recommending conventional opportunities (e.g., stream restoration and wetland enhancement), non-conventional mitigation approaches (e.g., stormwater BMPs and/or retrofits) will be considered.

MACTEC will utilize the data and maps collected to develop map products for identifying:

- Potential wetland and stream restoration projects, to meet compensatory mitigation requirements;
- Non-conventional mitigation projects (including BMPs, open space preservation, riparian corridor connectors, enhancement sites, and stormwater retrofits).

This information will be presented by prioritized subwatershed and catchment (using GIS, photo-documentation, GPS location information, and written site descriptions). This approach will include a discussion of how the recommended mitigation alternative(s) at each site should help address the specific cause(s) of degradation in that subwatershed. These recommendations may also discuss relative benefits of site-specific actions versus local policy changes. In general, site recommendations will be based on the following:

- Specific functional impairment to be addressed
- Anticipated cost effectiveness, constructability, site constraints, and functional benefits of mitigation alternatives
- Input from the NCEEP, the landowner, and local stakeholders
- Maximization of potential mitigation credits at each site
- Overall watershed benefits of the mitigation alternatives
- Aesthetic value of the proposed restorative actions/alternatives

The various attributes of each potential mitigation alternative will be summarized in a comparative mitigation table that will include a brief narrative for each site (to aid decision-making). Overall, a variety of beneficial opportunities may be available in the Lower Creek Watershed. Implementation of both conventional and non-conventional mitigation approaches may serve to locally improve and protect water quality, hydrologic stability, and habitat resources. However, due to the extent of NPS impairment, dramatic gains in water quality may be challenging to attain. A combination of site-specific restorative

actions and local policy changes (e.g., increased erosion and sediment control regulation enforcement) may provide the greatest hope for significant progress.

During initial watershed reconnaissance efforts, a variety of potential opportunities were visually identified (Table 9), based on observed conditions and/or evidence of impairment. It is anticipated that identification of specific watershed improvement sites will be conducted in subsequent efforts.

Table 9: Preliminary Potential Opportunities

SUB-WATERSHED	SITE ID	STREAM	APPROXIMATE LOCATION	POTENTIAL OPPORTUNITY
UL01	1	Lower Creek	Farm road off NC 18	Stream/buffer restoration, streambank stabilization
UL09	2	Zacks Fork and Lower Creek	Lenoir Golf Club	Stream/buffer restoration, livestock exclusion, stormwater management
UL07	4	Zacks Fork	Relic pond site	Stream/wetland restoration
UL11/ UL12	5	Blair Fork Creek	Valway Rd. (at Blair Fork Baptist Church)	Stream/buffer restoration, water quality monitoring site
UL06	6	UT to Zacks Fork	Cottrell Hill Rd. bridge	Stream/buffer restoration, livestock exclusion
UL07	7	Zacks Fork	Lenoir Rotary Soccer Complex	Buffer restoration
UL12	8	UT to Blair Fork Cr.	Indian Grave Rd.	Stream restoration
UL13	9	Blair Fork	Valway Rd.	Buffer restoration
UL08	17	UT to Lower Creek	Haigler Rd.	Stream restoration
UL08	23	Lower Creek	DWQ site/station LC1	Urban stream restoration
LL07	3	Lower Creek	Rocky Rd bridge	Stream restoration, livestock exclusion, erosion control BMPs
LL02	10	Greasy Creek	Abingdon Rd bridge	Buffer restoration
LL02	22	Miller Creek	Miller Hill Rd.	Water quality monitoring site
LL04	11	Abingdon Creek	Deerbrook Rd.	Buffer restoration
LL05	12	UT to Husband Creek	Country Acres Golf Course	Buffer restoration
LL10	13	Celia Creek	Hartland Rd.	Water quality monitoring site
LL12	14	White Mill Creek	Piney Rd.	Stream preservation
LL14	24	Lower Creek	DWQ monitoring station C1750000	Stream restoration, stormwater BMPs
LL15	15	Bristol Creek	Hartland Rd.	Stream/buffer restoration, streambank stabilization
LL14	16	Lower Creek	Antioch Rd.	Stream restoration, streambank stabilization, turbidity reduction BMPs (u/s NPDES discharge)
LL06	18	Husband Creek	Tree farm on Fleming Chapel Church Rd.	Stream restoration
LL15	19	UT to Lower Creek	Cattle farm on Jay Clark Rd.	Stream restoration, livestock exclusion, invasive species control
LL07	21	UT to Lower Creek	Craigs Mountain Rd.	Buffer restoration

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APPENDIX A

COMPILATION AND REVIEW OF EXISTING DATA AND INFORMATION

MACTEC

TECHNICAL MEMORANDUM

DATE: August 18, 2003
TO: Project File
FROM: Ben Leatherland; Greta Hawkins
THROUGH: Richard Darling
SUBJECT: Catawba – Lower Creek Local Watershed Planning (Phase 1)
GIS and Data Collection
COPIES: Kristin Cozza

The North Carolina Wetland Restoration Program (NCWRP) has contracted with MACTEC Engineering and Consulting, Inc. (MACTEC) to conduct comprehensive technical watershed assessments within the Catawba (03050101) Lower Creek Basin (62,833.1 acres, 98.2 square miles) located in Caldwell and Burke Counties, North Carolina (see attached project location map). Consistent with Catawba River basinwide water quality management planning, this watershed assessment is intended to:

- identify and compile existing data and information that relates to water quality and habitat for the targeted local watershed;
- develop Geographic Information System (GIS) data layers;
- provide sampling recommendations and field analysis, where appropriate;
- identify areas for potential wetland, stream, and/or riparian buffer restoration projects for compensatory mitigation as well as similar water quality improvement projects [Best Management Practices (BMPs)];
- develop or apply modeling tools to predict the impact of various restoration projects or management strategies, when applicable;
- involve local stakeholders in identifying local watershed concerns, high-priority sub-watersheds, and specific management and project recommendations;
- develop management plans for two local watersheds listed as follows:
  - Upper Lower Creek (HU 80010) 25,979.09 acres (40.59 square miles)
  - Lower Lower Creek (HU 80020) 36,853.96 acres (57.58 square miles)

This technical memorandum summarizes the data collection efforts undertaken by MACTEC as part of Phase 1 Catawba River Basin Local Watershed Planning. While the majority of the data sources in the watersheds have been compiled, additional data may be collected during the remaining phases of the project.

Data has been collected (and/or ordered) from a variety of sources, including Caldwell County, Burke County, the City of Lenoir, the Natural Resources Conservation Service (NRCS), the N.C. Department of Environment and Natural Resources (NCDENR), the N.C. Department of Transportation (NCDOT), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS). See attached GIS Data Collection Matrix for details regarding acquired data.

During the course of data collection efforts, various data "gaps" have been identified (unavailable data, or data of a quality/resolution that would limit future usefulness). The following "gaps" have been identified, and are in the process of being resolved:

1) Color infrared orthophotographs for Lenoir, NC and Colletsville, NC
2) Burke County Soil Survey *(no published soil survey at present, general soils data for watershed have been requested from NRCS)*
3) Historic aerial photography for Caldwell County and Burke County

During the data collection process, some challenges have been encountered. These have included variable data layer resolution, inconsistent data accuracy, and insufficient data layer extents (coverage) (see attached GIS Data Collection Matrix). MACTEC personnel are continuing to obtain GIS data, in order to resolve these challenges.

Attachments: Project Location Map
List of Contacted Stakeholders
GIS Data Collection Matrix

Contacted Stakeholders

First Name	Last Name	Agency	Address	City	State	Zip Code	E-Mail	Phone Number
Hal	Bryson	North Carolina Wetlands Restoration Program	1619 Mail Service Center	Raleigh	NC	27699-1619	Hal.Bryson@ncmail.net	919-715-7452
Andy	Abramson	The Land Trust for Central North Carolina	P.O. Box 4284	Salisbury	NC	28145-4284	andy@landtrustcnc.org	704-647-0302
Ashley	Conine	Catawba Lands Conservancy	105 W. Morehead Street	Charlotte	NC	28202	clcashle@bellsouth.net	704-342-3330
Bill	Duston	Centralina COG	P.O. Box 35008	Charlotte	NC	28235	bduston@centralina.org	704-348-2709
Dan	Brandon	NCDENR Division of Forest Resources	1933 Mountain Island Highway	Mount Holly	NC	28120	dan.brandon@ncmail.net	704-827-7576
Kevin	Harvell	NCDENR Division of Forest Resources	1933 Mountain Island Highway	Mount Holly	NC	28120	kevin.harvell@ncmail.net	
Bill	DeMay	NCDENR Division of Forest Resources	1163 N. US Hwy #1	Rockingham	NC	28379-8513	bill.demay@ncmail.net	910-997-9220
Ken	Knight	NCDENR Wildlife Resources Commission	1403 Heritage Court	Albemarle	NC	28001	kbknight@vnet.net	704-982-1600
Mark	Fowlkes	NCDENR Wildlife Resources Commission	200 N. Laurel Avenue, #4-D	Charlotte	NC	28207	fowlkesmd@earthlink.net	704-875-5370
Jim	Borawa	NCDENR Wildlife Resources Commission	37 New Cross Road N	Asheville	NC	28805-9213	borawajc@earthlink.net	
Forrest	Robson	NC Department of Transportation-GIS Unit	1587 Mail Service Center	Raleigh	NC	27699-1587	frobson@dot.state.nc.us	919-212-6001
Jim	Blose	DWQ-Special Watersheds Project unit	1617 Mail Service Center	Raleigh	NC	27699-1617	Jim.blose@ncmail.net	919-716-1924
John	Wear, PhD	Catawba College Center for Environmental Studies	2300 W. Innes Street	Salisbury	NC	28144	jwear@catawba.edu	704-637-4738
Cam	McNutt	DWQ-Planning	1617 Mail Service Center	Raleigh	NC	27699-1617	cam.mcnutt@ncmail.net	919-733-5083, ext. 575
Scott	Jackson	North Carolina Watershed Coalition					scotti@buncombe.main.nc.us	828-215-4015
Kevin	Parrish	Caldwell County			NC		kparrish@co.caldwell.nc.us	828-757-1452
Kate	Sturgeon	Western Piedmont Council of Governments	PO Box 9026	Hickory	NC	28603	kate.sturgeon@wpcog.dst.nc.us	828-485-4234
Mike	Struve	Western Piedmont Council of Governments	PO Box 9026	Hickory	NC	28603	struve@wpcog.dst.nc.us	828-485-4248
Scott	Black	Burke County			NC		bcgis@hci.net	828-438-5445
Kristin	Cozza	North Carolina Wetlands Restoration Program	311 McAlway Rd.	Charlotte	NC	28211	Kristin.Cozza@ncmail.net	704-572-0955
Andrea	Leslie	NCDENR Division of Water Quality	59 Woodfin Place	Asheville	NC	28801	Andrea.Leslie@ncmail.net	828-251-6208, ext. 226
Jim	Reid	NCDENR Division of Water Quality	59 Woodfin Place	Asheville	NC	28801	Jim.Reid@ncmail.net	828-251-6208
Jocelyn	Elliott	North Carolina Wetlands Restoration Program	1619 Mail Service Center	Raleigh	NC	27699	jocelyn.elliott@ncmail.net	919-716-1921
Brian	Jacobson	DWQ-Modeling Branch	1617 Mail Service Center	Raleigh	NC	27699	Brian.Jacobson@ncmail.net	919-733-5083, ext. 552
Cecil	Haynes	NRCS Caldwell County	120 Hospital Ave., NE, Suite 2	Lenoir	NC	28645		828-758-1111
Russell	Lyday	NRCS Burke County	130 Ammons Dr., Suite 3	Morganton	NC	28655		828-439-9727, ext.3

GIS Data Collection Matrix

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
Burke County										
dotlrsnode.shp	shp	endpoints of primary and secondary roads.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotsecroads.shp	shp	secondary roads.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotroads.shp	shp	all roads.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotrailrds.shp	shp	railroad lines.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotprimrds.shp	shp	primary roads.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotlrsrtrts.shp	shp	looks like combination of dot primary roads and dot secondary roads.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotlrsrt.shp	shp	looks like combination of dot primary roads and dot secondary roads.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotgovbdry.shp	shp		Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotcntybdry.shp	shp	county boundary	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotcitybdry.shp	shp	municipal boundaries.	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
dotairport.shp	shp	airport runways	Burke County	E://GIS Data Layers/Burke County/DOT Layers/Burke dot	NC DOT	2003	NC Stateplane		meters	
topo20.shp	shp	20-foot countours from NCDOT GIS division	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
topo.shp	shp	5-foot countours from NCDOT GIS division	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
streams.shp	shp	1:100,000 scale USGS stream data	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
roads.shp	shp	street centerlines with E911 road names	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
railroad.shp	shp	centerlines of rail lines	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
zone.shp	shp	county zoning	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
vote.shp	shp	voter precincts	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
valdzone.shp	shp	Valdese zoning	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
twp.shp	shp	township boundaries	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
school.shp	shp	Elementry, middle, and high school districts	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
parcel.shp	shp	Cadastral polygons, tax parcels	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
morgzone.shp	shp	Morganton zoning	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
lakerivr.shp	shp	lakes and rivers	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
flood.shp	shp	FEMA floodplain boundaries	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
fire.shp	shp	fire districts	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
etj.shp	shp	Extra-territorial jurisdiction.	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
county.shp	shp	County boundaries.	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
city.shp	shp	city limits	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
burkewsw.shp	shp	water supply watersheds	Burke County	BURKE COUNTY\Burke County CD	Burke County GIS; CD	2003			feet	
Town of Lenoir										
regecity_line.shp	shp	regional city extra-territorial jurisdictional boundaries.	Lenoir region	CALDWELL COUNTY\Town of Lenoir	Town of Lenoir; CD	July 2003			feet	
centerlines_7_03.shp	shp	road centerlines for Town of Lenoir.	Lenoir	CALDWELL COUNTY\Town of Lenoir	Town of Lenoir; CD	July 2003			feet	
municzonee00_polygon.shp	shp	Lenoir zoning.	Lenoir	CALDWELL COUNTY\Town of Lenoir	Town of Lenoir; CD	July 2003			feet	
Caldwell County										
dotlrsnode.shp	shp	endpoints of primary and secondary roads.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotsecroads.shp	shp	secondary roads.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotroads.shp	shp	all roads.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotrailrds.shp	shp	railroad lines.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotprimrds.shp	shp	primary roads.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotlrsrtrts.shp	shp	looks like combination of dot primary raods and dot secondary roads.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
dotlrsrt.shp	shp	looks like combination of dot primary raods and dot secondary roads.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotgovbdry.shp	shp		Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotcntybdry.shp	shp	county boundary	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotcitybdry.shp	shp	municipal boundaries.	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
dotairport.shp	shp	airport runways	Caldwell County	CALDWELL COUNTY\DOT Layers\Caldwell dot.av	DOT	April 2003	NC Stateplane	NAD 83	meters	origination date unclear
caldwellb.shp	shp	base soil survey	Caldwell County	E:\Catawba\soil survey	USDA NRCS		NC Stateplane	NAD 83	meters	origination date unclear
caldwellt.shp	shp	taxonomy soil survey	Caldwell County	E:\Catawba\soil survey	USDA NRCS		NC Stateplane	NAD 83	meters	origination date unclear

Other										
lenhydro	sdts	hydrography	Lenoir quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
lenmtrans	sdts	miscellaneous transportation	Lenoir quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
lenrail	sdts	railroads	Lenoir quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
lenroad	sdts	roads	Lenoir quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
kchydro	sdts	hydrography	Kings Creek quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
kcmtrans	sdts	miscellaneous transportation	Kings Creek quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
kcrail	sdts	railroads	Kings Creek quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
kcroad	sdts	roads	Kings Creek quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
drexhydro	sdts	hydrography	Drexel quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
drexmtrans	sdts	miscellaneous transportation	Drexel quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
drexrail	sdts	railroads	Drexel quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
drexroad	sdts	roads	Drexel quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
morgnhydro	sdts	hydrography	Morganton North quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
morgnmtrans	sdts	miscellaneous transportation	Morganton North quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
morgnrail	sdts	railroads	Morganton North quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
morgnroad	sdts	roads	Morganton North quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
collhydro	sdts	hydrography	Collettsville quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
collmtrans	sdts	miscellaneous transportation	Collettsville quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
collrail	sdts	railroads	Collettsville quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
collroad	sdts	roads	Collettsville quad	E:\usgsdlg	USGS; http://edc.usgs.gov/geodata					
lenoir_l	shp	NWI line (streams)	Lenoir quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
lenoir_p	shp	NWI polygons (wetlands, lakes)	Lenoir quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
kingsc_l	shp	NWI line (streams)	Kings Creek quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
kingsc_p	shp	NWI polygons (wetlands, lakes)	Kings Creek quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
drexel_l	shp	NWI line (streams)	Drexel quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
drexel_p	shp	NWI polygons (wetlands, lakes)	Drexel quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
morgno_l	shp	NWI line (streams)	Morganton North quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
morgno_p	shp	NWI polygons (wetlands, lakes)	Morganton North quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
collet_l	shp	NWI line (streams)	Collettsville quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
collet_p	shp	NWI polygons (wetlands, lakes)	Collettsville quad	E:\NWI	National Wetlands Inventory; http//www.nwi.fws.gov/downloads.htm		UTM	NAD 83		
kingck1	sid	color infrared DOQQ	Kings Creek quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
kingck2	sid	color infrared DOQQ	Kings Creek quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
kingck3	sid	color infrared DOQQ	Kings Creek quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
kingck4	sid	color infrared DOQQ	Kings Creek quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
drexel1	sid	color infrared DOQQ	Drexel quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
drexel2	sid	color infrared DOQQ	Drexel quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
drexel3	sid	color infrared DOQQ	Drexel quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
drexel4	sid	color infrared DOQQ	Drexel quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
morgan1	sid	color infrared DOQQ	Morganton North quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
morgan2	sid	color infrared DOQQ	Morganton North quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
morgan3	sid	color infrared DOQQ	Morganton North quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
morgan4	sid	color infrared DOQQ	Morganton North quad	E:\Catawba	NC DENR; ftp://gis.enr.state.nc.us/doqq98	1998				unprojected
collvl1	jpg	black & white DOQQ	Collettsville quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
collvl2	jpg	black & white DOQQ	Collettsville quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
collvl3	jpg	black & white DOQQ	Collettsville quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
collvl4	jpg	black & white DOQQ	Collettsville quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
drexel1	jpg	black & white DOQQ	Drexel quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
drexel2	jpg	black & white DOQQ	Drexel quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
drexel3	jpg	black & white DOQQ	Drexel quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
drexel4	jpg	black & white DOQQ	Drexel quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
kingck1	jpg	black & white DOQQ	Kings Creek quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
kingck2	jpg	black & white DOQQ	Kings Creek quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
kingck3	jpg	black & white DOQQ	Kings Creek quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
kingck4	jpg	black & white DOQQ	Kings Creek quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
lenoir1	jpg	black & white DOQQ	Lenoir quad	E:\Catawba\DOQQs\1993	NC DENR; ftp://gis.enr.state.nc.us/doqq93/	1993				
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morgan4	jpg	black & white DOQQ	Morganton North quad	E:\Catawba\DOQQs\1993	NCDENR; ftp://gis.enr.state.nc.us/doqq93	1993				
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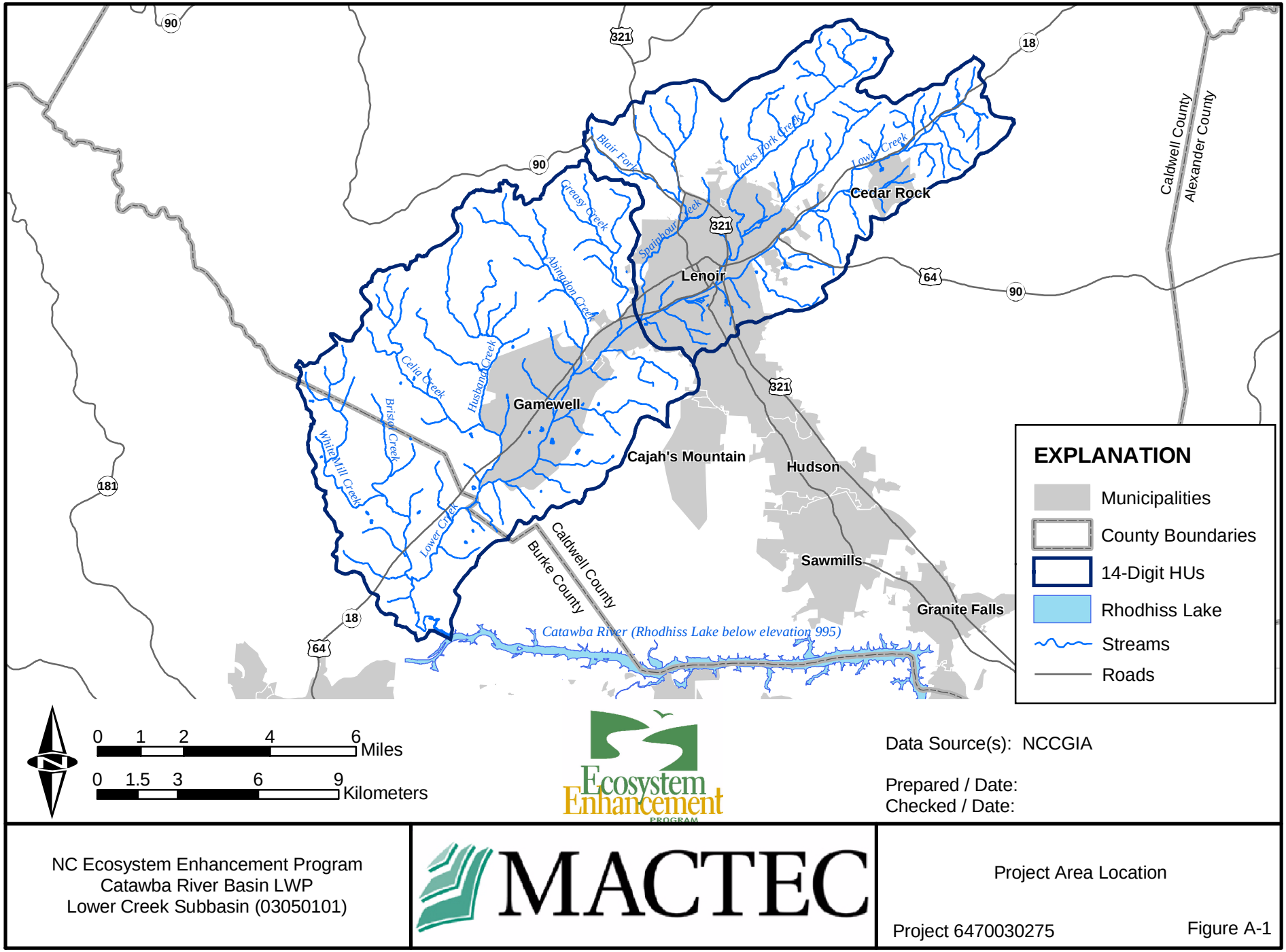
drexel	tif	DRG	Drexel quad	E:\Catawba\DRG	NC DENR; ftp://gis.enr.state.nc.us/drg/	1998?				not sure of date
kingck	tif	DRG	Kings Creek quad	E:\Catawba\DRG	NC DENR; ftp://gis.enr.state.nc.us/drg/	1998?				not sure of date

Layer	File Ext.	Description	Geographic Area	Location in E:/GIS Data Layers	Source/ Delivery Media	Origination Date	Projection	Datum	Units of Measure	Notes
lenoir	tif	DRG	Lenoir quad	E:\Catawba\DRG	NC DENR; ftp://gis.enr.state.nc.us/drg/	1998?				not sure of date
morgan	tif	DRG	Morganton North quad	E:\Catawba\DRG	NC DENR; ftp://gis.enr.state.nc.us/drg/	1998?				not sure of date
primary_roads	shp	primary roads	NC	E:\Catawba\basinpro	BasinPro3 CDs					
hunc	shp	14 digit hydrologic units	NC	E:\Catawba\basinpro	BasinPro3 CDs					
municipalbnd	shp	municipal boundaries	NC	E:\Catawba\basinpro	BasinPro3 CDs					
countybnd	shp	county boundaries	NC	E:\Catawba\basinpro	BasinPro3 CDs					
Watershed data										
monitoring stations		ambient water quality monitoring stations	Catawba river basin	http://www.esb.enr.state.nc.us/stations/ctbsta.asp	NC DWQ	varied				
assessment report	pdf	basinwide assessment report	Catawba river basin	P:\30141 natural resources\2003\0275 - NCWRP Catawba	NC DWQ; http://www.esb.enr.state.nc.us/bar.html					
water quality plan	pdf	basinwide water quality plan	Catawba river basin	http://h2o.enr.state.nc.us/basinwide/catawba/catawba_wq_management_plan.htm	NC DWQ					
biological assessment	doc	TMDL study	Lower Creek/Spainhour Creek	P:\30141 natural resources\2003\0275 - NCWRP Catawba	NC DWQ					
macrobenthic	xls	macrobenthic summary reports	Lower Creek	P:\30141 natural resources\2003\0275 - NCWRP Catawba	NC DWQ					
Transportation Improvement Program										
TIP data		DOT TIP data	NC	ftp://ftp.doh.dot.state.nc.us/TIPDATA/	NC DOT					



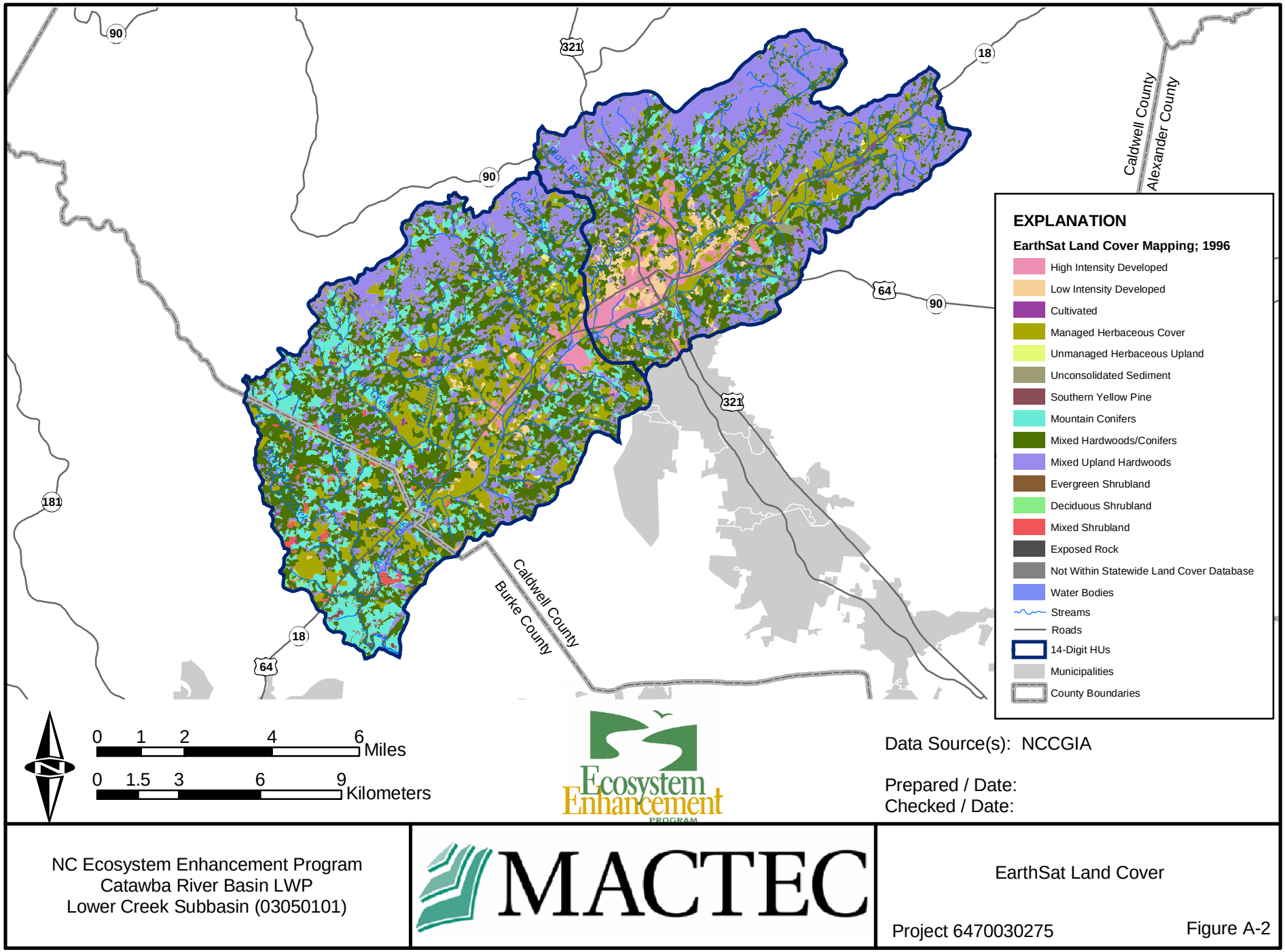
NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

Project Area Location

Project 6470030275

Figure A-1



NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

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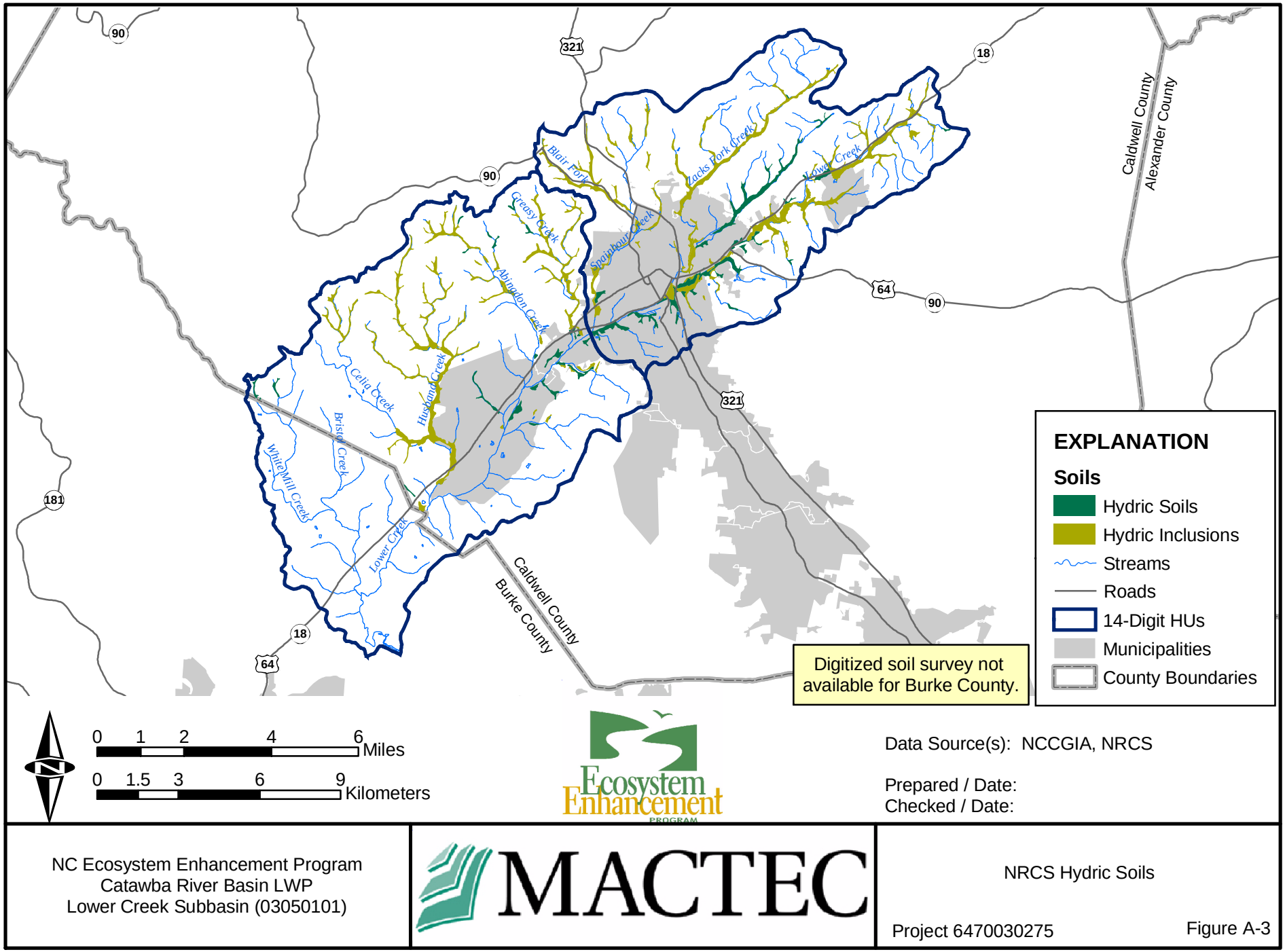
EarthSat Land Cover

Project 6470030275

Figure A-2



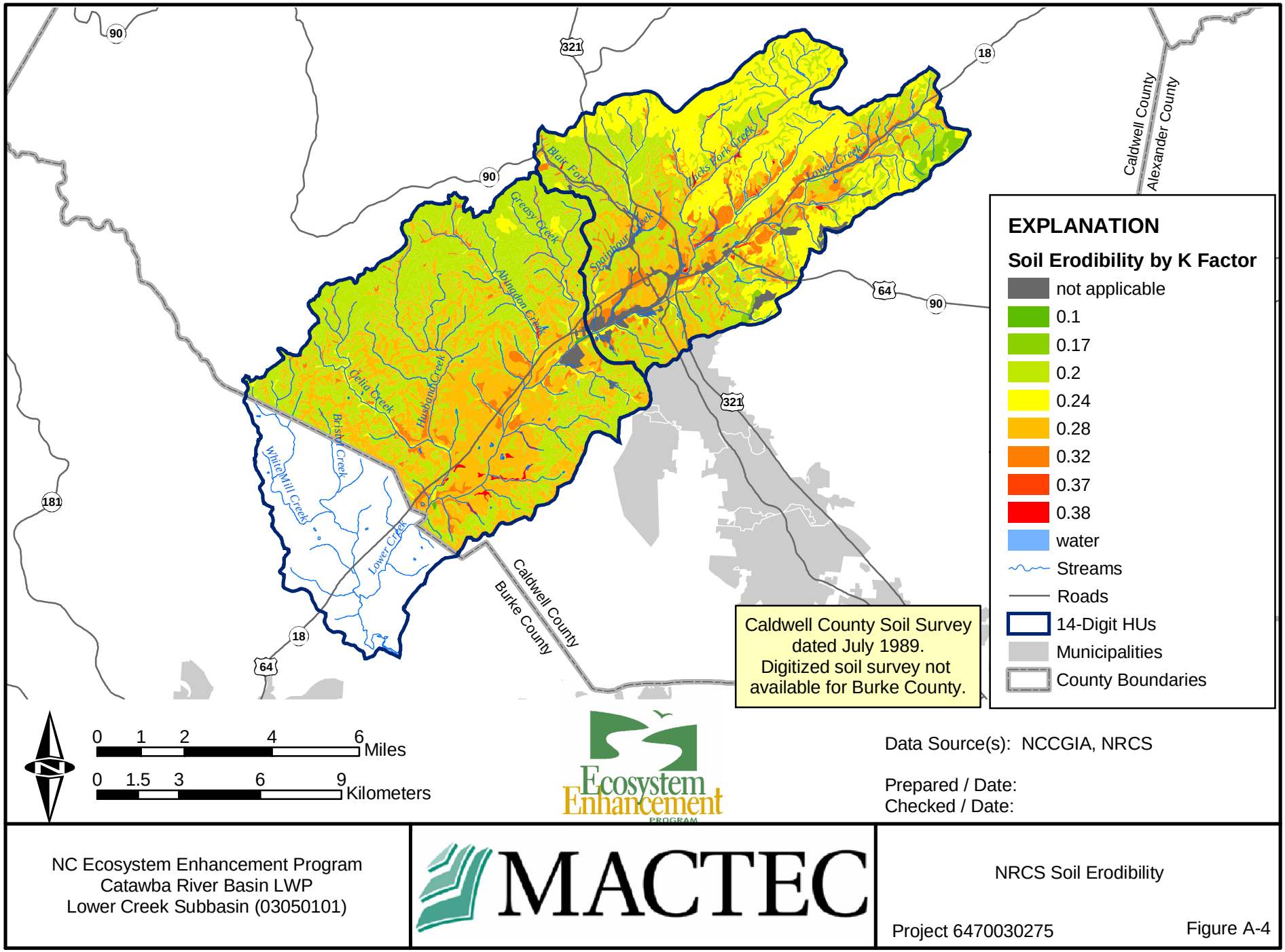
NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

NRCS Hydric Soils

Project 6470030275

Figure A-3



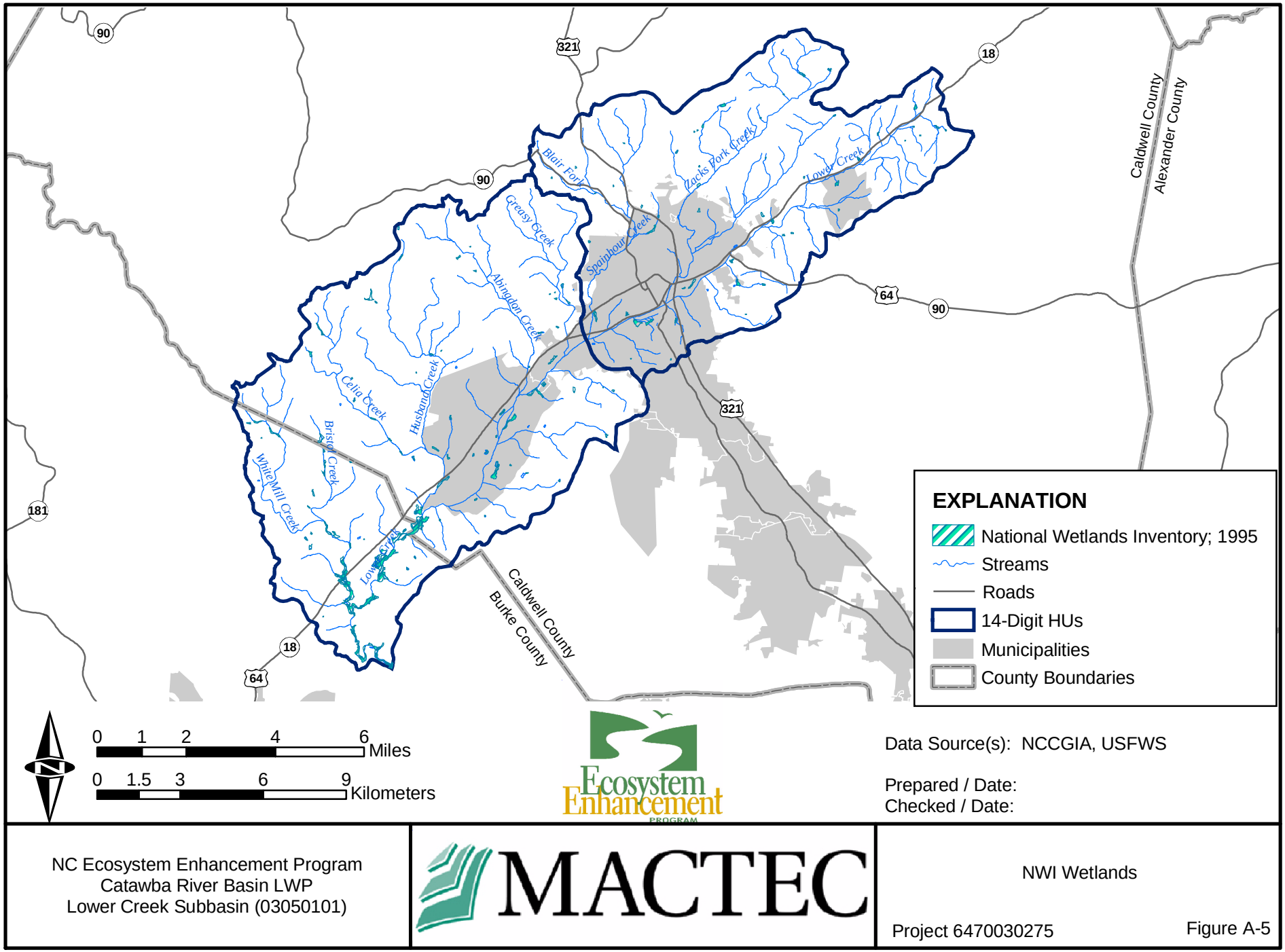
NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

NRCS Soil Erodibility

Project 6470030275

Figure A-4



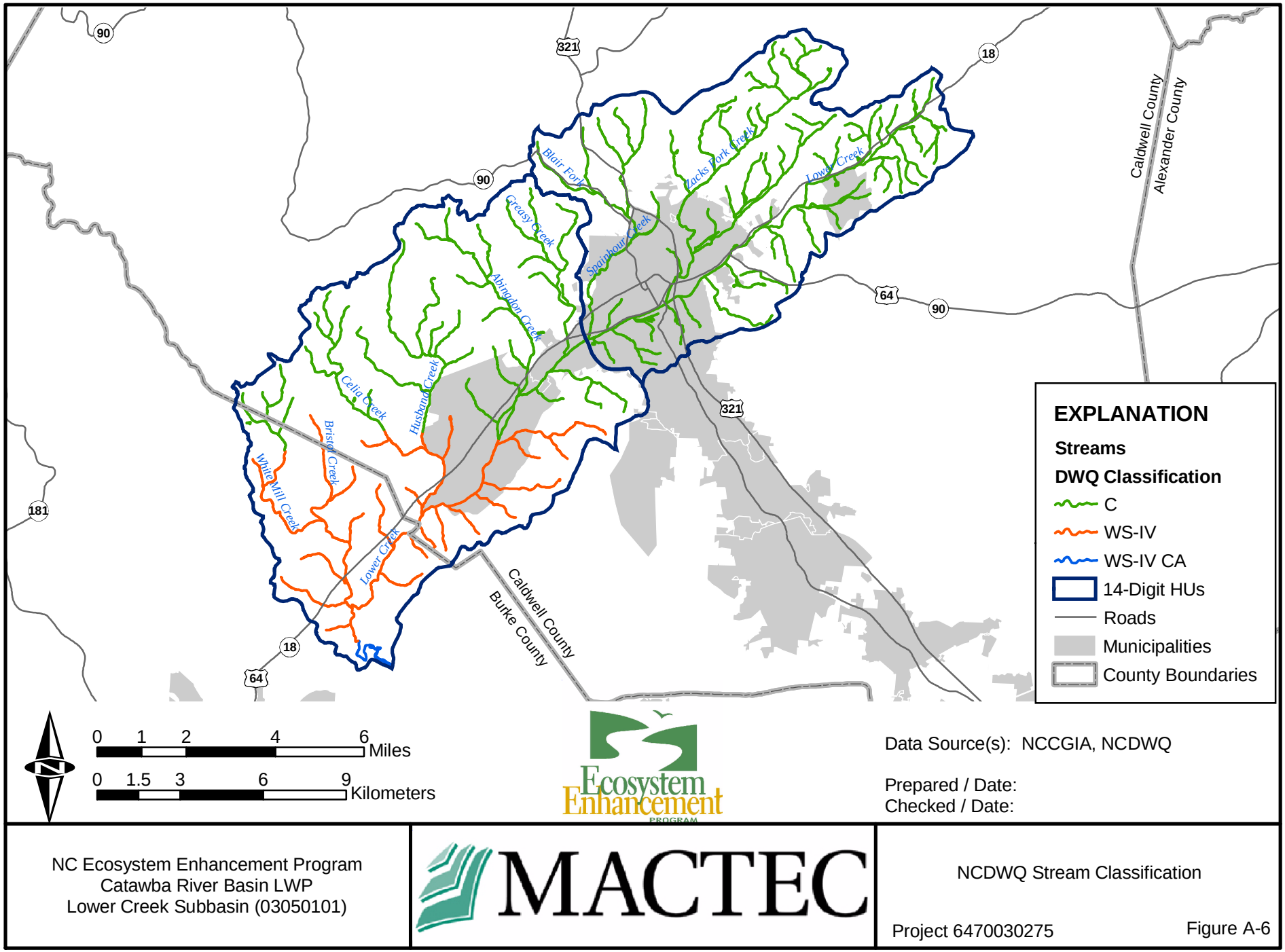
NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

NWI Wetlands

Project 6470030275

Figure A-5



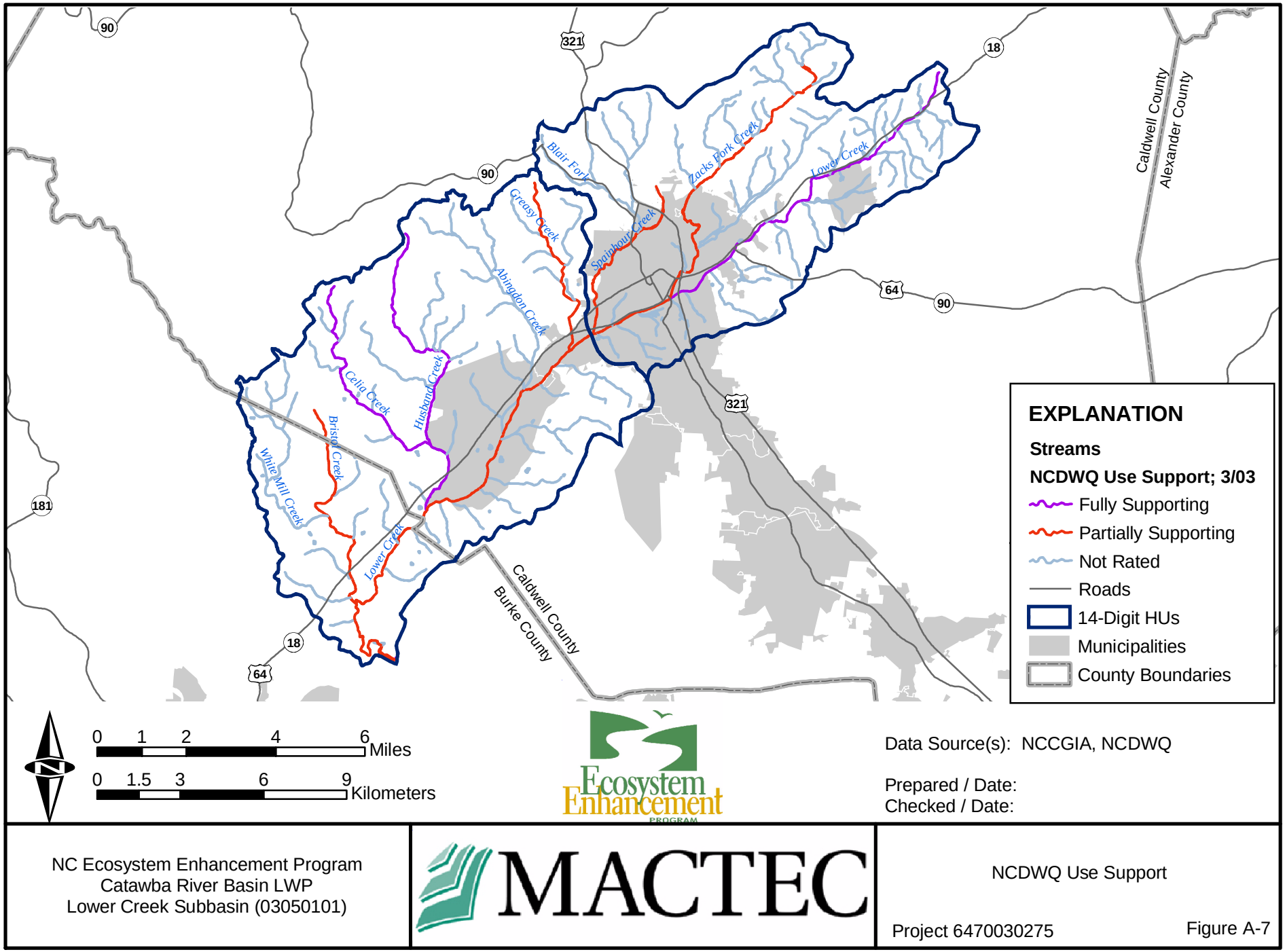
NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

NCDWQ Stream Classification

Project 6470030275

Figure A-6



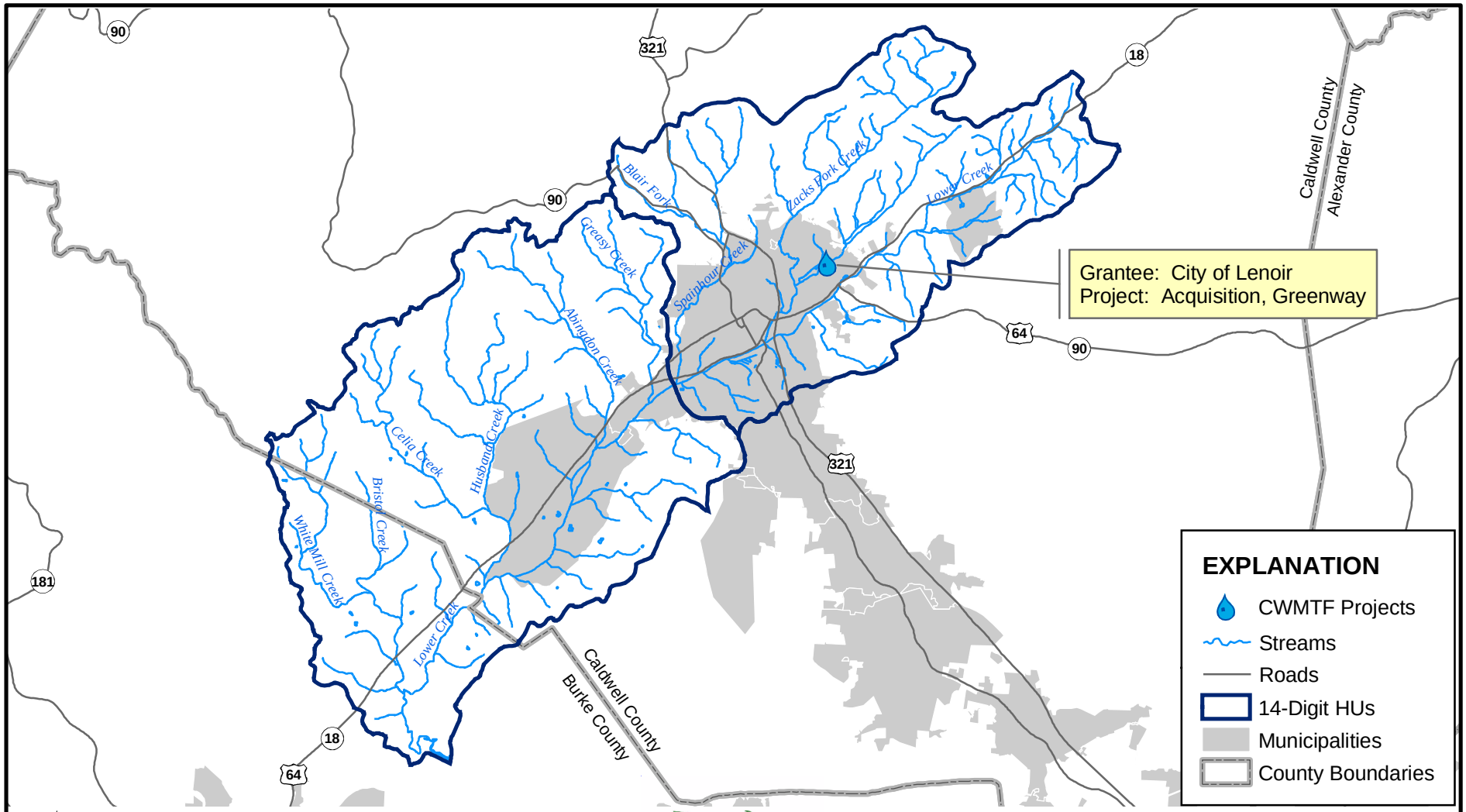
NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

NCDWQ Use Support

Project 6470030275

Figure A-7



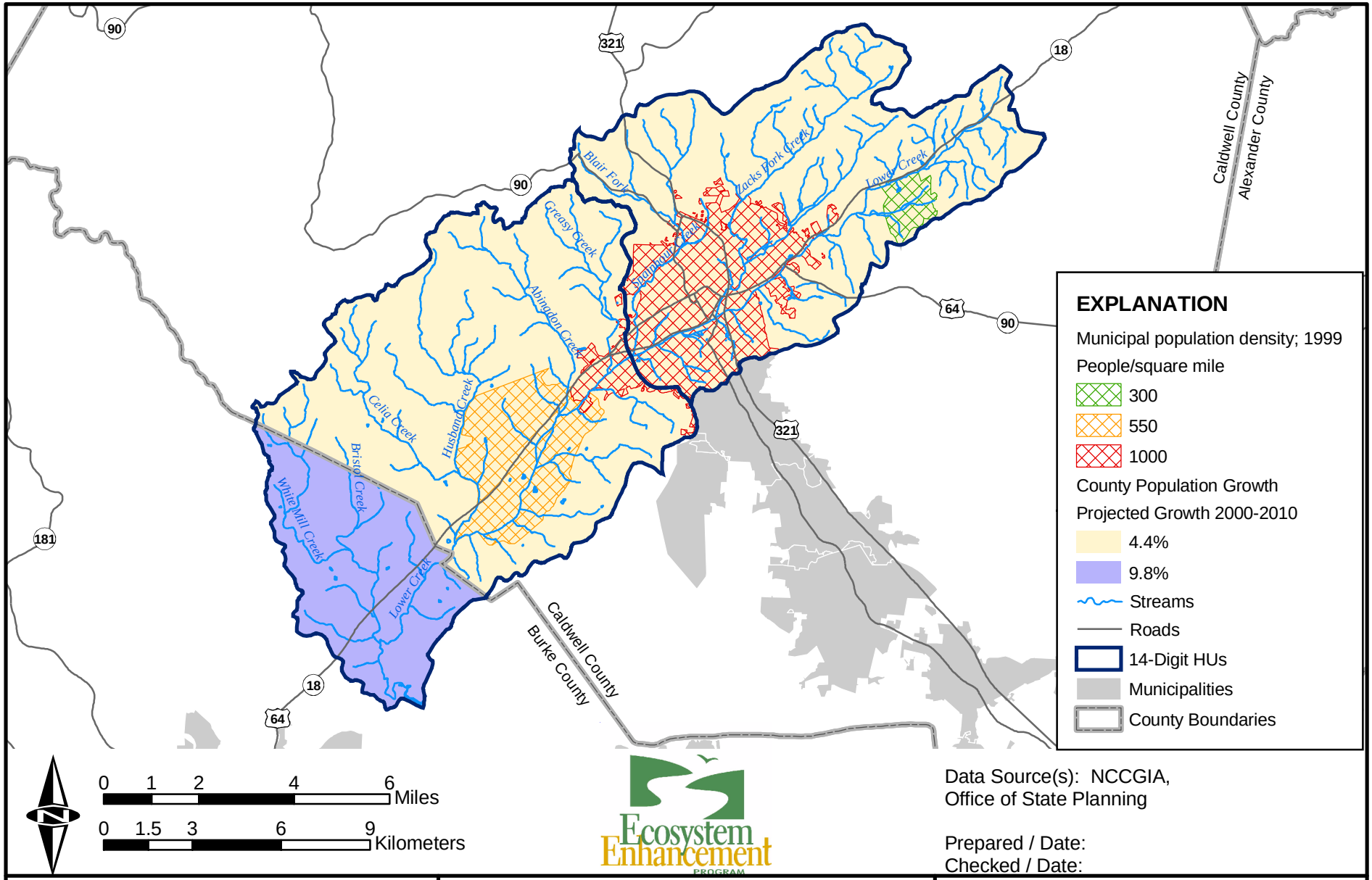
NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

BasinPro CWMTF Projects

Project 6470030275

Figure A-8

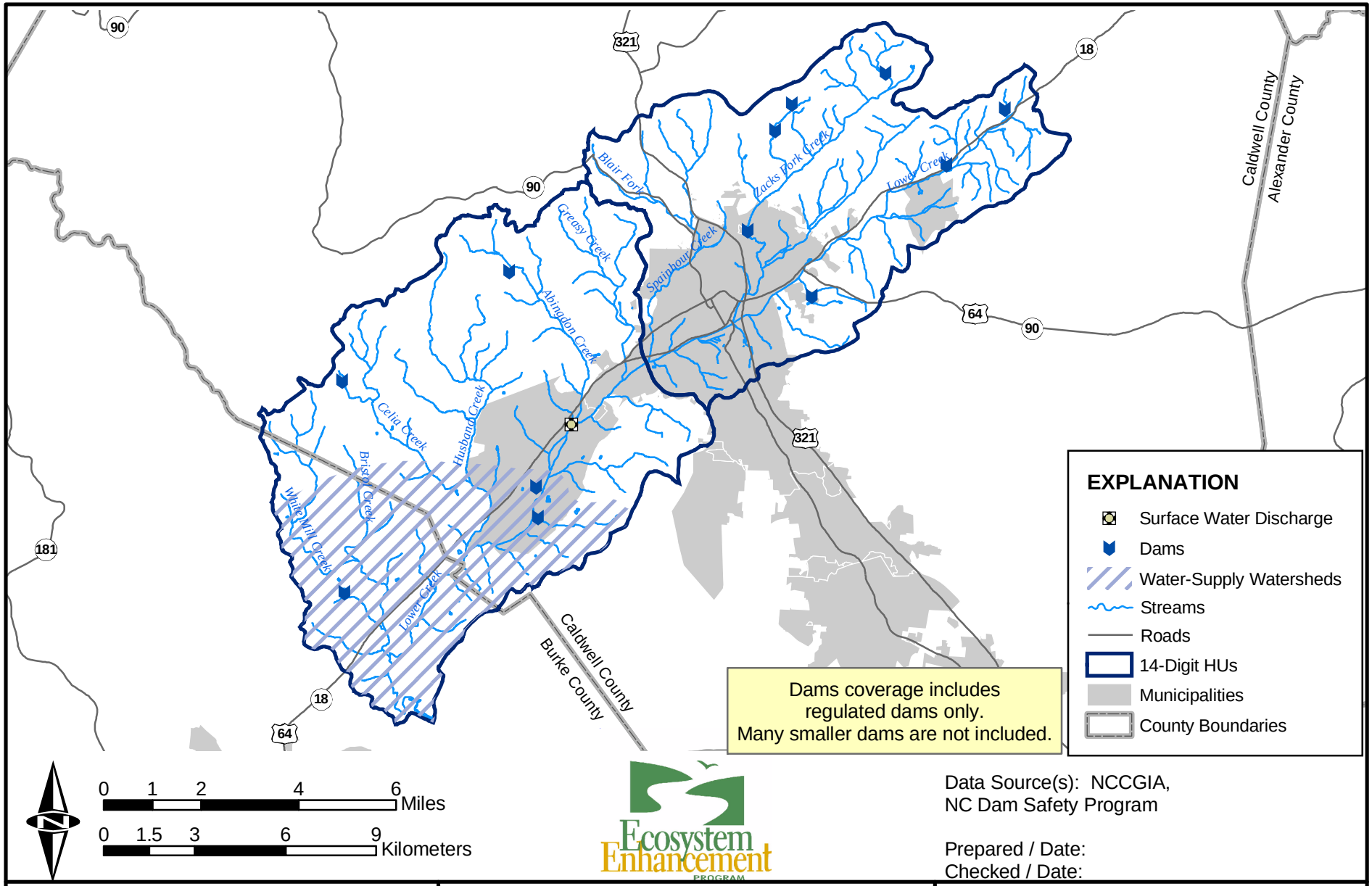


NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

BasinPro Demographics

Project 6470030275 Figure A-9

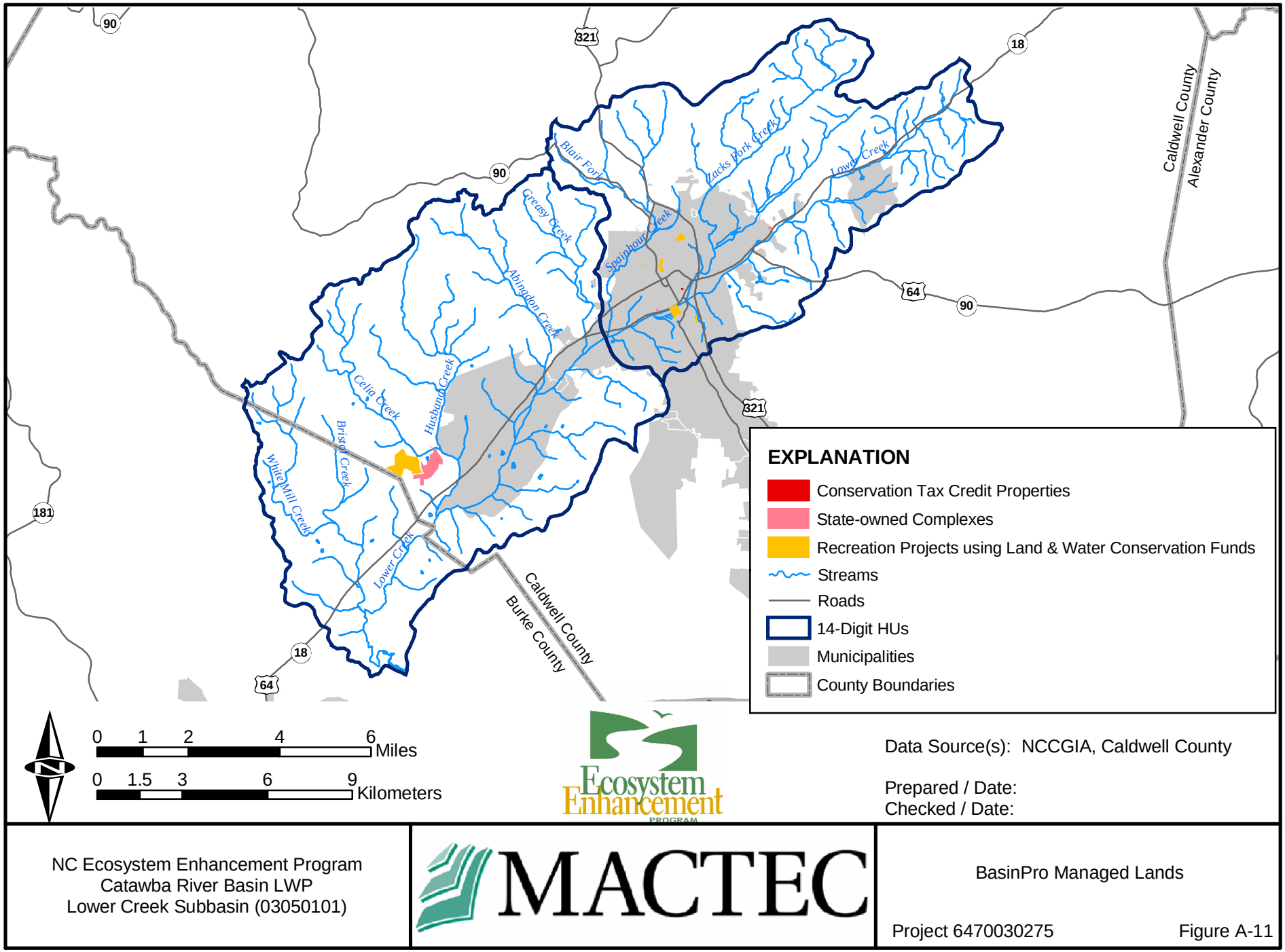


NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

BasinPro Infrastructure

Project 6470030275 Figure A-10

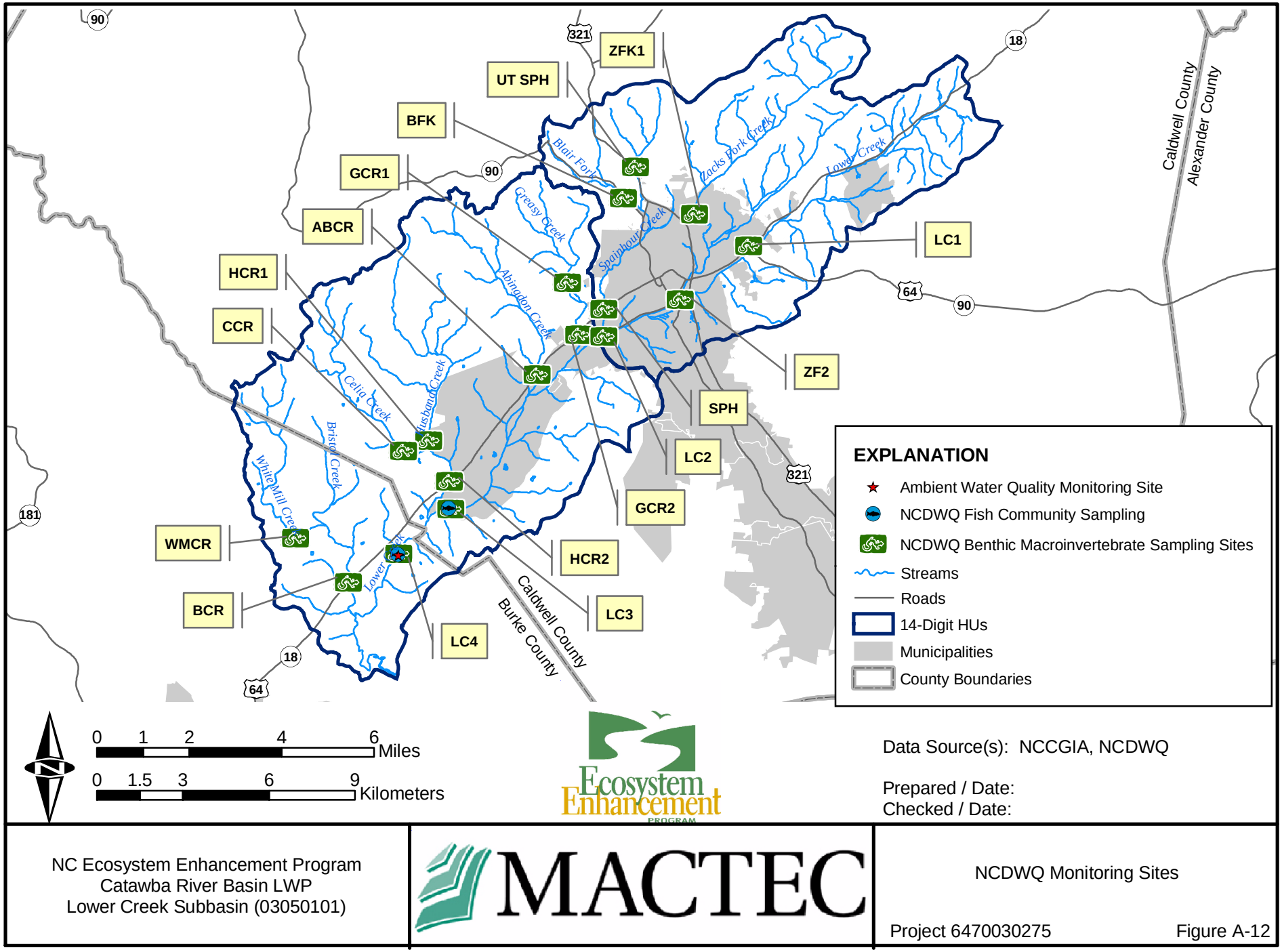


NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

BasinPro Managed Lands

Project 6470030275 Figure A-11

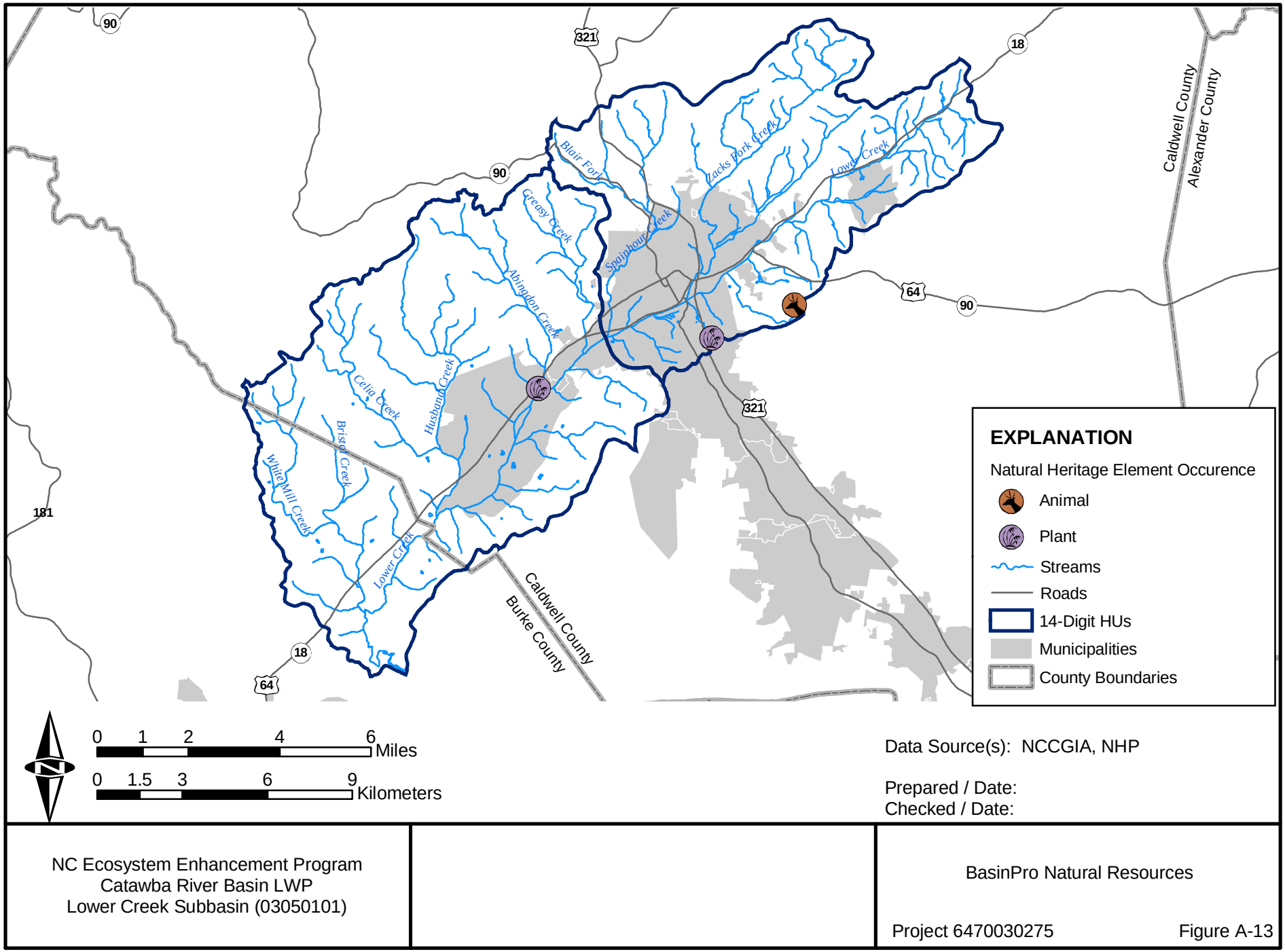


NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

NCDWQ Monitoring Sites

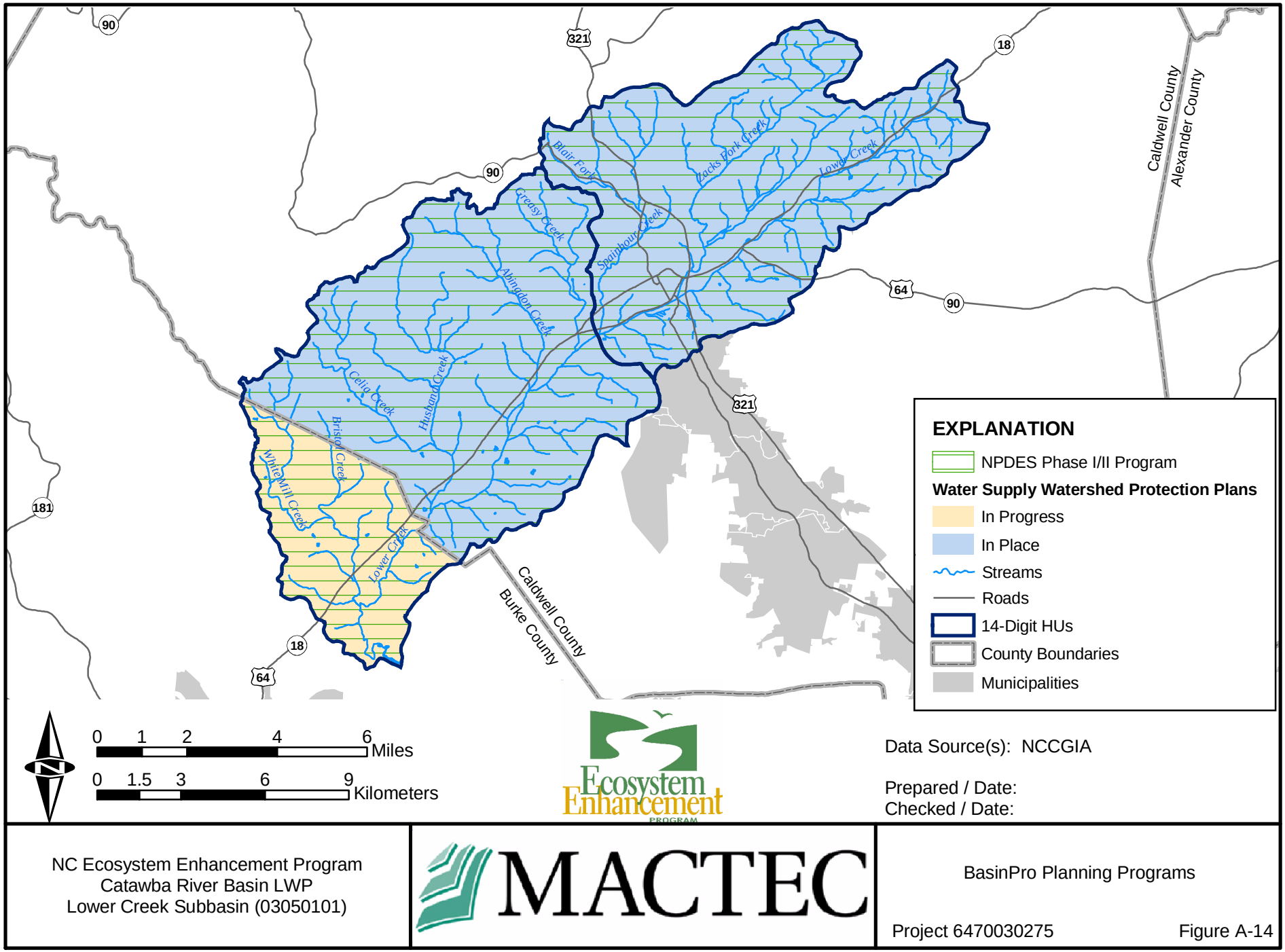
Project 6470030275 Figure A-12



NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

BasinPro Natural Resources

Project 6470030275 Figure A-13

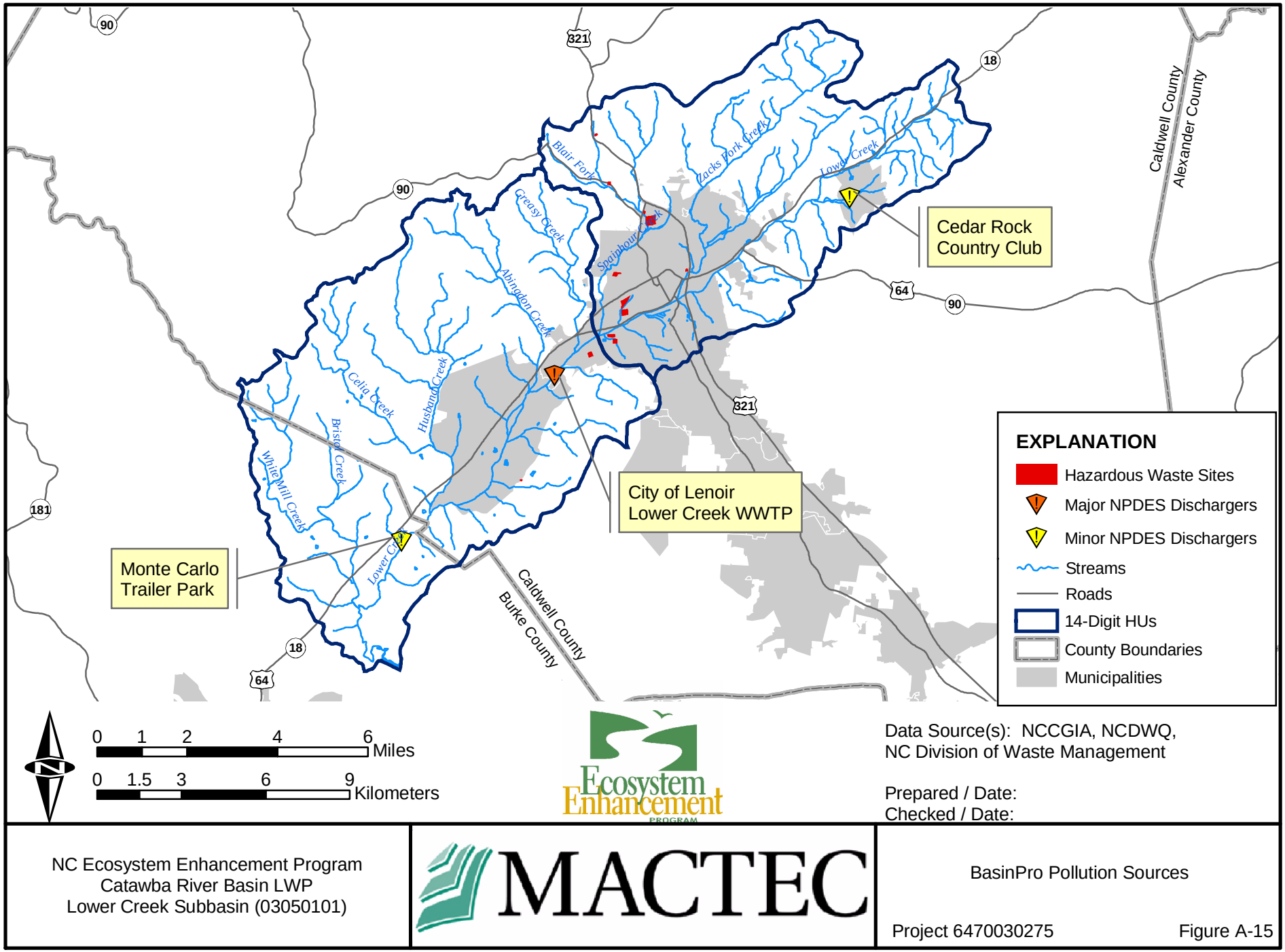


NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

BasinPro Planning Programs

Project 6470030275 Figure A-14



NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

BasinPro Pollution Sources

Project 6470030275 Figure A-15

APPENDIX B

INITIAL VISUAL ASSESSMENT OF THE LOCAL WATERSHED

MACTEC

TECHNICAL MEMORANDUM

DATE: October 20, 2003

TO: Project File

FROM: Greta Hawkins; Ben Leatherland

THROUGH: Richard Darling

SUBJECT: Catawba River Basin Local Watershed Planning
Initial Visual Assessment of the Watershed

COPIES: Kristin Cozza

MACTEC has performed a series of visual assessments in the Catawba (Cataloguing Unit 03050101) Lower Creek Basin (62,833.1 acres, 98.2 square miles) located in Caldwell and Burke Counties, North Carolina. A "windshield survey" of the two local watersheds (Hydrologic Units 80010 and 80020) comprising the study area was performed on July 30, 2003 by MACTEC personnel and DWQ staff around the City of Lenoir and Lower Creek. On September 4 and 19, 2003, MACTEC personnel reviewed additional areas of the watershed at road crossings and other accessible points along the tributaries to Lower Creek (Figure 1). MACTEC used these visual assessments to characterize the watershed and determine some initial restoration opportunities (Table 1).

Similar stream conditions were observed during all three field reviews. The major areas of concern in this basin include lack of riparian buffers, presence of livestock in the streams, previous channelization, stream bank erosion, sedimentation, potential furniture and timber production impacts, and point source pollution. While these issues may have degraded water quality, aquatic habitat, and natural hydrology of streams in the basin, such impairment also provides opportunities for enhancement and restoration.

During visual assessment efforts, riparian buffers were generally found to be either sparse or absent along many stream channels. This was particularly evident at Country Acres Golf Course, where no buffers exist along an unnamed tributary to Husband Creek (Figures 2 and 3), and at the Lenoir Golf Club, where no buffers exist along either Zack's Fork Creek or Lower Creek (Figures 4, 5, and 6). Re-establishing appropriate riparian buffers in these areas could significantly reduce active streambank erosion along these channels. Further upstream, narrow riparian buffers were observed along Lower Creek (low woody vegetation along the streambanks), though such vegetation was largely absent along most reaches (Figures 7 through 10).

Visual assessment efforts also revealed that livestock have access to streams in at least three locations; along Zack's Fork Creek, Lower Creek, and a tributary to Lower Creek. Cattle have access to Zack's Fork Creek on both sides of the Cottrell Hill Road bridge (Figures 11, 12, and 13). Cattle also cross underneath the Rocky Road bridge, with access to Lower Creek (Figures 14 and 15). The North Carolina Wetland Restoration Program (NCWRP) is currently evaluating specific reaches of Lower Creek near Rocky Road for restoration (Figures 16 through 19). An unnamed tributary to Lower Creek is the water source for a cattle farm along Jay Clark Road (Figures 20 and 21). Fencing these streams and providing alternative water sources would be an important component of restoration projects at these locations.

Channelized streams were observed throughout the Blair Fork sub-watershed. Indian Grave Road and Valway Road are both located within ten feet of the Blair Fork channel. MACTEC personnel observed piles of riprap apparently to continue channelization of Blair Fork along Valway Road (Figure 22). An unnamed tributary to Husband Creek appears to have been channelized through the Country Acres Golf Course (see Figures 2 and 3). Husband Creek also appears to have been channelized at a tree farm on Fleming Chapel Church Road (Figures 23

and 24). Similar modifications have likely occurred at locations along Zack's Fork, where additional cornfields and tree farms were observed.

Increased sedimentation was noted in the majority of streams observed within the basin. Construction activities along Zack's Fork Road (as observed on 9/4/03) may be contributing to sedimentation in Zack's Fork Creek. Eroding streambanks at tree farms on Hartland Road and Fleming Chapel Church Road (see Figures 23 and 24) and cornfields along Zack's Fork Road and Valway Road may also be contributing sediment to the basin's stream channels. A new residential development (Middleton Place) is in the early stages of construction near an unnamed tributary to Lower Creek (Figure 25). No erosion control measures were observed at this location during visual assessment efforts. Additional sedimentation may have also previously resulted from dam removal, as observed along Zack's Fork Creek (Figures 26 and 27).

Several furniture and timber production facilities were observed along North Carolina Highway 90 (NC-90), adjacent to Blair Fork. These facilities may pose some contamination risk, depending on wood treatment chemical use, storage, and disposal. These facilities should be monitored and assessed for possible restoration potential or storm water best management practice (BMP) retrofits.

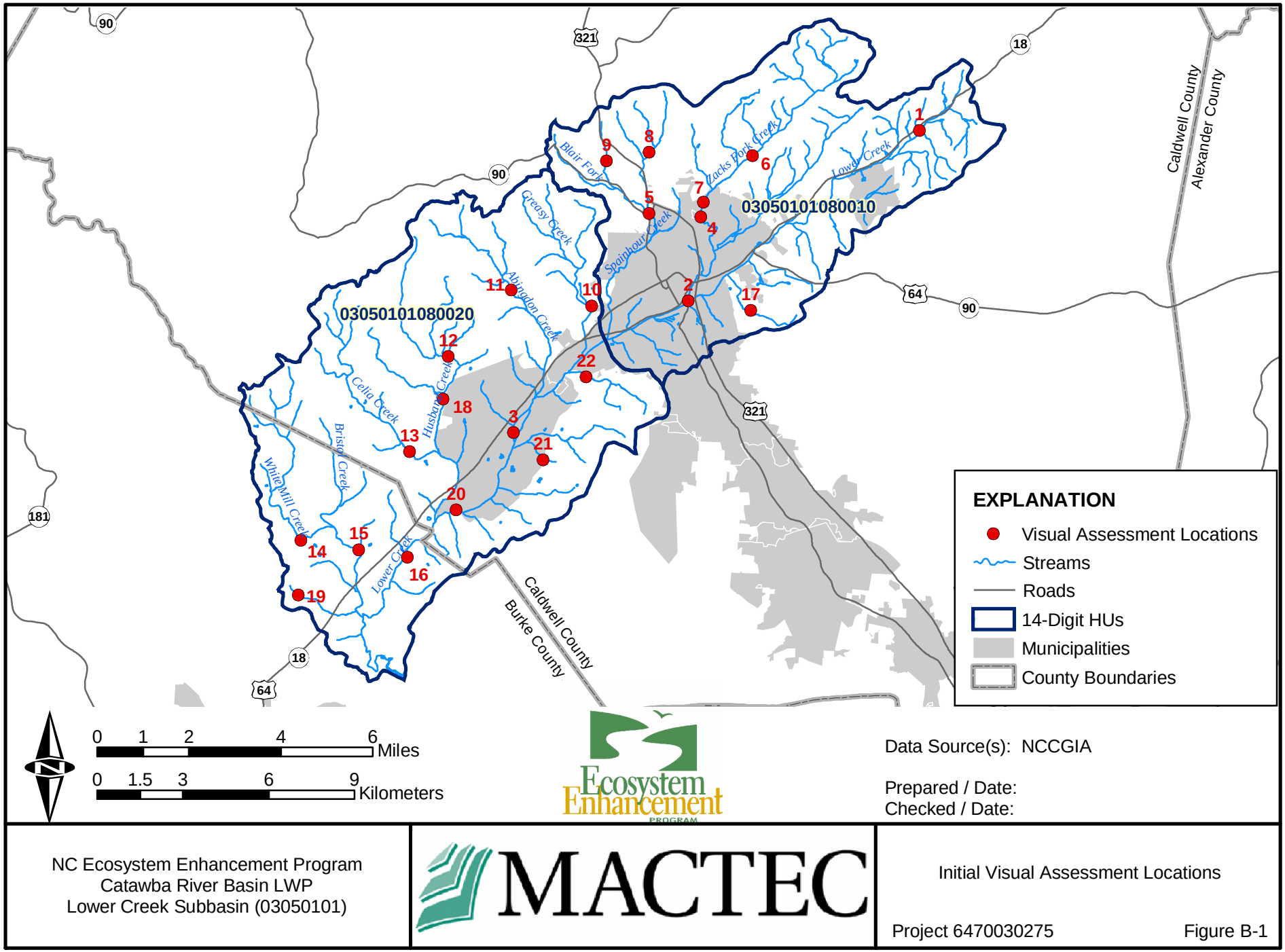
One major NPDES discharger and five minor NPDES dischargers are located within the watershed. During field reconnaissance efforts, MACTEC personnel observed two of these dischargers, Monte Carlo trailer park – a minor discharger – and the City of Lenoir Waste Water Treatment Plant – a major discharger. These sites may be considered for future water quality monitoring.

Based on three days of field visits to the watershed, it appears that current land use practices may provide restoration opportunities in three areas. First, streams with cattle access can be restored by excluding cattle and restoring the eroding banks. Second, channelized reaches in agricultural areas (i.e., tree farms and cornfields) may be restored to more appropriate sinuosity. Third, stream reaches with little or no buffer may be protected and planted to increase the riparian buffer. The most beneficial restoration sites appear to be those streams with cattle access that have been channelized and have little or no buffer. MACTEC personnel will continue to perform visual assessments of the watershed to determine other restoration opportunities.

Attachments:

Figure 1: Initial Visual Assessment Locations
Table 1: Initial Visual Assessment Summary
Figure 2: Unnamed Tributary to Husband Creek at Country Acres Golf Course, facing downstream
Figure 3: Unnamed Tributary to Husband Creek at Country Acres Golf Course, facing upstream
Figure 4: Zacks Fork Creek at Lenoir Golf Club (Norwood Street)
Figure 5: Zacks Fork Creek at Lenoir Golf Club (Norwood Street)
Figure 6: Lower Creek at Lenoir Golf Club (Norwood Street)
Figure 7: Lower Creek at NC-18 Farm Road, facing downstream
Figure 8: Lower Creek at NC-18 Farm Road, facing upstream
Figure 9: Tributary to Lower Creek at NC-18 Farm Road, confluence
Figure 10: Tributary to Lower Creek at NC-18 Farm Road, facing upstream
Figure 11: Tributary to Zack's Fork Creek at Cottrell Hill Road bridge, facing upstream
Figure 12: Tributary to Zack's Fork Creek at Cottrell Hill Road bridge, facing downstream
Figure 13: Tributary to Zack's Fork Creek at Cottrell Hill Road bridge, facing downstream
Figure 14: Lower Creek at Rocky Road bridge, facing upstream
Figure 15: Lower Creek at Rocky Road bridge, facing downstream
Figure 16: Lower Creek (potential NCWRP project site), facing downstream
Figure 17: Lower Creek (potential NCWRP project site), facing upstream
Figure 18: Lower Creek (potential NCWRP project site), facing upstream
Figure 19: Lower Creek (potential NCWRP project site), tributary

Figure 20: Unnamed tributary to Lower Creek at Cattle farm along Jay Clark Road
Figure 21: Unnamed tributary to Lower Creek at Cattle farm along Jay Clark Road
Figure 22: Blair Fork at H. Parsons, Inc. on Valway Road, downstream
Figure 23: Husband Creek at Tree farm on Fleming Chapel Church Road, facing downstream
Figure 24: Husband Creek at Tree farm on Fleming Chapel Church Road, facing upstream
Figure 25: Unnamed tributary to Lower Creek at Middleton Place Subdivision
Figure 26: Relic Pond Site on Zack's Fork Creek, facing upstream
Figure 27: Relic Pond Site on Zack's Fork Creek, facing upstream
Figure 28: Blair Fork at Valway Road (in front of Blair Fork Baptist Church), facing downstream
Figure 29: Blair Fork at Valway Road (in front of Blair Fork Baptist Church), facing upstream
Figure 30: Zack's Fork Creek at City of Lenoir Rotary Soccer Complex
Figure 31: Zack's Fork Creek at City of Lenoir Rotary Soccer Complex, facing upstream
Figure 32: Drainage ditch that runs into Zack's Fork Creek at City of Lenoir Rotary Soccer Complex
Figure 33: Drainage ditch that runs into Zack's Fork Creek at City of Lenoir Rotary Soccer Complex
Figure 34: Unnamed tributary to Blair Fork at Indian Grave Road, facing upstream
Figure 35: Unnamed tributary to Blair Fork at Indian Grave Road, facing downstream
Figure 36: Blair Fork at Valway Road, facing upstream
Figure 37: Blair Fork at Valway Road, facing downstream
Figure 38: Greasy Creek at Abington Road bridge, facing upstream
Figure 39: Greasy Creek at Abington Road bridge, facing downstream
Figure 40: Greasy Creek at Abington Road bridge, facing downstream
Figure 41: Abingdon Creek at Deerbrook Road, facing upstream
Figure 42: Abingdon Creek at Deerbrook Road, facing downstream
Figure 43: Celia Creek at Hartland Road, facing upstream
Figure 44: Celia Creek at Hartland Road, facing downstream
Figure 45: Celia Creek at Hartland Road
Figure 46: White Mill Creek at Piney Road, facing upstream
Figure 47: White Mill Creek at Piney Road, facing downstream
Figure 48: Bristol Creek at Hartland Road, facing upstream
Figure 49: Bristol Creek at Hartland Road, facing downstream
Figure 50: Lower Creek at Antioch Road, facing upstream
Figure 51: Lower Creek at Antioch Road, facing downstream
Figure 52: Unnamed tributary to Lower Creek at Haigler Road, facing upstream
Figure 53: Unnamed tributary to Lower Creek at Haigler Road, facing downstream
Figure 54: Lower Creek at Calico Road bridge, facing upstream
Figure 55: Lower Creek at Calico Road bridge, facing downstream
Figure 56: Unnamed tributary to Lower Creek at Craigs Mountain Road, facing upstream
Figure 57: Unnamed tributary to Lower Creek at Craigs Mountain Road, facing downstream
Figure 58: Miller Creek at Miller Hill Road bridge, facing upstream
Figure 59: Miller Creek at Miller Hill Road bridge, facing downstream



NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

Initial Visual Assessment Locations

Project 6470030275 Figure B-1

LOCATION[1]	LOCATION DESCRIPTION	LATITUDE / LONGITUDE	UPSTREAM OBSERVATIONS	DOWNSTREAM OBSERVATIONS	POTENTIAL OPPORTUNITY	COMMENTS	PHOTO (Figure)
1	Lower Creek at Farm road off NC-18	35°57'47.9" N 81°26'28.7" W	active cropland within 15 feet of stream, sparse riparian vegetation, channel incision	channel incision, sparse riparian vegetation, sediment deposition from tributary	riparian buffer restoration; streambank stabilization	sandy substrate, minimal riffle habitat	7, 8, 9, 10
2	Zack's Fork Creek and Lower Creek at Lenoir Golf Club	35°54'28.3" N 81°31'42.3" W	sparse riparian vegetation; significant channel incision; in-stream sedimentation	greater riparian vegetation density near confluence; channel incision	stream restoration or enhancement; riparian buffer restoration; stormwater management	sandy substrate; potential thermal impairment	4, 5, 6
3	Lower Creek at Rocky Road bridge (potential NCWRP restoration project)	35°51'54.8" N 81°35'43.2" W	significant streambank instability and channel incision; cattle crossing underneath bridge with access to stream	significant streambank instability and channel incision	stream enhancement/ restoration; streambank stabilization; cattle exclusion and alternative water source	sedimentation; large point bars; mass wasting of streambanks	14, 15, 16, 17, 18, 19
4	Relic pond site on Zack's Fork Creek	35°56'04.5" N 81°31'26.6" W	forested riparian corridor; remnants of previous structures on floodplain	naturalized previous channel incision; urban area	stream restoration/ enhancement; sediment removal BMP	downstream city park; greenway trail along stream floodplain; potential utility conflicts	26, 27

LOCATION[1]	LOCATION DESCRIPTION	LATITUDE / LONGITUDE	UPSTREAM OBSERVATIONS	DOWNSTREAM OBSERVATIONS	POTENTIAL OPPORTUNITY	COMMENTS	PHOTO (Figure)
5	Blair Fork Creek at Valway Road (NC-90, near Blair Fork Baptist Church)	35°56'7.5" N 81°32'42.1" W	railroad ROW, roadway ROW, and utility line ROW; channel incision; Burns Oil Company; furniture and lumber companies upstream; riprap from railroad tressle	bedrock exposure; railroad ROW, roadway ROW, and utility line ROW; channel incision; crosses under SR90 and runs along Thomasville furniture plant	stream enhancement; riparian buffer restoration; potential monitoring site	potential infrastructure and utility conflicts; limited belt width; decrease in observed macobenthics compared to upstream	28, 29
6	Tributary to Zack's Fork Creek at Cottrell Hill Road bridge	35°57'16.2" N 81°30'19.1" W	obvious cattle entrance in the stream; substrate - sandy with a little silt; channel widens before bridge (due to cattle)	another cattle entrance; water clear; riffles just below bridge; channel narrows from ~20 ft to ~5 ft	cattle exclusion devices; riparian buffer restoration		11, 12, 13
7	Lenoir Rotary Soccer Complex (Zack's Fork Creek)	35°56'21.9" N 81°31'26.3" W	construction up to and potentially within channel; bank is steep and unvegetated	stream runs into forest after soccer fields; good riparian buffer; dumping dirt from construction of drainage ditch on hill above stream	riparian buffer restoration	excavating culvert along edge of soccer field; turbid release into channel	30, 31, 32, 33
8	Unnamed tributary to Blair Fork at Indian Grave Road	35°57'17.4" N 81°32'43.7" W	sandy substrate; clear water; channel width ~2.5 ft; moderate overhanging vegetation; no functional buffer on left side due to road; sand deposition	sandy with some pebbles; channel width ~4ft; no buffer on right due to road; adequate buffer on left	add sinuosity		34, 35

LOCATION[1]	LOCATION DESCRIPTION	LATITUDE / LONGITUDE	UPSTREAM OBSERVATIONS	DOWNSTREAM OBSERVATIONS	POTENTIAL OPPORTUNITY	COMMENTS	PHOTO (Figure)
9	Blair Fork at Valway Road	35°57'06.0" N 81°33'43.2" W	Thick vegetation over creek; channel ~ 2ft wide; some rocks	sediment deposit at end of large metal culvert; some riprap; right side is mowed lawn right up to the stream	contact landowners to increase buffer zone by planting and not mowing up to stream	Jones - 2185 Valway Road	36, 37
10	Greasy Creek at Abington Road bridge	35°54'20.8" N 81°33'58.8" W	sandy bottom covering some rocks near bridge; good buffer with overhanging vegetation	wider channel ~10 ft; tire in middle of channel; coarser sediment; buffer not as functional; pasture on right; few trees on left	riparian buffer restoration	small electric fence may be preventing cattle access to stream	38, 39, 40
11	Abingdon Creek at Deerbrook Road	35°54'36.8" N 81°35'51.2" W	dense vegetation; sandy substrate	rocks/riffles just past road; sandy with some pebbles; meandering; no buffer on right (yard)	contact landowner about increasing buffer		41, 42
12	unnamed tributary to Husband Creek at Country Acres Golf Course	35°53'19.4" N 81°37'17.3" W	no buffer, open through golf course; sandy bottom; channel ~5 ft.	more sandy - pebbly; small buffer for about 200 ft then open again	contact golf course to increase buffer by planting and not mowing up to stream (also check for chemicals/fertilizers in the stream)	Country Acres Golf Course (754-1992)	2, 3

LOCATION[1]	LOCATION DESCRIPTION	LATITUDE / LONGITUDE	UPSTREAM OBSERVATIONS	DOWNSTREAM OBSERVATIONS	POTENTIAL OPPORTUNITY	COMMENTS	PHOTO (Figure)
13	Celia Creek at Hartland Road	35°51'30.1" N 81°38'7.4" W	dense vegetation; fast flow; some rocks; sediment in water (not clear)	grassy island in middle - water only flowing to the right of island; sediment in water; vegetative buffer; tree farm to the left	possible water quality monitoring site	Lelia Tuttle Recreation Center (on right when looking downstream) - property of Little John Methodist Church - for info call 758-0832	43, 44, 45
14	White Mill Creek at Piney Road	35°49'45.9" N 81°40'35.8 W	Sediment buildup upstream of rock riffle (artificial?); adequate buffer - dense vegetation; clear water	sandy substrate; dense overhanging vegetation; adequate buffer; clear water	preservation		46, 47
15	Bristol Creek at Hartland Road	35°49'36.7" N 81°39'14.6" W	sandy; adequate vegetation (some trees)	better buffer - adequate vegetation; water slightly turbid; sandy	riparian buffer restoration; bank stabilization	barking dogs not tied up; adjacent properties - 2811, 2862, 2877 Hartland Rd.	48, 49
16	Lower Creek at Antioch Road	35°49'30.0" N 81°38'6.9" W	High turbidity; ~60 ft wide; stream at bankfull; unstable banks; trees on either side - adequate buffer	Turbid water; inadequate buffer on left; channel width about same	stream bank stabilization	Monte Carlo Trailer Park (minor NPDES discharger) nearby; numerous garbage trucks driving by	50, 51

LOCATION[1]	LOCATION DESCRIPTION	LATITUDE / LONGITUDE	UPSTREAM OBSERVATIONS	DOWNSTREAM OBSERVATIONS	POTENTIAL OPPORTUNITY	COMMENTS	PHOTO (Figure)
17	unnamed tributary to Lower Creek at Haigler Road	35°54'20.2" N 81°30'16.1" W	adequate vegetative buffer; undercut at pipe under road; sediment buildup on right bank; pipe crossing stream	undercut at pipe; pool with fish just after road; sediment built up just after pool; exposed rock; open pasture with minimal buffer	riparian buffer restoration; riprap to attenuatre velocity through pipe	138, 140, 141 Haigler Rd.	52, 53
18	Husband Creek at Tree farm on Fleming Chapel Church Road	35°52'30.8" N 81°37'22.8" W	stream straight (channelized?); adequate buffer on opposite bank; inadequate buffer on the farm side	same as upstream	increase sinuosity of channel		23, 24
19	unnamed tributary to Lower Creek at Cattle farm along Jay Clark Road	35°48'43.5" N 81°40'37.6 W	Active erosion channels in adjacent pasture; cattle access to a small tributary	same as upstream	cattle exclusion devices; increase vegetation on hills	possible wetland area upstream of road; kudzu on trees; 2261 Jay Clark Rd.(property across street from cattle farm)	20, 21
20	Lower Creek at Calico Road bridge	35°50'25.1" N 81°37'00.4" W	high turbidity	log in middle of channel	none	wide channel with lots of overhanging vegetation	54, 55
21	unnamed tributary to Lower Creek at Craigs Mountain Road	35°51'24.5" N 81°35'00.8" W	rocky substrate, not much sediment; adequate buffer - many old trees	right is horse field, horses do not access stream; adequate buffer - old hardwoods	increase buffer through horse pasture	2013 Craigs Mtn. Rd. (property on left upstream)	56, 57

LOCATION[1]	LOCATION DESCRIPTION	LATITUDE / LONGITUDE	UPSTREAM OBSERVATIONS	DOWNSTREAM OBSERVATIONS	POTENTIAL OPPORTUNITY	COMMENTS	PHOTO (Figure)
22	Miller Creek at Miller Hill Road bridge	35°52'59.9" N 81°34'04.1" W	PET distribution center on left with paved and gravel parking lots	factory on right (Broyhill furniture); clear water; may be channelized?; adequate buffer	possible water quality monitoring site		58, 59

[1] See Figure 1

Prepared / Date: *GKH 10/17/03*
Checked / Date:



Figure 2: Unnamed Tributary to Husband Creek at Country Acres Golf Course, facing downstream



Figure 3: Unnamed Tributary to Husband Creek at Country Acres Golf Course, facing upstream



Figure 4: Zacks Fork Creek at Lenoir Golf Club (Norwood Street)



Figure 5: Zacks Fork Creek at Lenoir Golf Club (Norwood Street)



Figure 6: Lower Creek at Lenoir Golf Club (Norwood Street)



Figure 7: Lower Creek at NC-18 Farm Road, facing downstream



Figure 8: Lower Creek at NC-18 Farm Road, facing upstream



Figure 9: Tributary to Lower Creek at NC-18 Farm Road, confluence



Figure 10: Tributary to Lower Creek at NC-18 Farm Road, facing upstream



Figure 11: Tributary to Zack's Fork Creek at Cottrell Hill Road bridge, facing upstream



Figure 12: Tributary to Zack's Fork Creek at Cottrell Hill Road bridge, facing downstream



Figure 13: Tributary to Zack's Fork Creek at Cottrell Hill Road bridge, facing downstream



Figure 14: Lower Creek at Rocky Road bridge, facing upstream



Figure 15: Lower Creek at Rocky Road bridge, facing downstream



Figure 16: Lower Creek (potential NCWRP project site), facing downstream



Figure 17: Lower Creek (potential NCWRP project site), facing upstream



Figure 18: Lower Creek (potential NCWRP project site), facing upstream



Figure 19: Lower Creek (potential NCWRP project site), tributary



Figure 20: Unnamed tributary to Lower Creek at Cattle farm along Jay Clark Road



Figure 21: Unnamed tributary to Lower Creek at Cattle farm along Jay Clark Road



Figure 22: Blair Fork at H. Parsons, Inc. on Valway Road, downstream



Figure 23: Husband Creek at Tree farm on Fleming Chapel Church Road, facing downstream



Figure 24: Husband Creek at Tree farm on Fleming Chapel Church Road, facing upstream



Figure 25: Unnamed tributary to Lower Creek at Middleton Place Subdivision



Figure 26: Relic Pond Site on Zack's Fork Creek, facing upstream



Figure 27: Relic Pond Site on Zack's Fork Creek, facing upstream



Figure 28: Blair Fork at Valway Road (in front of Blair Fork Baptist Church), facing downstream



Figure 29: Blair Fork at Valway Road (in front of Blair Fork Baptist Church), facing upstream



Figure 30: Zack's Fork Creek at City of Lenoir Rotary Soccer Complex



Figure 31: Zack's Fork Creek at City of Lenoir Rotary Soccer Complex, facing upstream



Figure 32: Drainage ditch that run into Zack's Fork Creek at City of Lenoir Rotary Soccer Complex



Figure 33: Drainage ditch that runs into Zack's Fork Creek at City of Lenoir Rotary Soccer Complex



Figure 34: Unnamed tributary to Blair Fork at Indian Grave Road, facing upstream



Figure 35: Unnamed tributary to Blair Fork at Indian Grave Road, facing downstream



Figure 36: Blair Fork at Valway Road, facing upstream



Figure 37: Blair Fork at Valway Road, facing downstream



Figure 38: Greasy Creek at Abington Road bridge, facing upstream



Figure 39: Greasy Creek at Abington Road bridge, facing downstream



Figure 40: Greasy Creek at Abington Road bridge, facing downstream



Figure 41: Abingdon Creek at Deerbrook Road, facing upstream



Figure 42: Abingdon Creek at Deerbrook Road, facing downstream



Figure 43: Celia Creek at Hartland Road, facing upstream



Figure 44: Celia Creek at Hartland Road, facing downstream



Figure 45: Celia Creek at Hartland Road



Figure 46: White Mill Creek at Piney Road, facing upstream



Figure 47: White Mill Creek at Piney Road, facing downstream



Figure 48: Bristol Creek at Hartland Road, facing upstream



Figure 49: Bristol Creek at Hartland Road, facing downstream



Figure 50: Lower Creek at Antioch Road, facing upstream



Figure 51: Lower Creek at Antioch Road, facing downstream



Figure 52: Unnamed tributary to Lower Creek at Haigler Road, facing upstream



Figure 53: Unnamed tributary to Lower Creek at Haigler Road, facing downstream



Figure 54: Lower Creek at Calico Road bridge, facing upstream



Figure 55: Lower Creek at Calico Road bridge, facing downstream



Figure 56: Unnamed tributary to Lower Creek at Craigs Mountain Road, facing upstream



Figure 57: Unnamed tributary to Lower Creek at Craigs Mountain Road, facing downstream



Figure 58: Miller Creek at Miller Hill Road bridge, facing upstream



Figure 59: Miller Creek at Miller Hill Road bridge, facing downstream

APPENDIX C

SUBWATERSHED DELINEATION

MACTEC

TECHNICAL MEMORANDUM

DATE: January 27, 2004

TO: Project File

FROM: Ben Leatherland; Greta Hawkins

THROUGH: Richard Darling

SUBJECT: Catawba River Basin Local Watershed Planning
Subwatershed Delineation

COPIES: Kristin Cozza

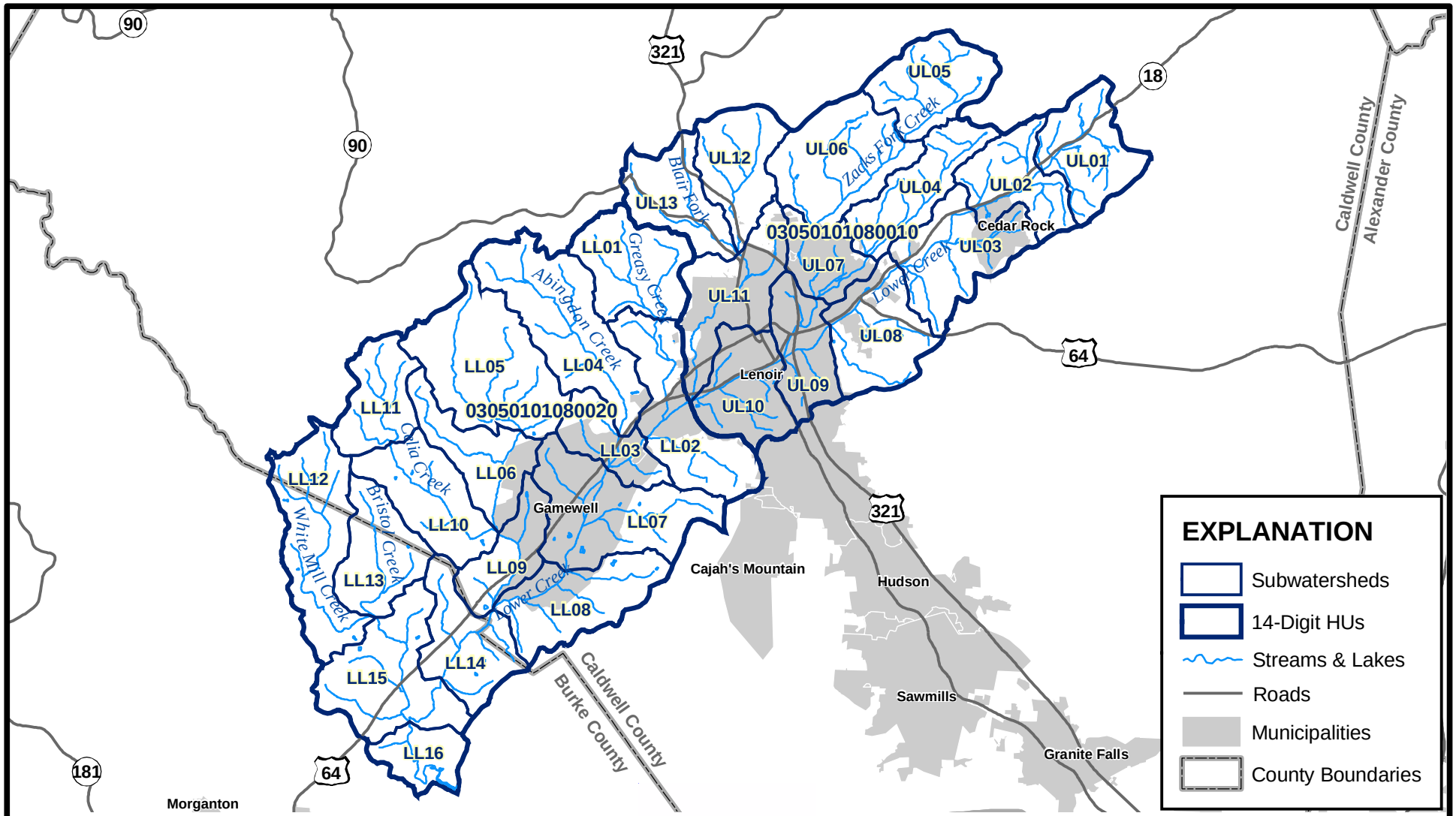
MACTEC has divided the Catawba River Cataloguing Unit 03050101 (Lower Creek Local Watershed) into 29 individual subwatersheds (Figure C-1). The local watershed includes Hydrologic Unit (HU) 03050101080010 (Upper Lower Creek) and HU 03050101080020 (Lower Lower Creek). The Lower Creek Local Watershed is approximately 62,833.1 acres in extent (approximately 98.2 square miles). The delineated subwatersheds will be used to rank and prioritize portions of the Lower Creek study area for restoration and preservation efforts. The delineated subwatersheds range in size from 1.66 square miles (LL16) to 5.67 square miles (LL05) (Table C-1). Subwatershed delineation involved creating subwatersheds for each tributary and stream segments between tributaries. Subwatersheds with similar land use were aggregated to arrive at the final 29 subwatersheds.

Table C-1: Lower Creek Subwatersheds

SUBWATERSHED	APPROXIMATE AREA (SQUARE MILES)	SUBWATERSHED	APPROXIMATE AREA (SQUARE MILES)
UL01	3.12	LL01	3.42
UL02	2.83	LL02	4.29
UL03	3.83	LL03	1.96
UL04	2.94	LL04	5.33
UL05	3.15	LL05	5.67
UL06	4.50	LL06	2.90
UL07	1.85	LL07	5.07
UL08	3.52	LL08	3.71
UL09	2.44	LL09	2.15
UL10	3.00	LL10	3.44
UL11	3.66	LL11	2.51
UL12	2.95	LL12	4.76
UL13	2.81	LL13	2.99
		LL14	3.11
		LL15	4.62
		LL16	1.66

Attachments:

Figure C-1: Sub-watershed Delineation



Data Source(s): NCCGIA

Prepared / Date:
Checked / Date:

NC Ecosystem Enhancement Program
Catawba River Basin LWP
Lower Creek Subbasin (03050101)

MACTEC

Subwatershed Designations

Project 6470030275 Figure C-1