Local Watershed Plan for the French Broad River Basin: South Hominy Creek Watershed

Technical Memorandum 3: Field Assessment and Functional Status Report

North Carolina Department of Environment and Natural Resources
Ecosystem Enhancement Program

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1 Introduction

1.1 Background

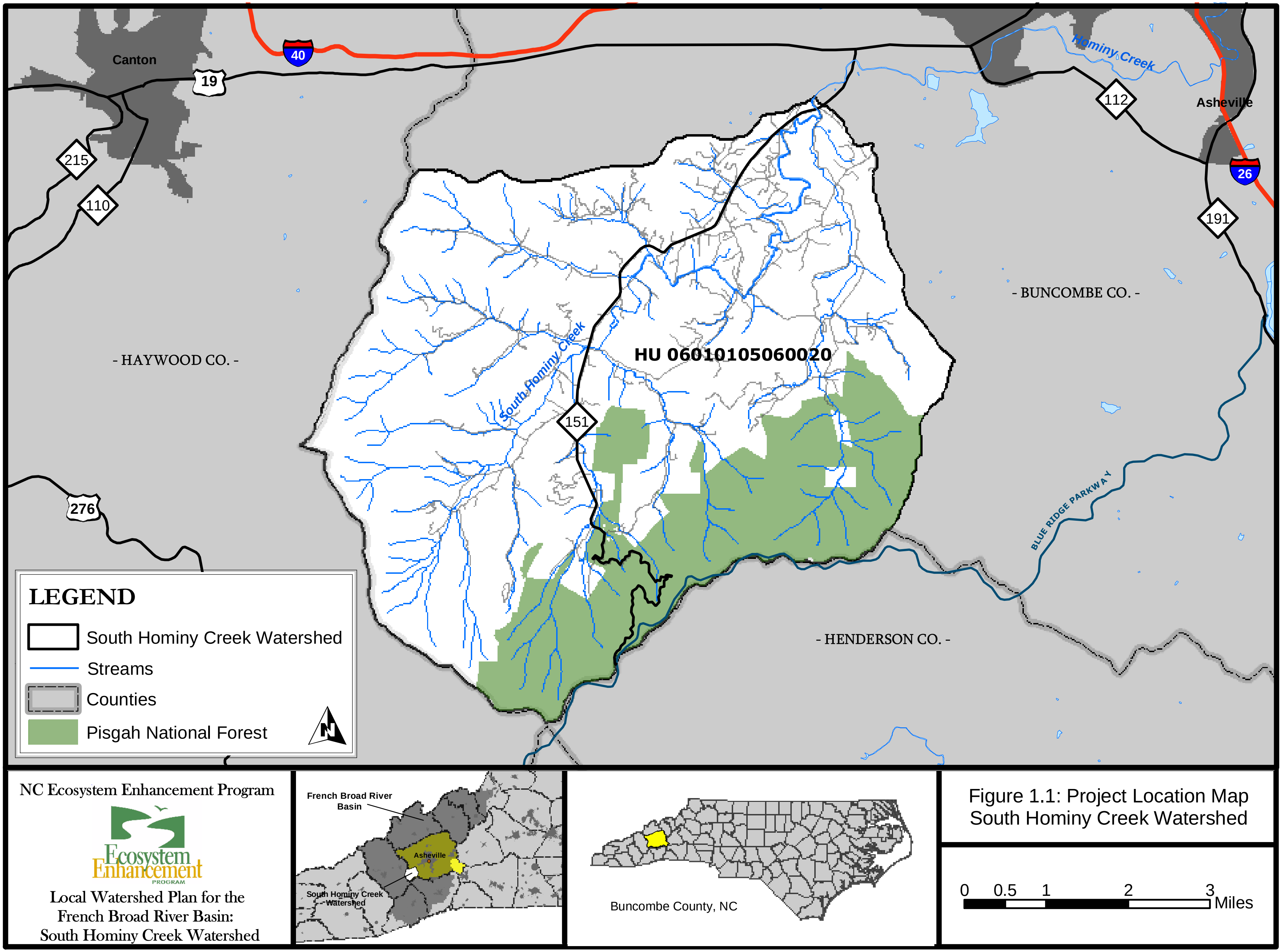
The North Carolina Division of Environment and Natural Resources (NCDENR) Ecosystem Enhancement Program (EEP) contracted with Buck Engineering to perform a technical assessment of a 14-digit hydrologic unit (HU) in the French Broad River Basin. This work is being completed as part of the Local Watershed Planning (LWP) initiative that is currently administered by the EEP. This Technical Memorandum presents a functional status overview of the HU in terms of water quality, hydrology, and habitat. It also suggests potential sources of observed degradation. The information described here will assist in identification and prioritization of watershed management strategies to address functional deficits.

The HU of interest is the South Hominy Creek Watershed, #06010105060020, which is located in the Southwest portion of Buncombe County (Figure 1.1) and has a drainage area of 38.4 square miles. The watershed includes the communities of Beaverdam, South Hominy, Stony Fork, Glady, Dunsmore, and portions of Candler. Pisgah National Forest spans the southern and southwestern periphery of the watershed and composes approximately 22.3% of the total watershed area. Major tributaries in the watersheds include: Beaverdam Creek, Stony Fork, Glady Fork, and Warren Creek.

During Phase I of the project, Buck Engineering collected and summarized existing watershed and land-use information for each of the 22 delineated sub-watersheds composing the South Hominy Watershed. This original characterization suggested that the main impacts to stream health are lack of riparian buffers, channelization, gravel road erosion, and agricultural land use. To further assess the ability of the existing watershed and channel to sustain various water quality and aquatic habitat functions, it was recommended that additional watershed data should be collected and analyzed.

The information presented in this memorandum supplements the watershed characterization that was submitted to EEP in Technical Memorandum 1. Buck Engineering conducted a detailed field assessment of watershed and riparian components in an effort to verify and quantify impacts to overall stream health in terms of hydrology and water quality, performing the following tasks:

- Analyze GIS to designate riparian assessment locations
- Collect habitat and geomorphic field data
- Analyze data to extrapolate field characteristics for all watershed locations
- Collect and review NCDWQ monitoring data
- Determine functional status of each functional assessment unit



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Local Watershed Plan for the French Broad River Basin: South Hominy Creek Watershed

Figure 1.1: Project Location Map
South Hominy Creek Watershed

1.2 Watershed Functions

The EEP works to replace functional watershed losses through stream, buffer, and wetland improvement and protection projects. In this section, the discussion focuses on the three principal watershed functions—habitat, hydrology, and water quality—which, when properly functioning, do so in a "natural" manner. Impacted systems do not provide the high level of function that is associated with natural systems. While less developed catchments are more likely to function properly, this functional assessment demonstrates that undeveloped catchments are not a requirement for achieving a functional system. Land use management also plays a role in the attainment of good watershed function.

1.2.1 Habitat Function

Habitat may be divided into aquatic and terrestrial components. Due to the regulatory emphasis placed on aquatic resources, there is typically more focus on assessing aquatic habitat. It is also the case that aquatic habitat covers a more finite area, making it easier to investigate. Additionally, because instream habitat typically reflects a more immediate response to watershed activities, it tends to represent more than just aquatic habitat. Nevertheless, a comprehensive watershed assessment requires a determination of what represents functioning habitat for both categories.

Functioning aquatic habitat provides a setting in which aquatic communities, such as fish and benthic invertebrates, can be diverse and balanced. Such communities meet the designated use of biological integrity, as determined by established metrics such as the North Carolina Biotic Index (NCDWQ, 2001), which measures pollution tolerance of organisms relative to their abundance. Good habitat in a study area has abundant and diverse microhabitat (sticks, leaf packs, logs, vegetated mats, and root masses), limited embeddedness (covering of channel by fine sediment), stable streambanks, and a variety of bottom substrate (sand, gravel, cobbles, and boulders). However, in spite of a good habitat, poor water quality due to toxicants and other pollutants might cause a degraded invertebrate community. A benthic macroinvertebrate survey often allows for the distinction between degradation due to habitat and degradation due to water quality.

For terrestrial habitat, a functioning system allows wildlife to move about more easily to find necessary resources (food, shelter, and community). Properly functioning systems in a study area have minimally fragmented native cover that promotes wildlife travel and provides resources. Another term that expresses this is connectedness, or the degree to which good habitat connects with other good habitat. Threatened and endangered species may be impacted by an abundance of invasive species and/or widespread development. For this particular project, the study of terrestrial habitat function looks at wildlife as a whole, not individual species that might inhabit a niche environment.

1.2.2 Hydrologic Function

Functioning streams effectively transport water and sediment. Good hydrologic function is most apparent in the stream channel, but it extends to the riparian and upland areas as well. A functioning stream channel typically has lower bank height ratios (vertical stability), reasonably stable streambanks (lateral stability), higher base flows, and lower peak flows than nonfunctioning stream channels. Riparian zones in catchments that display good hydrologic function promote groundwater recharge and store stormwater discharge and deposited sediment. Upland areas have higher amounts of pervious cover that encourages infiltration, as opposed to rapid runoff to stormwater conveyance systems. Infiltration provides surface water storage and delivers water to the stream channel network slowly, if at all (due to uptake by vegetation, loss to deep groundwater, and high soil field capacity).

1.2.3 Water Quality Function

Good water quality function is exemplified by lower pollutant levels that do not impair designated uses, such as biological integrity, recreation, or water supply. Practices that lead to good water quality are also considered part of a functioning system. For example, functioning riparian areas filter overland flow and are not circumvented by stormwater conveyance systems. Instream pollutant levels are a key indicator of water quality function; however, these quantities may be highly dynamic and difficult to characterize without extensive monitoring data over a full range of stream flows. An alternative to stream flow monitoring is benthic invertebrate or other biological monitoring, which provides long-term indicators of water quality. Another alternative, sediment chemistry and bioassays, also provides longer-term evidence of water quality, as many toxic pollutants adhere to fine-grained, organic-rich sediment.

Available data may be compared with state or local water quality standards to assess the frequency of exceedance, and with reference streams (which have minimal impacts) for a comparison to the high-quality end of the spectrum. A functioning stream seldom exceeds water quality standards and its pollutant levels are similar to those of reference streams. Evidence of toxicity that degrades an aquatic community is clear evidence of impaired water quality function. Water column bioassays, where test organisms are exposed to water samples, seek to measure water toxicity; however, biologic impairment due to toxicity may be difficult to monitor, though present nonetheless.

Benthic invertebrate surveys are considered to be suitable for assessing water quality function. These surveys use metrics that assess pollution tolerance and diversity of communities. The metrics are scored to arrive at a bioclassification. The temptation is to equate bioclassification with water quality function, but care must be taken because habitat is also a factor. Careful interpretation of the invertebrate survey results typically provides an indication of what roles habitat and water quality play in determining a given bioclassification.

2 Methods and Procedures

2.1 Watershed Assessment Approach

The assessment of watershed functions requires consideration of processes at both the watershed and reach-specific scales (Figure 2.1). These processes work together to influence water quality, hydrology, and instream and terrestrial habitats.

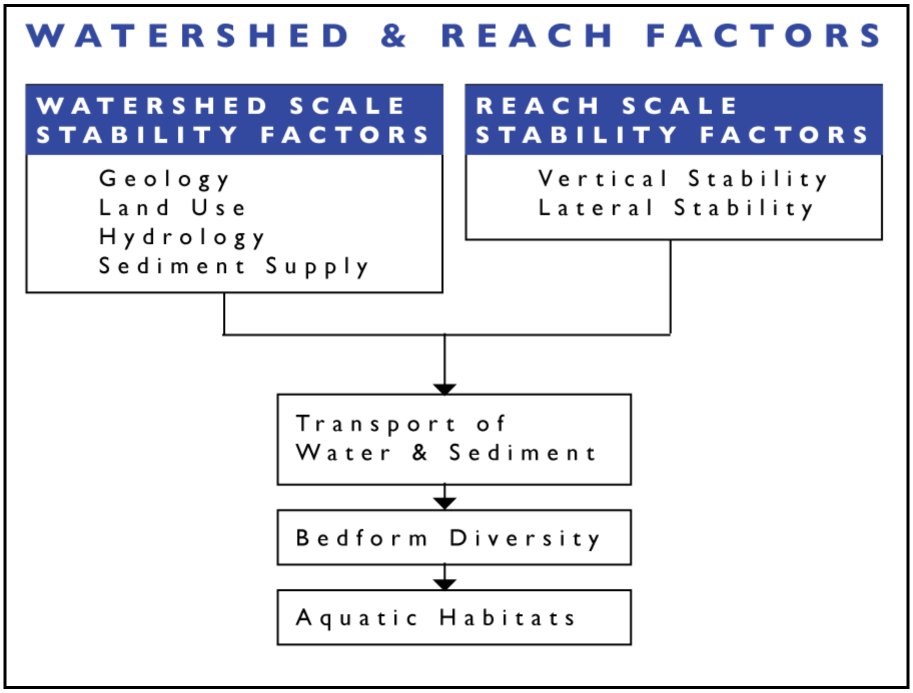


Figure 2.1 Overview of the Watershed Assessment Approach (Using Habitat and Stability as an Example)

2.1.1 Stream Functions

Reach-specific factors were the focus of field data collected for this report and included the assessment of water quality, fish and benthic macroinvertebrate populations, channel condition, streambank stability, and instream riparian habitat. Because it directly influences the function of all other factors operating at the reach scale, stream channel stability is one of the most important pieces of reach-specific data collected for this report.

A stable stream can transport the water and sediment load supplied by its watershed without significantly changing its character. Channel instability results when the balance between the transport of water and sediment from the watershed shifts, causing either excessive sedimentation (aggradation) or scouring of the channel bed (degradation). Both channel aggradation and degradation are associated with a higher potential for bank erosion. Channel instability is typically caused by disturbances affecting the entire watershed, as occurs with urbanization, which influence changes in the magnitude and frequency of stream discharge.

A stream's stability directly affects bedform diversity. Bedform adjustments such as the creation of riffles, scouring of pools, undercutting of banks, distribution of bed material, and formation of depositional bedforms occur in response to the interaction of water flow and sediment within the stream channel. Diverse bedforms, along with organic matter, are required to support a diversity of species, including fish and benthic organisms. Bedform influences the size range of interstical spaces that provide living space and cover for benthic organisms, while fish use pools and other bedform features for spawning, breeding, feeding, and growth to maturity.

2.1.2 Terrestrial Functions

Terrestrial functions are determined by processes at the watershed level, including geology, land use, soil, hydrology, infrastructure, habitat types, threatened and endangered species, and gap analysis, which were detailed in Technical Memorandum 1. Terrestrial functions evaluated in this report included bank stability, riparian buffer conditions, and the extent of wetlands. These measures address both floodplain functions (storing water and sediment, filtering pollutants) and habitat functions.

When assessing reach-specific factors, efforts were made to verify land use adjacent to riparian areas and the habitat within upland areas. Sediment supply within the watershed was also identified. Some additional watershed data was developed into GIS layers during this phase, including layers showing un-paved roads, detailed riparian buffers, wetlands, and agricultural practice.

2.2 Field Data Collection Protocol

Because all 112+ miles of perennial stream channel in the South Hominy Watershed could not be directly assessed without extraordinary effort, Buck Engineering devised a data collection and analysis protocol to perform sample assessments of specific reach types, which was then used to extrapolate the data for similar reaches throughout the watershed. At a minimum, 10% of the total stream length of each individual stream type was assessed.

2.2.1 Riparian Assessment Classifications

Using GIS, riparian corridors throughout the South Hominy watershed were remotely classified by riparian buffer, land use, and valley slope. By grouping the individual reaches based on the criteria listed in Table 2.1, a total of 17 different Riparian Assessment Classifications (RACs) were developed. Table 2.2 summarizes the 17 resulting RACs, and Figure 2.2 illustrates their spatial pattern throughout the watershed.

Table 2.1 Riparian Assessment Classification (RAC) Criteria

Map Code	Riparian Buffer Condition	Land Use	Valley Slope
A	Intact (buffer width > 30 feet on both banks)	Forested	Low Slope (< 2%)
B	Moderate Impact (buffer width < 30 feet on both banks or > 30 on one bank and absent on the other)	Forested/Agriculture	Medium Slope (2-5%)
C	Severe Impact (buffer absent on both banks or absent on one bank and buffer width < 30 feet on the other)	Forested/Agriculture/Residential	High Slope (> 5%)

Table 2.2 Summary of Riparian Assessment Classifications (RACs)

RAC	Buffer	Land Use	Valley Slope
AAA	Intact	Forested	High Slope (>5%)
AAB	Intact	Forested	Medium Slope (2 – 5%)
ABA	Intact	Forested/Agriculture	High Slope (>5%)
ABB	Intact	Forested/Agriculture	Medium Slope (2 – 5%)
ACB	Intact	Forested/Agriculture/Residential	Medium Slope (2 – 5%)
ACC	Intact	Forested/Agriculture/Residential	Low Slope (<2%)
BAA	Moderate Impact	Forested	High Slope (>5%)
BBA	Moderate Impact	Forested/Agriculture	High Slope (>5%)
BBB	Moderate Impact	Forested/Agriculture	Medium Slope (2 – 5%)
BCB	Moderate Impact	Forested/Agriculture/Residential	Medium Slope (2 – 5%)
BCC	Moderate Impact	Forested/Agriculture/Residential	Low Slope (<2%)
CBA	Severe Impact	Forested/Agriculture	High Slope (>5%)
CBB	Severe Impact	Forested/Agriculture	Medium Slope (2 – 5%)
CBC	Severe Impact	Forested/Agriculture	Low Slope (<2%)
CCA	Severe Impact	Forested/Agriculture/Residential	High Slope (>5%)
CCB	Severe Impact	Forested/Agriculture/Residential	Medium Slope (2 – 5%)
CCC	Severe Impact	Forested/Agriculture/Residential	Low Slope (<2%)

2.2.2 Riparian Assessment Classification Monitoring Sites

Representative riparian corridor monitoring sites were then selected for each of the 17 RACs. Several reaches were selected for each RAC, for a total of 52 assessment sites. These sites were carefully identified to capture the full range of watershed and local conditions of each RAC and to compose at least 10% of the total stream length per RAC. Once identified, Buck Engineering did in-field qualitative assessments at each site, monitoring habitat value, bank stability, geomorphic form, and riparian buffer. The quantitative geomorphic surveys, which measured dimension, pattern, profile, and sediment composition, were conducted at 17 monitoring sites, one per RAC. Field data was collected, post-processed, and extrapolated to the remaining stream reaches with similar RACs throughout the project watershed. Field data results occasionally varied substantially at different sites with the same RAC, but generally, the overall condition was predicted well by the RAC. We did not perform any statistical analysis on this variability. Figure 2.3 shows the RAC monitoring sites, where field data was collected and geomorphic surveys were conducted.

2.2.3 Functional Assessment Unit

To continue the analysis of the South Hominy Watershed on a more practical geographic scale, Buck Engineering divided the project boundary into six functional assessment units (FAUs): Pisgah Highlands, Lower Beaverdam, Western Highlands, Central South Hominy Valley, Lower South Hominy Valley, and Northern Coves (Figure 2.3). The divisions were based on similarity of land use, landform, and drainage area.

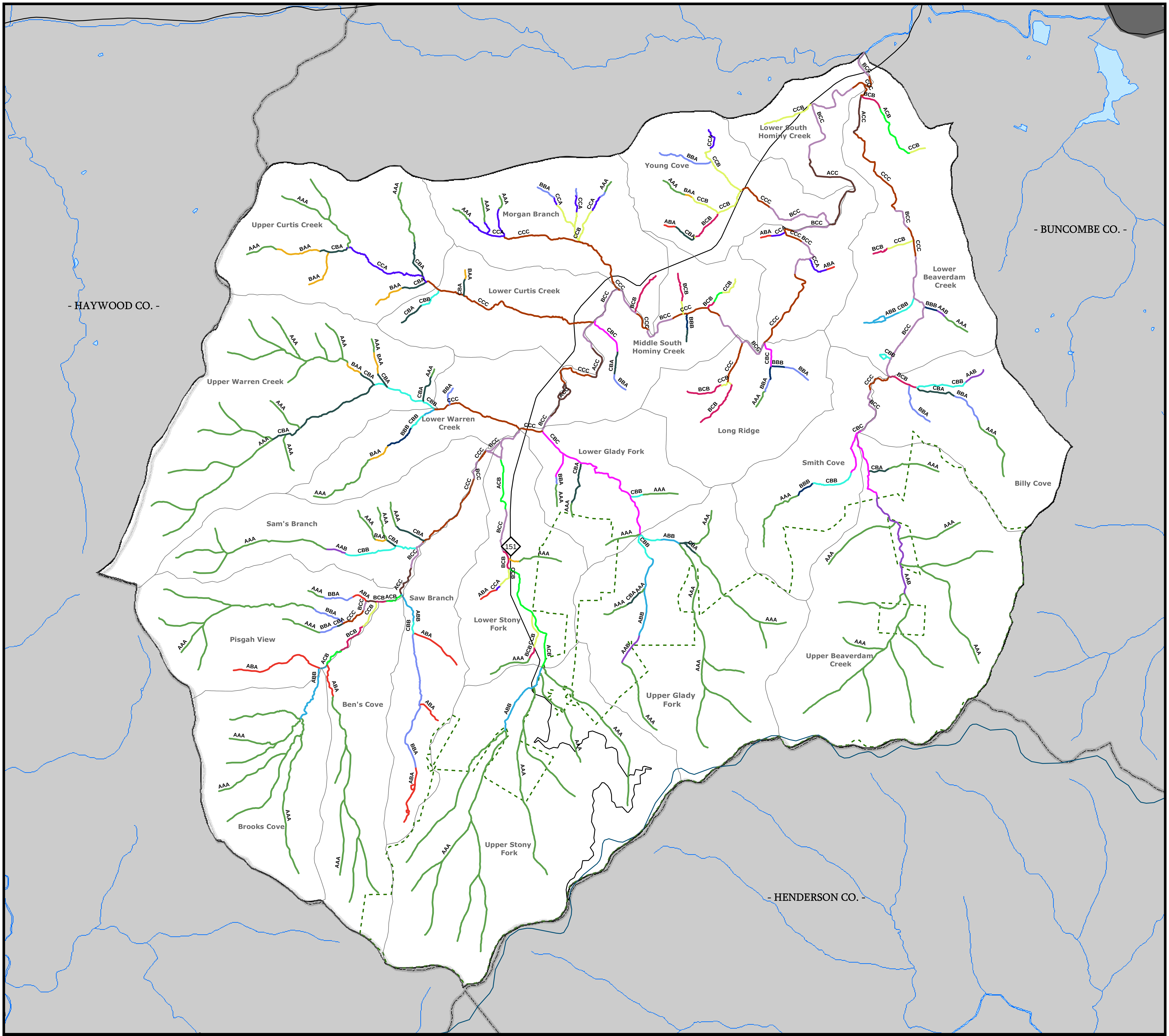
2.3 Data Collection

2.3.1 Aquatic and Terrestrial Habitat Assessment

Each study reach channel was evaluated for stream and terrestrial habitat features and habitat quality, based upon the Habitat Assessment Field Data Sheet for Mountain and Piedmont Streams from the North Carolina Division of Water Quality (NC DWQ) (see Appendix 1). Quantitative habitat scores were developed for each reach. Starting from the downstream end of each study reach, channel habitat was evaluated for channel modification, instream habitat, benthic substrate (riffle embeddedness), riffle and pool frequency, bank stability and vegetation, instream cover, and riparian buffer width. While scores are on a scale of 1 to 100, these are relative measures of stream habitat, as the protocol does not have specific rankings or classifications associated with the numerical scores. Nonetheless, these relative scores provide a basis for comparing habitat quality at different sites within the watershed, and they establish a baseline number to which future habitat conditions may be compared.

2.3.2 Channel Stability Evaluation

Channel Evaluation Forms were filled out, characterizing habitat, buffer health, geomorphic stability, anthropogenic impacts, and constraints to performing work (see Appendix 1). Scores from 0 to 4 were assigned for measurable features such as bedform diversity, bank stability, and severity of constraints. Using a similar 0 to 4 scale, field crews also qualitatively assessed reaches in terms of restoration, enhancement, and preservation suitability, with 0 being poor and 4 being excellent. Summary data derived from the Channel Evaluation Forms for each of the 52 RAC assessment sites is included in Appendix 1. Photos were taken at each of the 52 RAC assessment sites and a photo log is included in Appendix 3.



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LEGEND

RAC Designations

AAA	ACC	CBA
AAB	BAA	CBB
ABA	BBA	CBC
ABB	BBB	CCA
ACB	BCB	CCB
	BCC	CCC

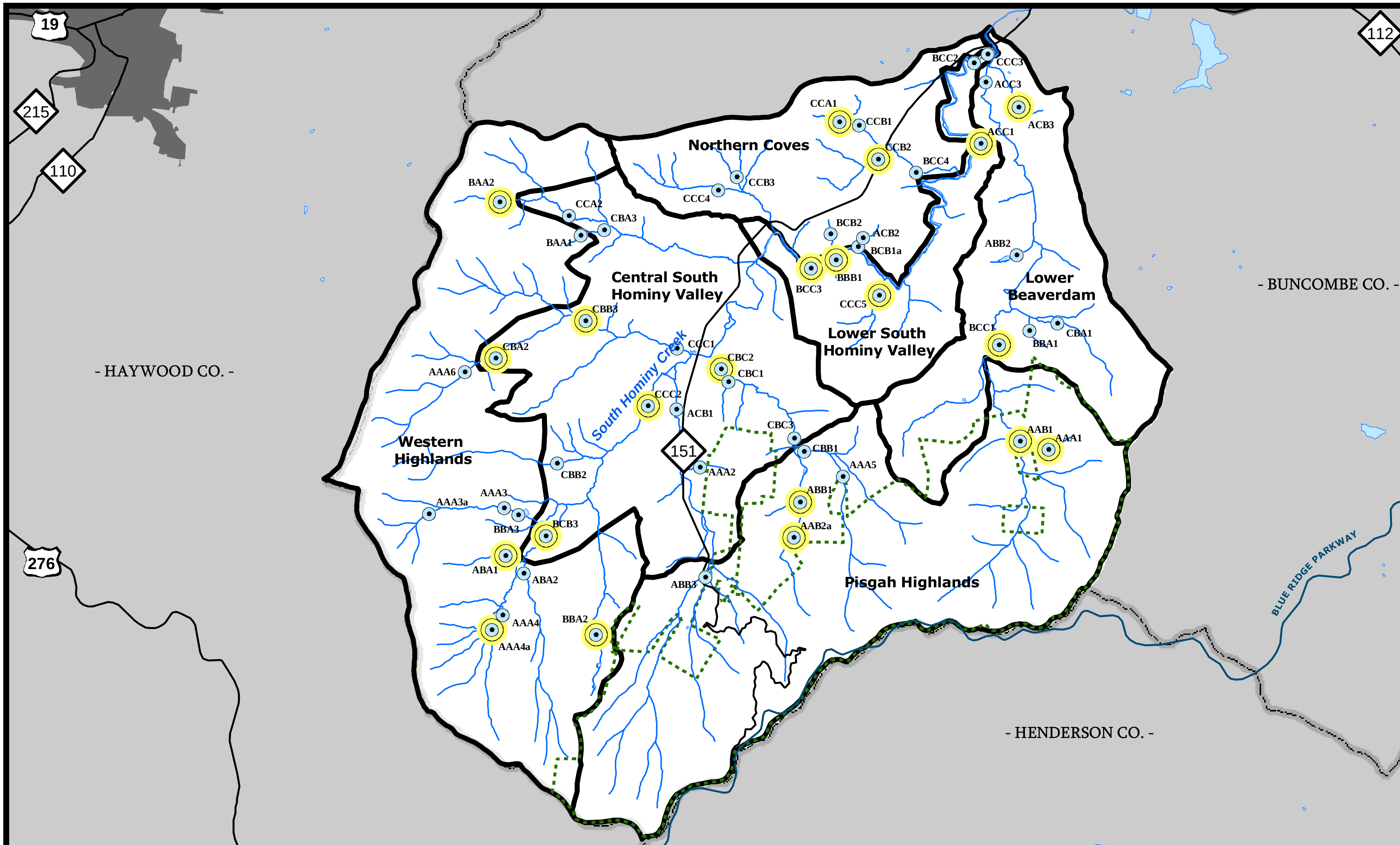
Sub-Watersheds

Pisgah National Forest

Counties

Figure 2.2: Riparian Assessment Classifications (RACs)

0 0.25 0.5 1 Miles



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LEGEND

- RAC Monitoring Sites
- RAC Geomorphic Survey Sites
- FAUs (Functional Assessment Units)
- Pisgah National Forest
- Counties
- Streams

N

Figure 2.3: Riparian Assessment Classification (RAC) Monitoring Sites

0 0.5 1 2 Miles

2.3.3 Geomorphic Surveys and Sediment Analysis

Longitudinal profiles were established for at least one site per RAC, using methods set forth in Harrelson (1994), but, due to the large number of RACs with designations AAA, AAB, BCC, and CCC, two longitudinal profiles were established at these RAC monitoring sites. The longitudinal profile surveys collected data for thalweg, water surface, bankfull indicators, and top of bank along the reach. For each longitudinal profile reach, cross sections that were determined to be representative of typical reach conditions were surveyed. One pool and two riffle cross sections (three total cross sections) were established at each longitudinal profile reach (see Appendix 2). The permanent cross sections were surveyed in conformance with standards set forth in Harrelson (1994).

Pavement and sub-pavement samples were collected at each riffle cross section. Samples were collected using methods described by Jessup (2002). The pavement/subpavement samples were returned to the Buck Engineering soils lab, sieved, and a grain size distribution developed. Using these samples, the critical depth for particle sediment transport for the study reaches was calculated and combined with the longitudinal profiles to perform an aggradation/degradation analysis on the study reaches.

2.3.4 Bank Erosion Hazard Index (BEHI)

Lateral streambank stability is an indicator of the sediment supplied to the stream due to bank erosion. The potential lateral erosion was determined in the field by measuring the Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) (Rosgen, 2001) throughout each study reach. For this project, BEHI results for individual study sites were assessed to determine an overall rating for the corresponding RAC.

2.3.5 Riparian Buffer and Wetland Extents and Conditions

Buffer conditions within 100 feet of all blue line streams (as shown on a US Geological Survey 7.5 minute quadrangle map) were estimated, using GIS resources, then enhanced with specific field data collected at each study site.

Buck Engineering did some ground-truthing for areas where mapped National Wetlands Inventory (NWI) wetlands were present, comparing observed wetland conditions to the NWI map data, then producing a wetlands GIS layer for analysis. Existing wetlands adjacent to study sites were also identified and incorporated into the wetlands GIS layer. Where the presence of wetlands was observed, additional habitat, hydrologic and water quality function was considered in the functional determination process.

Riparian areas adjacent to each RAC monitoring site were walked to determine the width and condition of any stream buffer (intact, stressed, or sensitive), identify adjacent land use/land cover, and document riparian conditions. The width of existing buffers was noted and photographs were taken of the immediate riparian zone. Riparian vegetation was described in terms of species composition, dominant species per stratum layer (canopy, understory/shrub, vine, herbaceous), and age-class distribution (seedlings, saplings, mature). Results of buffer conditions were mapped, compared to GIS-generated estimates, and combined into a single, revised GIS riparian buffer layer.

2.3.6 Other Data Sources

Terrestrial habitat was assessed on a watershed scale, involving upland areas, using a combination of GIS data, aerial reconnaissance, and windshield surveys. By evaluating GIS data layers, Buck Engineering located potential high-quality habitat sites such as seep/bog wetlands, cave habitat, and large-tract, high-elevation forests. These sites were evaluated to determine the feasibility of preservation or enhancement opportunities. During windshield surveys to verify RAC designations throughout the watershed, a handheld GPS unit was used to locate gravel roads and various agricultural sites, which were subsequently mapped in GIS.

2.4 Incorporation of Data from NC DWQ

To assess water quality in the South Hominy watershed, Buck Engineering merged NC DWQ monitoring data for fish, water quality, and macroinvertebrates with data sets generated from GIS and field-collected data. Reports summarizing the monitoring data from NC DWQ can be found in Appendix 4.

2.5 Determination of Functionality

To complete a functional assessment of habitat, hydrology, and water quality in the project area, Buck Engineering employed a “strength of evidence” approach (USEPA, 1998; USEPA, 2000). This approach uses the logical evaluation of various types (lines) of evidence to assess the strengths and weaknesses of that evidence in order to determine which of the options being assessed has the highest degree of support.

For each of the three watershed functions in each FAU, Buck Engineering applied ratings of *Functioning*, *Functioning at Risk,* or *Not Functioning*. These ratings are based on several distinct metrics per watershed function using a “strength of evidence” approach. Each metric received a rating of various levels of *Functioning*, *Functioning at Risk*, or *Not Functioning* and these were considered in the determination of the overall rating. The metrics, and data on which they are based, are considered “lines of evidence.”

Buck Engineering considered all lines of evidence developed during the course of the study, using a process that incorporated existing scientific knowledge and expert professional judgment. Lines of evidence (metrics) considered for habitat function were field assessment (using NCDENR DWQ Habitat Assessment Field Data Sheet for Mountain and Piedmont Streams), land use, riparian corridor condition, and substrate analysis. Lines of evidence considered for hydrologic function were bank height ratio, width/depth ratio, channel incision, riparian corridor condition, Bank Erosion Hazard Index or BEHI (Rosgen, 2001), degree of erosion, and land use. Last, the lines of evidence water quality function were water quality and benthic/fish monitoring data from NC DWQ, riparian corridor condition, BEHI, degree of erosion, and land use. See Figure 2.4 for a flow diagram that outlines the metrics that determined each function. Appendix 5 summarizes the metric value ranges used as a guide in the determination of functional ratings per RAC.

The endpoint of this process is the determination of the level of function for each FAU. Levels of function are described as follows:

Functioning - existing watershed conditions are functioning "naturally" and have not been significantly impacted. If several sites within an FAU were assessed, an attempt was made to broadly characterize function by considering all sites. Minor degradation at a particular site was overlooked if evidence suggested that impacts did not extend beyond its local area.

Functioning at Risk - existing watershed conditions, while still functioning, are moderately degraded and at risk of a *Not Functioning* rating if further impacted. This designation for an FAU might be assigned for several reasons: there may have been a local impact that extended slightly to other areas of an FAU; there may have been a more widespread problem that did not hinder function significantly; or, land use or channel conditions in an FAU had recently and dramatically changed, but the impacts had not yet been assessed. Planned alterations or other potential impacts beyond the immediate future were not sufficient reason to designate an FAU at risk.

Not Functioning - existing watershed conditions are highly degraded and/or no longer support the natural ecosystem. Earning this rating were sites with noteworthy functional failure.

South Hominy Creek Watershed

Functional Assessment

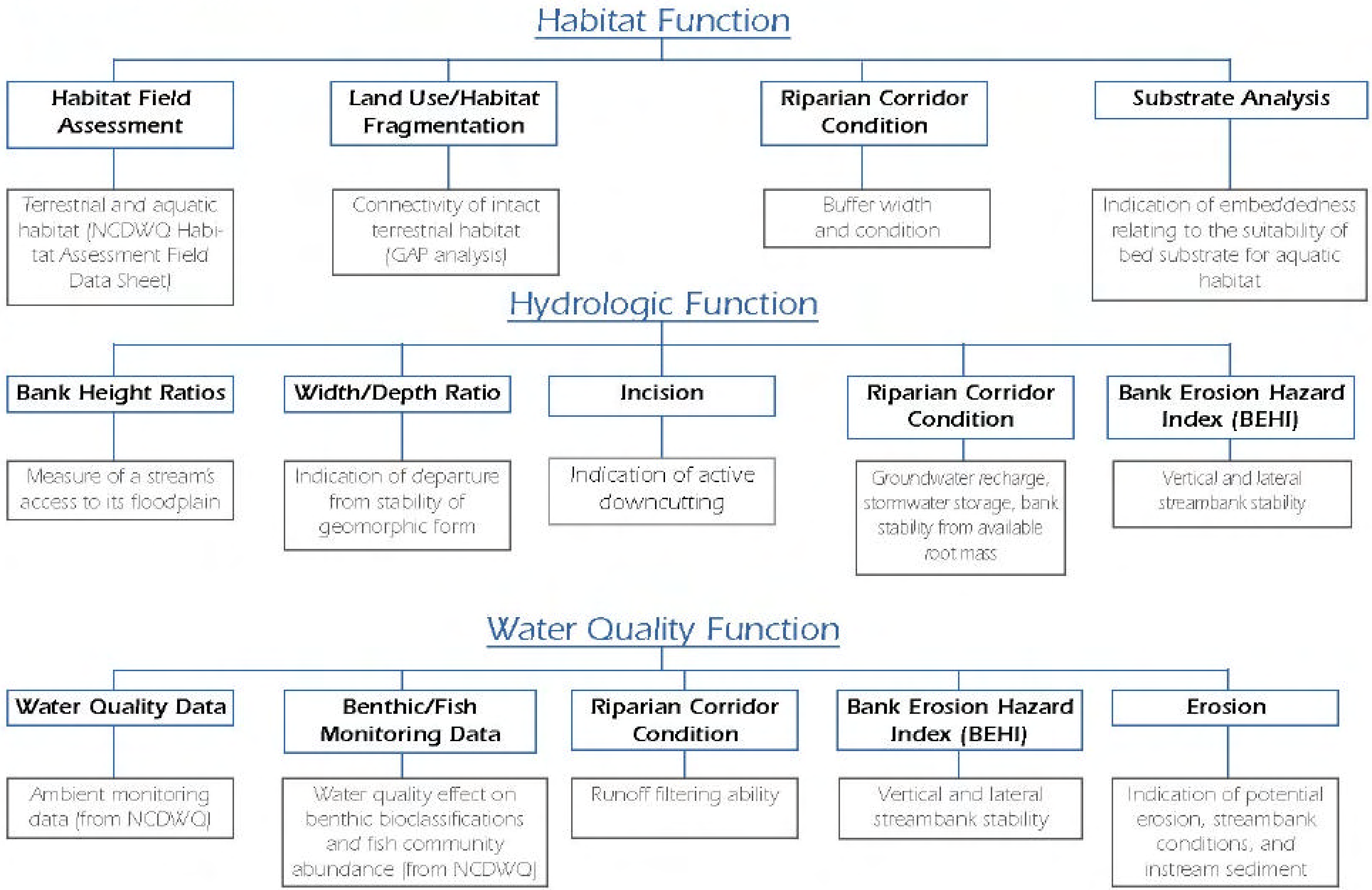


Figure 2.4 Metrics Used to Determine Watershed Functions

3 Functional Watershed Assessment Results

Buck Engineering assessed habitat, hydrology, and water quality in each of the six FAUs. The following sections present background and summary results for each overall function.

3.1 Habitat Function Assessment

Buck Engineering assessed habitat function in each of the six FAUs using four metrics: habitat fragmentation, field assessment using the NCDENR DWQ Habitat Assessment for Piedmont and Mountain Streams, riparian corridor condition and substrate analysis (pebble counts). The individual metrics were used to assign a function rating of Functioning (F), Functioning at Risk (FR), or Not Functioning (NF) for the 17 different RAC designations. This information was then applied to each of the FAUs, based on the percent stream length of each type of RAC. Table 3.1 and Figure 3.1A summarize the function ratings for each metric and provide an overall habitat function rating for each FAU. Figure 3.1B provides a larger scale illustration revealing spatial trends of functional deficiencies for habitat at the riparian corridor level per FAU.

Table 3.1 Overall Habitat Function by FAU

Functional Assessment Unit	Habitat Field Assessment	Habitat Fragmentation	Riparian Corridor Condition	Substrate Analysis	Overall
Pisgah Highlands	F	F	F	FR+	F
Western Highlands	F	F	F	FR+	F
Lower South Hominy Valley	FR	FR-	FR	F	FR
Lower Beaverdam	FR	FR	FR	F	FR
Central South Hominy Valley	FR	FR	FR-	F-	FR
Northern Coves	FR-	FR-	FR-	F-	FR
Note: *F = Functioning, FR = Functioning at Risk, NF = Not Functioning*					

The following sections present background and summary results for the habitat function of each FAU. Potential sources of observed degradation are also cited.

3.1.1 Pisgah Highlands FAU

Habitat field assessment, habitat fragmentation, and riparian corridor condition are all considered *Functioning* within the Pisgah Highlands FAU. Substrate is considered to be high-level *Functioning at Risk*, due to the amount of fine sediment sampled in representative RACs. Overall, the Pisgah Highlands FAU is considered *Functioning* for habitat.

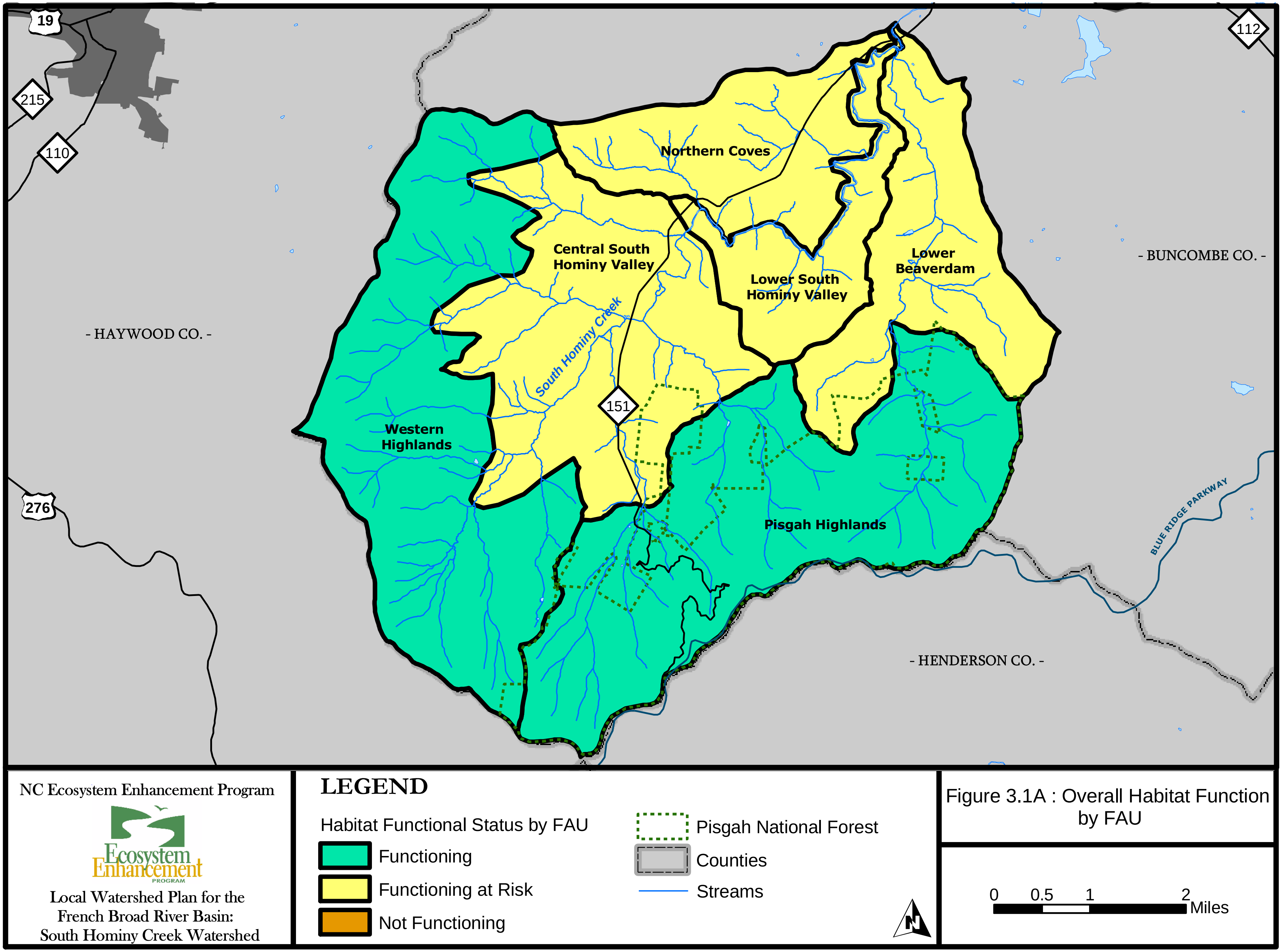
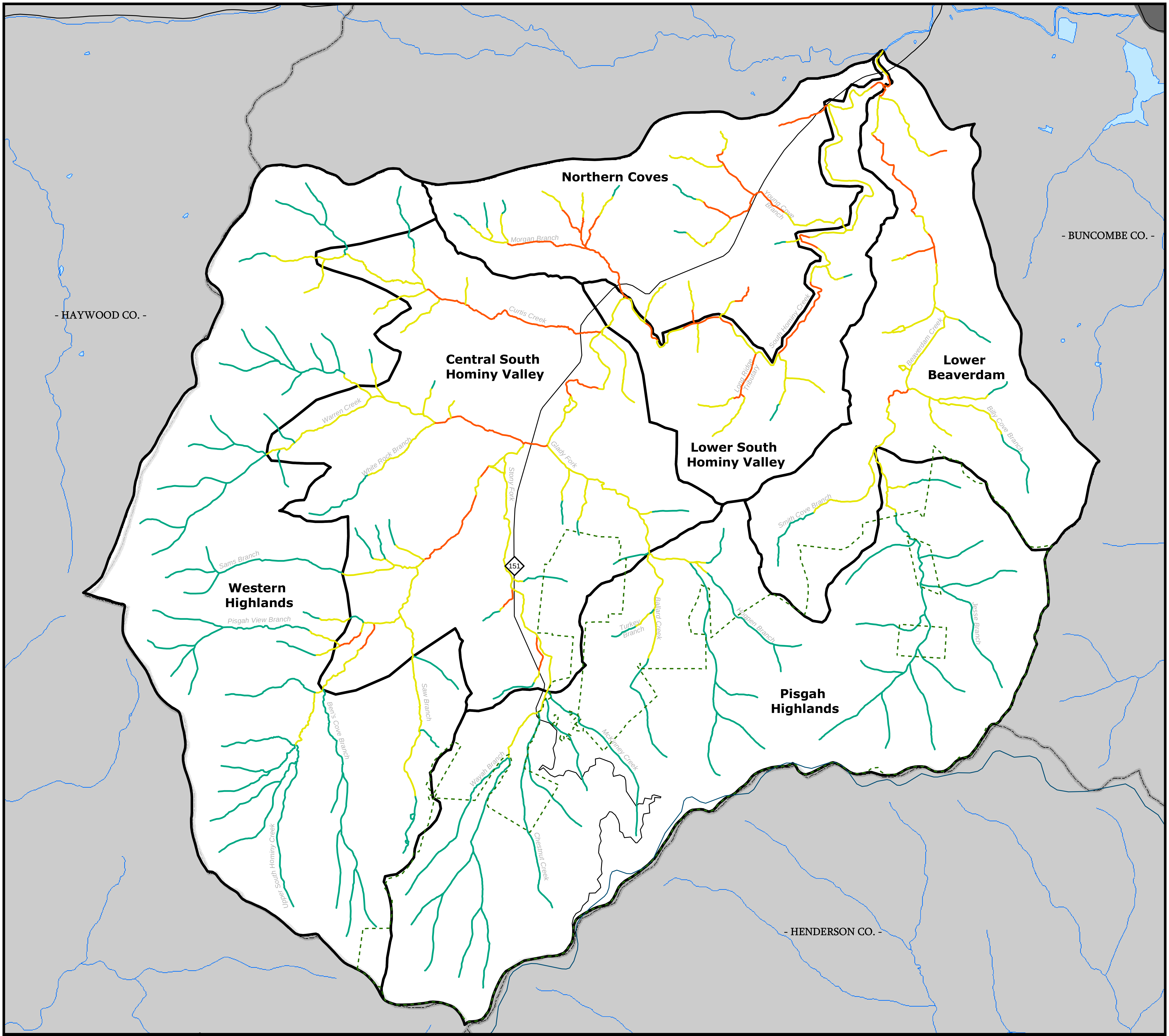


Figure 3.1A : Overall Habitat Function by FAU



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LEGEND

RAC Habitat Condition

- Functioning
- Functioning at Risk
- Not Functioning

- Functional Assessment Units
- Pisgah National Forest
- Counties

Figure 3.1B: Overall Habitat Function by RAC

0 0.25 0.5 1 Miles

Source of Degradation –

The primary cause of degradation in this FAU is sediment, probably from unpaved forest roads and localized landslides within the headwaters of heavy precipitation events associated with Hurricanes Ivan and Frances in the fall of 2004. Braided and active overflow channels were observed along portions of several reaches, indicating large sediment loads transported from the headwaters by higher-magnitude storm flows. Because they are in colluvial valleys, these steep-gradient, high-energy streams tend to transport large amounts sediment downstream over time.

3.1.2 Western Highlands FAU

Habitat field assessment, habitat fragmentation, and riparian corridor condition are all considered *Functioning* within the Western Highlands FAU. Due to the amount of finer sediments in the headwaters, 77% of the streams in the unit are classified as high-level *Functioning at Risk* for substrate analysis. No *Not Functioning* stream reaches were identified in this FAU for any of the four metrics. Overall, the Western Highlands FAU is considered *Functioning* for habitat.

Source of Degradation –

The primary cause of degradation in this FAU is sediment, probably from unpaved forest roads and localized landslides within the headwaters of heavy precipitation events associated with Hurricanes Ivan and Frances in the fall of 2004. Other probable sources of sediment entering the channel are unpaved roads and sporadic clear cuts associated with residential land development within Upper Curtis Creek and Upper Warren Creek sub-watersheds. Localized streambank erosion is a significant contributor of instream sediment supply where riparian buffers are minimal or impacted from road encroachments and homeowners. Because they are in colluvial valleys, these steep-gradient, high-energy streams tend to transport large amounts sediment downstream over time.

3.1.3 Lower South Hominy Valley FAU

Substrate is the only metric categorized as *Functioning* in the Lower South Hominy FAU. Habitat field assessment and riparian corridor conditions are considered *Functioning at Risk*. With 25% of the stream reaches within this FAU identified as *Not Functioning* for habitat fragmentation, this metric is considered to be a low-level *Functioning at Risk.* Overall, with 71% of the streams within the Lower South Hominy Valley FAU considered *Functioning at Risk*, the FAU designation for habitat is *Functioning at Risk.*

Source of Degradation –

The primary causes of functional loss in this FAU are increased habitat fragmentation and reduction in buffer widths, which are likely responses to increased development and agricultural encroachment in the watershed. Other causes of habitat degradation are moderate stream bank erosion, past channelization, and lack of substantial pool development.

3.1.4 Lower Beaverdam FAU

Substrate is the only metric considered *Functioning* in the Lower Beaverdam FAU. Habitat field assessment, habitat fragmentation, and riparian corridor condition are all considered *Functioning at Risk*. Overall, within this FAU, 65% of the streams have RAC designations of *Functioning at Risk*; therefore the Lower Beaverdam FAU is considered *Functioning at Risk* for habitat.

Source of Degradation –

With 38% of the streams within this FAU considered *Not Functioning* for riparian corridor condition, reduction in buffer widths has had the greatest impact on functional loss of habitat in this FAU. Other sources of habitat degradation are moderate stream bank erosion, past channelization, and lack of substantial pool development.

3.1.5 Central South Hominy Valley FAU

Substrate is the only metric considered *Functioning* in the Central South Hominy Valley FAU. Habitat field assessment, habitat fragmentation, and riparian corridor condition are considered *Functioning at Risk.* Overall, within this FAU, 64% of the streams have RAC designations of *Functioning at Risk*; therefore overall the Central South Hominy Valley FAU is considered *Functioning at Risk* for habitat.

Source of Degradation –

With 53% of the streams within this FAU considered *Not Functioning* for riparian corridor condition, reduction in buffer widths has had the greatest impact on functional loss of habitat in this FAU. This is partially due to drainages from several sub-watersheds converging with South Hominy Creek, forming the major agricultural valley in the watershed. Also, because this FAU is intersected by many of the major thoroughfares in the watershed, buffers and instream shading tend to be minimal along these corridors. Other sources of habitat degradation are moderate stream bank erosion, past channelization, and lack of substantial pool development.

3.1.6 Northern Coves FAU

Substrate was the only metric considered *Functioning* in the Northern Coves FAU. Habitat field assessment, habitat fragmentation, and riparian corridor condition are considered a low-level *Functioning at Risk*. Overall, within this FAU, 44% of the streams have RAC designation of *Not Functioning*, 45% of the streams have RAC designations of *Functioning at Risk* and 11% have RAC designations of *Functioning*; therefore, the Northern Coves FAU is considered *Functioning at Risk* for habitat. The Northern Coves FAU is the lowest *Functioning* FAU in the watershed for habitat.

Source of Degradation –

Functional loss of habitat within this FAU is attributable to 62% of the streams within this FAU considered *Not Functioning* for riparian corridor condition, 45% considered *Not Functioning* for field assessment, and 29% considered *Not Functioning* for habitat fragmentation. These three *Not Functioning* factors are most likely due to increased residential development, channelization and reduction in buffer widths.

3.2 Hydrologic Function Assessment

Buck Engineering assessed hydrologic function in each of the six FAUs, using eight metrics: bank height ratio, width/depth ratio, degree of incision, riparian corridor condition, BEHI, degree of erosion, land use, and sediment transport. The individual metrics were used to assign a function rating of Functioning (F), Functioning at Risk (FR), or Not Functioning (NF) for the 17 different RAC classifications. This information was then applied to each of the FAUs based on the percent stream length of each type of RAC. Table 3.2 and Figure 3.2A summarize the function ratings for each metric and provide an overall hydrologic function rating for each FAU. Figure 3.2B provides a larger scale illustration, showing spatial trends for hydrologic functional deficiencies at the riparian corridor level at each FAU.

Table 3.2 Overall Hydrologic Function by FAU

Functional Assessment Unit	Bank Height Ratio	Width / Depth Ratio	Incision	Riparian Corridor Condition	BEHI	Erosion	Land Use	Sediment Transport	Overall
Pisgah Highlands	F	FR+	F	F	F	F	F	NA	F
Western Highlands	F-	FR+	F	F	F	F-	F-	NA	F
Lower South Hominy Valley	FR	FR+	FR	FR	FR+	FR	NF	FR	FR
Lower Beaverdam	FR	FR+	FR+	FR	F-	FR	FR-	FR	FR
Central South Hominy Valley	FR	F-	FR+	FR-	F-	FR	FR-	FR	FR
Northern Coves	FR	F-	FR+	FR-	F-	FR	NF+	FR-	FR

Note:
F = Functioning, FR = Functioning at Risk, NF = Not Functioning, NA=Not Applicable

The majority of the RACs within the South Hominy Creek watershed are marginally stable to moderately unstable in terms of hydrologic function with the exception of the AAA RAC types. The AAA RAC types are generally concentrated within the Pisgah Highlands and Western Highlands FAUs and are largely stable. Bank height ratios are moderate to high throughout the watershed and typically range between 1.5 and 2.0. Channel incision has halted in many streams as a result of ample grade control in the form of bedrock, boulders, and large woody debris. A few of these RACs types have already begun to stabilize laterally as indicated by the development of lower elevation flood benches within the over-widened, incised channel.

Active headcuts were observed, but primarily within those RACs that transition between the steeper headwater streams and those within the lower valley that have flatter slopes.

These headcuts tend to be contained at knick points that prevent upstream migration thereby limiting channel instability to localized areas.

Bank erosion appears to be the most widespread cause of channel instability throughout all RACs. This is predictable given widespread channel incision and higher magnitude flows occurring recently in association with Hurricanes Ivan and Francis. BEHI estimates suggest that bank erosion was generally more severe in RACs having impacted buffers. BEHI estimated an average erosion rate over 30% higher for RACs with impacted buffers versus those with intact buffers. BEHI estimates also suggest that bank erosion was more severe in drainages of more than one square mile.

The following sections present background and summary results for the assessment of hydrology function at each FAU. Potential sources of observed degradation are also included.

3.2.1 Pisgah Highlands FAU

Width/depth ratio is considered to be a high-level *Functioning at Risk*, while the remaining seven metrics are considered *Functioning* in this FAU. Overall, the Pisgah Highlands FAU is considered *Functioning* for hydrology.

<u>Source of Degradation –</u>

Loss of hydrologic function is minimal in this FAU, but there are segments where erosion and instream sediment are having a negative impact on the streams in the area. Because they are in colluvial valleys, these steep-gradient, high-energy streams tend to transport large amounts sediment downstream over time.

3.2.2 Western Highlands FAU

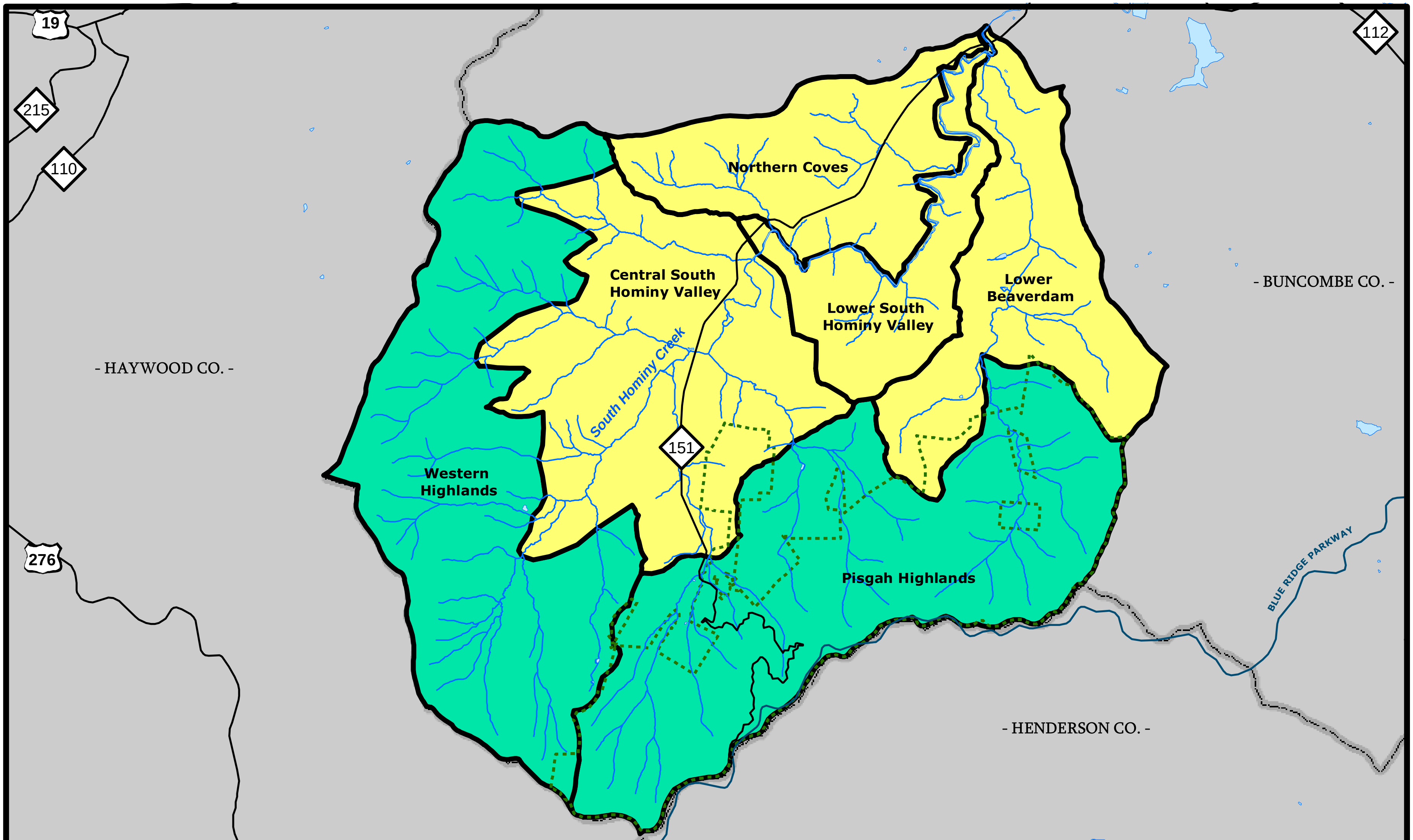
Bank Erosion Hazard Index (BEHI), level of incision, and riparian corridor condition are considered *Functioning* in the Western Highlands FAU. Bank height ratio, level of erosion and land use are determined to be low-level *Functioning* while the width/depth ratio is a high-level *Functioning at Risk*. Overall, with 82% of the streams in the FAU having RAC designations of *Functioning*, the Western Highlands FAU is considered *Functioning* for hydrology.

<u>Source of Degradation –</u>

Loss of hydrologic function is minimal in this FAU, but there are segments where erosion is having a negative impact on the streams in the area. Because they are in colluvial valleys, these steep-gradient, high-energy streams tend to transport large amounts sediment downstream over time.

3.2.3 Lower South Hominy Valley FAU

Land use is categorized as *Not Functioning* in the Lower South Hominy FAU. The other seven metrics are considered *Functioning at Risk*. Taking all eight metrics into consideration, the Lower South Hominy Valley FAU hydrology rating is *Functioning at Risk*.



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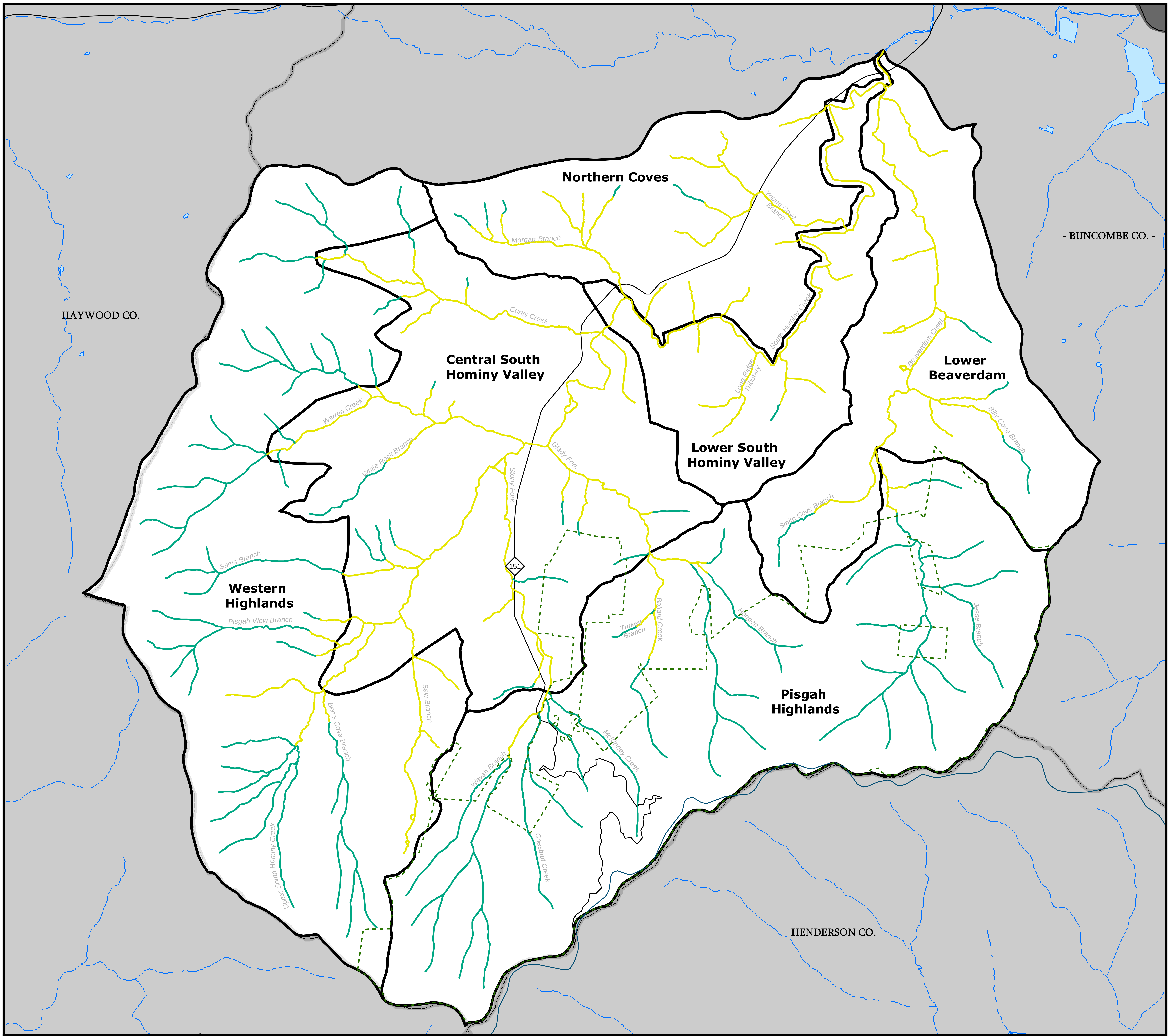
Hydrology Functional Status by FAU

- Functioning
- Functioning at Risk
- Not Functioning
- Pisgah National Forest
- Counties
- Streams

N

Figure 3.2A : Overall Hydrology Function by FAU

0 0.5 1 2 Miles



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LEGEND

RAC Hydrologic Condition

- Functioning
- Functioning at Risk

- Functional Assessment Units
- Pisgah National Forest
- Counties

N

Figure 3.2B: Overall Hydrologic Function by RAC

0 0.25 0.5 1 Miles

Source of Degradation –

The primary cause of loss of hydrologic function within this FAU is changes in land use, with 86% of the streams categorized as *Not Functioning* for land use, based on their RAC determination. Increased residential development and agriculture (at the downstream portion of the Lower South Hominy Valley FAU) tend to convey storm runoff to stream channels more rapidly due to the low infiltration rates and exposed catchment surfaces. Almost 32% of streams within this FAU also have severely impacted buffers along the mainstem of South Hominy Creek, which are generally associated with the encroachment of agriculture upon riparian corridors. Impacted buffers and increased runoff from more impervious land uses are the most probable factors influencing the loss of function at the stream channel scale and are threatening geomorphic stability within this FAU.

3.2.4 Lower Beaverdam FAU

Within this FAU, 98% of the streams had RAC designations of *Functioning at Risk*, giving the Lower Beaverdam FAU an overall *Functioning at Risk* hydrology rating.

Source of Degradation –

The Lower Beaverdam FAU hydrology functions similarly to that of the Lower South Hominy Valley FAU. Both have similar proportions of stream reaches with severely impacted buffers, moderate erosion potential, and threatened geomorphic stability, but the Lower Beaverdam FAU has slightly less residential development and a larger percentage of agricultural land use. More importantly, the Lower Beaverdam FAU has a larger proportion of forested land within its headwaters, which allows for more infiltration of precipitation and a longer basin lag time. With all other variables being equal at the two FAUs, the less flashy storm runoff regime at the Lower Beaverdam FAU translates into a lower potential for bank erosion (BEHI).

3.2.5 Central South Hominy Valley FAU

Width to depth ratio and BEHI are considered low-level *Functioning* in the Central South Hominy Valley FAU. The remaining metrics are all determined to be *Functioning at Risk*. Overall, the Central South Hominy Valley FAU is considered *Functioning at Risk* for hydrology.

Source of Degradation –

Hydrologic function is fairly uniform across the Central South Hominy Valley FAU and the Lower Beaverdam FAU. However, approximately 50% of the streams within the Central South Hominy Valley FAU have severely impacted buffers, as compared to 37% in the Lower Beaverdam FAU. The difference is primarily due to major thoroughfares near riparian buffers throughout the Central South Hominy Valley FAU. Longer basin lag times within the Central South Hominy Valley FAU are due to larger drainage areas and the larger composition of forested lands within the headwaters (originating from the Pisgah and Western Highlands FAUs), which are associated with receiving streams that drain into South Hominy Creek. Groundwater recharge and stormwater storage are also facilitated by several wetlands concentrated within Lower Glady Fork and Lower Stony Fork sub-watersheds, which comprise about 97% of the wetlands within the entire South Hominy watershed.

3.2.6 Northern Coves FAU

Width/depth ratio and BEHI are categorized at a low level of *Functioning* in the Northern Coves FAU. Bank height ratio, levels of incision, and erosion are considered *Functioning at Risk*. The FAU is determined to be *Not Functioning* for land use. Overall, the Northern Coves FAU is considered *Functioning at Risk* for hydrology.

<u>Source of Degradation –</u>

The primary cause of loss of hydrologic function within this FAU is density of residential development, with 76% of the streams categorized as *Not Functioning* for land use, based on their RAC determination. The Northern Coves FAU contains the highest density of land development—residential property, paved, and unpaved roads—within the South Hominy watershed. Approximately 62% of streams within this FAU have severely impacted buffers, while fill from home development and supporting infrastructure within these narrow floodplains inhibits groundwater recharge and stormwater storage.

3.3 Water Quality Function Assessment

Buck Engineering assessed water quality function in each of the six functional assessment units, using six metrics: NCDWQ water quality data, NCDWQ benthic/fish monitoring data, riparian corridor condition, BEHI, degree of erosion, and land use. The individual metrics were used to assign a function rating of Functioning (F), Functioning at Risk (FR), or Not Functioning (NF) for the 17 different RAC designations. This information was then applied to each of the FAUs, based on the percent stream length of each type of RAC. Table 3.3 and Figure 3.3A summarize the function ratings for each metric and provide an overall water-quality function rating for each FAU. Figure 3.3B provides a larger-scale illustration, showing spatial trends of water-quality function deficiencies at the riparian corridor level in each FAU.

Table 3.3 Overall Water Quality Function by FAU

Functional Assessment Unit	NCDWQ Water Quality Monitoring Data	NCDWQ Benthic/Fish Monitoring Data	Riparian Corridor Condition	BEHI	Erosion	Land Use	Overall
Pisgah Highlands	F	F	F	F	F	F	F
Western Highlands	F	F-	F	F	F-	F-	F
Lower South Hominy Valley	FR	FR+	FR	FR+	FR	NF	FR
Lower Beaverdam	FR	FR+	FR	F-	FR	FR-	FR
Central South Hominy Valley	FR+	F-	FR-	F-	FR	FR-	FR
Northern Coves	NF	NF	FR-	F-	FR-	NF+	NF

Note:
F = Functioning, FR = Functioning at Risk, NF = Not Functioning, NA=Not Applicable

The following sections present background and summary results for each FAU, along with potential sources of observed degradation area.

3.3.1 Pisgah Highlands FAU

All six metrics are considered *Functioning* in this FAU. According to water quality and benthic/fish monitoring results (metrics), streams within the Pisgah Highlands FAU are functioning naturally, in pristine-like conditions. These headwater streams are fairly remote and undisturbed, and they provide high-functioning instream habitat for trout (rainbow and brown trout) and a rich abundance of benthic macro-invertebrate taxa. Over 75% of the Pisgah Highlands FAU is occupied by Pisgah National Forest and approximately 89% of the streams are categorized as having an intact buffer. Overall, the Pisgah Highlands FAU is considered *Functioning* for water quality.

<u>Source of Degradation –</u>

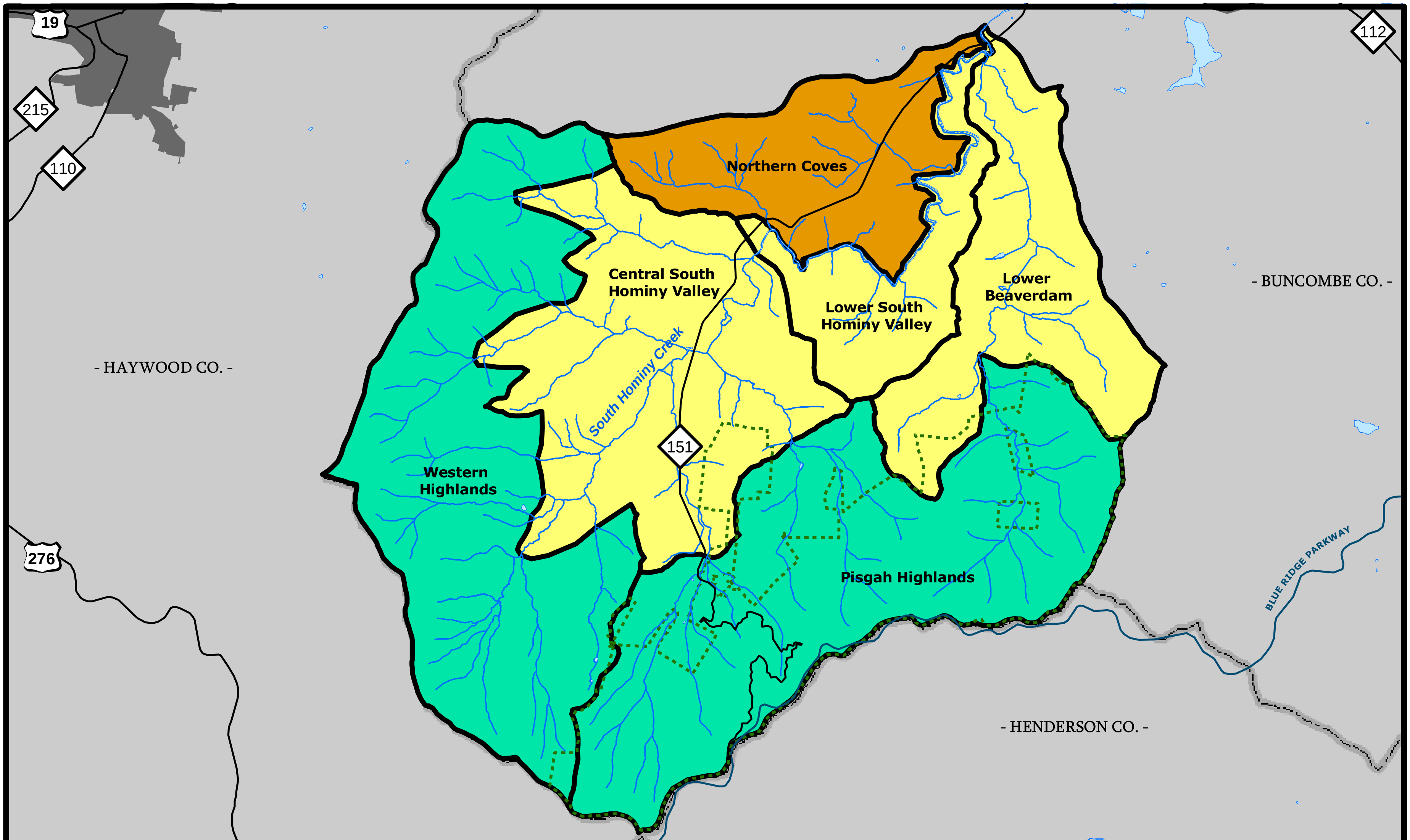
Loss of water quality function is minimal in this FAU because the native forest, acting as the dominant land cover, remains intact. High elevation streams and upland springs feed the major drainages with pure, cold water.

3.3.2 Western Highlands FAU

All six metrics are considered *Functioning* in this FAU. As with the Pisgah FAU, the Western Highlands FAU received some of the highest ratings for water quality and fish/benthic monitoring metrics in the South Hominy Creek watershed, due to a large proportion of forested land and naturally functioning headwater streams. Approximately 93% of the streams in this FAU have intact buffers. Biological monitoring results revealed a few reproducing populations of trout and an abundance of a fairly impact-intolerant community of benthic macroinvertebrates, though slightly degraded compared to the Pisgah FAU, due to encroaching residential development. The overall Western Highlands FAU water quality rating is *Functioning*.

<u>Source of Degradation –</u>

Loss of water quality function is minimal in this FAU because the native forest, acting as the dominant land cover, remains intact. High elevation streams and upland springs feed the major drainages with pure, cold water.



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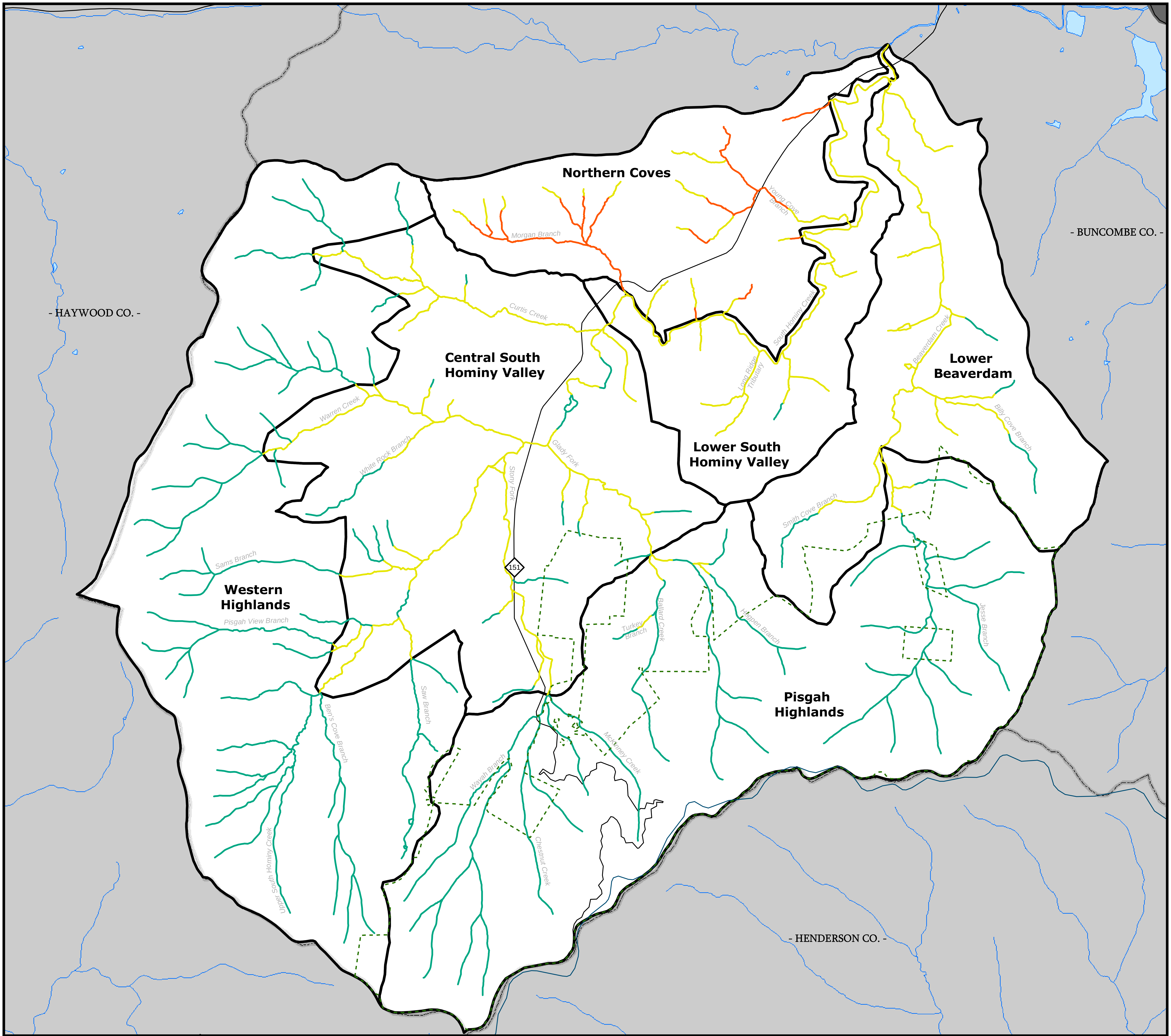
Water Quality Functional Status by FAU

- Functioning
- Functioning at Risk
- Not Functioning
- Pisgah National Forest
- Counties
- Streams

N

Figure 3.3A: Overall Water Quality Function by FAU

0 0.5 1 2 Miles



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LEGEND

RAC Water Quality Condition

- Functioning
- Functioning at Risk
- Not Functioning

- Functional Assessment Units
- Pisgah National Forest
- Counties

Figure 3.3B: Overall Water Quality Function by RAC

0 0.25 0.5 1 Miles

3.3.3 Lower South Hominy Valley FAU

Land use is categorized as *Not Functioning* in the Lower South Hominy FAU and the other five metrics are considered *Functioning at Risk.* Land use merited a poor rating because storm runoff conveyed to this portion of South Hominy Creek includes the runoff from the high density residential developments in the Northern Coves. Water quality and fish/benthic monitoring results indicated that these impacts to stream health were fairly minimal despite the potential for degraded water quality from increased development and impacted riparian buffers. Taking all six metrics into consideration, the Lower South Hominy Valley FAU water quality designation is *Functioning at Risk.*

Source of Degradation –

The primary cause of loss of water quality function within this FAU is land use, followed by riparian buffer conditions, with 86% of the streams categorized as *Not Functioning* for land use, based on their RAC determination. Approximately 32% of the streams in this FAU are categorized as having severely impacted buffers, while 50% have moderately impacted buffers, both of which increase the potential for bank erosion, permitting pollutant loads from agricultural and residential land uses to directly enter the stream from a lack of filtration.

Despite the degradation of terrestrial habitat due to land use and buffer conditions, water quality and fish/benthic metrics rated higher than expected. Benchmark concentrations for nitrate plus nitrite nitrogen (NO2+NO3) were exceeded, both upstream and downstream of the confluence with Beaverdam Creek. Finally, a fairly diverse community of fish and benthic macroinvertebrates was reported for the Lower South Hominy FAU. River chub and warpaint shiner were among the dominant fish species in the FAU.

3.3.4 Lower Beaverdam FAU

BEHI is the only metric considered *Functioning* in the Lower Beaverdam FAU. NCDWQ water quality data, NCDWQ benthic/fish monitoring data, riparian corridor condition, degree of erosion, and land use are considered *Functioning at Risk.* Overall, the Lower Beaverdam FAU is considered *Functioning at Risk* for water quality.

Source of Degradation –

As with the Lower South Hominy Valley FAU, moderately impacted buffers throughout the Lower Beaverdam FAU have limited the filtration ability of pollutant loads from this predominantly agricultural FAU. Benthic monitoring along Smith Cove Branch revealed the presence of a fairly impact-tolerant community dominated by baetid mayflies which are commonly found in organically enriched streams, like those downstream from pastures. Benchmark concentrations for fecal coliform bacteria were exceeded as well, along the downstream portion of Beaverdam Creek, due to a combination of stream access by cattle and horses, and runoff from actively grazed pastures.

3.3.5 Central South Hominy Valley FAU

Benthic/fish monitoring and BEHI are rated as low-level *Functioning* in the Central South Hominy Valley FAU. The remaining metrics are all determined to be *Functioning* *at Risk*. The Central South Hominy Valley overall FAU water quality rating is *Functioning at Risk.*

<u>Source of Degradation –</u>

The primary causes of loss of water quality function within the Central South Hominy Valley FAU are land use and the large extent of severely impacted buffers. While having similar functional water quality metrics as Lower Beaverdam FAU (riparian corridor condition, BEHI, degree of erosion, and land use), the Central South Hominy Valley FAU reported higher-functioning metric values from the NCDWQ water quality data and NCDWQ benthic/fish monitoring data. This is due in part to the large proportion of forested land surrounding the headwater drainages extending well into the Pisgah and Western Highlands FAUs. These well-buffered headwaters contain little to no land development activities and have a great capacity for pollutant-load filtration, minimizing the conveyance of pollutants downstream. In addition, the Central South Hominy Valley FAU contains approximately 97% (30 acres) of the wetlands within the entire South Hominy watershed, which also aid in pollutant filtration. The majority of these wetlands are situated either online or adjacent to each of the five major drainages entering South Hominy Creek in the FAU. A succession of wetlands immediately parallels stream channels within the sub-watersheds of Lower Glady Fork, Lower Stony Fork, and along the South Hominy Creek mainstem, just upstream from its confluence with Stony Fork.

3.3.6 Northern Coves FAU

Land use, DWQ water quality monitoring data, and benthic monitoring data are considered *Not Functioning* in this FAU. Overall water quality function in the Northern Coves FAU is considered *Not Functioning*.

<u>Source of Degradation –</u>

Loss of water quality function within this FAU is primarily land use, stemming from increased residential development, with 76% of the streams categorized as *Not Functioning* for land use, based on their RAC determination. Water quality is further degraded because approximately 62% of the streams have severely impacted buffers, which is the largest proportion of impacted buffers within all the FAUs of the South Hominy watershed. Many of the headwaters within this FAU are developed and are undergoing further development. As residential development continues to encroach upon riparian corridors, thereby increasing potential pollutant load, the lack of infiltration from impacted buffers, along with increased impervious surfaces and stormwater conveyances, permit higher concentrations of pollutants to directly enter the stream channel during first flush events. Benchmark concentrations were exceeded for several water quality monitoring parameters, including nitrate plus nitrite nitrogen (NO2+NO3), phosphorus, fecal coliform bacteria, and specific conductance. Dissolved oxygen concentrations (DO) within the Northern Coves FAU were among the lowest in the watershed, while water temperatures were among the highest. Due to a lack of richness and abundance of taxa among benthic macroinvertebrate communities sampled, the Northern Coves FAU received a 'Not Rated' bioclassification, which signifies a rating less than that of "Good-Fair" for a non-reference stream.

4 Summary and Conclusions

4.1 Summary

This Technical Memorandum presents a functional status overview of six assessment units for three major functions: habitat, hydrology, and water quality (Table 4.1). Buck Engineering examined a suite of several distinct metrics for each major function, then used a “strength of evidence” approach to assign a functional rating to each metric and major function in all the FAUs. These results will enable EEP to focus and prioritize efforts to preserve and/or restore the watershed. These results also show how functions are interrelated and how restoration efforts may best be undertaken.

Table 4.1 Habitat, Hydrology, and Water Quality Function by FAU

Functional Assessment Unit	Habitat	Hydrology	Water Quality
Pisgah Highlands	F	F	F
Western Highlands	F	F	F
Lower South Hominy Valley	FR	FR	FR
Lower Beaverdam	FR	FR	FR
Central South Hominy Valley	FR	FR	FR
Northern Coves	FR	FR	NF
Note: *F = Functioning, FR = Functioning at Risk, NF = Not Functioning*			

4.2 Conclusions

Conclusions are based on functional assessments and on a preliminary view of final recommendations. More detail will be provided in a final project report.

4.2.1 Habitat

The FAUs within the South Hominy Creek watershed with the best habitat function are the Pisgah Highlands and the Western Highlands. Even though all the remaining FAUs are *Functioning at Risk*, correlations exist among the assessed metrics that enable the further stratification of FAUs. Among these four remaining FAUs rated *Functioning at Risk* for habitat, the Lower Beaverdam FAU is functioning at the highest level, followed by the Lower South Hominy Valley, and Central South Hominy Valley FAUs; the Northern Coves FAU is functioning at the lowest level for habitat, apparently because it has the highest density of residential development and the largest proportion of severely impacted riparian buffers within the entire watershed. The Lower Beaverdam Valley, Lower South Hominy Valley, and Central South Hominy Valley FAUs also suffer from similar functional deficiencies for habitat, but their deficiencies are not as severe.

Land use and riparian corridor condition seem to be the greatest sources of habitat function loss. While agricultural and residential land use has fragmented habitat within many FAUs near the South Hominy Creek watershed outlet, streams with well-established buffers of ample width in those same areas typically resisted impacts from land development and tended to exhibit a functional terrestrial and aquatic habitat. However, many riparian areas adjacent to these land uses have immature buffers, composed of invasive species, have poor root mass, or are completely devoid of vegetation. This is true for many vertically unstable streams, which were incised from past channelization, where banks fail to support hearty vegetation due to the gradual lowering of the water table. These types of streams are frequent throughout the watershed and tend to be more susceptible to bank erosion because their banks are sparsely vegetated and/or exposed. Such poor riparian corridor conditions threaten the integrity of other metrics supporting habitat function, often introducing further degradation.

Stream channel embeddedness is another source of degradation commonly observed throughout all the FAUs, primarily reflected by those FAUs rated *Functioning at Risk* in the Habitat Field Assessment metric (Table 3.1). Pools and riffles at several RACs were filled and embedded, respectively. A slug of sediment may have been derived from landslides occurring within the headwaters of each respective FAU, due to heavy precipitation events associated with Hurricanes Ivan and Frances in the fall of 2004. However, unpaved roads, bank erosion, and sporadic clear cuts associated with land development and timber harvesting are also probable sources of sediment entering the channel. Aggraded channel sediment from these events threatens geomorphic stability by increasing near bank stresses, thereby escalating the potential for streambank erosion. Stream channel embeddedness is harmful to benthic invertebrates, as many species prefer aerated interstitial voids. Loss of benthic invertebrates in a stream has consequences for fish and other organisms in the food web.

4.2.2 Hydrology

The FAUs within the South Hominy Creek watershed with the best hydrologic function are the Pisgah Highlands and the Western Highlands, both rated *Functioning*. Among the four remaining FAUs rated *Functioning at Risk* for hydrology, the Lower Beaverdam FAU is functioning at the highest level, followed by the Central South Hominy Valley, and Lower South Hominy Valley FAUs, with the Northern Coves FAU having the lowest hydrologic function.

As in the case with habitat function, land use and riparian corridor condition are the greatest sources of hydrologic function loss. Past and present land development activities have increased drainage efficiency from exposed catchment surfaces; reducing groundwater recharge and basin lag times, while increasing peak storm flows. Past and present channel modifications (channelization) are common to streams adjacent to these types of developments. Such modifications to the channel result in increased channel slopes and flow velocities that cause excess scouring of the streambed. Vertical instability from channel incision often leads to lateral instability, or severe bank erosion and failing riparian vegetation as the stream continues to adjust over time. Flooding from heavy precipitation events associated with Hurricanes Ivan and Frances in the fall of 2004 have accelerated this process throughout the watershed, exacerbating streambank erosion and incision, while impacting much riparian vegetation in larger drainage areas.

4.2.3 Water Quality

The Pisgah Highlands and Western Highlands FAUs, rated as *Functioning,* have the best water quality function in the South Hominy Creek watershed. The Northern Coves FAU is the only *Non-Functioning* FAU within the watershed. Among the three remaining

FAUs rated *Functioning at Risk* for water quality, the Central South Hominy Valley FAU is functioning at the highest level, followed by the Lower South Hominy Valley FAU, then the Lower Beaverdam FAU.

Land use and riparian corridor condition are directly accountable for the greatest sources of water quality function loss within the South Hominy Creek watershed. The stream degradation for these two highly sensitive metrics has resulted in functional deficiencies to habitat and hydrology. Storm runoff containing pollutants from adjacent residential and agricultural land uses enters the stream channel with little to no filtration when riparian buffers are severely impacted or devoid of vegetation. This phenomenon is more detrimental to water quality function when such land uses are of higher density and are situated within headwater regions like those of the Northern Coves, Lower Beaverdam, and Lower South Hominy FAUs. Degraded water quality function for these three FAUs—the lowest in the watershed—is reflected in the low ratings reported for water quality and benthic/fish monitoring metrics in Table 3.3. Active cow pastures were observed in these FAUs, where cattle and other livestock were permitted direct access to stream channels.

The Central South Hominy Valley FAU received higher ratings for the same water quality metrics, despite having similar land uses and a larger proportion of severely impacted buffers. This is due in part to less concentrated development within the FAU, the widespread presence of wetlands along the major tributaries feeding into the South Hominy Creek mainstem and to the vast forested headwaters (Pisgah Highlands and Western Highlands), from which these tributaries flow. Both features not only serve to improve water quality functions by removing pollutants and sediment through filtering and accretion, but also by providing excellent source water. The higher rating (*Functioning*) reported for the benthic/fish monitoring metric for the Central South Hominy Valley FAU may have to do with the downstream drift of intolerant invertebrate species supplied from its large extent of forested headwaters.

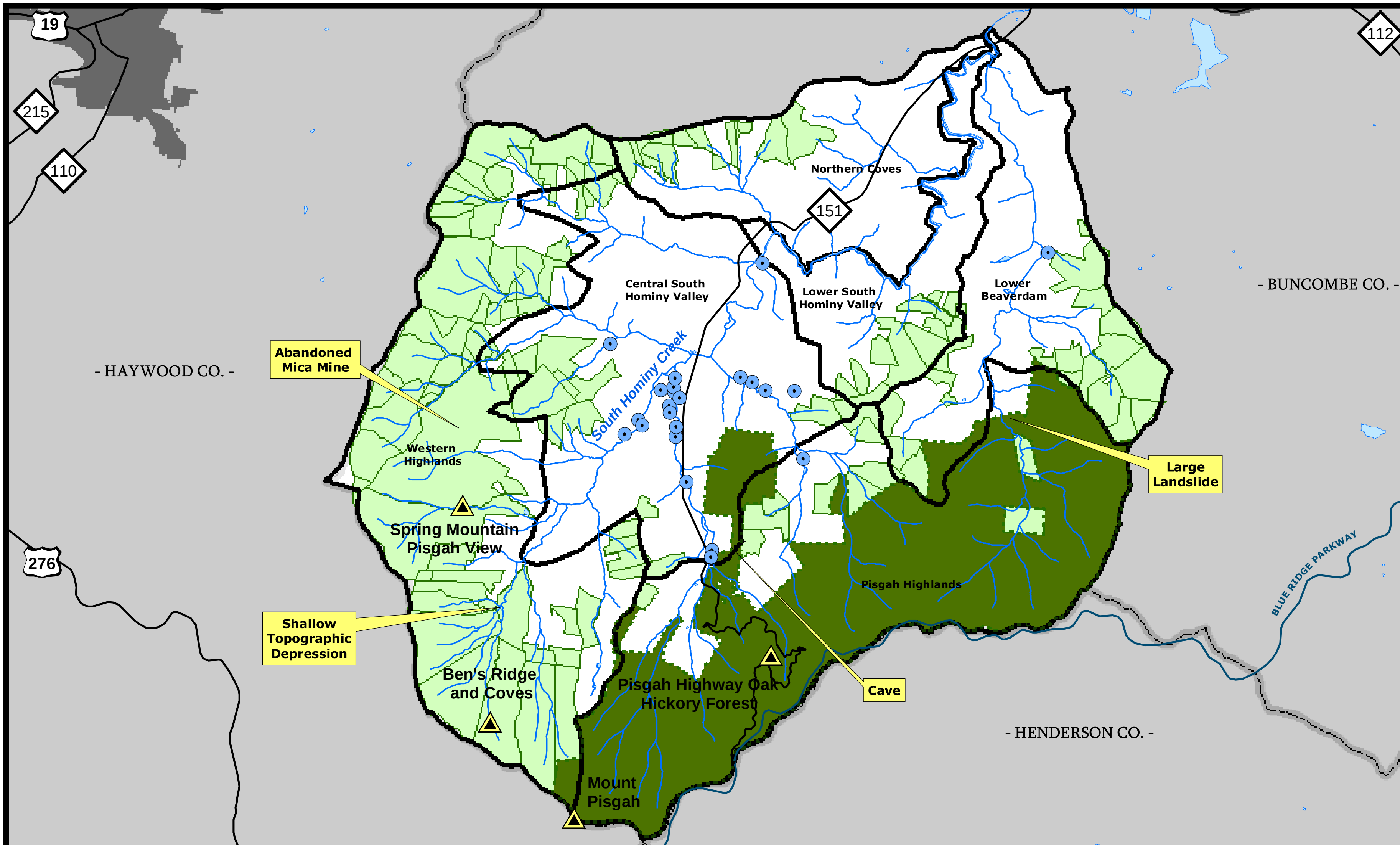
4.3 Terrestrial Habitat within Upland Areas

Existing terrestrial habitat was assessed at the watershed scale using GIS and field-collected data to locate potential high-quality sites suitable for preservation or enhancement. Sample upland areas within the South Hominy Creek watershed were also examined for habitat preservation opportunities and included the identification of existing seep/bog wetlands, cave habitat, and large-tract, high-elevation forest (see Figure 4.3). Preserving or enhancing these unique habitat features safeguards the connectivity of sensitive habitat areas from the threat of fragmentation caused by land development. Preservation of these areas also promotes the sustenance of other watershed functions related to water quality and hydrology. GIS layers used to remotely identify habitat features at the watershed scale include GAP data, National Wetlands Inventory (NWI), aerial photographs, and digital elevation models (DEM).

After Hurricanes Ivan and Francis in the fall of 2004, landslides on roads made some remote areas inaccessible. As a result, Buck Engineering charted a helicopter for aerial reconnaissance in an effort to ground-truth potential habitat sites identified with GIS data. Figure 4.3 represents an inventory of confirmed high-quality habitat sites verified from aerial reconnaissance and windshield surveys. The most prominent terrestrial habitat features identified for preservation within the South Hominy Creek watershed are wetlands and large, high-elevation tracts of relatively undisturbed land.

Conversations with local landowners provided information about additional terrestrial features within the South Hominy Creek. Among these are an old mica mine located on the Pisgah View Ranch property; a large cave located east of Highway 151, within the Lower Stony sub-watershed; and a large landslide that occurred just off Bear Farm Road, within the Upper Beaverdam Creek sub-watershed. Although no additional caves were observed during the aerial reconnaissance, bear studies taking place within the Pisgah National Forest indicate that hollowed-out Mountain Laurel and Rhododendra provide good habitat and cover for local bear populations. The Brooks Cove sub-watershed contains another unique terrestrial habitat feature: the origination of several seeps draining inefficiently from a large, shallow topographic depression at the confluence of South Hominy Creek and several headwater tributaries. Some of these features are depicted in Figure 4.3.

Of the 56.9 acres of existing wetlands within the watershed reported by the NWI, only 30.9 acres were field verified, including wetlands not previously mapped by the NWI. Approximately 97% of the 30.9 acres of wetlands (30 acres) within the watershed are located within the Central South Hominy Valley, along floodplains of major tributaries draining into South Hominy Creek. Parcels greater than 20 acres, containing large tracts of relatively undisturbed land, are marked for potential preservation, as shown in Figure 4.3. Mount Pisgah, Ben's Ridges and Coves, Spring Mountain, and The Pisgah Highway Oak Hickory Forest are natural areas containing significant and/or rare communities and species that should also be considered for preservation. Management strategies for specific habitat preservation areas will be included in Technical Memo 4.



NC Ecosystem Enhancement Program

Local Watershed Plan for the French Broad River Basin: South Hominy Creek Watershed

LEGEND

- Parcels for Potential Preservation
- Natural Areas
- Wetlands
- FAUs
- Pisgah National Forest
- Counties
- Streams

Figure 4.3: Terrestrial Habitat Points of Interest

0 0.5 1 2 Miles

5 General Management Recommendations Based on Functional Assessment

An important aspect of assessing a watershed's major functions is to provide a sense of where and how to direct resources for restoration and preservation. Of course, resource allocation depends on the decision makers' values and attitudes toward cost, benefit, and risk. However, by understanding where an FAU's functions fall short, how those affect the broader project area, and what the immediate threats are, decision makers need mainly consider only cost information to prioritize actions. Specific management recommendations for each FAU will be presented in the final report. General discussion of where and what types of actions can be recommended are briefly discussed below.

The existing level of function should guide planning. *Functioning* areas should primarily be targets for preservation. As development continues to spread throughout the South Hominy Creek watershed, *Functioning* areas are likely to become scarcer, so efforts should be made to protect them. These areas can provide valuable services beyond their boundaries by contributing, for instance, intolerant organisms to colonize polluted areas via downstream drift; higher base flows and lower storm flows; and large areas of terrestrial habitat to which only connecting corridors are needed to protect wildlife.

Preservation, BMPs, and restoration are appropriate for *Functioning at Risk* areas. Further insight comes from examining the sources of risk and function. As an example, a common source of risk in the project area is severely eroding streambanks from the degradation of riparian buffers. The near-term goal would be to prevent sedimentation in the stream channel by deflecting flow with root wads or veins and replanting the bank. Rather quick action must be taken to maintain some level of function. The long-term goal would be to stabilize the channel by undertaking restoration, using natural channel design. Stormwater management (to reduce peak flow events) might be another long-term task in those developed areas of high density. For at risk areas, it would also be advisable to preserve sources of function, such as good riparian buffers. For areas determined to be *Not Functioning*, restoration and BMPs are the main options.

Governmental agencies, local conservation groups, and area landowners must prioritize their limited resources for preservation, restoration, and other watershed improvements, and this prioritizing should reflect their values. For instance, would a municipality prefer to address *Functioning at Risk* areas or *Not Functioning* ones? Presumably, it would cost less to restore a *Functioning at Risk* area, since it is less removed from being *Functioning*. A local government's answer to this question will vary depending on its values and resources.

Specific management recommendations for each FAU will be presented in a final report that will allow land managers and local governments to plan future activities in the light of watershed functions.

6 References

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Field Assessment Data Matrix

AAA

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
AAA1	500	A/B	Well-shaded step pool system composed of a mixture of boulders, cobble, and gravel.	3.2	Mature forested riparian buffer and floodplain with minimal invasive species present.	3.9	Old logging road (culvert) adjacent to upper reach limits	4	Minor erosion with instances of exposed banks and in-stream sediment caused by recent flooding	3	No evidence of active downcutting.	3.8	17.85	N/A	Preservation
AAA2	730	A/B	Well-shaded, boulder/bedrock controlled step pool system. Riffles are 50% embedded.	3.6	Mature forested riparian buffer and floodplain with minimal invasive species present.	3.7	No evidence of recent human impacts.	4	Minimal erosion with substantial root mass. Moderate sediment splays present from recent flooding causing channel braiding in several locations.	3.8	Low bank angle/height. No evidence of active downcutting.	4.0	19.10	N/A	Preservation
AAA3	3500	A	Well-shaded, boulder/bedrock controlled step pool system with deep pools.	3.8	Mature forested riparian buffer and floodplain with minimal invasive species present.	3.6	Road crossing	3.5	Banks are partially exposed with mild to moderate erosion reach-wide. Abundance of sediment moving through system.	2.6	Incision observed in one location will be halted by boulders (grade control) just upstream.	3.2	16.67	N/A	Preservation
AAA3a	500	A	Steep, well-shaded, boulder/bedrock controlled step pool system with deep pools.	4	Mature forested riparian buffer and floodplain with minimal invasive species present.	4	No evidence of recent human impacts.	4	Minimal erosion due to boulder/bedrock toe protection lining steep banks	3.8	No evidence of active downcutting.	4.0	19.80	N/A	Preservation
AAA4	1500	A	Well-shaded, boulder/bedrock controlled step pool system with ample variations in pool depths.	4	Mature forested riparian buffer and floodplain with minimal invasive species present.	3.9	Portion of stream naturally diverted to old road bed from recent flooding events and has formed a new channel.	3	Banks exposed in many areas. Mild to moderate erosion with excess sediment present in a few areas along upstream limits.	2.7	No evidence of active downcutting. Channel is braided along upstream limits from recent flooding.	3.3	16.93	N/A	Preservation
AAA4a	1000	A	Riffles and pools are frequent with a fully shaded bed. Pools are deep and multiple habitat structures frequent.	3.5	Mature forested riparian buffer and floodplain with minimal invasive species present at road crossings (Multiflora Rose and Bittersweet).	3.9	Three road crossings/culverts bisect reach	2.5	Minor erosion and substantial root mass reinforcing banks. Some sediment entering stream from gravel road crossings.	3.4	No evidence of active downcutting.	4.0	17.30	N/A	Preservation
AAA5	800	B	Riffles and pools are frequent with a fully shaded bed. Pools are deep and multiple habitat structures frequent.	3.7	The riparian buffer is wide and consists of a mature forest. Banks are well vegetated and occassionally exposed.	4	Possible disturbance from past road construction and berming.	3.5	Minor erosion and substantial root mass reinforcing banks. Active transport of some fine sand/silt is evident.	3.6	No evidence of active downcutting.	4.0	18.80	N/A	Preservation
AAA6	1000	B	Riffles and pools are frequent with a partially to fully shaded bed. Pools are deep and multiple habitat structures frequent.	3.6	The bank and floodplain vegetation is primarily forested with a mature, wide buffer. Buffer is impacted in areas and contains many invasive species including, Multiflora Rose and Privet. Banks are occassionally exposed.	3.5	No evidence of any recent human disturbance.	4	Mild to moderate erosion and exposed banks in selected areas. Soils are cohesive and roots mass extensive. Water is slightly turbid downstream from road encroachment.	3.3	No evidence of active downcutting. Bank height ratios range from 1.0 to 1.5.	3.3	17.73	Workspace is available. Access from private property would be required.	Buffer Enhancement

AAB

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
AAB1	500	B/Ba	Combination of boulder controlled step pool system upstream and riffle/run dominated system downstream. Lower reach lacks pools. The bed is fully shaded in most areas.	3.2	Mature forested riparian buffer and floodplain with minimal invasive species present.	3.6	Channel appears to have been shifted to one side of the valley in the past.	3.5	Banks are partially exposed with moderate erosion occurring around outer meander bends. Substantial root mass holding unconsolidated bank material.	2.8	Past downcutting has occurred on the lower half of the reach.	2.2	15.27	N/A	Preservation
AAB2a	500	B	Riffles and pools are frequent with multiple habitat structures commonly featured throughout. Riffles are slightly embedded. The bed is fully shaded in most areas and partially shaded in some areas.	3	Mature forested riparian buffer and floodplain with minimal invasive species present. Rhododendron and shrubs plentiful throughout providing substantial root mass along banks.	3.6	Road crossing and log weir.	3	Erosion is minimal with a moderate amount of in-stream sediment present.	3	No evidence of active downcutting. Bank heights are low and channel has an active floodplain.	3.8	16.43	N/A	Preservation

ABA

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
ABA1	1000	A	Step pool system consisting of boulders and roots. The bed is fully shaded in most areas except in proximity of homes. Multiple habitat structures commonly featured throughout.	3.5	Mature forested riparian buffer and floodplain with sporadic breaks in buffer from selective clearing by homeowners. Buffer along right bank narrows within 30' of channel from paralleling road.	3.4	Past clearing of vegetation surrounding portions of channel in proximity to nearby homes.	3.5	Mild erosion from succession of migrating headcuts. Grading activities occurring upstream in watershed contributing sediment to channel.	2.8	Slight channel incision is evident due to a few minor headcuts, but widespread grade control in the form of boulders and roots should safeguard channel from system-wide degradation.	3.2	16.37	N/A	Preservation
ABA2	650	A	Well-shaded step pool system consisting primarily of boulders, cobble, and gravel with deep pools. An abundance of large boulders and overhanging shrubs comprise the majority of habitat structures.	3.7	Fairly mature forested riparian buffer and floodplain with sporadic breaks in buffer from road encroachment and scattered residential developments. Buffer narrows within 20-50' along right bank.	3.1	No evidence of recent human impacts.	4	Banks are typically vertical and partially exposed with mild to severe erosion. Majority of erosion is concentrated along the toe of bank where unconsolidated material is washing out.	2.4	Active incision is evident along lower half of reach where bank height ratios approach 2.0.	2.7	15.87	Work space is available but would require some clearing of dense vegetation and access from private property. A few homes are within 50' of channel.	Enhancement II

ABB

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
ABB1	500	B	Riffles and pools are frequent, but lower reach lacks well defined pools and riffles are slightly embedded. The bed is fully shaded in most areas and partially shaded in some areas along left bank.	2.9	The banks are partially vegetated with an abundance of Rhododendron, Tag Alder, and Mt. Laurel along with such invasives as Multiflora Rose. Buffer widths exceed 20' along right bank and fluctuate between 5-10' along left bank.	2	Small constructed berm on left bank	3	Portions of left bank are exposed where moderate erosion is occurring. Mild to moderate amounts of sediment present within channel	2.7	No evidence of active downcutting, but left bank appears somewhat disconnected from floodplain where bank height ratios approach 2.0 in some areas.	3.0	13.60	Work space is available along adjacent fallow farm field but would require private property access. Possible wetland enhancement on left bank.	Enhancement II
ABB2	500	E/F	Predominantly a riffle/run system with a few pools. Riffles are somewhat embedded, the channel is fairly well-shaded, and woody debris is plentiful throughout from recent flooding events.	2.6	The riparian buffer is greater than 30 feet in width with an approximate age ranging from 5-10 years and 15-20 years along the left and right banks respectively.	2.6	Road crossing and ponding of channel downstream of reach	3	Extensive erosion in some areas and a significant amount of sediment present in channel. Right bank is fairly well vegetated while the left bank is quite exposed.	1.9	One small active headcut observed. Channel disconnected from floodplain in several areas with bank height ratios ranging from 1.0 to greater than 2.0.	2.3	12.43	Some work space available, but impeded by dense understory vegetation. Other constraints include a few culverts and overhead electric.	Enhancement II
ABB3	500	B	Slightly embedded step pool system with good pool depth variations. Channel is almost entirely shaded.	3.4	Mature forested riparian buffer and floodplain with minimal invasive species present. Banks are well vegetated with Rhododendron	3.4	Most likely re-aligned away from road in the past.	3	Mild to moderate erosion and excessive in-stream sediment present in proximity to road. Adequate root mass throughout channel.	2.7	Channel has downcut slightly in the past and is somewhat disconnected from floodplain. Bank height ratios range from 1.0 - 1.5.	3.0	15.50	Some work space available, but impeded by mature forest and electric/phone utilities along roadway.	Enhancement II

ACB

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
ACB1	1000	B/Cb	Riffles and pools are frequent with adequate pool depth variations. The bed is partially to completely shaded.	3.2	Mature forested riparian buffer and floodplain with minimal invasive species present. Banks are partially to well vegetated with selected exposed areas revealing unconsolidated bank material from recent flooding.	3.5	Past channelization and dredged spoil piles observed along left bank within upper reach limits.	3	Mild to moderate erosion from recent flooding. Toe of steep banks exposed in some areas from the scouring of unconsolidated cobble in banks.	2.5	Past downcutting has occurred on the upper half of reach where bank height ratios approach 2.0. Large bedrock knickpoint located mid-reach at bridge.	2.3	14.53	N/A	Preservation
ACB2	400	B	Fairly well shaded bedrock/boulder controlled step pool system embedded with fine sediment supplied from headwaters.	2.6	Buffer width exceeds 50 feet and consists of a dense mix of shrubs and young hardwoods along the right bank with scattered mature hardwoods comprising the floodplain along the left bank. Invasive species include Multiflora Rose and briars.	2.1	Headwaters have been cleared for horse/cattle grazing. Two online ponds constructed in pasture just upstream of reach.	2	Banks are steep and partially vegetated with several raw areas present from the lack of ample root mass. Erosion is generally moderate to severe and is concentrated along constrictions and outer meander bends	2.1	Past downcutting has occurred and bank height ratios exceed 2.0. Bedrock/boulder steps provide excellent grade control.	1.8	10.63	Limited access available on right bank. Constraints include scattered mature trees, fencelines, and a few structures.	Buffer Enhancement
ACB3	600	E/G	Combination of cobble step pool system upstream and riffle/run dominated system downstream. Stable woody debris jams are frequent and channel bed is exposed to sunlight from lack of understory shading.	2.4	Banks are exposed to partially vegetated with grasses, forbes, and ferns. Floodplain buffer is greater than 50 feet and consists of a sporadic mature hardwood overstory with a minimal understory composed of grass and shrubs.	2.8	Low sinuosity and severe channel incision within upper reach is indicative of past channelization.	3.5	Several instances of bank slumping are evident and moderate to severe erosion is occurring along constrictions and outer meander bends.	2.4	Upper limits of reach has incised considerably in the past and is in the process re-establishing pattern through aggradation and widening. Stable woody debris jams serve as grade control.	2.7	13.77	Workspace available on both banks with minimal clearing of vegetation. Private property access would be required.	Enhancement I

ACC

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
ACC1	1000	B/Cb	Riffles and pools are present. Pools are less frequent but have good variations in depth while riffles are fairly embedded. Fallen woody debris from recent flooding lines both banks	2.6	Mature forested riparian buffer and floodplain with minimal invasive species present. Riparian vegetation includes Rhododendron, sycamore, oak, maple, and pine. Small breaks in buffer apparent downstream along floodplain of left bank.	3.3	No evidence of recent human impacts.	4	Mild to moderate erosion from recent flooding. Substantial root mass and boulder/bedrock outcroppings lining toe of bank throughout reach.	2.9	Past downcutting has occurred and bank height ratios range between 2.0 and 2.5. Bedrock knickpoints are common throughout upper reach limits.	2.2	14.97	N/A	Preservation
ACC3	1100	B	The bed is fully to partially exposed to sunlight with good variations in pool depths. Several habitat structures are present frequently.	3.4	The existing riparian vegetation consists of a mature forest with a fairly dense shrub understory. Buffer widths exceed 50 feet on each bank.	4	Bridge intersects channel and Beaverdam Rd encroaches floodplain.	3.5	Minimal erosion is occurring with a few areas of exposed banks.	3.9	The channel appears to have an active floodplain with no evidence of downcutting.	4.0	18.80	N/A	Preservation

BAA

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
BAA1	500	B	Small step pool system with excellent vegetative cover and frequent debris jams within upstream limits and minimal to no cover within downstream limits. Pools are filled with sediment and riffles are 85% embedded.	1.4	Mature forested riparian buffer and floodplain with minimal invasive species present. Riparian vegetation includes Rhododendron, oak, maple, and white pine. Gravel road embankment parallels left bank within 25' of channel along downstream limits where buffer becomes sparse.	2.4	Alterations within downstream limits include an offline pond, a constructed weir, culverts, and a channelized concrete ditch feeding a spring house.	1	Minimal erosion due to low bank height, bank angle and excellent root mass. Substantial sediment present in stream from gravel road and recent landslides upstream.	3.4	Bank height ratio ranges from 1.0 to 1.2. A few small active headcuts are present, but are contained by several stable debris jams and bedrock knickpoints.	3.2	11.37	Work space is available on left bank downstream along gravel road for buffer planting. Overhead electric parallels left side of gravel road and 2 sheds/barns are within 30' of either bank downstream.	Bank Stabilization and Buffer Planting
BAA2	490	A	Bedrock/boulder step pool system with fully to partially exposed stream bed and good variations in pool depths. Steps are 65% embedded and habitat structures such as large rocks, undercut banks, woody debris, and overhanging shrubs are frequent.	2.9	Riparian vegetation consists of an overstory of scattered mature hardwoods with a dense understory of elderberry, spicebush, Multiflora Rose, and briars. Buffer width on left bank diminishes downstream as stream approaches and parallels gravel road embankment.	2.2	Stream has been channelized and moved to the toe of slope (along the road embankment) in the past.	2	Minimal erosion is occurring with exception to that portion immediately adjacent to gravel road embankment where erosion is severe from recent flooding events. Extensive amounts of sediment present from clear-cut development in catchment headwaters and from gravel road. Majority of flow has abandoned old existing channel along road embankment upstream and now occupies overflow channel.	2.6	Bank height ratio ranges from 1.0 to 1.5. A few active headcuts are present in new overflow channel, but are contained by large boulders and several bedrock knickpoints.	3.2	12.87	Work space is available on right bank and on gravel road along left bank. Barbed wire fence parallels right bank and overhead electric is within 75' of right bank.	Bank Stabilization and Buffer Planting

BBA

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
BBA1	500	A/B	Step pool system composed of cobble. Pools are small and infrequent. Stream bed primarily shaded along left bank only.	2.3	Mature forested riparian buffer >100' on left bank and minimal to no buffer on right bank due to gravel road encroachment.	2.2	Gravel road bordering right bank of channel, culverts, and rip rap.	3	Minimal erosion throughout due to ample root mass in left bank and the reinforcement of the right bank with rip rap.	2.7	Bank height ratio is 2.0 and one active headcut is evident.	2.0	12.20	Very limited workspace on right bank along gravel road. Overhead electric is present.	Bank Stabilization
BBA2	1000	A/B	Well shaded boulder controlled step pool system embedded with fine sediment supplied from headwaters. Numerous habitat structures present and frequent along with excellent variations in pool depths.	3.6	Banks are well vegetated and the mature forested buffer extends beyond 100' on the left bank and remains under 30' on the right bank.	3.8	No evidence.	4	Moderate bank erosion and minimal in-stream sediment present.	2.9	No evidence of active downcutting. Bank height ratio ranges from 1.0 to 1.5.	3.5	17.80	Work space is available on selected portions of both banks.	Buffer Planting
BBA3	500	B	Fairly well shaded step pool system composed of cobble with excellent variations in pool depths.	3.2	Banks are well vegetated and the mature forested buffer spans 10' to 30' on the left bank and 30' to 50' on the right bank. Reach lacks understory vegetation in a few locations due to impacts from channel/bank reconstruction by homeowner.	3.5	Channel/bank reconstruction by homeowner in response to recent flooding events.	3	Moderate bank erosion in localized areas from channel/bank reconstruction. Braided channel in a few locations from recent flooding events. Substantial armoring of banks by root mass and river cobble.	3	Bank height ratio ranges from 1.0 to 1.5 and one active headcut is evident.	3.0	15.70	Work space is available but is impeded by scattered mature trees.	Enhancement II

BBB

Reach	Length (ft)	Rosgen Stream Type	Biological Information: Habitat	Average Score	Existing Riparian Vegetation	Average Score	Geomorphic and Stability Information: Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score	Total Score	Feasibility	Recommendation
BBB1	500	E (incised)/G	Partially to fully shaded riffle/run system with slightly embedded riffles and only a few pools. Overhanging shrubs and woody debris are among the fairly common habitat structures present.	2.4	Riparian buffer consists of mature trees on both banks interspersed with such invasives as Multiflora Rose, privet, and Japenese Honeysuckle. Breaks in canopy and buffer are common as open fields border the narrow 10' buffer along each bank.	2.4	Stream has possibly been channelized in the past. Piped offline pond is located on the left bank downstream.	3.5	Bank erosion is mild to moderate and is concentrated along outer meander bends and constrictions. Moderate amounts of in-stream sediment present.	2.4	Channel has disconnected from original floodplain and has downcut in the past. Small benches have formed at a lower elevation. Bank height ratio ranges from 2.0 to 2.5 and a few small headcuts were observed.	2.2	12.87	Work space is available within fallow field bordering each bank. Pipe within channel feeding offline pond. Private property access would be required.	Enhancement I

BCB

Reach	Length (ft)	Rosgen Stream Type	Biological Information: Habitat	Average Score	Existing Riparian Vegetation	Average Score	Geomorphic and Stability Information: Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score	Total Score	Feasibility	Recommendation
BCB1a	400	B	Bedrock/boulder controlled step pool system upstream and a riffle/run system downstream with minimal pool development. Stream bed is partially shaded to completely exposed and a few habitat structures consisting of woody debris and large rocks are present.	2	Banks are partially vegetated with sporadic mature trees, shrubs, and grasses with frequent breaks in the buffer. Buffer widths range between 10' to 15' on both banks and are bordered by fields.	1.9	Stream has possibly been channelized in the past.	3.5	Mild erosion due to low bank angle and dissipation of energy from step pools upstream. Minimal in-stream sediment present as a result of a significant debris jam upstream.	2.6	Channel has downcut in the past and re-established lower elevation flood benches in selected areas. Bank height ratio ranges from 1.0 to 1.5	3.5	13.50	Work space is available within fallow field bordering each bank. Fence is located along left bank and a shed is located within 50' of the right bank upstream. Private property access would be required.	Enhancement II
BCB2	650	G/F	Partially shaded, riffle/run dominated system with pools becoming more prevalent downstream. Several habitat structures, such as woody debris, are present and frequent.	2.6	The banks are partially to well vegetated while buffer widths exceed 50' on the right bank and range between 5' to 10' on the left bank. Floodplain vegetation consists of a mature forest on the right bank and a mix of mature trees and manicured grass on the left bank.	2.5	No recent evidence except for that of vegetation removal.	3.5	Banks are typically steep and exposed along the lower third. Erosion is moderate to severe.	2.2	Channel has disconnected from original floodplain and is continuing to actively downcut as a significant headcut is present midreach. Bank height ratios are much lower upstream of headcut where small benches have formed and channel pattern is evident.	1.5	12.30	Work space is available on left bank. Private property access would be required.	Bank Stabilization and Buffer Planting
BCB3	600	F (incised B)	Riffles and pools are present and frequent with good variations in pool depths. Several habitat structures are fairly frequent with a partially shaded bed.	3.3	The riparian buffer is composed of young forest along both banks spanning a width of 10' to 20'. Root mass is lacking in selected areas. Riparian vegetation includes Ironwood, Rhododendron, White Oak , and Sycamore.	2.2	No evidence.	4	Banks are typically steep and exposed in many areas. Soil cohesion is moderate lending to the extensive erosion in specific areas.	1.5	Channel has downcut recently and has disconnected from its original floodplain. Bank height ratio ranges from 2.0 to 2.5.	1.5	12.50	Work space is somewhat confined because the riparian corridor contains several mature trees. Private property access would be required.	Enhancement I

BCC

Reach	Length (ft)	Rosgen Stream Type	Biological Information: Habitat	Average Score	Existing Riparian Vegetation	Average Score	Geomorphic and Stability Information: Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score	Total Score	Feasibility	Recommendation
BCC1	1000	B (incised)	Riffles and pools are present and fairly frequent although riffles are slightly embedded. The stream bed is partially shaded and many habitat structures are common.	2.9	Riparian buffer on the right bank is a mature forest > 50' wide while the buffer on the left bank is vegetated with shrubs and trees and is < 10' wide. Active agricultural field situates the left bank throughout the reach. Invasive species such as Multiflora Rose and Oriental Bittersweet are present.	2.6	Stream may have been shifted to one side of valley in the past.	3	Bank erosion is minimal due to substantial root mass in both banks and moderate bank angle. Considerable sediment present in stream.	2.8	Homeowner has constructed a berm and stream is somewhat incised. Bank height ratio ranges from 1.5 to 2.0. No active headcuts are evident.	2.7	13.97	Access and workspace are available in farm field along entire left bank.	Enhancement II
BCC2	1000	E (incised)	Well shaded riffle/run dominated system with a few deep pools present. Habitat structures such as overhanging shrubs, large rocks, and woody debris are plentiful.	2.8	Banks are well vegetated with Rhododendrons, oak, maple, poplar, beech, and ironwood. A mature forest, exceeding a width of 50', situates the right bank while a fallow field borders the narrow buffer along the left bank.	3.2	Stream may have been shifted to one side of valley in the past.	3	Erosion is moderate with a few exposed bank areas. Root mass is dense and most erosion appears to have been caused by recent flooding events.	2.7	Past downcutting has occurred and bank height ratios range from 1.8 to 2.0.	2	13.70	Access and workspace are available in farm field along entire left bank.	Buffer Enhancement
BCC3	1600	Cb	Riffles and pools are present and fairly frequent although riffles are slightly embedded. The stream bed is partially shaded and many habitat structures are common.	3.3	Banks are vegetated with shrubs and trees but are exposed in several areas. Riparian buffer composition alternates between mature forest and grass on each bank and widths similarly fluctuate above and below 50' respectively.	2.9	No evidence.	4	Bank erosion is minimal reachwide due to substantial root mass and fairly gradual bank angles. One specific area spanning 100' contains severe bank erosion.	3.3	Channel has downcut in the past and re-established lower elevation flood benches in selected areas. Bank height ratio ranges from 1.0 to 1.5.	3.2	16.63	Access and workspace are available in field along left bank.	Buffer Enhancement
BCC4	1000	E (incised)	Riffles and pools are present and frequent although riffles are 60% embedded. The stream bed is partially to fully shaded. Variations in pool depth are excellent but habitat structures are lacking.	2.5	Invasive species such as Multiflora Rose and privet are abundant among scattered mature trees on both banks and within the floodplain on the right bank. Buffer widths vary from 0' to 20' along the left bank and exceeds a width of 50' along the right bank.	3.7	Stream may have been shifted to one side of valley in the past. Cow pasture spans the entire length of the left bank.	3	Bank angles are low except within constrictions and meanders where moderate to severe erosion is concentrated. Root mass is poor but cobble and boulders line the toe of bank in many areas.	2.6	Channel has downcut in the past and re-established lower elevation flood benches in selected areas. Bank height ratio ranges from 1.0 to 1.5.	2.8	14.63	Work space is available on both banks. Cow pasture, cattle fencing, and 2-3 fertilizing sheds situated along left bank.	Enhancement II

CBA

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
CBA1	1170	Cb	Riffles and pools are present but pools are lacking in frequency and depth while riffles are 40% embedded. Habitat structures are minimal and stream bed is exposed.	1.7	Banks are primarily exposed and devoid of vegetation except for grasses and forbes. Majority of stream corridor traverses a cow pasture and horse stables so the riparian buffer is absent on both banks.	0.4	Horse and cattle crossings are active along with evidence of straight piping to stream.	1	Banks are overly steep, raw, non-cohesive, and actively contributing excessive amounts of sediment to stream causing overwidening and braiding in a few areas.	0.6	Stream has downcut in the past and seldom has access to original floodplain. Bank height ratio is 2.0.	1.7	5.37	Work space is available on portions of both banks. Constraints include road within 50' of right bank, a few fences, and a barn within 10' of left bank.	Enhancement I
CBA2	900	B (incised)/G	Riffle cascades and short runs are prominent with fewer pools. Stream bed is partially shaded to exposed and a few habitat structures are present.	2.3	Banks are primarily exposed and only partially vegetated with a mix of grasses and shrubs. Majority of stream corridor traverses passive agricultural fields and a goat pasture and so the riparian buffer is sparse to absent on both banks.	1.4	Channel recently dug out from recent flooding events	2.5	Banks are overly steep, raw, and actively contributing moderate amounts of sediment to stream. Root mass is poor but an abundance of cobble and boulders in bank is preventing larger scale erosion.	1.8	Stream seldom has access to original floodplain. Bank height ratio ranges from 1.3 to 1.5. No active headcuts evident.	2.5	10.50	Work space is available on both banks upstream and on the right bank downstream. Constraints include driveway culverts, cattle fencing, and at least five structures within 50' of channel downstream.	Enhancement II
CBA3	500	B	Riffle/run dominated system lacking pool development and habitat structures. Stream bed is completely exposed to sunlight.	1.2	Riparian buffer is primarily absent as horse and cattle pastures span both banks. Banks are covered with grasses and forbes with shallow roots and in selected areas are minimally vegetated with Rhododendrons and invasives such as Multiflora Rose.	1.2	Horses and cattle have full access to channel. Heavy equipment/ATV crossings within channel.	0	Minimal erosion due to extremely low bank angles and cohesive bank material. Extreme amounts of sediment in the stream from headwater supply and gravel road upstream causing overwidening and braiding in some areas.	2.9	A few small active headcuts are evident downstream. Bank height ratio is 1.2.	2.7	7.97	Easy work access and minimal constraints.	Buffer Enhancement

CBB

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
CBB1	500	B/G	Riffle cascades and short runs are prominent with infrequent pools. Stream bed is partially shaded to exposed and habitat structures are rare.	2	Floodplain and bank vegetation is primarily grassy with extensive invasive species present such as Multiflora Rose. Riparian buffer width is limited to 10' to 15' on each bank.	2	No evidence.	4	Banks are steep, exposed, and severly eroding. Banks are fairly non-cohesive, root density is minimal but an abundance of cobble in bank is preventing larger scale erosion.	2.2	Stream seldom has access to original floodplain. Bank height ratio averages 1.5 but reaches 3.0 in some locations. No active headcuts evident.	2.67	12.87	Easy work access and minimal constraints.	Enhancement II
CBB2	500	B	Riffles and pools are present and frequent with a fully shaded stream bed. Variations in pool depths are excellent and several habitat structures are present and frequent.	1.8	Fairly well vegetated banks composed of alder, sycamore, and maple. Multiflora Rose is also plentiful along both banks. Floodplain vegetation is sparse to absent and primarily composed of grasses and forbes. Buffer width is generally 10' on each bank.	2.4	Stream has possibly been channelized in the past.	3.5	Moderate erosion with partially exposed banks.	2.6	The channel does not appear to have an active floodplain. Bank height ratio ranges from 1.5 to 2.0 and occasionally reaches 3.0 in a few locations.	2.50	12.80	Limited access and workspace due to road encroachment, fenceline, and utility building situated within 50' of channel.	Buffer Enhancement
CBB3	750	B/Cb	Riffle/run dominated system lacking pool development and habitat structures. Stream bed is completely exposed to sunlight and riffles are slightly embedded.	2.1	Floodplain and bank vegetation is sparse to absent and consists primarily of grass and scattered mature trees. Riparian buffer width is limited to 10' on each bank.	1.2	Recent channel alteration by homeowners from recent flooding events.	2	Bank erosion is moderate to severe as a result from recent flooding. Banks are exposed in several areas.	2.1	No evidence of headcuts. Bank height ratio is generally 1.0.	4.0	11.40	Workspace is available along portions of both banks. Constraints are minimal and include mature trees and barns/sheds bordering channel.	Buffer Enhancement

CBC

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
CBC1	530	G	Riffle dominated system with pools only present downstream of culverts. Stream bed is completely exposed, habitat structures are absent, and riffles are embedded.	0.6	Banks and floodplain are vegetated with grass. No riparian buffer is present.	0.6	Channel appears to be regularly maintained by homeowners. Four culverts span reach.	2	Root mass from grass-lined banks is minimal and no erosion is present. Channel is full of loose sand, small gravel, and silt.	2.7	No evidence of headcuts. Bank height ratio ranges from 1.5 to 2.2.	2.3	8.23	Workspace is available on both banks but would require access to private property. Four culverts span reach and a few structures are situated within 50' of channel.	Enhancement II
CBC2	1000	E (incised)	Riffles and pools are present with a partially shaded stream bed. Riffles are 60% embedded and several habitat structures are present and frequent.	2.7	Banks are typically well vegetated with shrubs and mature trees. Buffer width is 10' on each bank and hay fields comprise the floodplain vegetation along both banks.	2.8	No evidence.	4	Bank angle is generally less than 90 degrees with substantial root mass from mature trees holding banks. Banks are occassionally exposed with minimal erosion occurring.	3.2	No evidence of headcuts. Bank height ratio ranges from 1.5 to 2.0.	2.5	15.20	Workspace is available within hay fields bordering both banks. Fence line parallels left bank.	Buffer Enhancement
CBC3	520	B	Partially shaded riffle/run dominated system with minimal pool development. A few habitat structures are present including overhanging shrubs and large rocks.	2.1	Banks are typically well vegetated with shrubs and fewer mature trees. Buffer width is less than 20' on each bank and grasses/forbes comprise the floodplain vegetation along both banks.	2.2	Past reinforcement of banks with riprap in selected areas.	4	Mild to moderate erosion in localized areas containing poor root mass and exposed banks.	3	No evidence of headcuts. Bank height ratio ranges from 1.2 to 1.8.	2.7	13.97	Workspace is available. Constraints include a road within 50' of channel, one structure within 15' of channel, and overhead electric intersecting the reach.	Buffer Enhancement

CCA

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
CCA1	500	E	Partially to fully shaded channel dominated by frequent riffles and pools. Riffles are embedded, but several habitat structures are present and frequent.	3.4	Banks are typically well vegetated with shrubs and mature trees. Buffer width is less than 20' on each bank and grasses/forbes comprise the floodplain vegetation along both banks. Invasives are plentiful downstream of headcut.	2.3	No evidence.	4	Minimal erosion present due to fairly low bank angles and ample root mass. Sediment levels are high in the stream.	2.4	One headcut is present but bank height ratio is generally 1.0 throughout reach. Woody debris jam midreach is holding grade upstream of headcut. Lower elevation flood benches have formed within channel.	3	15.10	Workspace is available. Constraints include a road within 100' of the left bank and a few fences throughout the reach.	Buffer Enhancement
CCA2	820	B (incised)	Riffle/run dominated system with minimal pool development and no cover from sunlight. Habitat structures are severly lacking in variety and frequency.	1.5	Banks are fairly exposed and are primarily vegetated with grass and a few mature trees. Buffer is sparse to absent.	0.7	Channel alteration, bank stabilization, and culvert removal/repair have recently been conducted in repsonse to flood events.	0	Extensive erosion and exposed banks throughout reach.	1.9	Bank height ratio ranges from 1.3 to 2.0.	3	7.10	Workspace is available. Constraints include a road within 100' of the left bank, overhead electric paralleling right bank, and culverts throughout reach.	Enhancement II

CCB

			Biological Information				Geomorphic and Stability Information						Total Score	Feasibility	Recommendation
Reach	Length (ft)	Rosgen Stream Type	Habitat	Average Score	Existing Riparian Vegetation	Average Score	Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score			
CCB1	500	E	Riffles and pools are present and fairly frequent. Riffles are embedded and some pools have filled with sediment. The bed is mostly shaded with ample overhanging shrubs present.	2.3	Banks are typically well vegetated with shrubs and mature trees. Buffer width is less than 20' on each bank.	2.9	No evidence.	4	Moderate erosion and exposed banks in localized areas. An abundance of in-stream sediment causing filling of pools and mid-channel bars.	1.6	One headcut is present midreach. Bank height ratio ranges from 1.0 to 1.8.	2.5	13.30	Workspace is available along portions of both banks. Constraints include a road within 50' of the left bank, a few fences, and a home within 35' of the right bank.	Enhancement II
CCB2	990	E	Riffle dominated system with minimal pool development and no cover from sunlight. Habitat structures are severly lacking in variety and frequency. Riffles are embedded.	1.4	Banks and floodplain are primarily vegetated with grass and a few shrubs. No riparian buffer is present.	1.1	Channel alteration and bank stabilization have recently been conducted in repsonse to flood events.	2	Extensive erosion, exposed banks, and instream sediment throughout reach.	1.3	No evidence of active downcutting.	3.7	9.47	Workspace is available on both banks. Constraints include a road within 50' of the right bank, a few structures within 35' of the left bank, and overhead electric lines intersecting lower reach.	Restoration
CCB3	500	G/F	Riffle/run dominated system with minimal instream cover and a few habitat structures present.	2	Banks and floodplain are primarily vegetated with grass and a few trees and shrubs. Buffer width is less than 10' on each bank with an abundance of invasives such as Muliflora Rose and Japenese Honeysuckle.	1.5	Urban debris scattered within channel. May have been channelized in the past.	3	Mild to severe erosion with several locations of exposed banks. Sediment levels are high in the stream.	2.1	Channel is incised and generally disconnected with the floodplain. A few small headcuts are active.	2.2	10.77	Workspace is available along portions of both banks. Fences and sheds are prevalent throughout the reach within 50' of channel. A few mature trees are also present.	Enhancement I

CCC

Reach	Length (ft)	Rosgen Stream Type	Biological Information: Habitat	Average Score	Existing Riparian Vegetation	Average Score	Geomorphic and Stability Information: Human Impacts	Average Score	Erosion	Average Score	Incision	Average Score	Total Score	Feasibility	Recommendation
CCC1	1025	E	Riffle/run dominated system with minimal instream cover and embedded riffles. Only a few habitat structures are present.	1.2	Banks are partially vegetated and primarily consist of invasives such as Privet, Multiflora Rose, and Oriental Bittersweet. Some mature trees are also present on both banks. Buffer widths are less than 10' on each bank.	1	Stream has possibly been channelized in the past. Banks have been re-stabilized in selected areas as a result of recent flooding.	2	Banks are often exposed with only mild to moderate erosion due to cohesive soils and ample root mass. One area of severe bank erosion as a result from hillside drainage and recent flooding.	2.3	Channel is slightly incised and occassionally has access to floodplain. No evidence of headcuts.	2.7	9.17	Workspace is available in farm field on right bank, but would require private property access.	Buffer Enhancement
CCC2	1400	E	Riffles are slightly embedded with a fair variation in pool depths and a partially shaded stream bed. Habitat structures such as woody debris and overhanging shrubs are plentiful.	2.5	Banks are partially vegetated with a mix of mature and young hardwoods including sycamore, red maple, locust, alder, and tuliptree. Invasives such as Bittersweet and Multiflora Rose are also present. Fallow fields border each bank and buffer widths are less than 10'.	1.5	Stream has possibly been channelized in the past.	3	Banks are often exposed with minimal erosion due to fairly cohesive soils and ample root mass.	2.9	Channel has downcut in the past and re-established lower elevation flood benches in selected areas. Bank height ratio ranges from 1.0 to 1.5	2.7	12.57	Workspace available in fallow fields bordering each bank.	Buffer Enhancement
CCC3	1000	E/G	Riffle/run dominated system with minimal instream cover and moderately embedded riffles. Only a few habitat structures are present.	1.8	Existing riparian buffer is fairly mature but narrow on both banks. Banks are partially vegetated to exposed. Fallow fields border each bank.	1.5	Recent impacts to buffer are evident in addition to bank reinforcement efforts along the right bank adjacent to Beaverdam Rd.	3	Banks are often exposed with moderate to severe erosion. Banks are lined with woody debris from recent flooding events.	2.2	Channel has downcut in the past and is disconnected from floodplain. Bank height ratio ranges from 1.2 to 2.0.	2.0	10.50	Workspace available in fallow fields bordering each bank.	Bank Stabilization/Buffer Enhancement
CCC4	990	C	Embedded bedrock step pool system lacking habitat structures and stream bed cover.	1.4	Banks are partially vegetated with a mix of young shrubs and trees. Buffer width is less than 10' on each bank.	1.5	Banks have been re-stabilized in selected areas as a result of recent flooding. Channelization is also evident.	2.5	Banks are often exposed with moderate erosion. Pools are filled in and substrate is covered with sediment.	2.5	Channel has occassional access to floodplain. Bank height ratio ranges from 1.2 to 1.8.	2.8	10.73	Workspace is available along portions of both banks. Constraints include 2 bridge intersections, livestock encroachment, a few fences, and a house within 75' of channel.	Enhancement I
CCC5	960	E	Riffles and pools are present and fairly frequent. Riffles are slightly embedded pool depth variations are well represented. Channel is exposed to sunlight.	2.4	Banks are primarily exposed and sparsely vegetated with grass in some areas. No buffer present.	0.6	Cattle and mules have access to stream. Stream has possibly been channelized in the past.	2	Mild erosion with extensive areas of bank exposure. Large amounts of sediment moving through system.	1.8	Channel has frequent access to floodplain. Bank height ratio average is 1.0. Few small headcuts migrating upstream.	3	9.80	Workspace is plentiful in pasture on both banks. Constraints include active cattle/mule pasture, barbed wire fence, and a few barns within 35' of channel.	Restoration

Appendix 5
Assessment Metric Value Ranges

Assessment Functions and Metrics	*Assessment Metric Value Range per Function Rating*		
	F	*FR*	*NF*
Habitat Function			
Habitat Field Assessment	> 80	80-50	< 50
Land Use	Forested	Forested/Agriculture	Forested/Agriculture/Residential
Habitat Fragmentation	Assigned higher functional ratings to those FAU's continaing larger, contiguous areas or patches of minimally impacted land uses suitable for habitat. Such land uses included forested lands, natural herbaceous lands, shrub/grassy balds, fallow fields, we		
Riparian Corridor Condition	Intact (buffer width > 30 feet on both banks)	Moderate Impact (buffer width < 30 feet on both banks or > 30 on one bank and absent on the other)	Severe Impact (buffer absent on both banks or absent on one bank and buffer width < 30 feet on the other)
Substrate Analysis	RAC's having a unimodal distribution of substrate with a diverse mix of class sizes ranging from fine (silt) to very coarse (cobbles and boulders) generally received higher functional ratings. RAC's having a bimodal distribution of substrate and/or a pro		
Hydrologic Function			
Bank Height Ratio	less than or equal to 1.0	1.1 - 1.5	> 1.5
Width/Depth Ratio	8 -16	8 - 6 or 16 - 20	< 6 or > 20
Incision (from Channel Evaluation Form)	> 3	2 - 3	< 2
Riparian Corridor Condition	Intact (buffer width > 30 feet on both banks)	Moderate Impact (buffer width < 30 feet on both banks or > 30 on one bank and absent on the other)	Severe Impact (buffer absent on both banks or absent on one bank and buffer width < 30 feet on the other)
Sediment Transport	RAC's having an existing depth or slope that is approximately 2 times greater or less than the required (critical) depth or slope as determined from the competency analysis generally received a rating of 'Not Functioning'. Such an increase or decrease i		
BEHI	< 50 tons per 1000 feet of stream channel	50 - 1000 tons per 1000 feet of stream channel	> 100 tons per 1000 feet of stream channel
Land Use	Forested	Forested/Agriculture	Forested/Agriculture/Residential
Water Quality Function			
Ambient Monitoring Data (DWQ)	RAC's within monitored subwatersheds reporting several exceedances in bench mark values (for field parameters, nutrients, and fecal coliform bacteria) typically received a rating of 'Not Functioning'.		
Benthic Monitoring Data (DWQ)	Excellent - Good	Good Fair - Not Impaired	Fair - Poor (includes Not Rated for small non-reference streams)
Fish Monitoring Data (DWQ)	Comprehensive review of fish community data including tolerance ratings, adult trophic guild assignments, species abundance, and electroshocking data		
Riparian Corridor Condition	Intact (buffer width > 30 feet on both banks)	Moderate Impact (buffer width < 30 feet on both banks or > 30 on one bank and absent on the other)	Severe Impact (buffer absent on both banks or absent on one bank and buffer width < 30 feet on the other)
BEHI	< 50 tons per 1000 feet of stream channel	50 - 1000 tons per 1000 feet of stream channel	> 100 tons per 1000 feet of stream channel
Erosion (from Channel Evaluation Form)	< 3	2 - 3	< 2
Land Use	Forested	Forested/Agriculture	Forested/Agriculture/Residential

Summary of Water Quality Monitoring Results in South Hominy Creek and its Tributaries, French Broad River Basin

Prepared by the Division of Water Quality, North Carolina Department of Environment and Natural Resources

Prepared for the North Carolina Ecosystem Enhancement Program

February 2005

From December 2003 to January 2005, the Division of Water Quality (DWQ) conducted ambient water monitoring in South Hominy Creek and several of its tributaries (DWQ Subbasin 04-03-02) to support the North Carolina Ecosystem Enhancement Program's planning efforts in this area. This summary documents the nature of these monitoring activities and briefly describes the major water quality patterns observed during this study. Major findings and notable differences in water chemistry among the sampling sites and between stormflow and baseflow are discussed. Comparisons are made to existing water standards and criteria, and summary tables are provided for all monitoring sites.

I. DESCRIPTION OF STUDY PLAN

The Ecosystem Enhancement Program (EEP) Hydrological Unit 06010105060020 planning area is the South Hominy Creek watershed, an approximately 38 square mile area located southwest of Asheville and entirely within Buncombe County (Figure 1). South Hominy Creek is a major tributary to Hominy Creek. The main tributaries to South Hominy Creek are Stony Fork, Beaverdam Creek, Glady Fork and Warren Creek. The majority of the watershed's underlying geology is characterized by Muscovite-Biotite Gneiss, though Biotite Gneiss characterizes a small section along the western boundary. Ten of the twenty-nine soil series within the watershed represent approximately 85 percent of the area, and all are well-draining soils. Wetlands are primarily present in the Upper and Middle South Hominy Creek drainage areas, though a few wetlands occur in the Beaverdam Creek drainage. There are few to no wetlands present in the lower South Hominy drainage. The watershed contains several significant and/or rare ecological communities and species, specifically on Mt. Pisgah, Ben's Ridge and Coves, Spring Mountain, and the high elevations of HWY 151 (see Technical Memorandum 1, 2004)

There are no hazardous material sites and one minor NPDES permitted point source discharge within the study area. Laurelwood Mobile Home Park has a domestic subsurface sandfilter wastewater treatment facility (2000 gallons per day) which discharges into Beaverdam Creek.

A. Water Sampling

To provide supplemental information to support the Local Watershed Plan being developed for this area by EEP, DWQ conducted chemical-physical monitoring at thirteen sites (Figure 1). Detailed information about the types of data collected and the location of each site is provided in Table 1.

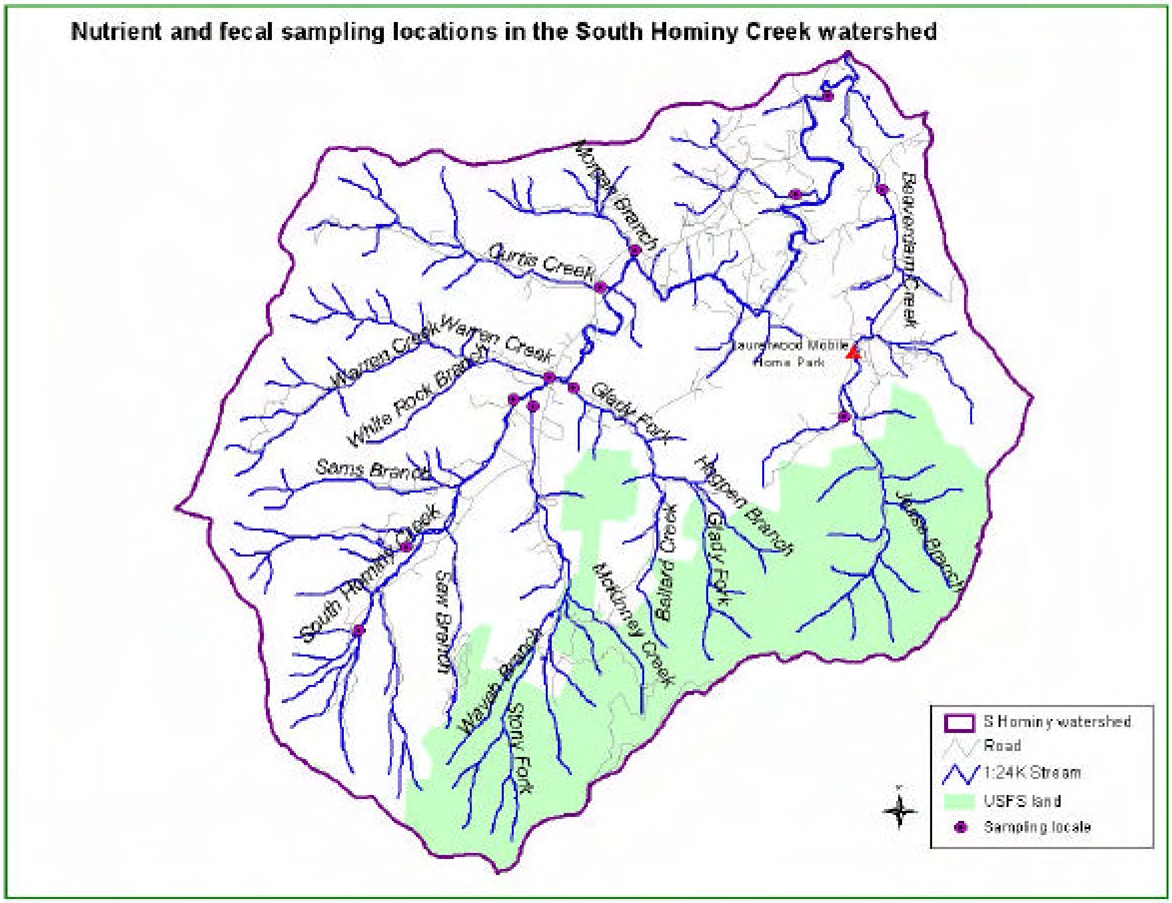

Figure 1: Sampling sites in the South Hominy Creek Watershed.

Site # (See Figure 1)	Location [ID #]	Benthos July 2004	Fish	Water Quality
1	South Hominy @ Old Hwy 151 [FRB02_B001]			
2	South Hominy Cr @ SR 3451 / Hominy Creek Rd [FRB02_B002]		x	**x**
3	Youngs Cove @ SR 3452 / Bailey Rd [FRB02_B003]	x		**x**
4	Morgan Branch @ NC 151 [FRB02_B004]			**x**
5	Curtis Cr @ NC 151 [FRB02_B005]	**x**		**x**
6	Warren Cr @ NC 151 [FRB02_B006]	**x**		
7	Glady Fork @ SR 3452/Upper Glady Rd [FRB02_B007]	**x**	**x**	**x**
8	South Hominy Cr @ SR 1109/Pisgah View Rd [FRB02_B008]	**x**	**x**	**x**
9	Stony Fork @ SR 1109/Pisgah View Rd [FRB02_B009]		**x**	**x**
10	Pisgah View Cr @Pisgah View Ranch Rd [FRB02_B010]		x	
11	South Hominy Cr @ Pisgah View Ranch campground off SR 1105 [FRB02_ B011]	x		**x**
12	Smith Cove @ SR 3449/Beaverdam Loop [FRB02_ B012]	x		**x**
13	Beaverdam Cr @ Beaverdam Rd [FRB02_B013]		**x**	**x**

Table 1: Locations and monitoring conducted at each sampling site in the South Hominy Creek watershed.

Three sites are located on the mainstem of South Hominy Creek and ten are positioned on smaller tributary creeks. Periodic samples were collected under both baseflow and stormflow conditions at one site on the main stem of South Hominy Creek from December 2003 through January 2005. The additional twelve sites were sampled on three separate dates during baseflow conditions. Baseflow conditions were defined as those that occurred at least 48 hours after measurable precipitation was recorded. Stormflow conditions were those that occurred within 48 hours of measureable precipitation, and all stormflow samples were collected during rising stream stage. All samples were grab samples, collected at surface depth (0.15 meters). Chemical and physical monitoring were conducted according to the procedures described in the Intensive Survey Unit's Standard Operating Procedures (SOP) manual (NCDWQ, 2003) and the DWQ Laboratory Section's sample submission guidance (NCDWQ, 2002).

Stream temperature, dissolved oxygen concentration, oxygen saturation, pH, and specific conductance were measured in the field. For all other parameters, samples were collected in the field and sent to the DWQ laboratory for analysis. Standard parameters included: suspended residue, turbidity, fecal coliforms, metals, and nutrients. The sample preservation procedures that were followed are available on the DWQ Laboratory Section website. DWQ Lab Methods and Practical Quantitation Limits (PQLs) for all parameters are provided in Table 2.

Parameter	EPA Method[1]	APHA Method[2]	Other Method	PQL	Revision Date
Coliform, MF fecal	600/8-78-017	9222D		1 colony/100mL	3/13/01
Susp. residue	160.2	2540D		2 mg/L	3/13/01
Susp. fixed residue	160.4			2 mg/L	3/13/01
Susp. volatile res.	160.4			2 mg/L	3/13/01
Turbidity	180.1	2130B		1 NTU	3/13/01
NH_3 as N	350.1 and 350.2		QUIK CHEM 10-107-06-1-J	0.01 mg/L	7/24/01
TKN as N	350.1 and 351.2		QUIK CHEM 10-107-06-2-H	0.20 mg/L	7/24/01
NO_2+ NO_3 as N	353.2		QUIK CHEM 10-107-04-1-C	0.01 mg/L	7/24/01
P total as P	365.1		QUIK CHEM 10-115-01-1-EF	0.02 mg/L	7/24/01
Copper (Cu)	200.8/220.2			2.0 µg/L	3/13/01
Nickel (Ni)	200.8/200.7			10 µg/L	3/13/01
Lead (Pb)	200.8/239.2			10 µg/L	3/13/01
Zinc (Zn)	200.8/200.7			10 µg/L	3/13/01
Aluminum (Al)	200.7			50 µg/L	3/13/01
Iron (Fe)	200.7			50 µg/L	3/13/01
Manganese (Mn)	200.8/200.7			10 µg/L	3/13/01
Sodium (Na)	200.7			0.10 mg/L	7/24/01
Calcium (Ca)	200.7			0.10 mg/L	3/13/01
Magnesium (Mg)	200.7			0.10 mg/L	3/13/01
Arsenic (As)	200.8/206.2			10 µg/L	3/13/01
Mercury (Hg)	245.1			0.02 µg/L	3/13/01
Silver (Ag)	200.8/272.2			5 µg/L	3/13/01
Chromium (Cr)	200.8/200.7			25 µg/L	3/13/01
Cadmium (Cd)	200.8/213.2			2.0 µg/L	3/13/01

1. Information on EPA methods is available at http://h2o.enr.state.nc.us/lab/qa/pqlinorg.htm.
2. APHA reference: Standard Methods for the Examination of Water and Wastewater, 18th ed.

Table 2: DWQ Laboratory Section Methods and Practical Quantitation Limits (PQL).

II. Summary of Results

This section provides a synopsis of water quality patterns observed at the thirteen sampling sites. Complete site summaries are provided in Section III.

A robust sampling plan was implemented at South Hominy Creek at Old Hwy 151, the furthest downstream site sampled in this study, while a more limited sampling scheme was conducted at the remaining twelve sites. The following parameters were measured exclusively at South Hominy Creek at Old Hwy 151: trace metals (aluminum, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, and zinc), major cations (calcium, sodium, and magnesium), residue (suspended, fixed, and volatile), and turbidity. Sampling at South Hominy Creek at Old Hwy 151 was conducted on sixteen dates between December 2, 2003 and December 22, 2004.

A. Metals

Of the twelve metals analyzed, all but arsenic (As), cadmium (Cd), and silver (Ag) were found at analytically reportable concentrations (Figure 3). For each element, benchmark values have been established to provide an estimate of the highest concentration of a pollutant to which an aquatic community can be exposed indefinitely (chronic limit) without resulting in an unacceptable effect (US EPA Water Quality Standards Database 2004). Aluminum (Al) exceeded benchmark concentrations in all but one of the sixteen samples, while Iron (Fe) exceeded the benchmark concentrations in seven samples. Both of these elements are major constituents of the native soils of this area and were the only metals to exceed benchmark concentrations in baseflow samples (Reid, 1993).

Manganese (Mn) concentrations were higher than the benchmark concentration in three storm samples, while copper (Cu) and lead (Pb) each surpassed the benchmarks in two storm samples. Chromium (Cr), copper (Cu), lead (Pb), and nickel (Ni) were only detectable in stormflow samples, and both nickel and chromium were found at concentrations above their respective analytical reporting limits (10 and 25 micrograms per liter) only in the stormflow sample taken during Hurricane Frances.

Metals (total, mg/L)		**Al**	**As**	**Cd**	**Cr**	**Cu**	**Fe**	**Pb**	**Mn**	**Hg**	**Ni**	**Ag**	**Zn**
Benchmarks		87	150	0.25	11	9.0	1000	2.5	120	0.77	52	0.36	120
Detection levels			*10*	*2**	*25**	*2*		*10**		*0.2*	*10*	*5**	*10*
12/2/2003	Base flow	**130**	U	U	U	U	210	U	17	U	U	U	U
12/10/2003	Storm flow	**6100**	U	U	U	8.8	**7600**	U	**180**	U	U	U	33
1/21/2004	Base flow	73	U	U	U	U	140	U	13	U	U	U	U
3/2/2004	Base flow	**160**	U	U	U	U	250	U	15		U	U	U
3/18/2004	Storm flow	**470**	U	U	U	U	680	U	28	U	U	U	U
3/25/2004	Base flow	**170**	U	U	U	U	270	U	14		U	U	U
4/20/2004	Base flow	**340**	U	U	U	U	490	U	20		U	U	U
4/26/2004	Storm flow	**1800**	U	U	U	3.5	**2500**	U	91		U	U	16
5/13/2004	Storm flow	**740**	U	U	U	U	**1100**	U	41		U	U	U
5/25/2004	Base flow	**920**	U	U	U	U	**1200**	U	34		U	U	13
6/15/2004	Storm flow	**1100**	U	U	U	**14.0**	**15,000**	**11**	**340**		U	U	60
9/7/2004 Storm flow Hurricane Frances		**31,000**	U	U	**33**	**34.0**	**40,000**	**31**	**1200**		17	U	**180**
9/22/2004	Base flow	**580**	U	U	U	U	840	U	61		U	U	U
10/19/2004	Storm flow	**660**	U	U	U	U	**1100**	U	80		U	U	U
12/2/2004	Base flow	**130**	U	U	U	U	270	U	43		U	U	U
12/22/2004	Base flow	**98**	U	U	U	U	200	U	36	U	U	U	U

Table 3: Metals Concentrations (µg/L) at South Hominy Creek at Old Hwy 151. Values exceeding benchmark concentrations in Table 4 are in **bold** font. Asterisks indicate that detection levels are higher than benchmark values. A "U" indicates that concentrations were below detection levels. Mercury (Hg) was only sampled on five dates.

	Sources in order of priority:			
Element	**EPA National Water Quality Standards Database, 2004**	**EPA National Recommended Water Quality Criteria, 1999**	**Risk Assessment Information System (RAIS)**	**USGS Paper, LI Briel, 1997**
Aluminum		87.00		
Arsenic	150.00			
Cadmium	0.25			
Chromium	11.00			
Copper	9.00			
Iron		1000.00		
Lead	2.50			
Manganese			120	
Mercury	0.77			
Nickel	52.00			
Potassium				0.80
Silver			0.36	
Zinc	120.00			

Table 4: Benchmark concentration ranges for metals (µg/L).

B. Major Cations

Magnesium (Mg) was highly influenced by flow. Magnesium was recorded at concentrations below the benchmark concentration of 1.1 mg/L in every baseflow sample, but exceeded benchmark concentrations in all but one of the seven storm samples (Figure 2). Baseflow calcium (Ca) concentrations ranged from 1.5 to 2.5 mg/L. With the exception of two stormflow samples, which exceeded the benchmark value of 3.4 mg/L, stormflow concentrations were only slightly higher than baseflow concentrations, ranging from 2.0 to 3.0 mg/L. Sodium (Na) concentrations exhibited minimal fluctuation between baseflow and stormflow events. All sodium concentrations varied from 1.6 to 2.2 mg/L and were below the benchmark value of 2.6 mg/L.

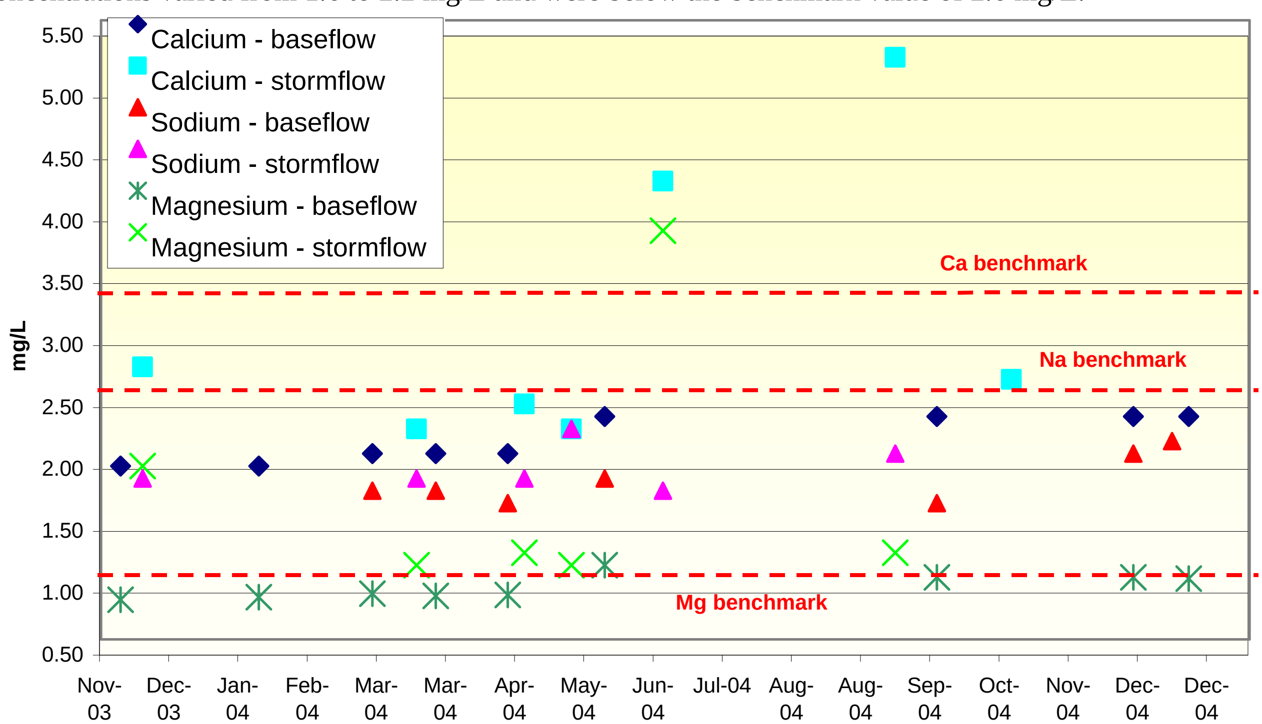

Figure 2: Concentrations of major cations (calcium, sodium, and magnesium) at baseflow and stormflow.

C. Residue

Suspended, volatile, and fixed residue concentrations were at or below 15 mg/L in all baseflow samples (Figure 3). Stormflow suspended residue concentrations were more variable. The median stormflow suspended residue concentration (43 mg/L) was almost 1,000% higher than the median baseflow concentration (4.5 mg/L). During extreme storm events, suspended residue increased to concentrations as high as 1,240 mg/L.

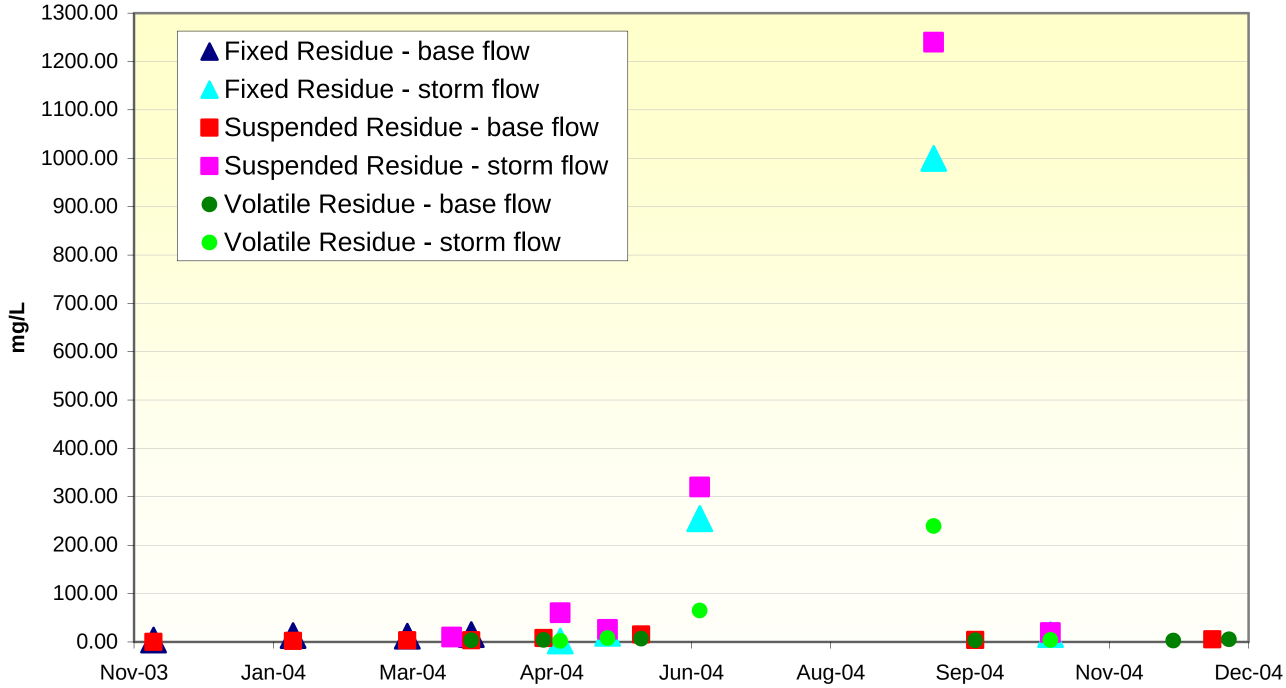

Figure 3: Suspended, fixed, and volatile residue concentrations at South Hominy Creek at Old Hwy 151.

D. Turbidity

Stormflow turbidity exceeded the state standard of 50 NTU in fifty percent of sampling events (Figure 4). All baseflow turbidity measurements were below 12 NTU with the exception of a turbidity recording of 500 NTU taken downstream of a direct discharge into the stream on 10/28/04. As observed in metals concentrations, turbidity was highest (550 NTU) in a sample taken during Hurricane Frances on 9/7/04.

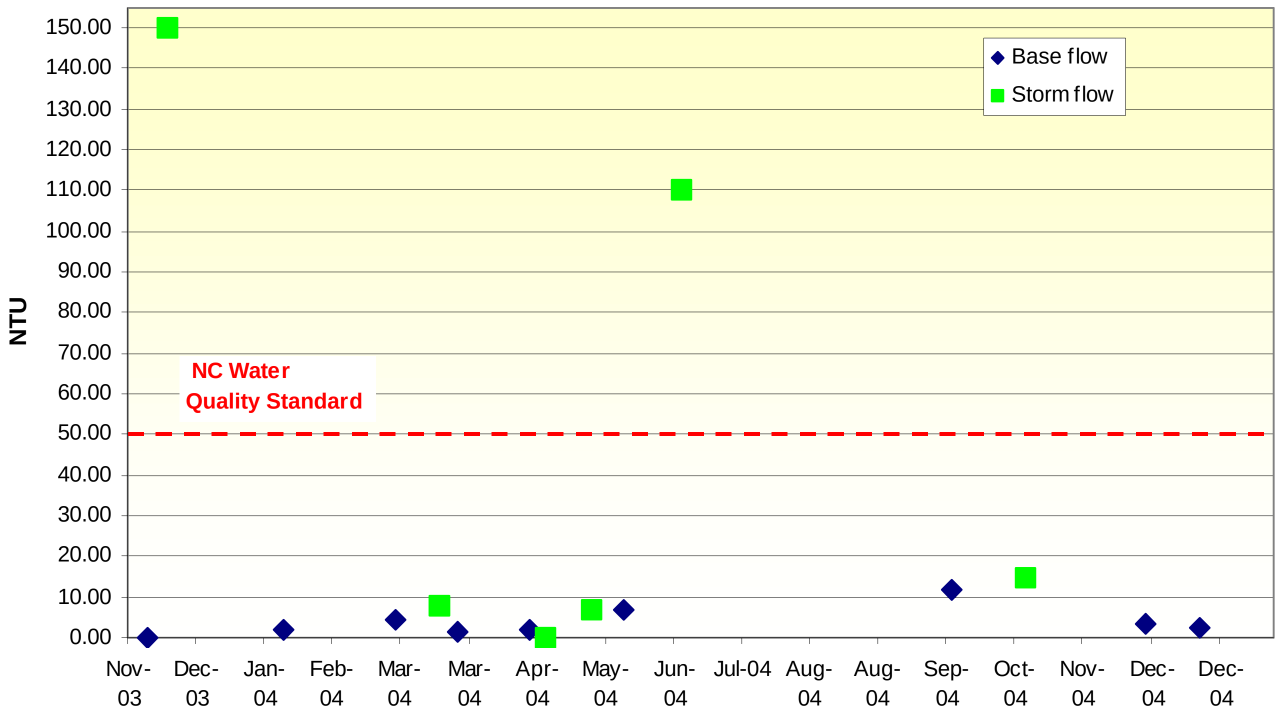

Figure 4: Turbidity recordings at South Hominy Creek at Old Hwy 151.

E. Field Parameters

Field parameters (including dissolved oxygen and specific conductance), fecal coliform bacteria, and nutrients (ammonia nitrogen, nitrate plus nitrite nitrogen, total Kjeldahl nitrogen (TKN), and total phosphorus) were measured at thirteen sites in the South Hominy watershed on 9/22/04, 12/2/04, and 12/16/04.

Dissolved oxygen concentrations followed a similar trend on 12/2/04 and 12/16/04. On both dates, DO remained fairly constant at the six most upstream sites, decreased over the next several sites, and gradually increased at the most downstream sites in the watershed (Figure 5). This pattern was not repeated on 9/22/04, when greater variability in DO concentrations was exhibited.

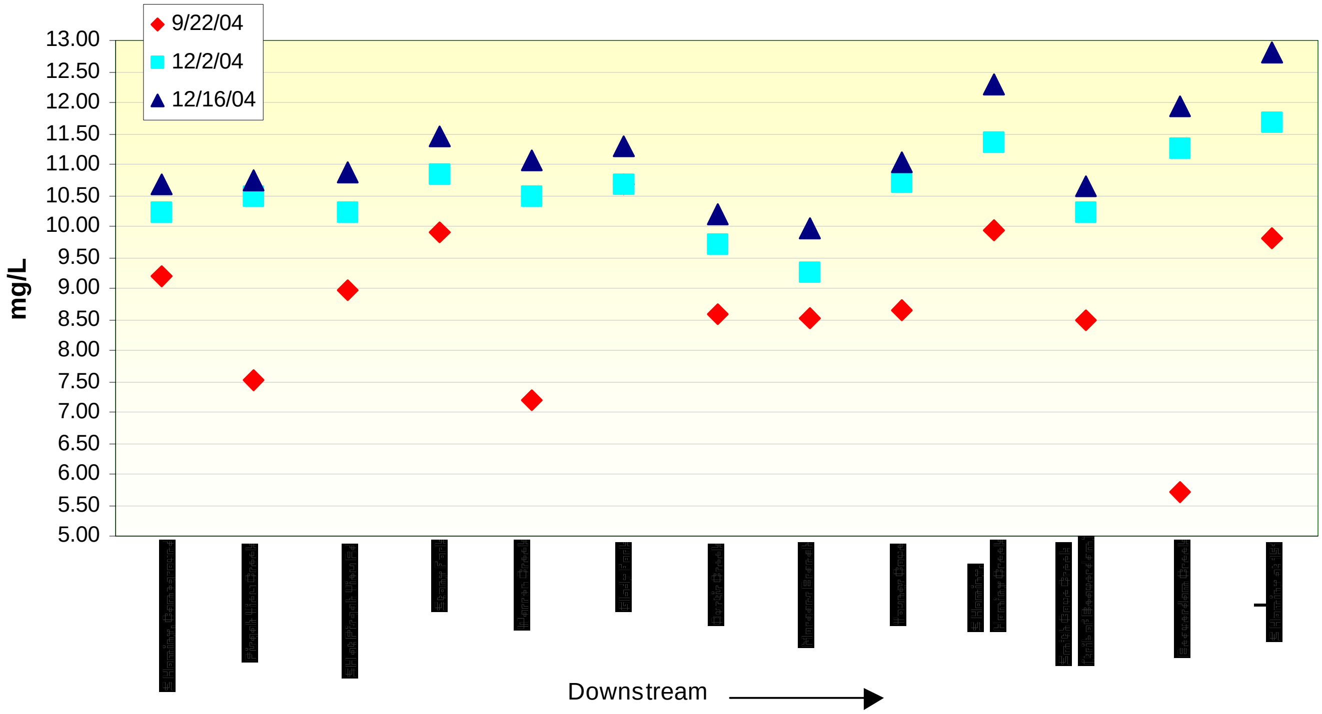

Figure 5: Dissolved oxygen concentrations at all sites at baseflow.

Comparisons of dissolved oxygen concentrations at baseflow and stormflow at South Hominy Creek at Old Hwy 151 indicate that DO decreased slightly in stormflow samples (Figure 6). While variation in both baseflow and stormflow samples was observed, the median baseflow concentration (10.57 mg/L) was only slightly higher than the median stormflow concentration (10.05 mg/L).

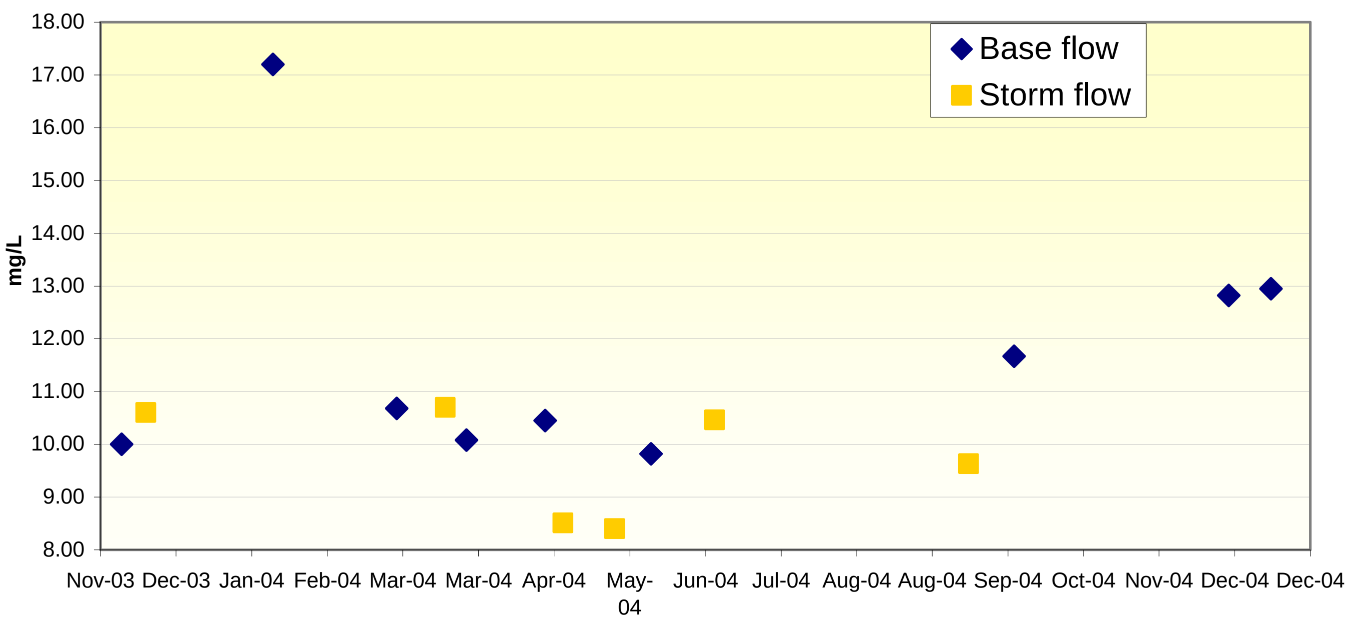

Figure 6: Stormflow and baseflow dissolved oxygen concentrations at the South Hominy at Route 151 site.

Specific conductance exceeded the benchmark value of 45 µg/L in all three samples taken at Morgans Branch and at Youngs Cove (Figure 7). All samples at the other eleven sites had specific conductance concentrations below the benchmark value. Excluding Morgans Branch and Youngs Cove, there is a gradual increase in specific conductance from the upstream to the downstream sites.

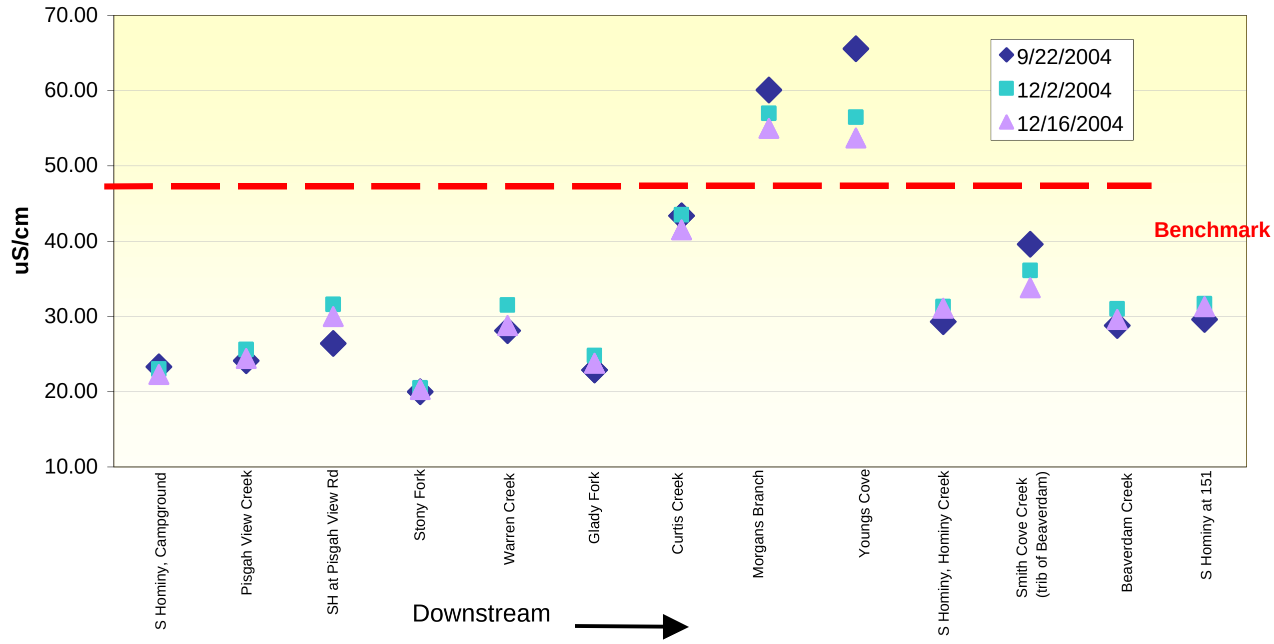

Figure 7: Specific conductance at all sites at baseflow.

Both stormflow and baseflow specific conductance remained below the benchmark value at South Hominy Creek at Old Hwy 151 (Figure 8). Baseflow specific conductance ranged from 28 µg/L to 32 µg/L, while stormflow specific conductance demonstrated much greater variability, extending from a low of 29 µg/L to a high of 41 µg/L.

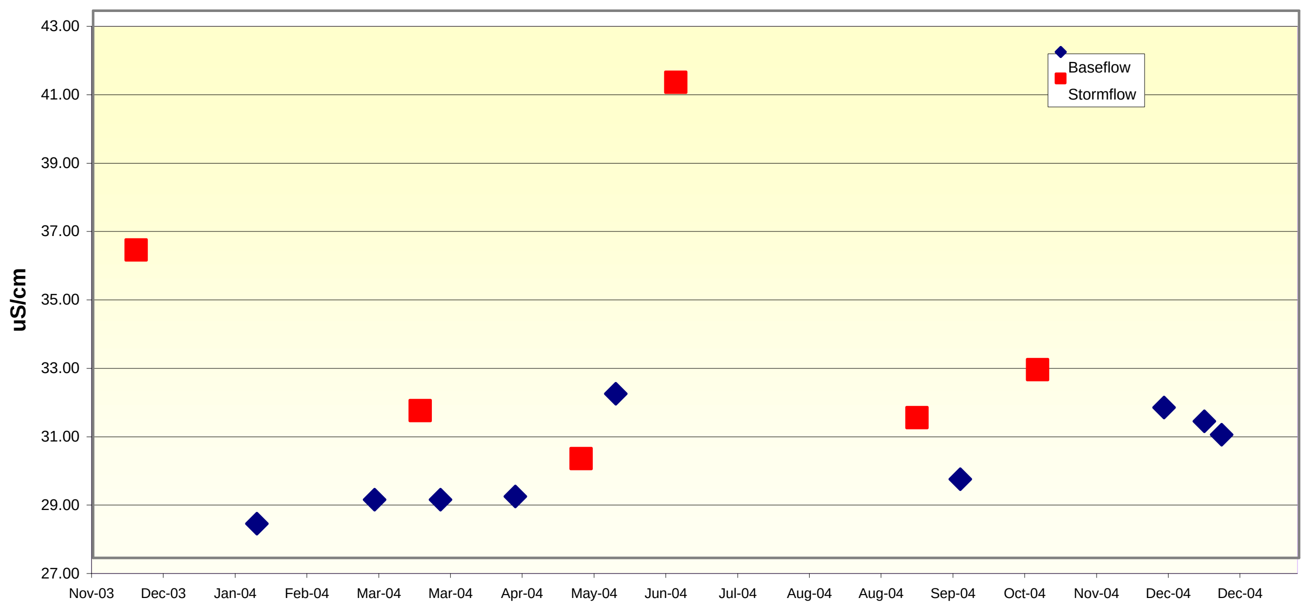

Figure 8: Stormflow and baseflow specific conductance at South Hominy Creek at Old Hwy 151.

Water temperatures follow the same trend in all three samples. Temperatures remain relatively constant in the six most upstream sites in the watershed, increase in the middle of the watershed, and generally decline in the downstream section of the watershed (Figure 9).

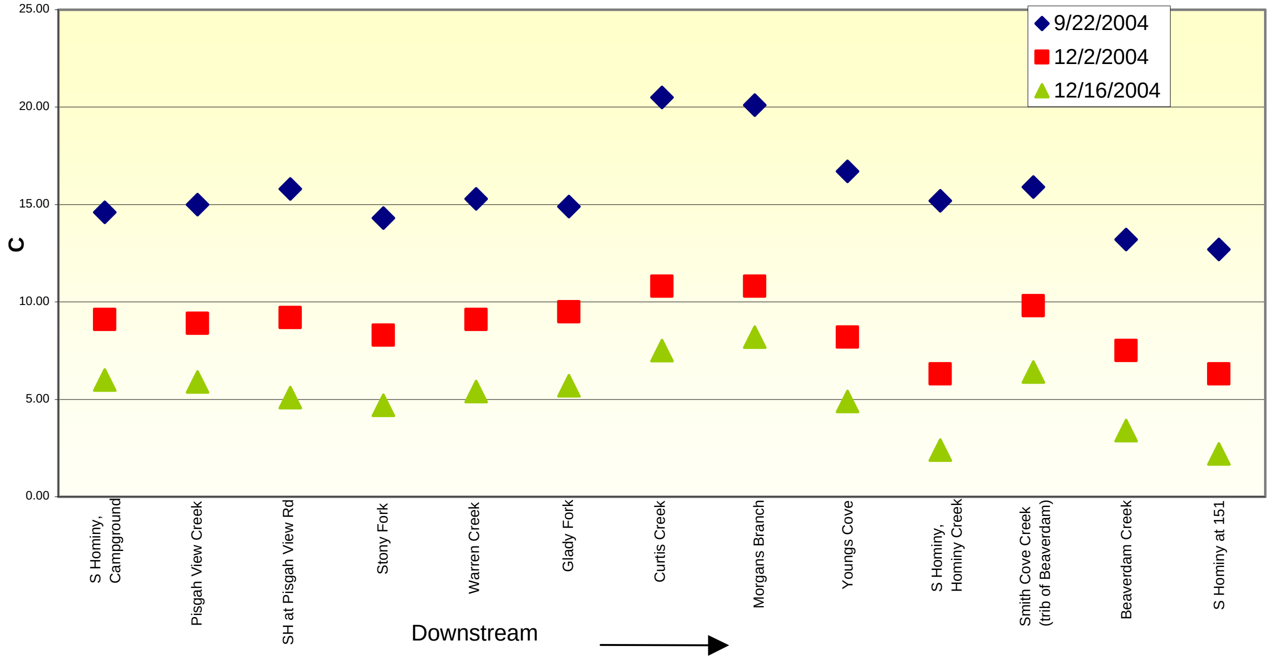

Figure 9: Water temperature at all sites at baseflow.

F. Fecal Coliform Bacteria

Four sites, Warren Creek, Morgans Branch, Youngs Cove, and Beaverdam Creek, exceeded the NC Water Quality Standard for fecal coliform of 200 colonies/100ml as a geometric mean (Figure 10). Stormflow samples taken at the South Hominy Creek at Old Hwy 151 site exhibited an extremely high geometric mean concentration of 3,543 colonies per 100 mL.

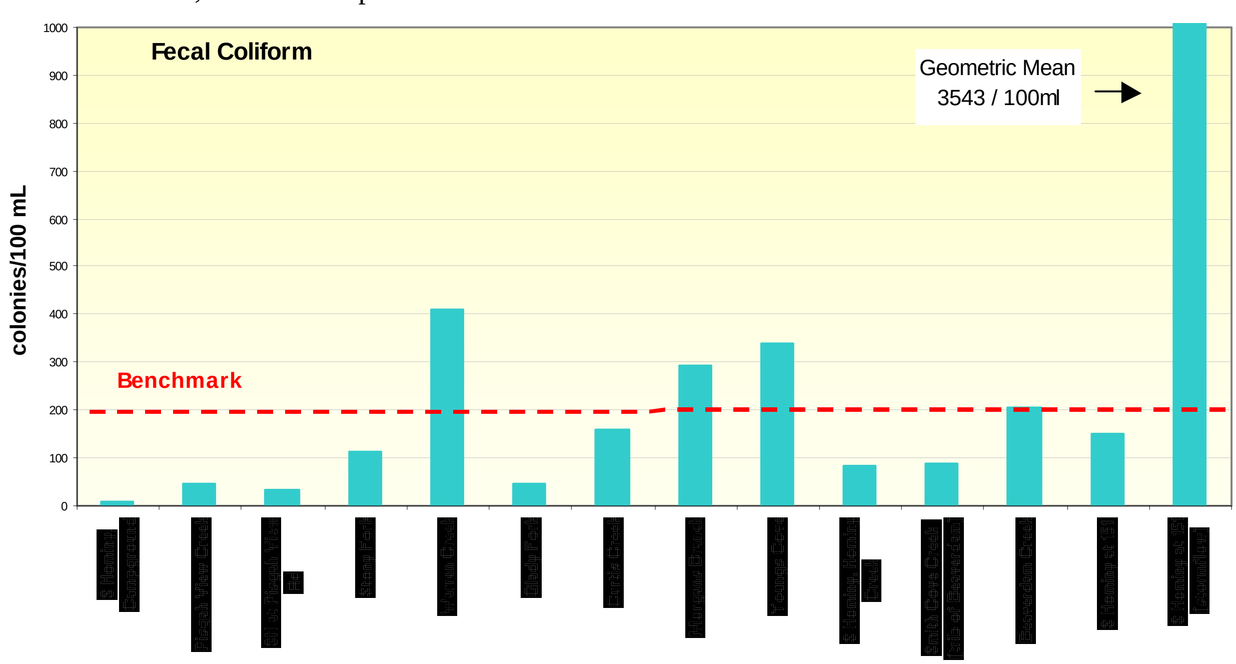

Figure 10: Fecal coliform geometric means for all sites.

G. Nutrients

Ammonia nitrogen concentrations were below detection levels in all but one sample (Figure 11). The sample taken at Glady Fork on 9/22/04 recorded a concentration of ammonia (0.06 mg/L) above the benchmark value of 0.05 mg/L.

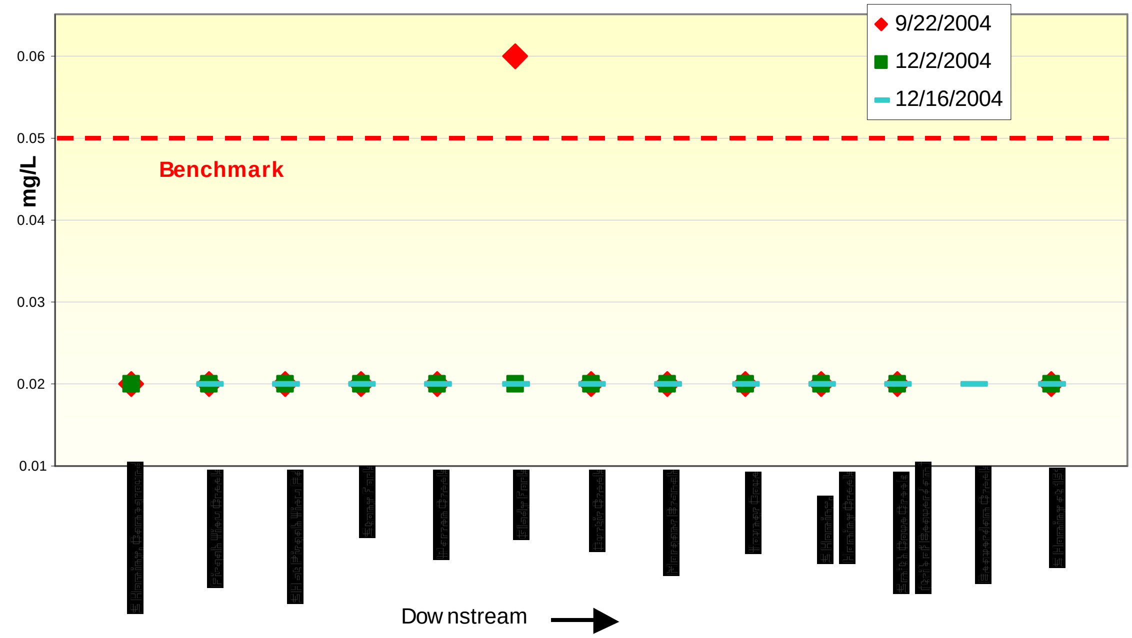

Figure 11: Ammonia concentrations at all sites at baseflow.

TKN concentrations were below the detection level of 0.02 mg/L in most samples (Figure 12). Only three samples had detectable concentrations of TKN at baseflow; one at Glady Fork on 9/22/04 and two at Stony Fork on 9/22/04 and 12/2/04.

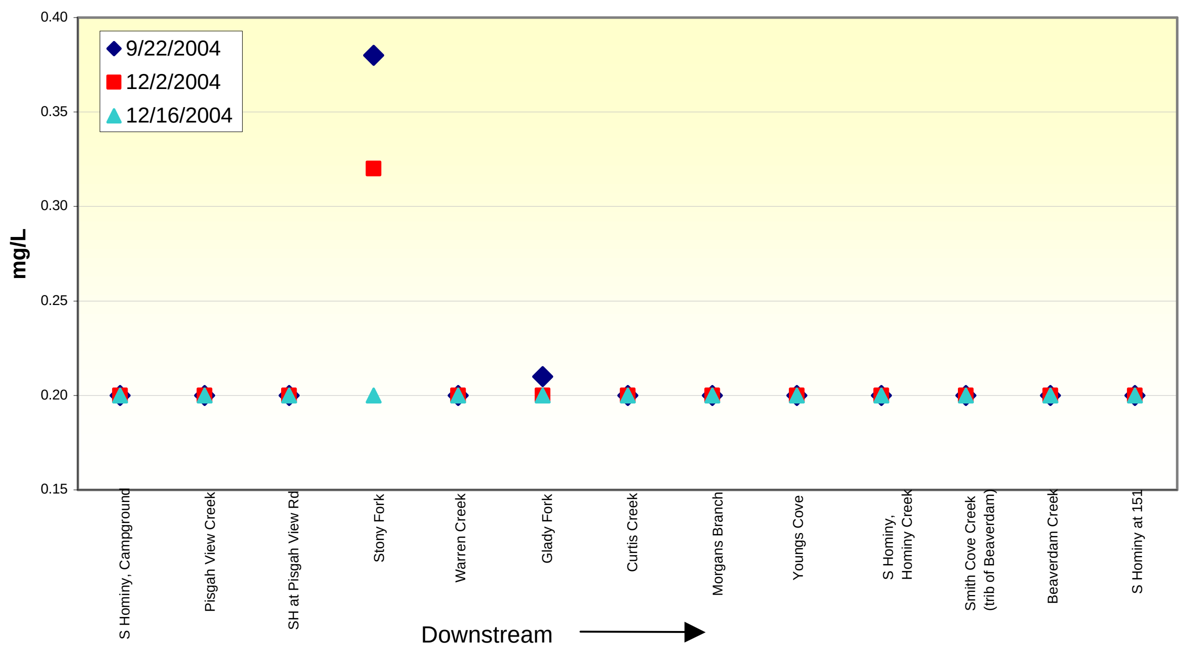

Figure 12: TKN concentrations at all sites at baseflow. Concentrations recorded as 0.2 mg/L were below detection levels.

Nitrate plus nitrite nitrogen concentrations exceeded the benchmark value of 0.23 mg/L on all three sampling dates at eight of the thirteen sites (Figure 13). Only three sites, South Hominy at Pisgah View Road, Stony Fork, and Glady Fork, had nitrate plus nitrite concentrations below the benchmark value in all samples.

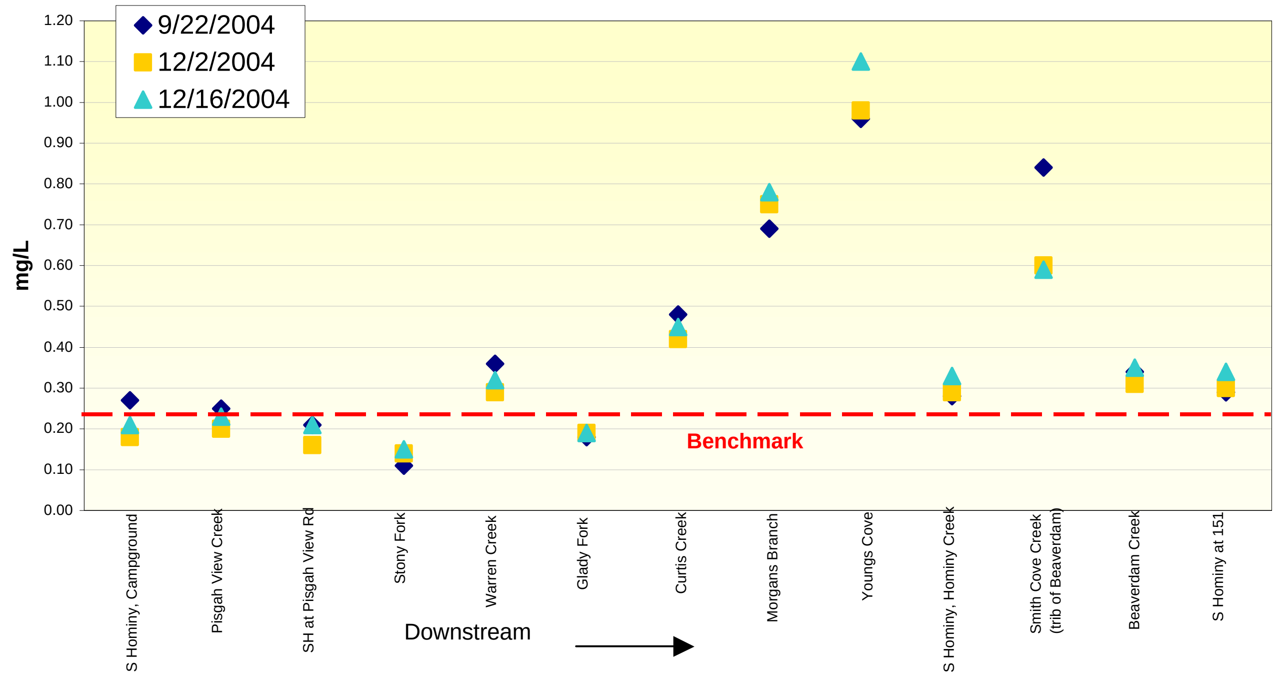

Figure 13: Nitrate plus nitrite nitrogen concentrations at all sites at baseflow.

Phosphorus was undetected at the four most upstream sites in the South Hominy watershed (Figure 14). The highest phosphorus concentration (0.14 mg/L) was observed at Warren Creek. Curtis Creek and Smith Cove Creek were the only sites at which phosphorus was detected on all three sampling dates. Phosphorus concentrations were recorded at or above the benchmark value of 0.04 mg/L in at least one sample at Warren Creek, Curtis Creek, Morgans Branch, Youngs Cove, Smith Cove Creek, and Beaverdam Creek (Briel, 1997).

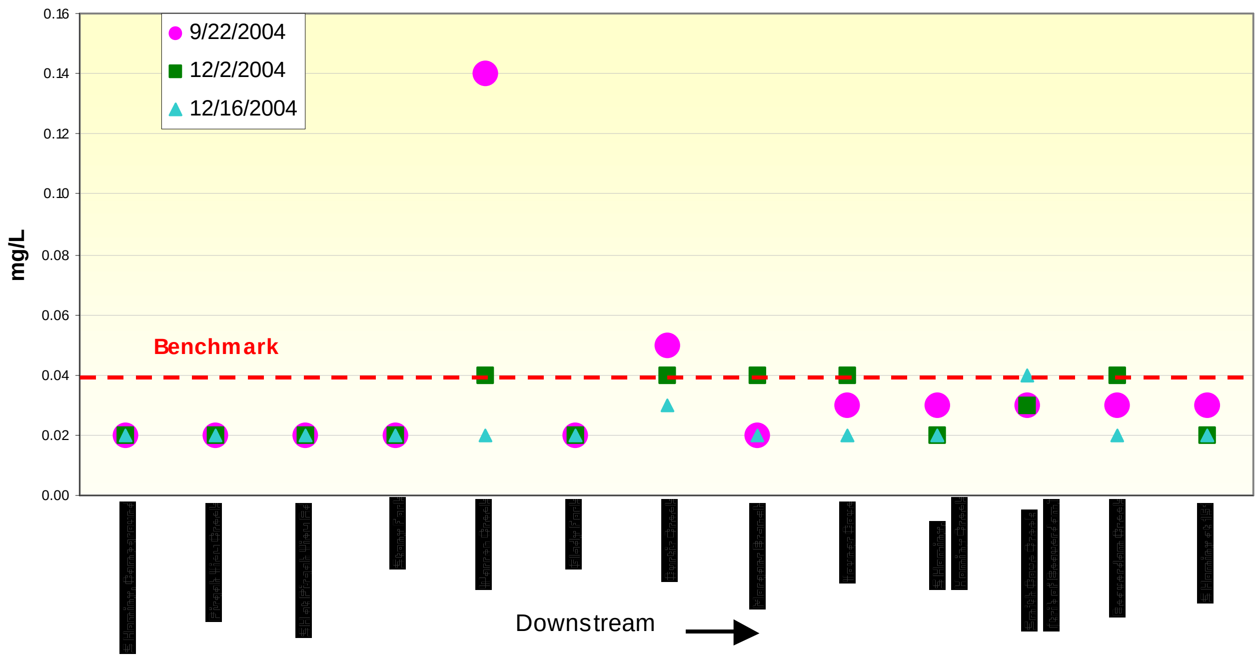

Figure 14: Phosphorus concentrations at all sites at baseflow.

Ammonia concentrations increased slightly during stormflow events (Figure 15). As with many other parameters, the highest ammonia concentration was observed following Hurricane Frances in the 9/7/04 sample. Nitrate plus nitrite nitrogen concentrations followed similar patterns during baseflow and stormflow samples. The baseflow median for Nitrate plus nitrite nitrogen (0.31 mg/L) was slightly higher than the stormflow median (0.26 mg/L). TKN were undetectable or just above the detection level of 0.2 mg/L for half of the stormflow and all of the baseflow samples. Stormflow concentrations above detection levels were recorded on 12/10/03 (0.36 mg/L), 4/26/04 (0.21 mg/L), and 9/7/04 (5.0 mg/L). All baseflow phosphorus concentrations were recorded at or below 0.05 mg/L. Stormflow phosphorus concentrations ranged widely, from below detection levels to 1.0 mg/L.

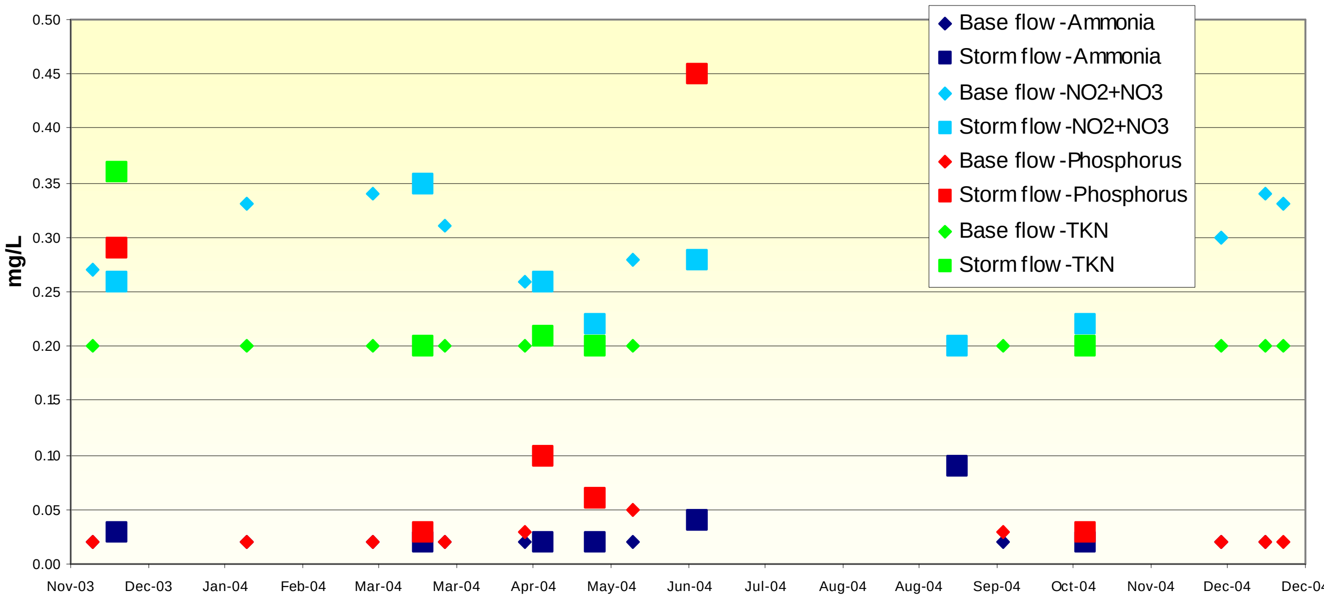

Figure 15: Nutrient concentrations at South Hominy Creek at Old Hwy 151. Note that neither the TKN concentration (5 mg/L) nor the phosphorus concentration (1.0 mg/L) recorded on 9/7/04 is visible on the chart.

Discussion of water quality results and trends

Stormflow samples had much higher concentrations for many parameters than baseflow samples. For the following parameters, stormflow concentrations were consistently higher than baseflow values at South Hominy Creek at Old Hwy 151: fecal coliform bacteria, turbidity, residue (suspended, volatile, and fixed), total phosphorus, total Kjeldahl nitrogen (TKN), copper, zinc, manganese, iron and aluminum. Stormflow values were usually lower than baseflow values for pH and for nitrate plus nitrite nitrogen. Levels of mercury, nickel, sodium and ammonia were relatively consistent at storm and base flows, except during the extreme storm event caused by Hurricane Frances in early September 2004.

Many parameters were reported at exceptionally high concentrations in the 9/7/04 stormflow samples taken during Hurricane Frances. The TKN concentration was over ten times higher in the 9/7/04 sample (5 mg/L) than in the next-highest stormflow sample. Fecal coliform bacteria, residue, phosphorus, and turbidity were also at their highest values in the 9/7/04 sample.

Baseflow concentrations of most trace metals measured at South Hominy Creek at Old Hwy 151 were well within accepted limits. Aluminum was the main exceptions to this rule, but its presence in suspended clay, rather than in the toxic dissolved form, would argue against likely toxic effects. It should be noted that the analytical reporting limits for several of the trace metals were higher than the chronic criteria; with more sensitive analyses, additional metals may have exceeded benchmark concentrations.

The data indicate that Curtis Creek, Morgans Branch, and Youngs Cove, which are situated in the northern part of the South Hominy Creek watershed, are the most impaired sites in the study area. These sites had the lowest

DO concentrations and the highest specific conductance concentrations of all thirteen sites, and comprise three of the four sites with the highest nitrate plus nitrite nitrogen concentrations. Two of the sites, Morgans Branch and Youngs Cove, not only were the sole sites to exceed the specific conductance benchmark value, but also surpassed the benchmark in all three samples. Both of these sites also exceeded the fecal coliform benchmark of 200 colonies/100ml as a geometric mean.

After Curtis Creek, Morgans Branch, and Youngs Cove, Beaverdam Creek and its tributary, Smith Cove Creek, appear to be the most impaired sites in the watershed. Beaverdam Creek, into which the watershed's one NPDES permitted point source is discharged, exceeds the fecal coliform benchmark of 200 colonies/100ml as a geometric mean and has the lowest DO concentration in the watershed, 5.72 mg/L. However, unlike Curtis Creek, Morgans Branch, and Youngs Cove, Beaverdam Creek does not have high specific conductance. Both Beaverdam Creek and Smith Cove Creek exceeded the phosphorus concentration benchmark in one sample, and have phosphorus levels at or above those recorded at Curtis Creek, Morgans Branch, and Youngs Cove. Smith Cove Creek's nitrate plus nitrite nitrogen concentrations are the third highest in the watershed.

There is an observable trend in water quality degradation from the upstream to the downstream sections of the watershed. In general, indicators of impairment remain relatively constant in the six most upstream sites in the watershed, increase in severity in the middle of the watershed, and lessen in severity in the downstream sites to levels similar to those recorded in the most upstream sites. This pattern can be observed in many of the parameters measured in this study.

Specific conductance and fecal coliform bacteria concentrations are fairly stable in the upstream portion of the watershed, increase substantially between Curtis Creek and Morgans Branch and again from Morgans Branch to Youngs Cove, and then decrease in the downstream portion of the watershed. Continuing this trend, DO concentrations from 12/2/04 and 12/16/04 decrease in the middle of the watershed (particularly in Curtis Creek and Morgans Branch) before increasing in the downstream sites to levels slightly higher than those found at the most upstream sites. This pattern is also observed, with slight deviations, in the nitrate plus nitrite nitrogen, phosphorus, and water temperature data. Nitrate plus nitrite nitrogen concentrations follow the same trend as fecal coliform concentrations and specific conductance but also increase at Smith Cove Creek and Beaverdam Creek, the third and second most downstream sites, respectively. Phosphorus concentrations are below detection levels in all samples at the four most upstream sites. They increase to detectable concentrations in the middle of the watershed from Warren Creek to Youngs Creek, except at Glady Fork, where phosphorus was undetected on all three sampling dates. Following the trend of nitrate plus nitrite nitrogen concentrations, phosphorus concentrations decrease to undetectable levels at the South Hominy at Hominy Creek site, increase at Smith Cove Creek and Beaverdam Creek, and decrease again at the most downstream site in the watershed. Finally, water temperatures rise at Curtis Creek, Morgans Branch, and Youngs Cove, and decrease in the downstream section of the watershed, except for a slight rise in temperature at Smith Cove Creek.

A final area of concern is Warren Creek. Warren Creek had the highest fecal coliform geometric mean, 409.84 colonies per 100 mL, of any of the sites at baseflow. It also had the highest concentration of phosphorus at baseflow.

The sites that appear to be least severely impacted by pollution are the three most upstream sites in the watershed, South Hominy Creek at the campground, Pisgah View Creek, South Hominy Creek at Pisgah View Road, as well as two downstream sites, South Hominy Creek at Hominy Creek and South Hominy Creek at Old Hwy 151. All five sites were below benchmark values for specific conductance and fecal coliform bacteria concentrations. The highest DO concentrations were recorded at South Hominy Creek at Hominy Creek and South Hominy Creek at Old Hwy 151.

Considering that the South Hominy Creek at Old Hwy 151 stormflow concentrations of many metals, two of the three major cations, turbidity, and fecal coliform bacteria were above benchmark values, and that at baseflow, South Hominy Creek at Old Hwy 151 was one of the least impaired sites, it can be hypothesized that the more impaired sites in the watershed would also exceed benchmark values for these parameters at stormflow.

It is important to keep in mind that analytical methods used for all metals data collected in this study yield "total recoverable" concentrations rather than "dissolved" concentrations, which are the basis for NAWQC benchmark values in Table 4. It is not known what fraction of the metals concentrations reported here are indeed dissolved and therefore directly comparable to the benchmark values, but as a general rule, the dissolved fraction decreases at higher suspended residue concentrations.

III. SITE SUMMARIES

The tables below summarize the physical and chemical data collected at sampling sites described in the main text. All tables cover sampling that was conducted between December 2003 and January 2004. Column headings for these tables are given below:

N	number of samples or measurements
Max	maximum value
Min	minimum value
Med	median
Mean	mean (geometric mean was calculated for fecal coliform)
BM	benchmark values (Additional information is provided in Table 5.)

Table 5: BENCHMARKS

Parameter	Benchmark	Source
Field parameters		
Air Temperature		
Water Temperature		
Dissolved Oxygen (mg/L)	9.6	USGS Professional Paper, Briel, 1999
DO%		
Specific Conductance (uS/cm)	45	USGS Professional Paper, Briel, 1999
pH	6.8	USGS Professional Paper, Briel, 1999
Nutrients (mg/L)		
Ammonia	0.05	USGS Professional Paper, Briel, 1999
TKN		
NO2+NO3	0.23	USGS Professional Paper, Briel, 1999
Phosphorus	0.04	USGS Professional Paper, Briel, 1999
Other (mg/L)		
Turbidity	50	NC Water Quality Standard
Suspended Residue		
Volatile Residue		
Fixed Residue		
Major cations (mg/L)		
Calcium	3.40	USGS Professional Paper, Briel, 1999
Magnesium	1.10	USGS Professional Paper, Briel, 1999
Sodium	2.60	USGS Professional Paper, Briel, 1999
Trace metals (mg/L)		
Silver	0.36	Risk Assessment Information System
Aluminum	87.00	EPA National Recommended Water Quality Criteria, 1999
Arsenic	150.00	EPA National Water Quality Standards Database, 2004
Cadmium	0.25	EPA National Water Quality Standards Database, 2004
Chromium	11.00	EPA National Water Quality Standards Database, 2004
Copper	9.00	EPA National Water Quality Standards Database, 2004
Iron	1000.00	EPA National Recommended Water Quality Criteria, 1999
Mercury	0.77	EPA National Water Quality Standards Database, 2004
Manganese	120.00	Risk Assessment Information System
Nickel	52.00	EPA National Water Quality Standards Database, 2004

Lead	**2.50**	**EPA National Water Quality Standards Database, 2004**
Zinc	**120.00**	**EPA National Water Quality Standards Database, 2004**
Fecal Coliform (col/100mL)	**Geo mean**	**Geo mean**
	200	**NC Water Quality Standard**

In calculating means, values below the practical quantitation limit (PQL) (coded as <) were assumed to be equal to the PQL. The PQL is about five times the calculated Method Detection Limit (MDL) and represents a practical and routinely available detection level with a relatively good certainty that any reported value is reliable. Additional laboratory information is available on the DWQ Laboratory Section web site at http://www.esb.enr.state.nc.us/lab/qa.htm.

Reported metals concentration data are total recoverable (not dissolved).

South Hominy Cr @ Pisgah View Ranch campground off SR 1105 [FRB02_ B011]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	3	23.00	10.00	12.00	15.00	
Water Temperature	3	14.60	6.00	9.10	9.90	
Dissolved Oxygen	3	10.69	9.18	10.21	10.03	**9.6**
DO%	3	90.20	85.90	88.40	88.17	
Specific Conductance	3	23.00	22.00	22.70	22.57	**45.00**
pH	3	7.05	6.42	6.50	6.66	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	2	0.02	0.02	0.02	0.02	**0.05**
TKN	0					
NO2+NO3	3	0.27	0.18	0.21	0.22	**0.23**
Phosphorus	3	0.02	0.02	0.02	0.02	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo Mean**	
	3	27.00	2.00	6.00	6.87	**200.00**

Pisgah View Cr @ Pisgah View Ranch Rd [FRB02_B010]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	3	25.00	9.00	16.00	16.67	
Water Temperature	3	15.00	5.90	8.90	9.93	
Dissolved Oxygen	3	10.73	7.53	10.50	9.59	**9.6**
DO%	3	90.60	74.30	85.90	83.60	
Specific Conductance	3	25.30	23.80	24.10	24.40	**45.00**
pH	3	6.64	6.45	6.54	6.54	**6.5-9.0**
Nutrients						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	0.25	0.20	0.23	0.23	**0.23**

Phosphorus	3	0.02	0.02	0.02	0.02	**0.04**
Fecal Coliform Bacteria (col/100mL)					Geo mean	
	3	100.00	26.00	35.00	44.98	**200.00**

South Hominy Cr @ SR 1109/Pisgah View Rd [FRB02_B008]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	2	15.00	12.00	13.50	13.50	
Water Temperature	3	15.80	5.10	9.20	10.03	
Dissolved Oxygen	3	10.88	8.98	10.23	10.03	**9.6**
DO%	3	90.60	85.40	88.90	88.30	
Specific Conductance	3	31.30	26.10	29.70	29.03	**45.00**
pH	3	7.03	6.49	6.71	6.74	**6.5-9.0**
Nutrients						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	0.21	0.16	0.21	0.19	**0.23**
Phosphorus	3	0.02	0.02	0.02	0.02	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	54.00	28.00	29.00	35.26	**200.00**

Stony Fork @ SR 1109/Pisgah View Rd [FRB02_B009]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	3	26.00	9.00	13.00	16.00	
Water Temperature	3	14.30	4.70	8.30	9.10	
Dissolved Oxygen	3	11.46	9.90	10.84	10.73	**9.6**
DO%	3	97.10	88.60	92.10	92.60	
Specific Conductance	3	20.20	19.70	20.00	19.97	**45.00**
pH	3	6.82	6.45	6.77	6.68	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	0.15	0.11	0.14	0.13	**0.23**
Phosphorus	3	0.02	0.02	0.02	0.02	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	870.00	30.00	56.00	113.49	**200.00**

Warren Cr @ NC 151 [FRB02_B006]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
B. Field Parameters						
Air Temperature	3	26.00	9.00	14.00	16.33	
Water Temperature	3	15.30	5.40	9.10	9.93	

Dissolved Oxygen	3	11.06	7.19	10.49	**9.58**	**9.6**
DO%	3	91.10	71.50	87.30	83.30	
Specific Conductance	3	31.20	27.80	28.50	29.17	**45.00**
pH	3	6.99	6.58	6.88	6.82	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.38	0.20	0.32	0.30	
NO2+NO3	3	0.36	0.29	0.32	**0.32**	**0.23**
Phosphorus	3	0.14	0.02	0.04	**0.07**	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	730.00	230.00	410.00	**409.84**	**200.00**

Glady Fork @ SR 3452/Upper Glady Rd [FRB02_B007]						
Parameter	**Base flow**					
	N	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	3	26.00	11.00	16.00	17.67	
Water Temperature	3	14.90	5.70	9.50	10.03	
Dissolved Oxygen	3	11.29	10.67	10.69	10.88	**9.6**
DO%	3	108.50	90.00	93.30	97.27	
Specific Conductance	3	24.50	22.60	23.50	23.53	**45.00**
pH	3	6.70	6.40	6.67	6.59	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.06	0.02	0.02	0.03	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	0.19	0.18	0.19	0.19	**0.23**
Phosphorus	3	0.02	0.02	0.02	0.02	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	92.00	19.00	50.00	44.38	**200.00**

Curtis Cr @ NC 151 [FRB02_B005]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	2	13.00	12.00	12.50	12.50	
Water Temperature	3	20.50	7.50	10.80	12.93	
Dissolved Oxygen	3	10.19	8.59	9.71	**9.50**	**9.6**
DO%	3	95.10	85.00	87.80	89.30	
Specific Conductance	3	43.20	41.20	43.10	42.50	**45.00**
pH	3	7.01	6.35	6.70	6.69	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.21	0.20	0.20	0.20	
NO2+NO3	3	0.48	0.42	0.45	**0.45**	**0.23**
Phosphorus	3	0.05	0.03	0.04	0.04	**0.04**

Fecal Coliform Bacteria (col/100mL)					Geo mean	
	3	230.00	100.00	180.00	160.57	**200.00**

Morgan Branch @ NC 151 [FRB02_B004]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
C. Field Parameters						
Air Temperature	2	15.00	13.00	14.00	14.00	
Water Temperature	3	20.10	8.20	10.80	13.03	
Dissolved Oxygen	3	9.97	8.52	9.25	**9.25**	**9.6**
DO%	3	93.00	83.90	84.50	87.13	
Specific Conductance	3	59.80	54.70	56.70	**57.07**	**45.00**
pH	3	6.95	6.39	6.80	6.71	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	0.78	0.69	0.75	**0.74**	**0.23**
Phosphorus	3	0.04	0.02	0.02	0.03	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	420.00	160.00	370.00	**291.87**	**200.00**

Youngs Cove @ SR 3452 / Bailey Rd [FRB02_B003]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	3	29.00	12.00	13.00	18.00	
Water Temperature	3	49.00	8.20	16.70	24.63	
Dissolved Oxygen	3	11.02	8.65	10.72	10.13	**9.6**
DO%	3	90.80	85.80	88.90	88.50	
Specific Conductance	3	65.30	53.40	56.20	**58.30**	**45.00**
pH	3	7.18	6.68	6.69	6.85	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	1.10	0.96	0.98	**1.01**	**0.23**
Phosphorus	3	0.04	0.02	0.03	0.03	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	1100.00	70.00	500.00	**337.67**	**200.00**

South Hominy Cr @ SR 3451 / Hominy Creek Rd [FRB02_B002]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	2	11.00	8.00	9.50	9.50	
Water Temperature	3	15.20	2.40	6.30	7.97	
Dissolved Oxygen	3	12.28	9.94	11.37	11.20	**9.6**

DO%	3	99.00	90.20	92.20	93.80	
Specific Conductance	3	31.00	29.00	30.80	30.27	**45.00**
pH	3	7.17	6.53	7.00	6.90	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	0.33	0.28	0.29	**0.30**	**0.23**
Phosphorus	3	0.03	0.02	0.02	0.02	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	140.00	53.00	77.00	82.98	**200.00**

Smith Cove @ SR 3449/Beaverdam Loop [FRB02_ B012]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	3	24.00	13.00	14.00	17.00	
Water Temperature	3	15.90	6.40	9.80	10.70	
Dissolved Oxygen	3	10.64	8.48	10.24	9.79	**9.6**
DO%	3	90.30	84.30	86.40	87.00	
Specific Conductance	3	39.30	33.50	35.80	36.20	**45.00**
pH	3	7.16	6.49	6.74	6.80	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	3	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	2	0.84	0.59	0.72	**0.72**	**0.23**
Phosphorus	3	0.04	0.03	0.03	0.03	**0.04**
Fecal Coliform Bacteria (col/100mL)					Geo mean	
	3	148.00	54.00	80.00	86.15	**200.00**

Beaverdam Cr @ Beaverdam Rd [FRB02_B013]						
	Base flow					
Parameter	**N**	**Max**	**Min**	**Med**	**Mean**	**BM**
Field Parameters						
Air Temperature	3	22.00	9.00	10.00	13.67	
Water Temperature	3	13.20	3.40	7.50	8.03	
Dissolved Oxygen	3	11.95	5.72	11.25	9.64	**9.6**
DO%	3	93.80	54.10	89.80	79.23	
Specific Conductance	3	30.70	28.50	29.30	29.50	**45.00**
pH	3	7.26	6.22	6.91	6.80	**6.5-9.0**
Nutrients (mg/L)						
Ammonia Nitrogen	1	0.02	0.02	0.02	0.02	**0.05**
TKN	3	0.20	0.20	0.20	0.20	
NO2+NO3	3	0.35	0.31	0.34	**0.33**	**0.23**
Phosphorus	3	0.04	0.02	0.03	0.03	**0.04**
Fecal Coliform Bacteria (col/100mL)					**Geo mean**	
	3	700.00	84.00	150	**206.61**	**200.00**

South Hominy @ Old Hwy 151 [FRB02_B001]											
	Baseflow						Stormflow				
Parameter	N	Max	Min	Med	Mean	BM	N	Max	Min	Med	Mean
Field parameters											
Air Temperature	9.00	27.00	6.00	16.00	14.91		5.00	22.00	10.00	21.00	19.20
Water Temperature	10.00	16.80	2.20	7.70	8.68		6.00	18.70	7.50	15.35	13.90
Dissolved Oxygen	10.00	17.20	8.52	10.57	11.42	**9.6**	6.00	10.70	8.40	10.05	9.72
DO%	6.00	97.20	87.80	94.10	93.52		6.00	111.30	86.00	92.10	95.53
Specific Conductance	9.00	31.80	28.00	29.30	29.81	**45**	6.00	40.90	29.90	31.90	33.62
pH	10.00	7.11	6.43	6.89	6.87	**6.5-9.0**	6.00	7.06	6.43	6.78	6.76
Nutrients (mg/L)											
Ammonia	9.00	0.02	0.02	0.02	0.02	**0.05**	7.00	0.09	0.02	0.02	0.03
TKN	10.00	0.20	0.20	0.20	0.20		7.00	5.00	0.20	0.21	1.07
NO2+NO3	10.00	0.34	0.26	0.31	**0.31**	**0.23**	7.00	0.35	0.20	0.26	**0.26**
Phosphorus	10.00	0.05	0.02	0.02	0.03	**0.04**	7.00	1.00	0.03	0.10	0.28
Other (mg/L)											
Turbidity	9.00	500.00	1.70	3.30	**59.39**	**50**	7.00	550.00	0.00	7.70	**98.54**
Suspended Residue	8.00	20.00	2.10	4.50	7.64		6.00	1240.00	10.00	43.00	279.17
Volatile Residue	6.00	6.60	2.50	3.70	4.08		6.00	240.00	0.00	6.05	53.18
Fixed Residue	6.00	13.40	0.40	4.40	6.18		6.00	1000.00	0.00	16.45	214.98
Major cations (mg/L)											
Calcium	9.00	2.30	1.90	2.00	2.11	**3.40**	6.00	5.20	2.20	2.65	3.22
Magnesium	9.00	1.10	0.82	0.87	0.93	**1.10**	7.00	8.30	1.10	1.20	**2.66**
Sodium	8.00	2.10	0.00	1.70	1.56	**2.60**	7.00	2.20	0.00	1.80	1.61
Trace metals (mg/L)											
Silver	9.00	U	U	U	U	**0.36**	7.00	U	U	U	U
Aluminum	9.00	920.00	73.00	160.00	**289**	**87.00**	7.00	31000.00	470.00	1100.00	**5981.43**
Arsenic	9.00	U	U	U	U	**150.00**	7.00	U	U	U	U
Cadmium	9.00	U	U	U	U	**0.25**	7.00	U	U	U	U
Chromium	9.00	U	U	U	U	**11.00**	7.00	33.00	U	U	**33.00**
Copper	9.00	U	U	U	U	**9.00**	7.00	34.00	U	3.50	**9.47**
Iron	9.00	1200.00	140.00	270.00	430	**1000.00**	7.00	40000.00	680.00	2500.00	**9711.43**
Mercury	3.00	U	U	U	U	**0.77**	2.00	U	U	U	U
Manganese	9.00	61.00	13.00	20.00	28.11	**120.00**	7.00	1200.00	28.00	91.00	**280.00**
Nickel	9.00	U	U	U	U	**52.00**	7.00	17.00	U	U	11.00
Lead	8.00	U	U	U	U	**2.50**	7.00	31.00	U	U	**13.14**
Zinc	9.00	13.00	U	U	10.33	**120.00**	7.00	180.00	U	16.00	45.57
Fecal Coliform (col/100mL)					**Geo mean**						**Geo mean**
	10.00	540.00	43.00	135.50	151.38	**200**	6.00	15000.00	600.00	4075.00	**3543.93**

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