Section 8
Conclusions

Findings regarding ecological function, major stressors and sources of pollution are summarized below. The section also presents a synopsis of factors impacting those stream sites for which degraded biological communities have been documented. Implications for the development of the Watershed Management Plan are discussed.

8.1 Summary of Ecological Function

This assessment analyzed sub-watershed scale ecological function in three areas—hydrology, habitat/biological communities and water quality. Varying degrees of ecological degradation were evident in most sub-watersheds, though it was seldom extreme. Based on the overall patterns of function, sub-watersheds were arranged into five tiers (Figure 7.5). The level of ecological function in most sub-watersheds is low or moderate. Sub-watersheds with low levels of function are significantly degraded, although they retain some indication of adequate ecological function and are not considered to be in the poorest condition. Sub-watersheds with moderate levels of function exhibit many characteristics of good ecological function but have sufficient impacts to be considered at risk of becoming functionally compromised if additional deterioration occurs.

Areas of low function include the lower half of the Slow Creek drainage, Middle Martins Creek and many of the smaller Hiwassee River tributaries. Only the sub-watershed draining the Mission Quarry area (MQT), received a Very Low classification. In general, ecological condition is best in the portion of the Peachtree drainage upstream of the Slow Creek confluence, where a number of sub-watersheds still maintain a high level of ecological function.

Overall, scores are higher for hydrologic function than for the other functional areas. Low scores are particularly evident for habitat/biological community indicators. For most indicators, functional condition is notably lower for areas in the low gradient topographic zone where slopes are ≤ 10%, than in steeper terrain. This zone constitutes only about 20% of the planning area, but includes many of the most impacted locations. Some differences in ecological condition at the sub-watershed scale can be attributed to variations in the extent of sub-watershed area that lies within this historically impacted low gradient zone. However, factors specific to individual sub-watersheds, such as impacts from Mission Quarry, are also important.

NCDWQ's draft Hiwassee River Basin Water Quality Plan (NCDWQ, 2006f) considers Martins Creek to be impaired for its entire length, based on a Fair rating of a fish community sample at Harshaw Road in 2004. The fish community at this site was rated Good-Fair in 2006, which is not indicative of impairment. Benthic community samples from both 2004 and 2006 also do not appear to indicate impairment. No other waters in the planning area are considered impaired by NCDWQ or received formal biological ratings during this assessment that are likely to lead to an impaired designation. However degradation at several sites too small to receive a formal rating was significant. These include McComb Branch, Sudderth Branch and the Hiwassee River tributary draining the Mission Quarry area.

8.2 Major Stressors, Sources and Impacts

8.2.1 Stressors and Sources

The major stressors documented in the Peachtree-Martins Creek planning area are discussed below. In some cases, the Phase 2 assessment confirmed impressions discussed in the Phase 1 report, providing additional data to better define the nature and extent of the problems. This was the case for channelization and the modification of riparian vegetation. In other cases, such as nutrients and fecal coliform bacteria, new data allowed for the assessment of stressors that could not be evaluated during Phase 1 because information was not available.

Lack of Riparian Vegetation

The lack of riparian vegetation is probably the most widespread stressor in the planning area. In areas with slopes under 10%, only 10% of stream length has adequate vegetation on both banks, which is defined as a zone of woody vegetation at least 30 feet wide. Both banks have inadequate riparian vegetation about 65% of the time. The situation is not nearly as severe in higher gradient areas, where two thirds of stream banks have adequate riparian zones on both banks.

Riparian land in low gradient areas has commonly been cleared for crop land and pasture, residential buildings and yards, and public and private roads. Streamside areas are often intensively managed and kept free of woody vegetation. A zone of woody vegetation along streams is critical to the maintenance of adequate shading, bank stability, the supply of woody debris and other organic material (for stream habitat and food supply for aquatic organisms), the removal of pollutants from storm runoff, and the provision of habitat for terrestrial animals. Continued human activities in the impacted areas serve both to perpetuate degraded riparian conditions and as a potential source of pollution.

Channel Modification

Channelization from stream relocation, straightening, dredging and similar activities is also widespread. There are approximately 26 miles of channelized stream in the planning area and about 36% of streams in the low gradient areas have been modified. Channelization commonly occurs in conjunction with other disturbances, especially the removal of riparian vegetation. Watershed observation suggests that channelization occurring in high gradient areas is often associated with roads or residential areas. While much of the channelization is historic, and some streams are recovering, channel disturbance in other areas is ongoing.

Channel modification is associated with a variety of impacts on habitat and stream quality, including incision, habitat degradation, sedimentation and bank erosion. For example, riffle embeddedness is more than twice as high in channelized reaches (65%) than in unchannelized reaches (30%) and overall aquatic habitat is much more degraded.

Sediment Impacts

Sediment deposition is widespread in area streams, though severity varies. Both riffles and pools are impacted by sediment deposition. Nine sub-watersheds had median embeddedness levels of 60% or greater. At 40% of sites assessed, pool quality rated 4 or less on a 10-point scale. Bank erosion is also common in the planning area, though severity (as measured by BEHI ratings) is generally moderate and extreme erosion is relatively usual.

IPSI estimates of total suspended solids loads indicate that sediment source areas are related to a variety of land uses and are widely dispersed. Mission Quarry is the largest single source of sediment, but developed areas, agricultural activities, road and stream erosion and new construction are all important sources and contribute to the problem. Potential impacts from future development are also a concern, since development is likely to result in an increase in many factors related to sediment inputs - including land clearing and road construction, ongoing post-construction sediment inputs and stream erosion due to increased imperviousness.

Nutrients

Biological community data indicate that nutrients are a fairly common stressor in the planning area, though impacts are not currently severe in most places. Chemical monitoring was limited, however, especially for storms when nutrient levels would be expected to be highest. Moderate baseflow nitrite-nitrate concentrations were found in Martins Creek, Slow Creek, Moore Branch and lower Peachtree Creek, while elevated storm concentrations were observed in McComb Branch. IPSI data on nitrogen and phosphorus loads indicate that both developed and agricultural areas are major nutrient sources, though these estimates are generic in nature and are not useful for identifying specific nutrient-generating activities, especially in developed areas.

Fecal Coliform

Fecal coliform sampling was not frequent enough to document whether state water quality standards were violated. However available data indicate that there are a number of streams where levels are high enough to be of concern, especially Martins Creek and Slow Creek. These are both streams to which livestock have extensive access, though other sources may be a factor as well. Straight-piping and septic system malfunction no doubt occur in the study area, but data on their extent are currently unavailable. Data from the WaDE investigation to be conducted later in 2007 should help to establish how important sources of domestic waste are in the planning area.

Fecal coliform contamination may be a public health concern in the planning area. It is not in itself a threat to ecological function, although fecal coliform contamination may occur in conjunction with the inputs of other pollutants like nutrients and oxygen consuming materials that may impact stream organisms.

8.2.2 Impacts on Biological Communities

The monitoring of aquatic communities provides a synoptic picture of watershed impacts, and is in many respects the cornerstone of the ecological assessment presented in this report. It is therefore important to understand as much as possible about the specific reasons for observed degradation in macroinvertebrate and fish communities. This issue was addressed to some extent in Section 4, based on NCDWQ field observations and benthic/fish community composition. An expanded discussion of the causes of biological impacts at individual sites is presented below, integrating the IPSI data and other observations made in this report. This discussion focuses on those sites where significant deterioration in the benthic community was noted (WAT Tier 4-6 sites and BAU sites of similar quality).

Peachtree Creek Drainage

Site 34 - Fate Puett Cove Creek (Moore Branch) at SR 1535/Upper Peachtree Rd (MOB Sub-watershed) - Not Impaired. Habitat degradation (notably heavy sedimentation) was noted by NCDWQ as a potential stressor for benthos at this site. Elevated baseflow nitrate-nitrate

concentrations were also found here. While the drainage to this site is predominately forested, it is less forested and contains more development and pasture land than other portions of the upper Peachtree drainage. Much of this activity is located along or near the stream, which for the lower half of its length flows through a relatively broad valley for a small mountain creek. The IPSI indicates that only half of the riparian areas in the Moore Branch sub-watershed (MOB) have adequate vegetation on both banks, an unusual situation for the upper Peachtree drainage. The fact that benthos is this stream are more impacted that other sites in this part of the study area is likely related to these factors.

Site 28 – Messer Branch at SR 1531/Hendrix Rd (MBR Sub-watershed) - Not Impaired. Though rated Not Impaired, the benthic community in Messer Branch was much more impacted than the other Slow Creek tributaries sampled. Taxonomic indicators of nutrient enrichment were found and habitat impacts related to riparian condition and a lack of available microhabitat area were noted (score of 48). The available data indicate the catchment of Messer Branch is more disturbed than the other major tributary catchments in the Slow Creek drainage, and the Messer Branch sub-watershed (MBR) stands out as one of the most impacted in the entire Peachtree drainage. The catchment is less forested than the other Slow Creek tributaries (only about 45%), while almost 1/3 of the sub-watershed is in pasture land and over 20% is developed. The stream is lower gradient than other major tributaries (even within the high gradient topographic zone), such as Snead Branch and Graham Branch, which may contribute to the degree of disturbance seen along almost the entire length of this stream. Forty-five percent of the streams within the low gradient zone portion of this sub-watershed have been channelized, a higher percentage than anywhere else in the Slow Creek drainage. Additionally only 23% of the riparian areas in the Messer Branch sub-watershed have adequate vegetation on both banks, the lowest percentage of any sub-watershed in the planning area. While the location of the monitoring site in an open area adjacent to a pasture may factor into the problematic benthic community condition, cumulative impacts from the catchment are likely.

Site 25 – Slow Creek at SR 1670/Greenlawn Cemetery Rd (LSL Sub-watershed) - Good-Fair. NCDWQ noted poor habitat (score of 47), including infrequent riffles and pools and a predominance of sand and silt. Taxonomic indicators of enrichment were found. Baseflow nitrite-nitrate concentrations were elevated here and the site had the highest levels of fecal coliform of all sites with 3 or more samples (geometric mean of 429 col/100ml). This site is in the heart of a largely unforested area in lower Slow Creek with significant pasture and development. It lies downstream from the relatively impacted Messer Branch, but upstream from the confluence of Slow Creek with Snead Branch and Graham, two tributaries with higher quality waters. According to the IPSI analysis, the concentration of livestock operations upstream is among the highest in the planning area, and more than 10,000 linear feet of stream have probable or confirmed livestock access. As was the case with Messer Branch, site specific factors may contribute to the condition of the benthic community. The reach flows through a pasture and microhabitat was sparse. However, both agricultural and development in the 4.5 square mile drainage are also likely a major contributor to degradation here.

Martins Creek Drainage

Site 6 – Martins Creek at SR 1576/Crisp Rd (MMC Sub-watershed) - Good.
Site 8 – Martins Creek at SR 1558/Harshaw Road (LMC Sub-watershed) - Good-Fair. Though the benthic communities at these two sites received different bioclassifications, the communities were similar. Taxonomic indicators of enrichment were evident at both locations. The fish community at Harshaw road (Good-Fair) was more diverse than at Crisp Road (Not Rated). Habitat was decent at Harshaw Road (74) but more degraded (65) upstream at Crisp Road, where the riparian area was very narrow and canopy coverage limited.. The Harshaw Road site

is located in a forested area with a relatively intact riparian zone, though the NCDOT right of way for the US64 Bypass crosses the creek upstream and appears to be contributing sediment. The Lower Martins Creek sub-watershed (LMC) is less disturbed than many, while the Crisp Road site is located toward the lower end of the Middle Martins Creek sub-watershed (MMC), one of the more impacted sub-watersheds. Only 26% of the riparian areas were rated adequate in MMC, compared to 66% in LMC. Pasture land is extensive and development has been increasing. Over 15,000 linear feet of stream with probable livestock access were recorded by the IPSI in MMC. Nitrite-nitrate, TKN and fecal coliform concentrations are all elevated at a site on Martins Creek located between the two benthic sampling locations.

Water quality issues, rather than habitat degradation, may be the major concern at these sites, with the impacts at the upper site due to activity in the MMC drainage. Impacts at the Harshaw Road site probably result primarily from lingering watershed impacts from the same area, though recent impacts from construction of the US64 Bypass are also likely.

UT Martins Creek (George Creek) at SR 1576/Crisp Rd (MMC Sub-watershed) - Not Rated. NCDWQ indicated both taxonomic enrichment indicators and habitat concerns (lack of microhabitat, limited riparian zone and abundant small substrate) in this small tributary to Martins Creek. Baseflow TKN and fecal coliform concentrations were elevated at this site, and TKN and TP were elevated in the single storm sample collected. Several livestock operations are located upstream. Virtually the entire channel network above the site has inadequate riparian vegetation on both banks, with most of it flowing through pasture.

Other Tributaries

Site 19 - Sudderth Branch at SR 1544/Mission Rd (CMB Sub-watershed) - Not Rated. NCDWQ noted both habitat impacts and taxonomic indicators of enrichment. Sudderth Branch appears to be more impacted than either Calhoun Branch or Mission Branch, the other streams sampled in the Calhoun-Mission Branch sub-watershed (CMB). In some respects this is puzzling because the watersheds of the three streams are broadly similar—upland areas with extensive forest, as well as some rural residential and pasture land, draining into more intense agricultural areas in the Hiwassee River floodplain. It is possible that the sampling results were influenced by the nature of the actual sampling locations. Sudderth Branch was sampled in the agricultural area at its downstream end, while the other two streams were sampled just upstream of this area. However, habitat is actually better in Sudderth Branch (score of 69) than in Calhoun Branch (score of 44), where habitat was relatively homogeneous and both cobbles and woody debris were lacking. It is not clear whether the impacts in Sudderth are due to agricultural activities or to water quality problems from the rural residential areas upstream.

Site 23 - UT Hiwassee River at SR 1537B/below quarry (MQT Sub-watershed) - Not Rated. The benthic community was decimated at this site and habitat was poor. Siltation was noted as a problem. Sediment inputs from Mission Quarry are a major impact on this stream. NCDWQ has documented conditions at the quarry and is working to remediate them. The highest specific conductance readings collected in the planning area were recorded here, indicating that water quality may also be a concern. The quarry is the most likely source of these problems. Drainage to the site is small (0.3 square miles) and may be disrupted by quarry operations, so it is possible that reliable flow could be an issue here as well.

Site 11 - Fall Branch at US 64 (FBR Sub-watershed) - Not Rated. NCDWQ noted sediment impacts at this site, with high levels of embeddedness. Most of the sub-watershed data does not indicate an area where substantial impacts would be expected. The catchment is largely forested and ¾ of riparian areas have adequate vegetation on both banks, the highest

percentage except for sub-watersheds in the upper Peachtree drainage. Streambank erosion is relatively uncommon. The area does have a dense network of unpaved roads, constructed several years ago and associated with a large subdivision that is under construction on a fairly steep mountainside. While it is not possible to establish conclusively that this is the source of the sediment in the stream, there can be little doubt that this development resulted in a sizeable increase in the level of disturbance in the Fall Branch catchment.

Site 13 - McComb Branch at Hiwassee River confluence (MCB Sub-watershed) - Not Rated. The benthic macroinvertebrate community at this site was one or the most impacted of all sites sampled. NCDWQ noted potential impacts of siltation at this site during benthic sampling. Specific conductance here is among the highest in the planning area and, though nutrient sampling was limited, nutrients (sampled upstream of the biological site) appear to be elevated during both storm and baseflow conditions. Some high metals concentrations were also observed during a storm event here. Of all the streams at which NCDWQ conducted toxicity evaluations, conditions in McComb Branch appear to be of greatest concern, and NCDWQ recommended a comprehensive toxicity evaluation of the stream.

The MCB sub-watershed included the densest development in the planning area and the highest levels of imperviousness. There is only limited agricultural activity upstream of the sampling sites. While the specific factors responsible for the biological impacts cannot be identified based on the available data, it seems most likely that they are related to development in the catchment.

8.3 Development of Watershed Management Plan

8.3.1 Schedule and Approach

Phase 3 of the Peachtree-Martins Creek Local Watershed Plan will involve the development of a WMP, scheduled for completion in the fall of 2007. That document will identify focus areas for management activity and include recommended management strategies to address the major concerns summarized in this Watershed Assessment Report. WMP recommendations will be developed in consultation with the HRWC and the Local Advisory Committee constituted to provide guidance to this project. The full set of issues to be considered by the plan was outlined earlier in Section 3.1. The Watershed Management Plan will also include a Project Atlas, documenting the location of specific priority sites recommended for stream/wetland restoration or enhancement, as well as the location of priority sites recommended for protection.

Additionally, the WMP will include an analysis of alternative development scenarios. This analysis will evaluate the extent to which increased residential construction, and other development, is likely within the project area over the next five to ten years, and will use the IPSI Nonpoint Source Model to quantify potential impacts of this development. The ability of potential management actions to mitigate these impacts will also be evaluated and management recommendations presented.

8.3.2 Implications of Assessment Findings

There is both good and bad news in the broad picture of ecological conditions described in this document. On the one hand, almost 18 square miles (about 45%) of the Peachtree-Martins Creek area has seen sufficient deterioration of ecological condition to be considered functionally

compromised, or even worse, severely degraded. Another 15 square miles (38% of the area) is functionally threatened. Impacts of riparian vegetation removal, channel modification, and sedimentation are widespread.

On the positive side, severe degradation on the sub-watershed scale is limited to the Mission Quarry area. While many individual sites in the planning area are severely impacted, at the sub-watershed level these impacts are mitigated to some degree by the areas that remain undisturbed or well-managed.

The fact that much of the existing degradation is not severe makes the potential for successful rehabilitation more favorable than if the severest conditions were widespread. The fact that substantial areas remain in relatively good condition means that there is still much to lose if both ongoing activities and future growth are not handled well.

Some problems are widespread and/or originate from a variety of sources. These include modification of riparian vegetation and stream channels, and inputs of sediment and nutrients. Because both the source activities and affected areas are widely dispersed, addressing these issues will require multifaceted strategies implemented over an extended period of time. A strong organizational presence, as provided by the HRWC, is a major asset in pursuing both remedial and protection efforts.

The specificity of the strategies recommended in the Watershed Management Plan will be limited by what is known about particular problems. For example, the location of channelized stream reaches and areas with severely altered riparian vegetation is fairly well documented. Recommendations can thus target particular areas with some confidence. Specific sources of nutrient and fecal coliform contamination, on the other hand, cannot be so clearly delineated. The investigation to be undertaken later this year by the NC Division of Environmental Health's Wastewater Discharge Elimination Program will help to some extent, but it is likely that the targeting of nutrient sources, and the delineation of strategies to address them, will be less specific than recommendations to address the loss of riparian vegetation.

Some localized problems are currently being addressed through the actions of NCDWQ and other agencies – notably groundwater contamination issues and impacts from Mission Quarry. Phase 3 of this project will provide general recommendations on these issues and an update on agency activities.

Sub-watershed functional condition, as indicated by the analysis presented above, will be a key factor in identifying focus areas for management recommendations. However, a number of other factors will also be considered. These include, but are not limited to:

- The concentration of many current impacts in low gradient areas, which often extend across sub-watershed boundaries;
- Expected patterns of future development;
- The importance of hydrologic connections between sub-watersheds (some watersheds receive significant discharge from upstream areas which differ substantially in water quality or ecological condition);
- The presence of existing protected areas (Nantahala National Forest); and
- The need for particular conservation efforts to address natural heritage concerns, such as protection of habitat for the state-threatened mountain creekshell.

Section 9

References Cited

Arnold, C.L. and C.J. Gibbons. Impervious surface coverage: the Emergence of a Key Environmental Indicator. Journal of the American Planning Association. 62:2:243-258.

Booth, Derek B., D. Hartley and R. Jackson. 2002. Forest Cover, Impervious Surface Area, and the Mitigation of Stormwater Impacts. J. of the American Water Resources Association. 38:3:835-845.

Briel L.I. 1997. Water Quality in the Appalachian Valley and Ridge, the Blue Ridge, and the Piedmont Physiographic Provinces, Eastern United States. U.S. Geological Survey Professional Paper 1422-D.

Center for Watershed Protection. 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph N0. 1. Center for Watershed Protection. Ellicott City, MD.

Equinox Environmental. 2006. Peachtree-Martins Creek Local Watershed Plan--Preliminary Findings and Recommendations Report. Report prepared by Equinox Environmental Consultation and Design, Inc. for the NC Ecosystem Enhancement Program. January 2006.

Equinox Environmental, 2006b. Bald Creek Local Watershed Plan. Developed for the NC Ecosystem Enhancement Program.

Galli, John. 1996. Final Technical Memorandum: Rapid Stream Assessment Technique (RSAT) Field Methods. Metropolitan Washington Council of Governments. Department of Environmental Programs. Washington, DC.

Gilliam, James F, H. Cakir and T. MacPherson. 2005. Urbanization and Decline in Water Quality: Do Statistically Identifiable Thresholds Exist? Paper presented at the 2005 Conference of the Water Resources Institute of North Carolina. April 5, 2005. Raleigh, NC.

Mason, Robert A., C.E. Simmons and S.A.Watkins. 1990. Effects of Channel Modifications on the Hydrology of Chicod Creek Basin, North Carolina, 1975-87. US Geological Survey. Water-Resources Investigations Report 90-4031. Raleigh NC.

McGarigal, Kevin. 2002. Landscape Pattern Metrics. Pp 1135-1142 in A.H. El-Shaarawi and W.W. Piegorsch (eds). Encyclopedia of Envirometrics. Vol 2. John Wiley & Sons. Sussex, England.

NCDWQ. 2005. Basinwide Assessment Report-Hiwassee River Basin. Environmental Sciences Section. April.

NCDWQ, 2006a. Results of Benthic Sampling for the Ecosystem Enhancement Program in Hiwassee Subbasin 02, March 2006. Biological Assessment Unit. Memorandum from Michael Walters to Jimmie Overton. July 31, 2006.

NCDWQ, 2006b. Hiwassee River Basin Ecosystem Enhancement Program's Peachtree and Martins Creek Projects (Cherokee County, Subbasin 02, Index Nos. 1-44, 1-44-9, and 1-49. Biological Assessment Unit. Memorandum from Bryn Tracy to Jimmie Overton. July 31, 2006.

NCDWQ, 2006c Peachtree Martins LWP Screening Study. Chemical and Physical Data Summary. Watershed Assessment Team. February 15, 2006.

NCDWQ. 2006d. Standard Operating Procedures for Benthic Macroinvertebrates. Biological Assessment Unit. North Carolina Department of Environment and Natural Resources. Division of Water Quality. Water Quality Section. Environmental Sciences Branch. Raleigh, NC. July

NCDWQ 2006e. Standard Operating Procedure. Biological Monitoring. Stream Fish Community Assessment Program. Biological Assessment Unit. North Carolina Department of Environment and Natural Resources. Division of Water Quality. Water Quality Section. Environmental Sciences Section. Raleigh, NC. August.

NCDWQ. 2006f. Hiwassee River Basin Water Quality Plan. Draft for Public Review.

NCDWQ. 2006g. Toxicity Assessment of Hiwassee Basin, Cherokee County, NC Baseflow Water and Sediment Samples Collected in 2005 and 2006. Draft Report prepared for the NCDWQ Watershed Assessment Team by the Aquatic Toxicology Unit. October

NCDWQ, 2006h. Hiwassee Tributaries – Subbasin 02; Cherokee County; EEP Screening Study. April 2006. Revised June 2006. .

NCDWQ. 2007. Peachtree-Martins Creek Water Quality Study. Report Prepared for the NCEEP. NCDWQ Watershed Assessment Team. Revised March 2007.

NCEEP. 2007. Revisions to 'Hiwassee Tributaries-Subbasin 02; Cherokee County; EEP Screening Study'. Memorandum from Andrea J Leslie. February 2.

NCWRC. 2005. North Carolina Wildlife Action Plan. NC Wildlife Resources Commission.

Price, Katie and D. S. Leigh. 2006. Morphological and Sedimentological Responses of Streams to Human Impact in the Southern Blue Ridge Mountains, USA. Geomorphology. 78:142-160.

Rosgen, David L. 2001. A Stream Channel Stability Assessment Methodology. Proceedings of the Seventh Federal Interagency Sedimentation Conference. Vol. 2, pp. II - 18-26, March 25-29, 2001, Reno, NV.

Rosgen, David, L. 1996. Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO.

Schueler. 1994. The Importance of Imperviousness. Watershed Protection Techniques. 2(1): 233-239.

Suter, G.W and C.L. Tsau. 1996. Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota. 1996 Revision. Report ES/ER/TM-96/R2. Prepared for the US Department of Energy by Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory. Oak Ridge, TN.

Sylte, Traci and C. Fischenich. 2002. Techniques for Measuring Substrate Embeddedness. US Army Corps of Engineers Research and Development Center. Report No. ERDC TN-EMRRP-SR-36. Vicksburg, MS

TVA, 2006. Tusquittee-Peachtree-Martins Creek Nonpoint Source Pollution Inventory. Tennessee Valley Authority. Knoxville. June 2006.

USEPA, 2000. Ambient Water Quality Criteria Recommendations-Information Supporting the Development of State and Tribal Nutrient Criteria. Rivers and Streams in Nutrient Ecoregion XI, EPA 822-B-00-020. Office of Water.

WNAT. 2003. Report from the Watershed Needs Assessment Team to the Mitigation Coordination Group. NC Ecosystem Enhancement Program. NCDENR. October.