TOTAL MAXIMUM DAILY LOAD (TMDL)

For

Siltation and Habitat Alteration

In The

Hiwassee River Watershed (HUC 06020002)

Bradley, Hamilton, McMinn, Meigs, Monroe, and Polk Counties, Tennessee

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LIST OF ABBREVIATIONS

ARS	Agricultural Research Station
BMP	Best Management Practices
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
DEM	Digital Elevation Model
DWPC	Division of Water Pollution Control
EFO	Environmental Field Office
EPA	Environmental Protection Agency
GIS	Geographic Information System
HUC	Hydrologic Unit Code
LA	Load Allocation
MGD	Million Gallons per Day
MOS	Margin of Safety
MRLC	Multi-Resolution Land Characteristic
MS4	Municipal Separate Storm Sewer System
NED	National Elevation Dataset
NHD	National Hydrography Dataset
NPS	Nonpoint Source
NPDES	National Pollutant Discharge Elimination System
NSL	National Sediment Laboratory
RM	River Mile
RMCF	Ready Mixed Concrete Facility
STATSGO	State Soil and Geographic Database
SSURGO	Soil Survey Geographic Database
TDA	Tennessee Department of Agriculture
TDEC	Tennessee Department of Environment & Conservation
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WCS	Watershed Characterization System
WLA	Waste Load Allocation
WMD	Water Management Division
WWTF	Wastewater Treatment Facility

SUMMARY SHEET

HIWASSEE RIVER WATERSHED (HUC 06020002)

Total Maximum Daily Load for Siltation / Habitat Alteration in Waterbodies Identified on the State of Tennessee's *2004 303(d) List*

Impaired Waterbody Information:

State: Tennessee
Counties: Bradley, Hamilton, McMinn, Meigs, Monroe, and Polk
Watershed: Hiwassee River (HUC 06020002)
Watershed Area: 1,011.1 mi^2
Constituent of Concern: Siltation/Habitat Alteration
Impaired Waterbodies: *2004 303(d) List*

Waterbody ID	Impacted Waterbody	Miles/Acres Impaired
TN06020002005_0900	Beaverdam Creek	3.07
TN06020002005_1000	Candies Creek	9.65
TN06020002005_1100	Unnamed Tributary To Candies Creek	1.55
TN06020002005_1200	Unnamed Tributary To Candies Creek	0.95
TN06020002005_1300	Unnamed Tributary To Candies Creek	1.14
TN06020002005_2000	Candies Creek	16.32
TN06020002005_3000	Candies Creek	9.51
TN06020002009_0200	Fillauer Creek	7.4
TN06020002009_0300	Woolen Mill Branch	3.92
TN06020002009_2000	South Mouse Creek	6.5
TN06020002012_0200	Little Chatata Creek	14.3
TN06020002012_1000	Chatata Creek	19.62
TN06020002081_1000	Conasauga Creek	33.99
TN06020002083_3000	Oostanaula Creek	7.4
TN06020002087_1000	Rogers Creek	21.6

Designated Uses: Fish & aquatic life, irrigation, livestock watering & wildlife, and recreation. Some waterbodies in watershed also classified for domestic and/or industrial water supply.

Applicable Water Quality Standard: Most stringent narrative criteria applicable to fish & aquatic life use classification.

Biological Integrity: The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06.

Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion, (b) is of the appropriate stream order specified for the bioregion, and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods.

Interpretation of this provision for all other streams, plus large rivers, reservoirs, and wetlands, may be made using *Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers* (EPA/841-B-99-002) and/or other scientifically defensible methods. Effects to biological populations will be measured by comparisons to upstream conditions or to appropriately selected reference sites in the same bioregion if upstream conditions are determined to be degraded.

Habitat: The quality of instream habitat shall provide for the development of a diverse aquatic community that meets regionally based biological integrity goals. The instream habitat within each subecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.

TMDL Development

General Analysis Methodology:

- Analysis performed using the Watershed Characterization System Sediment Tool (based on Universal Soil Loss Equation) applied to impaired HUC-12 subwatershed areas to calculate existing sediment loads.

- Target sediment loads (lbs/acre/year) are based on the average annual sediment load from biologically healthy watersheds (Level IV Ecoregion reference sites).

- TMDLs are expressed as the percent reduction in average annual sediment load required for a subwatershed containing impaired waterbodies relative to the appropriate target load.

- 5% of subwatershed target loads are reserved to account for WLAs for Ready Mixed Concrete Facilities (RMCFs) and regulated mining sites. Most loading from these sources is small compared to total loading.

- Since the TSS of STP discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced form erosional processes, TSS discharges from STPs were <u>not</u> considered in the TMDL analysis (ref.: Sections 3.0 and 6.0).

- WLAs for Municipal Separate Storm Sewer Systems (MS4s), WLAs for NPDES-regulated construction storm water discharges, and LAs for nonpoint sources are expressed as the percent reduction in average annual sediment load required for a subwatershed containing impaired waterbodies relative to the appropriate reduced target load (target load minus 5% reserved WLAs for RMCFs and mining sites).

Critical Conditions: Methodology takes into account all flow conditions.

Seasonal Variation: Methodology addresses all seasons.

Margin of Safety (MOS): Implicit (conservative modeling assumptions).

TMDL/Allocations

TMDLs, WLAs for MS4s and Construction Storm Water Sites, LAs for Nonpoint Sources:

HUC-12 Subwatershed (06020002___)	Waterbody ID	Waterbody	Level IV Ecoregion	TMDL (Required Overall Load Reduction)	Required Load Reduction	
					WLA (MS4s and Construction SW)	LA (Nonpoint Sources)
				[%]	[%]	[%]
0401	TN06020002081_1000	Conasauga Creek	66g	68.4	70.0	70.0
0402	TN06020002081_1000	Conasauga Creek	67f	43.8	46.7	46.7
0601	TN06020002012_0200	Little Chatata Creek	67f	51.2	53.6	53.6
	TN06020002012_1000	Chatata Creek				
0602	TN06020002005_1000	Candies Creek	67f	62.9	64.8	64.8
0603	TN06020002009_0200	Fillauer Creek	67g	43.1	46.0	46.0
	TN06020002009_0300	Woolen Mill Branch				
	TN06020002009_2000	South Mouse Creek				
0604	TN06020002087_1000	Rogers Creek	67i	8.5	13.1	13.1
0702	TN06020002083_3000	Oostanaula Creek	67i	59.4	61.5	61.5
0901	TN06020002005_3000	Candies Creek	67f	28.6	32.2	32.2
0902	TN06020002005_2000	Candies Creek	67h	50.1	52.6	52.6
	TN06020002005_3000	Candies Creek				
0903	TN06020002005_1000	Candies Creek	67g	7.3	11.9	11.9
	TN06020002005_2000	Candies Creek				
	TN06020002005_0900	Beaverdam Creek				
	TN06020002005_1100	Unnamed Trib. To Candies Creek				
	TN06020002005_1200	Unnamed Trib. To Candies Creek				
	TN06020002005_1300	Unnamed Trib. To Candies Creek				

Note: Calculations were conducted for all HUC-12 subwatersheds containing waterbodies identified as impaired for siltation/habitat alteration. Some impaired waterbodies extend across more than one HUC-12 subwatershed.

WLAs for Mining Sites and RMCFs:

WLAs for NPDES-regulated mining sites and RMCFs located in impaired subwatersheds are equal to existing permit limits for total suspended solids (TSS).

Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed 06020002__)	**NPDES Permit No.**	**Facility Name**	**TSS Daily Maximum Limit**
			[mg/l]
0401	TN0005487	Vulcan Construction	40
	TN0023957	Rogers Group	40
0402	TN0063835	Vulcan Construction	40
	TN0065901	Rogers Group	40

RMCFs Permitted to Discharge TSS and Located in Impaired Subwatersheds

HUC-12 Subwatershed (06020002__)	**NPDES Permit No.**	**Name**	**Daily Max TSS Limit**	**TSS Cut-off Conc.**
			[mg/l]	**[mg/l]**
0601	TNG110039	Bradley Concrete	50	200
0602	TNG110262	Cleveland Ready Mix Concrete	50	200
0702	TNG110047	Sequatchie Concrete	50	200
	TNG110280	Bradley Concrete	50	200
0902	TNG110231	Cleveland Ready Mix Concrete	50	200

TOTAL MAXIMUM DAILY LOAD (TMDL)
FOR SILTATION/HABITAT ALTERATION
HIWASSEE RIVER WATERSHED (HUC 06020002)

1.0 INTRODUCTION

Section 303(d) of the Clean Water Act requires each state to list those waters within its boundaries for which technology based effluent limitations are not stringent enough to protect any water quality standard applicable to such waters. Listed waters are prioritized with respect to designated use classifications and the severity of pollution. In accordance with this prioritization, states are required to develop Total Maximum Daily Loads (TMDLs) for those water bodies that are not attaining water quality standards. State water quality standards consist of designated use(s) for individual waterbodies, appropriate numeric and narrative water quality criteria protective of the designated uses and an antidegradation statement. The TMDL process establishes the maximum allowable loadings of pollutants for a waterbody that will allow the waterbody to maintain water quality standards. The TMDL may then be used to develop controls for reducing pollution from both point and nonpoint sources in order to restore and maintain the quality of water resources (USEPA, 1991).

2.0 WATERSHED DESCRIPTION

The Hiwassee River Watershed, designated by the Hydrologic Unit Code (HUC) 06020002 by the USGS, is located in North Carolina, Georgia and Southeast Tennessee (ref.: Figure 1). The Tennessee portion includes parts of Bradley, Hamilton, McMinn, Meigs, Monroe, and Polk Counties. The Hiwassee River Watershed lies within two Level III ecoregions (Blue Ridge Mountains, Ridge and Valley) and contains six Level IV subecoregions as shown in Figure 2 (USEPA, 1997):

- The Southern Sedimentary Ridges (66e) in Tennessee include some of the westernmost foothill areas of the Blue Ridge Mountains ecoregion, such as the Bean, Starr, Chilhowee, English, Stone, Bald, and Iron Mountain areas. Slopes are steep, and elevations are generally 1,000-4,500 feet. The rocks are primarily Cambrian-age sedimentary (shale, sandstone, siltstone, quartzite, conglomerate), although some lower stream reaches occur on limestone. Soils are predominantly friable loams and fine sandy loams with variable amounts of sandstone rock fragments, and support mostly mixed oak and oak-pine forests.

- Southern Metasedimentary Mountains (66g) are steep, dissected, biologically diverse mountains that include Clingman's Dome (6,643 feet), the highest point in Tennessee. The Precambrian-age metamorphic and sedimentary geologic materials are generally older and more metamorphosed than the Southern Sedimentary Ridges to the west and north. The Appalachian oak forests and, at higher elevations, the northern hardwoods forests include a variety of oaks and pines, as well as silverbell, hemlock, yellow poplar, basswood, buckeye, yellow birch, and beech. Spruce-fir forests, found generally above 5,500 feet, have been affected greatly over the past twenty-five years by the balsam wooly aphid. The Copper Basin, in the southeast corner of Tennessee, was the site of copper mining and smelting from the 1850’s to 1987, and once left more than fifty square miles of eroded bare earth.

- The Southern Limestone/Dolomite Valleys and Low Rolling Hills (67f) form a heterogeneous region composed predominantly of limestone and cherty dolomite. Landforms are mostly low rolling ridges and valleys, and the soils vary in their productivity. Landcover includes intensive agriculture, urban and industrial, or areas of thick forest. White oak forests, bottomland oak forests, and sycamore-ash-elm riparian forests are the common forest types, and grassland barrens intermixed with cedar-pine glades also occur here.

- The Southern Shale Valleys (67g) consist of lowlands, rolling valleys, and slopes and hilly areas that are dominated by shale materials. The northern areas are associated with Ordovician-age calcareous shale, and the well-drained soils are often slightly acid to neutral. In the south, the shale valleys are associated with Cambrian-age shales that contain some narrow bands of limestone, but the soils tend to be strongly acid. Small farms and rural residences subdivide the land. The steeper slopes are used for pasture or have reverted to brush and forested land, while small fields of hay, corn, tobacco, and garden crops are grown on the foot slopes and bottom land.

- The Southern Sandstone Ridges (67h) ecoregion encompasses the major sandstone ridges, but these ridges also have areas of shale and siltstone. The steep, forested ridges have narrow crests, and the soils are typically stony, sandy, and of low fertility. The chemistry of streams flowing down the ridges can vary greatly depending on the geologic material. The higher elevation ridges are in the north, including Wallen Ridge, Powell Mountain, Clinch Mountain, and Bays Mountain. White Oak Mountain in the south has some sandstone on the west side, but abundant shale and limestone as well. Grindstone Mountain, capped by the Gizzard Group sandstone, is the only remnant of Pennsylvanian-age strata in the Ridge and Valley of Tennessee.

- The Southern Dissected Ridges and Knobs (67i) contain more crenulated, broken, or hummocky ridges, compared to the smoother, more sharply pointed sandstone ridges. Although shale is common, there is a mixture and interbedding of geologic materials. The ridges on the east side of Tennessee’s Ridge and Valley tend to be associated with the Ordovician-age Sevier shale, Athens shale, and Holston and Lenoir limestones. These can include calcareous shale, limestone, siltstone, sandstone, and conglomerate. In the central and western part of the ecoregion, the shale ridges are associated with the Cambrian-age Rome Formation: shale and siltstone with beds of sandstone. Chestnut oak forests and pine forests are typical for the higher elevations of the ridges, with areas of white oak, mixed mesophytic forest, and tulip poplar on the lower slopes, knobs, and draws.

The Hiwassee River Watershed has approximately 3,103 miles of streams (NHD), of which 1,582 miles of stream (NHD) are in Tennessee as catalogued in the EPA/TDEC Assessment Database (ADB). This watershed drains approximately 2,099 square miles, of which 1,011 square miles are in Tennessee and empty to the Chickamauga Reservoir (Tennessee River). Watershed land use distribution is based on the 1992 Multi-Resolution Land Characteristic (MRLC) satellite imagery databases derived from Landsat Thematic Mapper digital images from the period 1990-1993. Land use for the Hiwassee River Watershed is summarized in Table 1 and shown in Figure 3.

Figure 1 Location of the Hiwassee River Watershed

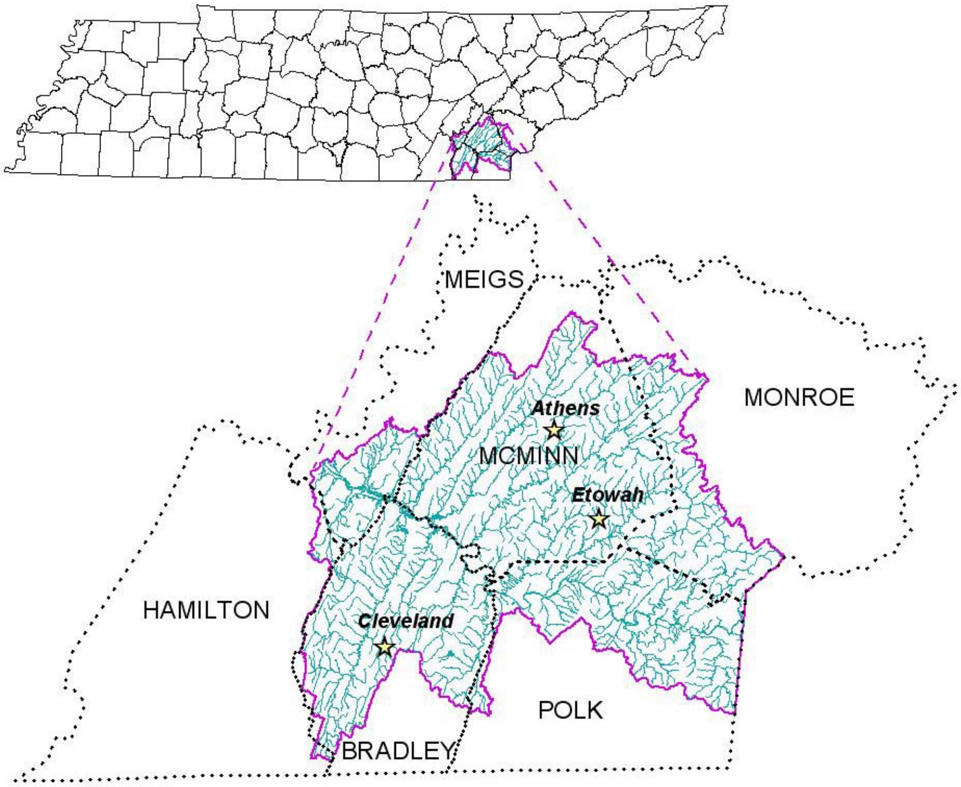


Table 1 Land Use Distribution – Hiwassee River Watershed

Land Use	Area		
	[acres]	[mi^2]	[% of watershed]
Deciduous Forest	200,349	313.05	31.0
Emergent Herbaceous Wetlands	1,241	1.94	0.2
Evergreen Forest	125,008	195.33	19.3
High Intensity Commercial/Industrial/Transportation	4,490	7.02	0.7
High Intensity Residential	1,625	2.54	0.3
Low Intensity Residential	8,959	14.00	1.4
Mixed Forest	137,283	214.50	21.2
Open Water	5,990	9.36	0.9
Other Grasses (Urban/Recreational)	3,848	6.01	0.6
Pasture / Hay	119,489	186.70	18.5
Quarries/Strip Mines/Gravel Pits	304	0.48	0.0
Row Crops	29,578	46.22	4.6
Transitional	4,968	7.76	0.8
Woody Wetlands	3,978	6.22	0.6
Total	**647,109**	**1,011.11**	**100.1** [a]

a. A spreadsheet was used for this calculation and values are approximate due to rounding.

Figure 2 Level IV Ecoregions in the Hiwassee River Watershed

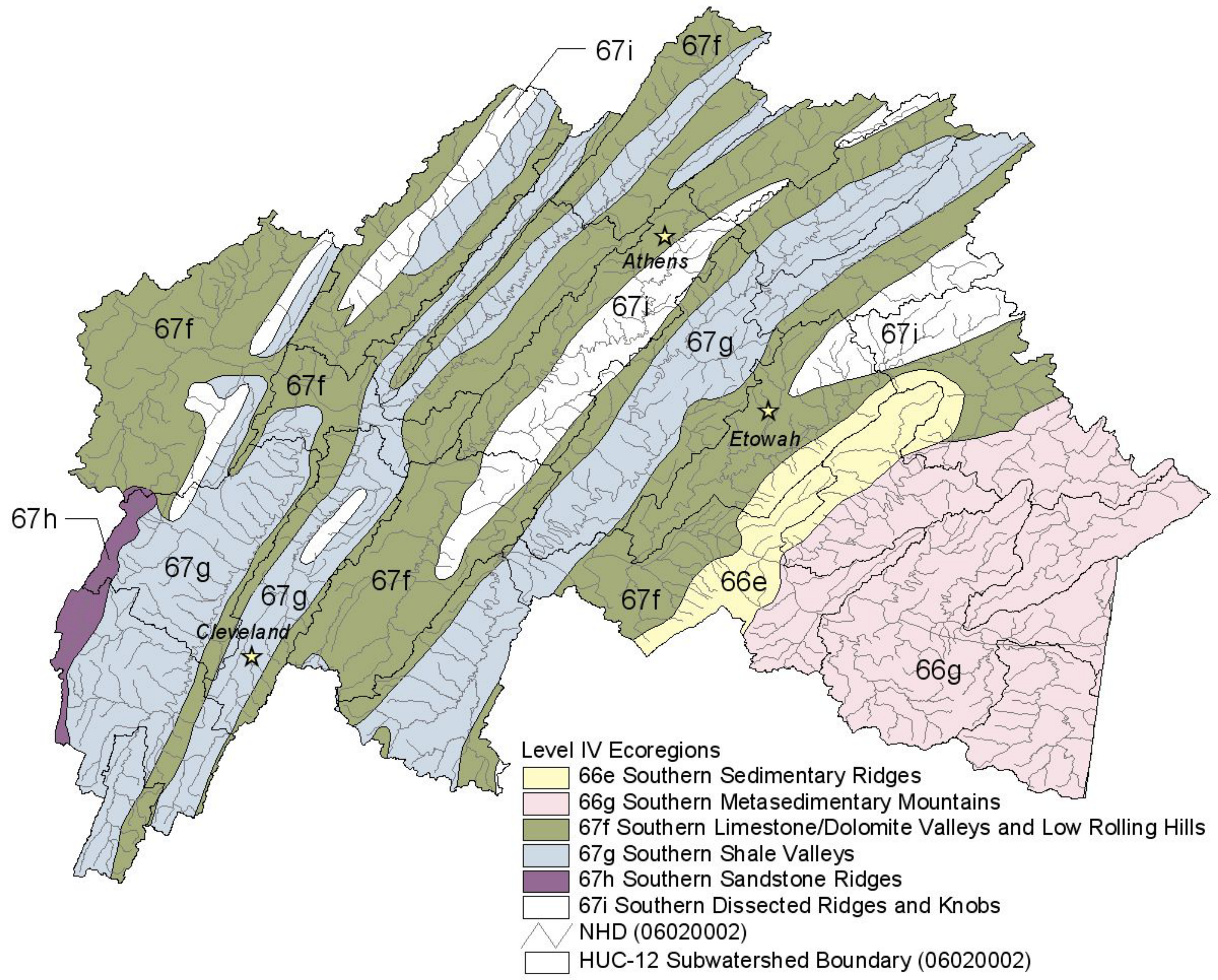
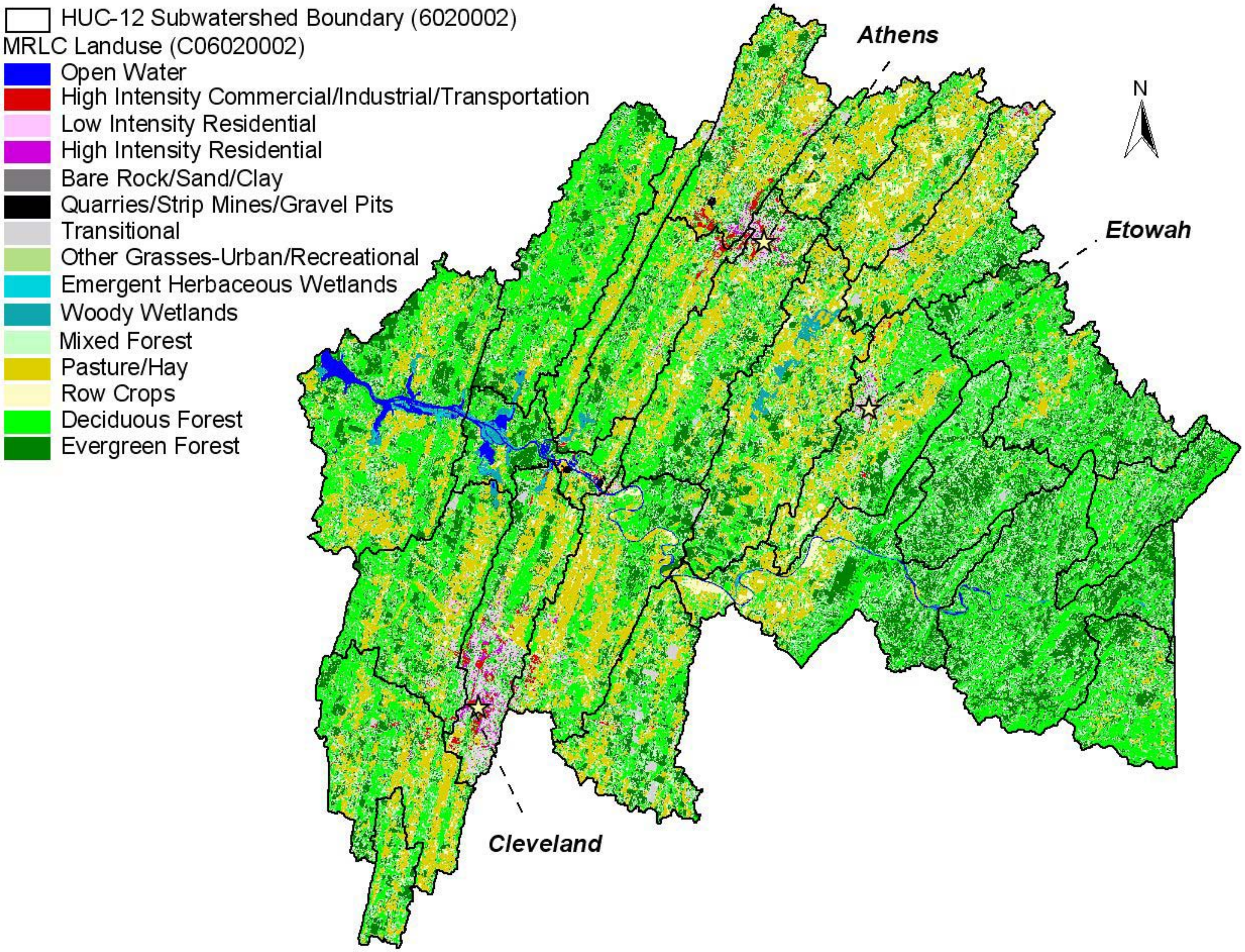


Figure 3 MRLC Land Use in the Hiwassee River Watershed



3.0 PROBLEM DEFINITION

The State of Tennessee's final *2004 303(d) List* (TDEC, 2005) was approved by the U. S. Environmental Protection Agency (EPA), Region IV on August 4, 2005, and identified a number of waterbodies in the Hiwassee River Watershed as not fully supporting designated use classifications due, in part, to siltation and/or habitat alteration associated with agriculture, urban runoff, land development, and bank modification. These waterbodies are summarized in Table 2 and shown in Figure 4. The designated use classifications for the Hiwassee River and its tributaries include fish & aquatic life, irrigation, livestock watering & wildlife, and recreation. Some waterbodies in the watershed are also classified for industrial water supply and/or domestic water supply.

A description of the stream assessment process in Tennessee can be found in *2004 305(b) Report, The Status of Water Quality in Tennessee* (TDEC, 2004a). This document states that "biological surveys using macroinvertebrates as the indicator organisms are the preferred method for assessing support of the fish & aquatic life designated use". The waterbody segments listed in Table 2 were assessed as impaired based primarily on biological surveys. The results of these assessment surveys are summarized in Table 3. The assessment information presented is excerpted from the EPA/TDEC Assessment Database (ADB) and is referenced to the waterbody IDs in Table 2. Assessment Database information may be accessed at:

http://gwidc.memphis.edu/website/dwpc/

A typical example of a stream assessment (Candies Creek) is shown in Appendix A.

Siltation is the process by which sediments are transported by moving water and deposited on the bottom of stream, river, and lake beds. Sediment is created by the weathering of host rock and delivered to stream channels through various erosional processes, including sheetwash, gully and rill erosion, wind, landslides, dry gravel, and human excavation. In addition, sediments are often produced as a result of stream channel and bank erosion and channel disturbance. Movement of eroded sediments downslope from their points of origin into stream channels and through stream systems is influenced by multiple interacting factors (USEPA, 1999).

Siltation (sedimentation) is the most frequently cited cause of waterbody impairment in Tennessee, impacting over 5,743 miles of streams and rivers (TDEC, 2004a). Unlike many chemical pollutants, sediments are typically present in waterbodies in natural or background amounts and are essential to normal ecological function. Excessive sediment loading, however, is a major ecosystem stressor that can adversely impact biota, either directly or through changes to physical habitat.

Excessive sediment loading has a number of adverse effects on fish & aquatic life in surface waters. As stated in excerpts from *Developing Water Quality Criteria for Suspended and Bedded Sediments (SABS) – Draft* (USEPA, 2003):

> In streams and rivers, fine inorganic sediments, especially silts and clays, affect the habitat for macroinvertebrates and fish spawning, as well as fish rearing and feeding

Table 2 *2004 303(d) List* **- Stream Impairment Due to Siltation/Habitat Alteration in the Hiwassee River Watershed**

Waterbody ID	Waterbody	Miles/ Acres	Cause (Pollutant)	Source (Pollutant)
TN06020002005_0900	Beaverdam Creek	3.07	Siltation/Alteration in stream-side or littoral vegetative cover	Pasture Grazing
TN06020002005_1000	Candies Creek	9.65	Siltation	Discharges from MS4 area/Pasture Grazing
TN06020002005_1100	Unnamed Trib. To Candies Creek	1.55	Physical Substrate Habitat Alterations/ Siltation	Pasture Grazing
TN06020002005_1200	Unnamed Trib. To Candies Creek	0.95	Alteration in stream-side or littoral vegetative cover/ Siltation	Pasture Grazing
TN06020002005_1300	Unnamed Trib. To Candies Creek	1.14	Siltation	Undetermined Source
TN06020002005_2000	Candies Creek	16.32	Physical Substrate Habitat Alterations/Siltation	Discharges from MS4 area/Pasture Grazing/ Streambank Modifications
TN06020002005_3000	Candies Creek	9.51	Siltation	Pasture Grazing
TN06020002009_0200	Fillauer Creek	7.4	Alteration in stream-side or littoral vegetative cover/Siltation/Escherichia coli	Discharges from MS4 area/Collection System Failure
TN06020002009_0300	Woolen Mill Branch	3.92	Alteration in stream-side or littoral vegetative cover/Organic Enrichment/Escherichia coli	Discharges from MS4 area/Illicit Connections to Storm Sewers/Collection System Failure
TN06020002009_2000	South Mouse Creek	6.5	Unknown Toxicity/Siltation/Physical Substrate Habitat Alterations/Escherichia coli	Discharges from MS4 area/Channelization/ Streambank Modification/Destabilization/ Collection System Failure
TN06020002012_0200	Little Chatata Creek	14.3	Siltation/ Alteration in stream-side or littoral vegetative cover/ Escherichia coli	Discharges from MS4 area/ Pasture Grazing
TN06020002012_1000	Chatata Creek	19.62	Siltation/Physical Substrate Habitat Alterations/Escherichia coli	Discharges from MS4 area/ Pasture Grazing
TN06020002081_1000	Conasauga Creek	33.99	Siltation	Discharges from MS4 area/Pasture Grazing/
TN06020002083_3000	Oostanaula Creek	7.4	Phosphate/Siltation/Total Fecal Coliforms	Municipal Point Source/Discharge/ Discharge from MS4 area
TN06020002087_1000	Rogers Creek	21.6	Alterations in stream-side or littoral vegetation/Escherichia coli	Pasture Grazing

Figure 4 Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

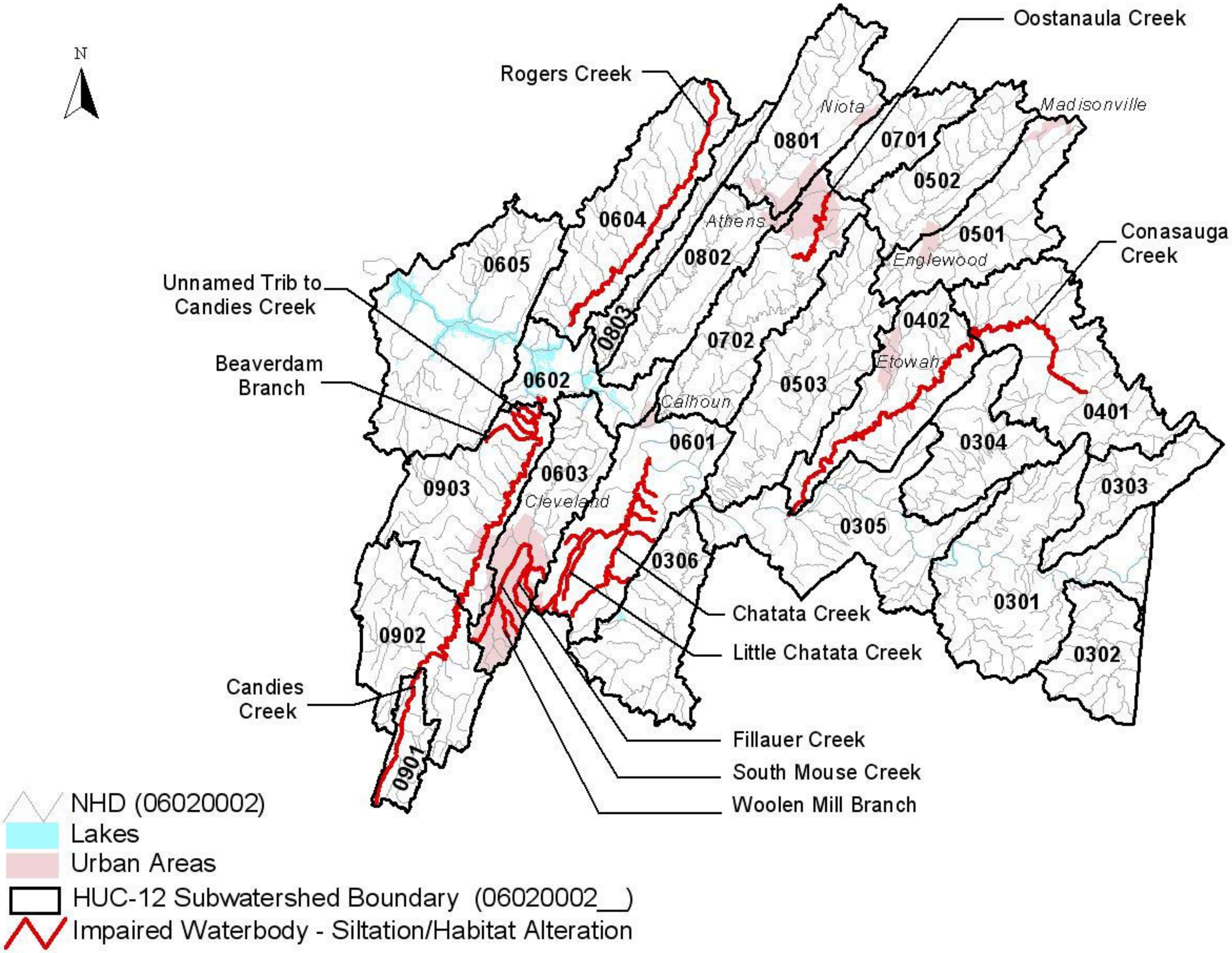


Table 3 Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration

Waterbody ID	Waterbody	Comments
TN06020002005_0900	Beaverdam Creek	2003 TDEC RBPIII station at mile 0.5 (Eureka Road). Habitat score = 98. RBPIII results: 4 EPT genera, 29 total genera. Index score = 20. Failed biocriteria
TN06020002005_1000	Candies Creek	2003 TDEC RBPIII and biorecon at mile 12.3 (off Candies Creek Ridge Road). RBPIII results: 5 EPT genera, 23 total genera. Index score = 24. Failed biocriteria. Biorecon results: 1 EPT genera, 1 intolerant, 10 total genera. Br score = 3. 1995 TVA biological station at mile 4.0. 10 EPT families. TDEC station at mile 8.2.
TN06020002005_1100	Unnamed Trib. To Candies Creek	2003 TDEC RBPIII station at mile 0.5 (Eureka Road). Habitat score = 109. RBPIII results: 6 EPT genera, 32 total genera. Index score = 24. Failed biocriteria. 1999: Surveyed in response to fish kill.
TN06020002005_1200	Unnamed Trib. To Candies Creek	2003 TDEC RBPIII station at mile 0.5 (Eureka Road). Habitat score = 80. RBPIII results: 3 EPT genera, 25 total genera. Index score = 20. Failed biocriteria. 1999:Surveyed in response to fish kill.
TN06020002005_1300	Unnamed Trib. To Candies Creek	2003 TDEC RBPIII station at mile 0.7 (Eureka Road). Habitat score = 147. RBPIII results: 1 EPT genera, 21 total genera. Index score = 16. Failed biocriteria. 1999: Surveyed in response to fish kill.
TN06020002005_2000	Candies Creek	2003 TDEC RBPIII and biorecon at mile 13.3 (off Candies Creek Ridge Road). RBPIII results: 5 EPT genera, 30 total genera. Index score = 36. Passed biocriteria. Biorecon results: 3 EPT genera, 1 intolerant, 12 total genera. Br score = 3. Habitat score = 72. 2001 TVA biorecon at Black Fox Road. 12 EPT families, 8 intolerant, 28 total families. Br score = 15. Passed biorecon criteria. TDEC station at Highway 310. Habitat score = 165. Not enough data to assess.
TN06020002005_3000	Candies Creek	2003 TDEC RBPIII and biorecon at mile 30.5 (Old Chattanooga Road). RBPIII results: 8 EPT genera, 27 total genera. Index score = 30. Failed biocriteria. Biorecon results: 5 EPT genera, 1 intolerant, 19 total genera. Br score = 5. Habitat score = 151.
TN06020002009_0200	Fillauer Creek	2003 TDEC RBPIII and pathogen station at mile 0.3 (Mouse Creek Road). G.M. of six samples = 792. Four out of six E. coli samples over 1,000. RBPIII results: 3 EPT genera, 24 total genera. Index score = 22. Failed biocriteria. Habitat score = 108.
TN06020002009_0300	Woolen Mill Branch	Two fish kill in the stream due to sewage overflows. Illicit industrial discharges. Stream choked with algae.

Table 3 (Cont.) Water Quality Assessment of Waterbodies Impaired Due to Siltation/Habitat Alteration

Waterbody ID	Waterbody	Comments
TN06020002009_2000	South Mouse Creek	2003 TDEC RBPIII and pathogen station at mile 10.6 (Smith Road). G.M. of six samples = 441. One out of six E. coli samples over 940. BPIII results: 2 EPT genera, 22 total genera. Index score = 16. Failed biocriteria. Habitat score = 109. 2003 TDEC RBPIII and pathogen station at mile 12.7 (Raider Road). G.M. of six samples = 1482. Five out of six E. coli samples over 1,000. RBPIII results: Zero EPT genera, 16 total genera. Index score = 14. Failed biocriteria. Habitat score = 85. 1998 rapid bioassessment (near Paul Huff Parkway) documented no EPT taxa.
TN 06020002012_0200	Little Chatata Creek	2003 TDEC RBPIII and pathogen station at mile 0.3 (Tasso Road). G.M. of six samples = 880. Three out of six E. coli samples over 940. RBPIII results: 8 EPT genera, 30 total genera. Index score = 26. Failed biocriteria. Habitat score = 122. Also 2003 TDEC pathogen station at mile 4.3 (Old Tasso Road). G.M. of six samples = 317. Zero out of six E. coli samples over 940. Intensive survey during 80s. Three fecal samples in 1999. Not enough data to assess.
TN 06020002012_1000	Chatata Creek	2003 TDEC RBPIII and pathogen station at mile 2.0 (Chatata Valley Road). G.M. of six samples = 1457. Six out of six E. coli samples over 940. RBPIII results: 5 EPT genera, 38 total genera. Index score = 16. Failed biocriteria. Habitat score = 102. 2003 TDEC pathogen station at mile 6.4 (Tasso Road). G.M. of six samples = 2224. Five out of six E. coli samples over 940. 2003 TDEC RBPIII and pathogen station at mile 9.3 (Wilkerson Road). G.M. of six samples = 165. None out of six E. coli samples over 940. RBPIII results: 4 EPT genera, 25 total genera. Index score = 34. Passed biocriteria. Habitat score = 108. TVA RAT Team 1994 assessment. 5 EPT taxa. Significantly different than reference condition. TDEC stations at mile Chatata Valley Road and Tasso Road. Pathogens elevated. E. coli 2400 and 700.
TN 06020002081_1000	Conasauga Creek	J. M. Huber survey on Conasauga Creek/Watershed monitoring site 1998.
TN06020002083_3000	Oostanaula Creek	2003 TDEC chemical and RBPIII station at mile 28.4 (Long Mill Road). Five E. coli samples out of seventeen over 940. RBPIII results: 1 EPT genera, 26 total genera. Index score = 22. Fails biocriteria. Habitat score = 123. 1999 TDEC fecal data from watershed monitoring.
TN06020002087_1000	Rogers Creek	2003 TDEC chemical station at mile? (Sanford Road). E. coli g.m. = 547. No E. coli samples out of five over 940. 2003 TDEC chemical station at mile ? (Riceville Road). E. coli g.m. = 461. One E. coli samples out of five over 940. 2003 TDEC biorecon and chemical station at mile 14.2 (Hwy 30). E. coli g.m. = 1125. Three E. coli samples out of five over 940. 3 EPT families, 1 intolerant, 15 total families. BR score = 7. Habitat score = 95. 1993 TVA survey. 11 EPT taxa. TDEC stations at McMinn County Road 50 and Highway 30. Pathogens elevated during dry conditions.

> behavior. Larger sands and gravels can scour diatoms and cause burying of invertebrates, whereas suspended sediment affects the light available for photosynthesis by plants and visual capacity of animals.
>
> Sedimentation alters the structure of the invertebrate community by causing a shift in proportions from one functional group to another. Sedimentation can lead to embeddedness, which blocks critical macroinvertebrate habitat by filling in the interstices of the cobble and other hard substrate on the stream bottom. As deposited sediment increases, changes in invertebrate community structure and diversity occur.
>
> Invertebrate drift is directly affected by increased suspended sediment load in freshwater streams. These changes generally involve a shift in dominance from ephemeroptera, plecoptera and trichoptera (EPT) taxa to other less pollution-sensitive species that can cope with sedimentation. Increases in sediment deposition that affect the growth, abundance, or species composition of the periphytic (attached) algal community will also have an effect on the macroinvertebrate grazers that feed predominantly on periphyton. ……. Effects on aquatic individuals, populations, and communities are expressed through alterations in local food webs and habitat. When sedimentation exceeds certain thresholds, ensuing effects will likely involve decline of the existing aquatic invertebrate community and subsequent colonization by pioneer species.

Historically, waterbodies in Tennessee have been assessed as not fully supporting designated uses due to siltation when the impairment was determined to be the result of excess loading of the inorganic sediment produced by erosional processes. In cases where impairment was determined to be caused by excess loading of the primarily organic particulate material found in sewage treatment plant (STP) effluent, the cause of pollution was listed as total suspended solids (TSS) or organic enrichment. In consideration of this practice, this document presents the details of TMDL development for waterbodies in the Hiwassee River Watershed listed as impaired due to siltation (excess inorganic sediment produced by erosional processes) and/or appropriate cases of habitat alteration. The TSS in STP effluent is considered to be a distinctly different pollutant and, therefore, is excluded in sediment loading calculations.

4.0 TARGET IDENTIFICATION

Several narrative criteria, applicable to siltation/habitat alteration, are established in *Rules of Tennessee Department of Environment and Conservation, Tennessee Water Quality Control Board, Division of Water Pollution Control, Chapter 1200-4-3 General Water Quality Criteria, January, 2004* (TDEC, 2004):

> Applicable to all use classifications (Fish & Aquatic Life shown):
>
> > Solids, Floating Materials, and Deposits – There shall be no distinctly visible solids, scum, foam, oily slick, or the formation of slimes, bottom deposits or sludge banks of such size and character that may be detrimental to fish & aquatic life.
> >
> > Other Pollutants – The waters shall not contain other pollutants that will be detrimental to fish or aquatic life.

Applicable to the Domestic Water Supply, Industrial Water Supply, Fish & Aquatic Life, and Recreation use classifications (Fish & Aquatic Life shown):

> Turbidity or Color – There shall be no turbidity or color in such amounts or of such character that will materially affect fish & aquatic life.

Applicable to the Fish & Aquatic Life use classification:

> Biological Integrity - The waters shall not be modified through the addition of pollutants or through physical alteration to the extent that the diversity and/or productivity of aquatic biota within the receiving waters are substantially decreased or adversely affected, except as allowed under 1200-4-3-.06.
>
> Interpretation of this provision for any stream which (a) has at least 80% of the upstream catchment area contained within a single bioregion and (b) is of the appropriate stream order specified for the bioregion and (c) contains the habitat (riffle or rooted bank) specified for the bioregion, may be made using the most current revision of the Department's Quality System Standard Operating Procedure for Macroinvertebrate Stream Surveys and/or other scientifically defensible methods.
>
> Interpretation of this provision for all other streams, plus large rivers, reservoirs, and wetlands, may be made using Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers (EPA/841-B-99-002) and/or other scientifically defensible methods. Effects to biological populations will be measured by comparisons to upstream conditions or to appropriately selected reference sites in the same bioregion if upstream conditions are determined to be degraded.
>
> Habitat - The quality of instream habitat shall provide for the development of a diverse aquatic community that meets regionally based biological integrity goals. The instream habitat within each subecoregion shall be generally similar to that found at reference streams. However, streams shall not be assessed as impacted by habitat loss if it has been demonstrated that the biological integrity goal has been met.

These TMDLs are being established to attain full support of the fish and aquatic life designated use classification. TMDLs established to protect fish and aquatic life will protect all other use classifications for the identified waterbodies from adverse alteration due to sediment loading.

In order for a TMDL to be established, a numeric "target" protective of the uses of the water must be identified to serve as the basis for the TMDL. Where State regulation provides a numeric water quality criteria for the pollutant, the criteria is the basis for the TMDL. Where State regulation does not provide a numeric water quality criteria, as in the case of siltation/habitat alteration, a numeric interpretation of the narrative water quality standard must be determined. For the purpose of these TMDLs, the average annual sediment loading in lbs/acre/yr, from a biologically healthy watershed, located within the same Level IV ecoregion as the impaired watershed, is determined to be the appropriate numeric interpretation of the narrative water quality standard for protection of fish & aquatic life. Biologically healthy watersheds were identified from the State's ecoregion reference sites. These ecoregion reference sites have similar characteristics and conditions as the majority of streams within that ecoregion. Detailed information regarding Tennessee ecoregion reference sites can be found in *Tennessee Ecoregion Project, 1994-1999* (TDEC, 2000). In general, land use in ecoregion reference watersheds contain less pasture, cropland, and urban areas and more forested areas compared to the impaired watersheds. The biologically healthy (reference) watersheds are considered the “least impacted” in an ecoregion and, as such, sediment loading from these watersheds may serve as an appropriate target for the TMDL.

Using the methodology described in Appendix B, the Watershed Characterization System (WCS) Sediment Tool was used to calculate the average annual sediment load for each of the biologically healthy (reference) watersheds in Level IV ecoregions 66e, 66g, 67f, 67g, 67h, and 67i. The geometric mean of the average annual sediment loads of the reference watersheds in each Level IV ecoregion was selected as the most appropriate target for that ecoregion. Since the impairment of biological integrity due to sediment build-up is generally a long-term process, using an average annual load is considered appropriate. The average annual sediment loads for reference sites and corresponding TMDL target values for Level IV ecoregions 66e, 66g, 67f, 67g, 67h, and 67i are summarized in Table 4. Reference site locations are shown in Figure 5.

> *Note: Ecoregion reference sites are continually reviewed, with sites added or deleted as circumstances warrant. Using the methodology described in Appendix B, the WCS Sediment Tool was used to determine the average annual sediment loads, due to precipitation-based sources, for the active Level IV ecoregion reference sites as of April 30, 2005. The WCS sediment tool utilizes DEM and MRLC coverages to calculate the sediment loads. The stations listed in Table 4 and shown in Figure 5 are the ecoregion reference sites as of April 30, 2005 for which the average annual sediment loads could be calculated with current information.*

Table 4 Average Annual Sediment Loads of Level IV Ecoregion Reference Sites

Level 4 Ecoregion	Reference Site	Stream	Drainage Area	Average Annual Sediment Load
			(acres)	[lbs/acre/year]
66e	Eco66e04	Gentry Creek	2,699	151.9
	Eco66e09	Clark Creek	5,886	69.3
	Eco66e11	Lower Higgins Creek	2,189	90.0
	Eco66e17	Double Branch	1,878	135.2
	Eco66e18	Gee Creek	2,728	221.0
			Geometric Mean (Target Load)	**123.1**
66g	Eco66g04	Middle Prong Little Pigeon River	12,469	90.9
	Eco66g05	Little River	19,998	68.3
	Eco66g07	Citico Creek	1,556	93.4
	Eco66g09	North River	7,470	377.7
	Eco66g12	Sheeds Creek	2,281	117.6
			Geometric Mean (Target Load)	**120.8**
67f	Eco67f06	Clear Creek	1,975	400.9
	Eco67f13	White Creek	1,724	272.4
	Eco67f17	Big War Creek	30,062	585.1
			Geometric Mean (Target Load)	**399.8**

Table 4 (Cont.) Average Annual Sediment Loads of Level IV Ecoregion Reference Sites

Level 4 Ecoregion	Reference Site	Stream	Drainage Area	Average Annual Sediment Load
			(acres)	[lbs/acre/year]
67g	Eco67g05	Bent Creek	21,058	904.9
	Eco67g08	Brymer Creek	4,237	605.0
	Eco67g09	Harris Creek	3,054	724.5
	Eco67g10	Flat Creek	13,236	651.8
	Eco67g11	N Prong Fishdam Creek	1,019	853.2
			Geometric Mean (Target Load)	**739.1**
67h	Eco67h04	Blackburn Creek	653	195.6
	Eco67h06	Laurel Creek	1,793	557.2
			Geometric Mean (Target Load)	**330.1**
67i	Eco67i12	Mill Branch	681	279.0
			Geometric Mean (Target Load)	**279.0**

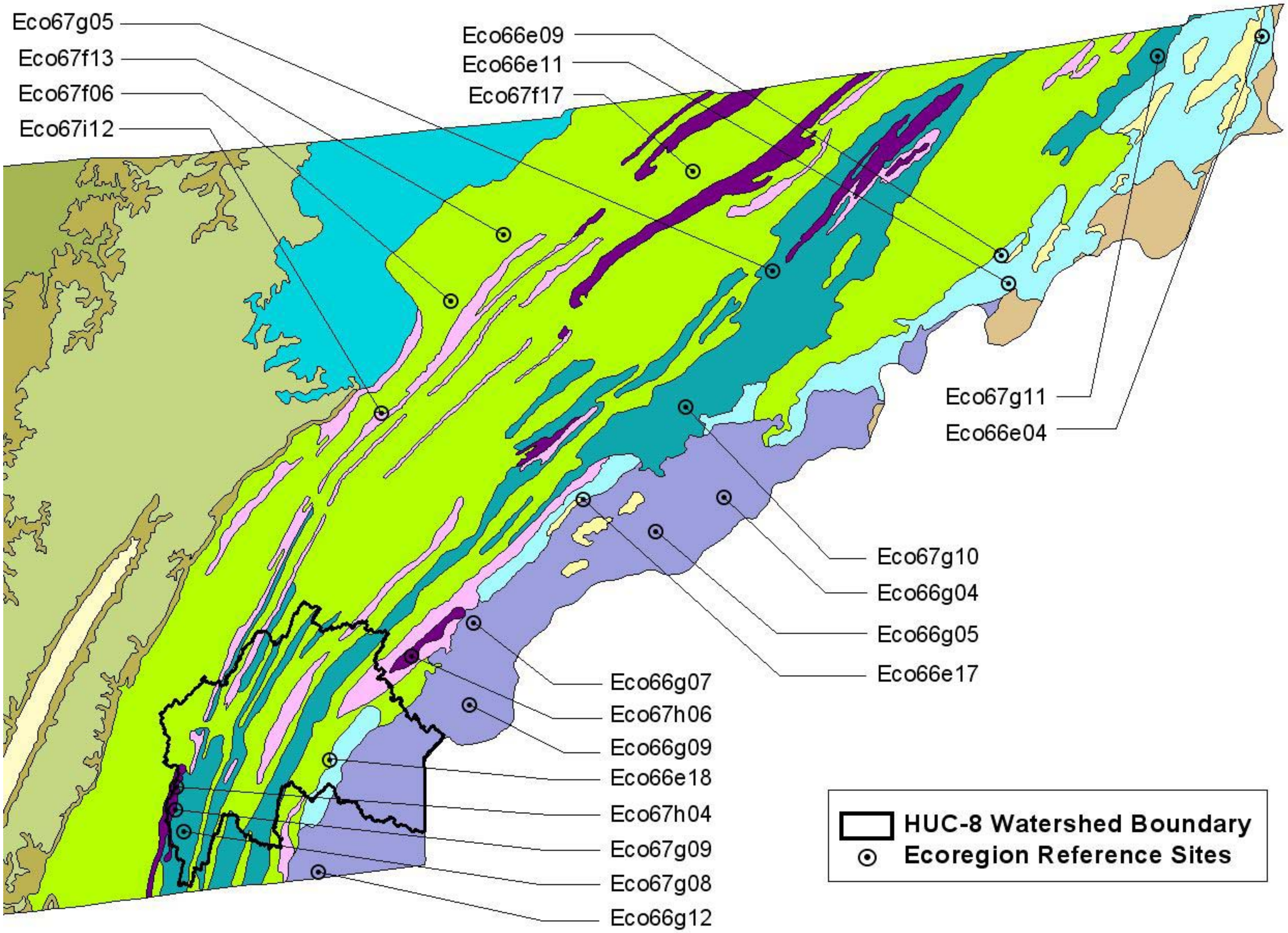
5.0 WATER QUALITY ASSESSMENT AND DEVIATION FROM TARGET

Using the methodology described in Appendix B, the WCS Sediment Tool was used to determine the average annual sediment load, due to precipitation-based sources, for all HUC-12 subwatersheds in the Hiwassee River Watershed (ref.: Figure 4). Existing precipitation-based sediment loads for subwatersheds with waterbodies listed on the *2004 303(d) List* as impaired for siltation/habitat alteration are summarized in Table 5.

Table 5 Existing Sediment Loads in Subwatersheds With Impaired Waterbodies

Huc-12 Subwatershed (06020002____)	Level IV Ecoregion	Existing Sediment Load
		[lbs/ac/yr]
0401	66g	382
0402	67f	712
0601	67f	819
0602	67f	1,079
0603	67g	1,300
0604	67i	305
0702	67i	688
0901	67f	560
0902	67h	662
0903	67g	797

Figure 5 Reference Sites in Level IV Ecoregions 66e, 66g, 67f, 67g, 67h, and 67i



6.0 SOURCE ASSESSMENT

An important part of the TMDL analysis is the identification of individual sources, source categories, or source subcategories of siltation in the watershed and the amount of pollutant loading contributed by each of these sources. Under the Clean Water Act, sources are broadly classified as either point or nonpoint sources. Under 40 CFR 122.2, a point source is defined as a discernable, confined and discrete conveyance from which pollutants are or may be discharged to surface waters. The National Pollutant Discharge Elimination System (NPDES) program regulates point source discharges. Regulated point sources include: 1) municipal and industrial wastewater treatment facilities (WWTFs); 2) storm water discharges associated with industrial activity (which includes construction activities); and 3) certain discharges from Municipal Separate Storm Sewer Systems (MS4s). A TMDL must provide Waste Load Allocations (WLAs) for all NPDES-regulated point sources. For the purposes of these TMDLs, all sources of sediment loading not regulated by NPDES are considered nonpoint sources. The TMDL must provide a Load Allocation (LA) for these sources.

6.1 Point Sources

6.1.1 NPDES-Regulated Wastewater Treatment Facilities

As stated in Section 3.0, the TSS component of STP discharges is generally composed of primarily organic material and is considered to be different in nature than the sediments produced from erosional processes. Therefore, TSS discharges from STPs are not included in the TMDLs developed for this document.

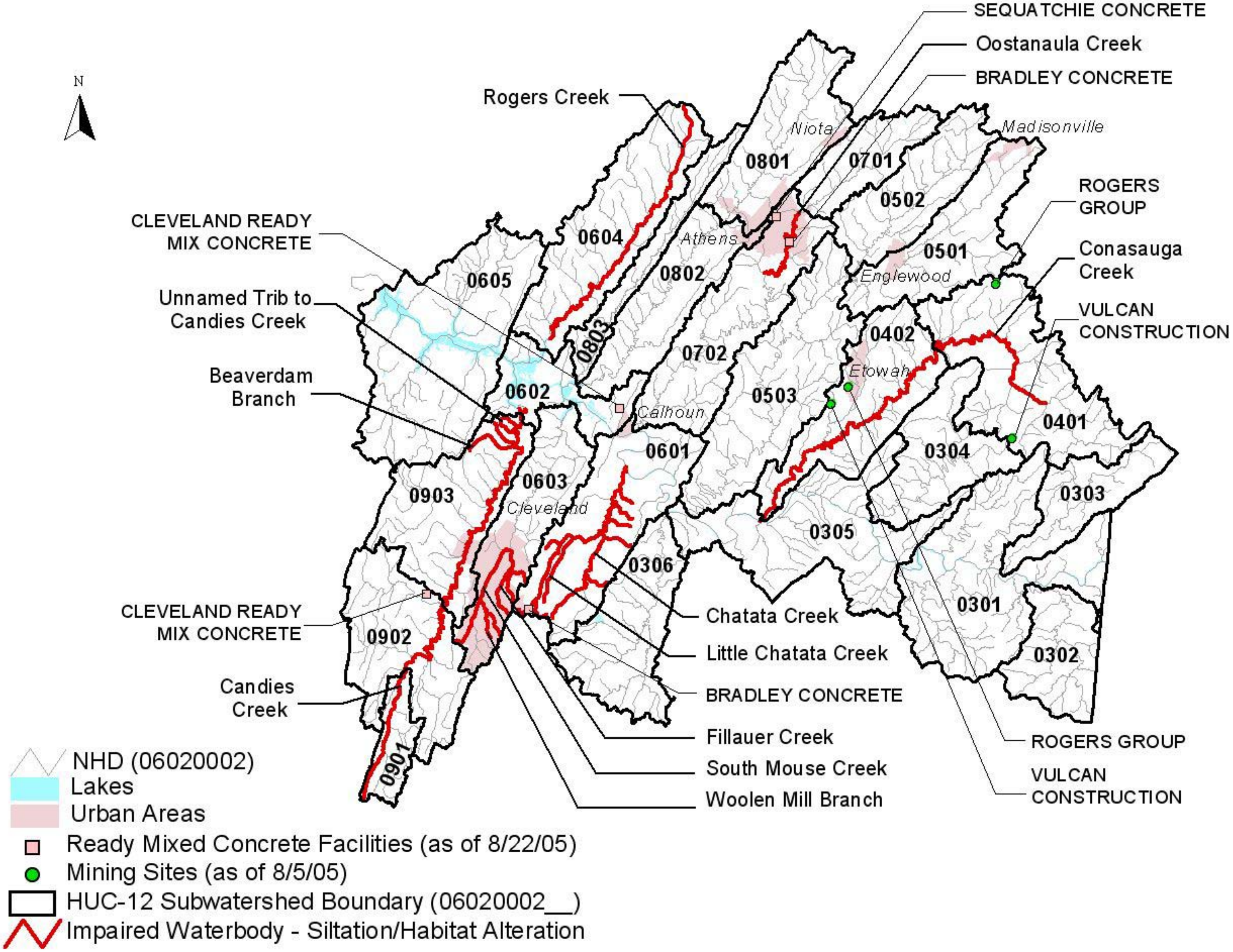
6.1.2 NPDES-Regulated Mining Sites

Discharges from regulated mining activities may contribute sediment to surface waters as TSS (TSS discharged from mining sites is composed of primarily inorganic material and is therefore included as a source for TMDL development). Discharges from active mines may result from dewatering operations and/or in response to storm events, whereas discharges from permitted inactive mines are only in response to storm events. Inactive sites with successful surface reclamation contribute relatively little solids loading. Of the fourteen permitted active mining sites in the Hiwassee River Watershed (as of August 5, 2005), four are located in impaired subwatersheds. These are listed in Table 6 and shown in Figure 6. Sediment loads (as TSS) to waterbodies from mining site discharges are very small in relation to total sediment loading (ref.: Appendix D).

6.1.3 NPDES-Regulated Ready Mixed Concrete Facilities

Discharges from regulated Ready Mixed Concrete Facilities (RMCFs) may contribute sediment to surface waters as TSS discharges (TSS discharged from RCMFs is composed of primarily inorganic material and is therefore included as a source for TMDL development). Most of these facilities obtain coverage under NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Storm Water Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2003). This permit establishes a daily maximum TSS concentration limit of 50 mg/l on process wastewater effluent and specifies monitoring procedures for storm water discharges. Facilities are also required to develop and implement storm water pollution prevention plans (SWPPPs). Discharges from RMCFs are generally intermittent, and contribute a small portion of

Figure 6 NPDES-Regulated Mining Sites and RMCFs Permitted to Discharge TSS and Located in Impaired Subwatersheds



total sediment loading to HUC-12 subwatersheds (ref.: Appendix D). In some cases, for discharges into impaired waters as documented on the *2004 303(d) List*, sites may be required to obtain coverage under an individual NPDES permit. Of the seven permitted RMCFs in the Hiwassee River Watershed as of August 22, 2005, five are located in impaired subwatersheds. These facilities are listed in Table 7 and shown in Figure 6.

Table 6 NPDES-Regulated Mining Sites Permitted to Discharge TSS and Located in Impaired Subwatersheds (as of August 5, 2005)

HUC-12 Subwatershed (06020002__)	NPDES Permit No.	Facility Name	TSS Daily Maximum Limit
			[mg/l]
0401	TN0005487	Vulcan Construction	40
	TN0023957	Rogers Group	40
0402	TN0063835	Vulcan Construction	40
	TN0065901	Rogers Group	40

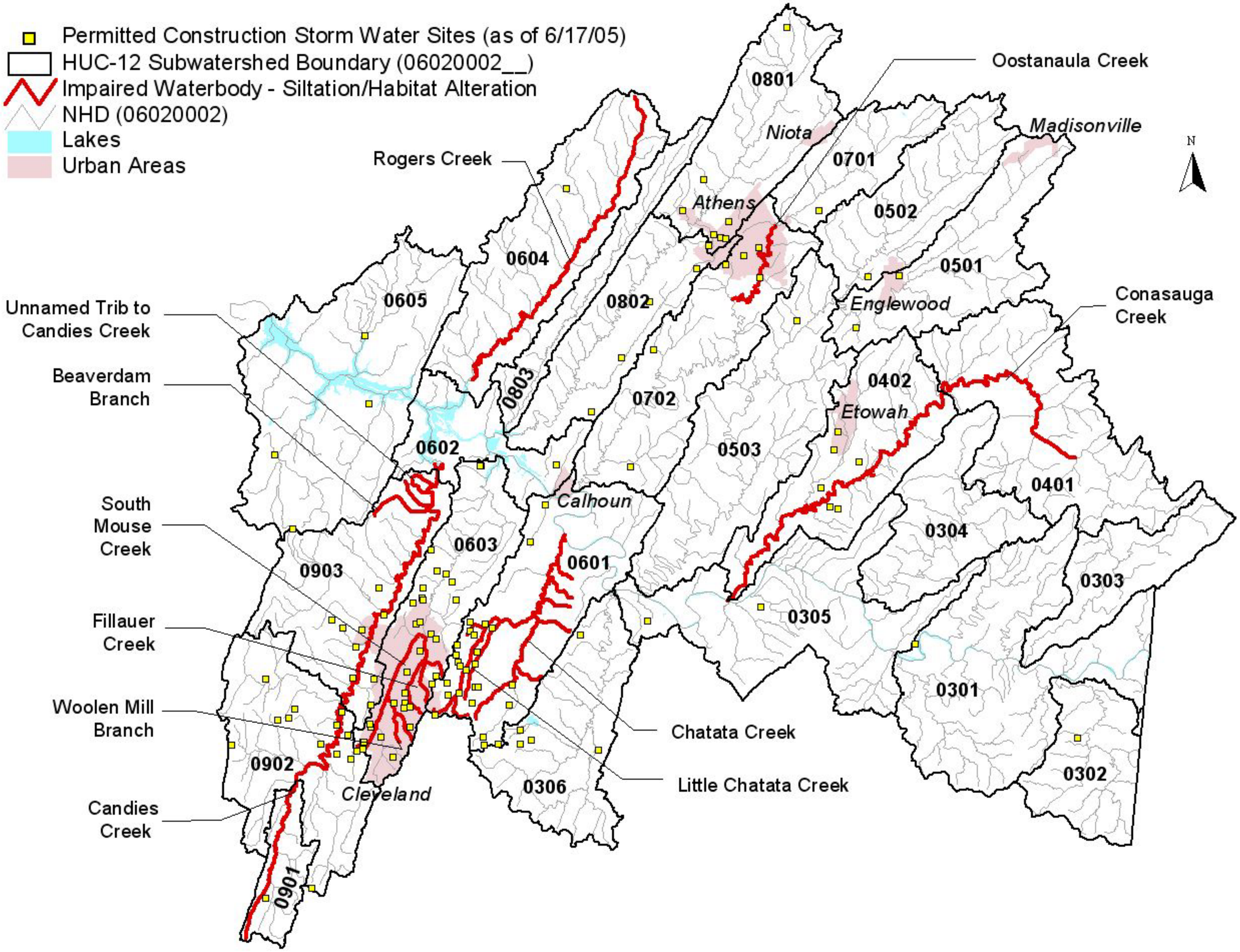
Table 7 NPDES-Regulated Ready Mix Concrete Facilities Located in Impaired Subwatersheds (as of August 22, 2005)

HUC-12 Subwatershed (06020002__)	NPDES Permit No.	Name	Daily Max TSS Limit	TSS Cut-off Conc.
			[mg/l]	[mg/l]
0601	TNG110039	Bradley Concrete	50	200
0602	TNG110262	Cleveland Ready Mix Concrete	50	200
0702	TNG110047	Sequatchie Concrete	50	200
	TNG110280	Bradley Concrete	50	200
0902	TNG110231	Cleveland Ready Mix Concrete	50	200

6.1.4 NPDES-Regulated Construction Activities

Discharges from NPDES-regulated construction activities are considered point sources of sediment loading to surface waters and occur in response to storm events. Currently, discharges of storm water from construction activities disturbing an area of one acre or more must be authorized by an NPDES permit. Most of these construction sites obtain coverage under NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activity* (TDEC, 2005a). Since construction activities at a site are of a temporary, relatively short-term nature, the number of construction sites covered by the general permit at any instant of time varies. In the Hiwassee River Watershed, there were 129 permitted active construction sites on June 17, 2005 (ref.: Figure 7).

Figure 7 Location of NPDES Permitted Construction Storm Water Sites in the Hiwassee River Watershed



6.1.5 NPDES-Regulated Municipal Separate Storm Sewer Systems

MS4s may also discharge sediment to waterbodies in response to storm events through road drainage systems, curb and gutter systems, ditches and storm drains. These systems convey urban runoff from surfaces such as bare soil and wash-off of accumulated street dust and litter from impervious surfaces during rain events. Large and medium MS4s serving populations greater than 100,000 people are required to obtain a NPDES storm water permit. At present, there are no large MS4s in the Hiwassee River Watershed. As of March 2003, small MS4s serving urbanized areas, or having the potential to exceed instream water quality standards, are required to obtain a permit under the *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a). An urbanized area is defined as an entity with a residential population of at least 50,000 people and an overall population density of 1,000 people per square mile. Three permittees are covered under Phase II of the NPDES Storm Water Program: City of Athens (TNS075141), City of Cleveland (TNS075213) and Bradley County (TNS077771). In addition, Hamilton County along with seven cities in Hamilton County have elected to obtain coverage jointly under a Phase II individual MS4 permit (TNS075566).

The Tennessee Department of Transportation (TDOT) is being issued an MS4 permit (TNS077585) for State roads in urban areas. The federal guidance for Phase 1 Municipal Separate Storm Sewer Systems shall apply as well as the Amended Consent Order and Agreement between TDOT and the Division of Water Pollution Control dated March 10, 2004. Information regarding storm water permitting in Tennessee may be obtained from the TDEC website at http://www.state.tn.us/environment/wpc/stormh2o/.

6.2 Nonpoint Sources

Nonpoint sources account for the vast majority of sediment loading to surface waters. These sources include:

- Natural erosion occurring from the weathering of soils, rocks, and uncultivated land; geological abrasion; and other natural phenomena.

- Erosion from agricultural activities can be a major source of sedimentation due to the large land area involved and the land-disturbing effects of cultivation. Grazing livestock can leave areas of ground with little vegetative cover. Unconfined animals with direct access to streams can cause streambank damage.

- Urban erosion from bare soil areas under construction and washoff of accumulated street dust and litter from impervious surfaces.

- Erosion from unpaved roadways can be a significant source of sediment to rivers and streams. It occurs when soil particles are loosened and carried away from the roadway, ditch, or road bank by water, wind, or traffic. The actual road construction (including erosive road-fill soil types, shape and size of coarse surface aggregate, poor subsurface and/or surface drainage, poor road bed construction, roadway shape, and inadequate runoff discharge outlets or “turn-outs” from the roadway) may aggravate roadway erosion. In addition, external factors such as roadway shading and light exposure, traffic patterns, and road maintenance may also affect roadway erosion. Exposed soils, high runoff velocities and volumes and poor road compaction all increase the potential for erosion.

- Runoff from abandoned mines may be significant sources of solids loading. Mining activities typically involve removal of vegetation, displacement of soils, and other significant land disturbing activities.

- Soil erosion from forested land that occurs during timber harvesting and reforestation activities. Timber harvesting includes the layout of access roads, log decks, and skid trails; the construction and stabilization of these areas; and the cutting of trees. Established forest areas produce very little soil erosion.

For the listed waterbodies within the Hiwassee River Watershed, the primary sources of nonpoint sediment loads include agriculture, roadways, and urban sources. The watershed land use distribution based on the 1992 MRLC satellite imagery databases is shown in Appendix C for impaired HUC-12 subwatersheds.

7.0 DEVELOPMENT OF TOTAL MAXIMUM DAILY LOAD

The TMDL process quantifies the amount of a pollutant that can be assimilated in a waterbody, identifies the sources of the pollutant, and recommends regulatory or other actions to be taken to achieve compliance with applicable water quality standards based on the relationship between pollution sources and in-stream water quality conditions. A TMDL can be expressed as the sum of all point source loads (Waste Load Allocations), non-point source loads (Load Allocations) and an appropriate margin of safety (MOS) which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\text{TMDL} = \Sigma \text{ WLAs} + \Sigma \text{ LAs} + \text{MOS}$$

The objective of a TMDL is to allocate loads among all of the known pollutant sources throughout a watershed so that appropriate control measures can be implemented and water quality standards achieved. 40 CFR §130.2 (i) states that TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure.

TMDL analyses are performed on a 12-digit hydrologic unit area (HUC-12) basis for subwatersheds containing waterbodies identified as impaired due to siltation or habitat alteration on the *2004 303(d) List*. HUC-12 subwatershed boundaries are shown in Figure 4.

7.1 Analysis Methodology

Sediment analysis for watersheds can be conducted using methods ranging from simple, gross estimates to complex dynamic loading and receiving water models. The choice of methodology is dependent on a number of factors that include watershed size, type of impairment, type and quantity of data available, resources available, time, and cost. In consideration of these factors, the following approach was selected as the most appropriate for first phase sediment TMDLs in the Hiwassee River Watershed.

Sediment loading analysis for waterbodies impaired due to siltation/habitat alteration in the Hiwassee River Watershed was accomplished using the Watershed Characterization System (WCS) Sediment Tool. This ArcView geographic information system (GIS) based model is described in Appendix B and was utilized according to the following procedure:

- The Watershed Characterization System (WCS) Sediment Tool was used to determine sediment loading to Level IV ecoregion reference site watersheds. These are considered to be biologically healthy watersheds. The average annual sediment loads in lbs/acre/yr of these reference watersheds serve as target values for the Hiwassee River Watershed sediment TMDLs.

- The Sediment Tool was also used to determine the existing average annual sediment loads of impaired watersheds located in the same Level IV ecoregion. Impaired watersheds are defined as 12-digit HUCs containing one or more waterbodies identified as impaired due to siltation/habitat alteration on the State's *2004 303(d) List* (ref.: Figure 4).

- The existing average annual sediment load of each impaired HUC-12 subwatershed was compared to the average annual load of the appropriate reference (biologically healthy) watershed and an overall required percent reduction in loading calculated. For each impaired HUC-12 subwatershed, the TMDL is equal to this overall required reduction:

$$\text{TMDL} = \frac{\text{(Existing Load)} - \text{(Target Load)}}{\text{(Existing Load)}} \text{ x } 100$$

  Although the Sediment Tool uses the best road, elevation, and land use GIS coverages available, the resulting average annual sediment loads should not be interpreted as an absolute value. The calculated loading reductions, however, are considered to be valid since they are based on the relative comparison of loads calculated using the same methodology.

- In each impaired subwatershed, 5% of the ecoregion-based target load was reserved to account for WLAs for NPDES permitted mining sites and RMCFs. The existing loads from these facilities are less than the five percent reserved in each impaired HUC-12 subwatershed. Any difference between these existing loads and the 5% reserved load provide for future growth and additional MOS (ref.: Appendix D).

- For each impaired HUC-12 subwatershed, WLAs for construction storm water sites, WLAs for MS4s, and LAs for nonpoint sources were considered to be the percent load reduction required to decrease the existing annual average sediment load to a level equal to 95% of the target value.

$$\text{WLA}_{\text{Const.SW}} = \text{WLA}_{\text{MS4}} = \text{LA} = \frac{\text{(Existing Load)} - [(.95)\ \text{(Target Load)}]}{\text{(Existing Load)}} \text{ x } 100$$

- TMDLs, WLAs for construction storm water sites and MS4s, and LAs are expressed as a percent reduction in average annual sediment loading. WLAs for mining sites and RMCFs are equal to loads authorized by their existing permits. Since sediment loading from mining sites and RMCFs are small with respect to storm water induced sediment loading for all subwatersheds, further reductions from these facilities was not considered warranted (ref.: Appendix D).

It is considered that the reduction of sediment loading as specified by WLAs and LAs in impaired watersheds will result in the attainment of fully supporting status for all designated use classifications, with respect to siltation/habitat alteration. According to 40 CFR §130.2 (i), TMDLs can be expressed in terms of mass per time, toxicity or other appropriate measure.

Details of the analysis methodology are more fully described in Appendix B. This approach is recognized as an acceptable alternative to a maximum allowable mass load per day in the *Protocol for Developing Sediment TMDLs* (USEPA, 1999).

7.2 TMDLs for Impaired Subwatersheds

Sediment TMDLs for subwatersheds containing waterbodies identified as impaired for siltation/habitat alteration are summarized in Table 8.

7.3 Waste Load Allocations

7.3.1 Waste Load Allocations for NPDES-Regulated Mining Activities

Of the fourteen active mining sites in the Hiwassee River Watershed with NPDES permits, four are located in impaired subwatersheds (ref.: Table 6). Since sediment loading from mining sites located in impaired subwatersheds is small (ref.: Appendix D) compared to the total loading for impaired subwatersheds, the WLAs are considered to be equal to the existing permit requirements for these facilities.

7.3.2 Waste Load Allocations for NPDES-Regulated Ready Mixed Concrete Facilities

Of the seven Ready Mixed Concrete Facilities (RMCFs) in the Hiwassee River Watershed with NPDES permits, five are located in impaired subwatersheds (ref.: Table 7). Since sediment loading from RMCFs located in impaired subwatersheds is small (ref.: Appendix D) compared to the total loading for impaired subwatersheds, the WLAs are considered to be equal to the existing permit requirements for these facilities.

7.3.3 Waste Load Allocations for NPDES-Regulated Construction Activities

Point source discharges of storm water from construction activities (including clearing, grading, filling, excavating, or similar activities) that result in the disturbance of one acre or more of total land area must be authorized by an NPDES permit. Since these discharges have the potential to transport sediment to surface waters, WLAs are provided for this category of activities. WLAs are established for each subwatershed containing a waterbody identified on the *2004 303(d) List* as impaired due to siltation and/or habitat alteration (ref.: Table 2). WLAs are expressed as the required percent reduction in the estimated average annual sediment loading for the impaired subwatershed, relative to the estimated average annual sediment loading (minus 5%) of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (ref.: Table 9). WLAs provided to NPDES-regulated construction activities will be implemented as Best Management Practices (BMPs), as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y (TDEC, 2005a). WLAs should <u>not</u> be construed as numeric permit limits.

Table 8 Sediment TMDLs for Subwatersheds with Waterbodies Impaired for Siltation/Habitat Alteration

HUC-12 Subwatershed (06020002___)	Waterbody ID	Waterbody Impaired by Siltation/ Habitat Alteration	Level IV Ecoregion	Existing Sediment Load	Target Load	TMDL (required load reduction)
				[lbs/ac/yr]	[lbs/ac/yr]	[%]
0401	TN06020002081_1000	Conasauga Creek	66g	382	120.8	68.4
0402	TN06020002081_1000	Conasauga Creek	67f	712	399.8	43.8
0601	TN06020002012_0200	Little Chatata Creek	67f	819	399.8	51.2
	TN06020002012_1000	Chatata Creek				
0602	TN06020002005_1000	Candies Creek	67f	1,079	399.8	62.9
0603	TN06020002009_0200	Fillauer Creek	67g	1,300	739.1	43.1
	TN06020002009_0300	Woolen Mill Branch				
	TN06020002009_2000	South Mouse Creek				
0604	TN06020002087_1000	Rogers Creek	67i	305	279.0	8.5
0702	TN06020002083_3000	Oostanaula Creek	67i	688	279.0	59.4
0901	TN06020002005_ 3000	Candies Creek	67f	560	399.8	28.6
0902	TN06020002005_2000	Candies Creek	67h	662	330.1	50.1
	TN06020002005_3000	Candies Creek				
0903	TN06020002005_1000	Candies Creek	67g	797	739.1	7.3
	TN06020002005_2000	Candies Creek				
	TN06020002005_0900	Beaverdam Creek				
	TN06020002005_1100	Unnamed Trib To Candies Creek				
	TN06020002005_1200	Unnamed Trib To Candies Creek				
	TN06020002005_1300	Unnamed Trib To Candies Creek				

Note: Calculations were conducted for all HUC-12 subwatersheds containing waterbodies identified as impaired for siltation/habitat alteration. Some impaired waterbodies extend across more than one HUC-12 subwatershed.

7.3.4 Waste Load Allocations for NPDES-Regulated Municipal Separate Storm Sewer Systems (MS4s)

Municipal separate storm sewer systems (MS4s) are regulated by the State's NPDES program (ref.: Section 6.1.5). Since MS4s have the potential to discharge TSS to surface waters, WLAs are specified for these systems. WLAs are established for each HUC-12 subwatershed containing a waterbody identified on the *2004 303(d) List* as impaired due to siltation or habitat alteration (ref.: Table 2). WLAs are expressed as the required percent reduction in the estimated average annual sediment loading for an impaired subwatershed, relative to the estimated average annual sediment loading (minus the 5% amount allocated to RMCFs and regulated mining sites) of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (ref.: Table 9).

WLAs provided to NPDES-regulated MS4s will be implemented as Best Management Practices (BMPs) as specified in Phase I and II MS4 permits. WLAs should not be construed as numeric permit limits.

7.4 Load Allocations for Nonpoint Sources

All sources of sediment loading to surface waters not covered by the NPDES program are provided a Load Allocation (LA) in these TMDLs. LAs are established for each HUC-12 subwatershed containing a waterbody identified on the *2004 303(d) List* as impaired due to siltation or habitat alteration (ref.: Table 2). LAs are expressed as the required percent reduction in the estimated average annual sediment loading for the impaired subwatershed, relative to the estimated average annual sediment loading (minus 5%) of a biologically healthy (reference) subwatershed located in the same Level IV ecoregion (ref.: Table 9).

Table 9 Summary of WLAs for MS4s and Construction Storm Water Sites and LAs for Nonpoint Sources

HUC-12 Subwatershed (06020002__)	Level IV Ecoregion	Percent Reduction - Average Annual Sediment Load	
		WLAs (Construction SW and MS4s)	LAs (Nonpoint Sources)
		[%]	[%]
0401	66g	70.0	70.0
0402	67f	46.7	46.7
0601	67f	53.6	53.6
0602	67f	64.8	64.8
0603	67g	46.0	46.0
0604	67i	13.1	13.1
0702	67i	61.5	61.5
0901	67f	32.2	32.2
0902	67h	52.6	52.6
0903	67g	11.9	11.9

7.5 Margin of Safety

There are two methods for incorporating a Margin of Safety (MOS) in the analysis: a) implicitly incorporate the MOS using conservative model assumptions to develop allocations, or b) explicitly specify a portion of the TMDL as the MOS and use the remainder for allocations. In these TMDLs, an implicit MOS was incorporated through the use of conservative modeling assumptions. These include:

- Target values based on Level IV ecoregion reference sites. These sites represent the least impacted streams in the ecoregion.
- The use of the sediment delivery process that results in the most sediment transport to surface waters (Method 2 in Appendix B).

In most presently impaired subwatersheds, some amount of explicit MOS is realized due to the WLAs specified for NPDES permitted mining sites and RMCFs being less than the 5% of the target load reserved for these facilities.

7.6 Seasonal Variation

Sediment loading is expected to fluctuate according to the amount and distribution of rainfall. The determination of sediment loads on an average annual basis accounts for these differences through the rainfall erosivity index in the USLE (ref.: Appendix B). This is a statistic calculated from the annual summation of rainfall energy in every storm and its maximum 30-minute intensity.

8.0 IMPLEMENTATION PLAN

8.1 Point Sources

8.1.1 NPDES-Regulated Mining Sites

Four of the fourteen NPDES-regulated mining sites in the Hiwassee River Watershed are located in impaired subwatersheds (ref.: Table 6). WLAs will be implemented through the existing permit requirements for these sites.

8.1.2 NPDES-Regulated Ready Mixed Concrete Facilities

Five of the seven RMCFs in the Hiwassee River Watershed are located in impaired subwatersheds (ref.: Table 7). WLAs will be implemented through NPDES Permit No. TNG110000, *General NPDES Permit for Discharges of Storm Water Runoff and Process Wastewater Associated With Ready Mixed Concrete Facilities* (TDEC, 2003).

8.1.3 NPDES-Regulated Construction Storm Water

The WLAs provided to existing and future NPDES-regulated construction activities will be implemented through Best Management Practices (BMPs) as specified in NPDES Permit No. TNR10-0000, *General NPDES Permit for Storm Water Discharges Associated With Construction Activity* (TDEC, 2005a). The permit requires the development and implementation of a site-specific

Storm Water Pollution Prevention Plan (SWPPP) prior to the commencement of construction activities. The SWPPP must be prepared in accordance with good engineering practices and the latest edition of the *Tennessee Erosion and Sediment Control Handbook* (TDEC, 2002) and must identify potential sources of pollution at a construction site that would affect the quality of storm water discharges and describe practices to be used to reduce pollutants in those discharges. At a minimum, the SWPPP must include the following elements:

- Site description
- Description of storm water runoff controls
- Erosion prevention and sediment controls
- Storm water management
- Description of items needing control
- Approved local government sediment and erosion control requirements
- Maintenance
- Inspections
- Pollution prevention measures for non-storm water discharges
- Documentation of permit eligibility related to TMDLs

The SWPPP must include documentation supporting a determination of permit eligibility with regard to waters that have an approved TMDL for a pollutant of concern, including:

a) identification of whether the discharge is identified, either specifically or generally, in an approved TMDL and any associated allocations, requirements, and assumptions identified for the discharge;

b) summaries of consultation with the division on consistency of SWPPP conditions with the approved TMDL; and

c) measures taken to ensure that the discharge of pollutants from the site is consistent with the assumptions and requirements of the approved TMDL, including any specific wasteload allocation that has been established that would apply to the discharge.

The permit does <u>not</u> authorize discharges that would result in a violation of a State water quality standard. In addition, a number of special requirements are specified for discharges entering high quality waters or waters identified as impaired due to siltation. These additional requirements include:

- The SWPPP must certify that erosion and sediment controls are designed to control runoff from a 5-year, 24-hour storm event.

- More frequent (twice weekly) inspections of erosion and sediment controls.

- If a discharger is complying with the SWPPP, but is contributing to the impairment of a stream, the SWPPP must be revised and implemented to eliminate further impairment to the stream. If these changes are not implemented within 7 days of receipt of notification, coverage under the general permit will be terminated and continued discharges covered under an individual permit. The construction project must be stabilized until the revised SWPPP is implemented or an individual permit issued. No earth disturbing activities, except for stabilization, are authorized until the individual permit is issued.

- For an outfall in a drainage area of a total of 5 or more acres, a temporary (or permanent) sediment basin that provides storage for a calculated volume of runoff from a 5-year, 24-hour storm and runoff from each acre drained, or equivalent control measures, shall be provided until final stabilization of the site.

- A 60-foot natural riparian buffer zone adjacent to a receiving stream designated as impaired or high quality waters must be preserved, to the maximum extent practicable, during construction activities at the site.

Strict compliance with the provisions of the *General NPDES Permit for Storm Water Discharges Associated With Construction Activit*y (TDEC, 2005a) can reasonably be expected to achieve reduced sediment loads to streams. The primary challenge for the reduction of sediment loading from construction sites to meet TMDL WLAs is in the effective compliance monitoring of all requirements specified in the permit and timely enforcement against construction sites not found to be in compliance with the permit.

8.1.4 NPDES-Regulated Municipal Separate Storm Sewer Systems (MS4s)

For existing and future regulated discharges from municipal separate storm sewer systems, WLAs will be implemented through Phase I & II MS4 permits. These permits will require the development and implementation of a Storm Water Management Program (SWMP) that will reduce the discharge of pollutants to the "maximum extent practicable" and not cause or contribute to violations of State water quality standards. The *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a) was issued on February 27, 2003 and requires SWMPs to include six minimum control measures:

- Public education and outreach on storm water impacts
- Public involvement/participation
- Illicit discharge detection and elimination
- Construction site storm water runoff control
- Post-construction storm water management in new development and re-development
- Pollution prevention/good housekeeping for municipal operations

For discharges into impaired waters, the Small MS4 General Permit (ref.: http://www.state.tn.us/environment/wpc/stormh2o/MS4II.php) requires that SWMPs include a section describing how discharges of pollutants of concern will be controlled to ensure that they do not cause or contribute to instream exceedances of water quality standards. Specific measures and BMPs to control pollutants of concern must also be identified. In addition, MS4s must implement the

WLA provisions of an applicable TMDL and describe methods to evaluate whether storm water controls are adequate to meet the WLA.

In order to evaluate SWMP effectiveness and demonstrate compliance with specified WLAs, MS4s must develop and implement appropriate monitoring programs. Instream monitoring, at locations selected to best represent the effectiveness of BMPs, must include analytical monitoring of pollutants of concern as well as stream surveys to evaluate biological integrity. A detailed plan describing the monitoring program must be submitted to the appropriate Environmental Field Office (EFO) of the Division of Water Pollution Control within 12 months of the approval date of this TMDL. The appropriate EFO can be determined based on the county (ref.: http://tennessee.gov/environment/eac/index.php).

Implementation of the monitoring program must commence within 6 months of plan approval by the EFO. The monitoring program shall comply with the monitoring, recordkeeping, and reporting requirements of *NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems* (TDEC, 2003a).

8.2 Nonpoint Sources

The Tennessee Department of Environment & Conservation (TDEC) has no direct regulatory authority over most nonpoint source discharges. Reductions of sediment loading from nonpoint sources (NPS) will be achieved using a phased approach. Voluntary, incentive-based mechanisms will be used to implement NPS management measures in order to assure that measurable reductions in pollutant loadings can be achieved for the targeted impaired waters. Cooperation and active participation by the general public and various industry, business, and environmental groups is critical to successful implementation of TMDLs. Local citizen-led and implemented management measures offer the most efficient and comprehensive avenue for reduction of loading rates from nonpoint sources. There are links to a number of publications and information resources on EPA's Nonpoint Source Pollution website (http://www.epa.gov/owow/nps/pubs.html) relating to the implementation and evaluation of nonpoint source pollution control measures.

TMDL implementation activities will be accomplished within the framework of Tennessee's Watershed Approach (ref.: http://www.state.tn.us/environment/wpc/watershed/). The Watershed Approach is based on a five-year cycle and encompasses planning, monitoring, assessment, TMDLs, WLAs/LAs, and permit issuance. It relies on participation at the federal, state, local and nongovernmental levels to be successful.

The actions of local government agencies and watershed stakeholders should be directed to accomplish the goal of a reduction of sediment loading in the watershed. There are a number of measures that are particularly well-suited to action by local stakeholder groups. These measures include, but are not limited to:

- Detailed surveys of impaired subwatersheds to identify additional sources of sediment loading.
- Advocacy of local area ordinances and zoning that will minimize sediment loading to waterbodies, including establishment of buffer strips along streambanks, reduction of activities within riparian areas, and minimization of road and bridge construction impacts.
- Educating the public as to the detrimental effects of sediment loading to waterbodies and

measures to minimize this loading.

- Advocacy of agricultural BMPs (e.g., riparian buffer, animal waste management systems, waste utilization, stream stabilization, fencing, heavy use area treatment protection, livestock exclusion, etc.) and practices to minimize erosion and sediment transport to streams.

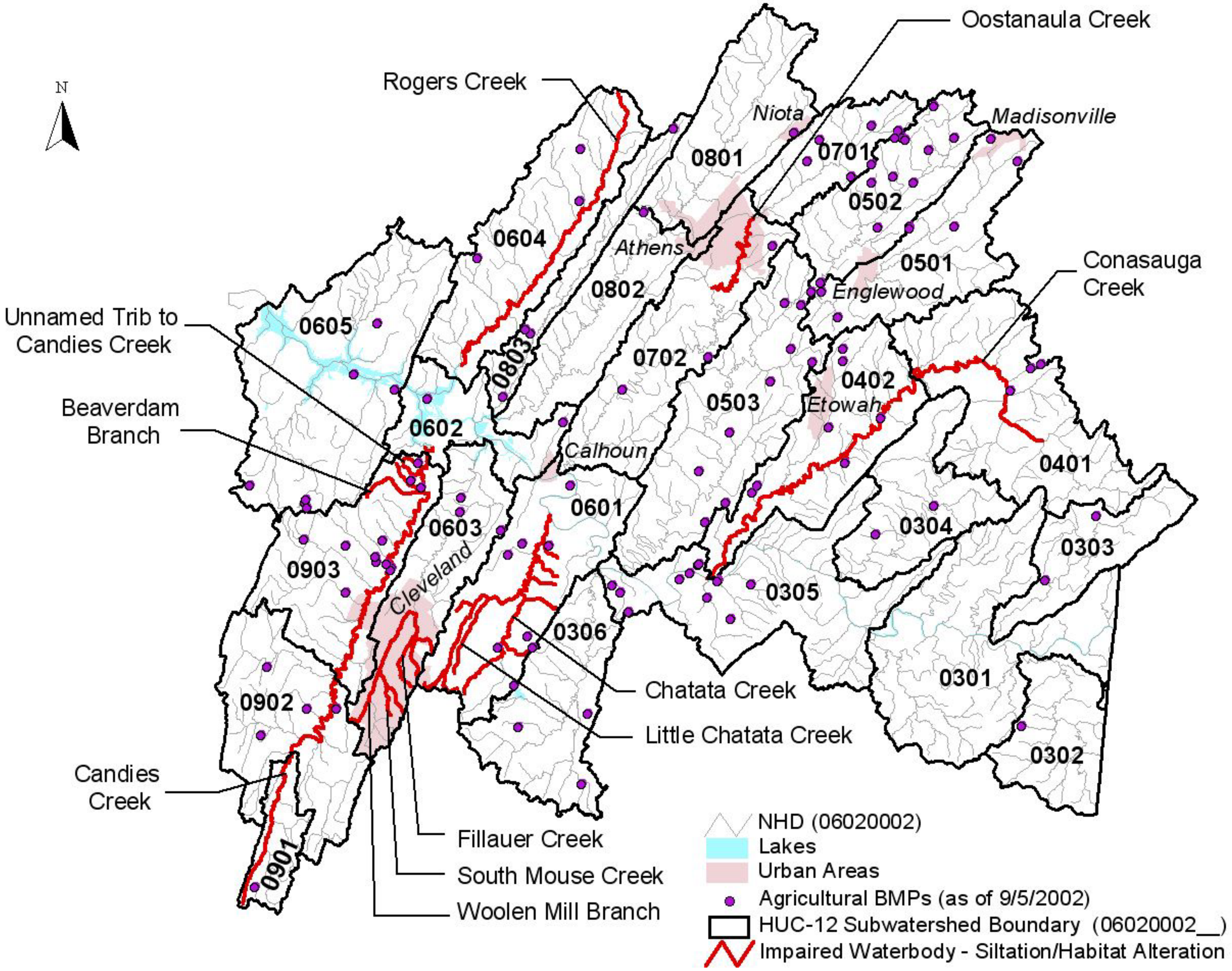
Excellent examples of stakeholder involvement for the implementation of nonpoint source load allocations (LAs) specified in an approved TMDL are the BMPs that have been utilized in the Oostanaula Creek in the Hiwassee River Watershed to reduce the amount of fecal coliform transported to surface waters from agricultural sources (ref.: http://www.state.tn.us/environment/wpc/tmdl/approvedtmdl/OostF2.pdf). A Unified Watershed Assessment (UWA) is ongoing to assess agricultural operations in upper Oostanaula Creek and improve water quality through improved planning, assessment, and funding for and establishment of BMPs. A multi-agency cooperative effort, the UWA focuses resources on agricultural sources in the prioritized subwatersheds of Oostanaula Creek and utilizes Agricultural Resource Funding administered by NRCS to install BMPS on farms. The participating agencies are the Tennessee Department of Agriculture (TDA), TDEC, the Tennessee Valley Authority (TVA), and U.S. Department of Agriculture (USDA) NRCS.

The TDA keeps a database of BMPs implemented in Tennessee. Of the 162 BMPs in the Hiwassee River Watershed as of September 5, 2002, 78 are in sediment-impaired subwatersheds (see Figure 8).

8.3 Evaluation of TMDL Effectiveness

The effectiveness of the TMDL will be assessed within the context of the State's rotating watershed management approach. Watershed monitoring and assessment activities will provide information by which the effectiveness of sediment loading reduction measures can be evaluated. Monitoring data, ground-truthing, and source identification actions will enable implementation of particular types of BMPs to be directed to specific areas in the subwatersheds. These TMDLs will be reevaluated during subsequent watershed cycles and revised as required to assure attainment of applicable water quality standards.

Figure 8 Location of Agricultural BMPs in the Hiwassee River Watershed



9.0 PUBLIC PARTICIPATION

In accordance with 40 CFR §130.7, the proposed sediment TMDLs for the Hiwassee River Watershed was placed on Public Notice for a 35-day period and comments were solicited. Steps that will be taken in this regard include:

1) Notice of the proposed TMDLs was posted on the Tennessee Department of Environment and Conservation website. The notice invited public and stakeholder comments and provided a link to a downloadable version of the TMDL document.

2) Notice of the availability of the proposed TMDLs (similar to the website announcement) was included in one of the NPDES permit Public Notice mailings.

3) A letter was sent to point source facilities in the Hiwassee River Watershed that are permitted to discharge treated total suspended solids (TSS) and are located in impaired subwatersheds advising them of the proposed sediment TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided on request. Letters were sent to the following facilities:

TN0005487	Vulcan Construction
TN0023957	Rogers Group
TN0063835	Vulcan Construction
TN0065901	Rogers Group
TNG110039	Bradley Concrete
TNG110262	Cleveland Ready Mix Concrete
TNG110047	Sequatchie Concrete
TNG110280	Bradley Concrete
TNG110231	Cleveland Ready Mix Concrete

4) A letter was sent to local interagency and stakeholder groups in the Hiwassee River Watershed advising them of the proposed sediment TMDLs and their availability on the TDEC website. The letter also stated that a written copy of the draft TMDL document would be provided on request. Letters were sent to the following water quality partners :

Natural Resources Conservation Service
USGS Water Resource Programs
USDA – Forest Service
Tennessee Valley Authority
Tennessee Department of Agriculture
Tennessee Wildlife Resources Agency
North Carolina Department of Environment and Natural Resources,
    Division of Water Quality, Hiwassee River Basin Planner
Hiwassee River Watershed Coalition

5) A draft copy of the proposed sediment TMDLs was sent to the following MS4s:

TNS075141	City of Athens
TNS075213	City of Cleveland
TNS075566	Hamilton County
TNS077585	Tennessee Department of Transportation (TDOT)
TNS077771	Bradley County

10.0 FURTHER INFORMATION

Further information concerning Tennessee's TMDL program can be found on the Internet at the Tennessee Department of Environment and Conservation website:

http://www.state.tn.us/environment/wpc/tmdl/

Technical questions regarding these TMDLs should be directed to the following members of the Division of Water Pollution Control staff:

Mary L. Wyatt, Watershed Management Section
e-mail: Mary.Wyatt@state.tn.us

Sherry H. Wang, Ph.D., Watershed Management Section
e-mail: Sherry.Wang@state.tn.us

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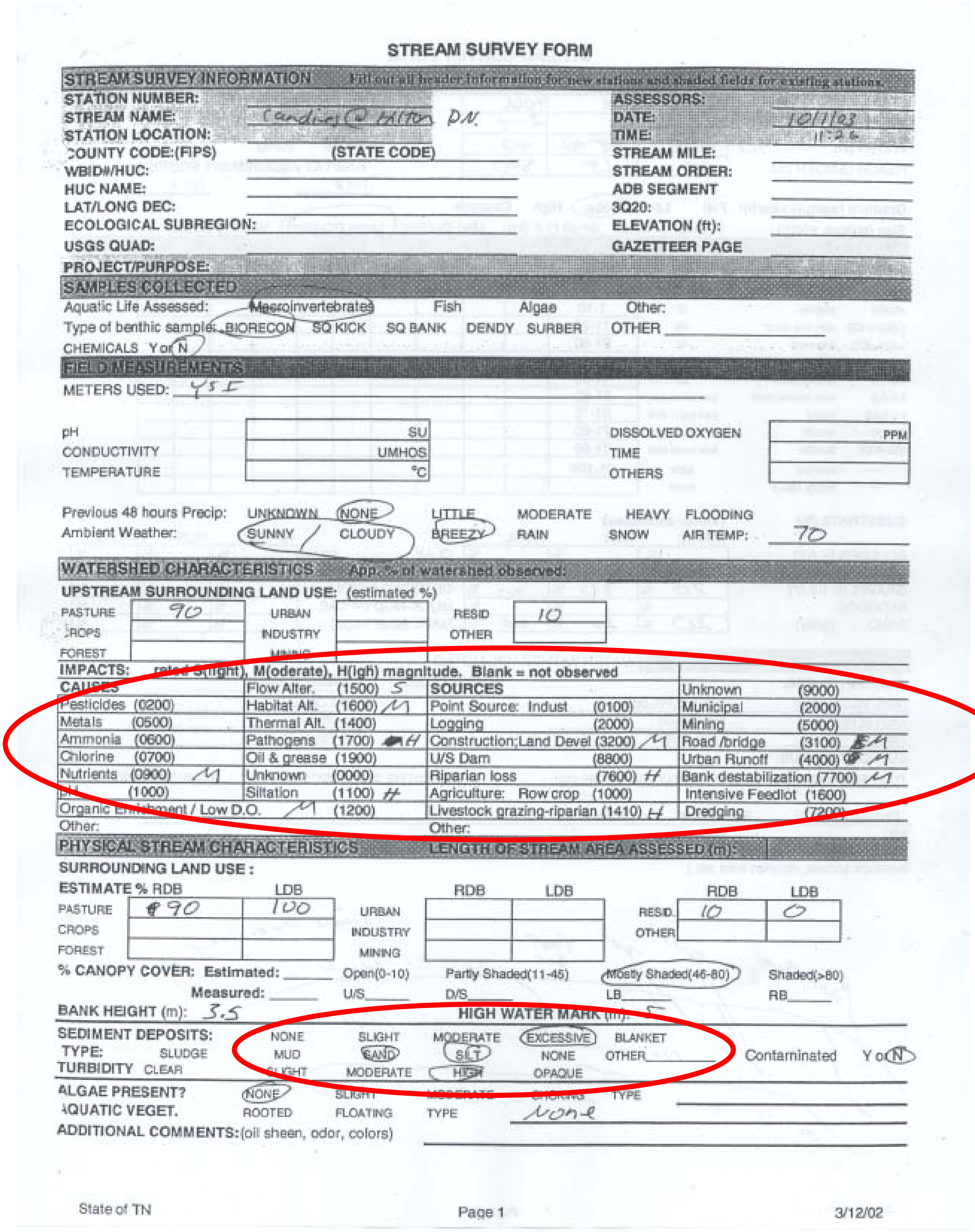
APPENDIX A

Example of Stream Assessment (Candies Creek)

Figure A-1 Stream Survey, Candies Creek at RM 12.3, p. 1 – October 1, 2003



STREAM SURVEY FORM

STREAM SURVEY INFORMATION Fill out all header information for new stations and shaded fields for existing stations.

STATION NUMBER:
STREAM NAME: Candies @ Hilton DN.
STATION LOCATION:
COUNTY CODE:(FIPS) (STATE CODE)
WBID#/HUC:
HUC NAME:
LAT/LONG DEC:
ECOLOGICAL SUBREGION:
USGS QUAD:
PROJECT/PURPOSE:
ASSESSORS:
DATE: 10/1/03
TIME: 11:26
STREAM MILE:
STREAM ORDER:
ADB SEGMENT
3Q20:
ELEVATION (ft):
GAZETTEER PAGE

SAMPLES COLLECTED

Aquatic Life Assessed: [✓ Macroinvertebrates] Fish Algae Other:
Type of benthic sample: [✓ BIORECON] SQ KICK SQ BANK DENDY SURBER OTHER
CHEMICALS Y or [✓ N]

FIELD MEASUREMENTS

METERS USED: YSI

pH	SU	DISSOLVED OXYGEN	PPM
CONDUCTIVITY	UMHOS	TIME	
TEMPERATURE	°C	OTHERS	

Previous 48 hours Precip: UNKNOWN [✓ NONE] LITTLE MODERATE HEAVY FLOODING
Ambient Weather: [✓ SUNNY / CLOUDY] [✓ BREEZY] RAIN SNOW AIR TEMP: 70

WATERSHED CHARACTERISTICS App. % of watershed observed:

UPSTREAM SURROUNDING LAND USE: (estimated %)

PASTURE	90	URBAN		RESID	10
CROPS		INDUSTRY		OTHER	
FOREST		MINING			

IMPACTS: rated S(light), M(oderate), H(igh) magnitude. Blank = not observed

CAUSES	Flow Alter. (1500) S	**SOURCES**	Unknown (9000)
Pesticides (0200)	Habitat Alt. (1600) M	Point Source: Indust (0100)	Municipal (2000)
Metals (0500)	Thermal Alt. (1400)	Logging (2000)	Mining (5000)
Ammonia (0600)	Pathogens (1700) H	Construction;Land Devel (3200) M	Road /bridge (3100) M
Chlorine (0700)	Oil & grease (1900)	U/S Dam (8800)	Urban Runoff (4000) M
Nutrients (0900) M	Unknown (0000)	Riparian loss (7600) H	Bank destabilization (7700) M
pH (1000)	Siltation (1100) H	Agriculture: Row crop (1000)	Intensive Feedlot (1600)
Organic Enrichment / Low D.O. M (1200)		Livestock grazing-riparian (1410) H	Dredging (7200)
Other:		Other:	

PHYSICAL STREAM CHARACTERISTICS **LENGTH OF STREAM AREA ASSESSED (m):**

SURROUNDING LAND USE :

ESTIMATE %	RDB	LDB		RDB	LDB		RDB	LDB
PASTURE	90	100	URBAN			RESID.	10	0
CROPS			INDUSTRY			OTHER		
FOREST			MINING					

% CANOPY COVER: Estimated: ____ Open(0-10) Partly Shaded(11-45) [✓ Mostly Shaded(46-80)] Shaded(>80)
Measured: ____ U/S____ D/S____ LB____ RB____
BANK HEIGHT (m): 3.5 HIGH WATER MARK (m): 5
SEDIMENT DEPOSITS: NONE SLIGHT MODERATE [✓ EXCESSIVE] BLANKET
TYPE: SLUDGE MUD [✓ SAND] [✓ SILT] NONE OTHER____ Contaminated Y or [✓ N]
TURBIDITY CLEAR SLIGHT MODERATE [✓ HIGH] OPAQUE
ALGAE PRESENT? [✓ NONE] SLIGHT MODERATE CHOKING TYPE
AQUATIC VEGET. ROOTED FLOATING TYPE None
ADDITIONAL COMMENTS:(oil sheen, odor, colors)

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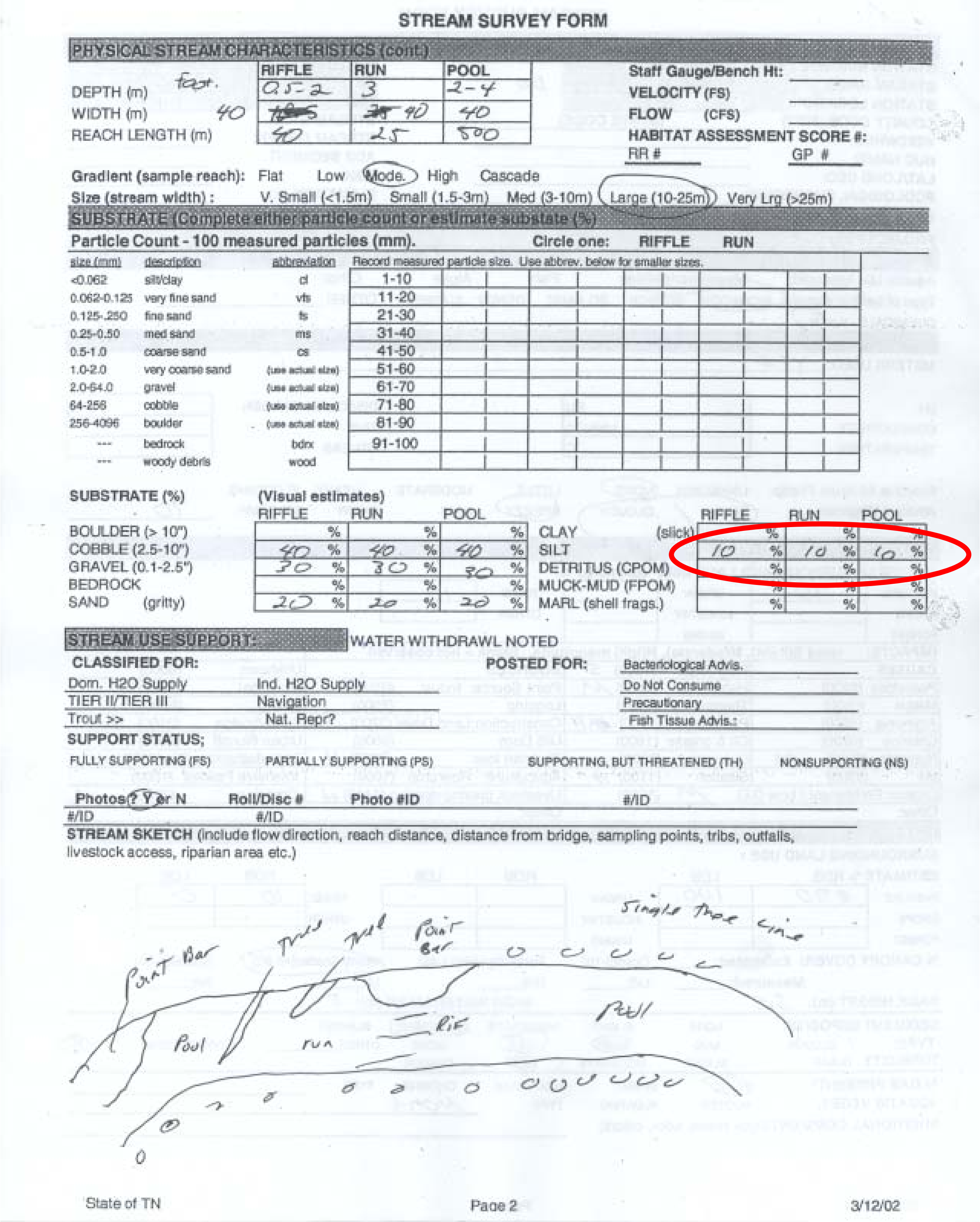
Figure A-2 Stream Survey, Candies Creek at RM 12.3, p. 2 – October 1, 2003



STREAM SURVEY FORM

PHYSICAL STREAM CHARACTERISTICS (cont.)

		RIFFLE	RUN	POOL
DEPTH (m)	fast.	0.5-2	3	2-4
WIDTH (m)	40		~~25~~ 40	40
REACH LENGTH (m)		40	25	500

Staff Gauge/Bench Ht:

VELOCITY (FS)

FLOW (CFS)

HABITAT ASSESSMENT SCORE #:

RR # GP #

Gradient (sample reach): Flat Low [✓ Mode.] High Cascade

Size (stream width) : V. Small (<1.5m) Small (1.5-3m) Med (3-10m) [✓ Large (10-25m)] Very Lrg (>25m)

SUBSTRATE (Complete either particle count or estimate substate (%)

Particle Count - 100 measured particles (mm). **Circle one:** **RIFFLE** **RUN**

size (mm)	description	abbreviation	Record measured particle size. Use abbrev. below for smaller sizes.
<0.062	silt/clay	cl	1-10
0.062-0.125	very fine sand	vfs	11-20
0.125-.250	fine sand	fs	21-30
0.25-0.50	med sand	ms	31-40
0.5-1.0	coarse sand	cs	41-50
1.0-2.0	very coarse sand	(use actual size)	51-60
2.0-64.0	gravel	(use actual size)	61-70
64-256	cobble	(use actual size)	71-80
256-4096	boulder	(use actual size)	81-90
---	bedrock	bdrx	91-100
---	woody debris	wood	

SUBSTRATE (%) **(Visual estimates)**

	RIFFLE	RUN	POOL		RIFFLE	RUN	POOL
BOULDER (> 10")	%	%	%	CLAY (slick)	%	%	%
COBBLE (2.5-10")	40 %	40 %	40 %	SILT	10 %	10 %	10 %
GRAVEL (0.1-2.5")	30 %	30 %	30 %	DETRITUS (CPOM)	%	%	%
BEDROCK	%	%	%	MUCK-MUD (FPOM)	%	%	%
SAND (gritty)	20 %	20 %	20 %	MARL (shell frags.)	%	%	%

STREAM USE SUPPORT: WATER WITHDRAWL NOTED

CLASSIFIED FOR:

Dom. H2O Supply
Ind. H2O Supply
TIER II/TIER III
Navigation
Trout >>
Nat. Repr?

POSTED FOR:

Bacteriological Advis.
Do Not Consume
Precautionary
Fish Tissue Advis.:

SUPPORT STATUS;

FULLY SUPPORTING (FS) PARTIALLY SUPPORTING (PS) SUPPORTING, BUT THREATENED (TH) NONSUPPORTING (NS)

Photos? [✓ Y] or N **Roll/Disc #** **Photo #ID** #/ID
#/ID #/ID

STREAM SKETCH (include flow direction, reach distance, distance from bridge, sampling points, tribs, outfalls, livestock access, riparian area etc.)

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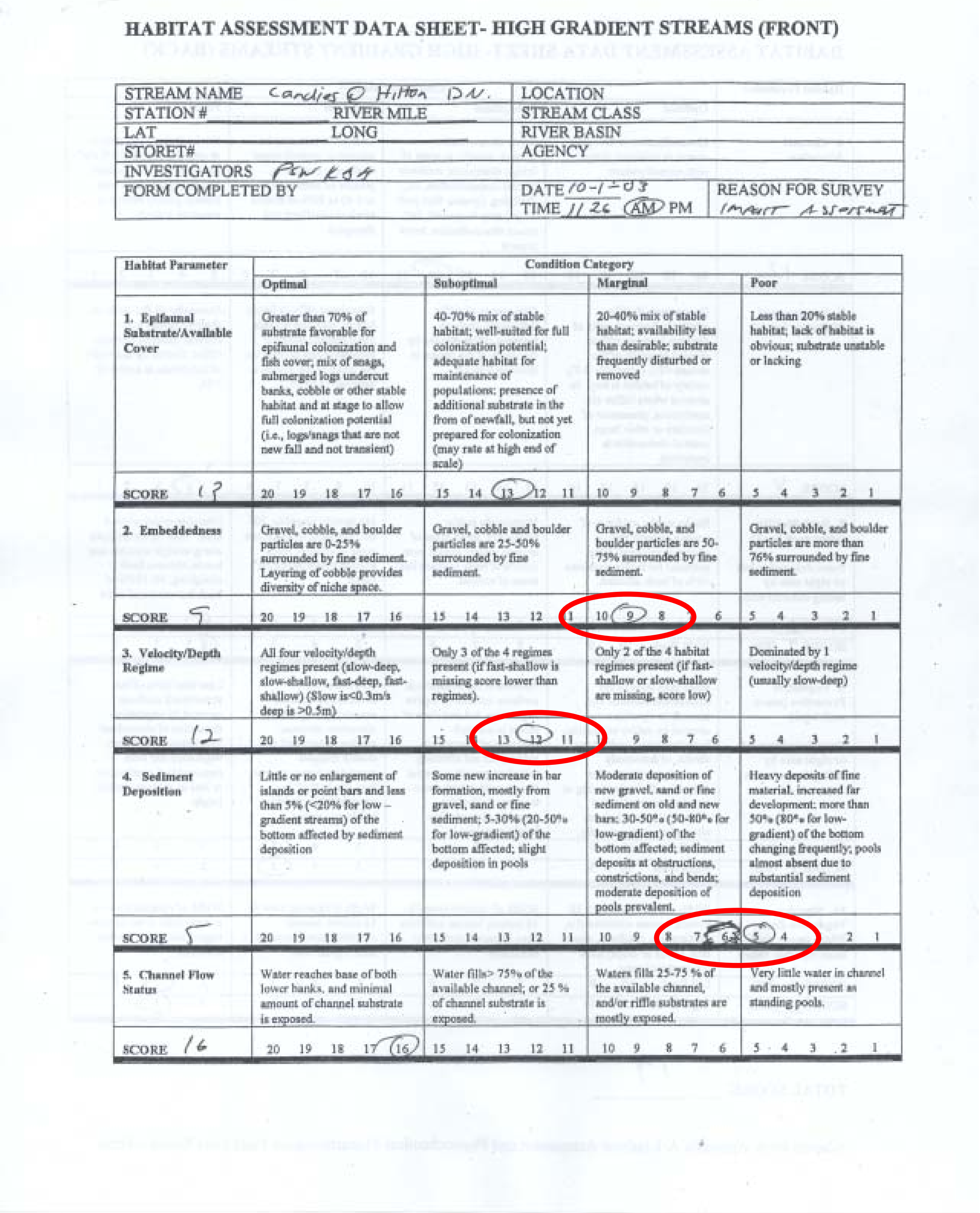
Figure A-3 Habitat Assessment Field Data Sheet, front, Candies Creek at RM 12.3 – October 1, 2003



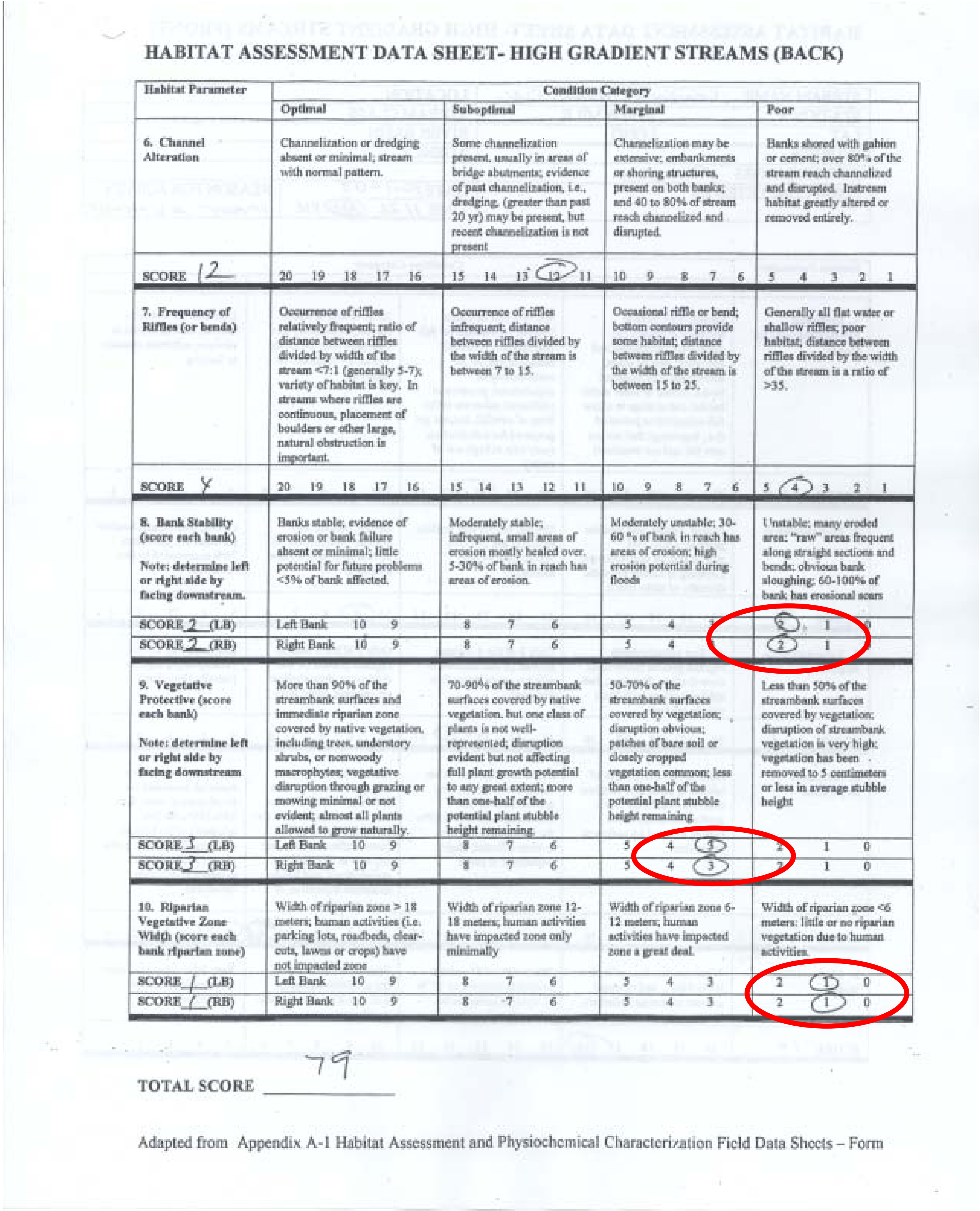
HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (FRONT)

STREAM NAME Candies @ Hilton DN.	LOCATION
STATION # RIVER MILE	STREAM CLASS
LAT LONG	RIVER BASIN
STORET#	AGENCY
INVESTIGATORS PCN KSH	
FORM COMPLETED BY	DATE 10-1-03 TIME 11 26 [✓ AM] PM

REASON FOR SURVEY IMPACT ASSESSMENT

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
1. Epifaunal Substrate/Available Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient)	40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the from of newfall, but not yet prepared for colonization (may rate at high end of scale)	20-40% mix of stable habitat; availability less than desirable; substrate frequently disturbed or removed	Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking
SCORE 13	20 19 18 17 16	15 14 [✓ 13] 12 11	10 9 8 7 6	5 4 3 2 1
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 76% surrounded by fine sediment.
SCORE 9	20 19 18 17 16	15 14 13 12 1	10 [✓ 9] 8 6	5 4 3 2 1
3. Velocity/Depth Regime	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow) (Slow is<0.3m/s deep is >0.5m)	Only 3 of the 4 regimes present (if fast-shallow is missing score lower than regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low)	Dominated by 1 velocity/depth regime (usually slow-deep)
SCORE 12	20 19 18 17 16	15 1 13 [✓ 12] 11	1 9 8 7 6	5 4 3 2 1
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low – gradient streams) of the bottom affected by sediment deposition	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased far development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition
SCORE 5	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	[✓ 5] 4 2 1
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills> 75% of the available channel; or 25 % of channel substrate is exposed.	Waters fills 25-75 % of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE 16	20 19 18 17 [✓ 16]	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1

Figure A-4 Habitat Assessment Field Data Sheet, back, Candies Creek at RM 12.3 – October 1, 2003



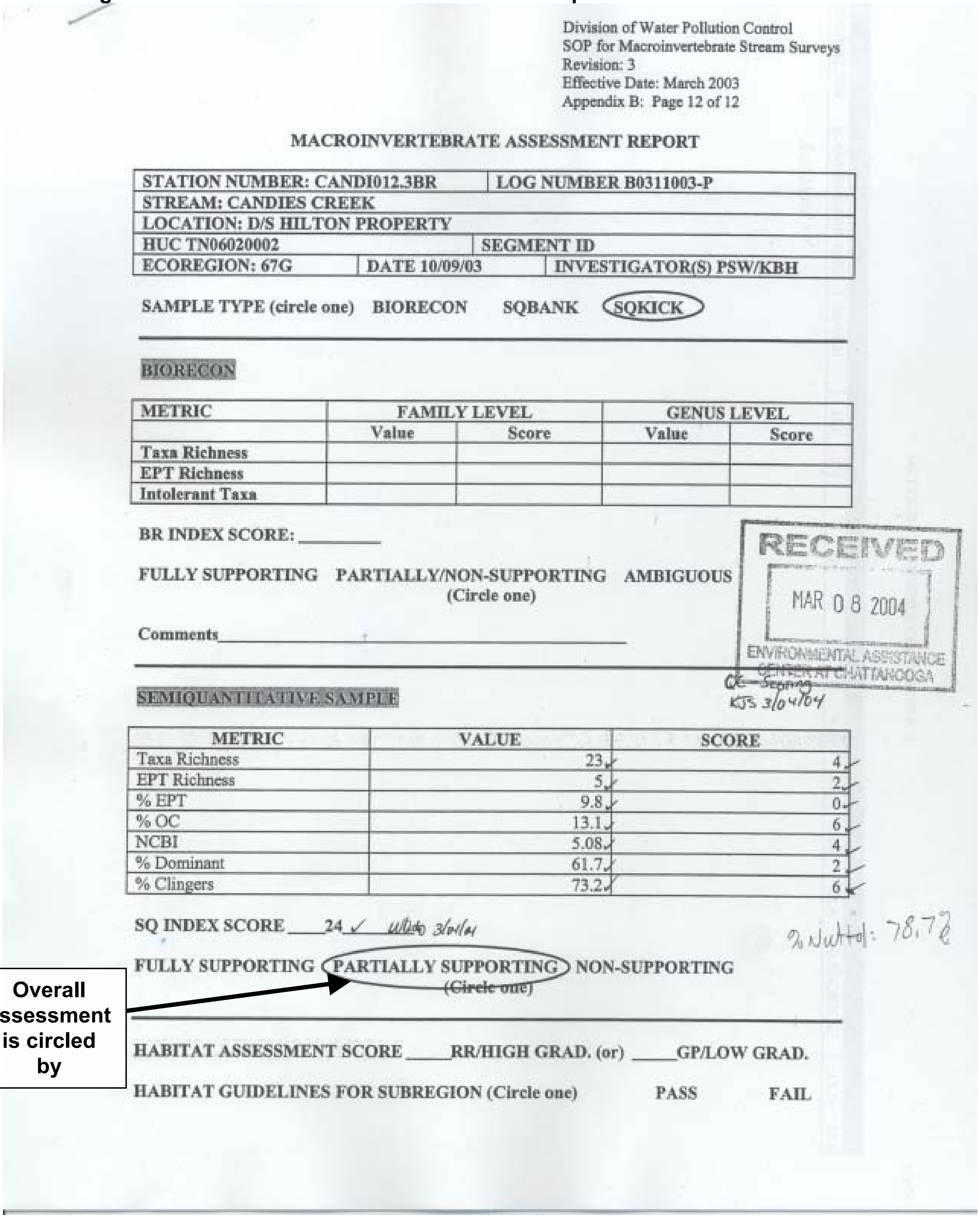
HABITAT ASSESSMENT DATA SHEET- HIGH GRADIENT STREAMS (BACK)

Habitat Parameter	Condition Category			
	Optimal	Suboptimal	Marginal	Poor
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present	Channelization may be extensive; embankments or shoring structures, present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE 12	20 19 18 17 16	15 14 13 [✓ 12] 11	10 9 8 7 6	5 4 3 2 1
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5-7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >35.
SCORE 4	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 [✓ 4] 3 2 1
8. Bank Stability (score each bank) **Note: determine left or right side by facing downstream.**	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60 % of bank in reach has areas of erosion; high erosion potential during floods	Unstable; many eroded area; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars
SCORE 2 (LB)	Left Bank 10 9	8 7 6	5 4 3	[✓ 2] 1 0
SCORE 2 (RB)	Right Bank 10 9	8 7 6	5 4 3	[✓ 2] 1 0
9. Vegetative Protective (score each bank) **Note: determine left or right side by facing downstream**	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height
SCORE 3 (LB)	Left Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0
SCORE 3 (RB)	Right Bank 10 9	8 7 6	5 4 [✓ 3]	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone > 18 meters; human activities (i.e. parking lots, roadbeds, clear-cuts, lawns or crops) have not impacted zone	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally	Width of riparian zone 6-12 meters; human activities have impacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
SCORE 1 (LB)	Left Bank 10 9	8 7 6	5 4 3	2 [✓ 1] 0
SCORE 1 (RB)	Right Bank 10 9	8 7 6	5 4 3	2 [✓ 1] 0

TOTAL SCORE 79

Adapted from Appendix A-1 Habitat Assessment and Physiochemical Characterization Field Data Sheets – Form

Figure A-5 Macroinvertebrate Assessment Report – Candies Creek at RM 12.3



Division of Water Pollution Control
SOP for Macroinvertebrate Stream Surveys
Revision: 3
Effective Date: March 2003
Appendix B: Page 12 of 12

MACROINVERTEBRATE ASSESSMENT REPORT

STATION NUMBER: CANDI012.3BR	LOG NUMBER B0311003-P	
STREAM: CANDIES CREEK		
LOCATION: D/S HILTON PROPERTY		
HUC TN06020002	SEGMENT ID	
ECOREGION: 67G	DATE 10/09/03	INVESTIGATOR(S) PSW/KBH

SAMPLE TYPE (circle one) BIORECON SQBANK [✓ SQKICK]

BIORECON

METRIC	FAMILY LEVEL		GENUS LEVEL	
	Value	Score	Value	Score
Taxa Richness				
EPT Richness				
Intolerant Taxa				

BR INDEX SCORE: ________

FULLY SUPPORTING PARTIALLY/NON-SUPPORTING AMBIGUOUS
(Circle one)

Comments________________________________

RECEIVED
MAR 08 2004
ENVIRONMENTAL ASSISTANCE
CENTER AT CHATTANOOGA

QC-Scoring
KJS 3/04/04

SEMIQUANTITATIVE SAMPLE

METRIC	VALUE	SCORE
Taxa Richness	23 ✓	4 ✓
EPT Richness	5 ✓	2 ✓
% EPT	9.8 ✓	0 ✓
% OC	13.1 ✓	6 ✓
NCBI	5.08 ✓	4 ✓
% Dominant	61.7 ✓	2 ✓
% Clingers	73.2 ✓	6 ✓

SQ INDEX SCORE ____24 ✓ [illegible] 3/01/04

% Nuttal: 78.7%

FULLY SUPPORTING [✓ PARTIALLY SUPPORTING] NON-SUPPORTING
~~(Circle one)~~

HABITAT ASSESSMENT SCORE _____RR/HIGH GRAD. (or) _____GP/LOW GRAD.

HABITAT GUIDELINES FOR SUBREGION (Circle one) PASS FAIL

Overall assessment is circled by

Figure A-6 Facing downslope from erosion gully in pasture leading to Candies Creek at RM 13.3 – October 1, 2003

Figure A-7 Photo taken from sediment bar on bank of Candies Creek at RM 13.3, looking upslope at erosion gully in pasture – October 1, 2003

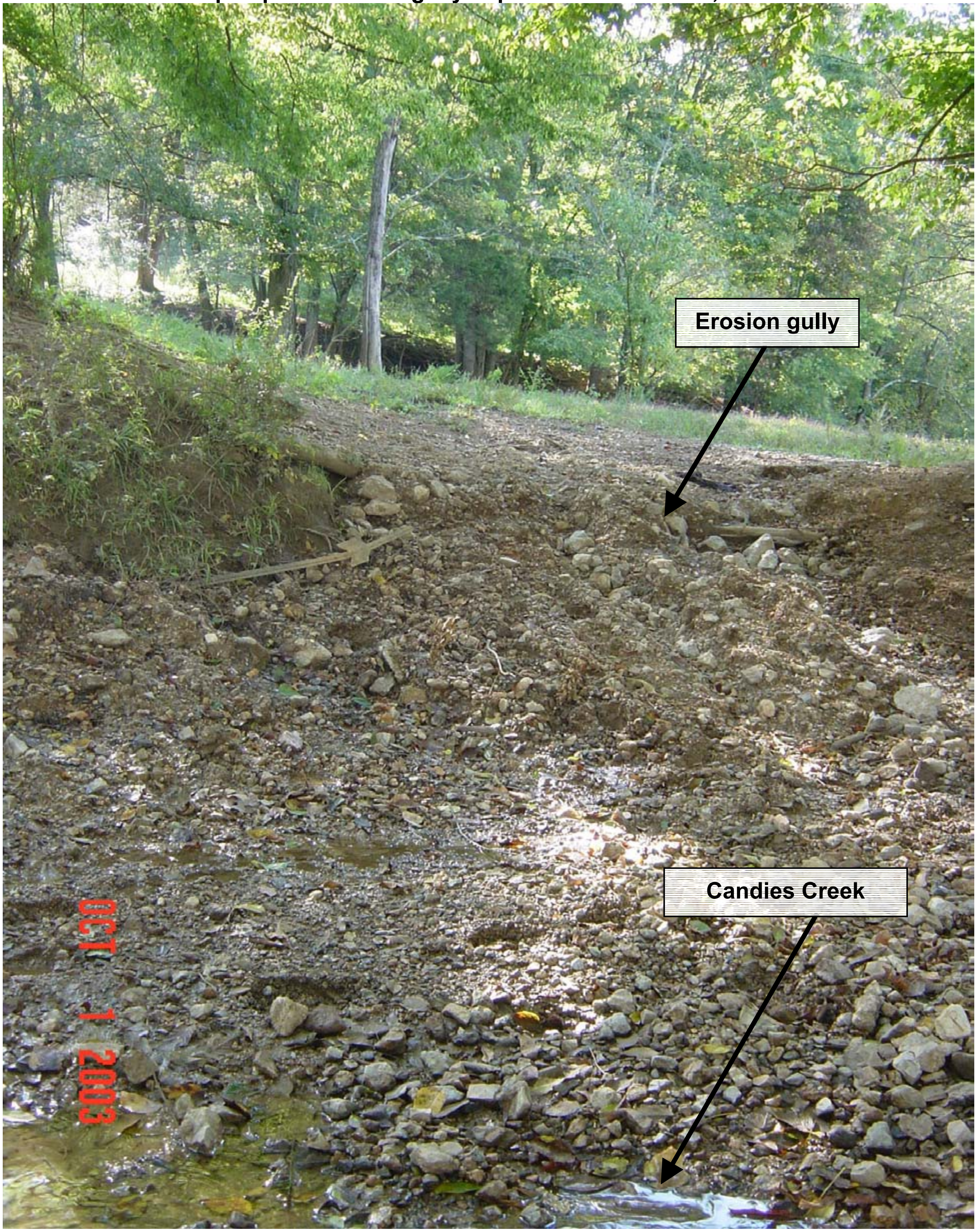


Figure A-8 Facing upstream on Candies Creek at RM 30.5 – October 1, 2003

APPENDIX B

Watershed Sediment Loading Model

WATERSHED SEDIMENT LOADING MODEL

Determination of target average annual sediment loading values for reference watersheds and the sediment loading analysis of waterbodies impaired for siltation/habitat alteration was accomplished utilizing the Watershed Characterization System (WCS) Sediment Tool (v.2.6). WCS is an ArcView geographic information system (GIS) based program developed by USEPA Region IV to facilitate watershed characterization and TMDL development. WCS consists of an initial set of spatial and tabular watershed data, stored in a database, and allows the incorporation of additional data when available. It provides a number of reporting tools and data management utilities to allow users to analyze and summarize data. Program extensions, such as the sediment tool, expand the functionality of WCS to include modeling and other more rigorous forms of data analysis (USEPA, 2001).

Sediment Analysis

The Sediment Tool is an extension of WCS that utilizes available GIS coverages (land use, soils, elevations, roads, etc.), the Universal Soil Loss Equation (USLE) to calculate potential erosion, and sediment delivery equations to calculate sediment delivery to the stream network. The following tasks can be performed:

- Estimate extent and distribution of potential soil erosion in the watershed.
- Estimate potential sediment delivery to receiving waterbodies.
- Evaluate effects of land use, BMPs, and road network on erosion and sediment delivery.

The Sediment Tool can also be used to evaluate different scenarios, such as the effects of changing land uses and implementation of BMPs, by the adjustment of certain input parameters. Parameters that may be adjusted include:

- Conservation management and erosion control practices
- Changes in land use
- Implementation of Best Management Practices (BMPs)
- Addition/Deletion of roads

Sediment analyses can be performed for single or multiple watersheds.

Universal Soil Loss Equation

Erosion potential is based on the Universal Soil Loss Equation (USLE), developed by Agriculture Research Station (ARS) scientists W. Wischmeier and D. Smith. It has been the most widely accepted and utilized soil loss equation for over 30 years. The USLE is a method to predict the average annual soil loss on a field slope based on rainfall pattern, soil type, topography, crop system and management practices. The USLE only predicts the amount of soil loss resulting from sheet or rill erosion on a single slope and does not account for soil losses that might occur from gully, wind, or tillage erosion. Designed as a model for use with certain cropping and management systems, it is also applicable to non-agricultural situations (OMAFRA, 2000). While the USLE can be used to estimate long-term average annual soil loss, it cannot be applied to a specific year or a specific storm. Based on its long history of use and wide acceptance by the forestry and agricultural communities, the USLE was considered to be an adequate tool for estimating the relative long-term average annual soil erosion of watersheds and evaluating the effects of land use changes and implementation of BMP measures.

Soil loss from sheet and rill erosion is primarily due to detachment of soil particles during rain events. It is the cause of the majority of soil loss for lands associated with crop production, grazing areas, construction sites, mine sites, logging areas and unpaved roads. In the USLE, five major factors are used to calculate the soil loss for a given area. Each factor is the numerical estimate of a specific condition that affects the severity of soil erosion in that area. The USLE for estimating average annual soil erosion is expressed as:

$$A = R \times K \times LS \times C \times P$$

where:

A = average annual soil loss in tons per acre
R = rainfall erosivity index
K = soil erodibility factor
LS = topographic factor - L is for slope length and S is for slope
C = crop/vegetation and management factor
P = conservation practice factor

Evaluating the factors in USLE:

R - Rainfall Erosivity Index

The rainfall erosivity index describes the kinetic energy generated by the frequency and intensity of the rainfall. It is statistically calculated from the annual summation of rainfall energy in every storm, which correlates to the raindrop size, times its maximum 30-minute intensity. This index varies with geography.

K - Soil Erodibility Factor

This factor quantifies the cohesive or bonding character of the soil and its ability to resist detachment and transport during a rainfall event. The soil erodibility factor is a function of soil type.

LS - Topographic Factor

The topographic factor represents the effect of slope length and slope steepness on erosion. Steeper slopes produce higher overland flow velocities. Longer slopes accumulate runoff from larger areas and also result in higher flow velocities. For convenience L and S are frequently lumped into a single term.

C – Crop/Vegetation and Management Factor

The crop/vegetation and management factor represents the effect that ground cover conditions, soil conditions and general management practices have on soil erosion. It is the most computationally complicated of USLE factors and incorporates the effects of: tillage management, crop type, cropping history (rotation), and crop yield.

P - Conservation Practice Factor

The conservation practice factor represents the effects on erosion of Best Management Practices (BMPs) such as contour farming, strip cropping and terracing.

Estimates of the USLE parameters, and thus the soil erosion as computed from the USLE, are provided

by the Natural Resources Conservation Service's (NRCS) National Resources Inventory (NRI) 1994. The NRI database contains information of the status, condition, and trend of soil, water and related resources collected from approximately 800,000 sampling points across the country.
The soil losses from the erosion processes described above are localized losses and not the total amount of sediment that reaches the stream. The fraction of the soil lost in the field that is eventually delivered to the stream depends on several factors. These include, the distance of the source area from the stream, the size of the drainage area, and the intensity and frequency of rainfall. Soil losses along the riparian areas will be delivered into the stream with runoff-producing rainfall.

Sediment Modeling Methodology

Using WCS and the Sediment Tool, average annual sediment loading to surface waters was modeled according to the following procedures:

1. A WCS project was setup for the watershed that is the subject of these TMDLs. Additional data layers required for sediment analysis were generated or imported into the project. These included:

   DEM (grid) – The Digital Elevation Model (DEM) layers that come with the basic WCS distribution system are shapefiles of coarse resolution (300x300m). A higher resolution DEM grid layer (30x30m) is required. The National Elevation Dataset (NED) is available from the USGS website and the coverage for the watershed (8-digit HUC) was imported into the project.

   Road – A road layer is needed as a shape file and requires additional attributes such as road type, road practice, and presence of side ditches. If these attributes are not provided, the Sediment Tool automatically assigns default values: road type - secondary paved roads, side ditches present and no road practices. This data layer was obtained from ESRI for areas in the watershed.

   Soil – The SSURGO (1:24k) soil data may be imported into the WCS project if higher-resolution soil data is required for the estimation of potential erosion. If the SSURGO soil database is not available, the system uses the STATSGO Soil data (1:250k) by default.

   MRLC Land Use – The Multi-Resolution Land Characteristic (MRLC) data set for the watershed is provided with the WCS package, but must be imported into the project.

2. Using WCS, the entire watershed was delineated into subwatersheds corresponding to USGS 12-digit Hydrologic Unit Codes (HUCs). These delineations are shown in Figure 4. Land use distribution for these delineations is summarized in Appendix C. All of the sediment analyses were performed on the basis of these drainage areas.

The following steps are accomplished using the WCS Sediment Tool:

3. For a selected watershed or subwatershed, a sediment project is set up in a new view that contains the data layers that will be subsequently used to calculate erosion and sediment delivery.

4. A stream grid for each delineated subwatershed was created by etching a stream coverage, based on the National Hydrography Dataset (NHD), to the DEM grid.

5. For each 30 by 30 meter grid cell within the subwatershed, the Sediment Tool calculates the

potential erosion using the USLE based on the specific cell characteristics. The model then calculates the potential sediment delivery to the stream grid network. Sediment delivery can be calculated using one of the four available sediment delivery equations:

- Distance-based equation (Sun and McNulty, 1998)
  $Mad = M * (1-0.97 * D/L)$
  where: Mad = mass moved (tons/acre/yr)
  M = sediment mass eroded (ton)
  D = least cost distance from a cell to the nearest stream grid (ft)
  L = maximum distance the sediment may travel (ft)

- Distance Slope-based equation (Yagow et al., 1998)
  $DR = \exp(-0.4233 * L * So)$
  $So = \exp(-16.1 * r/L + 0.057)) - 0.6$
  where: DR = sediment delivery ration
  L = distance to the stream (m)
  r = relief to the stream (m)

- Area-based equation (USDASCS, 1983)
  $DR = 0.417762 * A^{(-0.134958)} - 1.27097, \quad DR <= 1.0$
  where: DR = sediment delivery ratio
  A = area (sq miles)

- WEEP-based regression equation (Swift, 2000)
  $Z = 0.9004 - 0.1341 * X^2 + X^3 - 0.0399 * Y + 0.0144 * Y^2 + 0.00308 * Y^3$
  where: Z = percent of source sediment passing to the next grid cell
  X = cumulative distance down slope ($X > 0$)
  Y = percent slope in the grid cell ($Y > 0$)

The distance slope based equation (Yagow et al., 1998) was selected to simulate sediment delivery in the Hiwassee River Watershed.

6. The total sediment delivered upstream of each subwatershed "pour point" is calculated. The sediment analysis provides the calculations for six new parameters:

   - Source Erosion – estimated erosion from each grid cell due to the land cover
   - Road Erosion – estimated erosion from each grid cell representing a road
   - Composite Erosion – composite of the source and road erosion layers
   - Source Sediment – estimated fraction of the soil erosion from each grid cell that reaches the stream (sediment delivery)
   - Road Sediment – estimated fraction of the road erosion from each grid cell that reaches the stream
   - Composite Sediment – composite of the source and erosion sediment layers

   The sediment delivery can be calculated based on the composite sediment, road sediment or source sediment layer. The sources of sediment by each land use type is determined showing the types of land use, the acres of each type of land use and the tons of sediment estimated to be generated from each land use.

7. For each subwatershed of interest, the resultant sediment load calculation is expressed as a long-term average annual soil loss expressed in pounds per year calculated for the rainfall erosivity index (R). This statistic is calculated from the annual summation of rainfall energy in every storm (correlates with raindrop size) times its maximum 30-minute intensity.

   Calculated erosion, sediment loads delivered to surface waters and unit loads (per unit area) for subwatersheds that contain waters on the *2004 303(d) List* as impaired for siltation and/or habitat alteration are summarized in Tables B-1, B-2 and B-3, respectively.

Table B-1 Calculated Erosion - Subwatersheds With Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

HUC-12 Subwatershed (06020002__)	*EROSION*				
	Road [tons/yr]	Source [tons/yr]	Total [tons/yr]	%Road	%Source
0401	10,013	6,287	16,300	61.4	38.6
0402	9,664	14,837	24,500	39.4	60.6
0601	12,082	26,658	38,740	31.2	68.8
0602	4,621	15,377	19,998	23.1	76.9
0603	21,546	15,193	36,739	58.6	41.4
0604	4,336	7,071	11,407	38.0	62.0
0702	9,706	16,204	25,909	37.5	62.5
0901	1,091	2,538	3,629	30.1	69.9
0902	9,488	10,673	20,161	47.1	52.9
0903	14,491	10,995	25,486	56.9	43.1

Table B-2 Calculated Sediment Delivery to Surface Waters - Subwatersheds with Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

HUC-12 Subwatershed (06020002__)	*SEDIMENT*				
	Road [tons/yr]	Source [tons/yr]	Total [tons/yr]	%Road	%Source
0401	5,182	2,107	7,290	71.1	28.9
0402	4,688	5,438	10,126	46.3	53.7
0601	4,879	8,947	13,826	35.3	64.7
0602	2,105	5,898	8,004	26.3	73.7
0603	10,955	5,429	16,384	66.9	33.1
0604	2,570	2,667	5,237	49.1	50.9
0702	4,676	6,119	10,795	43.3	56.7
0901	814	1,336	2,151	37.9	62.1
0902	5,288	4,525	9,813	53.9	46.1
0903	7,333	4,678	12,010	61.1	38.9

Table B-3 Unit Loads - Subwatersheds With Waterbodies Impaired Due to Siltation/Habitat Alteration (Documented on the *2004 303(d) List*)

HUC-12 Subwatershed (06020002__)	***UNIT LOADS***			
	Erosion		**Sediment**	
	[tons/ac/yr]	**[lbs/ac/yr]**	**[tons/ac/yr]**	**[lbs/ac/yr]**
0401	0.427	853	0.191	382
0402	0.862	1,723	0.356	712
0601	1.147	2,295	0.409	819
0602	1.349	2,697	0.540	1,079
0603	1.457	2,914	0.650	1,300
0604	0.332	664	0.152	305
0702	0.826	1,652	0.344	688
0901	0.472	945	0.280	560
0902	0.680	1,360	0.331	662
0903	0.845	1,691	0.398	797

APPENDIX C

MRLC Land Use of Impaired Subwatersheds and Ecoregion Reference Site Drainage Areas

Table C-1 Hiwassee River Watershed – Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06020002___)							
	0401		0402		0601		0602	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	15,175	39.7	8,691	30.6	9,624	28.5	3,940	26.6
Emergent Herbaceous Wetlands	0	0.0	0	0.0	10	0.0	434	2.9
Evergreen Forest	9,359	24.5	4,237	14.9	4,727	14.0	3,287	22.2
High Intensity Commercial/Industrial/Transportation	16	0.0	242	0.9	323	1.0	173	1.2
High Intensity Residential	0	0.0	0	0.0	72	0.2	10	0.1
Low Intensity Residential	63	0.2	696	2.4	608	1.8	67	0.5
Mixed Forest	10,588	27.7	6,028	21.2	5,515	16.3	2,124	14.3
Open Water	5	0.0	13	0.0	402	1.2	1,450	9.8
Other Grasses (Urban/Recreational)	43	0.1	334	1.2	408	1.2	32	0.2
Pasture/Hay	2,079	5.4	6,061	21.3	9,648	28.6	1,607	10.8
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	14	0.0	168	1.1
Row Crops	386	1.0	1,885	6.6	2,236	6.6	637	4.3
Transitional	475	1.2	161	0.6	121	0.4	127	0.9
Woody Wetlands	0	0.0	0	0.0	39	0.1	768	5.2
Total	**38,188**	**100.0**	**28,424**	**100.0**	**33,747**	**100.0**	**14,826**	**100.0**

Table C-1 (Cont.) Hiwassee River Watershed – Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06020002___)							
	0603		0604		0702		0901	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	6,059	24.0	17,488	50.9	9,023	28.8	2,590	33.7
Emergent Herbaceous Wetlands	61	0.2	10	0.0	0	0.0	0	0.0
Evergreen Forest	2,979	11.8	6,063	17.7	5,831	18.6	1,260	16.4
High Intensity Commercial/Industrial/Transportation	1,203	4.8	28	0.1	404	1.3	9	0.1
High Intensity Residential	901	3.6	0	0.0	174	0.6	0	0.0
Low Intensity Residential	3,052	12.1	57	0.2	972	3.1	24	0.3
Mixed Forest	3,588	14.2	5,691	16.6	7,144	22.8	1,874	24.4
Open Water	52	0.2	25	0.1	12	0.0	4	0.0
Other Grasses (Urban/Recreational)	1,092	4.3	8	0.0	462	1.5	2	0.0
Pasture/Hay	4,522	17.9	3,868	11.3	5,785	18.4	1,590	20.7
Quarries/Strip Mines/Gravel Pits	0	0.0	16	0.0	6	0.0	0	0.0
Row Crops	1,301	5.2	639	1.9	1,357	4.3	329	4.3
Transitional	250	1.0	216	0.6	187	0.6	2	0.0
Woody Wetlands	138	0.5	229	0.7	0	0.0	0	0.0
Total	**25,198**	**100.0**	**34,338**	**100.0**	**31,357**	**100.0**	**7,684**	**100.0**

Table C-1 (Cont.) Hiwassee River Watershed – Impaired Subwatershed Land Use Distribution

Land Use	Subwatershed (06020002___)			
	0902		0903	
	[acres]	[%]	[acres]	[%]
Bare Rock/Sand/Clay	0	0.0	0	0.0
Deciduous Forest	9,945	33.6	10,675	35.4
Emergent Herbaceous Wetlands	0	0.0	9	0.0
Evergreen Forest	4,191	14.1	5,243	17.4
High Intensity Commercial/Industrial/Transportation	189	0.6	123	0.4
High Intensity Residential	9	0.0	82	0.3
Low Intensity Residential	282	1.0	795	2.6
Mixed Forest	6,243	21.1	5,718	19.0
Open Water	22	0.1	41	0.1
Other Grasses (Urban/Recreational)	125	0.4	199	0.7
Pasture/Hay	7,442	25.1	5,795	19.2
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0
Row Crops	1,105	3.7	1,081	3.6
Transitional	78	0.3	175	0.6
Woody Wetlands	0	0.0	202	0.7
Total	**29,630**	**100.0**	**30,138**	**100.0**

Table C-2 Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed									
	Eco66e04		Eco66e09		Eco66e11		Eco66e17		Eco66e18	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	2,021	74.5	3,144	53.4	1,226	56.1	469	25.0	977	35.8
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	210	7.8	1,157	19.7	386	17.6	696	37.0	884	32.4
High Intensity Commercial/Industrial/Transportation	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
High Intensity Residential	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Low Intensity Residential	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Mixed Forest	449	16.5	1,569	26.7	567	25.9	696	37.0	843	30.9
Open Water	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Other Grasses (Urban/Recreational)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pasture/Hay	0	0.0	14	0.2	4	0.2	16	0.9	0	0.0
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	18	0.7	1	0.0	6	0.3	0	0.0	0	0.0
Transitional	0	0.0	0	0.0	0	0.0	0	0.0	23	0.8
Woody Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**2,699**	**99.4**[a]	**5,886**	**100.0**	**2,189**	**100.2**[a]	**1,878**	**99.9**[a]	**2,728**	**99. 9**[a]

a. A spreadsheet was used for this calculation and values are approximate due to rounding.

Table C-2 (Cont.) Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed									
	Eco66g04		Eco66g05		Eco66g07		Eco66g09		Eco66g12	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	5,688	45.6	9,186	45.9	256	16.4	5,341	73.1	463	20.3
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	5,326	42.7	7,239	36.2	856	54.9	578	7.8	1,231	54.0
High Intensity Commercial/Industrial/Transportation	1	0.0	0	0.0	0	0.0	0	0.0	0	0.0
High Intensity Residential	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Low Intensity Residential	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Mixed Forest	1,434	11.5	3,569	17.8	443	28.4	1,510	20.2	583	25.5
Open Water	11	0.1	2	0.0	0	0.0	0	0.0	0	0.0
Other Grasses (Urban/Recreational)	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Pasture/Hay	7	0.1	1	0.0	0	0.0	35	0.5	0	0.0
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	3	0.0	2	0.0	0	0.0	1	0.0	0	0.0
Transitional	0	0.0	0	0.0	0	0.0	6	0.1	4	0.2
Woody Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**12,469**	**100.0**	**19,998**	**100.0**	**1,556**	**99.8** [a]	**7,470**	**99.8** [a]	**2,281**	**100.0**

a. A spreadsheet was used for this calculation and values are approximate due to rounding.

Table C-2 (Cont.) Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	**Ecosite Subwatershed**							
	Eco67f06		**Eco67f13**		**Eco67f17**		**Eco67g05**	
	[acres]	**[%]**	**[acres]**	**[%]**	**[acres]**	**[%]**	**[acres]**	**[%]**
Bare Rock/Sand	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	1,686	85.4	1,505	87.2	17,329	57.6	2,690	12.8
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	44	2.2	76	4.4	2,869	9.5	2,154	10.2
High Intensity Commercial/Industrial/Transportation	1	0.0	0	0.0	22	0.1	101	0.5
High Intensity Residential	0	0.0	0	0.0	0	0.0	24	0.1
Low Intensity Residential	2	0.1	0	0.0	16	0.1	114	0.5
Mixed Forest	236	12.0	132	7.6	4,178	13.9	3,787	18.0
Open Water	0	0.0	0	0.0	4	0.0	7	0.0
Other Grasses (Urban/Recreational)	0	0.0	0	0.0	10	0.0	193	0.9
Pasture/Hay	6	0.3	10	0.6	5,296	17.6	10,049	47.7
Quarries/Strip Mines/Gravel Pits	0	0.0	1	0.1	77	0.3	0	0.0
Row Crops	0	0.0	0	0.0	258	0.9	1,933	9.2
Transitional	0	0.0	0	0.0	4	0.0	0	0.0
Woody Wetlands	0	0.0	0	0.0	0	0.0	8	0.0
Total	**1,975**	**100.1** [a]	**1,724**	**99.9** [a]	**30,062**	**100.0**	**21,058**	**100.0**

a. A spreadsheet was used for this calculation and values are approximate due to rounding.

Table C-2 (Cont.) Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed									
	Eco67g08		Eco67g09		Eco67g10		Eco67g11		Eco67h04	
	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Deciduous Forest	1,076	25.4	1,603	52.5	3,165	23.9	719	70.6	447	68.3
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Evergreen Forest	721	17.0	696	22.8	2,669	20.2	162	15.9	66	10.1
High Intensity Commercial/Industrial/Transportation	23	0.5	1	0.0	17	0.1	0	0.0	0	0.0
High Intensity Residential	1	0.0	2	0.1	6	0.0	0	0.0	0	0.0
Low Intensity Residential	64	1.5	48	1.6	48	0.4	0	0.0	0	0.0
Mixed Forest	1,087	25.7	497	16.3	2,619	19.8	138	13.5	132	20.2
Open Water	2	0.1	1	0.0	4	0.0	0	0.0	0	0.0
Other Grasses (Urban/Recreational)	46	1.1	10	0.3	16	0.1	0	0.0	0	0.0
Pasture/Hay	1,019	24.1	156	5.1	4,420	33.4	0	0.0	4	0.6
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Row Crops	198	4.7	40	1.3	272	2.1	0	0.0	3	0.4
Transitional	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Woody Wetlands	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	**4,237**	**100.0**	**3,054**	**100.0**	**13,236**	**100.0**	**1,019**	**100.0**	**653**	**99.7** [a]

a. A spreadsheet was used for this calculation and values are approximate due to rounding.

Table C-2 (Cont.) Level IV Ecoregion Reference Site Drainage Area Land Use Distribution

Land Use	Ecosite Subwatershed					
	Eco67h06		Eco67h08		67i12	
	[acres]	[%]	[acres]	[%]	[acres]	[%]
Bare Rock/Sand	0	0.0	0	0.0	0	0.0
Deciduous Forest	485	27.0	542	79.6	457	67.1
Emergent Herbaceous Wetlands	0	0.0	0	0.0	0	0.0
Evergreen Forest	612	34.1	89	13.0	93	13.7
High Intensity Commercial/Industrial/Transportation	1	0.0	0	0.0	1	0.2
High Intensity Residential	0	0.0	0	0.0	0	0.0
Low Intensity Residential	0	0.0	0	0.0	3	0.5
Mixed Forest	657	36.6	49	7.3	112	16.4
Open Water	30	1.6	0	0.0	0	0.1
Other Grasses (Urban/Recreational)	0	0.0	1	0.2	0	0.0
Pasture/Hay	7	0.4	0	0.0	12	1.3
Quarries/Strip Mines/Gravel Pits	0	0.0	0	0.0	0	0.0
Row Crops	0	0.0	0	0.0	2	0.4
Transitional	1	0.1	0	0.0	0	0.0
Woody Wetlands	0	0.0	0	0.0	0	0.0
Total	**1,793**	**99.9** [a]	**681**	**100.1**	**681**	**100.0**

a. A spreadsheet was used for this calculation and values are approximate due to rounding.

APPENDIX D

Estimate of Existing Point Source Loads for NPDES Permitted Mining Sites and Ready Mixed Concrete Facilities

Determination of Existing Point Source Sediment Loads

The existing point source sediment loads for mining sites and RMCFs located in impaired HUC-12 subwatersheds were estimated using the methodologies described below.

Mining Sites

Existing loads for permitted mining sites are based on an assumed runoff from the site drainage area, the daily maximum permit limit for TSS, and the area of the HUC-12 subwatershed in which the mining site is located (ref.: Table D-1). Site runoff was estimated by assuming that one half of the annual precipitation falling on the site area results in runoff. Annual precipitation for the Hiwassee River Watershed is approximately 48 in/yr.

$$AAL_{Mining} = \frac{(A_d)\ (DMax)\ (Precipitation)\ (0.2266\ lb\text{-}l/ac\text{-}in\text{-}mg)\ (0.5)}{(A_{HUC\text{-}12})}$$

where: AAL_{Mining} = Average annual load [lb/yr]
A_d = Facility (site) drainage area [acres]
DMax = Daily maximum concentration limit for TSS [mg/l]
Precipitation = Average annual precipitation for watershed [in/yr]
A_{HUC-12} = Area of impaired HUC-12 subwatershed [acres]

Table D-1 Estimate of Existing Load – NPDES Permitted Mining Sites

HUC-12 Subwatershed (06010103___)	Subwatershed Area	Precipitation [a]	NPDES Permit No.	Site Drainage Area	Daily Maximum TSS Limit	Annual Average Load
	[acres]	[in/yr]		[acres]	[mg/l]	[lb/ac/yr]
0401	38,188	48	TN0071676	114	40	0.649
			TN0065790	17	40	0.097
0402	28,424	48	TN0071048	33	40	0.253
			TN0071056	14	40	0.107

a. *Livestock Waste Facilities Handbook*, 2nd Edition, 1985, Figure 11-12b

Ready Mixed Concrete Facilities (RMCFs)

Total loading from RMCFs is the sum of loading from process wastewater discharges and storm water runoff. Estimates of loading (ref.: Table D-2) from the RMCFs located in impaired subwatersheds were determined as follows.

The existing loading from process wastewater discharge for RMCFs is based on facility design flow, the monthly average permit limit for TSS, and the area of the HUC-12 subwatershed in which the facility is located. Loads are expressed as average annual loads per unit area and are summarized in Table D-2.

$$AAL_{RMCF} = \frac{(Q_d) \text{ x } (\text{MAvg}) \; (8.34 \text{ lb-l/gal-mg}) \; (365 \text{ days/yr})}{(A_{HUC\text{-}12})}$$

where: AAL_{RMCF} = Average annual load [lb/ac/yr]
Q_d = Facility design flow [MGD]
MAvg = Monthly average concentration limit for TSS [mg/l]
$A_{HUC\text{-}12}$ = Area of impaired HUC-12 subwatershed [acres]

The existing loading from storm water runoff for RMCFs is based on an assumed runoff from the site drainage area, the daily maximum permit limit for TSS, and the area of the HUC-12 subwatershed in which the facility is located (ref.: Table D-2). Site runoff was estimated by assuming that one half of the annual precipitation falling on the site area results in runoff. Annual precipitation for the Hiwassee River Watershed is approximately 48 in/yr.

$$AAL_{Mining} = \frac{(A_d) \; (\text{DMax}) \; (\text{Precipitation}) \; (0.2266 \text{ lb-l/ac-in-mg}) \; (0.5)}{(A_{HUC\text{-}12})}$$

where: AAL = Average annual load [lb/yr]
A_d = Facility (site) drainage area [acres]
DMax = Daily maximum concentration limit for TSS [mg/l]
Precipitation = Average annual precipitation for watershed [in/yr]
$A_{HUC\text{-}12}$ = Area of impaired HUC-12 subwatershed [acres]

Total Existing Point Source Loads for Impaired HUC-12 Subwatersheds

Estimated point source loads were summed for each impaired HUC-12 subwatershed and then compared to both existing and target subwatershed sediment loads (ref.: Table D-3).

Table D-2 Estimate of Existing Loads – Ready Mixed Concrete Facilities

HUC-12 Subwatershed (06020002__)	Subwatershed Area	NPDES Permit No.	Process Wastewater			Storm Water Runoff			Total Annual Average Load
			Estimated Flow	Daily Maximum TSS Limit	Annual Average Load	Site Drainage Area	TSS Cut-off Concentration	Annual Average Load	
			[MGD]	[mg/l]	[lb/ac/yr]	[acres]	[mg/l]	[lb/ac/yr]	[lb/ac/yr]
0601	33,747	TNG110039	0.0001	50	0.0005	4.4	200	0.1418	0.142
0602	14,826	TNG110262	0.0001	50	0.0010	18	200	1.3205	1.322
0702	31,357	TNG110047	0.0001	50	0.0005	3.1	200	0.1075	0.108
		TNG110280	0.0001	50	0.0005	5.3	200	0.1838	0.184
0902	29,630	TNG110231	0.0001	50	0.0005	18	200	0.6608	0.661

Table D-3 Estimate of Existing Point Source Loads in Impaired HUC-12 Subwatersheds

HUC-12 Subwatershed (06020002__)	NPDES Permit No.	Facility Type	Average Annual Point Source Load	Existing Subwatershed Load	Point Source Percentage of Existing Load	Subwatershed Target Load	Point Source Percentage of Target Load
			[lb/ac/yr]	[lb/ac/yr]	[%]	[lb/ac/yr]	[%]
0401	TN0005487	Mining	0.649	382	**0.20**	120.8	**0.62**
	TN0023957	Mining	0.097				
	Subwatershed 0401 Total		**0.746**				
0402	TN0063835	Mining	0.253	712	**0.05**	399.8	**0.09**
	TN0065901	Mining	0.107				
	Subwatershed 0402 Total		**0.360**				
0601	TNG110039	RMCF	**0.142**	819	**0.02**	399.8	**0.04**
0602	TNG110262	RMCF	**1.322**	1,079	**0.12**	399.8	**0.33**
0702	TNG110047	RMCF	0.108	688	**0.04**	399.8	**0.07**
	TNG110280	RMCF	0.184				
	Subwatershed 0702 Total		**0.292**				
0902	TNG110231	RMCF	**0.661**	662	**0.10**	330.1	**0.20**